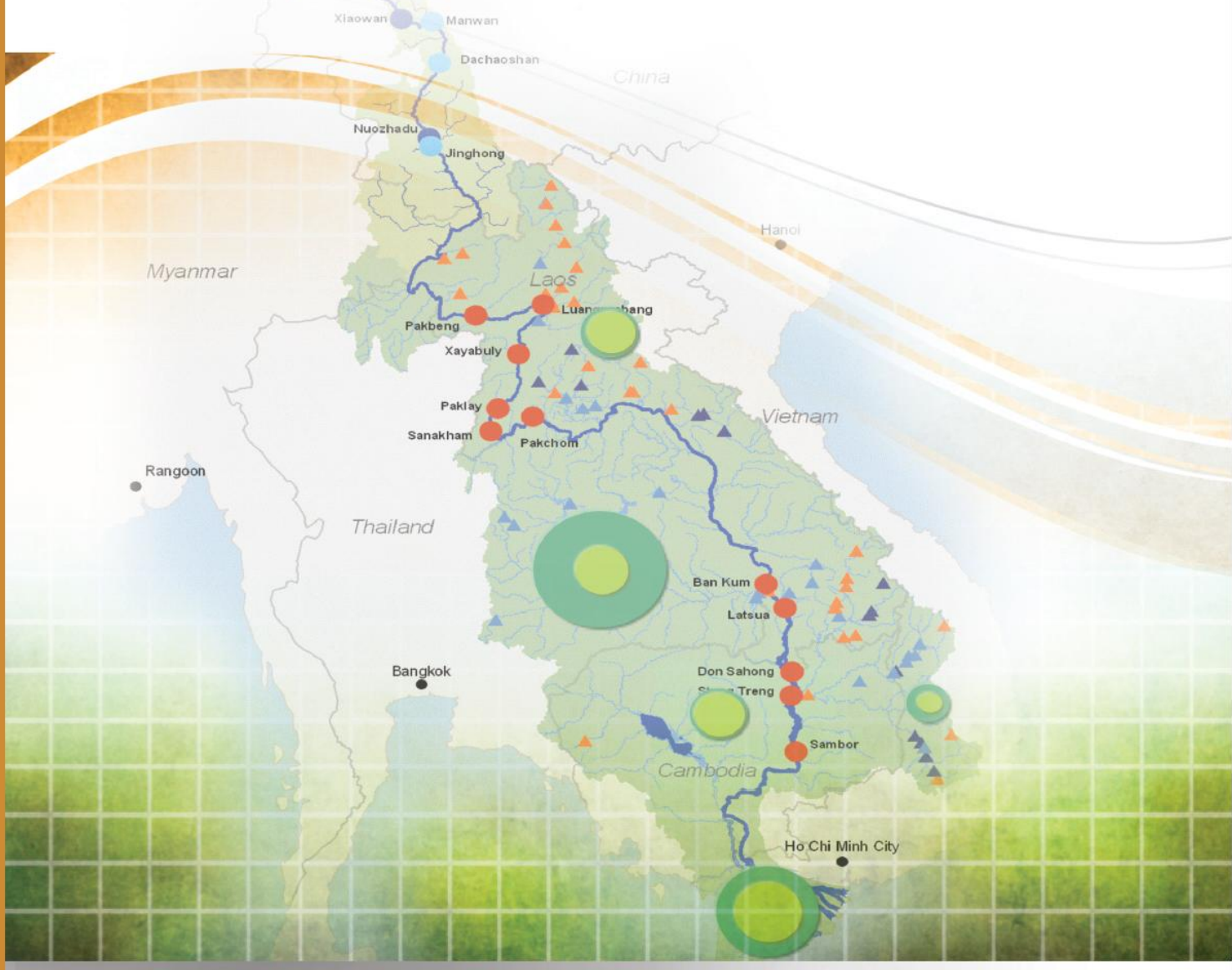
Basin Development Plan Programme Phase 2

Assessment of Basin-wide Development Scenarios

Main Report April 2011



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For sustainable development

Mekong River Commission

Basin Development Plan Programme, Phase 2

Assessment of Basin-wide Development Scenarios

Main Report

April 2011

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Assessment of Basin-wide Development Scenarios

Supporting Technical Notes

This report has been prepared drawing upon a series of technical notes prepared by a multi-discipline expert team to support and guide the assessment process and to facilitate informed discussion amongst stakeholders. These notes are made available in Volumes 2 to 6 as summarised below.

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Volume 1	Main Report	Assessment of Basin-wide Development Scenarios
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	Technical Note 4	Impacts on River Morphology
	Technical Note 5	Impacts on Water Quality
Volume 4 Power Benefits and Agricultural Impacts	Technical Note 6	Power Benefits
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The Basin Development Programme team was assisted and supported in preparing this report by a team of individually recruited consultants as given overleaf.

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Glossary

ADB	Asian Development Bank
AIFP	Agriculture, Irrigation and Forestry Programme
BCM	Billion cubic metres
BDP	Basin development programme
BDP1	BDP Phase 1
BDP2	BDP Phase 2
BS	Baseline scenario
CMD	Cambodian mainstream dams
DF	Definite future
DFS	Definite future scenario
DSF	Decision support framework
DOS	Development opportunity space
EGAT	Electricity Generating Authority of Thailand
EP	Environment Programme
GIS	Geographic information system
GW	Unit of power, gigawatt, 1000MW
FFS	Foreseeable future scenario
FMMP	Flood management and mitigation programme
FMMP-C2	Component 2 of FMMP
FP	Fisheries Programme
ha	Metric unit: hectare, 10,000m^2
HH	Household
HP	Hydropower Programme
IBFM	Integrated basin flow management
IQQM	Discharge modelling software
ISIS	Proprietary river modelling software
IKMP	Information and knowledge management programme
IWRM	Integrated water resources management
km	Metric unit: kilometre, 1,000m
LFS	Long-term future scenarios
LMB	Lower Mekong Basin
LMD	Mainstream dams in LMB
LTD	Long term development scenario
M	Million
MD	Mainstream dams
Mha	Million hectares
MRC	Mekong River Commission
MRCS	Mekong River Commission Secretariat
MW	Unit of power, megawatt
MWhr	Unit of energy, megawatt-hour
NMC	National Mekong Committee
NP	Navigation Programme
NPV	Net present value
OAA	Other aquatic animals
PIN	Project Identification Note
PDS	Project Description Sheet
PNPCA	Procedures for Notification, Prior Consultation and Agreement
PWUM	Procedures for Water Use Monitoring
RTWG	Regional technical working group
3S	Three “S” basin, comprising Sekong, Sesan and Sre Pok Rivers
SWAT	Open source hydrological modelling software
TMD	Thai mainstream dams
Tonne	Metric unit: 1000kg
ToR	Terms of reference
UMB	Upper Mekong basin
UMD	Upper mainstream dam scenario
US$	United States dollar
VHD	Very high development scenario
w/o	Without
WB	World Bank
WUP	Water utilisation programme
WUP-A	WUP component for DSF development
yr	Year

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Executive summary

Background

A fundamental objective of the 1995 Mekong Agreement is cooperation among LMB countries to achieve *'the full potential of sustainable benefits to all riparian countries and the prevention of wasteful use of Mekong River Basin waters'*. Basin planning is central to the Mekong Agreement as it requires the four countries in the Lower Mekong Basin to *'cooperate in the formulation of a basin development plan'*.

The second phase of MRC's Basin Development Plan Programme (2007-2010) supports the four countries in the Lower Mekong Basin (LMB) in the participatory development of a rolling Integrated Water Resources Management (IWRM) based Basin Development Plan (BDP) that comprises basin-wide development scenarios, an IWRM-based basin development strategy, and a project portfolio.

The first Basin Development Plan is being developed during a time of significant change, where rapid, large-scale development of the river is already taking place, and hydropower dams constructed on the Lancang in the Upper Mekong Basin and on tributaries in the LMB are changing the Mekong's flow regime. There has been increasing demand from both riparian countries and project developers for the provision of an integrated basin perspective on national water resources development plans and the extent of acceptability of their cumulative impacts. These cumulative impacts are studied through the assessment of basin-wide development scenarios.

The assessments were undertaken while recognizing the risk of some incomplete data and knowledge; however, accelerated developments have demanded early information on transboundary impacts. During the process, the highest priority areas where greater understanding is needed have been identified. These knowledge gaps will be addressed during the implementation of the Basin Development Plan (2011-2015). The updated knowledge of the basin will then be used to review and update the Plan in 2015, including the scenarios.

Scenario assessment

Each scenario was formulated to represent different combinations of nationally planned sector development, with a focus on water supply, irrigation, hydropower, and flood protection. These are the sectors identified by the LMB countries as most important for further water resources development, as well as having the greatest risk of transboundary environment and social impacts. The LMB countries agreed to assess the scenarios against 42 economic, environment and social criteria that provide a picture of how well each scenario meets the socio-economic development and environment protection objectives of each country as well as the basin's shared goals. In addition, a basin wide 'equity' criterion is included that measures the degree of 'equitable development' between each country that each scenario produces.

The scope of the scenario assessment embraces environmental, social and economic cumulative impacts ('triple bottom line') at a level that future directions for development can be determined jointly. Hydrological changes caused by each scenario have been assessed with MRC's suite of simulation models, taking into account the developments and plans in the Upper Mekong Basin. Based on the hydrological changes and physical impact caused by each scenario, a multi-disciplinary expert group had conducted an integrated assessment with the set of agreed criteria. The scenarios selected by LMB countries fall into four main categories:

- **Baseline Situation** – establishing the reference hydrological, economic, environmental and social conditions, against which future developments can be compared. This has been agreed as the hydrological situation of 1985-2000 and the socio-economic situation of the years 2008-2009.
- **Definite Future Situation** (DFS) – assessing the cumulative impacts of developments that are going to occur by 2015 (i.e. those built since 2000, under construction, or already firmly committed), including the new dams on the Lancang and 26 significant tributary reservoir developments in the LMB.
- **Foreseeable Future Situation** (FFS) – assessing the impacts of LMB countries' water resources development plans up to 2030, including irrigation expansion (1.6M hectares), water supply demands, the 11 proposed mainstream dams and additional 30 tributary dams. The scenarios investigate the transboundary impacts of these proposed

developments, with and without various combinations of mainstream dams ("20-year plan scenarios"). The "Mekong Delta Flood Management Scenario" investigates the impact of various flood management interventions within the Cambodian – Viet Nam floodplain.

- **Long-term Future Situation** (LFS) – looking at two possible levels of development for the longer term (next 50 years) and how these may impact upon near-term decisions.

The scenarios for both the FFS and LFS are assessed with and without the potential modifying influence of climate change.

Main assessment findings

Definite Future Situation (DFS)

Inter-annual variability of dry and wet season flows is a natural characteristic of the Mekong river. Water resources development is already a modifying factor and has been a reality in the basin for some time, for example with the development of the multi-purpose Nam Ngum project in the 1970s. The large storage dams on the Lancang and the existing or committed new LMB tributary dams, operated primarily for power generation in response to fluctuating demand, will alter mainstream river flows substantially along its length by reducing wet- and increasing dry-season flows. The changes from the Baseline Situation are most marked upstream of Vientiane.

A major finding is that the projected redistribution of seasonal flows will provide sufficient dry season volumes of water to meet all planned consumptive water demands of the LMB countries as evaluated in the FFS without contravening the Baseline Situation. Economic benefits from the DFS are expected from hydropower development, reduction of flood damage, less salinity intrusion, and increased reservoir fisheries. Employment opportunities (370,000) will be generated, primarily in the hydropower and fisheries sectors.

However, the inevitable and irreversible flow changes will have substantial impacts compared with the Baseline Situation. These include a reduction of wetlands, reduced flow reversal into Tonle Sap and reductions in sediment flows causing long-term irreversible river bed incision and bank erosion, with consequent impacts on delta-shaping processes. Reduced sedimentation will happen within a decade, with consequences for reduction of valuable wetland and agricultural productivity, and for the discharge of sediments and associated nutrients to coastal waters, which may affect marine fishery production. Capture fisheries will reduce by 7%, two environmental hotspots will be highly impacted, and the livelihoods of almost a million vulnerable people will be at risk to varying degrees.

Foreseeable Future Situation (FFS) focusing on irrigation and tributary hydropower - no LMB mainstream dams

The planned water resources developments under the FFS add relatively small changes in the flow regime that will be experienced under the DFS. Increased dry season releases will more than offset the large increase in irrigation and other consumptive water demands. For example, the dry season flows at Kratie under the FFS will be on average 28% higher than the Baseline conditions, but only a 6% increase over the DFS. The dry season flows at Tan Chau in March will be typically 33% higher than the Baseline condition and 9% higher than in the DFS.

The economic opportunities in this FSS would be large (with an additional Net Present Value of US$ 8 billion compared to the DFS). An additional 650,000 jobs would be created in all LMB countries, mainly from hydropower, irrigation, and fisheries. Irrigation expansion also provides opportunities for significant benefit from rice-field fisheries.

The incremental increase in impacts come principally from the additional 30 tributary dams in Lao PDR and Cambodia, reducing the flood season flows, in addition to their direct construction and barrier impacts. They also increase the amount of sediment trapping, heightening the uncertainties associated with wetland productivity and the stability of delta shaping processes. The impacts include a further reduction of capture fisheries from 7% in the DFS to 10% in this FFS, an increase of highly impacted environmental hotspots from two to five, and an increase by 400,000 to 1,400,000 of people exposed to some degree of livelihood risks.

Foreseeable Future Situation (FFS) with irrigation and tributary hydropower and up to eleven new LMB mainstream dams

This scenario is incremental to the previous one and creates the potential for both very high economic benefits but also much higher environmental and social impacts. Other than localized flow and changes relating to hydropower

operations, the incremental transboundary flow changes over the previous FFS will be insignificant as the 11 proposed projects are effectively run-of-the-river with no carry over storage from season to season. The following outline of the assessment results has also benefited from the Strategic Environmental Assessment of Mainstream Hydropower Dams (SEA).

Benefits are very substantial: the proposed 11 mainstream dams together would generate an extra US$ 15 billion NPV, 2.5 times the combined benefits of the 30 additional tributary dams included in the FFS. About 400,000 new employment opportunities would be created during the construction and operation phases of the mainstream dams. Furthermore, the 11 LMB mainstream dams would have the potential to reduce the greenhouse gas emissions of the regional power sector by about 50 million tonnes CO2/year by 2030.

But the impacts of the proposed 11 mainstream dams could be very severe: 60% of the ecologically valuable river channel between Kratie and Houei Xai lost to a series of connected impoundments; important habitats (e.g. deep pools, rapids and sandbars), resulting in lost biodiversity; nine environmental hotspots highly impacted, mostly in Cambodia (Tonle Sap, 3S-basin and the mainstream); 2 out of 4 flagship species at severe risk of extinction (Giant Catfish and Irrawaddy Dolphin); and a near-total barrier to fish migration along most of the mainstream unless new, and as yet untested, fish passage facilities are provided. This barrier effect will further reduce capture fisheries in the basin by 15%, bringing the overall decline of capture fisheries in the basin to 25% compared to the Baseline condition. As a result of the eleven mainstream dams, livelihoods put at risk would rise by nearly three times compared to the 20-year plan without mainstream dams (and nearly five times that under the DFS), bringing the total under this scenario to 4,360,000. Depending on their design and sediment management operations, the mainstream dams could heighten the impact on sediment and nutrient transport in the basin.

The impacts increase with both the increased number, and also with the location of the dams, with clearly more severe impacts resulting from dams proposed in Cambodia and southern Lao PDR, and less severe impacts for those located above Vientiane. The six mainstream dams in Lao PDR upstream of Vientiane would have incremental environmental impacts arising from the increased pondage and backwater and barrier effects in this part of the mainstream. Two environmental hotspots in Lao PDR will be severely impacted and crucially the Giant Catfish could become extinct along with other species locally. However, the scenario assessments and the SEA show that, given their location at the farther end of the basin's main migratory routes, these dams will have a relatively small transboundary effect on capture fisheries, reducing basin-wide productivity by a further 2-3% typically.

Foreseeable Future Situation (FFS) with flood protection measures in the Mekong Delta

The planned flood risk reduction measures in the Mekong Delta would have marginal positive and negative transboundary impacts. The planned measures result in lower risk in both countries with the exception of Long Xuyen Quadrangle (LXQ) in Viet Nam, which apart from the main Mekong and Bassac rivers, is more or less the only flood passage way to the sea. Projects are already underway to mitigate the increased risks by the widening of existing canals in the LXQ rather than constructing new large canals elsewhere.

Long-term Future Situation (LFS)

The LFS provides valuable insights up to 2050 on the impacts of expanded water resources development. There is sufficient storage potential in the LMB's tributaries to meet high-case increases in consumptive water uses, without reducing the baseline dry season flow. However, the assessment also highlighted the major impacts these developments would have on the eco-systems and social fabric of the basin, and underscore the need to proceed prudently and at a pace that allows knowledge to stay ahead of major infrastructure developments.

The assessments show that severe transboundary impacts will occur if significant areas of the presently flooded areas in the lower basin are given year-round flood protection. This will present major challenges in managing increased flooding and saline water intrusion, as well as further land development within the Cambodian and Viet Nam Delta, including the Tonle Sap floodplains. Whilst these issues are beyond the scope of the present planning period, a long-term scoping study needs to commence of the long term flood management options for the Mekong Delta to better inform subsequent basin planning processes.

Climate Change

The assessments of climate change point clearly towards more variable conditions within the basin and increasing runoff in the longer term. In the FFS, climate change could further increase the already high year-to-year variability of wet and dry season flows, as well as the frequency and intensity of floods and droughts, reversing the reduction of flooding (and wetlands) caused by current developments in the DFS. In the longer term, the increased average flood season flows could be offset by the increased tributary storage envisioned in the FFS and LFS.

The impacts of climate change on eco-systems and agricultural practices, as well as the identification of practical measures to combat droughts and extreme flooding, deserve careful study. The major significance of climate change is sea level rise. Combined with the likelihood of increased flooding, uncertainties of geomorphological impacts on the delta, and acknowledging the development pressures in both Cambodia and Viet Nam, the threat of sea level rise requires extensive study before a strategy for the Mekong Delta can be framed.

Distribution of benefits and risks

The DFS is for a considerable part 'shaped' by the flow changes caused by the hydropower developments in the Upper Mekong Basin. All four LMB countries are both benefitting and impacted by the DFS. In the FFS, excluding the proposed LMB mainstream dams, all countries will benefit economically, but Lao PDR, being the largest investor, would benefit most. The incremental impacts compared to the DFS are mainly associated with the additional 30 tributary dams in Lao PDR and Cambodia, and these impacts are mostly felt in these countries. The incremental transboundary impacts of the FFS without LMB mainstream dams are small compared to the transboundary impacts caused by the DFS.

In the FFS including all 11 LMB mainstream hydropower dams, Lao PDR would gain two-thirds of the economic benefits, while Thailand and Viet Nam benefit from hydro-electricity sharing. Cambodia's economic benefits would be low compared to its investments, due to adverse impacts on their capture fisheries and a less attractive mainstream hydropower project. Also the incremental impacts compared to the DFS are distributed unevenly. Cambodia and Viet Nam would be hardest hit by the risks from the proposed mainstream dams in Cambodia and southern Lao PDR. The uneven distribution of both benefits and risks across the four countries highlights the need for transboundary cooperation to reach mutually acceptable decisions.

Limitations of the assessment process

The assessment process as described above has been the product of extensive dialogue and consensus building between the LMB countries. This collective effort has led for the first time to the countries coming together to put forward their individual development aspirations and examine these within an agreed framework of shared aims and concerns.

It is recognised that there are limitations to the current assessment process, which should be borne in mind when considering the outputs from the assessments. The limitations and associated risks and uncertainties are related to several aspects of the scenario formulation and assessment process, including sufficiency of available data and the assumptions made. These are highlighted below; a detailed description of the full range of limitations, risks and uncertainties is provided in this report.

The main assumptions that should be borne in mind when considering the outputs from the assessments include the following:

- The developments embodied within the scenarios are limited to primarily those plans put forward by the countries to exploit opportunities for hydropower development and irrigation of mainly rice-based farming systems. Nevertheless, through the assessment process, key issues have been identified related to other forms of development such as management of capture fisheries, environmental protection, poverty alleviation etc, which may be expected to form a key part of integrated water resources management within the basin.

- The values of impacts are based on the assessment of the changes brought about to the 2008-09 economic, social and environmental landscapes. Thus, for instance the social characteristics of vulnerable people within affected communities in 2030 will be assumed to be those of 2008-09. Clearly these landscapes will change as a result of circumstances outside the water resources sector.

- Autonomous and/or exogenous conditions are not included generally with the one exception of aquaculture (for which the growth potential has been estimated). Examples of circumstances that might change include: the productivity of wild fisheries as a consequence of fisheries management practices and the numbers of vulnerable people dependent upon the river's eco-system as a consequence of continuing socio-economic development.

Key areas where greater understanding is needed about how impacts arise and how they may be managed beneficially include:

- ***Social data***: Detailed data sets are needed to understand more fully demographic patterns and social conditions in high impact areas in particular in order to assess the dependency of communities on water and related resources and their resilience to changes in these resources. In addition, studies are needed to investigate alternative approaches to managing proactively and beneficially the impacts of water resource developments amongst those exposed vulnerable water resource users, taking into consideration external influences on socio-economic conditions and integrating with existing national programmes.

- ***Fisheries data and response to changing conditions***: More information is needed on fisheries and how the sector performs and will respond to future changes are needed. Also, investigation of alternative approaches to better integrating fisheries management into future basin development plans in a manner that creates an appropriate balance with water resources infrastructure development and sustains fisheries production at levels that meet consumer demands and minimises impacts on the rural poor.

- ***Water quality and sediments***: The MRC monitoring programmes for water quality and sediments should be reviewed in the light of the assessments in this report and, where required, intensified and related to natural and human-induced changes in the basin, such as sediment trapping by dams, flood protection, river training and sand mining.

- ***Ecosystems***: Solid baseline is needed that demonstrates how the different functional units of the ecosystems, with their different structures, composition and time frames, interact and function together, and what are the roles of flows (water, sediment and nutrients) and connectivity.

- ***Flood-related impacts upstream of Kratie***: More detailed modelling in this area would be beneficial to understanding the impacts of flow changes on the different reaches upstream of Kratie, and how mainstream dams will impact upon these.

- ***Flood plain management***: Addressing the long term challenges presented by climate change, sea level rise, economic and infrastructure development within the Cambodian and Viet Nam flood plains, including the Tonle Sap to determine a long term plan for rationalising these competing demands in a sustainable manner, and which would guide near term development choices.

- ***Climate change data***: More information on the trends and ranges of climate change and extreme events that need to be incorporated into basin planning and water-related sector plans. Further studies are needed of the implications of climate change on the basin's long-term hydrology, on agriculture and food security and on ecological conditions and bio-diversity.

The type and extent of the above limitations are not unusual in scenario or 'future looking' basin planning studies. They do not necessarily prevent decisions being taken on what is an acceptable scenario for defining how development, and resource protection, can proceed. At issue is whether the limitations are significant with respect to, firstly, the evaluation of the particular impact and, secondly, to the overall strategic decisions that may be influenced by the particular assessment. The analysis in this report shows that the assessment results can be used to discuss and determine future directions for water resources development among the LMB countries.

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Baseline maps

The following maps are provided for the reader to have an initial understanding of the Lower Mekong Basin. Further maps illustrating the set up of each scenario are provided in Appendix B.

- **Key hydrological features - baseline situation**
- **Population density - baseline situation**
- **Key environmental features - baseline situation**
- **Existing dams and hydropower – definite future situation**
- **Irrigation coverage - baseline situation**
- **BDP planning areas and sub-basins**

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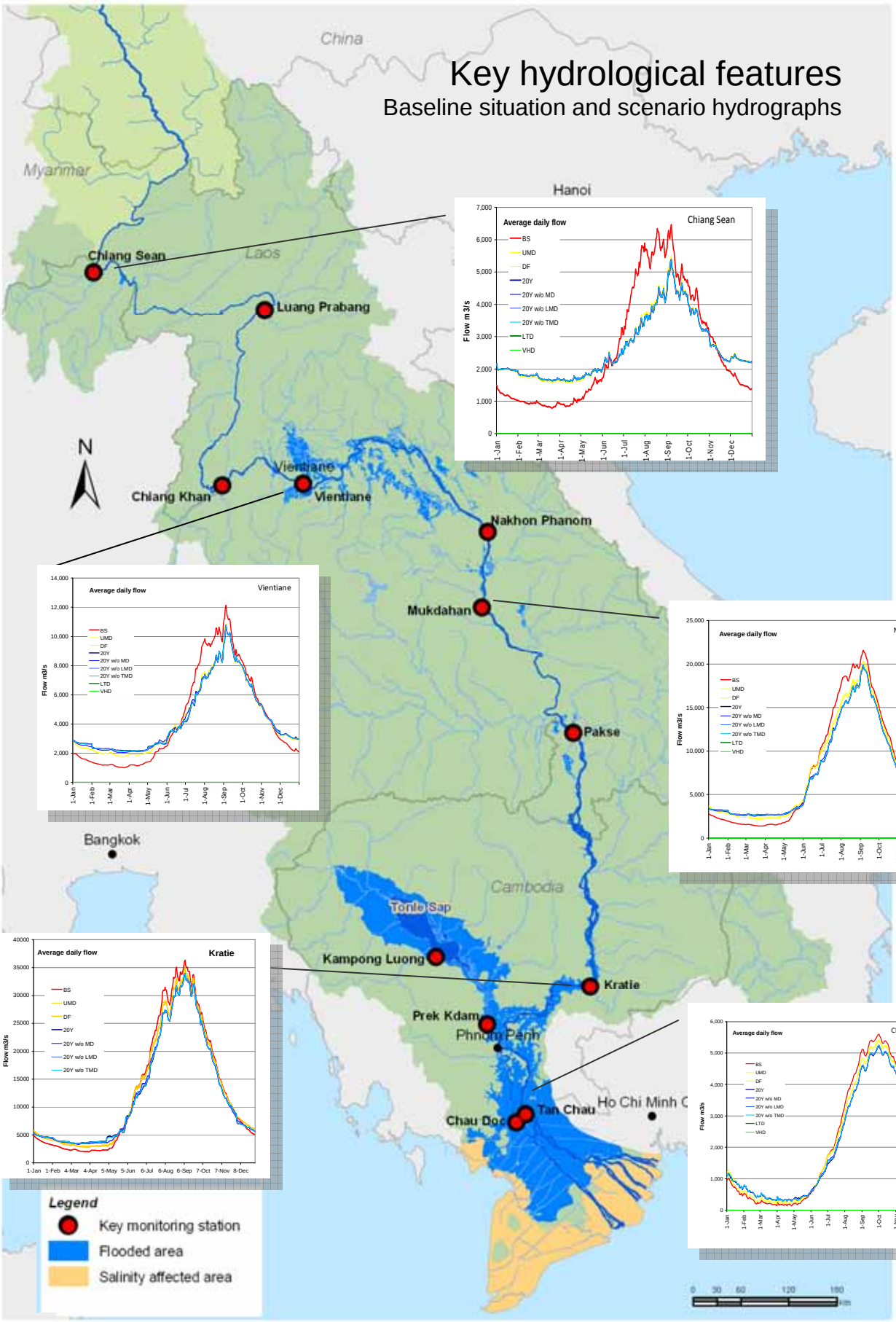
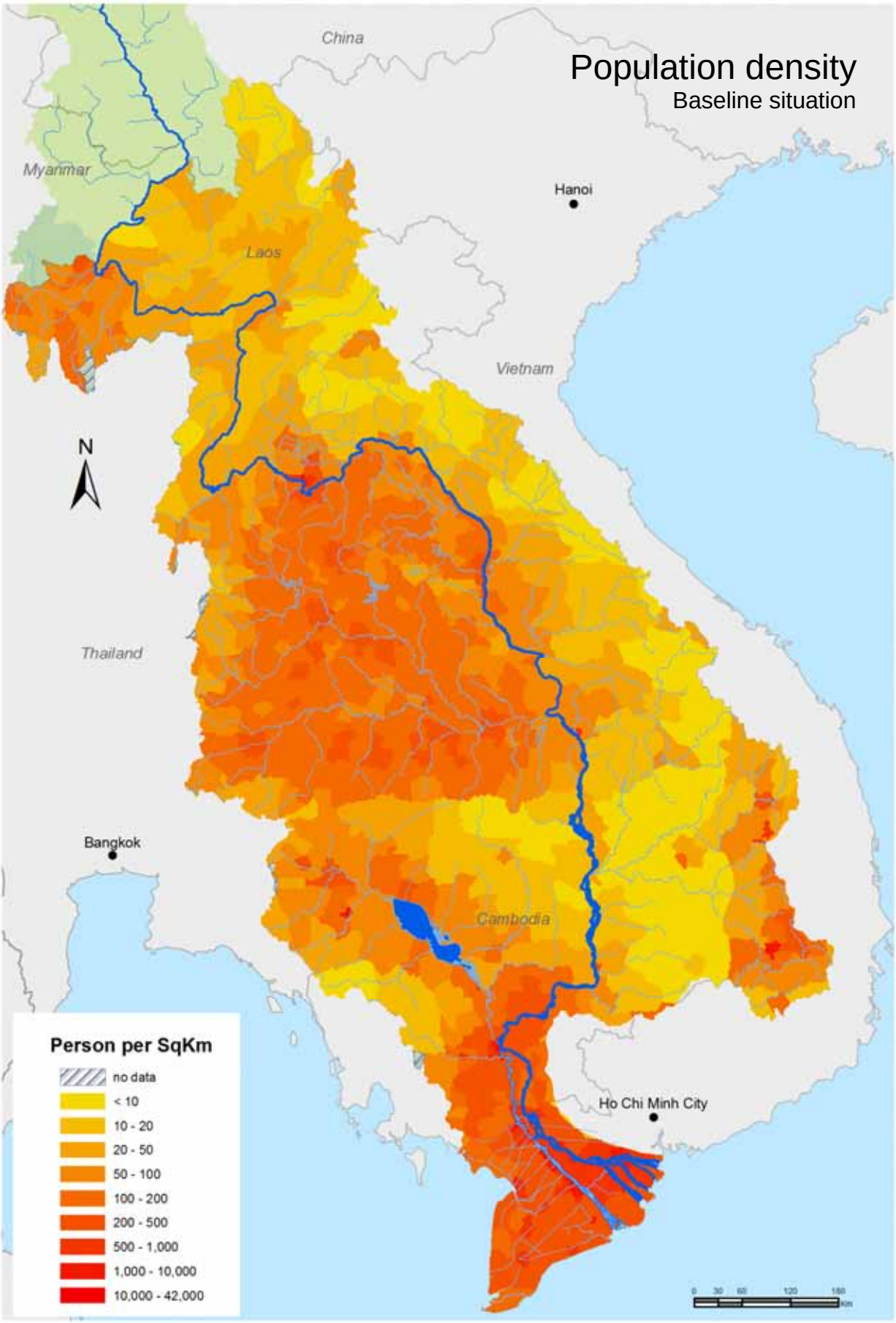
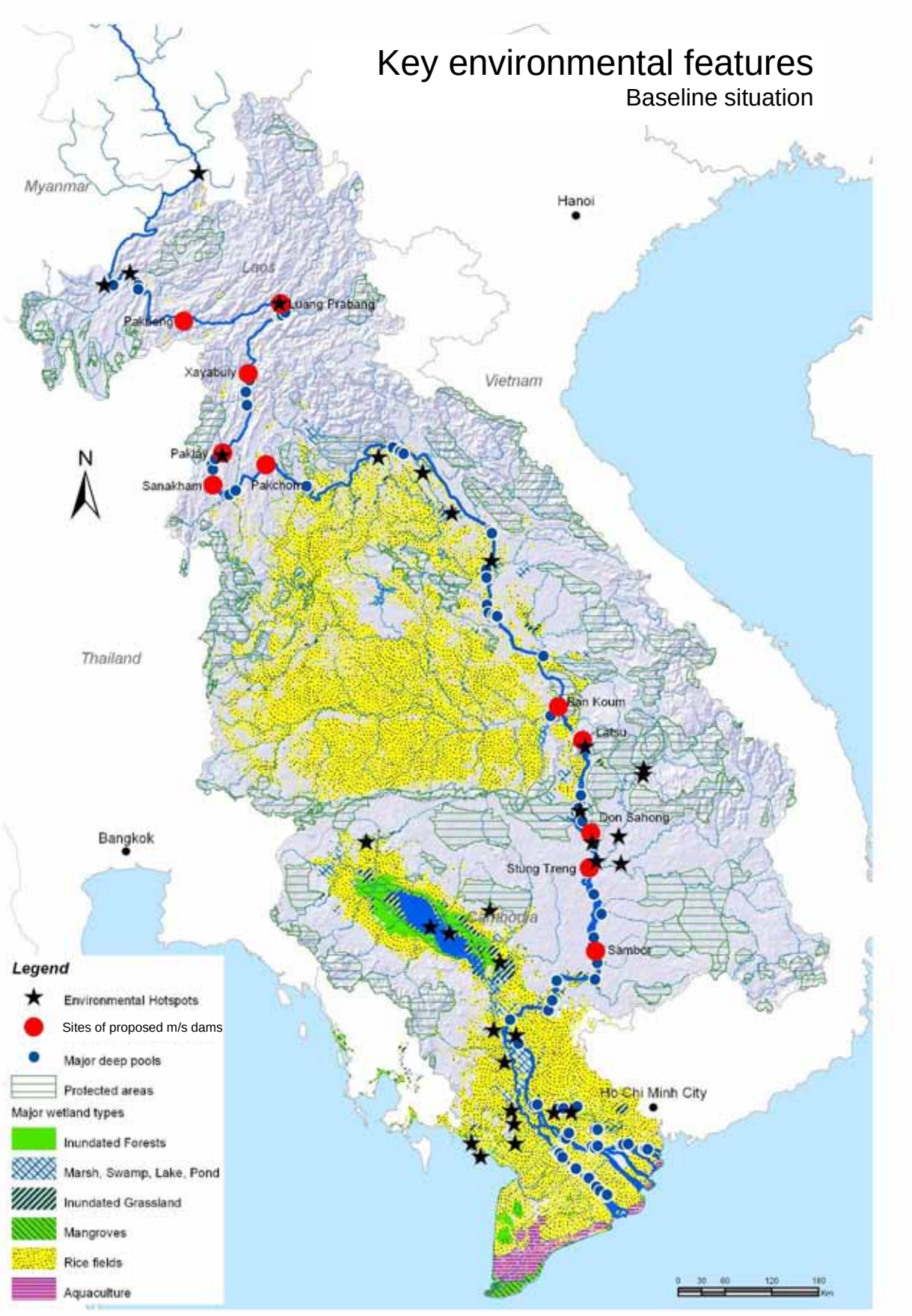
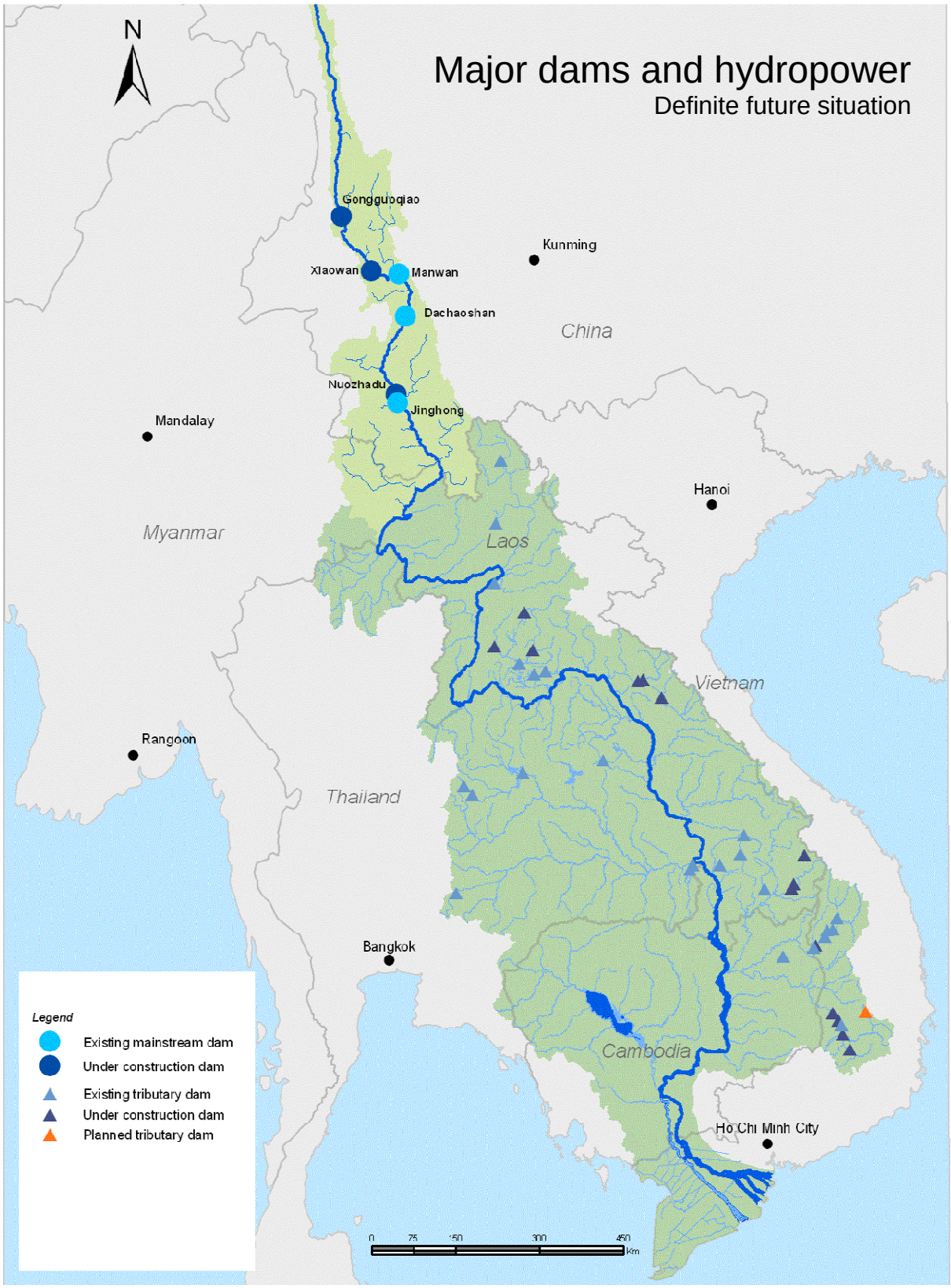
Key hydrological features

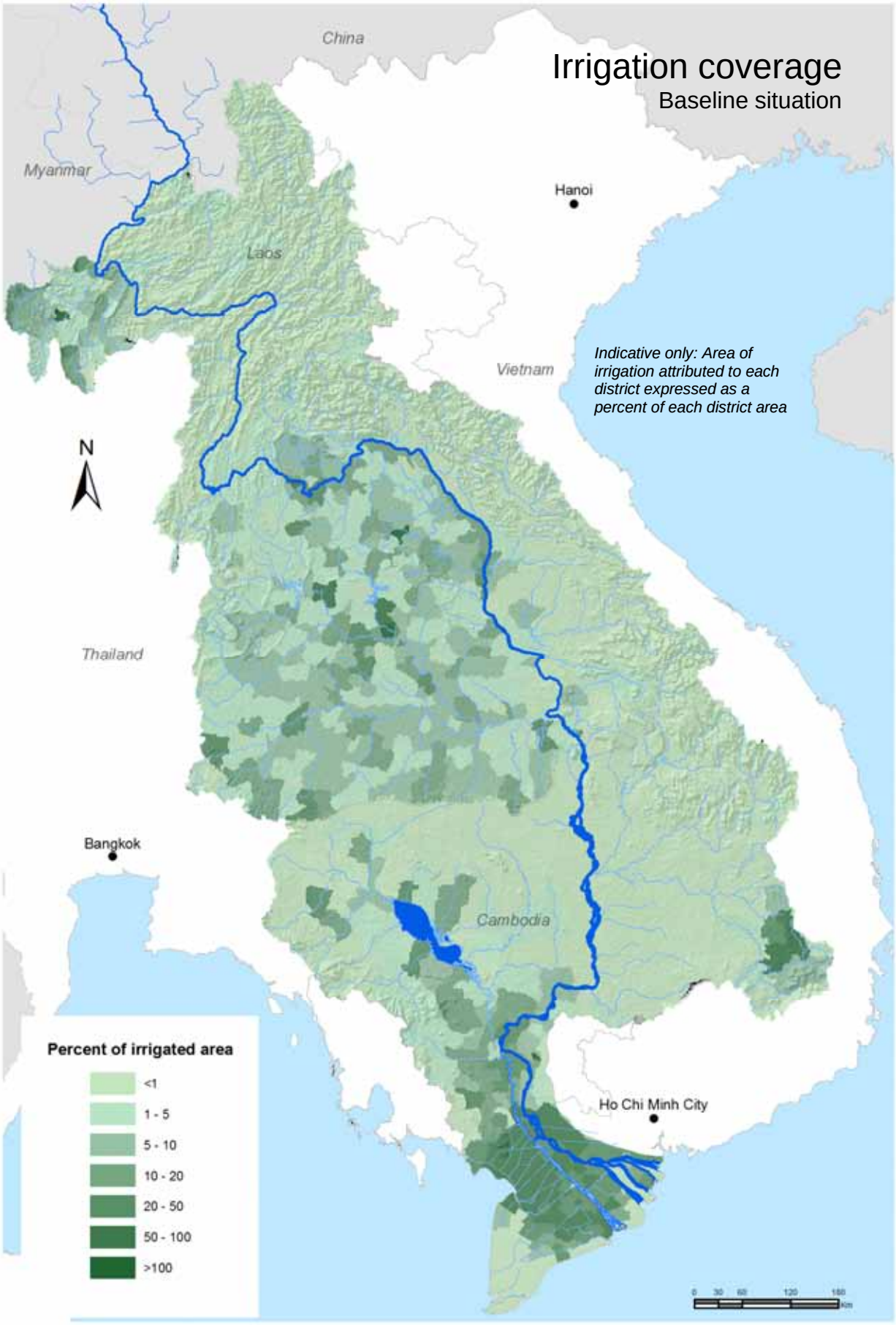
Baseline situation and scenario hydrographs

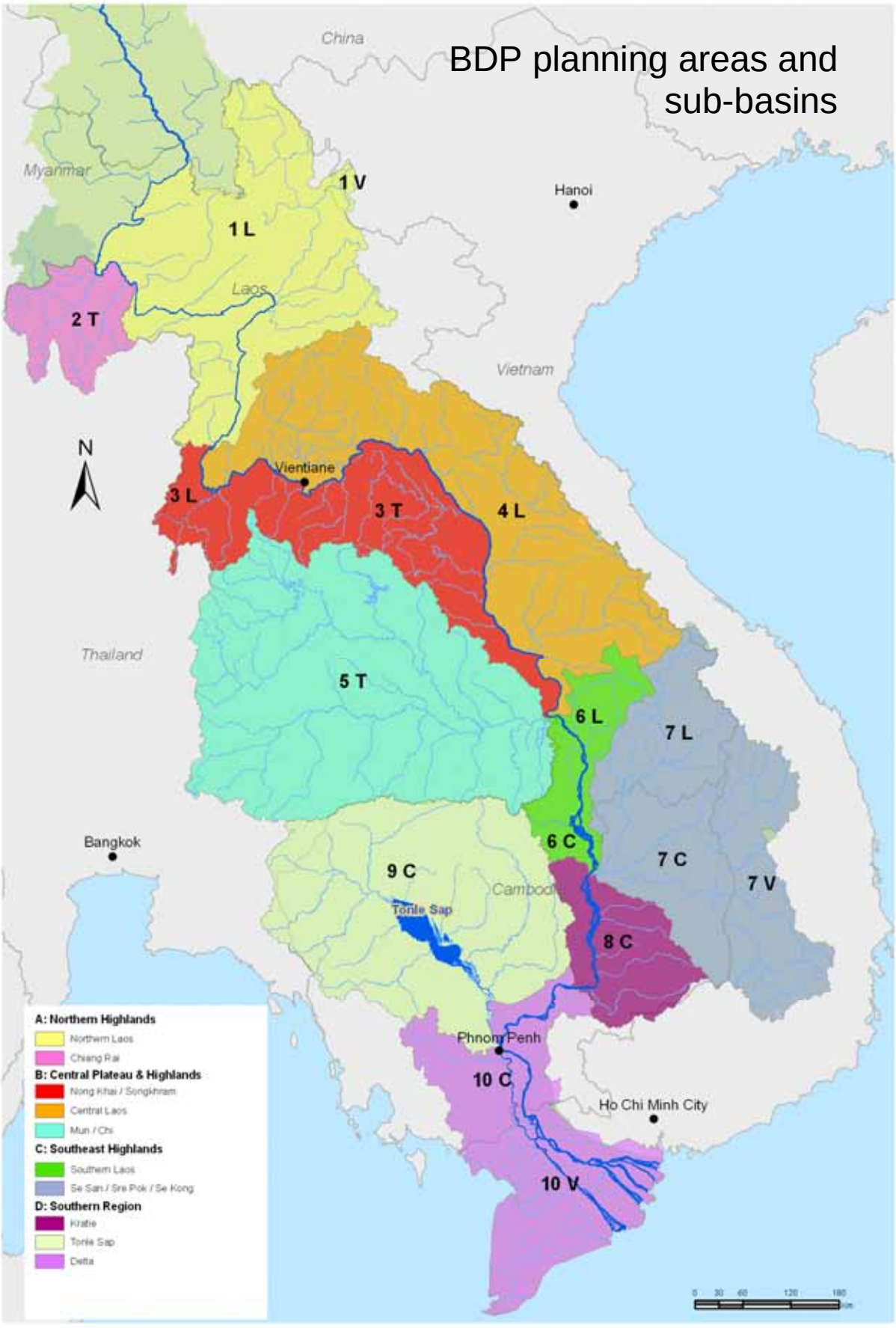



Population density
Baseline situation
China
Myanmar
Laos
Hanoi
Vietnam
N
Thailand
Bangkok
Cambodia
Ho Chi Minh City
Person per SqKm
no data
< 10
10 - 20
20 - 50
50 - 100
100 - 200
200 - 500
500 - 1,000
1,000 - 10,000
10,000 - 42,000


Key environmental features
Baseline situation
Myanmar
Laos
Vietnam
Thailand
Cambodia
Hanoi
Bangkok
Ho Chi Minh City
Luang Prabang
Pakbeng
Xayaburi
Paklay
Sanakham
Pakchom
Ban Koum
Latsu
Don Sahong
Stung Treng
Sambor
N
Legend
Environmental Hotspots
Sites of proposed m/s dams
Major deep pools
Protected areas
Major wetland types
Inundated Forests
Marsh, Swamp, Lake, Pond
Inundated Grassland
Mangroves
Rice fields
Aquaculture
0 30 60 120 180
Km


N
Major dams and hydropower
Definite future situation
Gongguoqiao
Kunming
Xiaowan
Manwan
Dachaoshan
China
Nuozhadu
Jinghong
Mandalay
Hanoi
Myanmar
Laos
Vietnam
Rangoon
Thailand
Bangkok
Cambodia
Ho Chi Minh City
Legend
Existing mainstream dam
Under construction dam
Existing tributary dam
Under construction dam
Planned tributary dam
0
75
150
300
450
km


Irrigation coverage
Baseline situation
China
Myanmar
Laos
Hanoi
Vietnam
Indicative only: Area of irrigation attributed to each district expressed as a percent of each district area
N
Thailand
Bangkok
Cambodia
Ho Chi Minh City
Percent of irrigated area
<1
1 - 5
5 - 10
10 - 20
20 - 50
50 - 100
>100


BDP planning areas and sub-basins
China
Myanmar
Laos
Vietnam
Thailand
Cambodia
Hanoi
Vientiane
Bangkok
Phnom Penh
Ho Chi Minh City
Tonle Sap
N
1 V
1 L
2 T
3 L
3 T
4 L
5 T
6 L
7 L
6 C
7 C
7 V
9 C
8 C
10 C
10 V
A: Northern Highlands
Northern Laos
Chiang Rai
B: Central Plateau & Highlands
Nong Khai / Songkhram
Central Laos
Mun / Chi
C: Southeast Highlands
Southern Laos
Se San / Sre Pok / Se Kong
D: Southern Region
Kratie
Tonle Sap
Delta

1 Introduction

1.1 Development context

A key part of the 1995 Mekong Agreement[1] is the need for the four riparian countries to cooperate in *the formulation of a basin development plan that would be used to identify, categorize and prioritize the projects and programs to seek assistance for and to implement at the basin level*.

Further, the countries have agreed to undertake this planning to achieve *the full potential of sustainable benefits to all riparian countries and the prevention of wasteful use of Mekong River Basin waters, with emphasis and preference on joint and/or basin-wide development projects and basin programs*.

This implies that basin water planning necessarily should seek to obtain a balance between water resources development and water resources protection, in a way that all the four sovereign countries agree is fair and equitable, expressed in social, economic and environmental terms.

The Mekong basin cooperation model is built on *cooperation, coordination and mutual respect*. Development of a common understanding of the transboundary issues is critical to understanding the importance of the environmental and social values and assets of the basin, and how these can be used and managed in the future development.

MRC has reaffirmed the fundamental aims of the 1995 Mekong Agreement through the MRC Strategic Plan 2006-2010 as being *an economically prosperous, socially just and environmentally sound Mekong Basin* and that this should be achieved through adopting an integrated water resources management (IWRM) approach[2]. The IWRM Strategic Directions document identifies eight major areas of IWRM that are seen as most relevant to the MRC's goals of *sustainable, optimal and equitable development*.

Priorities IWRM issues expressed in IWRM Strategic Directions (2005)

- Economic development and poverty alleviation
- Environmental protection
- Social development and equity
- Dealing with climate variability
- Information based planning and management
- Regional cooperation
- Governance
- Integration through basin planning

[1] Agreement on the Cooperation for the Sustainable Development of the Mekong River Basin, signed on 5 April 1995 at Chiang Rai, Thailand. By the Kingdom of Cambodia, the Lao People's Democratic Republic, the Kingdom of Thailand and the Socialist Republic of Viet Nam

[2] IWRM Strategic Directions, MRC 2005

1.2 Development trends and plans

1.2.1 The Mekong River Basin

The Mekong River flows for almost 4,800 km from its source in Tibet through China, Myanmar, Lao PDR, Thailand, Cambodia and Viet Nam via a Delta into the East Sea, draining a basin area of 795,000 km^2 and with a mean annual discharge of approximately 475 km^3. The per capita water resources are high relative to other international river basins. The flow from the Lancang-Upper Mekong Basin contributes 16% of the average annual flow in LMB but up to 30% of dry season flow[3]. There is a very large difference in wet and dry season flow, caused by the southwest monsoon, generating wet and dry seasons of about equal length. Inter-annual variability is large in terms of river discharges, flooded areas, and the start and end of the wet and dry seasons. The seasonal cycling of water levels at Phnom Penh causes the large water flow reversal to and from the Great Lake via the Tonle Sap, with the associated flooding and drying creating a rich ecology. The Mekong is the second most bio-diverse river in the world after the Amazon, and supports the world's largest fresh water capture fishery of about 2.3 million tons per year.

The LMB population in 2007 was estimated at 60 million, with about 90% of the population of Cambodia (13 million), 97% of the population of Lao PDR (5.9 million), 39% of the population of Thailand (23 million), and 20% of the population of Viet Nam (17 million in the Delta and 3 million in the Central Highlands) living within the basin. Population growth in the basin is 1-2% in Thailand, Viet Nam and Cambodia, and 2-3% in Lao PDR. Although urbanization is occurring in all LMB countries, about 85% of the basin's population lives in rural areas.

The livelihoods and food security of most of the rural population are closely linked to the river system, with over 60% of the economically-active population having water-related occupations that are vulnerable to water-related shocks and degradation. Millions of poor people depend on capture fisheries for food security and income. While all LMB countries are making good progress towards achieving the MDGs, about 25% of the population of Cambodia and Lao PDR has incomes below the poverty line, with much higher percentages in many rural areas. Food security and malnutrition pose great challenges. About half of all households have no safe water supply and half of all villages are inaccessible by all-weather roads. Throughout the LMB, inequalities are generally increasing between urban and rural groups.

1.2.2 Current water resources development and management

The average annual withdrawals for agricultural, industrial and other consumptive uses in the LMB are about 60 billion m^3, or 12% of the Mekong's average annual discharge. There are

[3] The dry season can be defined in many ways, but in this report the months of December to May inclusive are treated as the "dry season".

currently only minor diversions from the mainstream upstream of the Delta in Viet Nam although large-scale diversions are being considered. Existing reservoir storage of water is less than 5% of the mean annual flow, insufficient to redistribute water significantly between seasons. Groundwater use in the Basin is modest except in Northeast Thailand and Viet Nam where surface water is scarce during the dry season; sustainable groundwater development potential requires careful assessment.

Agriculture is the dominant water-related sector, particularly in Thailand and Viet Nam whereas agriculture in Cambodia and Lao PDR is currently less intensively developed. Overall, the dry-season irrigated area of about 1.2 million hectares is less than 10% of the total agricultural area in the LMB (15 million hectares). Expansion of the present levels of irrigation is limited by the availability of dry season flows. The dry season flows reaching the Viet Nam Delta are fully used for economic, environmental and social purposes, including combating seawater intrusion.

The full hydropower potential of the LMB is estimated at 30,000 megawatt with 10% developed to date. Navigation is important but largely undeveloped as an integrated transport sector. Efforts to reduce the vulnerability to major floods have primarily been by non-structural measures. Water resources have been developed on a small scale for the improvement of wetlands and aquaculture. River-related tourism is important for national revenue and local income generation.

Monitoring indicates the river's resilience to current human-induced pressures. The flow regime of the mainstream is mostly in its natural state, although tributary dams impact some mainstream locations. Water quality is generally good, except in the Delta and other areas with extensive development, where high nutrient levels are a cause for concern. The river's annual flood pulse continues to support a rich fishery, although there are reports of declining catches. However, the outlook for the basin's forests is not so positive, with increasing demand for timber and land causing deforestation and soil degradation.

Basin fauna, including 14 critically endangered species, 21 endangered species and 29 vulnerable species, are threatened by rapid developments that will alter habitats and mechanisms which are essential to sustain high ecosystem productivity.

Water resources management in the LMB is a mix of a "cooperative and coordinating model" at the basin-scale, facilitated through the MRC, and four national models, reflecting individual sovereignty, custom and administrative systems. MRC acts as a focal point for cooperation, assisting in achieving basin-scale aims through provision of shared information, technical guidance and mediation. Each country is embracing IWRM adapted to its needs, with clear statements of national water policy and strategy supported by strengthened institutional and regulatory frameworks. This identifies the agency responsible for water resources management, empowered by ongoing modernization of water resources legislation. In all LMB countries, river basin organizations/committees are being established for participatory water management at the catchment and local level.

1.2.3 Development trends and emerging issues

The region is rapidly growing and integrating into the world's economy. Fluctuating oil and gas prices, an emphasis on renewable and non-fossil fuel generation and the availability of private finance, are making hydropower increasingly attractive and accelerating its development in the LMB. Global food shortages and rising prices can make irrigation more profitable in the LMB, while irrigation development may attract foreign investments seeking intensified and diverse food production.

Climate change models for the Mekong mainstream flows predict higher flood season flows and largely unaffected dry season flows. The Delta is highly vulnerable to sea level rise. Water-related planning must adapt to global economic trends and to climate change in order to ensure sustainability.

Integration is a significant trend in the Greater Mekong Sub-region (GMS). LMB countries are all members of the Association of South East Asian Nations (ASEAN) and signatories to ASEAN agreements for economic integration and promotion of regional approaches to sector development. In the GMS cooperation framework, the countries are working together on sector approaches and priority programmes, with energy sector activities promoting regional power trade to develop the sub-region's energy potential, the facilitation of the development of grid interconnection, and private sector investment. The GMS Core Environmental Programme is improving environmental planning and management capacities for strategic environmental assessment of sector strategies and plans, promotion of pro-poor biodiversity conservation corridors, and environmental management.

China is completing its hydropower cascade on the Lancang River. The Manwan, Dachaoshan, Jinghong and Xiaowan dams are currently operational and the Nuozhadu Dam will be completed in 2014. The Xiaowan and the Nuozhadu dams, with 9,800 and 12,400 million m3 of active storage, may cause significant seasonal redistribution of flow from the wet season to the dry season and further reduce sediment transport in the Mekong mainstream, providing both opportunities and risks to downstream countries.

Economic growth across the LMB is expected to continue, supported by economic diversification, regional economic integration, and investments in infrastructure and human resource development. Lao PDR and Cambodia seek to graduate from least developed country status, while Vietnam seeks middle-income status by 2030. Increasing populations and living standards and growing economies will accelerate food and electricity demand.

In overcoming persistent rural poverty, it is essential to address the regular and devastating effects of severe droughts and floods, which claim lives and property and cause substantial economic losses. All LMB countries have poverty reduction strategies that include water supply for drinking and irrigation, flood management, hydropower generation, fisheries and other uses of Mekong water. Hydropower is projected to provide an important source of foreign exchange earnings and revenues and contribute to the reduction of the climate change impacts.

Hydropower development Lower Mekong Basin continues with 26 hydropower projects (>10 Mw) are under construction on tributaries, creating, together with the dams in China, 36 billion m^3 of additional active storage. Over the next 20 years, further LMB dams are planned, including 12 mainstream projects and 30 tributary dams, mostly in Lao PDR. All mainstream dams are classified as "run-of-river", with limited storage capacity and regulation potential. Many tributary dams include significant reservoirs, adding 21 billion m^3 of storage.

There are plans to increase dry season irrigation by 50% (from 1.2 to 1.8 million hectares) in the next 20 years, with Lao PDR planning to expand irrigation from about 100,000 to over 300,000 hectares. Major irrigation expansion is being studied in Cambodia, linked to investments in flood control in the undeveloped Cambodian Delta, and elsewhere linked to hydropower development. Mainstream water transfers have long been considered by Thailand, to complement national approaches to alleviate drought in the Northeast.

LMB countries also plan to further develop aquaculture and improve fisheries management, navigation, flood and drought management and tourism development. Aquaculture growth is forecasted to double to 4 million tons in the next 20 years. Development on this scale will bring both great opportunities and high risks. Cooperation will be needed to minimize and mitigate these risks and to share the benefits across basin population groups.

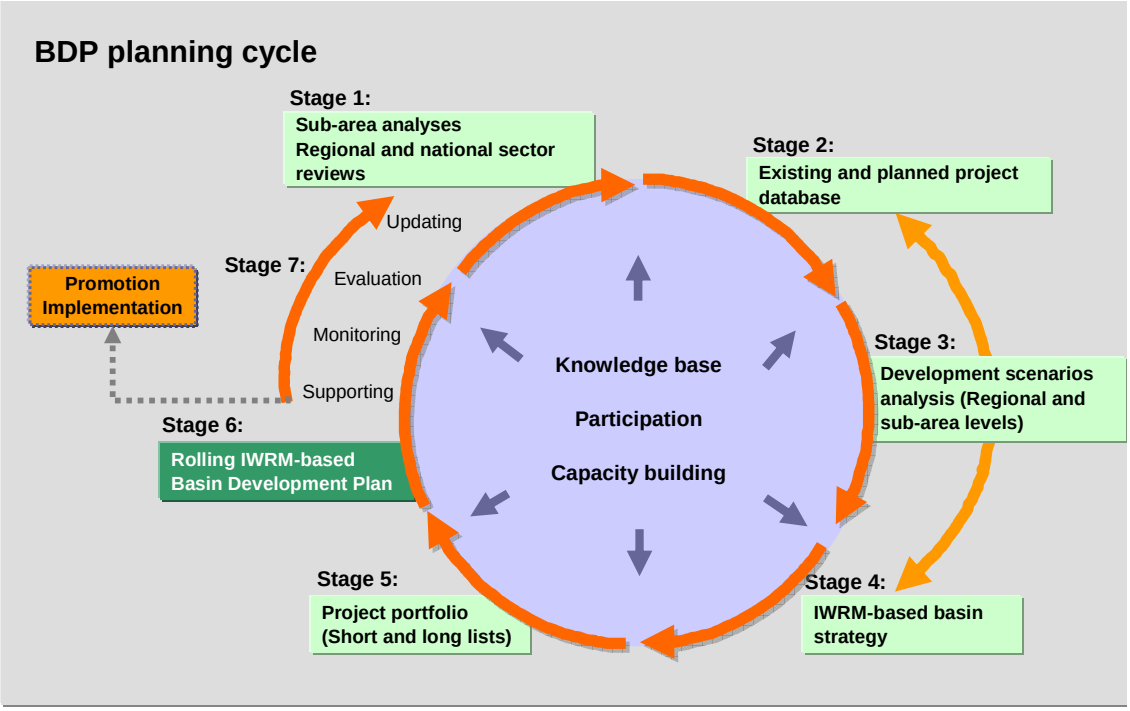
There are increasing opportunities for the private sector and foreign "state-owned companies" in the development of water and related resources, such as hydropower, navigation, large-scale irrigation, fishery and industry (mining, forestry, and tourism). In many of these areas, private sector investment now exceeds that of the public sector. In comparison to conventional public sector developments, private sector developments are more opportunity-driven, with relatively short planning cycles and assessment processes. While private sector participation is welcomed it needs to be open to public scrutiny and sensitive to civil society concerns. This will require effective regulatory systems, including enabling legislation and regulations and enforcement capacity, as well as strong and empowered water resource management agencies.

1.3 Approach to developing a basin-wide development plan

The earlier stages of the MRC's basin planning activities formulated a rolling' basin development planning process that followed seven stages as shown in Figure 1 overleaf, a process which has been has been extensively discussed during BDP1 and refined during BDP2.

The key feature of the process is the necessary inter-play between national and sub-national plans with the opportunities at basin-level that are made possible through effective transboundary cooperation. The process adopted is one that seeks to ensure integrated management of water resources across the basin. This requires recognition of the many different uses that are made of water and the identification of the best mix of uses to achieve an acceptably balanced and, as far as possible, optimal outcome in terms of social, economic and environmental impacts. The key steps in the process are:

Figure 1 BDP planning cycle



- Analysis of national and sub-national plans as affect water resources management;
- Aggregation of these plans and assessment of their impacts upon the sustainability of the available water resources, mindful of exogenous factors such as developments in the upper basin and changes in climate, social and economic conditions;
- Identification of opportunities at basin-level to add value to the plans through mutual cooperation and by adopting a fully integrated approach to water resources management; and
- Feeding back these opportunities into national and sub-national plans and fostering a common IWRM-based approach throughout the basin

Within this context, the IWRM-based Basin Development Plan has been defined as a rolling plan set within a 50-year horizon, addressing planning requirements over the next 20 years and to be updated every 5 years reflecting actual development progress, changing social, economic and environmental circumstances and evolving national priorities. The Plan comprises three main components, viz.:

- **Basin-wide Development Scenarios**, which will facilitate Governments and other stakeholders in developing a common understanding of the most acceptable balance between resource development and resource protection in the various parts of the LMB. Each considered scenario represents a specific balance between economic, social and

environmental objectives. The results of the economic, environmental and social assessment of the considered scenarios will guide the formulation of the IWRM-based Basin Development Strategy.

- **IWRM-based Basin Development Strategy**, which provides a shared vision and strategy of how the water and related resources in the LMB could be developed in a sustainable manner for economic growth and poverty reduction, and a coherent and consistent IWRM planning framework that brings basin perspectives into the national planning process, and vice versa. The results will guide the formulation of the Project Portfolio.

- **A Project Portfolio** of significant water resources development projects and supporting non-structural projects that would require either promotion or strengthened transboundary water governance, as envisioned in the 1995 Mekong Agreement.

The IWRM-based Basin Development Strategy will support national and transboundary planning, decision-making, and governance processes. It will consider various levels, or packages, of nationally-proposed water related development, resource protection and 'people' related projects and actions, and focuses on how these developments, projects and actions could proceed in a way that meets national objectives and goals, strengthens regional and national institutional and management arrangements and within agreed IWRM guidelines and concepts.

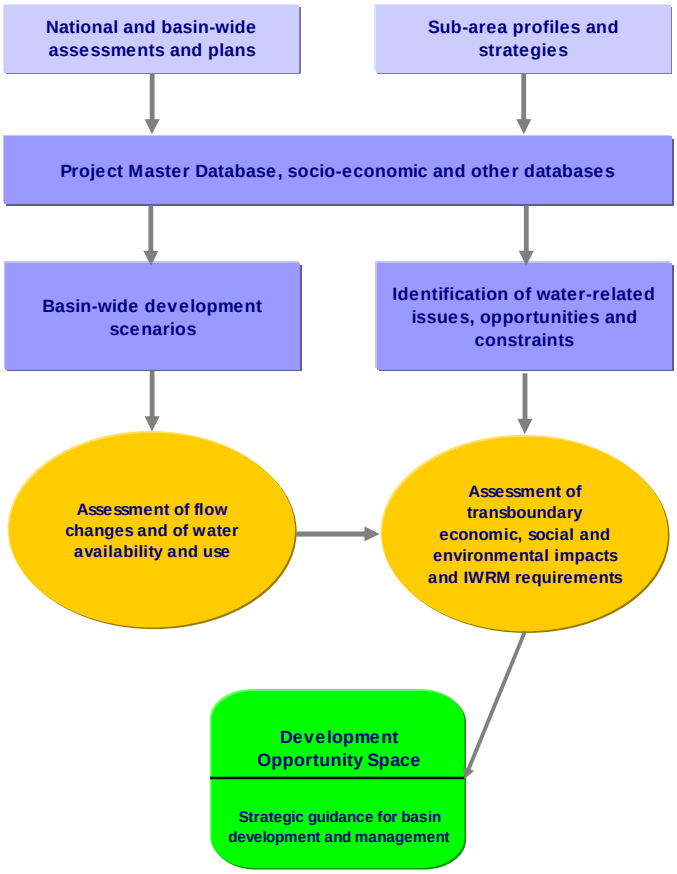
The most sensible option to determine what might be the 'acceptable future levels of development' in a way that is sustainable from a basin perspective and mutually beneficial to the LMB countries, based on a basin-wide dialogue of the results of a comprehensive assessment of basin-wide development scenarios, supplemented by other assessments, such as the Strategic Environmental Assessment (SEA) of proposed mainstream dams.

The approach is shown diagrammatically in Figure 2 overleaf. The process is driven initially by the assembly of country and sub-area plans (including aspirations), together with specific information on current and potential infrastructure developments and a wide range of information on how these may impact on environmental, social and economic conditions.

A range of expected or possible development scenarios comprising different types and level of infrastructure development are then each assessed as to how these would affect year-round flows within the main river system. The transboundary impacts are then assessed in the light of the predicted flow changes and by drawing upon the wealth of other knowledge and information available to the MRC on likely and possible impacts.

Through examining the impacts of these scenarios and by a process of judgement by each country as to what levels of impact are mutually acceptable, the process leads to identification of development opportunities that are both mutually beneficial and acceptable in terms of levels of transboundary social and environmental impacts.

Figure 2 Towards Development Opportunity Space and Strategic Guidance for its use and enhancement



In addition, the understandings reached through undertaking the assessment process lead to identification of issues where specific guidance is required relating to the development opportunities and/or where there is an apparent need to establish best practice in implementing specific types of development.

Apart from ***water resources development opportunities*** that are often primarily focused on economic growth (industrial water supply, irrigation, hydropower and flood protection), the "Development Opportunity Space" (DOS) also contains a range of ***water-related opportunities*** that would contribute significantly to improving livelihoods (fisheries, flood warning, watershed management, biodiversity conservation, safe river trade, climate change adaptation) or improves the management of water and related resources (basin resources monitoring systems, navigation systems, and policy, institutional and capacity development). Together, these two areas of the DOS represent the opportunities for coordinated basin development and management.

Table 1 overleaf shows that the DOS is an intermediate step in the filtering process that moves from considering the full range of project possibilities to eventually a portfolio of projects that both meets a shared vision among member countries and satisfies the prevailing regulatory requirements at national and regional levels. It does NOT in any way indicate endorsement of any national plan and project that are brought into the scenarios. It provides a broad picture of what level of basin development would be acceptable to the LMB countries, based on the examinination of the transboundary environmental and social impacts. For an opportunity to move to the stage of project identification and feasibility, it needs to pass through national planning and assessment processes and transboundary approval through the MRC Procedures, where applicable.

Table 1 Moving towards sustainable development of water resources

	Stages	Process	Main Supporting Tools
1	**IWRM-based assessment** of combined national water resources development plans, water-related sector plans and other possible developments	National and regional discussions to define the basin-wide scenarios and environment, social and economic assessment objectives and criteria Expert and participatory assessment process and verification of results	The comprehensive assessment of basin-wide development scenarios; SEA of proposed mainstream dams; Other basin-wide assessment.
2	**DOS**: identification of the total package of basin-wide water resources development and water-related opportunities	National and regional discussions and negotiations on acceptable levels of basin development This could include options for benefit and impact sharing that will enhance the DOS	The comprehensive assessment of basin-wide development scenarios; Strategic Priorities; Studies of strategic importance.
3	**Identification** of water resources development and water-related projects, using the DOS	Project identification, also considering alternative options within and outside the water sector; Notification and incorporation in Project Master Database	Broader (regional and national) sustainability considerations; Strategic Priorities; Option analysis; Project Master Database.
4	**Preparation** of water resources development and water-related projects	Project preparation, including where applicable feasibility studies, EIAs, etc. Periodic updates of Project Master Database	Broader (regional and national) sustainability considerations; Strategic Priorities; WRM and sector guidelines; Project Master Database.
5	**Transboundary approval** of identified projects	Implementation of MRC Procedures	MRC Procedures; Strategic Priorities; WRM and sector guidelines; Project portfolio.
6	**Implementation and operation** of agreed projects	In accordance with regional and national standards, values and safeguards	National laws and regulations; WRM and sector guidelines.

The DOS can also be enhanced as countries use it as a ‘cooperation space’ or ‘negotiation space’ to explore mutually beneficial options, including benefit and impact sharing agreements that go beyond the specific project level and bring other opportunities outside the water-related sectors into consideration.

1.4 Planning through a participatory approach

The focus of both phases of the MRC’s Basin Development Plan programme (BDP1 and BDP2) has been on planning through a participatory approach in which, primarily, each of the four

member States has been fully engaged and steering the planning process through collective decision taking at every stage since inception of the BDP.

Within this, the role of the MRCS has been to provide expert guidance and facilitation of the process. During BDP2, much of the burden has fallen on the BDP's Regional Technical Working Group (RTWG), made up of experts drawn from key Government agencies and relevant institutions in each country, supported by the National BDP Units from the National Mekong Committee Secretariats (NMCSs) and MRC Programmes.

The NMCSs have also arranged extensive consultations within their respective countries, which together with the RTWG have provided much valued guidance to the planning process and related technical assessments. The authors of this report express their great appreciation of the guidance and advice provided by each country.

Steps have also been taken to ensure that the wider stakeholder groups have also been involved in the process. To this end, and to assure transparency at all stages, all relevant documents have been posted on the MRC web-site. In addition regular meetings have been held with the BDP's stakeholder forum (comprising representatives from each country, from the NGO communities, research institutes, Development Partners and others) to keep stakeholders informed of the process and to elicit feedback and suggestions on key issues.

A summary of the main consultations held over the last two years is provided in Table 2 below, illustrating the commitment made by BDP to ensure relevance and quality of the formulation and assessment processes for the basin-wide development scenarios.

Table 2 Summary list of main consultations held during BDP2

Event	No of meetings	Participants	Objective
MRC Joint Committee meetings	8 at the regional level	20-40	Review and approval of scenario formulation and assessment
National advisors/facilitators	12 at the regional level	5	Advisory, facilitation and mediation services
Regional BDP stakeholder forums	Annually at the regional level	150-300	Discussion of national positions at the regional level
Regional Technical Working Group	9 at the regional level	40-60	Technical validation of assessments
National consultations	4-7 in each country	20-40	Development of national policy and negotiation positions
Sub-area forums	2 in priority sub-areas	50-100	Data and information improvement
Transboundary meetings	1 in the 3Ss basin	120	Discussion of scenarios and improvement of transboundary cooperation
Various meetings with interest groups (M-POWER, private developers, etc.)	6	10-100	Discussion of assessment approaches, methodologies, tools, data, results etc.

2 Scenario assessment approach

2.1 Purpose and scope of the scenario assessment

The background to and the overall intent of the Assessment of Basin-wide Development Scenarios is set out in Technical Note 2 of this report *Scoping and planning of the assessment of basin-wide development scenarios*, March 2009, which was prepared in consultation with the MRC member countries. The methodologies employed are set out in a subsequent set of reports prepared by the BDP assessment team entitled *Economic, environmental and social impact assessment of basin-wide development scenarios - Assessment methodology* dated and discussed with RTWG in October 2009 (Technical Note 3). The methodology report contains an overview of the assessment approach together with individual annexes detailing the methodologies for the hydrological, environmental, fisheries, social and economic assessments.

The purpose of assessing each scenario is to provide an appreciation of how different water-related developments within the basin impact upon economic, environmental and social objectives of the MRC member countries so as to enable the examination of the trade-offs between different types of development. The scenarios were selected by the countries and fall into four main categories:

- **Baseline situation** – establishing the reference situation as regards hydrological, economic, environmental and social conditions against which all future developments can be compared - this has been agreed as the hydrological situation of 1985-2000 and the socio-economic situation of the year 2008-2009;

- **Definite future situation** – looking at developments that are fully expected to occur by 2015 (ie are existing, under construction or already committed) including the new dams in the UMB and other significant reservoir developments in the LMB;

- **Foreseeable future situation** – looking at country plans that they have put forward for development in the next 20 years through to 2030, including 11 mainstream dams and variants on these, other tributary dams (mainly for hydropower development), irrigation expansion and rising water supply demands; and

- **Long term future situation** – looking at two levels of development that might occur in the very long term, as formulated by the countries and how these may impact upon near term decisions.

The **scope of the assessment** of the development scenarios is triple bottom line, i.e. embracing economic, social and environmental cumulative impacts, at a level of detail that enables decisions to be reached based on the key transboundary impacts of different developments at basin scale. The scope of assessments is expressly not to endorse specific project-level

interventions, which will require detailed studies of their own to confirm their individual viability and acceptability.

The extent of the assessment is focussed on those areas where the developments within the scenarios may be expected to impact upon the eco-system and/or on the livelihoods of those dependent upon the river system and related natural resources. These areas include:

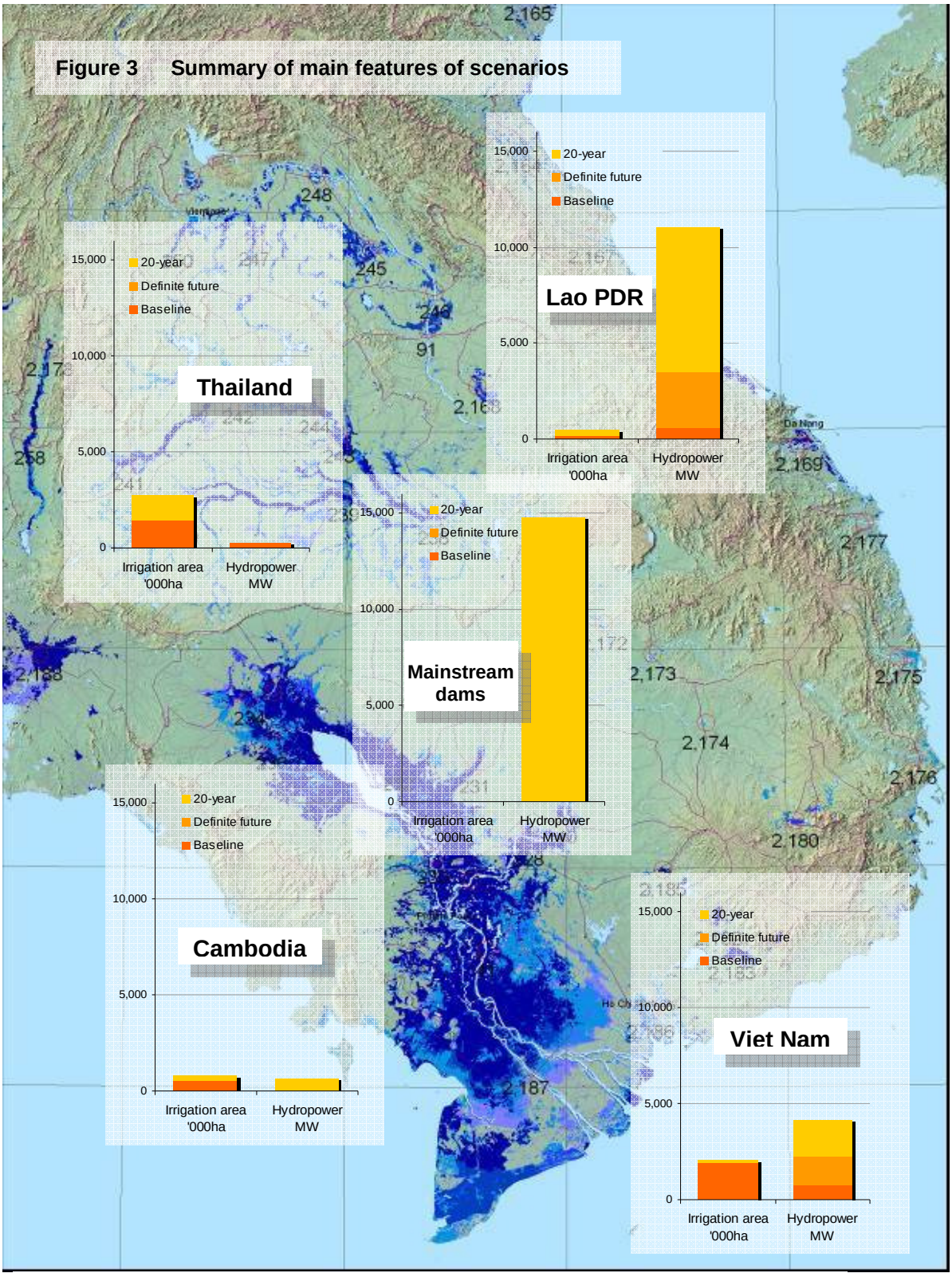
- Those areas directly affected by changed hydrological and water quality conditions (including sediments) in the mainstream, being a corridor along the mainstream and up tributaries where flooding and backwater effects may occur, extending to the coastal areas of Viet Nam;
- The Tonle Sap and adjacent areas and the flood plains in Cambodia and Viet Nam;
- Those areas where there is direct dependence upon capture fisheries, including rivers, natural water bodies and other wetland areas both connected and disconnected from the mainstream;
- Those areas within the LMB where irrigation is practiced; and
- Those other areas where socio-economic impacts are expected to directly arise as a direct impact of the developments proposed in each scenario, in general, but not limited to, being those areas affected by dam and reservoir construction.

2.2 Scenario formulation

The basin-wide development scenarios under current consideration by the BDP2 contain a range of economically-driven developments that will or may be taken up within the next 20 years. Both 20-year and longer-term development scenarios (50 years) are assessed with and without the potential impacts of climate change.

The scenarios (see Figure 3 overleaf) have been formulated by each country to help build an understanding of the potential economic, environmental and social impacts (in relation to current conditions) of:

- **The Definite Future Scenarios** – developments within the Upper and Lower Basins that are already under implementation and expected to be in place within the next 5 years (by 2015). These include the completion of six of the cascade of hydropower dams on the Lancang River, referred to as the Upper Mekong Dam Scenario (UMD), and the completion of 26 hydropower projects in the tributaries of Lower Mekong Basin (LMB), which together with the UMB comprise the Definite Future Scenario). No significant expansion of irrigation development is assumed in this scenario.
- **The Foreseeable Future Scenarios** – which comprise the developments in the DF plus the developments which each country has put forward as being within their plans and intentions to implement within the next 20 years. These comprise further hydropower



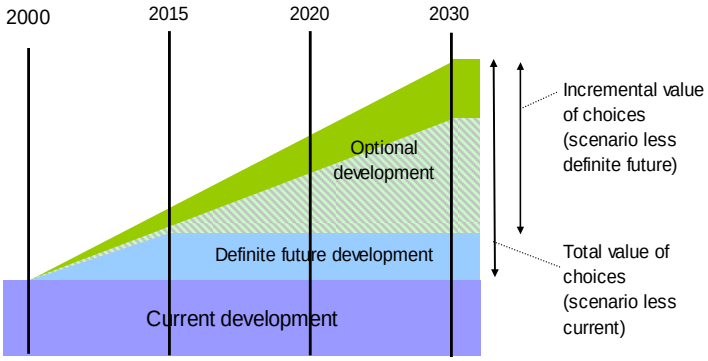
Note: Country charts exclude mainstream hydropower, which is shown separately as above

development in the tributaries and on the mainstream and irrigation development. The scenarios have been structured to investigate the alternative impacts of these developments with and without different combinations of mainstream dams. In addition, the Foreseeable Future Scenarios separately consider various *flood management* projects within the Cambodian – Viet Nam floodplain with respect to their impacts on baseline conditions.

- **The Longer-term Scenarios** – which represent a possible (but not currently planned) continuation of the Foreseeable Future with the main purpose of examining the potential impacts of further development of hydropower and irrigation development on the eco-system and on livelihoods. These are considered at two levels: *Long-term Development*, being notionally those that might logically follow on from the developments in the Foreseeable Future 20-year plan and *Very High Development*, being an extreme case including virtually all potential hydropower and irrigation developments.

A full list of the thirteen scenarios considered in the assessment is presented overleaf in Table 3.

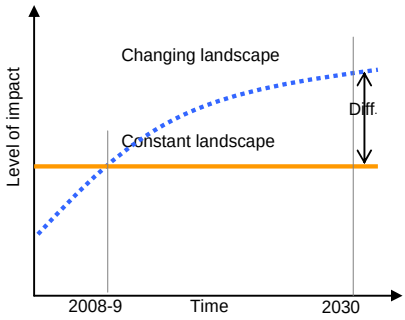
Figure 4 Concept of development choices



As illustrated in Figure 4, the assessment of these different scenarios has been undertaken in a manner that enables an understanding to be built up about what changes will occur within the next 5 years, which are already set in motion by past decisions, and what other developments may be taken up, about which there are choices that can still be made. The merits and demerits of those choices are represented by the difference between the scenario in question compared to the definite future scenario, as illustrated above.

The values of impacts are based on the assessment of the changes brought about to the 2008-09 economic, social and environmental landscapes. Thus for instance the social characteristics of vulnerable people within affected communities in 2030 will be assumed to be those of 2008-09.

Figure 5 Changing economic, social and environmental landscapes



Clearly these landscapes will change as a result of circumstances outside the water resources sector. At issue is whether the difference between a changing and a constant landscape is significant with respect to, firstly, the evaluation of the particular impact and, secondly, to the overall strategic decisions that may be influenced by the particular assessment. If this is true in both instances, then it is appropriate to recommend more detailed studies.

Table 3 Scenarios under consideration

No.	Short Title	Full Title	Development Period	Interventions/Projects
Baseline situation				
1	**BS**	Baseline Scenario		Year 2000 infrastructure including existing HEP dams
Definite future situation				
2	**2015-UMD**	Upper Mekong Dam Scenario	2000 - 2015	Baseline extended to include the full HEP cascade on the Lancang
3	**2015-DF**	Definite Future Scenario	2000 - 2015	2015-UMD plus 26 additional HEP dams in LMB and 2008 irrigation and flood measures
Foreseeable future situation				
4.0	**2030-20Y**	LMB 20-Year Plan Scenario	2010 - 2030	2015 DF plus 11 LMB mainstream dams and 30 planned tributary dams, irrigation, and water supply
4.1	**2030-20Y+CC**	LMB 20-Year Plan Scenario Climate change	2010 - 2030	As above plus climate change for average year between 2010-30 and 17cm sea level rise[4]
5	**2030-20Y-w/o MD**	LMB 20-Year Plan Scenario without mainstream dams	2010 - 2030	As above, excluding 11 LMB mainstream dams
6.1	**2030-20Y-w/o LMD**	LMB 20-Year Plan Scenario with 6 mainstream dams in Northern Lao PDR	2010 - 2030	As above plus 6 LMB mainstream dams in upper LMB
6.2	**2030-20Y-w/o TMD**	LMB 20-Year Plan Scenario with 9 mainstream dams, excl. Thailand	2010 - 2030	2030-20Y, excluding the two Thai mainstream dams
6.3	**2030-20y-w/o CMD**	LMB 20-Year Plan Scenario with 9 mainstream dams, excl. Cambodia	2010-2030	2030-20Y, excluding the two Cambodian mainstream dams
7	**2030 – 20Y Flood**	Mekong Delta Flood Management Scenario	2010 - 2030	Baseline plus 3 options for flood control in Cambodia and Viet Nam Delta
Long term future situation				
8.0	**2060-LTD**	LMB Long-term Development Scenario	2030-2060	2030-20Y plus further infrastructure developments in LMB
8.1	**2060-LTD+CC**	LMB Long-term Development Scenario Climate change	2030-2060	As above plus climate change for average year between 2030-50 and 30cm sea level rise
9	**2060–VHD**	LMB Very High Development Scenario	2030-2060	As 2060-LTD, extended to full potential infrastructure developments

[4] See Technical Note 3, Assessment of Flow Changes for further explanation.

2.3 Scenario assessment process

The assessment of each scenario has being undertaken following the *Assessment Methodology* presented in draft in October 2009 (as summarised in the process chart in Figure 6), which includes a description of the underlying data used and intended methodologies.

A total of 74 parameters have been used to assess each scenario, falling into seven assessment areas that reflect the sequencing of the overall assessment process as summarised in Figure 6. These categories are:

- Hydrological assessment
- Land use and condition assessment
- Water quality and geomorphology
- Production assessment
- Environmental assessment
- Economic assessment
- Social assessment

These 74 parameters are then aggregated to evaluate the 42 criteria which are used to assess the degree to which each scenario responds to 12 development objectives. These objectives were previously established under the IWRM-based BDP assessment framework for economic, environmental, social and equitable development as being most pertinent for examining the relative performance of each scenario. The three main summary indicators for equitable development are finally assembled in the form of a decision support chart to help readers appreciate the main characteristics of each of the Foreseeable Future Scenarios to help in making their choices.

The 12 development objectives and 42 criteria, making up the triple-bottomed line assessment framework, are set out in Table 4 overleaf. In addition and on the basis of feedback during consultations, for the convenience of decision takers a further summarisation has been made of nine criteria as listed below:

- Wetland extent
- Bank erosion
- Capture fisheries
- Water quality
- Environmental hotspots
- Overall environment impact
- Livelihoods
- Economic production
- Other economic impacts

A common approach has been adopted in all assessments, for which the key elements are as follows. As regards **timelines**, the following data sets have been used for assessing impacts of the scenarios:

Base data

- Impact assessment baseline year: 2000
- Definite future scenario: Incremental change 2000-2015
- 20 year plan: Incremental change 2000-2030
- Long term development: Incremental change 2000-2060

Timelines

- Hydrological baseline (for comparison of flows only): 1985-2000
- Economic productivity, social and environmental impact data baseline: 2008-09 (approx)
- Economic prices: constant 2009

Figure 6 Assessment flow chart of individual scenarios

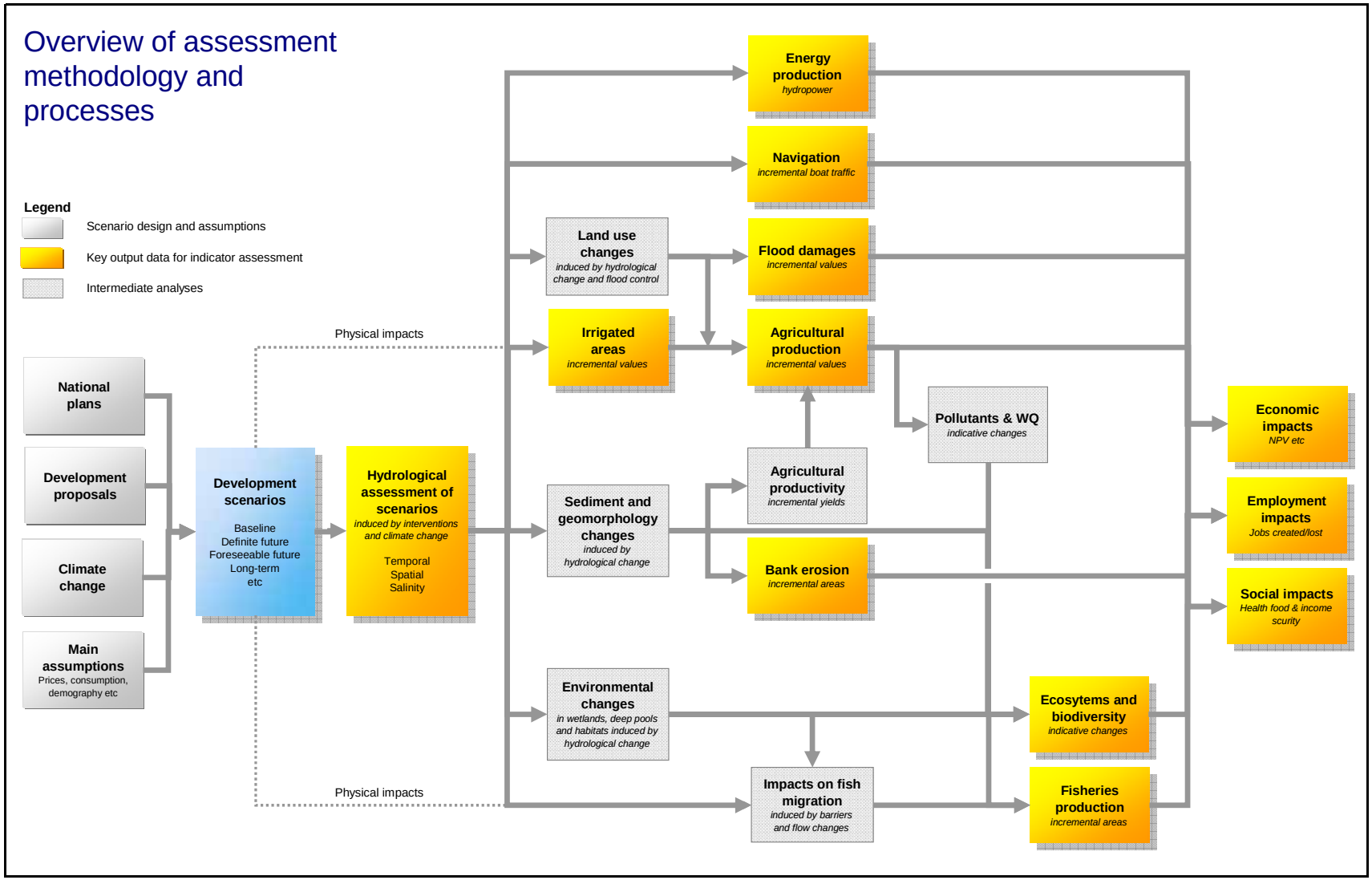


Table 4 Assessment criteria

Specific development objective	Issue	Assessment criteria	Unit
1. Economic development			
1.1 Increase irrigated agricultural production	Irrigable area, production tonnage and value	Incremental area	'000 ha
		Crop production	Mtonne / yr
		Net economic value	NPV US$M
1.2 Increase hydropower production	Hydropower capacity, power generated and value	Installed capacity	MW
		Power generated	GWh/yr
		Net economic value from generation	NPV US$M
		Net economic value from purchased	NPV US$M
1.3 Improve navigation	River transport	Navigable days by class	'000 boat-days
		Net economic value	NPV US$M
1.4 Decrease damages by floods	Extent and duration of annual flooding by class	Average area flooded annually to max 1.0m depth	'000 ha
		Average area flooded annually > 1.0m depth	'000 ha
		Net economic value of flood damage	NPV US$M
1.5 Maintain productivity of fishery sector	Capture fisheries and aquaculture production	Annual average capture fish availability	Mtonne / yr
		Annual average aquaculture production	Mtonne / yr
		Net economic value of capture fish	NPV US$M
2. Environmental protection			
2.1 Maintain water quality and acceptable flow conditions	Water quality	Total pollutant discharge	tonnes / yr
		Water quality conditions	Severity
	Flow characteristics	Average flow in March	MCM
		Average wet season peak daily flow	m3/s
		Average flow volume entering Tonle Sap	MCM
	Protection of forests around Tonle Sap	Forest, marshes and grasslands flooded at Tonle Sap	'000 ha
		Net economic value	NPV US$M
2.2 Maintain wetland productivity and ecosystem services	Productivity of wetland ecosystems	Area of wetlands (forest, marshes, wetland)	'000 ha
		Net economic value	NPV US$M
2.3 Manage salinity intrusion in the Mekong delta	Impact of salinity intrusion on land use	Area within delta within threshold level of salinity	'000 ha
		Net economic value	NPV US$M
2.4 Minimize channel effects on bank erosion and deep pools	River bank erosion	Area at risk to erosion	Severity
		Net economic value	NPV US$M
	Flow and sediment transport changes	Functioning deep pools	No.
		Induced geomorphological changes	Severity
2.5 Conservation of biodiversity	Impacts of flow management changes on endangered species	Status of river channel habitats	Severity
		Flagship species	no.
		Unaffected environmental hot spots	No.
		Biodiversity condition	Severity
		Incremental net economic value of habitat areas	NPV US$M
3. Social development			
3.1 Maintain livelihoods of vulnerable resource-users	Health, food and income security	No. of people affected	'000
		Severity of impact on health, food and income security	Severity
3.4 Increased employment generation in water related sectors	Incremental sustainable employment from water resource interventions	Incremental number of people engaged in:	
		Agriculture	'000
		Fisheries	'000
		Water-related service industries	'000
		Tourism	'000
4 Equitable development			
4.1 Ensure that all four LMB countries benefit from the development of water and related resources	Aggregate benefits by country	Total net economic value	NPV US$M
		No. of people affected vulnerable to changes	'000
		No. of jobs generated	'000
		Overall environment impact	Severity

The assessment tables (see Appendices B and C) generally record the incremental impacts occurring at the end year of each scenario relative to the 2000 baseline year, valued as if those impacts occurred on the 2008-09 economic, social and environmental landscapes. Autonomous and/or exogenous conditions are not included generally with the one exception of aquaculture (for which the growth potential has been estimated). Economic values are expressed as the NPV of the cumulative costs and benefits between 2000 and the scenario end year assuming thereafter benefits and costs remain at end year values for the remainder of 50 years discounting period (relating to life of infrastructure).

All criteria are be evaluated for all scenarios. Where these cannot be reasonably be quantified the following nomenclature has been used (where "0" is neutral).

Table 5 Severity ratings

Positive outcomes		Negative outcomes	
5	**Extremely positive**	**-1**	**Mildly negative**
4	**Highly positive**	**-2**	**Negative**
3	**Very positive**	**-3**	**Severely negative**
2	**Positive**	**-4**	**Extremely negative**
1	**Mildly positive**	**-5**	**Catastrophic**

2.4 Reporting of scenario assessments

The positive and negative impacts of all scenarios as reflected by the 74 parameters are set out in Appendix B.

These are presented in three tables for each scenario as total values, incremental with respect to the Baseline and incremental with respect to the Definite Future Scenario. Maps of the main developments incorporated in each scenario are presented in this Appendix as well.

These results are then summarised in Appendix C to show the assessment outcomes on the 14 issues (and 42 criteria) within the agreed assessment framework. These are similarly presented for all scenarios as total values, incremental with respect to the baseline and incremental with respect to the Definite Future Scenario.

The outcomes with respect to each country and to the LMB overall are then presented in Appendix D for the incremental impacts of each scenario against both the baseline and the Definite Future Scenario.

The Flood Management Scenarios have been assessed by FMMP Component 2 as a separate exercise and these are summarised in Appendix A.

A discussion of the overall findings is presented in Chapter 3 to help develop an overall understanding of how the different scenarios impact on the different sectors under consideration.

Chapter 4 then examines the merits and demerits of each scenario in relation to national objectives (as expressed in the 20-year plans put forward) and to the overall aims of the MRC members collectively to achieve *the full potential of sustainable benefits to all riparian countries and the prevention of wasteful use of Mekong River Basin waters, with emphasis and preference on joint and/or basin-wide development projects and basin programs.*

Chapter 4 concludes with an overview of the potential opportunities presented by the scenarios and a discussion of the nature of tradeoffs that may be considered.

This is followed in Chapter 5 by a review and discussion of the significant planning risks and uncertainties that emerge from the findings presented in Chapters 3 and 4.

Finally Chapter 6 takes the findings above and sets out the implications that may be drawn for future planning and implementation of the developments that potentially may form part of an agreed basin-wide development strategy.

2.5 Limitations of the assessment process

The assessment process as defined above represents the product of extensive dialogue and consensus building between the member countries, as illustrated earlier in Table 2. This collective effort has led for the first time to the countries coming together to put forward their individual development aspirations and examine these within an agreed framework of shared aims and concerns.

The approach to scenario formulation is set out in detail in the accompanying Technical Note 1[5]. This approach was founded on an examination of national development plans and intentions and set in the context of the urgent need expressed by the member countries to establish a basin perspective of these developments. Each member country's plans offered different perspectives reflecting different levels of plan preparation. Implementation of the approach also had to take into account the ability of each country to make available the data and other information needed to support the agreed process, which in some cases has constrained the depth of analysis possible in these assessments.

It is recognised therefore that there are limitations to the current assessment process which should be borne in mind when considering the outputs from the assessments. These are

[5] Technical Note 1, Scoping and Planning of the Assessment of Development Scenarios, MRC BDP, March 2009

highlighted below for the benefit of the reader and also for those engaged in updating future plans every five years under the proposed rolling process.

- **Nature of developments considered in the scenarios**: The developments embodied within the scenarios are limited to primarily those plans put forward by the countries to exploit opportunities for hydropower development and irrigation of mainly rice-based farming systems. These interventions are those most likely to impact on basin's hydrology and eco-system.

  Nevertheless, through the assessment process, key issues have been identified related to other forms of development such as agricultural development, management of wild fisheries, environmental protection, poverty alleviation etc, which may be expected to form a key part of integrated water resources management within the Basin. Consideration of these issues can inform, firstly, the preparation of the first ever Basin Development Strategy, secondly the priority actions needed in these complementary areas and thirdly the nature of further studies and planning required over the next five years to enrich future editions of the development strategy. These are further discussed in Chapter 6.

- **Alternative types of development**: Article 1 of the MRC Agreement commits the MRC *to cooperate in all fields of sustainable development … in a manner to **optimize** the multiple-use and mutual benefits of all riparians and to **minimize** the harmful effects that might result from natural occurrences and man-made activities.* As in the situation above, the scenarios are made up of a series of specific infrastructure developments and the task at hand and agreed with the countries has been to compare the relative merits and demerits of these developments as grouped within the scenarios.

  Whilst the task at hand has not been to develop or optimise these and alternative scenarios, the assessment process does flag up where specific interventions (or groups of interventions) may cause significant negative impacts, thus prompting consideration of design improvements where appropriate. Again as above, the further studies and requirements for additional guidance are discussed in Chapter 6.

- **Factors external to the water resources sector**: Section 2.2 sets out the approach adopted in the assessments for dealing with circumstances external to the water resources sector, namely that the impacts of water resource developments are measured against the prevailing environmental, social and economic conditions in 2008-09 within an agreed baseline of hydrological and land cover as existed from 1985 to 2000. This ensures a transparent and level playing field in examining the relative impacts of different scenarios. However, this does not take into full account how the conclusions drawn might change in the future if circumstances outside the immediate sphere of water resources management change.

  Examples of circumstances that might change include: the productivity of wild fisheries as a consequence of fisheries management practices; the numbers of vulnerable people dependent upon the river's eco-system as a consequence of continuing economic development, urbanisation and poverty alleviation measures; agricultural practices as a

consequence of climate change, private sector development and/or changes in demand patterns; evolving patterns of land use and land coverage as a consequence of population growth and socio-economic development.

Clearly how these and other circumstances will change in the future will have bearing on how the basin's water and related resources should be best managed in line with MRC's vision for *an economically prosperous, socially just and environmentally sound Mekong River Basin*. The process of a rolling plan updated every 5 years is designed to address this. Where appropriate, further studies are recommended in Chapter 6 to feed into the next round of strategic planning.

- **Data and knowledge gaps**: The situation with regard to exogenous circumstances in part reflects that there are a number of data and knowledge gaps that inhibit detailed analyses of certain issues. These are discussed further under risks and uncertainties in Section 5.2.

  As much as possible these gaps are flagged up in the discussions of impacts that follow in Chapters 3 and 4 so that the reader is aware of where uncertainties might significantly affect the conclusions that may be drawn from the assessments made.

  As above, it should be appreciated that this first assessment of basin-wide scenarios by the MRC countries forms part of a longer term process. Opportunity has been taken therefore to flag those data gaps which, from the understandings reached through this first assessment process, are clearly of significance for future strategic decision making. These are elaborated further in Chapter 6 in a manner that permits an increased focus of MRC on key development issues.

3 Overview of assessment findings

3.1 Introduction

This chapter presents the findings from the scenario assessments in the form of an overview of the impacts expected in different sectors. The purpose is to help the reader appreciate the many different interactions between these sectors and how they influence the assessment of the different scenarios, which are presented in Chapter 4. The presentation of these findings follows broadly the order of the assessment process flow chart as set out previously in Figure 6.

The data used in each scenario set-up has been discussed extensively with each country and is set out in detail in Volume 3, Technical Note 3 *Assessment of Flow Changes*. Table 7 overleaf provides a summary of the key assumptions in each scenario and Table 6 below sets out the key infrastructure data, the main aspects of which are summarised in Figure 7 to Figure 9. Assumptions on future domestic and industrial water demands are set out thereafter in Table 8.

Table 6 Key scenario infrastructure data

		Total installed HEP, MW					Total active storage, MCM					
Ref	Scenario	Lao	Thailand	Cambodia	Viet Nam	**Total**	Lao	Thailand	Cambodia	Viet Nam	**LMB**	**UMB**
1000	BS	621	245	0	720	**1,586**	5,593	3,276	0	779	**9,649**	**257**
2000	2015-UMD	621	245	0	720	**1,586**	5,593	3,276	0	779	**9,649**	**23,193**
3000	2015-DF	3,502	745	1	2,284	**6,532**	17,166	3,566	0	2,620	**23,352**	**23,193**
4000	2030-20Y	15,385	3,696	4,761	2,583	**26,424**	39,817	3,876	2,450	3,156	**49,299**	**23,193**
4001	2030-20Y+CC	15,385	3,696	4,761	2,583	**26,424**	39,817	3,876	2,450	3,156	**49,299**	**23,193**
5000	2030-20Y-w/o MD	7,919	745	481	2,583	**11,727**	36,972	3,566	380	3,156	**44,073**	**23,193**
6100	2030-20Y-w/o LMD	14,339	1,824	481	2,583	**19,226**	39,080	3,566	380	3,156	**46,181**	**23,193**
6200	2030-20Y-w/o TMD	15,385	745	4,761	2,583	**23,473**	39,507	3,566	2,450	3,156	**48,679**	**23,193**
6300	2030-20y-w/o CMD	15,385	3,696	481	2,583	**22,144**	39,817	3,876	380	3,156	**47,229**	**23,193**
7000	2030 – 20Y Flood	15,385	3,696	4,761	2,583	**26,424**	5,593	3,276	0	779	**9,649**	**257**
8000	2060-LTD	17,321	3,696	5,507	2,583	**29,107**	49,964	3,876	15,715	3,156	**72,710**	**23,193**
8001	2060-LTD+CC	17,321	3,696	5,507	2,583	**29,107**	49,964	3,876	15,715	3,156	**72,710**	**23,193**
9000	2060–VHD	17,816	3,696	5,590	2,583	**29,684**	57,995	4,186	18,895	3,156	**84,232**	**23,193**

		Total irrigated area '000ha					Total irrigated cropped area '000ha					Cropping intensity
Ref	Scenario	Lao	Thailand	Cambodia	Viet Nam	**Total**	Lao	Thailand	Cambodia	Viet Nam	**Total**	
1000	BS	204	1,266	273	1,996	**3,739**	332	1,422	563	4,312	**6,629**	**177%**
2000	2015-UMD	204	1,266	273	1,996	**3,739**	332	1,422	563	4,312	**6,629**	**177%**
3000	2015-DF	166	1,355	273	1,670	**3,465**	271	1,756	563	4,218	**6,807**	**196%**
4000	2030-20Y	450	2,635	457	1,795	**5,337**	820	3,624	877	4,404	**9,725**	**182%**
4001	2030-20Y+CC	450	2,635	457	1,795	**5,337**	820	3,624	877	4,404	**9,725**	**182%**
5000	2030-20Y-w/o MD	450	2,635	457	1,795	**5,337**	820	3,624	877	4,404	**9,725**	**182%**
6100	2030-20Y-w/o LMD	450	2,635	457	1,795	**5,337**	820	3,624	877	4,404	**9,725**	**182%**
6200	2030-20Y-w/o TMD	450	2,635	457	1,795	**5,337**	820	3,624	877	4,404	**9,725**	**182%**
6300	2030-20y-w/o CMD	450	2,635	457	1,795	**5,337**	820	3,624	877	4,404	**9,725**	**182%**
7000	2030 – 20Y Flood	450	2,635	457	1,795	**5,337**	820	3,624	877	4,404	**9,725**	**182%**
8000	2060-LTD	715	2,760	678	1,813	**5,966**	1,335	3,896	1,833	4,890	**11,953**	**200%**
8001	2060-LTD+CC	715	2,760	678	1,813	**5,966**	1,335	3,896	1,833	4,890	**11,953**	**200%**
9000	**2060–VHD**	**1,896**	**2,994**	**1,667**	**1,848**	**8,406**	**3,686**	**4,434**	**5,407**	**5,061**	**18,587**	**221%**

Table 7 Summary of scenario set-up data

Ref	Short description	Title	Hydrology	Hydropower dams			Irrigation and water supply demands
				China	Mainstream	Tributary	
Baseline							
1000	BS	Baseline Scenario	Standard 1985-00	First 1 no.	None	Existing in 2000 (15 no.)	As in 2000
Definite future							
2000	2015-UMD	Upper Mekong Dam Scenario	Standard 1985-00	First 6 no.	None	Existing in 2000 (15 no.)	As in 2000
3000		Definite future scenario	Standard 1985-00	First 6 no.	None	Existing + 26 under construct.	As in 2015
Foreseeable future situation (2030)							
4000	2030-20Y	LMB 20-Year Plan Scenario	Standard 1985-00	First 6 no.	All 11 dams	Existing + 56 under construction or planned by 2030	Existing + planned by 2030
4001	2030-20Y+CC	LMB 20-Year Plan Scenario	Climate change: 2011-2050	First 6 no.	All 11 dams	Existing + 56 under construction or planned by 2030	Existing + planned by 2030
5000	2030-20Y-w/o MD	LMB 20-Year Plan Scenario without mainstream dams	Standard 1985-00	First 6 no.	None	Existing + 56 under construction or planned by 2030	Existing + planned by 2030
6100	2030-20Y-w/o LMD	LMB 20-Year Plan Scenario with 6 mainstream dams in Northern Lao PDR	Standard 1985-00	First 6 no.	6 in northern Lao only	Existing + 56 under construction or planned by 2030	Existing + planned by 2030
6200	2030-20Y-w/o TMD	LMB 20-Year Plan Scenario with 9 mainstream dams, excl Thailand	Standard 1985-00	First 6 no.	9 dams excl. Pak Chom & Ban Kum	Existing + 56 under construction or planned by 2030	Existing + planned by 2030
6300	2030-20y-w/o CMD	LMB 20-Year Plan Scenario with 9 mainstream dams, excl Cambodia	Standard 1985-00	First 6 no.	9 dams excl. Stung Treng and Sambor	Existing + 56 under construction or planned by 2030	Existing + planned by 2030
7000	Cam0	Early flood protection and full flood protection in Cambodia		Mekong Delta Flood Management Scenarios		All conducted against baseline conditions	
7001	VNA	Early flood protection and full flood protection in Viet Nam					
7002	Cam0VNa	Combination of above					
LMB long-term development scenarios							
8000	2060-LTD	LMB Long-term Development Scenario	Standard 1985-00	First 6 no.	All 11 dams	Existing + 91 expected by 2060	Existing + expected by 2060
8001	2060-LTD+CC		Climate change: 2011-2050	First 6 no.	All 11 dams	Existing + 91 expected by 2060	Existing + expected by 2060
9000	2060–VHD	LMB Very High Development Scenario	Standard 1985-00	First 6 no.	All 11 dams	Existing + 110 further	Full potential

Figure 7 Installed hydropower capacity for selected scenarios

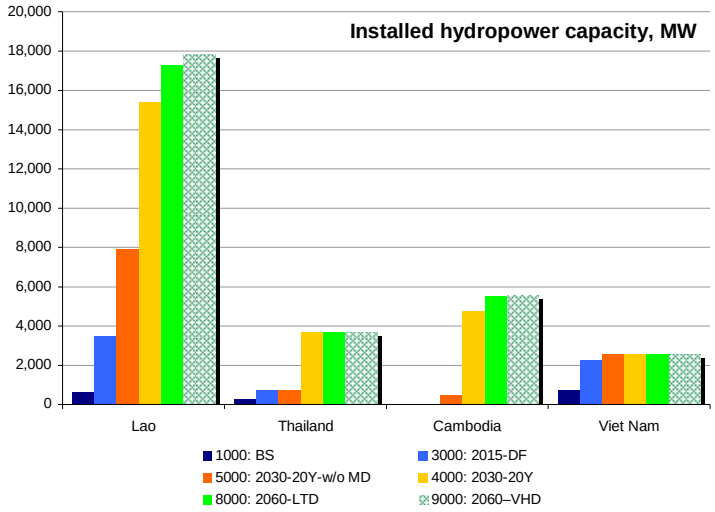


Figure 8 Installed irrigation area by country and scenario for selected scenarios

Note irrigation development the same for all foreseeable future scenarios

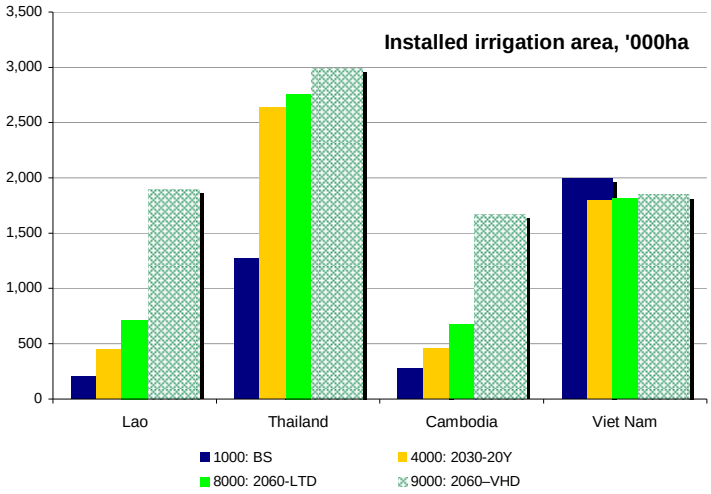


Figure 9 Total live (active) storage in basin by scenario and total irrigated cropped area by scenario for selected scenarios

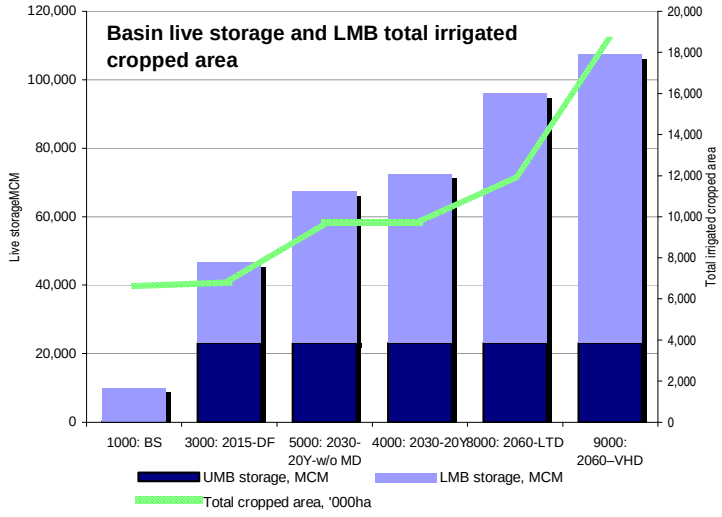


Table 8 Estimated future water supply demands

Country	Year 2000 (BL and UMD)	Year 2007 (DF)	Year 2030 (20Y Plan)	Year 2060 (LT and VH)
Population (million person)				
Lao PDR	4.965	5.233	8.440	15.744
Thailand	22.271	23.079	24.725	27.050
Cambodia	10.830	12.954	20.524	31.344
Viet Nam	18.134	18.653	24.597	35.285
Highland	*1.995*	*2.148*	*2.832*	*4.063*
Delta	*16.139*	*16.505*	*21.765*	*31.222*
Total LMB	**56.200**	**59.919**	**78.286**	**109.423**
Annual domestic water use (million m^3)				
Lao PDR	116	203	388	705
Thailand	935	1,404	1,593	1,937
Cambodia	127	435	767	1,183
Viet Nam	443	488	1,090	1,554
Total LMB	1,621	2,530	3,838	**5,379**
Annual industrial water use (million m^3)				
Lao PDR	12	20	47	190
Thailand	94	140	239	581
Cambodia	13	20	108	331
Viet Nam	44	122	149	837
Total LMB	163	302	543	1,939

3.2 Hydrological impacts

The starting point of the assessments has been to determine the impacts of the developments set out in the scenarios on the river system in terms of flow changes and flooding. The impacts that these changes, together with the direct impact of the infrastructure included in each scenario, have on basin's eco-system and environmental assets are discussed in the following Section 3.3.

3.2.1 Changes in wet and dry season mainstream flows

The Definite Future Scenario - flow changes in the next 5 years

The dams in the UMB under construction will together introduce an additional storage of 22.9 BCM into the basin, which together with the completion of 26 hydropower projects in the LMB

with a total active storage of 13.7 BCM, will increase the total active storage in the basin by 370% to an amount equivalent to 10% of the mean annual runoff (MAR). This will have a substantial impact on the natural flow regime of the mainstream, which previously has seen no observed net change since recording began in 1915[6].

This new storage is primarily for hydro-electric generation and will store, and release, water in the wet season reducing flood peaks and, significantly, will release increased flows during the dry season[7]. These changes will result in an increase in dry season flows at Kratie of 19% on average and in March by 40% with water levels rising by typically 0.8m. In contrast wet season discharges will reduce by about 4% on average with peak daily flows reduced on average by 7%.

An overview of how daily hydrographs are expected change is given overleaf in Figure 10. These illustrate that the trends observed at Kratie above in general are reflected throughout the length of the main stream. The difference between the baseline and the other scenarios is most marked at the northerly end (eg Vientiane) where the influence of the UMD mainstream dams is greatest and, as shown, this effect diminishes further downstream as the effect attenuates.

Foreseeable Future Scenarios - further changes up to 2030

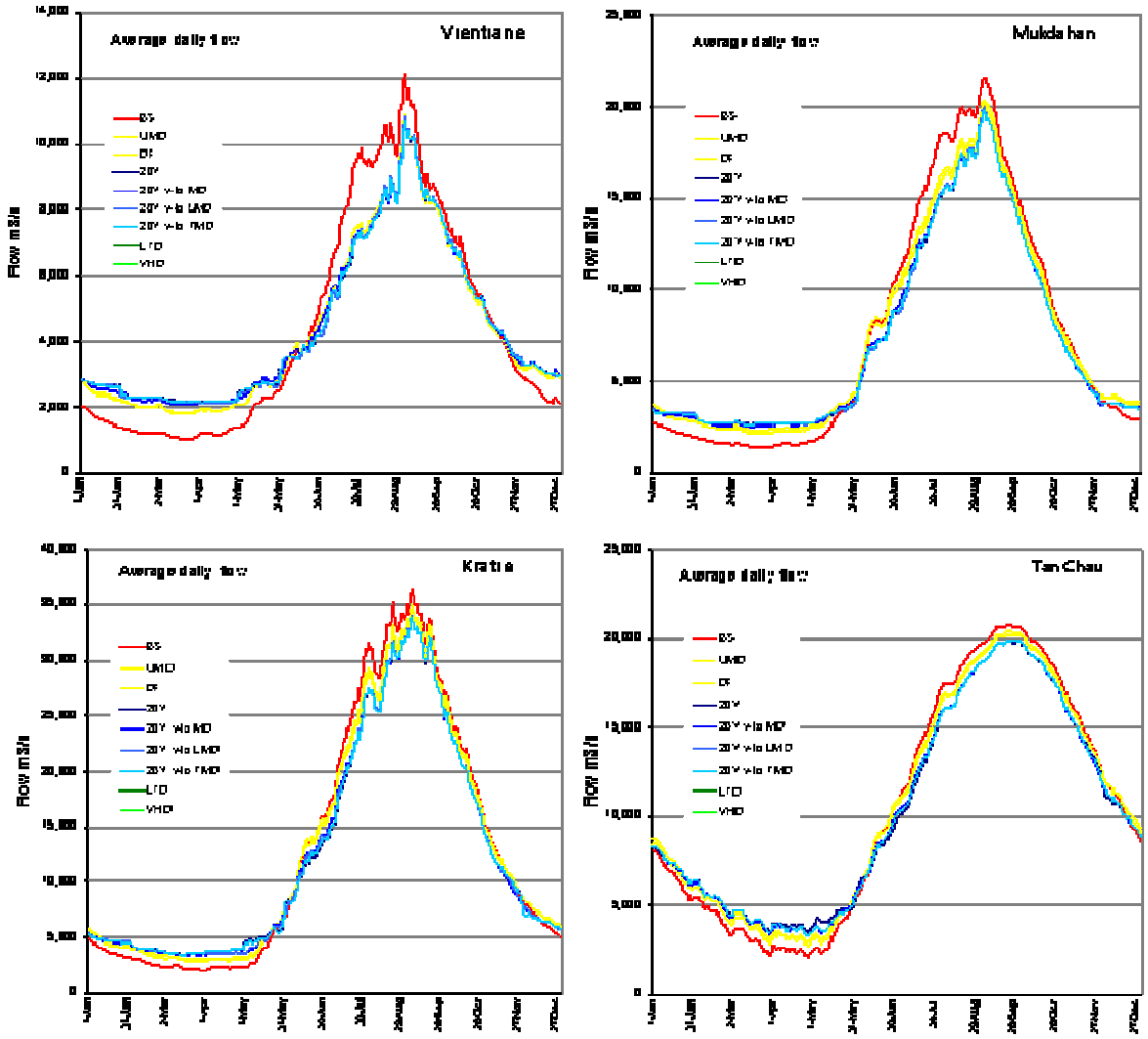
The developments included in the Foreseeable Future Scenarios include the rapid expansion of irrigation by 50% over and above current levels (as included in the Definite Future Scenario) and the construction of a further 30 tributary hydropower dams with an additional active storage of 20.7 BCM (representing a 50% increase over the Definite Future Scenario), raising total active storage in the basin to 15% of the MAR.

In addition the Foreseeable Future Scenarios include all or some of the 11 identified mainstream dams in the LMB. These are run-of river dams and potentially add up to only a further 5.2 BCM of active storage in total. Thus, in broad terms, the mainstream dams in the LMB would have only a marginal effect on the overall mainstream flow volumes, which is reflected in the similarity of all Foreseeable Future hydrographs as illustrated in Figure 10.

[6] While the developments so far on the tributaries have had localized impacts, the impacts on the flow regime of the mainstream have been until recently insignificant. This is because the net impacts of past individual development in the sub-basins on the flows upstream of the Viet Nam-Cambodia border are small compared to the unregulated flows from elsewhere in the basin. Evidence suggests that the increased runoff that would have been expected to have occurred as a result significant regional deforestation since the 1960's has been offset by the retention and re-regulation introduced through the parallel expansion of bunded rice fields and, generally small scale, storage reservoirs. The construction of the dams in the Lancang in the UMB signals the first significant change to this long-established flow regime.

[7] In the flow analyses made for these and other scenarios, it has been assumed that all storages in the LMB would be operated to maximise hydropower production. This method of operation means that generally reservoir operators will seek to ensure that their storages are full towards the end of the wet season so as to maximise assured releases in the dry season. As a consequence, there tends to be less scope for regulating late wet season floods than would be the case if the reservoirs were operated on the basis of flood control. Operation of the dams in the UMB has been the subject of technical discussion with Chinese counterparts, and the mode of operation assumed favours hydropower production.

Figure 10 Scenario hydrographs at Vientiane, Mudakhan, Kratie and Tan Chau



However, the operation of the mainstream dams can cause significant downstream fluctuations during any one day if they are operated as peaking projects. In this case, water level fluctuations locally may amount to typically 2-4m or more in extreme cases. The mainstream dams are generally sized and sited at intervals where the backwater effects of one reaches close to the next[8]. Thus, although they may have a small effect at basin-scale on flow volumes, water levels will be significantly affected both up and downstream of their sites.

[8] LMB mainstream dams are assumed to be operated over an annual cycle in a manner that permits flushing of sediments, thus maintaining substantially their planned storage and backwater effects.

The planned 50% increase in irrigation abstractions over current levels would be more than offset by the planned increase in active storage on the LMB tributaries. Compared to the new flow regimes established under the Definite Future Scenario, the different Foreseeable Future Scenarios would cause an average further net increase of overall dry season flow volumes of typically 9-12% with about a further 4% reduction in wet season flow. In March, during the dry season, average daily flows would be expected to become typically between 30% and 100% above baseline conditions, representing a further increase over the Definite Future Scenario of between 7% and 19%, depending on location along the mainstream and the scenario under consideration.

Peak daily discharges during the flood season would be somewhat less affected, being typically between 4% and 15% less than the baseline and between 2% and 4% below Definite Future conditions.

Whilst the picture that emerges is that with the developments as set out in the scenarios, in all cases the average monthly flows in the dry season will be exceeded relative to the Baseline.

However, more detailed assessments have been made at the transitions between the wet and dry season. In early December, water levels predicted for Tan Chau, whilst averaging higher than the baseline, are below the baseline by typically 5cm only in up to 20% of the years simulated. At end of the dry season during May similar circumstances arise right at the end of the month. These small deficits could possibly be removed with minor adjustments to upstream reservoir operating rules.

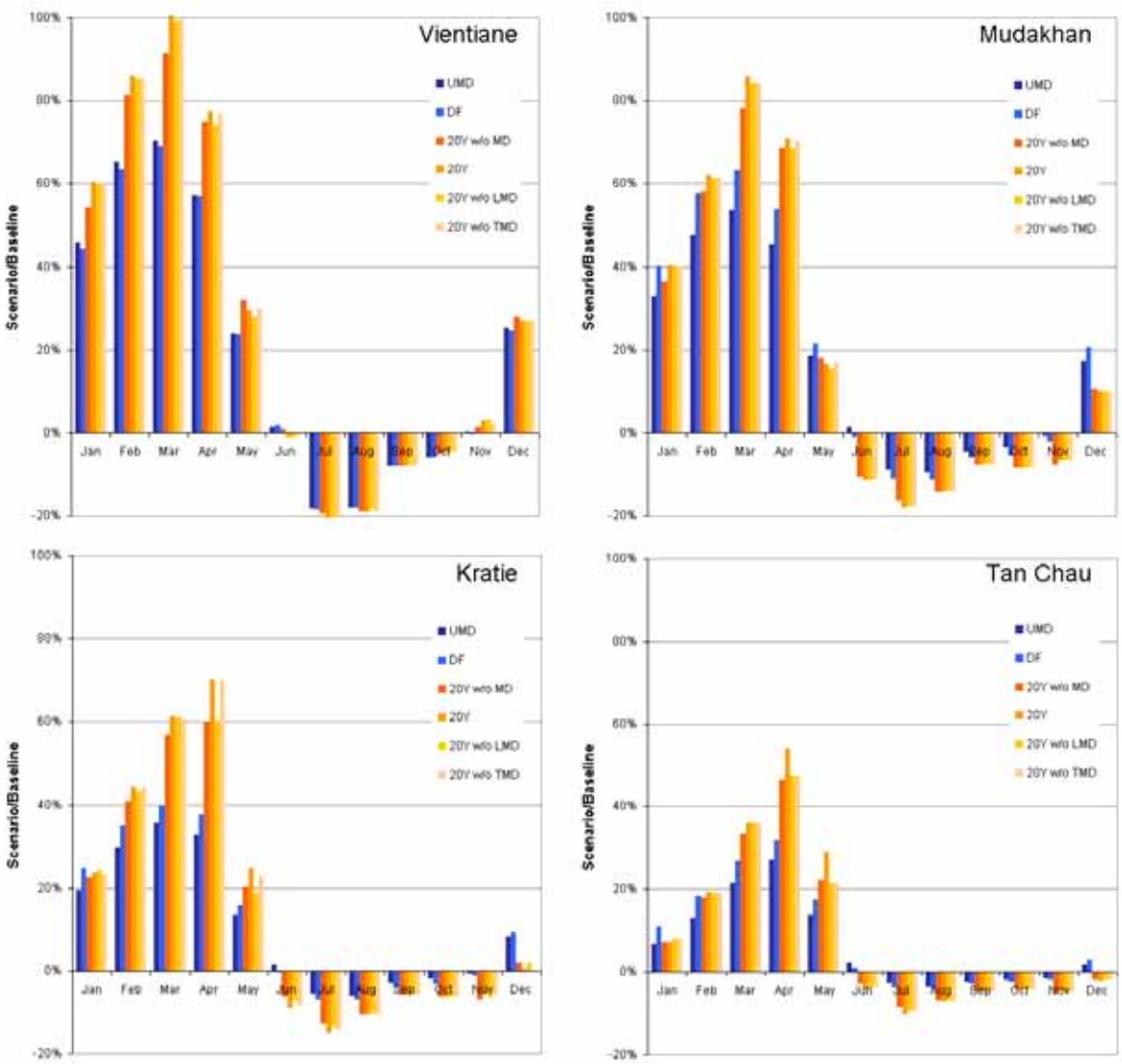
In dry years (without climate change) the percentage changes in flooded areas tends to be less with changes in Lao PDR and Thailand being smaller (typically below -3% for all scenarios compared to the Baseline) compared to Cambodia (9-12.5%) and Viet Nam (3.5%) compared to the Baseline for all scenarios. By contrast in a wet year, flooding in Lao PDR and Thailand, compared to the Baseline, increases somewhat whereas in Cambodia and Viet Nam the total flooded area decreases slightly.

Long-term Development Scenarios - further changes up to 2060

Mainly due to the synergies between the irrigation and hydropower sectors, the longer term scenarios would marginally change the mainstream flows over and above the changes caused by the foreseeable future scenarios (2030).

The predicted changes in timing and flow levels are a few percent. In March, for instance, average daily flows would be typically between 34% and 105% above baseline conditions, representing a further increase over the Foreseeable Future Scenario of around 5%. Peak daily discharges during the flood season would be somewhat less affected, being typically between 6% and 16% less than the baseline, about 1% lower than the Foreseeable Future conditions.

Figure 11 Comparison of average monthly flows with baseline



3.2.2 *Climate change*

Climate change impact modelling for the scenario assessment has been undertaken using downscaled outputs from the ECHAM4 global climate model for IPCC scenario B2. This B2 scenario was selected in consultation with the countries and represents one of several mid-value projections of how climate may vary in the years ahead. The impacts upon key variables such as temperature, rainfall and runoff are illustrated below in Figure 12.

Two scenarios (the 20-year plan under the Foreseeable Future and the Long Term Development Scenario) have been modelled with runoff modified by climate change to assess the broad implications of climate change. The results are illustrated in Table 9 overleaf.

Figure 12 Projected changes in mean annual values under IPCC B2 Climate Change

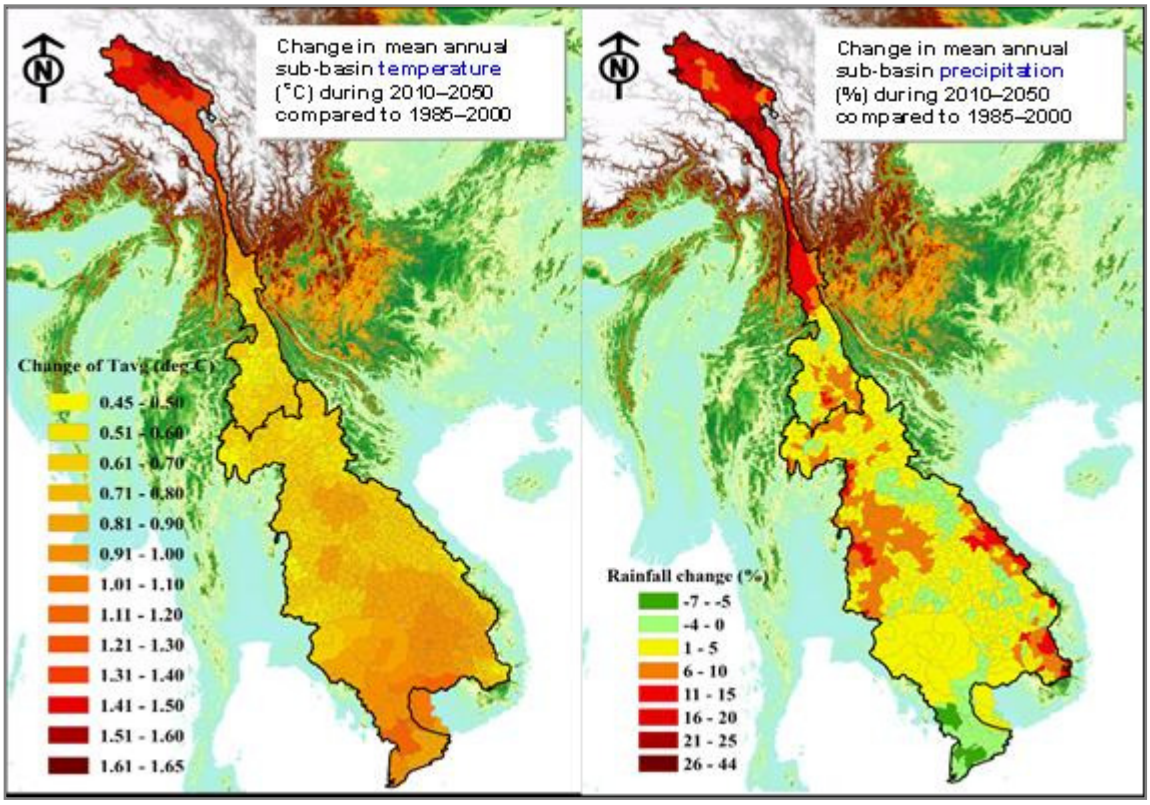


Table 9 Summary results from climate change scenarios

Location	Unit	Vientiane	Mudakhan	Kratie	Tan Chau	Average
4000 LMB 20-Year Plan Scenario						
Monthly average dry season flow (March)	m3/s	2,218	2,698	3,546	4,179	**3,160**
Average peak daily flow in wet season	m3/s	13,540	23,417	43,307	20,455	**25,180**
4001 LMB 20-Year Plan Scenario Climate change						
Monthly average dry season flow (March)	m3/s	2,265	2,759	3,577	4,077	**3,170**
Average peak daily flow in wet season	m3/s	13,691	25,919	50,515	21,529	**27,914**
Percent change with climate change						
Monthly average dry season flow (March)		2.1%	2.2%	0.9%	-2.4%	**0.3%**
Average peak daily flow in wet season		1.1%	10.7%	16.6%	5.2%	**10.9%**
8000 LMB Long-term Development Scenario						
Monthly average dry season flow (March)	m3/s	2,200	2,608	3,708	4,103	**3,155**
Average peak daily flow in wet season	m3/s	13,597	23,574	41,698	20,160	**24,757**
8001 LMB Long-term Development Scenario Climate change						
Monthly average dry season flow (March)	m3/s	2,250	2,664	3,716	4,107	**3,184**
Average peak daily flow in wet season	m3/s	13,738	26,083	48,886	21,154	**27,465**
Percent change with climate change						
Monthly average dry season flow (March)		2.3%	2.2%	0.2%	0.1%	**0.9%**
Average peak daily flow in wet season		1.0%	10.6%	17.2%	4.9%	**10.9%**

These indicate that in broad terms the effect of climate change will be to increase runoff during both dry and wet seasons. In the case of the dry season the changes are generally very small, but in the wet season average peak daily flows is expected to increase by about 11% on average along the mainstream, but with the greatest impacts seen in the middle reaches upstream of Kratie.

These assessments are based upon changes to average wet and dry season flows in the Mekong region. Further studies have been undertaken by MRC's Environment Programme and are details of the results are reported separately[9]. These include consideration also of the IPCC scenario A2, a more severe forecast of climate change than is seen in IPCC scenario B2.

Climate change modelling

The assessment of climate change impacts on flow regime is based on existing climate change data downscaled to the Mekong Basin by the SEA START (South East Asia SysTem for Analysis, Research and Training) Regional Center using the PRECIS (Providing Regional Climates for Impacts Studies) Regional Climate Model (RCM) developed by the Hadley Centre, a leading climate research centre in the United Kingdom. PRECIS data were adjusted against the available observed data used for setting-up and calibrating the DSF models.

RCM data are available until 2100, but the time horizon of the MRC analysis is up to 2050 since this is more realistic for the current BDP Development Scenarios. Because observed data in the DSF are available only for the 16 years from 1985 - 2000, and are used for the Baseline Scenario, future comparisons are also divided into 16 year periods, i.e. 2010 - 2025, 2026 - 2041, 2042 - 2050 thus covering the whole period of 2010 - 2050.

Abstracted from MRC Technical Paper No. 29 Impacts of climate change and development on Mekong flow regimes, June 2010

A wider assessment of the hydrological regime has been also considered in the MRC Annual Flood report and this suggests that a greater issue with climate change is the increased variability of flows, which will have much significance on how future developments are planned.

For instance, by 2030, whereas the annual maximum flows at Vientiane appear to be unaffected by climate change, the variance of annual flows between years may increase by as much as 40%. In contrast at Kratie the mean annual runoff is predicted to increase by c.22% with an increase in variability of annual flows of 13%. In addition, the mean onset date of the flood is estimated to be only a few days later by 2030 but with a dramatic increase in variance. The mean end date is expected to be delayed by two to three weeks. Thus in the reaches upstream of Kratie, the increase in variability is likely to prompt an increase in the severity of floods and droughts.

The threats posed by climate change in the Mekong Delta are more severe. Whilst estimates of sea level rise adopted in this report are 17cm by 2030 and 30cm by 2060, long term estimates for sea level rise are up to 1 metre by 2100. If a 1 metre rise does happen, 90 per cent of the Delta could become inundated annually. Whilst most studies predict that flows during the dry season will increase largely as a result of a greater snowmelt contribution from the Upper Basin,

[9] Impacts of climate change and development on Mekong flow regimes: First assessment – 2009, MRC Technical Paper No. 29, June 2010

the projected rise in mean sea level is anticipated to lead also to potentially severe water quality problems.

Further detailed modelling studies are clearly needed to understand better the implications of different responses to these threats, the transboundary implications and the influence that upstream developments could have on mitigating these risks.

3.2.3 *Flooded areas*

The attenuation of flood season flows due to increasing amounts of storage envisaged within the basin under the different storages would have a consequential effect on year-to-year average flooding. The total area inundated by the mainstream flooding in an average hydrological year reduces from 4.76 Mha to 4.45 Mha (-7%) going from the Baseline to the LMB 20-Year Plan Scenario. In percentage terms, changes are biggest in Thailand (-21.8%) and Lao (-18.6%), are moderate in Cambodia (-6.5%) and small in Viet Nam (-0.9%). In a dry year changes in Lao PDR and Thailand are smaller, only about 3%, in Cambodia bigger (-9%).

The impacts are mostly caused by the Definite Future Scenario with relatively small incremental impacts caused by the Foreseeable Future Scenarios, as illustrated in Table 10.

Table 10 Changes in total average flooded areas, '000ha

Ref	Scenario	Lao	Thailand	Cambodia	Viet Nam	Total
1000	**Baseline**	405	369	2,183	1,802	**4,759**
3000	**Definite Future**	341	300	2,077	1,792	**4,510**
	Change from baseline ha	-64	-69	-106	-11	**-249**
	Change from baseline %	-16%	-19%	-5%	-1%	**-5%**
5000	**20-year Plan w/o MS dams**	331	288	2,054	1,786	**4,459**
	Change from baseline ha	-74	-80	-129	-16	**-300**
	Change from baseline %	-18%	-22%	-6%	-1%	**-6%**
4000	**20-year Plan**	330	288	2,041	1,786	**4,445**
	Change from baseline ha	-75	-80	-142	-16	**-314**
	Change from baseline %	-19%	-22%	-6%	-1%	**-7%**
4001	**20-year Plan + CC**	400	342	2,469	1,854	**5,065**
	Change from baseline ha	-6	-27	286	52	**306**
	Change from baseline %	-1%	-7%	13%	3%	**6%**
8000	**Long term development**	331	291	2,015	1,774	**4,411**
	Change from baseline ha	-74	-78	-168	-28	**-348**
	Change from baseline %	-18%	-21%	-8%	-2%	**-7%**
8001	**Long term development + CC**	460	423	2,300	1,856	**5,040**
	Change from baseline ha	55	55	117	53	**281**
	Change from baseline %	14%	15%	5%	3%	**6%**
9000	**Very high development**	327	288	1,981	1,771	**4,367**
	Change from baseline ha	-78	-80	-202	-32	**-391**
	Change from baseline %	-19%	-22%	-9%	-2%	**-8%**

Under the Long Term Development and Very High Development scenarios the flooded areas decrease by a further 8%.

As may be seen, in absolute terms the reductions in flooded areas (without climate change) are greatest in Cambodia (up to 142,000ha reduction under the 20-year plan and potentially more in the longer term). However, when climate change is taken into account, the total flooded area in Cambodia is estimated to increase by 13% (286,000ha) under the 20-year plan scenario. A similar trend is forecast across the overall basin with total flooded areas increasing by 6% in both the 20-year and long term scenarios with climate change.

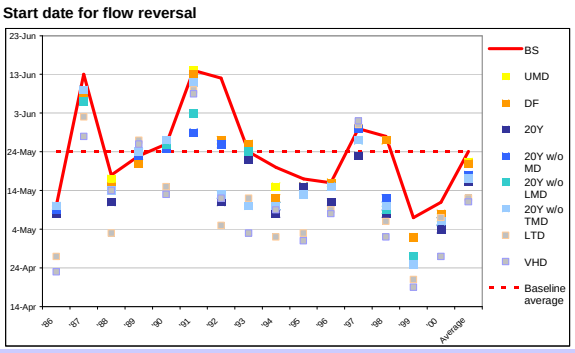
As reported in Technical Note 9 accompanying this report, **in dry years** changes in flooded area in Lao PDR, Thailand and Viet Nam are typically 3.0-3.5% lower than quoted in Table 10 in all scenarios, whereas in Cambodia the decreases in flooded area are typically lower by 9% (20 Year plan scenario) and 12.5% (Very High Development scenario). However, when climate change is taken into account flooding in Lao PDR and Cambodia in dry years decreases with 35 to 50%, whereas in Cambodia and Viet Nam the flooding tends to increase.

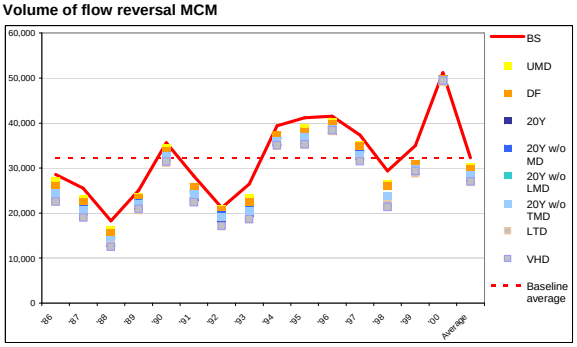
In wet years, flooding in Lao PDR and Thailand increases somewhat above the values given in Table 10, with the exception of the scenarios that take climate change into account, which show marked decreases in flooding for the 20 year period and only small changes in the long term. In Cambodia and Viet Nam the total flooded area decreases slightly under the various scenarios compared to the Baseline, again with the exception of the scenarios that take climate change into account. Under these scenarios the total flooded area in Cambodia increases with some 8% compared to the Baseline, in Viet Nam with about 2%.

3.2.4 *Flow reversal in the Tonle Sap river*

Flow reversal in the Tonle Sap river will also be affected. In the baseline the average start date for flow reversal is about 24 May with the natural year-to-year variation by +/- 19 days (5 May-12 June). In comparison with the baseline, flow reversal occurs typically on average 3 days earlier and with slightly increased variability. Also the flow reversal volume into the Tonle Sap Lake reduces on average by 7-8%. Whilst, by comparison, the natural year-to-year variation in flow volume amounts to up to about 300%, it will be appreciated that the forecast changes indicate a downward trend in flow reversal volume. These effects are illustrated in Figure 13.

Figure 13 Flow reversal in Tonle Sap, start date and volume





	BS	UMD	DF	20Y	20Y w/o MD	20Y w/o LMD	20Y w/o TMD	LTD	VHD
Average start date	24-May	21-May	21-May	16-May	18-May	17-May	17-May	12-May	11-May
Days earlier	0	3	3	8	6	7	7	12	13
Max-min start date	38	43	42	47	40	40	47	49	50
Range increase (days)	0	5	4	9	2	2	9	11	12

	BS	UMD	DF	20Y	20Y w/o MD	20Y w/o LMD	20Y w/o TMD	LTD	VHD
Average volume	32,259	30,145	29,740	27,993	28,358	28,339	28,340	26,937	27,008
Change from BS	0%	-7%	-8%	-13%	-12%	-12%	-12%	-16%	-16%
Max-min volume	32,950	33,530	34,286	36,065	35,833	35,633	35,631	36,270	36,855
Range increase (MCM)	0%	2%	4%	9%	9%	8%	8%	10%	12%

3.2.5 *Salinity intrusion*

As a consequence of the increased dry season flows, salinity intrusion will also reduce with the area potentially affected each year being 15% less than currently observed (272,000 ha), as illustrated in Figure 14.

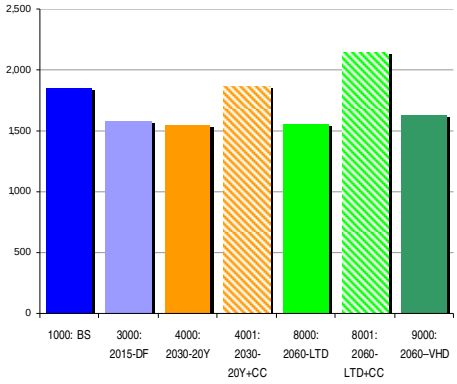


Figure 14 Area affected by salinity greater than 1.3 mg/l by scenario

However, these gains may be offset by climate change as currently forecast over the next 20 years. Further discussion of the implications of changes in salinity affected areas is presented in Section 3.3.7.

3.3 Environmental impacts

3.3.1 *Assessment context and connectivity*

The wetlands of the Lower Mekong river basin play a vital role in the lives of the inhabitants and the socio-economic development of the region. The river and its tributaries, backwaters, lakes and swamps support many unique ecosystems, such as the river's deep pools, plains of reeds and mangrove forests. Recent studies show that rural people use a large number of species caught or collected in wetlands. These species are collected from a wide variety of both permanent and seasonally flooded habitats, including perennial rivers, ponds, marshes and flooded forests.

As well as their direct use for rice cultivation and freshwater capture fisheries, wetlands have other indirect uses, such as absorbing floodwaters that could otherwise be disastrous during the wet season. Cambodia's Great Lake, for example, expands in surface area as much as four to five times during the wet season. Without this natural absorption capacity, Phnom Penh would be completely flooded every year.

Since wetlands occur in a transition zone where water-based ecosystems gradually change to land-based ones, a small difference in the amount, timing or duration of water flows can result in a profound change in the nature of the wetland and its unique plants, animals and processes.

The Mekong Basin is also one of the richest areas of biodiversity in the world. Its wetland and forest ecosystems provide a range of habitats for an astonishing collection of flora and fauna. Recent estimates of the biota of the greater Mekong region include 20,000 plant species, 430 mammal, 1200 bird, 800 reptile and amphibian, and 850 fish species, with new species still being described [MRC State of Basin Report, 2010].

However, accelerating economic development, population growth and increased consumption patterns are placing pressure on the environment. Many important bird habitats have been degraded by wetland drainage, overgrazing, peat mining, reservoir construction, pesticide use and changes to agricultural practices. As well as degradation and fragmentation of habitats, birds are threatened by subsistence egg collection, hunting and trade.

The basin's diverse fish fauna include several large fish species whose numbers appear to be declining, including the critically endangered giant catfish (*Pangasianodon gigas*). These and other migratory fish are further threatened by infrastructure development, such as dams that alter the natural flow of the river and block migration routes.

Some of the world's most spectacular and threatened amphibians and reptiles are present in the basin, but many populations are being destroyed by hunting and trading. Aquatic or semi-aquatic turtles, snakes and lizards are hunted for instance for subsistence or sold for food or medicine in local markets.

Nevertheless, the plains of the lower Mekong still retain some areas of near pristine habitat for water birds, with mosaics of open deciduous forests, seasonally inundated wetlands and grasslands and riverine habitats. The Tonle Sap Great Lake is also extremely important for large water birds. Efforts are being made to protect the surrounding grassland habitat from being converted to rice farms. Other threats to wetland bird habitats are the expansion of human settlements and, in the Mekong Delta, by the large-scale intensification of agriculture.

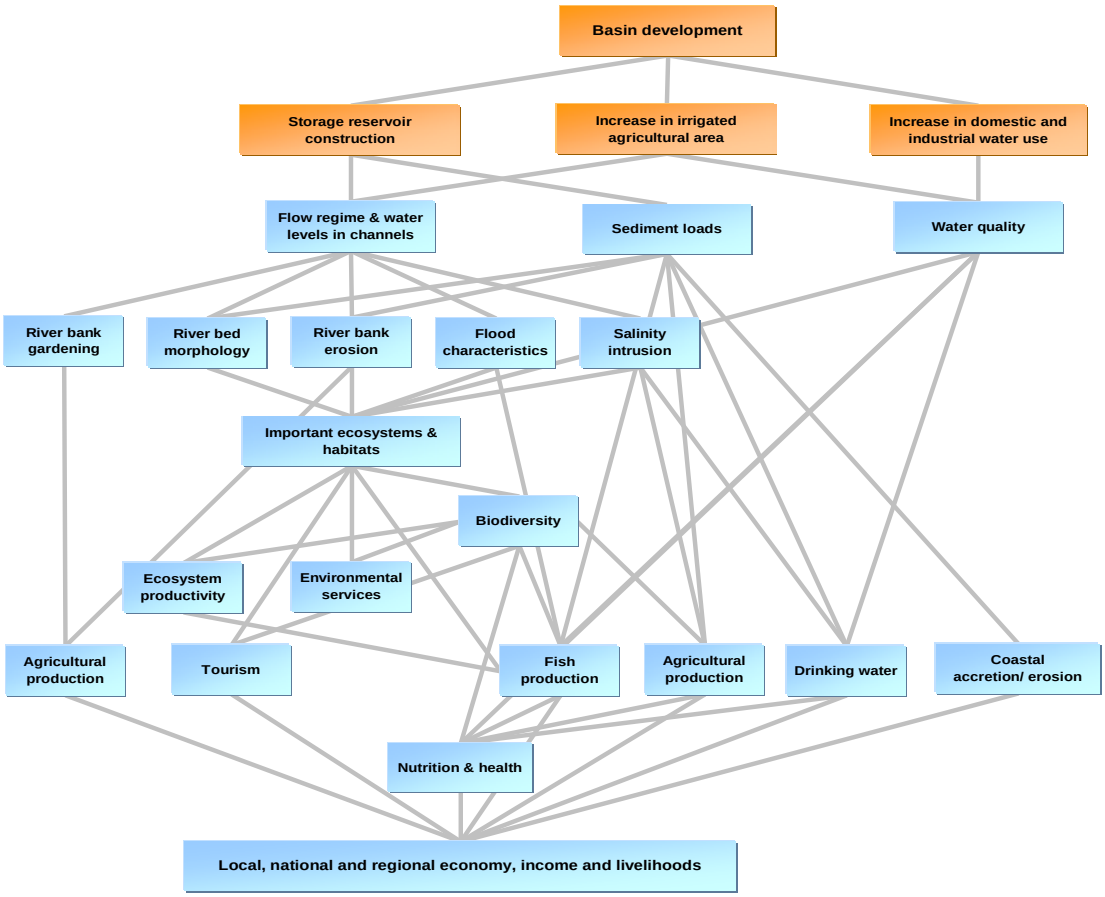
Within this context, the assessment of environmental impacts of the different scenarios must take fully into account the connectivity of the river system and its constituent parts with the related natural resources of the basin. This system extends from the Tibetan snow fields to the luxuriant delta and embraces not only the flow of water, but also the flow of sediments, nutrients and pollutants, as well as the natural annual movement of fish and other fauna through the system.

The considerable complexity and interconnectivity of these many issues are recognised and, in order to maintain a systematic approach for the scenario assessments, are illustrated diagrammatically in Figure 15 overleaf.

Accordingly, the environmental assessment, which is set in the context of the hydrological changes in the river system as described in Section 3.2, focuses on the main components of the network illustrated and their inter-linkages:

- Geomorphological assessment
- Sandbars, rapids and deep pools
- Floodplain sedimentation and marine sediment plume
- Bank erosion
- Water quality
- Salinity intrusion
- Inundated forest areas
- Marshes and inundated grasslands
- Mangroves and inundated rice fields.
- Bio-diversity and eco-tourism
- Impacts on the Tonle Sap system

Figure 15 Cause effect network for basin development scenarios



3.3.2 *Geomorphological assessment*

An assessment has been made of the potential geomorphological impacts of the scenarios in relation to the baseline conditions. Data are relatively scarce and the assessment has been made on a mixture of documentary review and expert opinion supported by modelling of typical processes. The views reached are based on an understanding that approximately 40% of the sediments in the mainstream system are derived from the upper catchments in China, 40% from the 3S basin in the LMB and 20% from other catchments in the LMB[10].

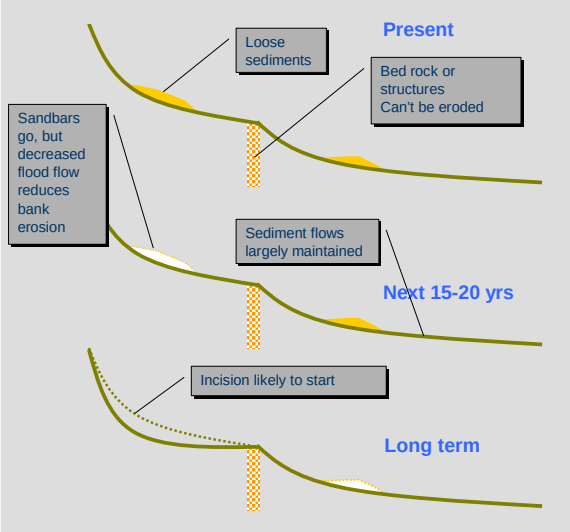
[10] There are differences of view over the exact distribution of sediment sources throughout the basin and further monitoring is being undertaken in an attempt to narrow these differences. The significance of this discourse is that the estimates of sediment trapping require an understanding of both the location of dams and the sediment flows from the dam's catchment. Whilst there is some consensus on the proportion emanating from China, it appears there remains a divergence of view concerning the 3S basin. This is of particular relevance to the impact of the dams within this tributary system as well as to the lower of the proposed LMB mainstream dams.

The developments planned in the Definite Future Scenario, which include substantial development of dams in the Upper Mekong Basin in China and in the 3S basin, indicate that substantial reductions in sediments entering the mainstream system will occur under this scenario.

Further developments on other tributaries principally in Lao PDR and in the mainstream as envisaged under the Foreseeable Scenarios (20-year plan) will thus impact only on the remaining 20% of sediments entering the system from the other catchments.

The consequences of reductions in sediments entering the mainstream system, combined with only relatively small modifications to the geomorphologically significant wet season flows, are that the river will seek to restore the sediment balance firstly be scouring existing sediments in the river and secondly, as these are cleared out, by attempting to adjust its slope and shape to one compatible with the reduced sediment concentrations. The timing of these processes is difficult to predict with accuracy without further data collection and predictive modelling. The manner in which this happens will be constrained by the presence of rock beds in parts of the river (which will determine minimum bed levels at specific locations). The introduction of mainstream dams will affect these processes both in the context of fixing bed levels at the dams' locations and through the temporary storage of sediments influencing sediment concentrations downstream of the dams.

Figure 16 Illustration of geomorphological processes



Given these understandings, the potential major changes to the morphology of the mainstream will be induced by current developments in the Definite Future Scenario, such that irreversible changes will occur. However, other than at specific locations where local effects can be expected, as a result of mainstream dams, for instance, in the medium term at a regional scale the morphological changes are likely to be small.

The loss of impounded sediments in the upper reaches is being compensated by the take-up of existing deposits in the system. Effects on channel morphology will be noticed in upstream reaches first and in downstream reaches at later dates. Upstream effects may become evident in the Foreseeable Future Scenarios. In the longer term (> 20 years), the river's shape will start to adjust more aggressively.

Because the geology through which the river flows changes down its length, these impacts will be felt differently along the mainstream. In broad terms this can be characterised as set out in Table 11 overleaf.

Table 11 Anticipated geomorphological impacts in mainstream reaches

Reach	Description
1. Chiang Saen to Vientiane	This is a bedrock channel so no major changes in channel shape will occur but sediment will be flushed out from the channel in the Foreseeable Future Scenario.
2. Vientiane to Nong Khai	The channel is alluvial and readily erodible. Bed levels may begin to fall within the Foreseeable Future Scenario (next 20 years), and river bank stability may decrease locally.
3. Nong Khai to Pakse	The channel is alluvial upstream but has major bedrock bed level controls downstream. Consequently, channel change effects will be more evident in the alluvial sections but are not likely to be significant within the Foreseeable Future Scenario.
4. Pakse to Stung Treng	This is a bedrock channel so no major changes in channel shape will occur and sediment is not likely to be flushed out within the Foreseeable Future Scenario
5. Stung Treng to Kratie	This is a bedrock channel so no major changes in channel shape will occur. However, the 3S Basin is thought to supply large amounts of sediment to the main river at the confluence near Strung Treng. Due to dam construction in the 3S Basin sediment inflow to the main river will decrease. Consequently, sediment is likely to be flushed out within the Foreseeable Future Scenario.
6. Kratie to the Delta	The channel is alluvial and readily erodible. Sediment loss may occur immediately downstream of Kratie within the Foreseeable Future Scenario and sediment losses further downstream will become noticeable at some point in the next 10-30 years. However, projected local engineering works and sand mining are more likely to induce medium-term effects on channel morphology rather than flow regulation by the existing and proposed dams.

3.3.3 Sandbars, rapids and deep pools

Understanding how sandbars, rapids and deep pools, which form important habitats for various fish and other aquatic animal species, and floodplain sedimentation are potentially impacted by changes in river flows is founded on the geomorphological findings above.

In broad terms the environmental utility of rapids and deep pools is unlikely to change significantly as a result of flow changes over the next 20 years. On the other hand sandbars are expected to disappear progressively over time starting from the upstream end, becoming noticeable in the next 20 years.

Construction of the mainstream dams under the LMB 20-Year Plan Scenario will heavily affect sandbars, rapids and deep pools. Nearly 60% of the river stretch between Sambor at km 575 and Houei Xai (at km 2,300) will change in character from a free flowing river to a cascade of impoundments. Sandbars and rapids in these impoundments will drown and deep pools will gradually start to fill in. This will have very significant negative impacts on the species diversity. Fish and water birds will be affected most. These impacts will affect the ‘river bank dwellers’ that rely on the river and the fertile banks for livelihood values.

3.3.4 *Floodplain sedimentation and marine sediment plume*

Floodplain sedimentation will decrease within a decade with consequences for agricultural production, prompting a much greater reliance on fertilisers if the same levels of productivity are to be maintained. Other than the direct impacts of sedimentation rates of flood control works, both issues are driven by events in the Definite Future Scenario and only marginally impacted by subsequent developments.

The Mekong delta undergoes a complex process of erosion and aggradation. Initiated by the Definite Future Scenario less sediments will wash along the eastern coast of the delta, exacerbating the effects of erosion in these provinces and also reducing the rate of deltaic growth currently experienced by the Ca Mau peninsula. The erosion problems will become increasingly visible in the longer term[11].

The predicted reductions in the discharge of fine sediments and associated nutrients to the coastal water will negatively impacts on productivity of the system and thus may affect biodiversity and costal fisheries yields. The SEA of hydropower mainstream dams estimated that the Definite Future Scenario may halve the current discharge of about 16,000 tonnes of Total Phosphate to the estuarine marine environments off the Mekong delta coast. The resulting discharge of 8,500 tonnes would be halved again by the implementation and operation of all proposed LMB mainstream dams.

3.3.5 *Bank erosion*

The areas currently affected by bank erosion in Lao PDR and Thailand reaches of the mainstream have been identified and are estimated to be of the order of 24 ha/year and 20 ha/year respectively. As discussed above, the vulnerability of these areas will not change significantly within the next 20 years and, if anything, may slightly reduce due to the lower wet season discharges[12].

As discussed in Section 3.3.2, in the longer term downstream of dam sites, the river will incise and this may increase bank erosion locally. The river bed downstream of Kratie will incise by up to 2 metres at some locations, resulting in serious bank erosion. Little is known of the impact of the scenarios on coastal erosion. Autonomous developments (flood protection, river training, sand mining) may have a more severe impact than flow induced morphological changes.

[11] Again there are differences of view over time-scale of coastal impacts. An alternative line of argument suggests that the delta has already started a process of regression and any reductions in sediment may precipitate at some point a step-change in the rate of regression. A view expressed is that this point may be reached in the near term as a result of new dams in China and in the tributaries in the DFS, exacerbated by sand mining in the LMB mainstream. Further studies are clearly merited.

[12] Increases in flood peak variability and magnitude that may be brought by climate change may render some sections of the river banks more vulnerable but overall this will significantly affect the conclusions above,

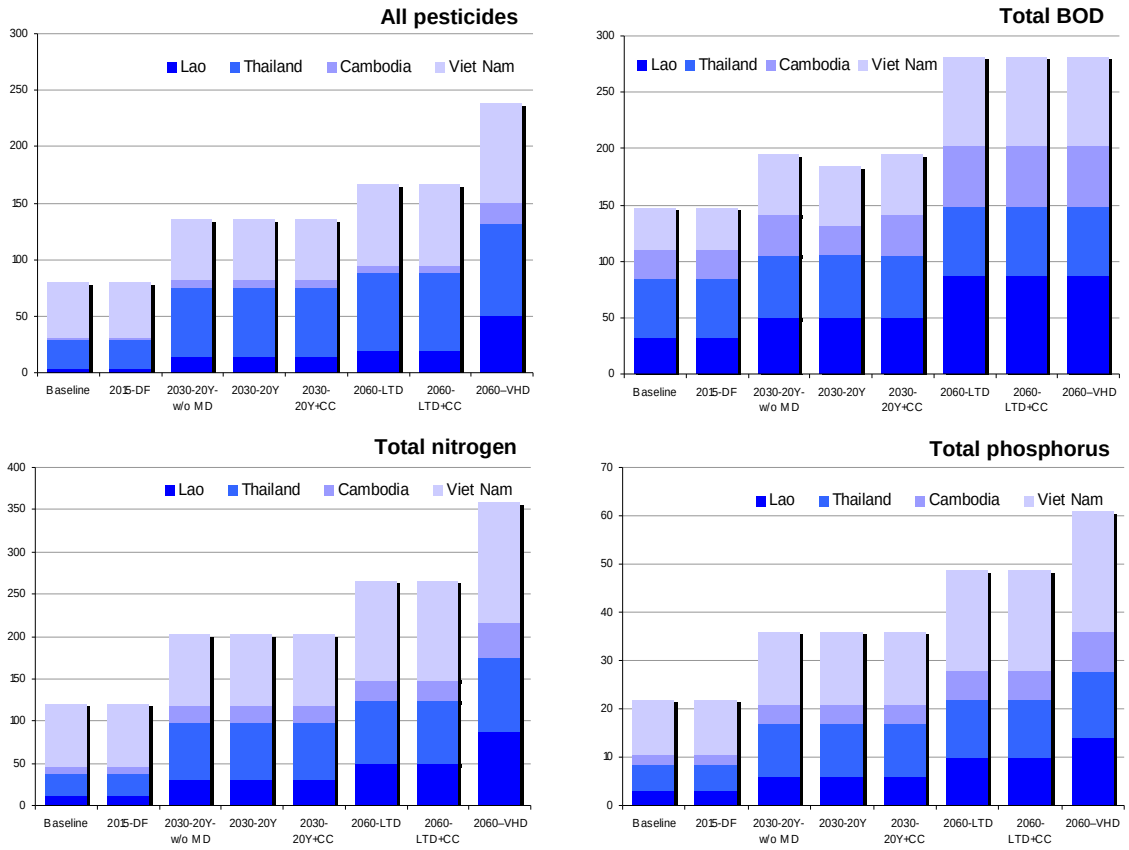
3.3.6 *Water quality*

Water quality changes will occur due to three main mechanisms, as follows.

Sediment flows and **the nutrients** associated with these are expected to reduce noticeably in less than a decade due to sediment trapping by the mainstream dams in China and the tributary dams in Lao PDR. Additional mainstream dams will further reduce floodplain sedimentation and sediment inflow in the Tonle Sap. In the longer term, sediments and nutrients may well reduce as a consequence of the storage introduced during the Definite Future Scenario with only marginal reductions attributable to subsequent developments in the Foreseeable Future Scenarios.

The second mechanism is the increased likelihood of **agro-chemical residues** entering the river system as a consequence of agricultural intensification. This intensification is expected to be mainly associated with the expansion of irrigation areas and increased use of agro-chemicals, which are related to the developments associated with the Foreseeable Future Scenarios. The analysis indicates that the Chi-Mun, 3S and Tonle Sap basins are the most likely areas where significant increases in residue runoff will occur.

Figure 17 Pollutant runoff, MT/year



However, due to the fact that dry season flows of the main river will increase in the Foreseeable Future, N and P concentrations will most probably remain below threshold values. Nevertheless, the tributary streams directly entering the Tonle Sap will all support expanded irrigation in the future, increasing drainage flows and raising the likelihood of increased agricultural input residues entering the Tonle Sap. This will need to be carefully monitored.

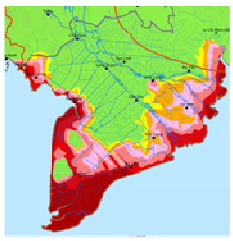
Adoption of improved management practices in irrigated areas are likely to be required.

The third potential growth is rising **wastewater discharge** due to population growth and increased clustering in urban centres and expanding rural villages and towns. Not only will the volume of waste increase, but also so will its concentration at points of entry to the river system.

Nutrient loads from wastewater discharges are small compared with nutrient loads from irrigated agriculture. This, in combination with the fact that sanitation levels in the region are excepted to increase, leads to the conclusion that impacts on water quality of increasing wastewater discharges will only be of local importance and accordingly addressed.

Nevertheless, at the basin-scale it is important that monitoring for any transboundary pollution is continued. All scenarios under consideration increase dry season flows and thus dilute pollution. Reduced inflows to Tonle Sap, and population growth together with economic developments around the lake, suggest water quality in the lake must continue to be carefully monitored.

3.3.7 *Salinity intrusion*



The areas affected by salinity intrusion will decrease mainly as a result of the Definite Future Scenario with marginal further changes associated with the Foreseeable Future Scenarios. An assessment has been made of the likely impact on land productivity within the saline-affected areas. These are based on estimates of the productivity of land under different salinity conditions and the changes of areas under different salinity classes as shown in Figure 18.

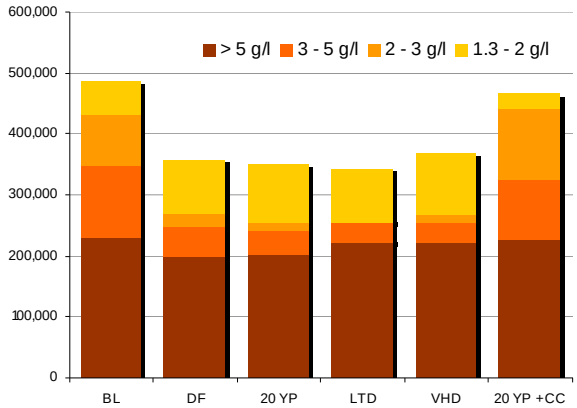


Figure 18 Saline affected areas in Viet Nam delta

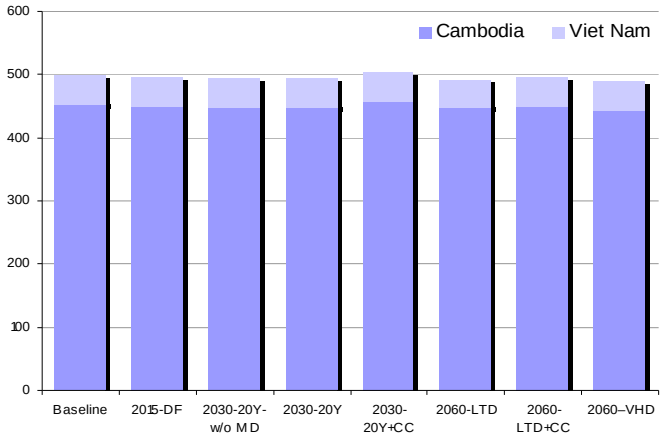
The preliminary findings are that the predicted reductions in salinity intrusion will contribute to an increase in agricultural production in the delta area of 467,000 tons under the Definite Future Scenario and a further 27,000 tons under conditions in the Foreseeable Future Scenarios[13].

Under long term and very high development (2060), production increases are sustained but at slightly lower levels at 444,000 tons and 416,000 tons. However, with climate change and sea level rise in particular over the next 20 years, these increases are almost completely countered with production being just 44,000 tons above baseline conditions.

3.3.8 Inundated forest areas

Inundated forests comprise both seasonally inundated riverine forests and seasonally inundated floodplain forests.

Figure 19 Inundated forest areas, '000ha



Small pockets of floodplain forest in Lao PDR and Thailand are included in the wetland category marshes/seasonal wetlands.

Under the Definite Future and LMB 20-Year Plan Scenarios, changes in forest areas in an average year are expected to be small, as illustrated in Figure 19.

In Cambodia the presently flooded forest area will be reduced by about 1%. However, areas of shallow flooding will increase at the expense of deep flooded areas with the average flood depth decreasing by 0.4 to 0.6 m.

Average flood duration may also decrease by up to one month in some areas. In dry years the changes are larger than in average hydrological years, in a wet year changes are smaller.

[13] It is noted that brackish water aquaculture is also a significant and very valuable activity within the saline-affected areas. This is practiced in a zone where seawater and freshwater can be mixed. With increased dry season flows and modification of the saline front, it is reasoned that this zone moves marginally towards the coast but that its extent need not change. Therefore the net impact of increased dry season flows on brackish water aquaculture is viewed as both small and manageable.

3.3.9 *Marshes and inundated grasslands*

Under the Foreseeable Future Scenarios the area of marshes flooded in an average year decreases by about 24% in Lao PDR and 19% in Thailand as compared with the baseline.

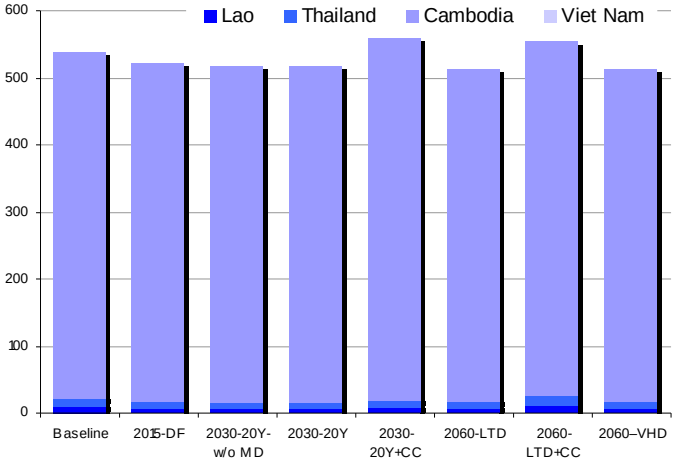


Figure 20 Marsh areas in average year, '000ha

Most of these changes can already be attributed to the developments in the Definite Future Scenario.

In Cambodia marsh areas flooded by the average flood decrease by about 4% under the Foreseeable Future Scenarios as compared to the Baseline Scenario.

The Long Term Development scenarios will create an increase in marshland/seasonal wetland areas for Lao PDR due to the increase in reservoir areas.

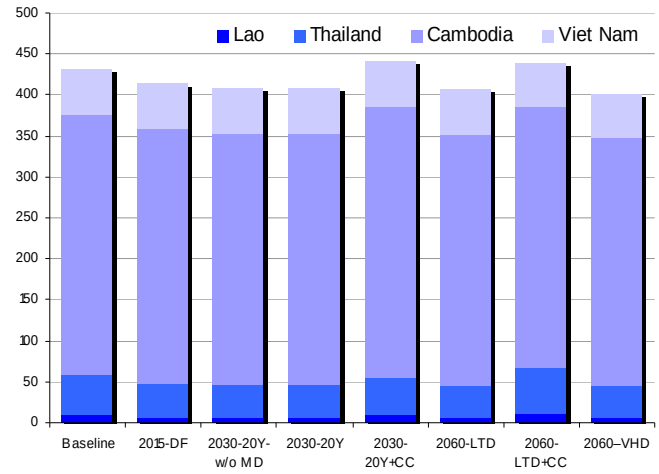
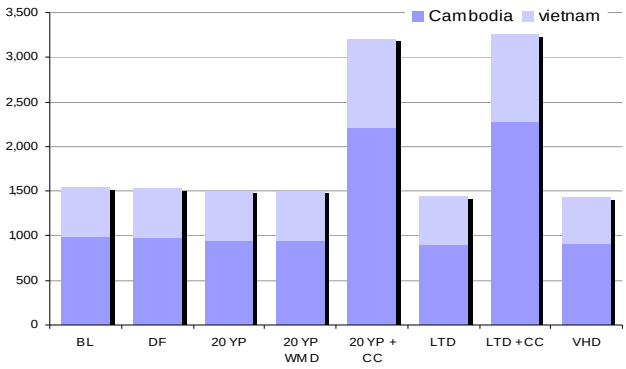


Figure 21 Inundated grassland area in average year, '000ha

Inundation of grassland will decrease considerably in Lao PDR (44%) and Thailand (18%) under the Foreseeable Future Scenarios as compared with the Baseline Scenario. Changes in flooded grassland areas in Cambodia and Viet Nam are smaller.

Again, where flooded area decreases, so also does the flood depth and duration of the grasslands and changes are bigger in a dry year than in an average or wet year.

3.3.10 *Mangroves and inundated rice fields*

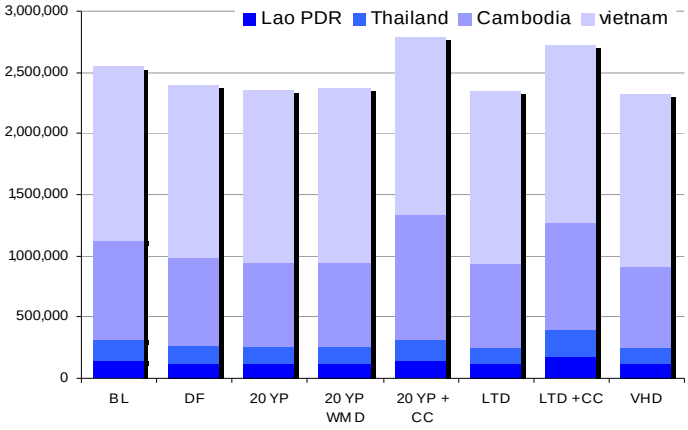


Changes in inundated Mangroves areas in Cambodia under the Foreseeable Future Scenarios are small, about 5%, while the area for Viet Nam remains unchanged.

Figure 22 Flooded mangroves area in average year, ha

Over the longer term scenarios with climate change, mangrove areas will increase significantly as compared with the Baseline Scenario.

Figure 23 Flooded rice field area in average year, ha



The 20 Year Scenario and the Long-term Development and Very High Development Scenarios show similar results of an decrease in areas of inundated rice fields about 19%, 23% and 17% for Lao PDR, Thailand and Cambodia respectively. The impacts of climate change will offset decreases and for the Long Term Development with climate change there will even be an overall increase across the basin for inundated rice fields.

3.3.11 *Bio-diversity and eco-tourism*

Bio-diversity is affected significantly by the predicted reductions in wetlands, changes in sediment and water quality, impoundment of large parts of the main channel under the LMB 20-Year Plan Scenario, as discussed above and elaborated in Technical Note 9, Impacts on wetlands and bio-diversity.

Migratory fish species will be highly affected by the expansion of mainstream dams and some tributary dams. Although this complex subject is still under review, it seems likely that barriers caused by mainstream dams will have a more dramatic input the lower they are down the basin. An obvious example is the Irrawaddy dolphin that will undoubtedly be threatened during construction and operation of the Cambodian dams and

Don Sahong. However, for species that migrate to northerly spawning grounds, any barrier along their route will cause a major impact on their sustainability. A case in point may be the Giant Catfish.

With regard to the sustainability of four flagship species, preliminary findings are as follows. The *Mekong Dolphin* and the *Giant Catfish*, which are already under threat from human activity, are both migratory and depend upon access to deep pools. The presence of mainstream dams in the LMB will cut off their access to these pools and hasten the likelihood of their extinction.

Table 12 Sustainability of flagship species

Flagship species	BL	DF	20Y	20Y +CC	20Y w/o MD	20Y w/o 5 lower MDs	20Y w/o 2 Thai MDs	20Y w/o 2 Camb. MDs	LTD	LTD +CC	VHD
Mekong River Dolphin, Irrawaddy Dolphin *Orcaella brevirostris (CR)*	H	H	EX	EX	H	H	EX	H	EX	EX	EX
Mekong Giant Catfish *Pangasianodon gigas (CR)*	H	H	EX	EX	H	EX	EX	EX	EX	EX	EX
Siamese Crocodile *Crocodylus siamensis (CR)*	M	M	H	H	M	M	H	M	Ew	Ew	Ew
Eastern Sarus Crane *Grus antigone sharpii (VU)*	L	L	M	H	M	M	M	M	H	H	H

H = high; M = moderate; L = low; EX = extinct; Ew = Extinct in the wild

The *Siamese Crocodile* is currently under threat in the wild, but the changes in the flow regime will cause only small change to its natural habitats. Breeding programmes may ensure the sustainability of this species.

The fourth flagship species is the *Sarus Crane*, which depends upon the availability of inundated grassland. This habitat is expected to diminish slightly, but not to the extent that it will threaten the sustainability of this graceful bird.

The 2004 IUCN Red List of Threatened Species mentions 197 species in Cambodia considered at risk of extinction, endangered, critically endangered, or vulnerable. Of these, 24 are critically endangered, 39 are endangered, and 53 are vulnerable. Many of these are found in the Tonle Sap

ecosystem: the Tonle Sap inundated forests form one of the most important breeding sites for at least seven large water birds in Asia.

Loss of inundated forest area, combined with a likely decrease in the ecosystems quality due to changing flood conditions, will further jeopardize the survival of these rare and endangered species. Also depending on the system are the Hairy-nosed Otter, more than five commercial species of water snakes (caught and traded) and the endemic Tonle Sap water snake *Enhydris longicauda*.

Of the 32 identified 'environmental hotspots' (Ramsar Sites, Biosphere Reserves, Protected Areas, and Important Bird Areas (see environmental baseline map at front of report for locations) in the impact area, 9 will be moderately and 1 highly affected under the Definite Future Scenario, see Table 13 overleaf. Due to the large impacts on biodiversity of the Lower Mainstream Dams, the number of highly affected hotspots increases to 12 under the LMB 20-Year Plan Scenario (with mainstream dams), as illustrated in Table 13.

Eco-tourism is an economic activity of increasing importance and the disappearance of flagship species and deterioration of environmental hotspots in particular would be expected to have a negative impact on this growing industry.

Table 13 Number of impacted hotspots

	No of impacted Hotspots		
	Low	Medium	High
BS	29	3	0
2015-UMD	24	8	0
2015-DF	23	7	2
2030-20Y	11	7	14
2030-20Y+CC	1	16	15
2030-20Y-w/o MD	11	16	5
2030-20Y-w/o LMD	11	14	7
2030-20Y-w/o TMD	11	7	14
2030-20y-w/o CMD	11	10	11
2060-LTD	0	17	15
2060-LTD+CC	0	11	21
2060–VHD	0	0	32

3.3.12 *Impacts on the Tonle Sap system*

Overview

Potentially severe impacts on the ecologically very important Tonle Sap system would be caused by an interaction between the inevitable impacts from ongoing developments in the Definite Future Scenario and the potential impacts from planned developments in the 20-year plan scenarios.

The inevitable and irreversible impacts caused by the Definite Future Scenario are mainly related to changes in flooded areas and flow reversal, resulting from changes in

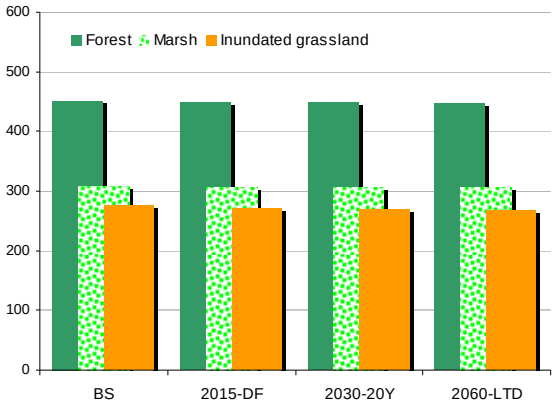
the hydrological regime associated with flows into the lake from the mainstream during the flood season and followed by an extended period of outflow during the start of the dry season.

The developments in the 20-year plan scenarios would further increase the flow related impacts and add non-flow related impacts, including a reduction in capture fisheries and biodiversity caused by dams.

Flooded areas

For the 20-year plan scenarios, a reduction is forecast of the total flooded area of 60,000 ha (4.5 %) in an average year, and as much as 100,000 ha (9%) in a dry year. Flooded forest areas will reduce by 5,000 ha (1.1%) in an average year and by 23,000 ha (5.3 %) in a dry year. Most of this reduction will be caused by ongoing developments.

Figure 24 Average areas flooded annually around Tonle Sap, '000ha



Inundated grasslands will also reduce by 8,500 ha (3.2%) in an average year and 25,000 ha (10 %) in a dry year, with lesser reductions in the area of flooded marshes (3,000 ha (1.0%) in an average year, 5,500 ha (1.8 %) in a dry year).

However the reduction of flooding on rice fields will be more significant, with 41,000 ha (18%) less flooded in an average year and 48,000 ha (28 %) in a dry year.

In the forest areas around Tonle Sap flood depths will typically reduce by just over 0.5m in both an average and dry year and flood duration with generally be less by up to 2 weeks in an average year and up to 1 month in a dry year. In the areas of inundated grasslands the situation is more complex: for 70% of the area flood durations in an average year will reduce by up to 1 month, whereas in 25% of the area an increase of flood duration of up to 1 month can be expected. A similar pattern is to be seen in dry years, even with a bit more pronounced increase.

Flow reversal

The annual flood pattern responsible for the inundation of large areas of southern Cambodia (including the Tonle Sap system) and the Mekong Delta is essential for fisheries productivity of the system.

The annual reversal of the flow in the Tonle Sap River is essential for ecosystem functioning. If the flow is not reversed (or if reversal is delayed), fish larvae drifting from upstream spawning sites in the Mekong River cannot access the important floodplain habitats of the Tonle Sap System.

A delayed flow reversal would also lead to a reduced floodplain area adjacent to the river and lake, and thus, reduced fish production. A reduction in flow reversal volume, brought about by delayed flow reversal, also has impacts on the volumes of flow, sediments and nutrients released from Tonle Sap during the end of the flood season and the early part of the dry season, potentially diminishing the productivity of downstream systems that benefit from these flows.

Changes in behaviour of the Tonle Sap system thus have impacts not only on the productivity of Tonle Sap but also elsewhere within the river system, including the downstream delta area.

The timing of the flow reversal date is expected to be on average 3 days earlier under the Definite Future scenario. Under the 20-year Foreseeable Future Scenario the flow reversal date advances by 8 days, with no or fewer mainstream dams the change is somewhat smaller, 6 or 7 days. Under the Long-Term Development and Very High Development scenarios the flow reversal date is expected to advance with 12 to 13 days. The volume of the flow reversal will reduce with 8% (Definite Future) rising to 13% under the 20 Year Plan scenario, and to 16% under the Long-Term Development and very High Development scenarios.

Water levels in the dry season are forecast to increase with 22 cm between the Baseline and the Definite Future and 36 cm under the 20 Year Plan Scenario. No or fewer mainstream dams reduce the water level increase to about 27 cm. Water levels increase slightly more under the Long-Term Development scenario (up to 34 cm). Under the Very High Development scenario the increase is only 16 cm compared to the Baseline. The scenarios that take climate change into account result in a water level rise of 50 to 60 cm. These water level rises will not result in a noticeable increase of the lake size, since banks of the lakes are steep and fairly high.

However, the volume of the lake in the dry season will increase considerably. With a dry season area of about 250,000 ha, an increase in water level of 22 to 37 cm equals an increase in lake volume with about 550 to 925 MCM, a considerable addition to the present 1,500 MCM lake volume in an average dry season. Under the long term climate change scenario the lake volume would nearly double.

Productivity of the Tonle Sap system

Most of the flow related changes are inevitable and will be caused by the Definite Future Scenario. The change in flow regime affects not only the extent of flooding (which is an important element of eco-system productivity within the lake), but also sediment in- and out-flows from the lake, affecting nutrient supplies both within the lake and for downstream users of the lake outflows. In addition, flow regime changes affect the timing of flow reversal, thought to be a key trigger associated with the life cycle of fish.

The 20-year plan scenarios would cause a deterioration of water quality resulting from increased nutrient loadings from agricultural return flows and wastewater discharges into the Cambodian tributaries that discharge into the Tonle Sap Lake. This would be accompanied by a loss of natural nutrients and sediments entering the Tonle Sap system as a result of a decrease in reverse flow.

Under the LMB 20-Year Plan Scenario, white fish production in the area may be halved and the possibilities for local people to collect timber and non-timber products from the wetlands will reduce. Furthermore blockage of the migration paths, in particular by the two proposed mainstream dams in Cambodia, will significantly reduce the large number of ecologically and commercially important fish species.

As a result, the ecology and primary productivity of the Tonle Sap system could change significantly through the simultaneous interaction of all above threats: reduced flooding, reduced reverse flows, and reduced inflow of nutrients associated to fine sediments (caused by the Definite Future Scenario) and the large decline in fisheries and biodiversity caused by the additional developments in the 20-Year Plan Scenario (with all LMB mainstream dams).

3.3.13 Summary of impacts on eco-systems and environment

The assessment of the environmental impacts in the foregoing sections highlights the inter-connectivity of the ecosystem impacts across all countries in the basin founded on:

- **Changes in the river system flow and flooding patterns** brought about by the introduction of the significant amounts of new storage both in the UMB and in the tributaries and increased irrigation abstractions as included in the different scenarios, all potentially further modified by climate change;
- **Changes in sediment flows** principally as a consequence of sediment trapping of the reservoirs and to a lesser extent by the run-of-the-river proposed new mainstream dams, but also as affected by changes in stream power and flooding patterns;
- **Changes in water quality and nutrient flows** brought about by both of the above together with the risk of increased run-off of residues from expanded irrigated agriculture (and to a lesser and relatively manageable extent increases in wastewater from urban and industrial centres); and
- **The barrier effect of new mainstream dams** on fish migration (which is discussed more fully in the next section on fisheries impacts)

Whilst the main focus of the environmental assessments has been on transboundary impacts, local impacts of the specific interventions are taken into consideration where their cumulative impacts are viewed as being of particular significance to basin-level assessment. In particular, the assessments are mindful of the cumulative local impacts of the proposed new mainstream dams and their operation on flow conditions within the mainstream.

The key impact areas have been identified and, to the extent that available information allows, the level of impact in these areas has been quantified. These key impacts include:

- The decrease in flood plain and coastal land productivity as a consequence of reduction of flooding, sediment and nutrient flows primarily as a consequence of increased storage and sediment trapping within the basin;

- The risk of bank erosion in part lessened by reduced wet season flows but increased by river regime change as the river system adjusts to new sediment loads, an issue particularly pertinent to stability of the Mekong Delta;

- The impacts of increased dry season flow depths, compounded by the presence of the proposed new mainstream dams, on riverine habitats including bank-side and exposed river bed seasonal gardens and deep pools and the consequential impacts on local livelihoods and on fish refuges and spawning areas;

- The reduction in natural nutrients driven by increased sediment trapping and modified by changes in flow patterns (particularly with regard to the Tonle Sap system, but also the Mekong Delta flood plains) whilst at the same time the likelihood of increased runoff of agricultural input residues due to irrigated agriculture expansion and economic pressures to raise yields;

- The reduction in saline intrusion in the Mekong Delta brought about by increases in dry season flows from the increases in storages (especially those in the UMB), and the related potential for increased agricultural production in these areas;

- The reduction in extent of wetlands and key habitat areas as a consequence of modified flow patterns, the reduction of their productivity as a result of reduced sediment and nutrient flows and the consequential impact of both on the sustainability of various species, some of which are already endangered by human activity; and

- The consequential threats of all of the above on the basin's rich bio-diversity, particularly (but not limited to) to at least two of the four flagship species.

Whilst there remain some differences of view over the magnitude and immediacy of some impacts (most notably with regard to geomorphological aspects) the assessments conducted reveal a clear pattern of the environmental impacts that would arise from the different scenarios under consideration. These are summarised below.

The Definite Future Scenario

The substantial increase in storage in the basin, principally in the UMB, will have a direct and irreversible change on the basin's hydrology and geomorphology. The hydrological impacts will be immediate and the geomorphological impacts over a period of time. These changes will reduce the extent of wetlands and of other key habitats throughout the basin. The changes in river regime will be more marked in the upstream areas and proportionately less in the downstream areas (but on larger vulnerable habitat areas). The changes in sediment flow will be felt more markedly downstream of Kratie and may have significant impact on the Delta's

stability. For now, the timing of significant geomorphological changes is viewed as being within the medium and longer term, but others view this as a more immediate threat.

The key point concerning the Definite Future Scenario is that the changes will happen and that many impacts will be experienced within the near term in response to hydrological change (about which there is much consensus). Thus a strategy is unquestionably needed to cope with these changes and to, as far as possible, protect and sustain the vulnerable environmental and ecological assets within the basin.

The Foreseeable Future Scenarios

The Foreseeable Future Scenarios include a significant increase in tributary storage (for hydropower generation) and in irrigation abstractions, together with various combinations of up to 11 new mainstream run-of-the-river dams for hydropower generation. The planned increase dry season flows from the incremental tributary storage is broadly balanced by the increased levels of irrigation abstraction and consequentially at basin scale, given that the mainstream dams are run-of-the-river dams, the overall change in hydrological conditions is small compared to the changes to be witnessed in the Definite Future Scenario. Nevertheless, the increased amount of storage will lead to higher levels of sediment trapping, which will serve to exacerbate the geomorphological changes prompted by the Definite Future Scenario.

The impacts of the mainstream dams can be overlain upon the perspective above. These dams will individually and collectively contribute to a further modification of mainstream flow levels, to local disturbance of bed levels and to some extent on sediment flows. As with the tributary dams, how the mainstream dams are operated will significantly affect the nature of local impacts. On the other hand, the extent and timing of sediment flushing of these dams will have wider significance within the basin.

The mainstream dams will also create barriers to fish migration, which at basin-scale gains increased significance the lower down the mainstream they are located. Thus the impacts of mainstream dams are, firstly, local and location specific and, secondly and additionally, cumulative if viewed from an upstream to downstream order, with lesser basin-scale impacts attached to the upstream end.

Thus the impacts from the Foreseeable Future Scenarios may be considered in two parts. The first is those associated with tributary dams and increased irrigation. The tributary dams, as discussed above, will contribute towards increased sediment trapping and a reduction of nutrient flows, reducing eco-system productivity. As assessed, these impacts are only relatively small compared to those which will occur in the Definite Future Scenario.

The additional tributary dams may, depending upon location, also have impacts on fish migration and will certainly have local impacts (including positively creating opportunities for reservoir fisheries), which will need to be managed. Increased irrigation areas both raise the risk of input residue runoff and, as discussed in Section 3.4, create the opportunity for increased rainfed rice field habitats.

The major considerations in the Foreseeable Future Scenarios evidently relate to the number and location of the new mainstream dams and the degree to which they disrupt fish migration and the local impacts associated with raised and variable water levels (noting that at basin scale they cause only a small degree of flow modification). The unsurprising conclusion from the assessment is that all mainstream dams have significant local impacts and that impacts on fisheries are less severe for the upstream groups and more severe for the downstream ones.

The Long-term Scenarios

The Long-term Scenarios demonstrate the impacts of increasing numbers of tributary dams and irrigation expansion and therefore exacerbate the impacts attributed to these interventions. Depending upon the balance sustained of increased storage with increased irrigation, the principal additional effects are associated with increased risk of encroachment of valuable wetland areas and a further reduction in wet season peak flows due to the increased storage. Together with impacts of increased sediment trapping and dislocation of fish migratory routes within the tributaries, the further encroachment of wetland areas would place increasing pressure on existing environmental and ecological assets.

Climate change

The hydrological impacts of climate change are most significantly to increase runoff and the variability of flows prompting increase risk of both peak flooding and dry season drought. These impacts will not be uniform across the LMB. In terms of flooded areas and the extent of wetlands, in the medium term (2030) climate change is forecast on average to more than offset reductions in flooding caused by the new storages, but unevenly so, with Cambodia in particular seeing a significant increase in flooded area relative to the baseline.

In the very long term (2060), this trend is maintained, but with all countries seeing more flooding than the baseline. Whilst it is possible to conclude that climate change has a positive impact on the extent of wetlands, there are other features of climate change (such as impacts of temperature rising, increased variability of flows and timing of the seasons, etc) which need to be understood much better before fully understanding the impacts of climate change.

Overview of impacts of the scenarios

The assessments and conclusions drawn above have been assembled in a simple matrix to illustrate the overall severity of environmental impacts of each scenario. This is presented in Table 14 overleaf as a means of conveying an overview of the relative merits or demerits of each scenario from national and basin-scale perspective.

The scoring is based on expert judgement and in all cases relative to the baseline. It takes account of the significance to each country of the different impacts that may arise (thus for instance a large impact on the small area of wetlands in one country would be scored more severely than a small impact on a large area in another country even though the total area impacted in the former is less than the latter). It also seeks to factor in the timing of impacts

such as those associated with geomorphological changes (and adopts in this regard the views expressed in this report).

Table 14 Overall assessment of severity of environmental impacts by scenario

Ref	Scenario	Lao	Thailand	Cambodia	Viet Nam	Average
3000	Definite Future Scenario	-1 Mildly negative	-1 Mildly negative	-1 Mildly negative	-1 Mildly negative	-1 Mildly negative
5000	LMB 20-Year Plan Scenario without mainstream dams	-2 Negative	-2 Negative	-1 Mildly negative	-1 Mildly negative	-2 Negative
6100	LMB 20-Year Plan Scenario with 6 mainstream dams in Northern Lao PDR	-3 Severely negative	-2 Negative	-2 Negative	-1 Mildly negative	-2 Negative
6300	LMB 20-Year Plan Scenario with 9 mainstream dams, excl Cambodia	-3 Severely negative	-3 Severely negative	-2 Negative	-1 Mildly negative	-2 Severely negative
6200	LMB 20-Year Plan Scenario with 9 mainstream dams, excl Thailand	-3 Severely negative	-3 Severely negative	-3 Severely negative	-1 Mildly negative	-3 Severely negative
4000	LMB 20-Year Plan Scenario	-3 Severely negative	-3 Severely negative	-3 Severely negative	-1 Mildly negative	-3 Severely negative
4001	LMB 20-Year Plan Scenario Climate change	-3 Severely negative	-3 Severely negative	-2 Negative	-2 Negative	-3 Severely negative
8000	LMB Long-term Development Scenario	-3 Severely negative	-3 Severely negative	-3 Severely negative	-3 Severely negative	-3 Severely negative
8001	LMB Long-term Development Scenario Climate change	-3 Severely negative	-3 Severely negative	-2 Negative	-3 Severely negative	-3 Severely negative
9000	LMB Very High Development Scenario	-3 Severely negative	-3 Severely negative	-4 Extremely negative	-3 Severely negative	-3 Extremely negative

3.4 Impacts on fisheries

3.4.1 Fish consumption

The total consumption of fish and other aquatic animals (OAA) in the LMB is currently estimated (2008) to be about 2.8 Mt (million tonnes), of which 1.8 Mt is from capture, including some stocked and feral fish. The total production of fish and OAA in the LMB is about 3.8Mt, as a considerable amount is produced by aquaculture and exported elsewhere within the MRC countries (but outside the LMB) and to international markets. Current estimates are that total aquaculture is of the order 2.0 Mt, of which more than half is exported outside the basin.

Demand for consumption of fisheries products is expected to increase in line with population growth, to about three million tonnes in 2015 and 3.6 million tonnes in 2030; this increase was taken into account in the overall evaluation.

3.4.2 *Impact assessment per habitat*

A preliminary assessment has been made to estimate the likely impacts of developments and on the current yield from fisheries. Capture fisheries yield includes a very wide range of species of fish and other aquatic animals (OAA) caught in many different habitats.

The approach adopted has been to consider three broad categories of habitats and the likely impacts of changes to the extent and condition of those habitats on fisheries yield within those habitats. This has then enabled changes to be estimated of the amounts of fish and OAA available for consumption in the LMB. The habitats considered in these estimates are (i) river-floodplain wetlands, (ii) rainfed wetlands and (iii) reservoirs.

River-floodplain wetland habitats

River-floodplain habitats include all the rivers and floodplains within the major flood zone, defined as all land inundated during the Year 2000 flood. This land includes rivers, recession rice fields, flooded forests, swamps and other floodplain water bodies. A significant proportion of this land is irrigated in the dry season. Fisheries yield per unit area is much higher than in the rainfed zone, but the river-floodplain zone is much smaller, so total yield from the two main zones is similar.

Yield from R-FP habitats is estimated to be of the order of one million tonnes (see Figure 25 overleaf). Their fisheries are vulnerable to, inter alia, changes in the extent, duration and depth of flooding, changes in nutrient flows and water quality, changes in migration triggers and dislocation of migratory paths by dam construction in both the mainstream and the tributaries and by flood control works.

It should be noted that most of this habitat in Thailand is already disconnected by dams and weirs, so is not vulnerable to dams on the mainstream. The impacts on fish and OAA in the river-floodplain zone are difficult to predict because of the many ways in which they may be affected by dams, the large number of dams proposed, the lack of specific details for each project, the limitations of survey data and the difficult of modelling inter-specific interactions.

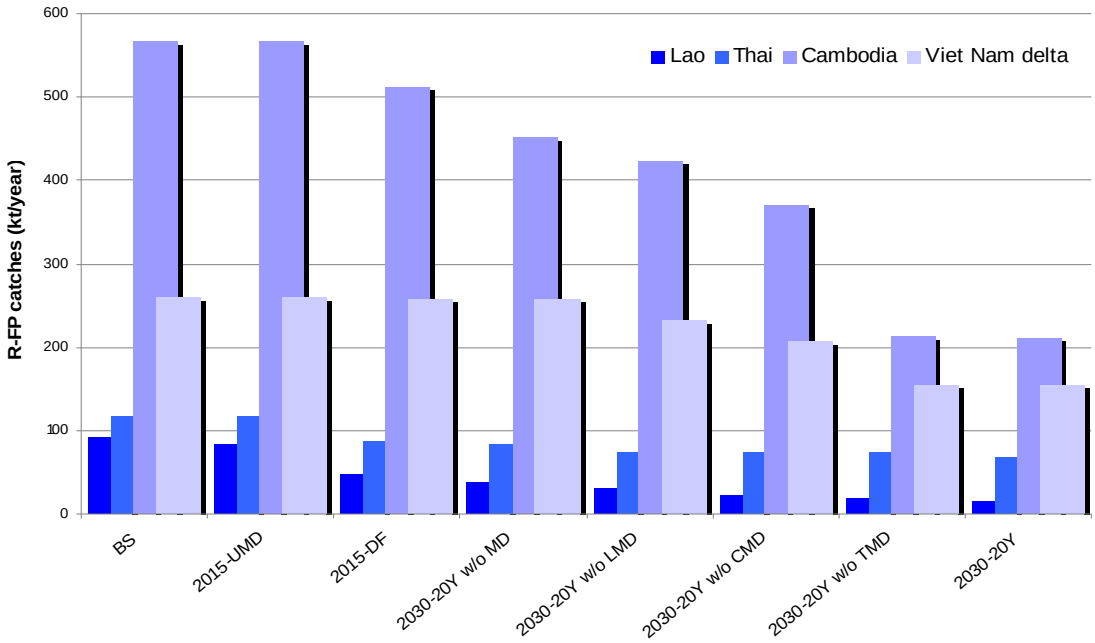
Based on various observations and data, about half of the river-floodplain fish catch may be black fish (or resident species) that will be less susceptible to dam impacts and about half will be more ‘river-dependent’ species including ‘white fish’ which are more likely to be affected by dams[14].

[14] It is recognised here that there is a body of opinion that believes the proportion of fish that are migratory lies within a range of 30-70% and that therefore potentially the barrier impact of dams upon wild fisheries could be higher than forecast in this report.

Taking all factors into account, by 2030 if all dams would be built, the total loss to river-floodplain catches is hypothesised as 593 thousand tonnes per year or about 58% of the total yield from this habitat class. Losses would be less if fewer dams are built, with the most impact being from mainstream dams in Cambodia.

The country experiencing the largest impact as a percentage of existing catches would be Lao, with a loss of 84% of its baseline of 92 thousand tonnes, because of the likely high proportion of river-dependent fish. However, the highest loss in absolute terms and the largest component of total losses will be in Cambodia, which would lose 354 of 565 thousand tonnes, a 63% loss. Thailand (48 of 117 thousand tonnes) and Viet Nam delta (105 of 260 thousand tonnes) would experience smaller but nevertheless significant impacts by 2030 if all dams are built.

Figure 25 Hypothesised losses of total catches (fish and OAA) in each country from the river-floodplain habitat class under each scenario

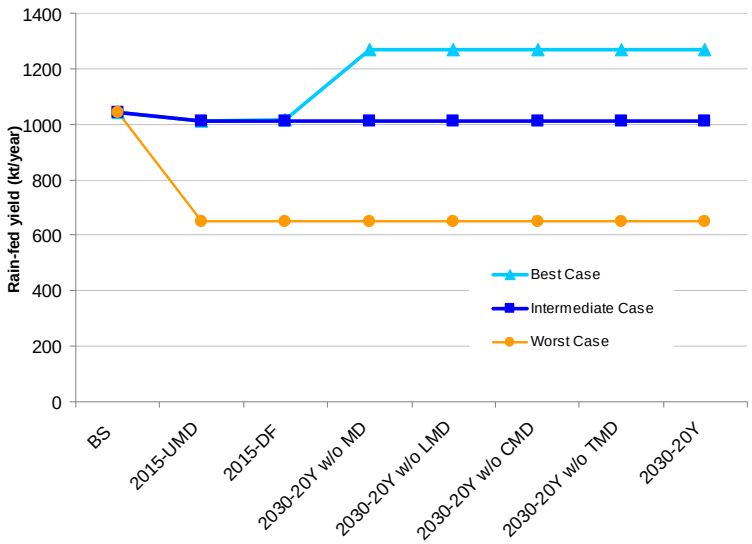


Rainfed wetland habitats

Rainfed habitats comprise principally rice fields and associated small ponds, canals and ditches, as well as some remnant marshes and small watercourses. Some rainfed land is irrigated from storages. Most rainfed habitat is in Thailand and, to a lesser extent, Lao and in Cambodia surrounding floodplains and in the Viet Nam delta outside the main flood zone.

River-dependent species cannot migrate into rainfed habitats because of the many barriers, shallow depths and fluctuating water levels, so these habitats support mainly black fish and other resident species that recruit locally.

Figure 26 LMB fisheries yield from rainfed rice field habitats, showing the 'best-case – worst- case' change in fisheries yield from irrigation under each scenario



As they are in this sense 'disconnected' they will be little-affected by any impacts on river-dependent species. The yield of these areas is relatively low per unit area, but due to their extent, their total yield is estimated to be of the order of one million tonnes.

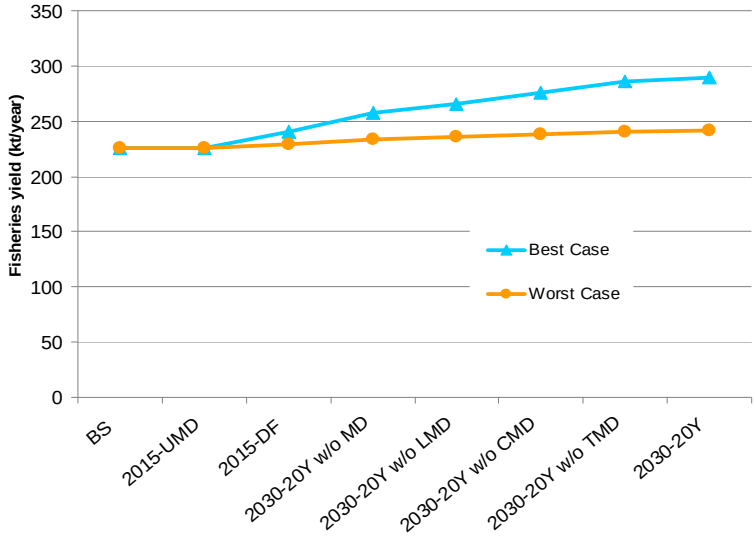
Their fisheries yield may be significantly increased by additional irrigation; in the best-case by 2030 by about 22% or about 386 thousand tonnes, making up for about 40% of the loss to river-floodplain catches, at a basin-wide scale.

However, intensifying rice farming often entails reducing irrigation depth and increasing pesticide use which may offset any gains from irrigation, which in the worst case may therefore lead to a net loss of rice field fisheries.

Reservoir fisheries

The expansion of reservoirs will lead to an increase in fisheries production and catches. The yield from all permanent surface water outside the major flood zone is currently estimated at about 226 thousand tonnes, mostly from reservoirs, and the proposed reservoirs are likely to add about 16-64 thousand tonnes (worst-best case) to this total, so are likely to provide only a minor compensation (up to 11%) for lost catches from river-floodplain habitats.

Figure 27 Change in fisheries yield from permanent surface waters under each scenario due to additional 'best-case' yield from reservoirs

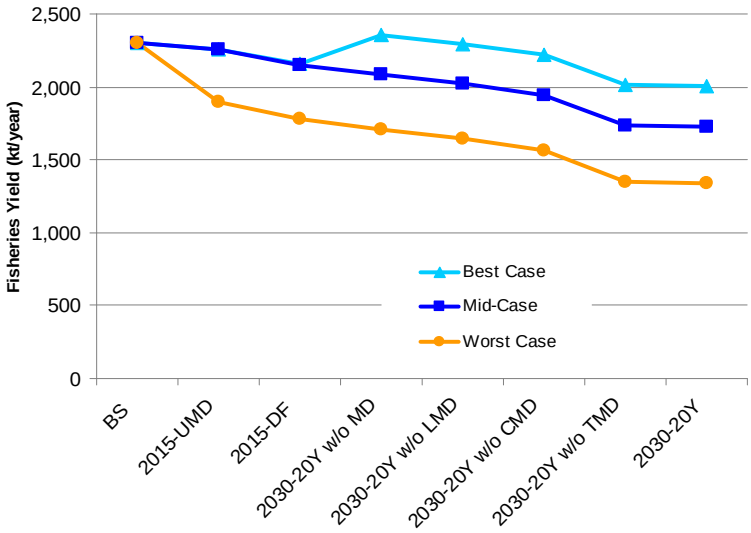


3.4.3 *Overall assessment of impact on capture fisheries*

After taking into account losses to river-floodplain fisheries, and best-case gains to rainfed and reservoir fisheries, under the 20-Year Plan Scenario, with all LMB 11 mainstream, the net loss to capture fisheries basin-wide would be 295 thousand tonnes or about 13% of the baseline.

In the worst-case however if intensive rice-farming impacts fisheries, and assuming low reservoir yields, there would be a nett loss to inland fisheries basin-wide of 42% or 964 thousand tonnes, a very significant loss by any measure.

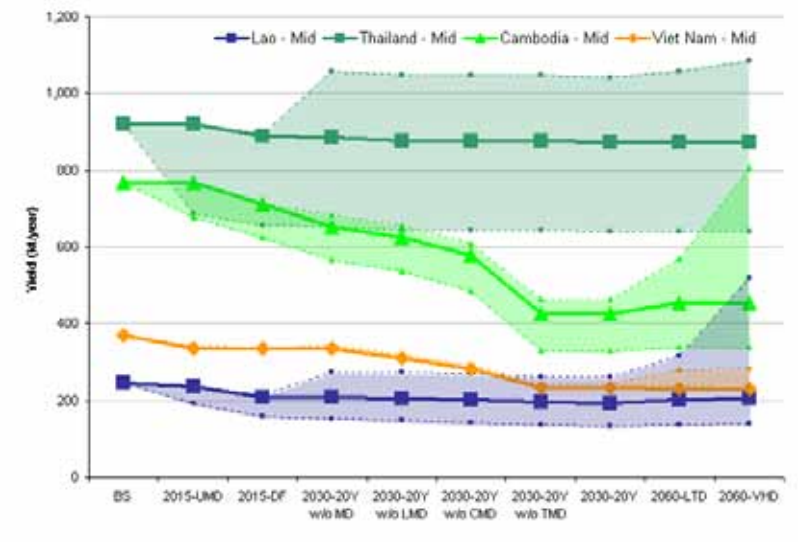
Figure 28 Overall assessment of gains and losses in capture fisheries in the LMB



These overall figures mask the inequitable distribution of losses between the four countries. Cambodia (40-57%) and Viet Nam (36-43%) will suffer the highest losses under the 20-Year Plan Scenario.

Under the 20-Year Plan Scenario without LMD (i.e. with only mainstream dams only in the Northern part of Lao PDR), the decline in capture fisheries would be much less: 14-30% in Cambodia and 14-20% in Viet Nam. The longer term scenarios would cause a wider best case – worst case spread in possible outcomes, dependent largely on management of rice farming.

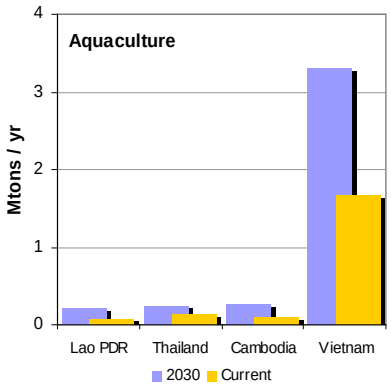
Figure 29 Overall assessment of changes to capture fisheries in each country showing 'mid-case' and best-worse ranges



Within countries, the losses will impact most on those people dependent on river fisheries, whereas any gains are likely to benefit lowland rice farmers. Hence social inequity is also very significant issue.

3.4.4 *Aquaculture development*

Aquaculture has great potential to offset losses in the capture fishery. Increasing river regulation and the development of other water distribution systems and other infrastructure are generally favourable to aquaculture, even as they are likely to be generally damaging to capture fisheries.



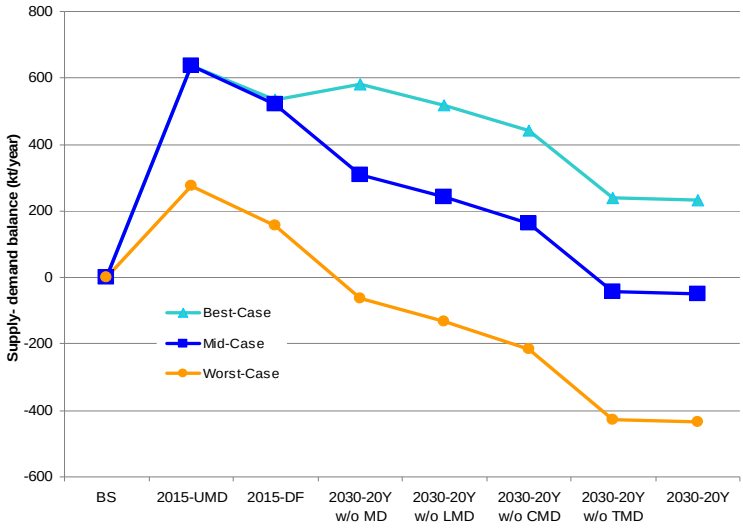
Aquaculture growth will be driven also by market prices. Aquaculture yield in the LMB is forecast to double over the next 20 years, to about four million tonnes, so the net fisheries yield basin-wide is likely to increase, despite dam impacts.

However, much of the production will continue to be in the delta where it is assumed that about 65% continues to be exported, and the products within the LMB will not generally be available or affordable for the most-affected people, those who depend on fisheries on floodplains or along rivers well-upstream. In the worst-case, despite increasing aquaculture output, by 2030 there could be a significant deficit in supply of fish and other aquatic animals basin-wide.

3.4.5 *Overall fish supply and consumption demand*

Viewed from a basin-wide perspective, under best-case assumptions, the large increase in aquaculture yield for domestic consumption that is predicted will compensate for predicted/hypothesised changes to capture fisheries yield. This is illustrated in Figure 30 where, under mid-case assumptions the total production potential of capture fisheries and aquaculture will exceed domestic consumption demands in all Foreseeable Future Scenarios, except when all mainstream (or w/o TMD) dams are built.

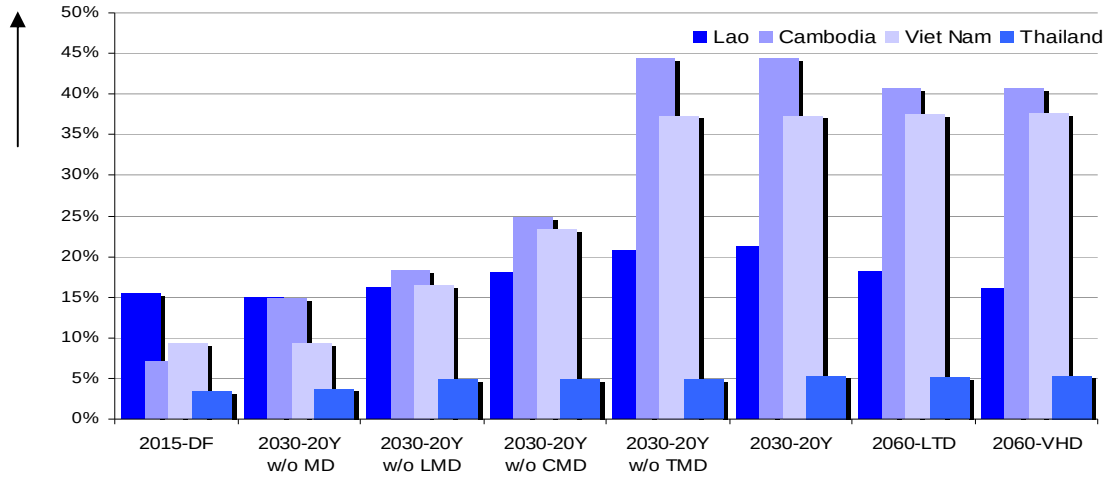
Figure 30 Predicted net total consumption of capture fisheries and aquaculture in the LMB



In the worst case, there would be a significant deficit after 2015 under any scenario of 436 kt/year, or the fish/OAA consumption of 9.6 million people at the current rate of 45.5 kg/person/year.

However, from a distributional perspective, most of this deficit would accrue in Cambodia, as illustrated in Figure 29, in Figure 31 and overleaf in Figure 32. Thailand and the Viet Nam highlands would also suffer a deficit, and in Lao there would be a small deficit in the worst case. The Viet Nam delta, benefitting most from aquaculture growth, would be in excess under any scenario and assumptions.

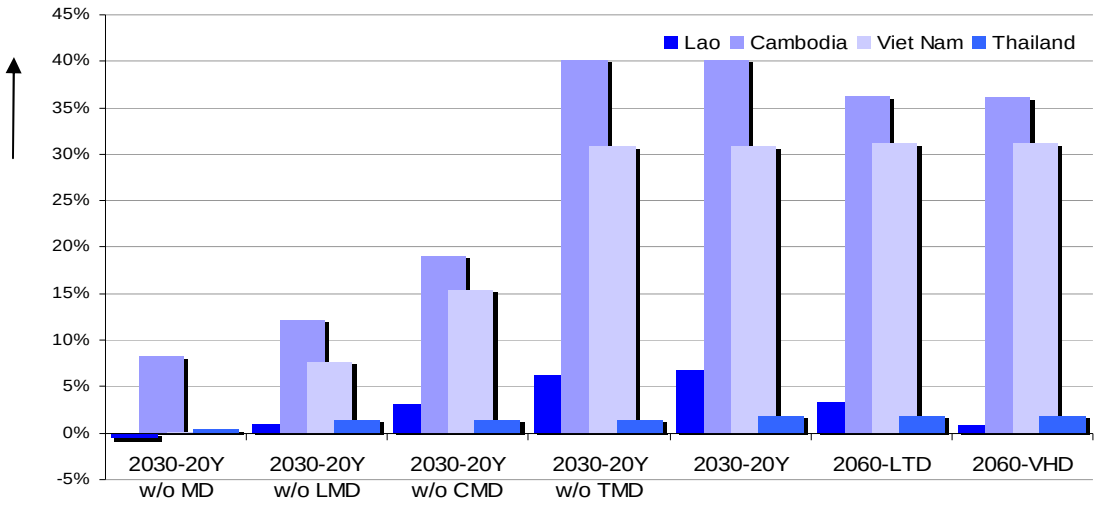
Figure 31 Capture fisheries percent losses relative to baseline (mid-case)



These findings may be broadly elaborated by country under the various assumptions made and under full-development to 2030 as follows:

- **Lao PDR**: there would be significant losses from river-floodplain fisheries, which in the best case would be more than offset by increases in rain-fed and reservoir fisheries. Additional aquaculture provides a further safety margin so that in the worst case at a

Figure 32 Capture fisheries percent losses relative to Definite Future (mid-case)



national level there is a small predicted loss. However, within the country the losses would directly impact those who depend upon capture fisheries, for example along the Mekong and large tributaries. Possible benefits would accrue to others, e.g. lowland rice farmers or commercial fishers in reservoirs**.**

- **Thailand**: there would be relatively limited impacts on river-floodplain fisheries, but potentially very large positive or negative impacts on rain-fed habitats where irrigation would be expanded. The overall situation could vary from a large excess to a large deficit in the supply needed to meet consumption demand, despite some benefit from increasing aquaculture. Most fisheries yield derives from subsistence capture fisheries (some stocked), but most policy focuses on aquaculture. The major issue to be addressed is how to develop 'fish-friendly' irrigation systems which will support increased subsistence capture fisheries yield to meet demand.
- **Cambodia**: Cambodia has much to lose from intensive development, with very significant effects on the yield from its productive river-floodplain capture fisheries. The most damaging dams are likely to be those on the mainstream in Cambodia itself as they directly impact migration routes and spawning grounds of many of the fishery species in the river-floodplain catches. Any possible compensation in rain-fed habitats and by aquaculture is likely to be relatively minor leading to very large nett losses even under the best-case assumptions by 2030, and would not directly compensate those most-affected, the many landless and poor people who depend directly upon capture fisheries.
- **Viet Nam delta**: there would be a steady decline in capture fisheries yield with significant nett losses and little difference between best and worst-cases. However, aquaculture would under any assumptions more than compensate for losses and would supply a considerable excess for internal consumption, but this excess may not be available or affordable to compensate for losses elsewhere in the basin. The success of aquaculture in the Mekong delta depends upon its dense canal system and flat and low-lying landscape, and many other factors, which will limit the extent to which it can be replicated elsewhere.

- **Viet Nam highlands**: there is at present and would continue to be a deficit of fisheries products under any scenario. Currently there are significant imports from the other places including the delta and even under the best case (with significant increases in yield from new reservoirs) there would be a continuing need for internal imports.

If nothing is done to mitigate and manage capture fisheries impacts, and if current trends to intensification of agriculture continue, there would therefore be local significant deficits that cannot be replaced by aquaculture yield.

It should be noted that these figures do not include the large quantity of aquaculture products produced in the delta that are or will be exported out of the LMB. At a regional scale, these could theoretically compensate for any deficit, but as well as the limitations on distribution systems, the most-affected people would also be least able to pay for such products.

Large increases in river-floodplain capture fisheries yield could probably be achieved at present, by managing water and habitat, by re-instating fish passage across the thousands of existing barriers, by stocking, and by regulating fishing activities. In the absence of such measures within the currently defined scenarios, this assessment simply assumes that impacts on river-floodplain fisheries will be significant and unavoidable, which may be a pessimistic view.

Efforts are clearly needed to create real improvement in both habitat and fisheries management and introduce effective mitigation measures to those changes brought about by the Definite Future Scenario and by other choices that may be made with regard to the Foreseeable Future. Significant benefits to fisheries could readily be achieved by managing rainfed rice fields and irrigation systems in a fish-friendly way. Increasing rice yields while at the same time maintaining or increasing yields from fisheries will require careful management of both technical and socio-economic issues, including promotion of integrated pest management (IPM) and maintaining traditional deep-water rice farming systems. The likely gains from reservoir fisheries are relatively modest in comparison with those achievable in rice fields.

3.5 Social impacts

3.5.1 Preamble

Assessment of the social impacts of the different scenarios has focussed on the impacts arising principally from dam construction, flow regime change and depletion of capture fisheries, taking into account also the outcomes of the environmental and fisheries assessments above. The assessment dimensions and key indicators used are summarised in Table 15 overleaf. The variables have been selected based on relevance and availability of updated official statistical data.

There are also close links between the social assessment and the economic assessment, especially with regard to employment in water resource related sectors. For convenience, the opportunities for employment generation associated with the investments in infrastructure

Table 15 Assessment dimensions and key indicators

Dimensions	Definition	Key indicators
Dependency	The proportion of the population for whom river resources are important for upholding livelihoods, health and well-being.	% Part-time fishers % Full-time fishers % Households (HHs) engaged in collection OAA/P Consumption of fish/fish products
Exposure	The state of being exposed to contact with something - here defined by location viz. hydropower dams and rivers that are affected by dam construction.	Location in areas directly affected by hydropower dams – upstream/downstream Location on floodplains Proximity to rivers, tributaries and wetlands connected to the main river system Impacts on fish and OAA/P Increase in irrigation area Flooding risks
Sensitivity	The degree to which a system (e.g., human, environmental, biological, etc.) is affected by and responds to stimuli in proportion to their magnitude.	Dependency value/rank (percent fishers) Importance of fish and OAA for food security
Resilience	The capacity of a system(e.g., human, environmental, biological, etc.) to absorb disturbance and reorganize while undergoing change so as to still retain essentially the same function, structure, identity, and feedbacks	Poverty rate Access to social services Alternative livelihoods, incl. aquaculture Literacy rate

making up each scenario, whilst estimated through the economic assessment, are discussed later in this section on social assessment.

It is appropriate to preface the social assessment by noting that development processes are much wider than those related to changes in the river resources. In the longer-term it is very likely that these wider processes will override the direct shorter-term impacts on people's livelihoods from dam construction, flood protection, and irrigation development. Social processes in parts of the region, e.g., in Viet Nam, have moved at a fast pace in the last decade, with reduction in the poverty rate to well below 20 percent, though not uniformly so.

However, in other parts of the basin, social development has taken place at a slower rate. There are pockets of poverty and extensive areas where people's livelihoods to a very high degree depend on the quality and their access to natural aquatic resources. By extension, both vulnerability and resilience to the negative effects on livelihoods from water resources developments must be assessed at a more local level and need to consider the impacts on different socio-economic groups as defined by their dependence on natural water resources.

As noted in Section 2.2, impacts are evaluated based on the assessment of the changes brought about to the 2008-09 economic, social and environmental landscapes. As previously stated, clearly these landscapes will change over time as a result of circumstances outside the water resources sector. It seems probable that the broader economic growth being seen in each

country, coupled with the ongoing poverty alleviation programmes, will have significant impacts on rural livelihoods in the years ahead.

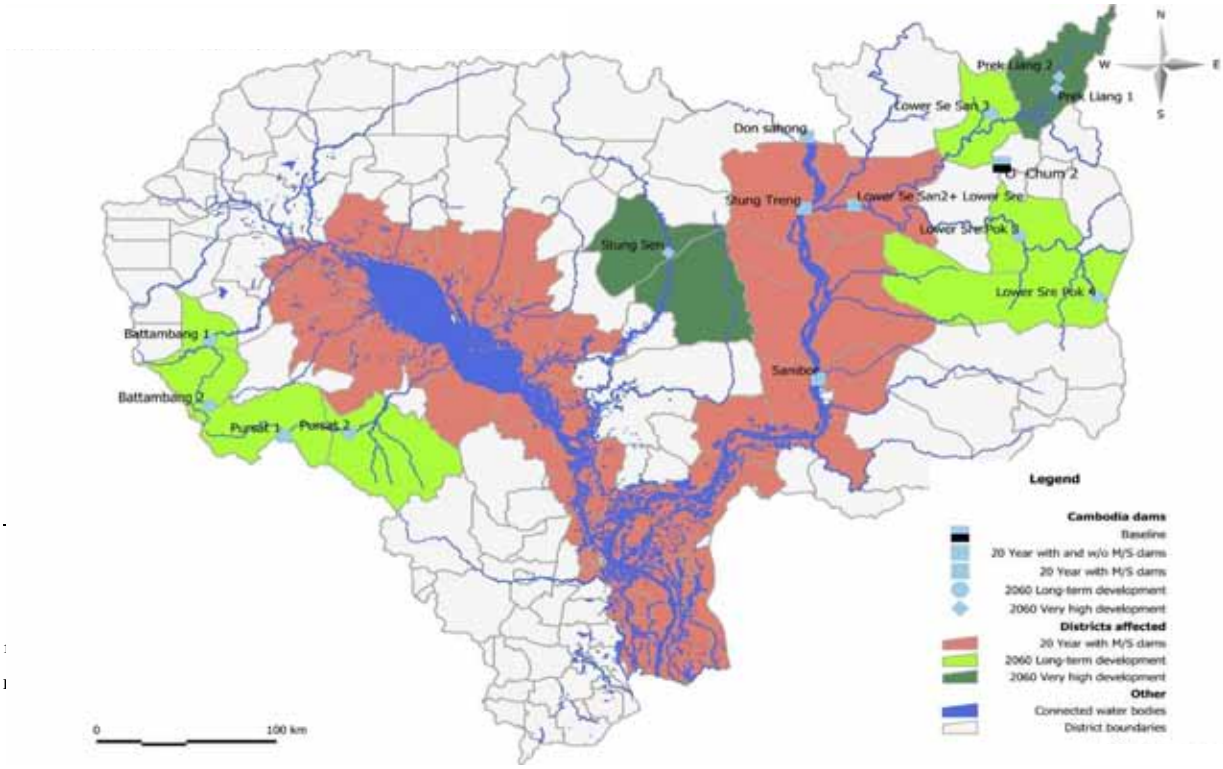
The scope of the current assessment is such that these factors cannot be accounted for. However, given the likelihood that dependency on water resources amongst vulnerable communities is likely to decrease and that resilience will improve, it appears likely that the assessments made on the 2008-09 landscapes will represent an upper limit to the social impacts. This prompts two further considerations: that the longer some developments are delayed, the likelihood that some of the social impacts will be less[15] and, secondly, the need for further studies to fully address these issues.

3.5.2 *Cambodia*

The main data sources that have been used for the social assessment of impacts in Cambodia are: Cambodia Census 2008 (obtained from NIS in December 2009); Commune Database 2007 from NCDD Program (obtained in September 2009); Commune Poverty Rate 2007 (obtained from WFP in September 2009); and Statistical Yearbook of Cambodia 2008 (obtained from Economic Planning Department in 2009).

Under the different scenarios considered, Cambodia is expected to be socially impacted by the changes in flow regime affecting the extent of flooding around Tonle Sap, the barrier effect of mainstream dams and other flow related effects on capture fisheries, and the resettlement issues associated with new dam construction, notably at Sambur and Stung Treng. The districts expected to be impacted by one or more scenarios are illustrated in Figure 33.

Figure 33 Cambodia dams and impacted districts



Based on an analysis of the Census data, approximately 1 million people in Cambodia are assessed to be dependent on river fisheries in large-scale, community and subsistence fishing and in fisheries related occupations. Within this, the number of vulnerable water resource users dependent on water resources for their livelihoods and who are exposed to changes varies from scenario to scenario. The nature of these impacts is summarised below.

In the **Definite Future Scenario**, the main social impacts are as a consequence of loss of fisheries caused by the changes in flow regime as a result of upstream dams, together with a small number of people in a Krong Ban Leung district likely to be directly impacted by dam construction.

In the **Foreseeable Future Scenarios**, the social impacts arise from further dam construction and the degree to which these disrupt the capture fisheries within Cambodia. One tributary dam in the lower Se San River is envisaged in all scenarios and this will impact upon **t**he exposed vulnerable population amongst fishing households and the people to be resettled directly as a result of the dam's construction.

The more substantial social impacts in Cambodia arise however from the reduced capture fisheries as a result of tributary dam construction outside Cambodia together with the envisaged mainstream dams. As discussed in Section 3.4, these impacts are greatest when the lower of the mainstream dams are included.

In addition to these substantial impacts on fisheries, water quality deterioration in the Mekong and Tonle Sap may also cause disruption to the natural ecosystem and could cause health-related problems where the surface water is used for drinking. Furthermore, the reduced volume of reverse flow to Tonle Sap and increased variability of timing will impact on recession rice agriculture and the productivity of wetlands.

Other developments such as mining, land concessions and increasing (agricultural) landlessness are likely to have negative social impacts in a manner that cannot yet be predicted but which could exacerbate the situation for those vulnerable to the specific scenario developments.

The **long term development scenarios**, which include all mainstream dams, include further tributary dam construction in Cambodia, which will add to the already substantial negative impacts described above by introducing further direct impacts from dam building and local impacts on aquatic resources and fisheries. However, given the autonomous changes expected in the social landscape by 2060, the estimates for these scenarios are considered very tentative.

A summary of the social impacts estimated for each scenario, expressed in terms of exposed vulnerable resource users, is given in Table 16.

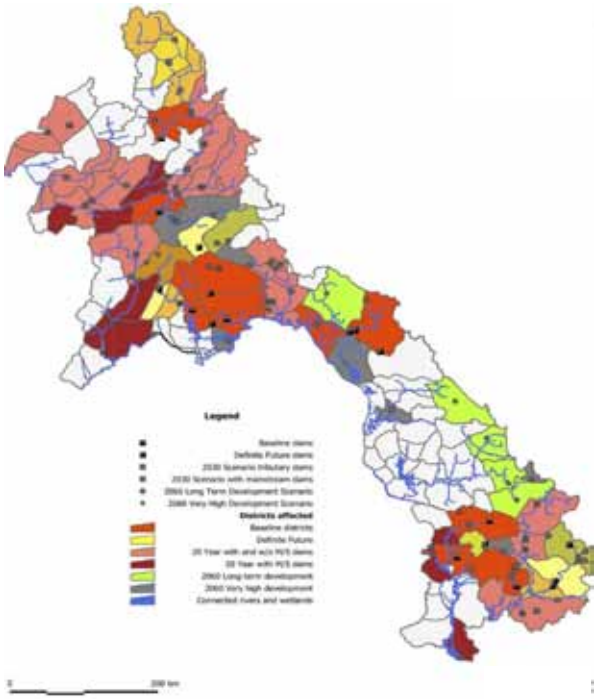
Table 16 Cambodia - Exposed vulnerable resource users by scenario

Scenario	Total fish and dam related
Definite Future	62,000
20 year without mainstream dams	274,000
20 Year without LMB dams	294,000
20 Year without Cambodia mainstream dams	321,000
20 Year without Thai mainstream dams	1,212,000
20 Year with mainstream dams	1,212,000
2060 Long-term Development	1,224,000
2060 Very High Development	1,231,000

3.5.3 *Lao PDR*

The social assessment of impacts in Lao PDR has been made using the Census 2005 and the LECS4 of 2007/08. The latter survey covers the whole of Lao PDR with a sample of more than 8,000 households. It includes information on the involvement in fisheries.

Figure 34 Lao PDR – Dams and impacted districts for all scenarios



The LECS4 data shows that the population in Lao PDR overwhelmingly is engaged in capture fisheries with 74% of all households in the country having fished in the previous last 12 months. Of these 78% catch fish in rivers. This compares to 24-25% of all households that catch fish in rice fields, swamp and flood plains.

It should be noted that the importance of capture fisheries varies between households. However, the data on households' capture fisheries in the previous 24 hours (before the time of interview) shows that 21% of households had been fishing during that limited period of time, spending on average 2.8 hours on this activity. This indicates a general high importance of capture fisheries for subsistence and food security.

With the planned number of dams in Lao PDR, the natural fish yield in the dammed rivers is expected to decline dramatically, which will affect a large part of the population using these rivers. The social assessment is based on the number of Districts which will be exposed to the changes in the river flows in each of the scenarios, and thereby how many people will be affected.

Table 17 Lao PDR - Exposed vulnerable resource users by scenario

Scenario	Fish related
Definite Future	297,000
20 year without mainstream dams	699,000
20 Year without LMB dams	782,000
20 Year without Cambodia mainstream dams	782,000
20 Year without Thai mainstream dams	907,000
20 Year with mainstream dams	907,000
2060 Long-term Development	1,029,000
2060 Very High Development	1,106,000

The number of vulnerable resource users in the various scenarios has then been calculated as shown in Table 14. A 'high' figure has been obtained by including both households that have fished in rivers and floodplains/swamps, and a 'low' figure by including only river fishing households; the middle value of these two figures has then been used.

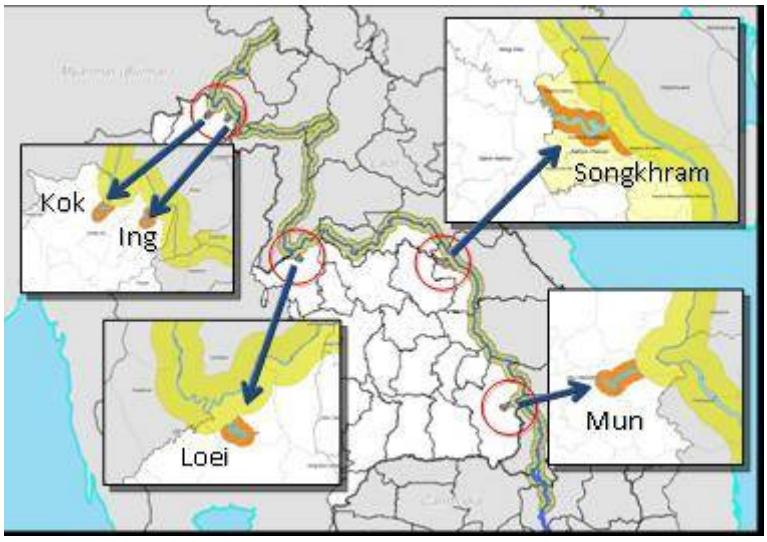
3.5.4 Thailand

The assessment of social impacts in Thailand has been undertaken on a different basis to the other three countries due to the somewhat different nature of the circumstances creating social impacts in the different scenarios. In Thailand's case impacts are expressed instead in terms of the numbers of exposed vulnerable resource users, based on the assumption that 45% (NSO 2007 with 40% on-farm employment and assumption of 5% landless) of the population adjacent to the mainstream.

The principal reason for this difference of approach is that within Thailand wild fisheries are already substantially disconnected from the mainstream[16]. Thus the productivity of capture fisheries within the tributary systems is largely immune from changes in flow regime and fish migration in the mainstream. In fact, wild fisheries within these areas are likely to increase due to the planned expansion of irrigated areas, increasing the opportunities for fish and OAA production within the rice fields.

[16] See Technical Note 11, Impacts on Fisheries, where in Section 2 it is noted that river-floodplain habitats are potentially impacted by dams and other developments upstream or connected via migration routes. However, in Thailand most tributary rivers and floodplains are already disconnected by dams and weirs, preventing or severely restricting immigration of aquatic animals, so cannot be further impacted by dams elsewhere. For Thailand a conservative (over-estimated) level of possible impact was assumed.

Figure 35 Thailand – Social impact corridor along mainstream and impact hotspots



However, those directly dependent upon mainstream fisheries will be affected by changes in productivity within the mainstream, mainly occasioned by the barrier effects of the proposed new mainstream dams. This corridor along the mainstream in Thailand is also impacted by changes in water levels and water quality brought about by current and planned reservoir development in the UMB, Lao tributaries and new mainstream dams. Mainstream dams will in particular have significant impacts in terms of resettlement and changed water levels.

As noted, dry season water levels in the mainstream will generally be higher and flood levels reduced with the planned developments. The presence of mainstream dams will create in addition impoundment (with significant daily fluctuations) along nearly 60% of the river stretch between Sambor at km 575 and Houei Xai (at km 2,300).

In addition to consideration of those exposed to changes in **mainstream fish productivity**, provisional estimates for those placed at risk within Thailand include:

- **Mainstream dam construction**: Approximately 400 people would be directly impacted at the Pak Chom dam site and 300 at Ban Koum (EGAT);
- **River bank vegetable garden**: Increased impoundment will impact negatively on river gardens, affecting approximately 12,600 people (2,500 HH) between Chiang Sean to Nakhon Pnom and 3,700 (740 HH) between Nakhon Pnom to Ubol Rachathani (using GIS calculation);
- **Flooded areas**: The changing pattern of flooding along the mainstream corridor in Thailand is estimated to affect up to 896,000 people (179,000 HH), in both positive and negative ways, based on the numbers recorded in high floods;
- **Navigation:** Increased water levels in the dry season will improve navigability, offset to some extent by the need to pass through locks where mainstream dams are constructed; these impacts are most relevant between Chiang Sean and Chiang Khong.

The overall assessment of the social impacts of the different scenarios within Thailand expressed in terms of the numbers of exposed vulnerable resource users is presented in Table 18.

Table 18 Thailand - Exposed vulnerable resource users by scenario

Scenario	Fish related
Definite Future	46,000
20 year without mainstream dams	201,000
20 Year without LMB dams	201,000
20 Year without Cambodia mainstream dams	514,000
20 Year without Thai mainstream dams	259,000
20 Year with mainstream dams	514,000
2060 Long-term Development	514,000
2060 Very High Development	514,000

3.5.5 Viet Nam

The main data sources used in the assessment of social impacts in Viet Nam are: the Viet Nam Household Living Standard Survey (VHLSS), 2008; BDP Fisheries Assessment, 2010; Magnitude of capture fisheries and aquaculture in the Mekong Delta in Viet Nam, 2008; An Giang Fisheries Survey, RIA2, MRC, 2000; and TraVinh Fisheries Survey, RIA2, MRC, 2002.

The impacts of the developments in each scenario on Viet Nam have been distinguished between (i) impacts in the Central Highlands, where hydropower dams already exist and where more will be constructed and (ii) the Mekong Delta, which will be directly affected by flow regime changes caused by upstream developments.

The Central Highlands are not impacted by developments within the mainstream and other tributaries, but will be affected by planned new dam construction and related effects on fisheries. In contrast, the Mekong Delta's population of more than 17 million, being the highest concentration of people in the basin, is directly impacted by changes in upstream flow and water quality conditions. The delta area is also the most vulnerable part of the basin to the impacts of climate change, particularly potential sea level rise.

As for other countries, the social impacts of the scenarios fall into two principal categories: those relating to declining capture fisheries and those occasioned by dam construction. In the case of the Central Highlands, indications are that the proportion of the population who are vulnerable resource users is relatively small and, combined with a mid-case fisheries increase generally of 10% for this part of the basin, the degree of negative impact is assumed to be negligible.

Data on numbers likely to be impacted by dam construction in the Central Highlands are not readily available, but in the context of the basin as a whole are expected to be small.

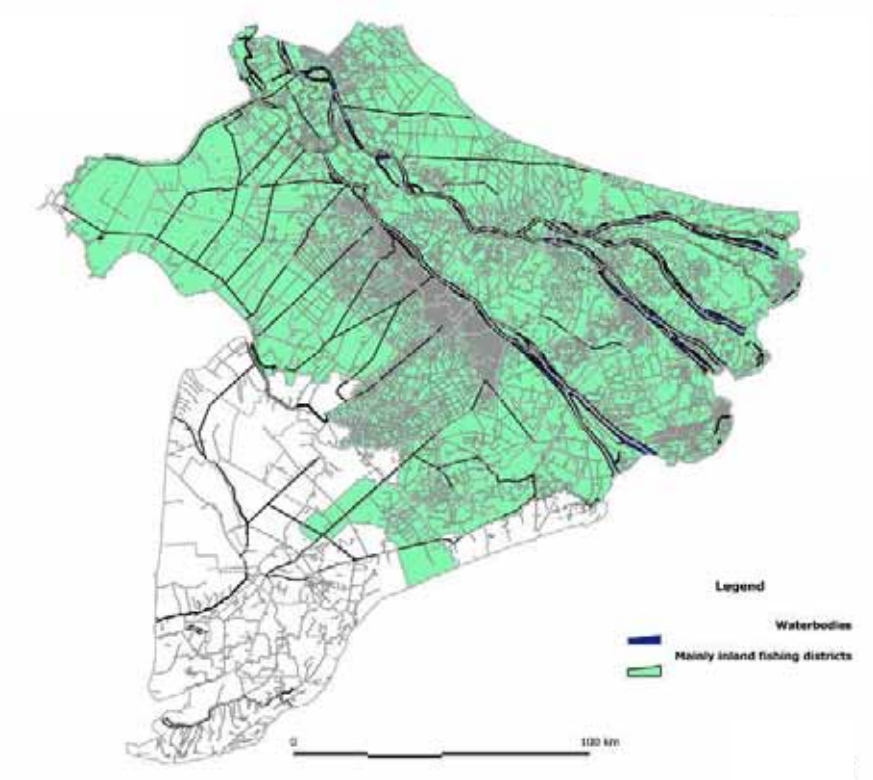


Figure 36 Main inland fisheries districts in Viet Nam delta

In the delta area, those who are likely to be vulnerable to changes in fisheries productivity (no dams are proposed in the delta for obvious topographic reasons) are those engaged directly in wild fish capture fishing and in fisheries dependent occupations.

Estimates have been made of the number of people falling within these categories and, in proportion to changes in fisheries productivity, the number of exposed vulnerable resource users in each scenario. Given the predicted size of fishery losses compared to the size of this population, the impacts are rated only moderately negative.

Table 19 Viet Nam - Exposed vulnerable resource users by scenario

Scenario	Directly engaged in fisheries	Fisheries related occupations	Total
Definite Future	382,000	60,000	442,000
20 year without mainstream dams	391,000	61,000	452,000
20 Year without LMB dams	666,000	104,000	770,000
20 Year without Cambodia mainstream dams	941,000	147,000	1,088,000
20 Year without Thai mainstream dams	1,491,000	234,000	1,725,000
20 Year with mainstream dams	1,491,000	234,000	1,725,000
2060 Long-term Development	1,502,000	235,000	1,737,000
2060 Very High Development	1,506,000	235,000	1,741,000

3.5.6 *Employment creation*

In the Definite Future Scenario, significant employment opportunities will be generated during the construction of the hydropower plants and jobs will also created by annual O&M activities following project completion. Total employment creation in the hydropower sector (see Table 20 overleaf) is estimated at about 104,000 jobs per annum. The development of reservoir fisheries will also provide sustainable livelihood opportunities for rural communities (approximately 15,000 jobs) in addition to 251,000 jobs created in the aquaculture sector. A small rise in navigation and tourism jobs is expected.

Very substantial employment opportunities would also be generated in the 20 Year Plan Scenarios during the construction of hydropower plants as well subsequent annual operation/maintenance activities. In total, the job opportunities are estimated to range from 224,000 without mainstream dams to 612,000 with all tributary and mainstream dams, in addition to the Definite Future Scenario.

The development of irrigated agriculture will also create employment opportunities during the construction of the infrastructure as well as for annual O&M works. Furthermore, additional labour will be required for farm operations. It is estimated that an additional 410,600 jobs will be generated by irrigation development in the LMB. Reservoir fisheries and further expansion of aquaculture will also provide a significant number of additional livelihood opportunities for rural communities (64,000 for reservoir fisheries and 352,000 for aquaculture). However, employment generated in these sectors is unlikely to offset the loss of livelihoods due to the decline in capture fisheries.

Over the next 20 years, total number of additional job opportunities which could be generated by the hydropower, agriculture and fisheries sectors within LMB could therefore range from 1.02 million (without mainstream dams) to 1.44 million (full development). After 20 years, employment could increase further and these sectors could provide between 2.80 million (long term development) and 4.40 million jobs (very high development). This level of employment creation would therefore make a very significant contribution to economic growth and rural household incomes within the LMB.

3.5.7 *Summary of social assessment findings*

The assessment of social impacts has been made in terms of the number of people exposed to changes in the river water resources and connected wetlands, and the number of people who are dependent on these resources for their livelihoods. The overall findings for LMB countries of livelihoods that would be affected by different scenarios are shown overleaf in Figure 37.

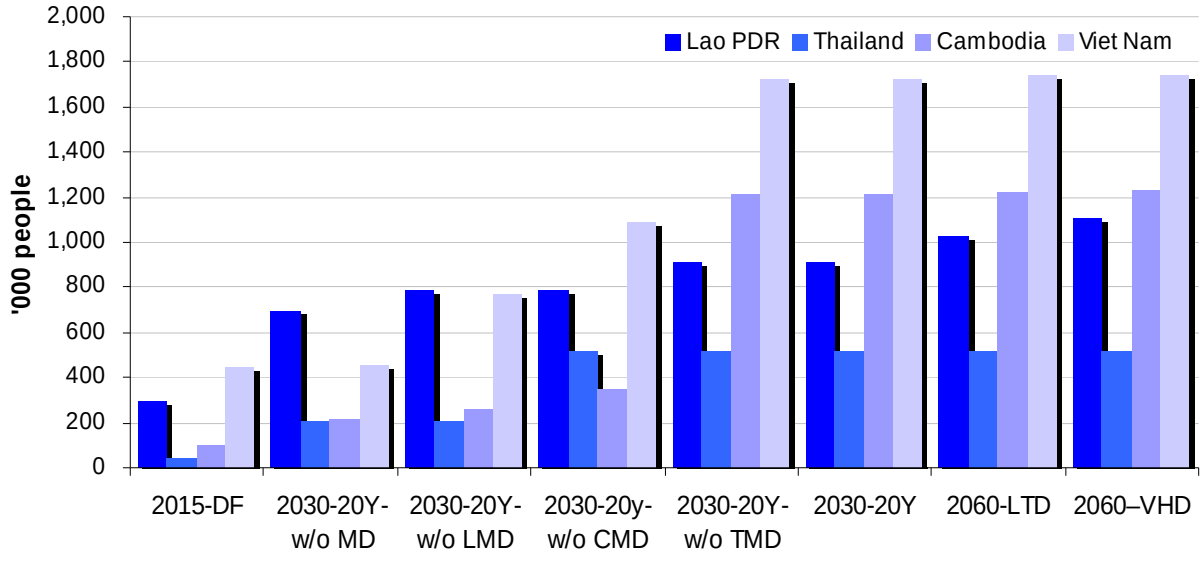
These findings provide an indication only of the extent to which rural livelihoods are likely to be impacted. They are based on a number of significant assumptions (see Technical Note No.

12) as to the dependency and vulnerability of rural dwellers on the natural resource system[17] and likely to be impacted by dam construction.

Table 20 Comparison of employment creation by development scenario, sector and country ('000 job-years)

	Definite Future	20-Year Plan w/o MS Dams	20-Year Plan w/o Lower MS Dams	20-Year Plan w/o Thai MS Dams	20-Year Plan w/o Cambodia MS Dams	20-Year Plan	20-Year Plan + Climate Change	Long Term Devt Scenario	Long Term Dev't + Climate Change	Long Term Very High Dev't
Hydropower	104	224	387	534	469	612	612	661	661	**708**
Irrigated Agriculture	0	411	411	411	411	411	411	1,483	1,483	**2,826**
Reservoir Fisheries	15	32	40	60	51	64	72	126	126	**141**
Aquaculture	251	352	352	352	352	352	352	528	528	**704**
Total LMB	**370**	**1,019**	**1,189**	**1,357**	**1,283**	**1,439**	**1,447**	**2,798**	**2,798**	**4,379**
Lao PDR	93	354	512	530	577	581	581	864	864	**1,465**
Thailand	44	334	347	334	369	366	366	964	964	**1,060**
Cambodia	36	108	108	271	115	271	278	636	636	**1,410**
Viet Nam	197	222	222	222	222	222	222	334	334	**445**
Total LMB	**370**	**1,019**	**1,189**	**1,357**	**1,283**	**1,439**	**1,447**	**2,798**	**2,798**	**4,379**

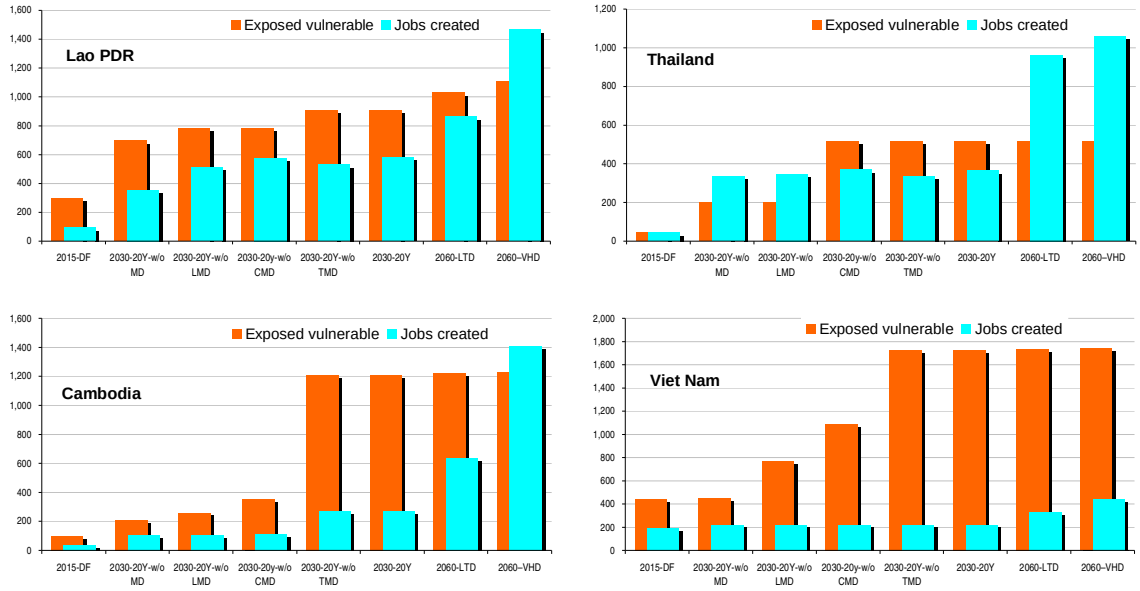
Figure 37 Summary of exposed vulnerable resource users by country and scenario



[17] It is recognised that others view these assumptions as underestimates of the numbers of people affected, particularly taking into account

A comparison can be made of the numbers of jobs created with the numbers of people estimated to be exposed vulnerable resource users. This is presented in Figure 38 for each country.

Figure 38 Comparison of numbers of exposed vulnerable resource users with jobs created, '000 persons



However three key points need to be borne in mind.

- Firstly and foremost, it should be appreciated that the **nature of the jobs created may not be appropriate for those whose livelihoods are threatened**. Thus the current infrastructural investments embodied within the various scenarios may, and most probably do not, offer an immediate solution to the impacts they create on rural livelihoods.

- Secondly it is apparent that under the scenarios, notwithstanding the expected increase in aquaculture, Viet Nam appears potentially exposed to a much greater extent than other countries, notwithstanding that the severity is expected be less, but nevertheless with proportionately fewer jobs being created within the current scenarios.

- Thirdly, it is evident that under the scenarios with Cambodian mainstream dams, the social impacts in Cambodia are particularly severe. However, it is observed that the majority of new rural jobs are associated with expansion of irrigation, most of which occurs only in the long term or very high development, well after the severe impacts have been incurred.

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secondary activities such as those engaged in marketing and distribution of wild fish catches. Some view that the numbers of vulnerable livelihoods could be as much as double those estimated in this report.

The availability of sufficiently detailed information has constrained the social assessments made in this report. Nevertheless, the information generated does point with a degree of confidence as to where social impacts can be expected from the developments in each scenario.

Definite Future Scenario

The Definite Future Scenario relates to the completion of the UMB mainstream dam cascade and the completion of 26 dams in the tributaries, which are under construction or for which commitments have been made. These developments will have both local effects (including resettlement, disruption of local fishing activities and the like) as well as transboundary impacts caused by flow and sediment flow modifications depressing the productivity of capture fisheries activities elsewhere within the basin.

These impacts will be felt most in Lao (local effects of dam construction) and in Cambodia and Viet Nam (reduction in fisheries productivity). In total nearly 900,000 people could be affected to one degree or another. The severity of these impacts is hard to predict (in the absence of detailed social surveys of the affected locations – see earlier maps) but it should be viewed as unquestionable that rural livelihoods will be impacted in all four countries as a result of these developments.

The key issue here is that these are inevitable consequences of projects that are already under way and that actions are needed in each country to manage the consequences.

Foreseeable Future Scenario

The Foreseeable Future Scenarios include a significant increase in tributary storage and in irrigated agriculture, together with various combinations of up to 11 new mainstream run-of-the-river dams for hydropower generation. As in the Definite Future Scenario, these developments will have both local effects related to dam construction and operation and transboundary impacts related to reduction in productivity of capture fisheries activities.

The planned development of a further 30 tributary dams (together with widespread expansion of irrigated areas) will more than double the impacted numbers of vulnerable livelihoods affected in Lao PDR (primarily as a result of dam construction) and in Cambodia (primarily as a result of reduced capture fisheries productivity). Overall the numbers of vulnerable people will rise to approximately 1.4 million.

The development of mainstream dams substantially increases the number of people affected by nearly 2.9 million over and above the 1.4 million above if all 11 dams are constructed (raising the total to nearly 4.4 million people affected compared to the baseline), principally as a result of a reduction in flood plain fisheries productivity but also as a result of the modified water levels and fisheries reduction along the mainstream as a direct impact of dam construction.

Lao PDR and Thailand suffer moderate increases as a direct impact of mainstream dam construction and modified mainstream flow conditions, whereas Cambodia and Viet Nam suffer

substantially as a result of reduced flood plain productivity (plus in Cambodia's case the additional impacts of mainstream dam construction).

The intermediate scenarios considered under the Foreseeable Future Scenarios follow a similar pattern of impacts related to where dams are constructed and their overall impact on fisheries (the latter being the more significant factor in terms of total numbers of people affected within the basin – although in the cases of Lao PDR and Thailand, from a national perspective, the key issue is the location of the mainstream dams and the manner in which they are operated).

Of the mainstream dam scenarios considered, the one with the least impact is that with only the upper six dams constructed wherein the total number of people affected is reduced from the 4.3 million above to just over 2.0 million (or 600,000 more than without any mainstream dams). Of these 2.0 million, 782,000 are in Lao (direct effects), 201,000 in Thailand (mainly backwater effects) and, as a result of fisheries productivity decreases, 262,000 in Cambodia and 770,000in Viet Nam (noting that the severity of impact in Viet Nam per capita is lower than in Cambodia).

Long-term scenarios

In the long term scenarios, the key drivers are continued expansion of both tributary dam construction and irrigated areas. These contribute to increasing numbers of people affected directly by dam construction (felt where the dams are located) and less pronounced increase in fisheries productivity reduction. Thus the total numbers affected rise a further 230,000 to 4.6 million, with the majority of these being in Lao PDR.

Overview of impacts of the scenarios

As with the environmental assessment, the social assessments and conclusions drawn above have been assembled in a simple matrix to illustrate the overall severity of environmental impacts of each scenario.

This is presented in Table 21 as a means of conveying an overview of the relative merits or demerits of each scenario from national and basin-scale perspective. The scoring is inevitably subjective and in all cases relative to the baseline. It takes account of the significance to each country of the different impacts that may arise (thus for instance a large impact on a small number of people in one country would be scored more severely than a small impact on a population in another country even though the total population impacted in the former is less than the latter).

It is very evident that, as with some of the environmental issues above, complementary studies are needed over the next 5 years to provide strategic direction as to how development projects are implemented in the affected areas.

Table 21 Overall assessment of severity of social impacts by scenario

Ref	Scenario	Lao	Thailand	Cambodia	Viet Nam	Average
3000	Definite Future Scenario	-2 Negative	-1 Mildly negative	-1 Mildly negative	-1 Mildly negative	-1 Negative
5000	LMB 20-Year Plan Scenario without mainstream dams	-3 Severely negative	-1 Mildly negative	-2 Negative	-1 Mildly negative	-2 Negative
6100	LMB 20-Year Plan Scenario with 6 mainstream dams in Northern Lao PDR	-3 Severely negative	-1 Mildly negative	-3 Severely negative	-2 Negative	-3 Severely negative
6300	LMB 20-Year Plan Scenario with 9 mainstream dams, excl Cambodia	-3 Severely negative	-1 Mildly negative	-3 Severely negative	-2 Negative	-2 Negative
6200	LMB 20-Year Plan Scenario with 9 mainstream dams, excl Thailand	-3 Severely negative	-2 Negative	-4 Extremely negative	-2 Negative	-3 Severely negative
4000	LMB 20-Year Plan Scenario	-3 Severely negative	-3 Severely negative	-4 Extremely negative	-2 Negative	-3 Severely negative
4001	LMB 20-Year Plan Scenario Climate change	-3 Severely negative	-3 Severely negative	-4 Extremely negative	-2 Negative	-3 Severely negative
8000	LMB Long-term Development Scenario	-3 Severely negative	-3 Severely negative	-4 Extremely negative	-2 Negative	-3 Severely negative
8001	LMB Long-term Development Scenario Climate change	-3 Severely negative	-3 Severely negative	-4 Extremely negative	-4 Extremely negative	-4 Extremely negative
9000	LMB Very High Development Scenario	-3 Severely negative	-3 Severely negative	-4 Extremely negative	-2 Negative	-3 Severely negative

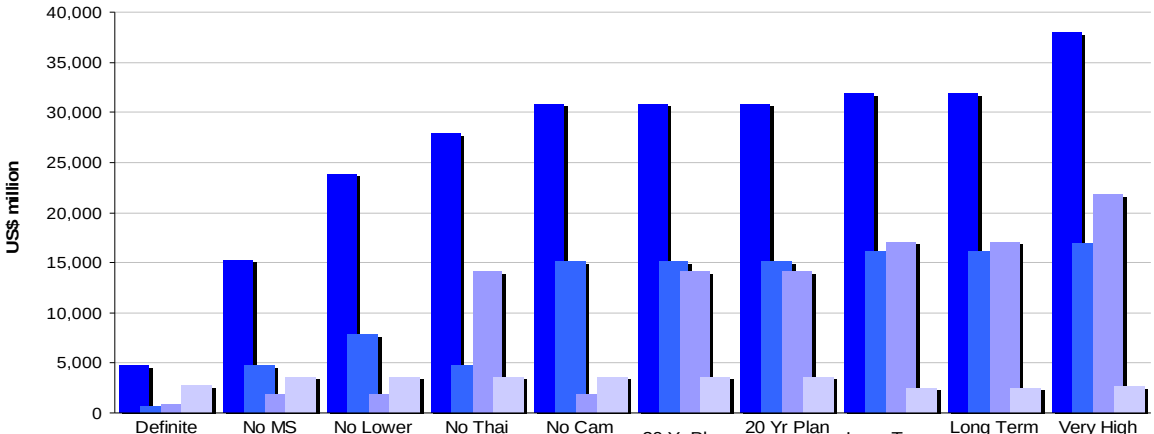
3.6 Economic impacts

3.6.1 Economic costs and benefits

Economics costs and benefits have been evaluated for all scenarios following the methodologies set out in Technical Note 2, Assessment Methodologies. The results of the economic assessment are summarised below by scenario, sector and country.

As summarised in Figure 39, total **investment costs** range from approximately US$8.9 billion in the Definite Future Scenario to US$63.7 billion in the LMB 20-Year Plan Scenario and US$77.3 billion in the Long Term Very High Development Scenario. The major part comprises investments in hydropower developments with Lao PDR accounting for the high proportion of the hydropower investments.

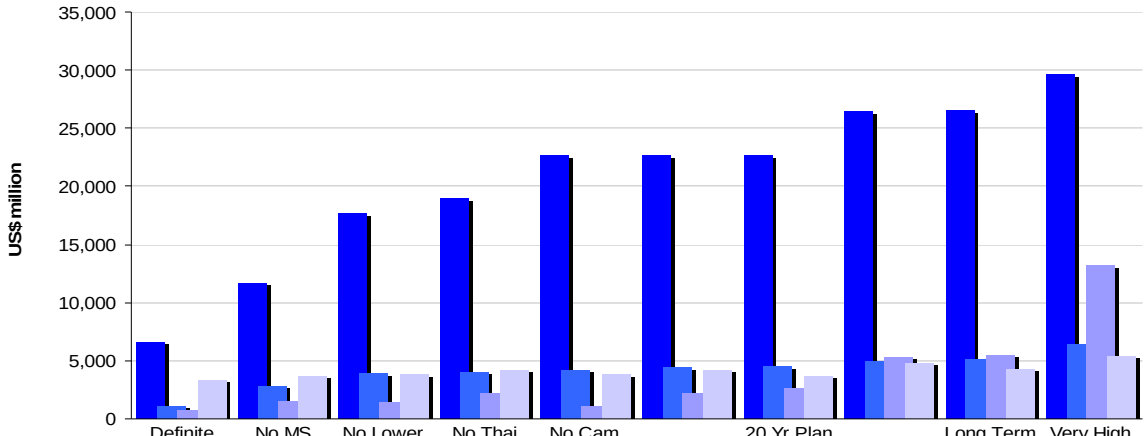
Figure 39 Investment costs by country and development scenario



	Definite Future	No MS Dams	No Lower MS	No Thai Dams	No Cam Dams	20 Yr Plan	20 Yr Plan +CC	Long Term	Long Term +CC	Very High Devt
Lao PDR	4,683	15,271	23,853	27,887	30,872	30,872	30,872	31,850	31,850	37,884
Thailand	682	4,703	7,761	4,702	15,125	15,125	15,125	16,126	16,126	16,995
Cambodia	806	1,837	1,837	14,115	1,830	14,115	14,115	17,134	17,134	21,729
Vietnam	2,747	3,601	3,601	3,601	3,601	3,601	3,601	2,577	2,577	2,684

The distribution of **economic net present value** (NPV) is presented in Figure 40 and also in Table 22 overleaf. The analysis clearly demonstrates the overwhelming economic significance of hydropower within the different developments under consideration.

Figure 40 NPV of economic benefits by country and development scenario



	Definite Future	No MS Dams	No Lower MS	No Thai Dams	No Cam Dams	20 Yr Plan	20 Yr Plan +CC	Long Term	Long Term +CC	Very High Devt
Lao PDR	6,595	11,688	17,636	18,927	22,632	22,588	22,604	26,401	26,501	29,608
Thailand	1,095	2,750	3,913	3,970	4,223	4,410	4,445	5,011	5,097	6,351
Cambodia	693	1,446	1,351	2,237	1,143	2,237	2,628	5,302	5,470	13,134
Vietnam	3,317	3,711	3,828	4,142	3,741	4,151	3,727	4,755	4,292	5,423

Table 22 Comparison of economic NPV in each scenario with the Baseline by sector and country (US$ million)

	Definite Future	20-Year Plan w/o MS Dams	20-Year Plan w/o Lower MS Dams	20-Year Plan w/o Thai MS Dams	20-Year Plan w/o Cambodia MS Dams	20-Year Plan	20-Year Plan + Climate Change	Long Term Devt Scenario	Long Term Dev't + Climate Change	Long Term Very High Dev't
Hydropower	11,491	17,603	25,002	28,706	30,333	32,823	32,823	37,865	37,865	**38,787**
Irrigated Agriculture	0	1,659	1,659	1,659	1,659	1,659	1,659	4,268	4,268	**16,129**
Reservoir Fisheries	91	107	132	202	169	215	215	420	420	**473**
Aquaculture	1,129	1,261	1,261	1,261	1,261	1,261	1,261	1,892	1,892	**2,522**
Capture Fisheries Losses	-946	-732	-952	-1,914	-1,218	-1,936	-1,936	-1,818	-1,818	**-1,801**
Wetland Area Reduction[18]	-228	-176	-178	-225	-178	-225	101	-260	36	**-310**
Eco-hotspots/Biodiversity	-85	-220	-240	-330	-305	-330	-415	-435	-525	**-700**
Forests	-153	-183	-228	-349	-254	-372	-372	-731	-731	**-822**
Recession Rice	-144	-173	-175	-178	-176	-178	278	-226	185	**-274**
Flood Mitigation	461	360	360	360	360	377	-273	408	-296	**432**
Saline Area Reduction	20	25	23	21	23	27	-2	22	-2	**16**
Riverbank Erosion	0	n	n	n	n	n	n	n	n	**n**
Navigation	64	64	64	64	64	64	64	64	64	**64**
Total LMB	**11,700**	**19,596**	**26,729**	**29,277**	**31,739**	**33,386**	**33,404**	**41,469**	**41,359**	**54,516**
Lao PDR	6,595	11,688	17,636	18,927	22,632	22,588	22,604	26,401	26,501	**29,608**
Thailand	1,095	2,750	3,913	3,970	4,223	4,410	4,445	5,011	5,097	**6,351**
Cambodia	693	1,446	1,351	2,237	1,143	2,237	2,628	5,302	5,470	**13,134**
Viet Nam	3,317	3,711	3,828	4,142	3,741	4,151	3,727	4,755	4,292	**5,423**
Total LMB	**11,700**	**19,596**	**26,729**	**29,277**	**31,739**	**33,386**	**33,404**	**41,469**	**41,359**	**54,516**

In addition to the current developments in the Definite Future Scenario, the 27 tributary hydropower dams proposed in the Foreseeable Future Scenarios have an overall NPV of US$6.1 billion in economic terms, and the 11 mainstream dams potentially would add a further US$15.2 billion to this.

In contrast, all other productive sectors (e.g. irrigated agriculture and culture fisheries) generate between 9% and 16% of the hydropower NPV (depending on the scenario under consideration), and economic losses incurred in by capture fisheries and wetlands/environmental hotspots are at most 9% of the hydropower NPV.

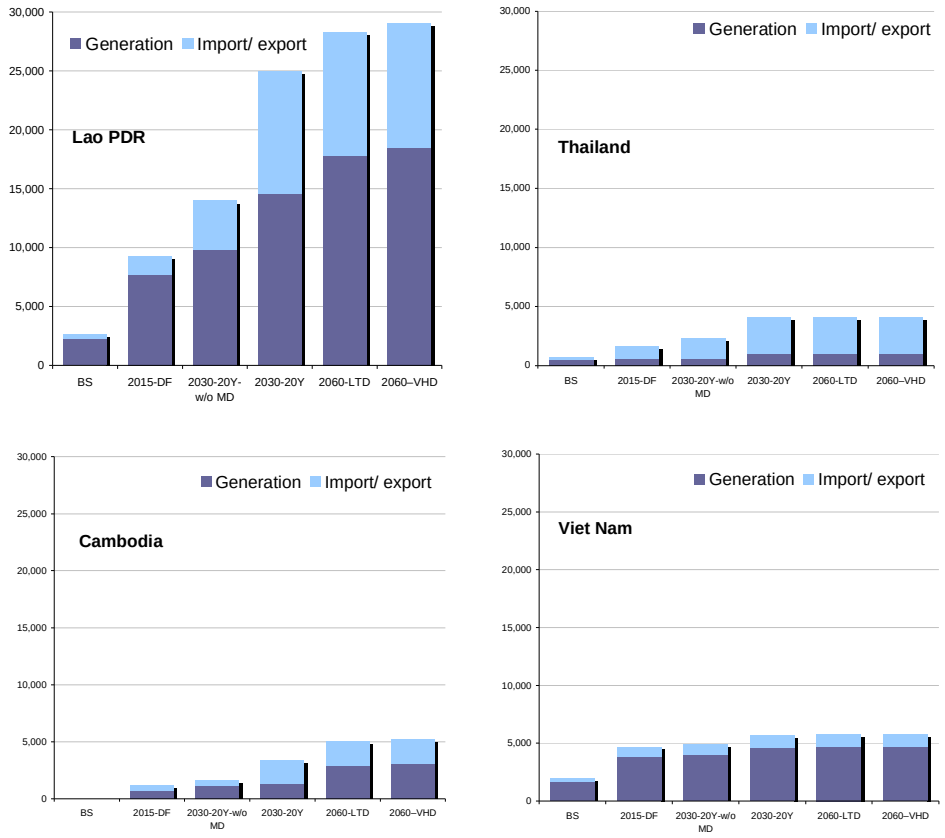
The benefits attributed to hydropower are derived from those associated with generating energy at source and additionally from subsequently importing / exporting energy through trading

[18] Includes impacts on garden areas alongside the Mekong mainstream as determined in Technical Note 9, Section 4.2.2

between countries. The approximate splits between these two benefits for each country are illustrated in Figure 41 below.

Figure 41

Approx split of hydropower benefits between generation and import/export, NPV US$ million

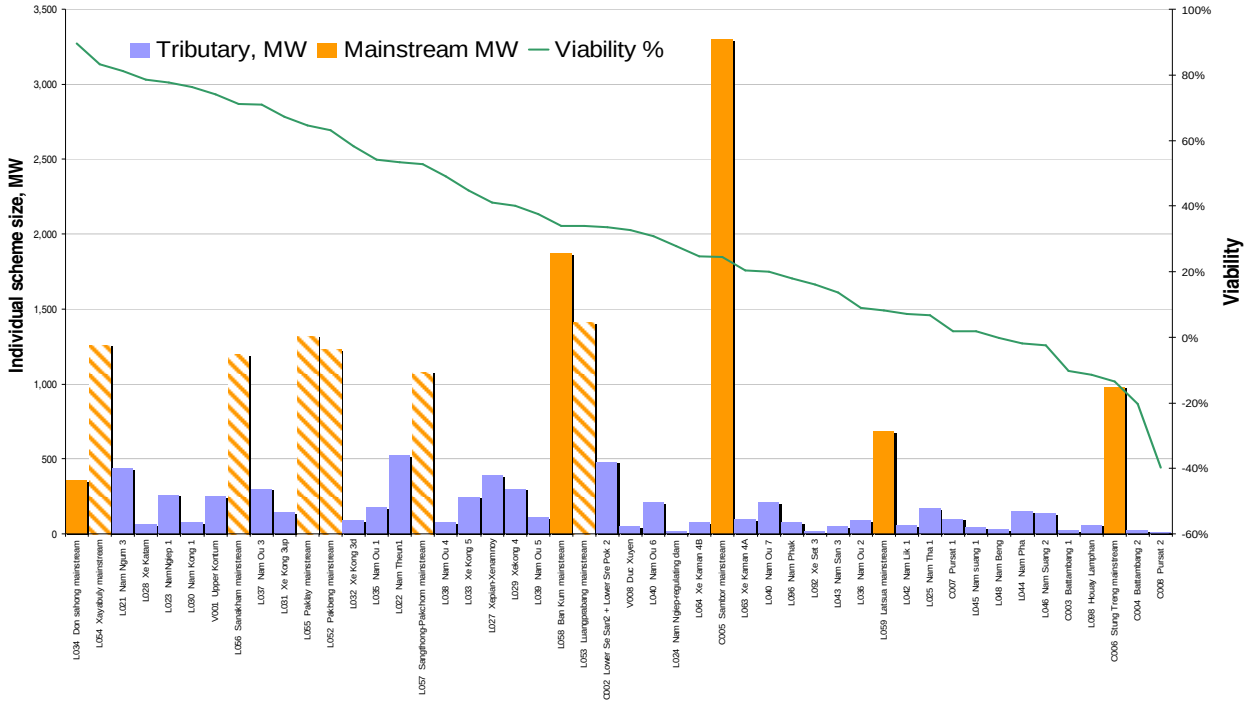


It should be noted however that investment decisions in hydropower are generally made on financial grounds and are greatly influenced by the electricity tariffs that the energy generated can command. Analyses conducted in the BDP2 study of hydropower benefits suggest that, notwithstanding their economic attractiveness, it can be expected that somewhere in the order of 20% of the installed capacity in the 20 Year Plan Scenario may be difficult to finance. Furthermore, from the analyses undertaken, these same 20% represent some 35% of the incremental storage associated with the Foreseeable Future Scenarios.

The ranking of hydropower projects within the 20-year scenario based on their financial attractiveness at a mid-range tariff of US$50/MWhr is illustrated in Figure 42 overleaf.

Economic losses in the fisheries sector, whilst offset by increases in reservoir fisheries and the potential rapid expansion of aquaculture, are of the order of US$0.95 billion (NPV) in the Definite Future Scenario. In the Foreseeable Future Scenario with mainstream dams, these losses rise to US$1.94 billion NPV. The point here is not that this is small compared to the

Figure 42 Ranking of hydropower projects based on their financial attractiveness at a tariff of US$50/MWhr



hydropower benefits, but that this loss would have to be largely borne by the rural fishing community, many of whom are the vulnerable poor.

Economic benefits from irrigation development are satisfactory with an overall NPV of US$1.66 billion in the 20 Year Plan Scenario. Thailand accounts for 65% of the proposed irrigated area, but benefits per hectare are lower in comparison to other countries. This is due to more limited potential for dry season cropping in the absence of storage reservoirs.

The distribution of net economic benefits between countries (see Figure 40) is substantially determined by the value of economic benefits accruing to each country. This is based on a conventional approach whereby both the power generator and the power user both benefit from the power supplied. Under these assumptions, Lao PDR (as the largest investor and power generator) gains the most economic benefits in all development scenarios. Under the LMB 20-Year Plan Scenario, the economic benefits to Cambodia are relatively low due to the adverse impact on capture fisheries and wetlands/environmental hot spots, as well as the negative NPV of the Stung Treng mainstream dam.

4 Relative merits of scenarios

4.1 Introduction

This chapter draws on the understandings reached in overall findings set out in Chapter 3 and sets out an appreciation of the main benefits and disbenefits of each scenario.

Full details of the assessments made are presented in Appendices B, C and D in increasing levels of summary. An overview of the performance of the scenarios against the agreed assessment framework is presented in Section 4.6.2 at the end of this Chapter.

4.2 Definite Future Scenario

Scenario content

This scenario examines the impacts of developments already in place, under construction or for which commitments have been made to proceed with the development. The main features are the construction of the major new storages in the UMB in China and an additional 26 tributary dams within the LMB. No additional irrigation is assumed. The scenario thus investigates the impacts of these committed developments, which are expected to be in place by 2015.

Hydrological impacts

The dams in the UMB under construction will together introduce an additional storage of 22.9 BCM into the basin, which together with the completion of 26 hydropower projects in the LMB with a total active storage of 13.7 BCM, will increase the total active storage in the basin by 370% to an amount equivalent to 10% of the mean annual runoff (MAR). This will have a substantial impact on the mainstream river flows, which previously has seen no observed net change since recording began in 1915.

These changes will result in an increase in dry season flows at Kratie of 19% on average and in March by 40% with water levels rising by typically 0.8m. In contrast wet season discharges will reduce by about 4% on average with peak daily flows reduced on average by 7%. The trends observed at Kratie in general are reflected throughout the length of the main stream with the difference between the baseline and the other scenarios being most marked at the northerly end (eg Vientiane) where the influence of the UMD mainstream dams is greatest. These effects attenuate further downstream. From subsequent analyses (see Section 5.4) it is noted that the additional dry season flows from the UMB are by themselves sufficient to meet incremental demands in the 20-year Foreseeable Future Scenarios.

The regulation of the mainstream flows will reduce the extent of annual average flooding in the LMB by some 249,000ha (5%). Flooding extent will reduce in Lao PDR by 64,000 ha (16%), in

Thailand by 64,000 ha (16%), in Cambodia with 106,000 ha (5%) and in Viet Nam by 11,000 ha (1%). Flow reversal volume into Tonle Sap by will reduce by some 8% with an average 3-day delay in this occurring and, in the absence of increased irrigation areas in Viet Nam affected by salinity intrusion will be reduced by some 15%.

Environmental impacts

The increased storage within the basin will also significantly reduce sediment inflows to the LMB. This will precipitate a long term change in the river's geomorphology leading to slope adjustment, scouring and bank erosion (see Section 3.3.2). Whilst there are different views of how soon before these changes become noticeable, it is unquestioned that they are irreversible. A key issue in this regard is the timing of impacts caused in the delta area and how soon and to what extent regression of the delta may occur. Further research is needed to understand these processes and the degree of threat posed.

The combination of reduced flooding and depleted natural nutrients within the system will reduce wetlands and their productivity. Wetland areas will reduce by about 35,000ha (2.4%), river habitats will be diminished noticeably in Lao and Thailand. Environmental hotspots on the mainstream in Northern Thailand and on the Lower Sesan in Cambodia will be impacted by the ongoing developments in this scenario.

The combination of these changes and blockage of fish migration caused mostly by current tributary dam development in the LMB will deplete capture fisheries, which will be reduced by an estimated 15% in Lao PDR, 3% in Thailand, 7% in Cambodia, and by 9% in Viet Nam. Reductions in sediment outflow from the basin will also negatively impact upon marine fisheries.

Social impacts

The combined impacts of principally reservoir construction and wetland productivity reduction are estimated to put at risk the livelihoods of some 887,000 people within the LMB. In Lao PDR some 297,000 are likely to be affected, in Thailand some 46,000, in Cambodia 102,000 and in Viet Nam about 442,000. At the same time, construction activities, new reservoir fisheries and aquaculture are forecast to generate some 370,000 new jobs.

Economic impacts

The scenario will create a net economic benefit to the LMB countries of US$ 11,700 million NPV, mainly from new hydropower but also from reductions of flood damages and salinity intrusion and increases of reservoir fisheries and navigation. The investments are highest in Lao PDR and Viet Nam and these countries will benefit most: Lao PDR with US$ 6,595 million and Viet Nam with US$ 3,317 million. Thailand and Cambodia benefit with US$ 1,095 million and US$ 693 million, respectively.

In summary

This scenario is already being implemented. Notwithstanding the favourable economic benefits that will arise, the assessment has highlighted the inevitable and irreversible environmental and social impacts that will occur over time.

On a positive note, these developments provide sufficient storage within the basin, which if operated as assumed, will provide sufficient dry season flow augmentation to meet the demands for increased irrigation as set out in the 20-year plan scenarios.

4.3 Foreseeable Future Scenarios (20-year plan)

The foreseeable future scenarios comprise the development plans for each country over the next 20 years (to 2030) and are distinguished principally by different combinations of the 11 mainstream dams under consideration for the LMB. In addition, a separate assessment has been made of flood management plans set out for Cambodia and Viet Nam.

4.3.1 20-Year Plan Scenario without Mainstream Dams

Scenario content

The 20-Year Plan Scenario without Mainstream Dams examines the impacts of the planned development in the LMB by 2030 of 56 additional tributary dams (30 more than in the Definite Future Scenario) and 1.6 Mha of irrigation, of which 245,000ha is in Lao PDR, 1,370,000ha in Thailand and 183,000ha in Cambodia. In contrast, the irrigation area in Viet Nam is expected to be some 201,000ha less than the baseline.

The 56 dams are for expansion of hydropower and represent a total incremental capacity of 10.1 GW with a combined additional active storage of 34.4 BCM. Total irrigated cropped area is forecast to rise by 3.1Mha, giving an average irrigated cropping intensity of 182%.

Hydrological impacts

The increase in dry season flows from the new storages is more than sufficient to meet the additional irrigation demands and as a result the dry season flows in March will be typically 33% higher than the baseline at Tan Chau and 91% greater at Vientiane, representing a 9% increase over the Definite Future Scenario. Similarly, average peak daily flows in the flood season will be typically 8% less than the baseline and 3% less than the Definite Future Scenario.

These modifications to flow will cause similar but somewhat larger changes than the Definite Future Scenario to flooding (a 300,000ha reduction in average annual area from the baseline), saline intrusion (305,000ha reduction in affected areas) and flow reversal (a 12% reduction of volume entering Tonle Sap compared to the baseline).

Environmental impacts

The 45% increase in storage within the overall basin (89% increase in the LMB) over and above the Definite Future Scenario will further reduce sediment inflows to the LMB and exacerbate the geomorphological changes forecast for the Definite Future Scenario (over which there are different views of these will be become noticeable). Together with reduction in flooding and depletion of natural nutrients these changes will further reduce wetland areas and their productivity. Compared to the baseline, wetland areas will be reduced by about 47,000ha (3.2%), and river habitats will be diminished noticeably in Lao (more so than in the Definite Future) and Thailand. Environmental hotspots on the mainstream will be markedly affected in Lao PDR, Thailand and Cambodia.

The combination of the reductions in wetlands, blockage of fish migration by the tributary dams in the LMB and the reduced sediment flows will deplete capture fisheries, which will be reduced by an estimated 10% in the LMB (15% in Lao PDR, 4% in Thailand, 15% in Cambodia, and by 9% in Viet Nam) compared to the baseline. Reductions in sediment outflow from the basin will also negatively impact upon marine fisheries. Compared to the Definite Future Scenario, capture fisheries would further decline, most significantly in Cambodia (8%) but less in the other countries: Lao PDR (0%), Thailand (1%), and Viet Nam (4%).

The number of highly impacted environmental hotspots would increase from two in the definite future situation to five. All three additional highly impacted hotspots are situated along the Mekong mainstream: two in Northern Lao PDR and one between Vientiane and the Mun river confluence.

Social impacts

The combined impacts of principally reservoir construction and wetland productivity reduction are estimated to put at risk the livelihoods of some 1,409,000 people within the LMB. In Lao PDR some 699,000 are likely to be affected, in Thailand some 210,000, in Cambodia 212,000 and in Viet Nam about 452,000. Compared to the Definite Future Scenario, livelihoods threatened would rise by 76% in the basin, principally in Lao PDR (135%) and Cambodia (108%).

At the same time the scenario would create 820,000 job opportunities in all four LMB countries compared to the baseline (up 450,000 compared to the Definite Future Scenario), primarily in the hydropower, irrigation, and fisheries (reservoir and aquaculture) sectors. It is estimated that an additional 411,000 jobs would be created in the irrigation sector, of which 119,000 would be in Thailand.

Economic impacts

Relative to the baseline, this scenario would generate net economic benefits of US$ 19,596 million NPV, of which US$ 11,688 million would arise in Lao PDR, US$ 2,750 million in Thailand, US$ 1,446 million in Cambodia and US$ 3,712 million in Viet Nam. Overall this represents an increase of US$ 7,896 million NPV over and beyond those in the Definite Future

Scenario (a 46% increase with Lao PDR and Thailand benefitting the most). The benefits stem largely from new hydropower dams on the tributaries and new irrigation. As in all 20-year plan scenarios, new irrigation contributes US$ 1,659 million of these net benefits. The contribution of benefits and losses in the other water related sectors (environment, fisheries, navigation, salinity intrusion, recession rice, etc.) is relatively small and in the range of US$ 0-200 million NPV.

In summary

All countries benefit economically from this scenario, the largest benefits accruing to Lao PDR, mainly from hydropower and associated reservoir fisheries, and to Thailand (large scale irrigation expansion and associated rise in rice-field fisheries potential). Elsewhere, some irrigation benefits accrue in Cambodia, and Viet Nam benefits from a reduction in saline intrusion over and above that in the Definite Future Scenario. Flood damages are generally reduced also. Overall net benefits rise by some 46% compared to the Definite Future Scenario.

These substantial gains are offset by an increased threat level to environmental hotspots and a reduction in wetlands productivity, with an estimated overall decline in capture fisheries (including reservoir fisheries) of an estimated 10% in the LMB, with Lao PDR and Cambodia both losing 15% compared to the baseline, and with Cambodia suffering a further 8% loss compared to the Definite Future Scenario. Overall, notwithstanding the creation of an additional 820,000 job opportunities, the number of rural livelihoods threatened are estimated to be 1,409,000, a rise of 59% compared to the Definite Future Scenario.

4.3.2 *20-Year Plan Scenario without Lower Mainstream Dams*

Scenario content

The 20-Year Plan Scenario without Lower Mainstream Dams examines the impacts of adding six mainstream dams to the scenario above, being in upstream to downstream order:

Ref	Project Name	Installed capacity MW	Live storage MCM
L052	**Pakbeng**	1,230	442
L053	**Luang Prabang**	1,410	734
L054	**Xayabuly**	1,260	225
L055	**Paklay**	1,320	384
L056	**Sanakham**	1,200	106
L057	**Sangthong-Pakchom**	1,079	217

The other components of the scenario are as before, namely 56 additional tributary dams (30 more than in the Definite Future Scenario) and 1.6 Mha of irrigation. The total incremental capacity of the hydropower is 17.6GW of which 7.5GW is associated with the mainstream

dams. Being run-of-the-river, the mainstream dams add only 2.5 BCM of additional active storage to the incremental 34.4 BCM in UMB and tributary storages.

Hydrological impacts

The mainstream dams, being run-of-the-river, have only minor effect on the basin-scale hydrology but will have significant impact locally, raising water levels in upstream pondage areas and, depending upon their operation, downstream. Whilst flood season flows will remain largely unchanged from the scenario without mainstream dams, there will be a small increase in dry season flows (typically 3%) as a consequence of the increased regulation.

Thus for this scenario, compared to the baseline, overall flooded areas are 307,000ha below the average annual area, saline intrusion affected areas are 319,000ha less and flow reversal remains at about a 12% reduction of volume entering Tonle Sap with a slight increase in the delay of flow reversal occurring.

Environmental impacts

The presence of the mainstream dams will have significant impact on local sedimentation, the extent of which will depend very much on how they are operated and the effectiveness of sediment flushing. Whilst recognising that there are differences of view over the basin scale impacts on sedimentation, the view expressed in this report is that over time sedimentation behind the mainstream dams will reach equilibrium and not cause a net reduction in sediments flowing to the downstream areas. The timing of flushing in relation to early floods and the manner in which flood protection is operated is an area which will need careful consideration however.

The presence of the mainstream dams would have incremental environmental impacts over and above the 20-year plan without mainstream dams. These will arise from the increased pondage and backwater effects of these dams and their barrier effect on the fish migrating in this part of the mainstream. There will be a direct and severe negative impact on local environmental hotspots with a further two affected: one between Lao PDR and Myanmar (Golden Quadrangle) and one between Lao PDR and Thailand (Songkram River Floodplains). Crucially, the mainstream dams will have a severe impact upon Giant Catfish numbers, one of the flagship species, and could lead to its extinction along with other species locally.

Given their location at the farther end of the basin's main migratory routes, the presence of the mainstream dams as barriers to migration will have a marginal effect on capture fisheries, reducing productivity by a further 2% typically. In relation to the baseline however, overall capture fisheries production would be some 12% depleted, being by 16% in Lao PDR, 5% in Thailand, 18% in Cambodia and 16% in Viet Nam.

However compared to the Definite Future Scenario, capture fisheries would continue decline most significantly in Cambodia (12%) and Viet Nam (8%), but less in the other countries: Lao PDR (1%) and Thailand (1%). Reductions in sediment outflow from the basin will remain

similar to the 20-year plan without mainstream dams and will have negative impacts upon marine fisheries.

Social impacts

Over and above the impacts of the 20-year plan without mainstream dams, the conversion of the mainstream in the Northern part of Lao PDR into a series of slow moving waters between run-of-the-river hydropower schemes would create localised impacts for people dependent on the river system for their livelihoods.

Together with the other impacts of that scenario and the further reduction of capture fisheries and construction activities, the 20-Year Plan Scenario without Lower Mainstream Dams would altogether impact upon 2,015,000 livelihoods (782,000 in Lao PDR, 201,000 in Thailand, 262,000 in Cambodia and 770,000 in Viet Nam. This represents an overall increase of 43% over the 20-year plan without mainstream dams and a 127% increase over the definite future scenario.

At the same time the scenario would create an additional 170,000 jobs compared to the 20-year plan without mainstream dams, bringing the total to 990,000 job opportunities in all four LMB countries compared to the baseline (up 620,000 compared to the Definite Future Scenario).

Economic impacts

Relative to the baseline, this scenario would generate net economic benefits of US$ 26,728 million NPV, of which US$ 17,636 million would arise in Lao PDR, US$ 3,913 million in Thailand, US$ 1,351 million in Cambodia and US$ 3,828 million in Viet Nam.

Compared to the to the 20-year plan without mainstream dams, the incremental net benefits (gains and losses) of the six mainstream dams are US$ 7,132 million of which Lao PDR gains US$ 5,948 million, Thailand US$ 1,163 million and Viet Nam US$ 117 million, but with Cambodia losing marginally by US$ 95 million.

Nevertheless compared to the Definite Future Scenario, all countries gain by a total of US$ 15,028 million of which Lao PDR gains US$ 11,041 million, Thailand US$ 2,818 million, Cambodia US$ 657 million and Viet Nam US$ 511 million.

In summary

All countries benefit economically from this scenario, the largest benefits accruing to Lao PDR, mainly from hydropower and associated reservoir fisheries, and to Thailand (large scale irrigation expansion and associated rise in rice-field fisheries potential). Elsewhere, some irrigation benefits accrue in Cambodia, and Viet Nam benefits from a reduction in saline intrusion over and above that in the Definite Future Scenario. Flood damages are generally reduced also. Overall net benefits rise by some 87% compared to the Definite Future Scenario.

From an economic perspective, this scenario provides substantial economic gain with Lao PDR and Thailand gaining most from the presence of the six mainstream dams and with the majority of environmental and social impacts from those dams falling to Lao PDR.

Nevertheless, as with the previous scenario without mainstream dams, these substantial gains are offset by an increased threat level to environmental hotspots and a reduction in wetlands productivity, with an estimated overall decline in capture fisheries (including reservoir fisheries) of an estimated 12% in the LMB, with Lao PDR, Cambodia and Viet Nam losing between 16-18% compared to the baseline. Overall, notwithstanding the creation of an additional 990,000 job opportunities, the number of rural livelihoods threatened are estimated to be 2,015,000, a rise of 127% compared to the Definite Future Scenario.

4.3.3 20-Year Plan Scenario (with all mainstream dams)

Scenario content

The 20-Year Plan Scenario with all Mainstream Dams represents the summation of overall plans for 2030 which the countries have put forward for assessment. It examines the impacts of adding to the *20-year plan without mainstream dams* eleven mainstream dams, being in upstream to downstream order:

Ref	Project Name	Installed capacity MW	Live storage MCM
L052	**Pakbeng**	1,230	442
L053	**Luang Prabang**	1,410	734
L054	**Xayabuly**	1,260	225
L055	**Paklay**	1,320	384
L056	**Sanakham**	1,200	106
L057	**Sangthong-Pakchom**	1,079	217
L058	**Ban Kum**	1,872	403
L059	**Latsua**	686	530
L034	**Don Sahong**	360	115
C006	**Stung Treng**	980	70
C005	**Sambor**	3,300	2,000

The other components of the scenario are as before, namely 56 additional tributary dams (30 more than in the Definite Future Scenario) and 1.6 Mha of irrigation. The total incremental capacity of the hydropower rises to 24.8GW, of which 14.7GW is associated with the eleven mainstream dams. Being run-of-the-river, the mainstream dams add only 5.2 BCM of additional active storage to the previous 34.4 BCM in UMB and tributary dams.

Hydrological impacts

The mainstream dams, being run-of-the-river, have a small incremental effect on the basin-scale hydrology, but will have large significant impacts locally and near contiguously along most of the LMB mainstream between Kratie and Chiang Sean, raising water levels in upstream pondage areas and, depending upon their operation, downstream as well. Whilst flood season flows will remain largely unchanged from the scenario without mainstream dams, there will be a small increase in dry season flows (typically 6%) as a consequence of the increased regulation.

Thus for this scenario, compared to the baseline, overall flooded areas are 314,000ha below the average annual area, saline intrusion affected areas are 309,000ha less and flow reversal remains at about a 13% reduction of volume entering Tonle Sap with a slight increase in the delay of flow reversal occurring to 8 days on average.

Environmental impacts

As with the scenario above, the presence of the mainstream dams will have significant impact on local sedimentation, the extent of which will depend very much on how they are operated and the effectiveness of sediment flushing, which may reach equilibrium over time. The timing of flushing in relation to early floods, and the coordination of this between the many dams, will need careful consideration.

The environmental impacts will arise from the increased pondage and backwater effects of these dams and their barrier effect on the fish migrating throughout much of the mainstream. There will be a direct and severe negative impact on most environmental hotspots. Fourteen out of the 32 environmental hotspots would be highly impacted and another 9 moderately impacted; some of these sites are listed under the Ramsar Convention. Compared to the previous scenario with mainstream only in Northern Lao PDR, all except one further impacted hotspots are situated in Cambodia (Tonle Sap area, Mekong mainstream, and 3Ss basin). One further impacted hotspot is situated on the Sekong in the Lao PDR portion of the 3Ss basin.

Crucially, the eleven mainstream dams will have a severe impact upon two flagship species, with the likelihood of their extinction along with other species. They will also create a near-total barrier to fish migration along most of the mainstream. In relation to the baseline, overall capture fisheries production would be depleted by 25% within the basin, being by 21% in Lao PDR, 5% in Thailand, 44% in Cambodia and 25% in Viet Nam.

Capture fisheries would also decline compared to the Definite Future Scenario and would be severely affected in both Cambodia (37% decline) and Viet Nam (28% decline). The decline in capture fish yield is much less in Lao PDR (6%) and Thailand (2%). Sixty percent of the ecologically valuable river channel between Kratie and Houei Xai would change to a series of connected impoundments. Important habitats like deep pools, rapids and sandbars would be lost largely, resulting in severe loss of biodiversity. Two of the four flagship species would be very severely impacted, even to the point of extinction.

Social impacts

Although aquaculture is expected to expand to compensate for lost protein availability, the very substantial losses to wild fisheries will have a very substantial impact on rural livelihoods. This will be felt particularly in Cambodia and Viet Nam, as increases in aquaculture are unlikely to benefit the poor people, many of whom would lose their wild fishing whilst having no access to land, water and capital to fall back on. The loss of protein supply from capture fisheries in Cambodia, by way of comparison, would be larger than its current combined production of cattle, pig and chicken meat.

In total the number of vulnerable livelihoods in this scenario is estimated to be 4,360,000 of which 907,000 would be in Lao PDR, 516,000 in Thailand, 1,212,000 in Cambodia and 1,725,000 in Viet Nam. This represents overall an increase of three times that with no mainstream dams and five times that to be experienced in the Definite Future Scenario.

At the same time the scenario would create an additional 420,000 jobs compared to the 20-year plan without mainstream dams, bringing the total to 1,240,000 job opportunities in all four LMB countries compared to the baseline (up 870,000 compared to the Definite Future Scenario).

Economic impacts

Relative to the baseline, this scenario would generate overall net economic benefits of US$ 33,386 million NPV, of which US$ 22,588 million would arise in Lao PDR, US$ 4,410 million in Thailand, US$ 2,237 million in Cambodia and US$ 4,151 million in Viet Nam.

Within these figures, economic losses in vulnerable sectors are substantial, being a total of US$ 3,041 million compared to the baseline. Cambodia's capture fisheries alone contributes over a third of these losses and the capture fisheries in the other three countries contributing together another third.

In summary

This 20-year plan scenario would create the highest economic benefits to all LMB countries, mainly derived from transboundary hydro-electricity sharing. Whilst all countries economically benefit substantially from this scenario, Lao PDR would gain two-thirds of the total.

These substantial gains are offset by the very substantial impacts on capture fisheries and severe impacts on nearly all environmental indicators, including capture fisheries, environmental hotspots, flagship species and biodiversity. The negative impacts are particularly severe in Cambodia and Viet Nam. The extent to which these severe adverse impacts are caused by the Thai and/or Cambodian mainstream dams is explored in the next scenarios.

Over 4.3 million livelihoods would be threatened, far in excess of the 1.2 million jobs created.

4.3.4 *20-Year Plan Scenario without the Cambodian Mainstream Dams*

Scenario content

The 20-Year Plan Scenario without the Cambodian Mainstream Dams represents the 20-year plan above but with the two Cambodian mainstream dams (Stung Treng and Sambor) omitted. It examines therefore the impacts of adding to the *20-year plan without mainstream dams* nine mainstream dams, being in upstream to downstream order:

Ref	Project Name	Installed capacity MW	Live storage MCM
L052	**Pakbeng**	1,230	442
L053	**Luang Prabang**	1,410	734
L054	**Xayabuly**	1,260	225
L055	**Paklay**	1,320	384
L056	**Sanakham**	1,200	106
L057	**Sangthong-Pakchom**	1,079	217
L058	**Ban Kum**	1,872	403
L059	**Latsua**	686	530
L034	**Don Sahong**	360	115

The other components of the scenario are as before, namely 56 additional tributary dams (30 more than in the Definite Future Scenario) and 1.6 Mha of irrigation. The total incremental capacity of the hydropower is 20.6GW, of which 10.9GW is associated with the nine mainstream dams. Being run-of-the-river, the mainstream dams add only 3.2 BCM of additional active storage to the previous 34.4 BCM in UMB and tributary dams.

Hydrological impacts

The mainstream dams, being run-of-the-river, have a small incremental effect on the basin-scale hydrology, but will have large significant impacts locally and near contiguously along most of the LMB mainstream between Don Sahong and Chiang Sean, raising water levels in upstream pondage areas and, depending upon their operation, downstream as well. Whilst flood season flows will remain largely unchanged from the scenario without mainstream dams, there will be a small increase in dry season flows (typically 5%) as a consequence of the increased regulation.

Thus for this scenario, compared to the baseline, overall flooded areas are 307,000ha below the average annual area, saline intrusion affected areas are 288,000ha less and flow reversal remains at about a 12% reduction of volume entering Tonle Sap with a slight increase in the delay of flow reversal occurring to 7 days on average.

Environmental impacts

The environmental impacts will arise from the increased pondage and backwater effects of these dams and their barrier effect on the fish migrating throughout much of the mainstream. By not building the two Cambodian mainstream dams, fish migration from the Mekong mainstream into the 3S-Basin would still be possible and the ecologically valuable stretch between Kratie and Houei Xai would be as for the Definite Future Scenario. The number of highly impacted environmental hotspots would be 11, down by three from the 20-year plan with all eleven mainstream dams.

The nine mainstream dams will have a severe impact upon two flagship species, with the likelihood of the extinction of Giant Catfish along with other species. They will also create a near-total barrier to fish migration upstream from Don Sahong. In relation to the baseline, overall capture fisheries production would be depleted by 16% within the basin (9% less than if the Cambodian dams are present), being by 18% in Lao PDR, 5% in Thailand, 25%in Cambodia (down from 44% with the Cambodian dams) and 16% in Viet Nam (down from 25% with the Cambodian dams).

Capture fisheries would also decline by 10% compared to the Definite Future Scenario and would be severely affected in both Cambodia (19% further decline) and Viet Nam (15% further decline), whereas in Lao PDR (3%) and Thailand (1%) the changes would be much smaller. Upstream of Don Sahong the ecologically valuable river channel would change to a series of connected impoundments and important habitats like deep pools, rapids and sandbars would be lost largely, resulting in severe loss of biodiversity.

Social impacts

The substantial losses to wild fisheries will have a severe impact on rural livelihoods, particularly in Cambodia and Viet Nam. Predicted increases in aquaculture are unlikely to benefit the poor people, many of whom would lose their wild fishing whilst having no access to land, water and capital to fall back on.

In total the number of vulnerable livelihoods in this scenario is estimated to be 2,738,000 of which 782,000 would be in Lao PDR, 516,000 in Thailand, 352,000 in Cambodia and 1,088,000 in Viet Nam. Although less severe than with all eleven mainstream dams, this represents overall an increase of nearly double that with no mainstream dams and nearly four times that to be experienced in the Definite Future Scenario.

At the same time the scenario would create an additional 264,000 jobs compared to the 20-year plan without mainstream dams, bringing the total to 1,084,000 job opportunities in all four LMB countries compared to the baseline (up 714,000 compared to the Definite Future Scenario).

Economic impacts

Relative to the baseline, this scenario would generate overall net economic benefits of US$ 31,738 million NPV, of which US$ 22,632 million would arise in Lao PDR, US$ 4,223 million in Thailand, US$ 1,142 million in Cambodia and US$ 3,741 million in Viet Nam.

Within these figures, economic losses in vulnerable sectors remain substantial being a total of US$ 2,131 million compared to the baseline. Cambodia's share of these losses is expected to be in excess of half this total.

In summary

This scenario has, unsurprisingly, similar but less positive and negative impacts than the 20-year scenario with all mainstream dams, arising from the absence of the two Cambodian mainstream dams from the full set. Economic benefits would be reduced by US$ 1,647 million overall with Cambodia bearing most of this reduction (US$ 1,095 million), principally as a result of reduced hydropower generation. At the same time the absence of these two dams would allow connectivity in the mainstream to be maintained up to the outfall of the 3S basin, with a consequential less severe impact upon Cambodian and Viet Nam capture fisheries. Thus, compared to the 20-year plan with all mainstream dams, the losses and gains are substantially borne by Cambodia.

Overall, the scenario would create substantial economic benefits mainly derived from transboundary hydro-electricity sharing. However, whilst all countries benefit economically from this scenario, Lao PDR would enjoy 71% of the total incremental net benefits above the baseline, with the remainder being shared between Thailand (13%), Cambodia (4%) and Viet Nam (12%). Nevertheless, these gains are still offset by substantial impacts on capture fisheries and severe impacts on nearly all environmental indicators, including capture fisheries, environmental hotspots, flagship species and biodiversity. Over 2.7 million livelihoods would be threatened, far in excess of the 1.5 million jobs created.

4.3.5 20-Year Plan Scenario without Thai Mainstream Dams

This scenario includes 9 mainstream dams excluding the two Thai mainstream dams, Pak Chom and Ban Kum. The scenario has an NPV of US$ 29,277 million compared to US$ 33,386 million for the 20-Year Plan Scenario. The net economic benefits to Thailand would be reduced by US$ 441 million NPV. In most respects, the impacts are similar to those with all eleven mainstream dams, as the Cambodian and Lao mainstream dams would already be impacting on fisheries and other environmental values.

Scenario content

The 20-Year Plan Scenario without the Thai Mainstream Dams represents the 20-year plan above but with the two Thai mainstream dams (Sangthong-Pakchom and Ban Kum) omitted. It examines therefore the impacts of adding to the *20-year plan without mainstream dams* nine mainstream dams, being in upstream to downstream order:

Ref	Project Name	Installed capacity MW	Live storage MCM
L052	**Pakbeng**	1,230	442
L053	**Luang Prabang**	1,410	734
L054	**Xayabuly**	1,260	225
L055	**Paklay**	1,320	384
L056	**Sanakham**	1,200	106
L059	**Latsua**	686	530
L034	**Don Sahong**	360	115
C006	**Stung Treng**	980	70
C005	**Sambor**	3,300	2,000

The other components of the scenario are as before, namely 56 additional tributary dams (30 more than in the Definite Future Scenario) and 1.6 Mha of irrigation. The total incremental capacity of the hydropower is 21.9GW, of which 11.7GW is associated with the nine mainstream dams. Being run-of-the-river, the mainstream dams add only 4.6 BCM of additional active storage to the previous 34.4 BCM in UMB and tributary dams.

Hydrological impacts

The mainstream dams, being run-of-the-river, have a small incremental effect on the basin-scale hydrology, but will have large significant impacts locally and near contiguously along most of the LMB mainstream between Sambor and Chiang Sean, raising water levels in upstream pondage areas and, depending upon their operation, downstream as well. The absence of the two Thai dams, compared to the full 20-year plan scenario with all mainstream dams, will ameliorate these local effects between Ban Kum and Sanakham sites. Whilst flood season flows will remain largely unchanged from the scenario without mainstream dams, there will be a small increase in dry season flows (typically 1%) as a consequence of the increased regulation.

Thus for this scenario, compared to the baseline, overall flooded areas are 307,000ha below the average annual area, saline intrusion affected areas are 288,000ha less and flow reversal remains at about a 12% reduction of volume entering Tonle Sap with a slight increase in the delay of flow reversal occurring to 7 days on average.

Environmental impacts

The environmental impacts will arise from the increased pondage and backwater effects of these dams and their barrier effect on the fish migrating throughout much of the mainstream. Given the presence of the two Cambodian mainstream dams and notwithstanding the absence of the two Thai mainstream dams, fish migration along the Mekong mainstream will be almost as severely impacted as if all eleven mainstream dams were constructed. The number of highly impacted environmental hotspots would be 14, the same as with the 20-year plan with all eleven mainstream dams.

The nine mainstream dams will have a severe impact upon two flagship species, with the likelihood of the extinction of the Mekong River Dolphin, the Giant Catfish and other species. They will also create a near-total barrier to fish migration upstream from Sambor.

In relation to the baseline, overall capture fisheries production would be depleted by 25% within the basin, being by 21% in Lao PDR, 5% in Thailand, 44%in Cambodia and 37% in Viet Nam, all as expected with the full eleven mainstream dams. Capture fisheries would also decline by 19% compared to the Definite Future Scenario and would be severely affected in both Cambodia (40% further decline) and Viet Nam (31% further decline), whereas in Lao PDR (6%) and Thailand (1%) the changes would be much smaller.

Upstream of Sambor the ecologically valuable river channel would change to a series of connected impoundments and important habitats like deep pools, rapids and sandbars would be lost largely, resulting in severe loss of biodiversity.

Social impacts

The substantial losses to wild fisheries will have a severe impact on rural livelihoods, particularly in Cambodia and Viet Nam. Predicted increases in aquaculture are unlikely to benefit the poor people, many of whom would lose their wild fishing whilst having no access to land, water and capital to fall back on.

In total the number of vulnerable livelihoods in this scenario is estimated to be 4,359,000 of which 907,000 would be in Lao PDR, 515,000 in Thailand, 1,212,000 in Cambodia and 1,725,000 in Viet Nam, of similar severity as with all eleven mainstream dams. Thus this represents overall an increase of three times that with no mainstream dams and nearly five times that to be experienced in the Definite Future Scenario.

At the same time the scenario would create an additional 338,000 jobs compared to the 20-year plan without mainstream dams, bringing the total to 1,158,000 job opportunities in all four LMB countries compared to the baseline (up 788,000 compared to the Definite Future Scenario).

Economic impacts

Relative to the baseline, this scenario would generate overall net economic benefits of US$ 29,276 million NPV, of which US$ 18,927 million would arise in Lao PDR, US$ 3,970 million in Thailand, US$ 2,237 million in Cambodia and US$ 4,143 million in Viet Nam.

Within these figures, economic losses in vulnerable sectors remain substantial being a total of US$ 2,996 million compared to the baseline, two-thirds of which would be made up by capture fisheries losses. Cambodia’s share of these losses is expected to be 58% of the total.

In summary

This scenario has overall net economic benefits lower by US$ 2,462 million than the 20-year scenario above without Cambodian mainstream dams. However, the presence of the two

Cambodian mainstream combined with the other seven mainstream dams further upstream would create a similar barrier effect to fish migration as would be seen with all eleven dams present.

Similarly, the impacts on environmentally and ecologically important sites would be almost as severe as with the full 20-year scenario with all mainstream dams, leading to severe impacts upon bio-diversity.

Over 4.3 million livelihoods would be threatened, far in excess of the 1.2 million jobs created.

4.4 Long Term Development Scenarios

The long term scenarios offer a perspective of what impacts may arise as a result of possible further development of hydropower and irrigation over the next 50 years. These developments do not form a part of country plans, but by considering them now it is possible to gain some insight into the issues that such continued developments would create.

However, with such a long time frame, it is evident that circumstances outside the water sector would change brought about by, for instance, socio-economic development, demographic change, market forces, technological change, climate change and sea level rise. As discussed in Section 2.3, other than a preliminary investigation of aquaculture, climate change and sea level rise, these external changes have not been evaluated. The assessments made of the long-term scenarios are against baseline conditions, and this should be borne in mind when viewing the results.

A further consideration in looking at long term scenarios is the impacts of developments in the near term scenarios which may not be noticed immediately but which will arise at a later date as a direct consequence of near-term developments. Chief amongst these are the geomorphological changes induced by sediment trapping, which as described in Section 3.3.2 will not necessarily be felt immediately but which, over 50 years may have significant impact. A similar situation can be expected with bio-physical changes as eco-systems adapt over time to new circumstances. In general in this report, and as discussed for instance in Section 3.3.2, these potential consequences are discussed in the context of the developments in the Definite Future and Foreseeable Future Scenarios that cause them. The discussion below of the long term scenarios is therefore limited to further consequences that may arise as a consequence of continued development.

4.4.1 LMB Long-term Development Scenario

Scenario content

This scenario builds from the full 20-year Foreseeable Future Scenario with all eleven mainstream dams. In addition, the scenario contains a further 35 tributary dams (bringing the total to 91 including existing dams), which together add a further 2,682MW of installed

hydropower capacity and 2.3BCM of active storage within the lower basin, raising total storage within the basin (including UMB) to 21.0% of the mean annual runoff (MAR).

Irrigation development expands by a further 629,000ha (of which 266,000ha is in Lao PDR, 124,000ha in Thailand, 221,000ha in Cambodia and just 18,000ha in Viet Nam), bringing the total in the basin to 5,966,000ha, a 60% increase over the baseline. Notably, overall irrigated cropping intensity in the Long-term Development Scenario rises from 177% in the Baseline to 200% under this scenario, signalling a proportionately greater increase in use of dry season flows.

Industrial and domestic water supplies also increase to service an estimated total in-basin population by 2060 of 109.4 million (15.7 million in Lao PDR, 27.1 million in Thailand, 31.3 million in Cambodia, 35.3 million in Viet Nam), representing a near doubling of the overall those living within the LMB over the baseline.

Hydrological impacts

The significant increase in tributary storage is more than sufficient to offset the increased demands from irrigation. In general dry season flow would be slightly higher than the 20-year plan scenarios as a result and wet season flooded areas would remain similar. The area affected by salinity intrusion would also remain similar to the 20-year plan.

Climate change (under IPCC scenario B2 and with 30cm sea level rise) would have a significant further impact, principally in the wet season (average dry season flows are expected to increase very slightly). The reduction in flooded area predicted without climate change would be reversed and average total flooded area would rise to 5.04 million ha (6% more than the baseline). Notwithstanding the similarity of dry season flows to the Foreseeable Future, the impact of sea level rise would be to cause a substantial increase in land affected by saline intrusion, which is forecast to increase to 2.15 million ha (16% more than the baseline).

Environmental impacts

The substantial environmental impacts as forecast for the 20-year plan with eleven mainstream dams would in general terms be exacerbated by the continued developments in the Long-term Scenario. The risks of increased agricultural pollutant runoff would increase.

There are significant uncertainties for Cambodian and Viet Nam flood plain management associated with the cumulative impacts of geomorphological change, flood magnitudes and variability and sea level rise.

Social impacts

In total the number of vulnerable livelihoods in this scenario would rise to between 4,506,000 and 4,810,000 as a result of the incremental developments and the uncertainties above.

At the same time the scenario would create an additional 599,000 jobs (mainly in agriculture) compared to the 20-year plan with all eleven mainstream dams, bringing the total to 1,839,000 job opportunities in all four LMB countries compared to the baseline (up 1,469,000 compared to the Definite Future Scenario).

Economic impacts

Relative to the baseline, this scenario would generate overall net economic benefits of US$ 41,468 million NPV, of which US$ 26,401 million would arise in Lao PDR, US$ 5,010 million in Thailand, US$ 5,302 million in Cambodia and US$ 4,755 million in Viet Nam.

Within these figures, economic losses in vulnerable sectors remain substantial totalling US$ 3,470 million compared to the baseline, over half of which would be made up by capture fisheries losses. Cambodia's share of these total losses is expected to be 58% of the total.

In summary

This scenario demonstrates that there is sufficient storage potential in the LMB's tributaries to meet continued irrigation expansion plans without touching the present dry season flow, as represented by the Baseline Scenario (1985-2000).

At the same time, continued development will exacerbate the already severe environmental and social impacts forecast for the full 20-year plan with eleven mainstream dams.

Considerable uncertainties exist over the long term consequences of development, climate change and sea level rise on the Cambodian and Viet Nam flood plains.

4.4.2 LMB Very High Development Scenario

This scenario extends the level development of hydropower and irrigation within the LMB to what is considered to be the full technical potential (ie irrespective of economic viability).

Thus in addition to developments in the LMB Long-term Development Scenario a further 19 tributary dams are considered, which together add 0.6GW of installed hydropower capacity, 11.6 BCM of active storage and 2.44 million ha of irrigation (mainly in Lao PDR and Cambodia), raising the totals for the LMB to 29.7GW of installed hydropower, 74.6 BCM of storage and 8.4 million ha at 221% irrigated cropping intensity. Together with storage in the UMB, total active storage is then 23.5% of MAR.

Whilst most environmental and social impacts are further exacerbated, the significance of this scenario is only that there remains sufficient storage to sustain dry season flows above current baseline conditions.

4.5 Mekong Delta Flood Management Scenarios

The Mekong Delta Flood Management Scenarios have been assessed as a separate exercise to those above and are described more fully in Appendix A.

The scenarios comprise a number of specific flood management schemes on either side of the Cambodia – Viet Nam border which have been assessed against baseline conditions. The assessments do not take into account the impacts of upstream water consumptive projects (irrigation) or mainstream and tributary hydropower developments[19]. There are therefore no direct implications for Lao PDR and Thailand, as any impacts from these scenarios are within the delta reaches and downstream of Khone Falls.

Foreseeable Future Scenarios

The scenarios associated with potential flood management developments over the next 20 years (ie within the Foreseeable Future) were determined by FMMP in close consultation with both Cambodia and Viet Nam. They involve areas in both countries (see Figure 43). In Cambodia the study areas comprised: (i) Floodplains on the West Bassac (ii) floodplains between Bassac and Mekong and (iii) floodplains on the left bank of the Mekong and south of the NR #1. In Viet Nam focus was given to: (i) Long Xuyen Quadrangle (LXQ), (ii) area between Bassac and Mekong north of the Vam Nao, and (iii) Plain of Reeds north of the Nguyen Van Tiep Canal.

Figure 43 Location of 20-year Flood Management Scenarios

From these, three main scenarios were defined to represent the Foreseeable Future Scenario (20-year), being: (i) in Cambodia early flood protection and full flood protection in Cambodia; (ii) in Viet Nam a mix of early flood protection and full flood protection; and (iii) a combination of the two above.

The main conclusions from the FMMP-C2 study are that the combined scenario results in lower risk in both countries with the exception of LXQ, where it is suggested that the increased risks are better mitigated by the widening of the canals in the LXQ rather constructing new large canals elsewhere.

[19] The FMMP-C2 report considers that the hydrological changes brought about by these upstream developments would not materially affect the conclusions that are drawn from the studies (although unquestionably there would be need to take upstream plans into account in developing project designs).

Long term development scenarios

In addition and in the run-up to defining the scenarios above, other scenarios were looked into. These included differing levels of flood protection in Viet Nam, diversion of flood flows into Tonle Sap and diversion of flows to the Gulf of Thailand. The diversions to Tonle Sap were shown to have some positive effects on flooding downstream, but limited in nature compared to the massive investments that would be required.

Issues arising

The review of climate change set out in Section 3.2 underscores the long term challenges associated with flood plain management in the Mekong Delta. Current option studies under FMMP have focussed on investigating specific schemes from which considerable understanding has been gained on local flood management best practice leading to best practice guidelines have been developed.

However, as apparent, a much wider consideration of flood plain options is needed to take into account the threats of climate change and geomorphological consequences for the delta and the potential massive social and economic consequences that arise. Whilst these threats are clearly evident for Viet Nam, the studies undertaken by FMMP emphasise the inter-dependence of possible solutions between Viet Nam and Cambodia. In addition, as demonstrated by the assessments made in this report of upstream developments, clearly Cambodia has a number of other potentially overlapping major issues to address, particularly with impacts on the Tonle Sap from upstream flow modifications and barrier effects of new dam construction.

It is evident therefore that, to address these issues in an integrated manner, major further studies are needed to investigate long term issues of flood management in the context of both climate change and emerging strategies for upstream development and to explore the potential for synergies between the two. The outcome of such a study should be aimed at guiding developments in a manner that leads to prudent investment in the near term that will better enable long term solutions to be achieved.

4.6 Summary of scenario assessments

4.6.1 Summary of findings

The merits and demerits of each of the scenarios are discussed individually above. This section draws together the main findings that emerge from these assessments when viewed collectively.

It is important to recall that the assessments are not without limitations (as set out in Section 2.5) and that there a number of uncertainties and risks that have been identified during the course of the assessment process. These uncertainties and risks are reviewed and discussed in Chapter 5 of this report.

The findings are summarised by considering the implications that arise from the scenarios within each of the three main planning horizons, viz.: the Definite Future, the Foreseeable Future (with and without mainstream dams) and the Long-term.

The Definite Future Scenario (DFS)

- The Definite Future Scenario represents developments which are already under construction and/or committed, involving major new storages in UMB and 15 new tributary dams. **This additional storage has been estimated to provide for all irrigation expansion within the next 20 years (1.6Mha).** Therefore, further expansion beyond the DFS of tributary storage within the Foreseeable Future timescale needs to be weighed against its economic benefits from energy and flood control against any downsides from wetlands and bio-diversity reduction, sediment trapping, fisheries reduction and social consequences.

- **The ability to expand irrigation in the LMB under the 20-year scenarios whilst maintaining (or exceeding) baseline dry season flows depends very much upon the new storages being constructed in the UMB**. As such, it is important that coordination with China over operation of the UMB dams is strengthened.

- **The consequences of sediment trapping are an important aspect of reservoir development**, particularly with regard to the timing of resulting impacts and the geomorphological stability of the delta. Further research is needed to address this. Apart from the viability of individual reservoirs, the key issue is the potential for cumulative impacts of sediment trapping within the basin on wetland productivity and especially on the delta-shaping processes, which are potentially exacerbated by sea level rise. Even if these impacts take 50-100 years to occur, and some think the timeline is very much shorter, development choices now may have major consequences for the delta in the future.

- **The DFS is inevitable and happening. Actions are needed now to address the downsides associated with environmental, fisheries and social impacts and to set a framework for managing future developments as well.**

The Foreseeable Future Scenario without mainstream dams

- The Foreseeable Future Scenario without mainstream dams has **substantial economic benefits arising from irrigation expansion and 30 additional tributary dams**. However, as noted above, the tributary dams are not required to support the 1.6Mha irrigation expansion within the Foreseeable Future Scenario and their merits and demerits may be considered individually.

- **The incremental environmental impacts are relatively small compared to the Definite Future Scenario** and are principally associated with the tributary dams reducing the flood season flows, in addition to their direct construction and barrier impacts. They also increase the amount of sediment trapping, heightening the uncertainties associated with delta stability and wetland productivity.

- In contrast, the **numbers of livelihoods placed at risk will rise to 59% above the Definite Future Scenario** reaching 1,409,000 people within the LMB. The main increases above the DFS will be felt in Lao PDR (135% up), due principally to direct impacts of reservoir construction, and in Cambodia (108% up) due to transboundary impacts on capture fisheries.

- **The parallel development of irrigation and tributary dams maintains the mainstream dry season flows substantially at DFS levels**, which is significantly above baseline conditions. Although this may be beneficial to address long term irrigation expansion, in the medium term sustaining dry season flows at substantially above Baseline conditions may simply reinforce the ecological downsides associated with higher water levels (which in the northern reaches is unavoidable but will benefit navigation).

- Compared to the DFS, the economic upsides from this scenario are for hydropower US$ 6,112 million NPV, for irrigation US$ 1,659 million NPV, and for the rest US$ 546 million NPV. The downsides, which mostly stem from the tributary dams, are US$ 422 million NPV. At face value, **the tributary hydropower component has significant economic benefits, even after accounting for the environmental disbenefits**.

- The **irrigation expansion**, which can occur as a consequence of the DSF, has been assumed to have **potentially significant benefit in terms of rice-field fisheries. Risks of increased runoff of agricultural input residues have been flagged as well**. It will be beneficial on both counts if best practices in both areas are developed and followed.

- The total net benefits attributed to this scenario relative to the Baseline are US$19,596 million NPV, which are shared between the countries as follows: Lao PDR US$11,688 million (60%), Thailand US$2,750 million (14%), Cambodia US$1,446 million (7%) and Viet Nam US$3,712 million (19%). **More than half the net economic benefits attribute to one country, Lao PDR**, principally as a result of the additional tributary dams.

The Foreseeable Future Scenario with mainstream dams

- **The inclusion of up to eleven new mainstream run-of-the river dams within the Foreseeable Future Scenario creates the potential for both very substantial economic benefits as well as very severe environmental and social impacts**. Whilst the economic benefits are easy to recognise, it is important to distinguish the environmental and social disbenefits that may be attributed to the mainstream dams from those which arise from tributary dam development in the scenarios.

- The direct environmental impacts of the mainstream dams are very significant (as elaborated in the SEA). Although, being run-of-river, the mainstream dams have only small impact on basin-scale mainstream flows, **locally they will modify water levels very significantly with considerable harm caused to eco-systems within the affected reaches**. In addition, the **mainstream dams create a barrier to fish migration**, the severity of which is broadly proportional to the extent of the river system disconnected from the Tonle

Sap. The barrier effect will also affect local fish migrations as well, with **both the Giant Catfish and Mekong Dolphin placed at risk of extinction**, along with many other species.

- **The mainstream dams also will have impacts on sediment transport**. Again, being run-of-river, in the context of basin-scale impacts, the volumes of sediment trapped should reach equilibrium within a few years of construction. However, local impacts can be expected to be significant. The manner in which the dams are operated will have significant bearing on their geomorphological impacts. This suggests further detailed study of individual dam proposals is certainly merited before any final decisions are taken.

- **The eleven mainstream dams together generate an extra US$ 15,220 million NPV, but also cause sixty percent of the ecologically valuable river channel between Kratie and Houei Xai to change to a series of connected impoundments.** Important habitats like deep pools, rapids and sandbars would be largely lost, resulting in **severe loss of biodiversity**. Fourteen out of the 32 environmental hotspots would be highly impacted and another nine moderately impacted. Two of the four flagship species would be put at severe risk of extinction along with many others.

  The eleven mainstream dams will also create a near-total barrier to fish migration along most of the mainstream. In relation to the baseline, overall **capture fisheries production would be depleted by 25% within the basin**. These declines would be most severe in comparison to the Definite Future Scenario in Cambodia (37% decline) and Viet Nam (28% decline). **As a result of the eleven mainstream dams, livelihoods put at risk would rise by nearly three times compared to the 20-year plan without mainstream dams** (and nearly five times that under the Definite Future Scenario), bringing the total under this scenario to 4,360,000 of which 907,000 would be in Lao PDR, 516,000 in Thailand, 1,212,000 in Cambodia and 1,725,000 in Viet Nam.

- The clear evidence from the assessments is that **the lower of the proposed eleven mainstream dams have a very substantial impact upon the LMB's capture fisheries** over and above that which can be anticipated under the Definite Future Scenario. As may be seen from the assessments, the absence of the two Thai mainstream dams (Sangthong-Pakchom and Ban Kum) from the cascade makes very little difference to the capture fisheries impact due to the presence of Don Sahong, Stung Treng and Sambor further downstream creating a barrier effect.

- **The upper six mainstream dams have substantial economic benefits, generating US$ 7,132 million NPV, or 17% more than the combined benefits of the 30 additional tributary dams. Nevertheless, the presence of the mainstream dams would have incremental environmental impacts arising from the increased pondage and backwater effects and their barrier effect on the fish migrating in this part of the mainstream**. Two environmental hotspots will be severely impacted and crucially the Giant Catfish could become extinct along with other species locally.

However, given their location at the farther end of the basin's main migratory routes, these dams will have **a marginal effect on capture fisheries, reducing productivity by a further 2% typically**. Nevertheless, in relation to the baseline, overall capture fisheries production would be some 12% depleted, being by 16% in Lao PDR, 5% in Thailand, 18% in Cambodia and 16% in Viet Nam[20]. Reductions in sediment outflow from the basin will remain similar to the 20-year plan without mainstream dams and will have negative impacts upon marine fisheries. **As a result of the six mainstream dams, livelihoods put at risk would rise by 43% compared to the 20-year plan without mainstream dams**, bringing the total under this scenario to 2,015,000 livelihoods (782,000 in Lao PDR, 201,000 in Thailand, 262,000 in Cambodia and 770,000 in Viet Nam).

- Under the scenario with the upper six mainstream dams, the total net benefits attributed to this scenario relative to the Baseline are US$ 26,728 million NPV, of which US$ 17,636 million (66%) would arise in Lao PDR , US$ 3,913 (15%) million in Thailand, US$ 1,351 million in Cambodia (5%) and US$ 3,828 million (14%) in Viet Nam. **Nearly two-thirds of the net economic benefits attribute to one country, Lao PDR**, principally as a result of hydropower development.

The flood management scenarios

- These scenarios demonstrate that the **combined schemes put forward within the scenario are beneficial** and that this is a matter for Cambodia and Viet Nam to decide between themselves.

- The studies undertaken by FMMP-C2 nevertheless flag up that a balance is needed between partial and full flood protection. Given the pressures on the Mekong Delta arising from autonomous development, climate change, sea level rise and changes in sediment flows from upstream, it is clear that **a much wider study is needed** to guide management and development of the Mekong Delta flood plains in a sustainable manner.

The long-term scenarios and climate change

- The long term scenarios provide some confidence that it is **possible to maintain acceptable water balances** with all envisaged possible dam and irrigation developments in place. However, they also **highlight the massive impacts** these developments would have on the eco-systems and social fabric of the basin and point to the need to proceed prudently and at a pace that allows knowledge to stay ahead of actions.

[20] It is worth noting that the 12% depletion is made up of 7% occurring in the DFS as a result of flow modifications principally arising from dams in the UMB together with the ongoing development of 26 tributary dams, 3% from the further addition of 30 tributary dams and 2% from these six mainstream dams.

- **The assessments made of climate change point clearly towards increasing runoff and more variable conditions within the basin**. These predictions, which are still very preliminary, suggest that whilst they may relax dry season abstraction constraints, drought and floods will become more of a problem. **Understanding how climate change will impact** on eco-systems and agricultural practices **will be important**, as also will be the role of irrigation in combating drought and measures to combat more extreme flooding.

- **The major significance of climate change is sea level rise**. Combined with the likelihood of increased flooding, uncertainties of geomorphological impacts on the delta and acknowledging the development pressures in both Cambodia and Viet Nam, **the threat of sea level rise requires extensive study before a strategy for the delta can be framed**.

4.6.2 Assessment summary results

The different economic, environmental and social impacts of all the scenarios are summarised and presented overleaf in Table 23 and Table 24 for the LMB, set within the agreed assessment framework[21]. A further summary is presented thereafter in Table 25 and Table 26 of selected indicators that have emerged from the consultations as being of particular interest. Full details are presented in Appendices B, C and D.

[21] Similar tables are presented for each country in Appendix D

Table 23 Summary of assessment results for the LMB compared to baseline

Summary of scenario assessment

Incremental values relative to Baseline

Lower Mekong Basin

Specific development objective	Issue	Assessment criteria	Unit	2000 2015-UMD		3000 2015-DF		4000 2030-20Y		4001 2030-20Y+CC		5000 2030-20Y-w/o MD		6100 2030-20Y-w/o LMD		6200 2030-20Y-w/o TMD		6300 2030-20Y-w/o CMD		8000 2060-LTD		8001 2060-LTD+CC		9000 2060–VHD	
1. Economic development																									
1.1 Increase irrigated agricultural production	Irrigable area, production tonnage and value	Incremental area	'000 ha			-275	-7%	1,597	43%	1,597	43%	1,597	43%	1,597	43%	1,597	43%	1,597	43%	2,226	60%	2,226	60%	4,666	125%
		Crop production	Mtonne / yr					27.153	97%	27.153	97%	27.153	97%	27.153	97%	27.153	97%	27.153	97%	43.372	155%	43.372	155%	93.307	333%
		Net economic value	NPV US$M			-144		1,481		1,938		1,487		1,484		1,481		1,483		4,041		4,453		15,855	
1.2 Increase hydropower production	Hydropower capacity, power generated and value	Installed capacity	MW			4,946	312%	24,839	1566%	24,839	1566%	10,142	639%	17,641	1112%	21,888	1380%	20,559	1296%	27,521	1735%	27,521	1735%	28,098	1772%
		Power generated	GWh/yr			35,417	389%	194,136	2135%	194,136	2135%	74,389	818%	136,129	1497%	171,381	1885%	156,630	1723%	206,800	2274%	206,800	2274%	209,735	2307%
		Net economic value from generation	NPV US$M			8,350	186%	17,028	379%	17,028	379%	11,069	246%	13,638	303%	15,187	338%	16,410	365%	21,783	485%	21,783	485%	22,711	505%
		Net economic value from purchased	NPV US$M			3,142	385%	15,796	1934%	15,796	1934%	6,534	800%	11,364	1392%	13,519	1655%	13,922	1705%	16,082	1969%	16,082	1969%	16,076	1969%
1.3 Improve navigation	River transport	Navigable days by class	'000 boat-days	n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a	
		Net economic value	NPV US$M	-0	0%	64	35%	64	35%	64	35%	64	35%	64	35%	64	35%	64	35%	64	35%	64	35%	64	35%
1.4 Decrease damages by floods	Extent and duration of annual flooding by class	Average area flooded annually to max 1.0m depth	'000 ha			118	8%	151	10%	-179	-12%	153	10%	152	10%	152	10%	152	10%	184	12%	-261	-17%	198	13%
		Average area flooded annually > 1.0m depth	'000 ha			-367	-11%	-465	-14%	485	15%	-453	-14%	-459	-14%	-459	-14%	-459	-14%	-532	-16%	542	17%	-590	-18%
		Net economic value of flood damage	NPV US$M			462		377		-273		360		360		360		360		408		-296		432	
1.5 Maintain productivity of fishery sector	Capture fisheries and aquaculture production	Annual average capture fish availability	Mtonne / yr	-0.044	-2%	-0.142	-6%	-0.515	-20%	-2.530	-100%	-0.187	-7%	-0.245	-10%	-0.512	-20%	-0.314	-12%	-0.418	-17%	-2.530	-100%	-0.397	-16%
		Annual average aquaculture production	Mtonne / yr	1.025	52%	1.025	52%	2.063	105%	2.063	105%	2.063	105%	2.063	105%	2.063	105%	2.063	105%	4.078	207%	4.078	207%	6.094	310%
		Net economic value of capture fish	NPV US$M			274		-459		-459		636		441		-452		212		494		494		1,194	
2. Environmental protection																									
2.1 Maintain water quality and acceptable flow conditions	Water quality	Total pollutant discharge	tonnes / yr					189,447	51%	199,809	54%	199,809	54%	199,809	54%	199,809	54%	199,809	54%	393,559	107%	199,809	54%	570,281	155%
		Water quality conditions	Severity																						
	Flow characteristics	Average flow in March	m3/s	748	38%	844	43%	1,205	62%	1,214	62%	1,105	56%	1,190	61%	1,189	61%	1,189	61%	1,199	61%	1,229	63%	719	37%
		Average wet season peak daily flow	m3/s	-1,288	-5%	-1,424	-5%	-2,194	-8%	540	2%	-2,175	-8%	-2,080	-8%	-2,191	-8%	-2,136	-8%	-2,617	-10%	91	0%	-2,866	-10%
		Average flow volume entering Tonle Sap	MCM	-2,113	-7%	-2,518	-8%	-4,265	-13%	-1,596	-5%	-3,900	-12%	-3,920	-12%	-3,918	-12%	-3,919	-12%	-5,322	-16%	-2,477	-8%	-5,250	-16%
	Protection of forests around Tonle Sap	Forest, marshes and grasslands flooded at Tonle Sap	'000 ha			-9	-1%	-14	-1%	15	1%	-14	-1%	-14	-1%	-14	-1%	-14	-1%	-19	-2%	-6	-1%	-29	-3%
		Net economic value	NPV US$M			-153		-372		-372		-183		-228		-349		-254		-731		-731		-822	
2.2 Maintain wetland productivity and	Productivity of wetland ecosystems	Are of wetlands (forest, marshes, wetland)	'000 ha			-35	-2%	-48	-3%	35	2%	-47	-3%	-48	-3%	-48	-3%	-48	-3%	-55	-4%	24	2%	-66	-4%
		Net economic value	NPV US$M			-228		-225		101		-176		-178		-225		-178		-260		36		-310	
2.3 Manage salinity intrusion in the Mekong	Impact of salinity intrusion on land use	Area within delta within threshold level of salinity	'000 ha	-240	-13%	-272	-15%	-309	-17%	23	1%	-305	-16%	-319	-17%	-288	-16%	-288	-16%	-299	-16%	297	16%	-221	-12%
		Net economic value	NPV US$M			20		27		-2		25		23		21		23		22		-2		16	
2.4 Minimize channel effects on bank erosion and deep pools	River bank erosion	Area at risk to erosion	Severity	Mildly positive		Mildly positive		Mildly negative		Negative		Positive		Positive		Mildly negative		Mildly negative		Negative		Negative		Negative	
		Net economic value	NPV US$M																						
	Flow and sediment transport changes	Functioning deep pools	No.					-20	-43%	-20	-43%			-13	-28%	-14	-30%	-18	-38%	-20	-43%	-20	-43%	-20	-43%
		Induced geomorphological changes	Severity	Neutral		Mildly negative		Negative		Negative		Mildly negative		Mildly negative		Negative		Negative		Extremely negative		Extremely negative		Extremely negative	
2.5 Conservation of biodiversity	Impacts of flow management changes on endangered species	Status of river channel habitats	Severity	Neutral		Mildly negative		Negative		Negative		Mildly negative		Negative		Negative		Negative		Extremely negative		Extremely negative		Extremely negative	
		Flagship species	Survival	n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a	
		Unaffected environmental hot spots	Severity	Neutral		Mildly negative		Severely negative		Extremely negative		Negative		Negative		Severely negative		Negative		Extremely negative		Catastrophic		Catastrophic	
		Biodiversity condition	Severity	Neutral		Mildly negative		Severely negative		Severely negative		Negative		Negative		Severely negative		Negative		Severely negative		Severely negative		Extremely negative	
		Incremental net economic value of habitat areas	NPV US$M			-85		-330		-415		-220		-240		-330		-305		-435		-525		-700	
3. Social development																									
3.1 Maintain livelihoods of vulnerable resource-users	Health, food and income security	No. of people affected	'000	527		887		4,360		4,360		1,564		2,015		4,359		2,738		4,506		4,810		4,594	
		Severity of impact on health, food and income security	Severity	Mildly negative		Negative		Severely negative		Severely negative		Negative		Severely negative		Severely negative		Severely negative		Severely negative		Extremely negative		Severely negative	
3.4 Increased employment generation in water related sectors	Incremental sustainable employment from water resource interventions	Incremental number of people engaged in:																							
		Irrigated agriculture	'000					212	51%	212	51%	212	51%	212	51%	212	51%	212	51%	658	157%	658	157%	1,535	367%
		Reservoir fisheries (incremental to BS)	'000			15		64		72		32		40		60		51		126		126		141	
		Hydropower production	'000			104		612		612		224		387		534		469		527		527		573	
		Aquaculture (incremental to BS)	'000			251		352		352		352		352		352		352		528		528		704	
4 Equitable development																									
4.1 Ensure that all four LMB countries benefit from the development of water and related resources	Aggregate benefits by country	Total net economic value	NPV US$M	-0	0%	11,700	213%	33,386	608%	33,403	608%	19,596	357%	26,728	486%	29,276	533%	31,738	578%	41,468	755%	41,358	753%	54,517	992%
		No. of people affected vulnerable to changes	'000	527		887		4,360		4,360		1,564		2,015		4,359		2,738		4,506		4,810		4,594	
		No. of jobs generated	'000			370	89%	1,240	297%	1,248	299%	820	196%	990	237%	1,158	277%	1,084	259%	1,839	440%	1,839	440%	2,954	707%
		Overall environment impact	Severity			Mildly negative		Severely negative		Severely negative		Negative		Negative		Severely negative		Severely negative		Severely negative		Severely negative		Extremely negative	

Table 24 Summary of assessment results for the LMB compared to Definite Future Scenario

Summary of scenario assessment

Incremental values relative to Definite Future Scenario

Lower Mekong Basin

Specific development objective	Issue	Assessment criteria	Unit	2000 2015-UMD	3000 2015-DF	4000 2030-20Y		4001 2030-20Y+CC		5000 2030-20Y-w/o MD		6100 2030-20Y-w/o LMD		6200 2030-20Y-w/o TMD		6300 2030-20Y-w/o CMD		8000 2060-LTD		8001 2060-LTD+CC		9000 2060–VHD	
1. Economic development																							
1.1 Increase irrigated agricultural production	Irrigable area, production tonnage and value	Incremental area	'000 ha			1,872	54%	1,872	54%	1,872	54%	1,872	54%	1,872	54%	1,872	54%	2,501	72%	2,501	72%	4,941	143%
		Crop production	Mtonne / yr			27	97%	27	97%	27	97%	27	97%	27	97%	27	97%	43	155%	43	155%	93	333%
		Net economic value	NPV US$M			1,625	-1128%	2,082	-1445%	1,631	-1132%	1,628	-1130%	1,625	-1128%	1,627	-1129%	4,185	-2905%	4,597	-3191%	15,999	-11105%
1.2 Increase hydropower production	Hydropower capacity, power generated and value	Installed capacity	MW			19,892	305%	19,892	305%	5,195	80%	12,694	194%	16,941	259%	15,612	239%	22,575	346%	22,575	346%	23,152	354%
		Power generated	GWh/yr			158,719	357%	158,719	357%	38,973	88%	100,712	226%	135,964	305%	121,213	272%	171,383	385%	171,383	385%	174,318	392%
		Net economic value from generation	NPV US$M			8,678	68%	8,678	68%	2,719	21%	5,288	41%	6,837	53%	8,061	63%	13,433	105%	13,433	105%	14,362	112%
		Net economic value from purchased	NPV US$M			12,654	320%	12,654	320%	3,393	86%	8,222	208%	10,377	262%	10,781	272%	12,940	327%	12,940	327%	12,934	327%
1.3 Improve navigation	River transport	Navigable days by class	'000 boat-days			n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a	
		Net economic value	NPV US$M																			-0	0%
1.4 Decrease damages by floods	Extent and duration of annual flooding by class	Average area flooded annually to max 1.0m depth	'000 ha			33	2%	-297	-18%	35	2%	34	2%	34	2%	34	2%	66	4%	-379	-23%	80	5%
		Average area flooded annually > 1.0m depth	'000 ha			-98	-3%	851	30%	-86	-3%	-92	-3%	-92	-3%	-92	-3%	-165	-6%	909	32%	-223	-8%
		Net economic value of flood damage	NPV US$M			-85	-18%	-735	-159%	-102	-22%	-102	-22%	-102	-22%	-102	-22%	-54	-12%	-758	-164%	-30	-6%
1.5 Maintain productivity of fishery sector	Capture fisheries and aquaculture production	Annual average capture fish availability	Mtonne / yr			-0	-16%	-2	-100%	-0	-2%	-0	-4%	-0	-15%	-0	-7%	-0	-12%	-2	-100%	-0	-11%
		Annual average aquaculture production	Mtonne / yr			1	35%	1	35%	1	35%	1	35%	1	35%	1	35%	3	102%	3	102%	5	169%
		Net economic value of capture fish	NPV US$M			-734	-268%	-734	-268%	362	132%	167	61%	-726	-265%	-62	-23%	220	80%	220	80%	920	336%
2. Environmental protection																							
2.1 Maintain water quality and acceptable flow conditions	Water quality	Total pollutant discharge	tonnes / yr			189,447	51%	199,809	54%	199,809	54%	199,809	54%	199,809	54%	199,809	54%	393,559	107%	199,809	54%	570,281	155%
		Water quality conditions	Severity																				
	Flow characteristics	Average flow in March	m3/s			361	13%	370	13%	260	9%	346	12%	344	12%	345	12%	355	13%	384	14%	-125	-4%
		Average wet season peak daily flow	m3/s			-770	-3%	1,964	8%	-750	-3%	-656	-3%	-767	-3%	-712	-3%	-1,192	-5%	1,516	6%	-1,441	-6%
		Average flow volume entering Tonle Sap	MCM			-1,747	-6%	922	3%	-1,382	-5%	-1,402	-5%	-1,400	-5%	-1,401	-5%	-2,803	-9%	41	0%	-2,732	-9%
	Protection of forests around Tonle Sap	Forest, marshes and grasslands flooded at Tonle Sap	'000 ha			-5	0%	24	2%	-5	0%	-5	0%	-5	0%	-5	0%	-9	-1%	3	0%	-20	-2%
		Net economic value	NPV US$M			-219	143%	-219	143%	-29	19%	-74	48%	-195	127%	-100	65%	-577	376%	-577	376%	-669	436%
2.2 Maintain wetland productivity and	Productivity of wetland ecosystems	Are of wetlands (forest, marshes, wetland)	'000 ha			-13	-1%	70	5%	-12	-1%	-13	-1%	-13	-1%	-13	-1%	-20	-1%	59	4%	-30	-2%
		Net economic value	NPV US$M			3	-1%	329	-144%	53	-23%	50	-22%	3	-1%	50	-22%	-32	14%	264	-116%	-81	36%
2.3 Manage salinity intrusion in the Mekong	Impact of salinity intrusion on land use	Area within delta within threshold level of salinity	'000 ha			-37	-2%	295	19%	-33	-2%	-47	-3%	-16	-1%	-16	-1%	-27	-2%	569	36%	51	3%
		Net economic value	NPV US$M			7	35%	-22	-110%	5	25%	3	15%	1	5%	3	15%	2	10%	-22	-110%	-4	-20%
2.4 Minimize channel effects on bank erosion and deep pools	River bank erosion	Area at risk to erosion	Severity			Negative		Severely negative		Neutral		Neutral		Negative		Mildly negative		Severely negative		Severely negative		Severely negative	
		Net economic value	NPV US$M																				
	Flow and sediment transport changes	Functioning deep pools	No.			-20	-43%	-20	-43%			-13	-28%	-14	-30%	-18	-38%	-20	-43%	-20	-43%	-20	-43%
		Induced geomorphological changes	Severity			Mildly negative		Mildly negative		Mildly negative		Neutral		Mildly negative		Mildly negative		Severely negative		Severely negative		Severely negative	
2.5 Conservation of biodiversity	Impacts of flow management changes on endangered species	Status of river channel habitats	Severity			Mildly negative		Negative		Mildly negative		Mildly negative		Mildly negative		Mildly negative		Severely negative		Severely negative		Severely negative	
		Flagship species	Survival			n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a	
		Unaffected environmental hot spots	Severity			Negative		Severely negative		Mildly negative		Negative		Negative		Negative		Severely negative		Extremely negative		Catastrophic	
		Biodiversity condition	Severity			Negative		Negative		Mildly negative		Mildly negative		Negative		Mildly negative		Negative		Negative		Severely negative	
		Incremental net economic value of habitat areas	NPV US$M			-245	288%	-330	388%	-135	159%	-155	182%	-245	288%	-220	259%	-350	412%	-440	518%	-615	724%
3. Social development																							
3.1 Maintain livelihoods of vulnerable resource-users	Health, food and income security	No. of people affected	'000			3,473	392%	3,473	392%	677	76%	1,128	127%	3,472	391%	1,851	209%	3,619	408%	3,923	442%	3,707	418%
		Severity of impact on health, food and income security	Severity			Negative		Negative		Mildly negative		Mildly negative		Negative		Mildly negative		Negative		Severely negative		Negative	
3.4 Increased employment generation in water related sectors	Incremental sustainable employment from water resource interventions	Incremental number of people engaged in:																					
		Irrigated agriculture	'000			212	51%	212	51%	212	51%	212	51%	212	51%	212	51%	658	157%	658	157%	1,535	367%
		Reservoir fisheries (incremental to BS)	'000			49	325%	57	375%	17	112%	24	161%	45	298%	35	233%	111	729%	111	729%	126	833%
		Hydropower production	'000			508	490%	508	490%	120	116%	283	273%	430	415%	366	353%	424	409%	424	409%	470	453%
		Aquaculture (incremental to BS)	'000			101	40%	101	40%	101	40%	101	40%	101	40%	101	40%	277	110%	277	110%	453	181%
4 Equitable development																							
4.1 Ensure that all four LMB countries benefit from the development of water and related resources	Aggregate benefits by country	Total net economic value	NPV US$M			21,685	126%	21,703	126%	7,896	46%	15,028	87%	17,576	102%	20,038	117%	29,768	173%	29,658	172%	42,816	249%
		No. of people affected vulnerable to changes	'000			3,473	392%	3,473	392%	677	76%	1,128	127%	3,472	391%	1,851	209%	3,619	408%	3,923	442%	3,707	418%
		No. of jobs generated	'000			870	111%	878	111%	450	57%	620	79%	788	100%	714	91%	1,469	187%	1,469	187%	2,584	328%
		Overall environment impact	Severity			Negative		Negative		Mildly negative		Mildly negative		Negative		Negative		Negative		Negative		Severely negative	

Table 25 Summary of scenario assessment for selected indicators incremental to baseline

Country and indicator		Definite Future Scenario	20-year plan scenarios						Long term scenarios		
			Vithout mainstream dams	With 6 mainstream dams in Northern Lao PDR	With 9 mainstream dams, excl Cambodia	With 9 mainstream dams, excl Thailand	With 11 mainstream dams	With 11 mainstream dams and climate change	Long term scenario with 11 mainstream dams	Long term scenario with climate change	Very High Development Scenario
		3000	5000	6100	6300	6200	4000	4001	8000	8001	9000
Lao PDR											
Wetland extent	Severity	-3	-3	-3	-3	-3	-3	-1	-3	2	-3
Bank erosion	Severity	1	2	2	-1	-1	-1	-2	-2	-2	-2
Capture fisheries	Severity	-2	-2	-2	-2	-2	-2	-5	-2	-5	-2
Water quality	Severity	-1	-2	-2	-3	-3	-2	-2	-3	-3	-3
Environmental hotspots	Severity		-2	-2	-2	-3	-3	-4	-4	-4	-5
Overall environment impact	Severity	-1	-2	-3	-3	-3	-3	-3	-3	-3	-3
Livelihoods	Severity	-2	-3	-3	-3	-3	-3	-3	-3	-3	-3
Economic production	NPV US$B	6.8	11.9	17.9	23.0	19.3	23.0	23.0	26.9	26.9	30.1
Other economic impacts	NPV US$B	-0.2	-0.3	-0.3	-0.4	-0.4	-0.4	-0.4	-0.5	-0.4	-0.5
Thailand											
Wetland extent	Severity	-2	-2	-2	-2	-2	-2	-2	-2	1	-2
Bank erosion	Severity	1	2	2	-1	-1	-1	-2	-2	-2	-2
Capture fisheries	Severity	-1	-1	-1	-1	-1	-1	-5	-1	-5	-1
Water quality	Severity	-1	-2	-2	-2	-2	-2	-2	-2	-2	-3
Environmental hotspots	Severity	-1	-2	-3	-3	-3	-3	-3	-4	-4	-5
Overall environment impact	Severity	-1	-2	-2	-3	-3	-3	-3	-3	-3	-3
Livelihoods	Severity	-1	-1	-1	-1	-2	-3	-3	-3	-3	-3
Economic production	NPV US$B	1.2	2.8	4.1	4.4	4.1	4.6	4.6	5.2	5.2	6.5
Other economic impacts	NPV US$B	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.2	-0.1	-0.2
Cambodia											
Wetland extent	Severity	-1	-1	-1	-1	-1	-1		-1		-1
Bank erosion	Severity		1	-1		-1	-1	-2	-3	-3	-3
Capture fisheries	Severity	-1	-2	-2	-3	-4	-4	-5	-4	-5	-4
Water quality	Severity		-2	-2	-2	-2	-2	-2	-3	-3	-4
Environmental hotspots	Severity	-1	-2	-2	-3	-3	-3	-3	-3	-3	-5
Tonle Sap wetlands	Severity	-1	-1	-1	-1	-1	-1		-1	-1	-1
Overall environment impact	Severity	-1	-1	-2	-2	-3	-3	-2	-3	-2	-4
Livelihoods	Severity	-1	-2	-3	-3	-4	-4	-4	-4	-4	-4
Economic production	NPV US$B	1.3	2.2	2.2	2.2	3.9	3.9	3.9	7.3	7.3	15.3
Other economic impacts	NPV US$B	-0.6	-0.7	-0.8	-1.0	-1.7	-1.7	-1.3	-2.0	-1.8	-2.2
Viet Nam											
Wetland extent	Severity	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
Bank erosion	Severity							-1	-3	-3	-3
Capture fisheries	Severity	-1	-1	-2	-3	-4	-4	-5	-4	-5	-4
Water quality	Severity	1	-1	-1	-1	-2	-2	-2	-3	-2	-4
Environmental hotspots	Severity							-2	-2	-5	-5
Salinity intrusion	Severity	1	1	2	1	1	1	-1	1	n/a	1
Overall environment impact	Severity	-1	-1	-1	-1	-1	-1	-2	-3	-3	-3
Livelihoods	Severity	-1	-1	-2	-2	-2	-2	-2	-2	-4	-2
Economic production	NPV US$B	3.5	3.8	4.0	4.0	4.5	4.5	4.5	5.2	5.2	6.0
Other economic impacts	NPV US$B	-0.2	-0.1	-0.1	-0.2	-0.4	-0.4	-0.8	-0.5	-0.9	-0.6
LMB overall											
Wetland extent	Severity	-1	-1	-1	-1	-1	-1		-1		-1
Bank erosion	Severity	1	1	1	-1	-1	-1	-2	-3	-3	-3
Capture fisheries	Severity	-1	-1	-2	-2	-3	-3	-5	-3	-5	-3
Water quality	Severity	-0	-2	-2	-2	-2	-2	-2	-3	-2	-3
Environmental hotspots	Severity	-0	-1	-2	-2	-2	-2	-3	-3	-4	-5
Tonle Sap wetlands	Severity	-1	-1	-1	-1	-1	-1		-1	-1	-1
Salinity intrusion	Severity	1	1	2	1	1	1	-1	1	n/a	1
Overall environment impact	Severity	-1	-2	-2	-2	-3	-3	-3	-3	-3	-3
Livelihoods	Severity	-1	-2	-2	-2	-3	-3	-3	-3	-4	-3
Economic production	NPV US$B	12.8	20.7	28.1	33.5	31.9	36.0	36.0	44.5	44.5	58.0
Other economic impacts	NPV US$B	-1.1	-1.1	-1.4	-1.7	-2.6	-2.6	-2.6	-3.0	-3.1	-3.5
		11.7	19.6	26.7	31.7	29.3	33.4	33.4	41.5	41.4	54.5

Severity indices

1	Mildly positive	-1	Mildly negative
2	Positive	-2	Negative
3	Very positive	-3	Severely negative
4	Highly positive	-4	Extremely negative
5	Extremely positive	-5	Catastrophic

Low
Medium
Medium
High
High

Note: wetland scores based on percentage loss in country vs country total. LMB score based on total wetland areas.

Table 26 Summary of scenario assessment for selected indicators incremental to Definite Future Scenario

		Definite Future Scenario	20-year plan scenarios						Long term scenarios		
			Without mainstream dams	With 6 mainstream dams in Northern Lao PDR	With 9 mainstream dams, excl Cambodia	With 9 mainstream dams, excl Thailand	With 11 mainstream dams	With 11 mainstream dams and climate change	Long term scenario with 11 mainstream dams	Long term scenario with climate change	Very High Development Scenario
		3000	5000	6100	6300	6200	4000	4001	8000	8001	9000
Lao PDR											
Wetland extent	Severity		-2	-2	-2	-2	-2	2	-1	4	-2
Bank erosion	Severity		1	1	-2	-2	-2	-3	-3	-3	-3
Capture fisheries	Severity			-1	-1	-1	-1	-5	-1	-5	-1
Water quality	Severity		-2	-2	-2	-2	-2	-2	-2	-2	-3
Environmental hotspots	Severity		-2	-2	-2	-3	-3	-4	-4	-4	-5
Overall environment impact	Severity		-1	-2	-2	-2	-2	-2	-2	-2	-2
Livelihoods	Severity		-1	-1	-1	-1	-1	-1	-1	-1	-1
Economic production	NPV US$B		5.1	11.1	16.2	12.5	16.2	16.2	20.0	20.0	23.3
Other economic impacts	NPV US$B		-0.0	-0.1	-0.1	-0.1	-0.2	-0.2	-0.2	-0.1	-0.3
Thailand											
Wetland extent	Severity		-1	-1	-1	-1	-1	1	-1	2	-1
Bank erosion	Severity		1	1	-2	-2	-2	-3	-3	-3	-3
Capture fisheries	Severity		-1	-1	-1	-1	-1	-5	-1	-5	-1
Water quality	Severity		-1	-1	-2	-2	-1	-2	-2	-2	-2
Environmental hotspots	Severity		-1	-2	-2	-2	-2	-2	-2	-2	-4
Overall environment impact	Severity		-1	-1	-2	-2	-2	-2	-2	-2	-2
Livelihoods	Severity					-1	-2	-2	-2	-2	-2
Economic production	NPV US$B		1.6	2.9	3.2	2.9	3.4	3.4	4.0	4.0	5.3
Other economic impacts	NPV US$B		0.0	-0.0	-0.0	-0.0	-0.1	-0.0	-0.1	0.0	-0.1
Cambodia											
Wetland extent	Severity		-1	-1	-1	-1	-1		-1		-1
Bank erosion	Severity		1	-1		-1	-1	-2	-3	-3	-3
Capture fisheries	Severity		-1	-2	-2	-4	-4	-5	-4	-5	-4
Water quality	Severity		-2	-2	-2	-2	-2	-2	-3	-3	-4
Environmental hotspots	Severity		-1	-1	-2	-2	-2	-3	-3	-3	-4
Tonle Sap wetlands	Severity		-1	-1	-1	-1	-1		-1		-1
Overall environment impact	Severity			-1	-1	-2	-2	-1	-2	-1	-3
Livelihoods	Severity		-1	-2	-2	-3	-3	-3	-3	-3	-3
Economic production	NPV US$B		0.9	0.9	0.9	2.6	2.6	2.6	6.0	6.0	14.0
Other economic impacts	NPV US$B		-0.1	-0.2	-0.4	-1.1	-1.1	-0.7	-1.4	-1.2	-1.6
Viet Nam											
Wetland extent	Severity		-1	-1	-1	-1	-1		-1	-1	-1
Bank erosion	Severity							-1	-3	-3	-3
Capture fisheries	Severity		-1	-1	-2	-3	-3	-5	-3	-5	-3
Water quality	Severity		-2	-2	-2	-2	-2	-2	-4	-3	-4
Environmental hotspots	Severity							-2	-2	-5	-5
Salinity intrusion	Severity							-3		n/a	-1
Overall environment impact	Severity							-1	-2	-2	-2
Livelihoods	Severity			-1	-1	-1	-1	-1	-1	-3	-1
Economic production	NPV US$B		0.3	0.5	0.5	1.1	1.1	1.1	1.8	1.8	2.5
Other economic impacts	NPV US$B		0.1	0.0	-0.1	-0.3	-0.2	-0.7	-0.3	-0.0	-0.4
LMB overall											
Wetland extent	Severity		-1	-1	-1	-1	-1		-1		-1
Bank erosion	Severity		1	0	-1	-1	-1	-2	-3	-3	-3
Capture fisheries	Severity		-1	-1	-1	-2	-2	-5	-2	-5	-2
Water quality	Severity		-2	-1	-2	-2	-2	-2	-3	-2	-3
Environmental hotspots	Severity		-1	-1	-2	-2	-2	-3	-3	-4	-5
Tonle Sap wetlands	Severity		-1	-1	-1	-1	-1		-1		-1
Salinity intrusion	Severity							-3		n/a	-1
Overall environment impact	Severity		-1	-1	-1	-2	-2	-2	-2	-2	-2
Livelihoods	Severity		-1	-1	-1	-2	-2	-2	-2	-2	-2
Economic production	NPV US$B		7.9	15.3	20.7	19.1	23.2	23.2	31.7	31.7	45.2
Other economic impacts	NPV US$B		-0.0	-0.3	-0.7	-1.5	-1.6	-1.5	-2.0	-2.1	-2.4

Severity indices

1 Mildly positive	-1 Mildly negative	Low
2 Positive	-2 Negative	Medium
3 Very positive	-3 Severely negative	Medium
4 Highly positive	-4 Extremely negative	High
5 Extremely positive	-5 Catastrophic	High

Note: wetland scores based on percentage loss in country vs country total. LMB score based on total wetland areas.

5 Risks and uncertainties

5.1 Introduction

There are inevitable risks and uncertainties associated with the accuracy of forecasted impacts. These fall broadly into four categories associated with:

- The accuracy of information and analytical tools employed;
- The availability of information at an extent and level of detail necessary to adequately understand the impact of development processes sufficient to support basin-scale planning; and
- Uncertainties about the manner and timing of implementation and operation of water resource developments in the future and how these may affect impacts of those developments on the environmental, social and economic conditions in the basin; and
- Uncertainties about how future developments outside the water resource sector will influence the outcomes and impacts of water and related resource developments.

The assessments undertaken have been mindful of each of these. Based on the overall findings, this chapter discusses the significance of each of these categories of risk and uncertainty.

5.2 Accuracy and availability of tools

The principal tool used for predicting impacts of water resource developments on flow regime (and hence on environmental social conditions) is the suite of models contained within the MRC's Decision Support Framework (DSF). These models were developed by MRC in 2004 and their performance was verified by the countries against detailed performance criteria at the time. The DSF was subsequently adopted by MRC as the tool to be used for assessing transboundary flow assessment. The level of accuracy remains appropriate for basin scale planning given that the nature of the assessments are about predicting relative rather than absolute results.

Most other analyses have been conducted using proprietary GIS and spreadsheet tools. The results from these analyses have been drawn together in a master sheet that has facilitated checking of consistency of results generated from different sources and the identification (and subsequent challenging) of any outlier values.

5.3 Sufficiency of information and knowledge about impact processes

5.3.1 Sufficiency of available data

The sources of data used have been generally either the MRC Master Catalogue data or data supplied by each country. The Master Catalogue data used comprise various time series data (eg hydrometeorological data) which have been checked and cleaned by IKMP and layers of spatial data generally compiled by the MRC Programmes (eg wetland data). Scenario set up data (eg hydropower and irrigation data) have been extensively reviewed and verified by each country. In all of the above cases, the data appear adequate to support basin-scale assessments.

Nevertheless the wide-reaching assessments undertaken have identified a number of knowledge gaps where data availability is either limited or unavailable. These are principally in the following areas:

- **Social data**: Whilst a variety of government statistics have been accessed on demographic patterns and social conditions, the level of disaggregation across the basin is not uniform and in many instances inadequate to identify the dependency of communities on water and related resources and their resilience to changes in these resources. Thus the extent and degree of social impacts can only at this time be assessed in broad terms.

- **Fisheries data and response to changing conditions**: Although much data and analyses have been assembled in the past, as with the social data, more information on fisheries and how the sector performs and will respond to future changes are needed. The predictions made in support of these assessments should be considered indicative, but sufficient at this stage to appreciate the significance between scenarios.

- **Water quality and sediments**: Whilst MRC has monitoring programmes in place for water quality and sediments, the length of records and extent of data are still limited and the assessments have inevitably depended much on expert opinion. Efforts have been made to seek consensus amongst several experts where seemingly contentious issues have arisen and this report reflects the consensus reached.

- **Flood-related impacts upstream of Kratie**: The DSF models used in this assessment do not explicitly model water levels upstream of Kratie. The influence of the UMB dams, combined with additional tributary dams and potential LMB mainstream dams will have impacts along the mainstream corridor and adjacent floodplains upstream of Kratie. It has been possible to interpret from predicted discharge changes the impacts of change flow regime in this reach of the mainstream. However in the run-up to further developments more detailed modelling in this area would be beneficial.

There are of course other areas where data and the understanding of detailed impact processes can be beneficially improved. This is considered further in Chapter 6 of this report alongside the data issues above.

5.3.2 *Influence of knowledge gaps on risks and uncertainties*

The impacts of the planned or proposed developments included within the scenarios have been assessed based on existing knowledge and against the current landscapes. However, over the different planning horizons circumstances may change.

The extent of these external changes is not usually predictable with ease. The influence of these and of other factors on how risks and uncertainties may be viewed is discussed below.

Morphological changes

As discussed in Section 3.3.2, the timeline for geomorphological change initiated by the Definite Future Scenario is such that generally these impacts will not become evident within the next 15-20 years. There is some risk however that bed levels in the alluvial stretches such as at Vientiane may start to fall with increased risk of bank erosion. Also floodplain sedimentation will decrease within a decade with consequences for agricultural production, if not compensated with fertilizers. Beyond 20 years bed level incision in erodible reaches is likely to become more evident and sandbars will start to diminish from the upper reaches progressing to the lower.

However, of potentially much greater importance is the risk that increased sediment trapping due to reservoir construction may have significant consequences for the stability of the Mekong Delta. There are differences of view over both the timing and extent of possible impacts, which are in any event likely to be strongly influenced by autonomous developments (flood protection, river training, sand mining) and by sea level rise.

Further studies and more detailed guidance on how best to respond to geomorphological change are clearly merited and should form part of the planned activities during the next 5 years alongside developing guidance on how to minimise sediment trapping.

Climate change

Whilst the scenario assessments are based upon changes to average wet and dry season flows in the Mekong region brought about by climate, a wider assessment of the hydrological regime has been considered in the Annual Flood report (viz.: the onset and end of the flood season, the seasonal pattern of flow, the variance of the statistics and the distribution of annual maximum discharge).

Overall, climate change is not expected to significantly increase the annual average wet and dry season flows in the foreseeable future, but may be expected to cause increased runoff in the longer term. The increased average flood season flows could be offset by the increased tributary storage envisaged in the scenarios. However, the already high year-to-year variability of wet and dry season flows would further increase together with the frequency and intensity of floods and droughts.

Agriculture is the most vulnerable economic sector to the less reliable patterns of rainfall. Greater drought risk combined with the increased incidence of long term flood inundation will

potentially lead to greater crop losses and lower food security. The predicted rise in temperature will also affect crop water demands and reduce rice yields, potentially substantially unless new varieties are introduced which are more resistant to water stress.

Most regional climate change impact studies forecast an increase in extreme flood events based on the expected increase in number of typhoons and severe tropical storms affecting the LMB. These extreme events are responsible for the majority of the most damaging events, amounting on average to annual losses in the order of US$76 million, rising to over US$800 million in an extreme year. The economic implications of an increase in extreme events are therefore considerable.

The threats posed by sea level rise due to climate change in the Mekong Delta are severe. Estimates of sea level rise range by 2010 vary between 30cm and 1 metre and by as soon as 2030, just 17cm of sea level rise could cause a significant increase in the Delta's land area exposed to salinisation and crop damage through flooding, notwithstanding the increase in dry season flows due to upstream developments. The vulnerability of the Delta area to climate change (and also to sediment trapping) and the realistic options for addressing this through a programme of adaptation are both clearly of great strategic importance.

The focus of the current assessments has been on economic development projects (hydropower and irrigation mainly) in the medium term during which the impacts of climate change may not be so strongly felt. However, in the longer term beyond the proposed 20-year planning horizon, the threats posed by climate change are of such potential magnitude that further strategic studies should be taken up so as to develop a long term plan that will prudently guide near term developments in the Cambodian and Viet Nam flood plains. Consideration may be given in particular to:

- The links between increased variability in rainfall and the greater risk of drought - influence how may the countries respond in both operational and planning terms to periods of below average dry season flows;
- The planning response to an increased severity of flooding in the future and how best to defend against (or live with) this threat;
- The response to sea level rise and the transboundary implications and the influence that upstream developments could have on mitigating this risk[22]; and
- The need to understand better the impacts of climate change on agriculture (the largest consumer of water in the basin) and the consequences of changing cropping patterns and consumptive demands for maintaining water balance in the longer term.

[22] Could, for instance, reservoir storage be used to mitigate against these increased risks, and is there a need to set aside parts of the flood plains to meet long term flood storage requirements?

Environmental issues

The assessments of the Definite Future Scenario and the 20 Year Scenarios have identified a number of uncertainties relating to impacts in and around the Tonle Sap, the fisheries assessments, the impacts related to wetlands reductions (particularly relating to local communities), flagship species, environmental hotspots and localised impacts within river reaches above and below dams.

Given the complexities of the bio-physical and ecological processes involved, the type and extent of uncertainties encountered are to be expected. These uncertainties may be exacerbated by a lack of knowledge of how other developments outside may also impact upon environmental assets[23]. However, whilst in some cases the impacts may not be possible to precisely quantify, the directions of change and in most cases the orders of magnitude are clear and sufficient to enable decisions to taken on what is a suitable scenario for defining how development, and resource protection, can proceed.

Nevertheless, these uncertainties do clearly define what future complementary studies should occur over the next 5 years to provide strategic direction and guidance as to how development projects are implemented in these locations.

Social issues

The social assessment has been constrained by the lack of detailed data on the potentially impacted populations. Nevertheless, it has been possible to establish for each scenario the magnitude of the number of exposed vulnerable resource users, which provides a useful indication of the extent of the social impact. Further data and studies are required to assess the numbers within these populations who would require direct intervention to sustain their livelihoods.

In addition, it is very evident that socio-economic conditions within the basin are changing due to overall increase in economic prosperity, poverty alleviation programmes and migration. The extent to which these changes will impact upon the numbers of vulnerable resource users needs to be understood better in order to ensure both appropriate timing of developments and that appropriate safeguards are introduced.

[23] External developments may include fisheries management practices, population growth and migration, pressure to develop land for other purposes, construction of roads and other infrastructure on flood plains, etc.

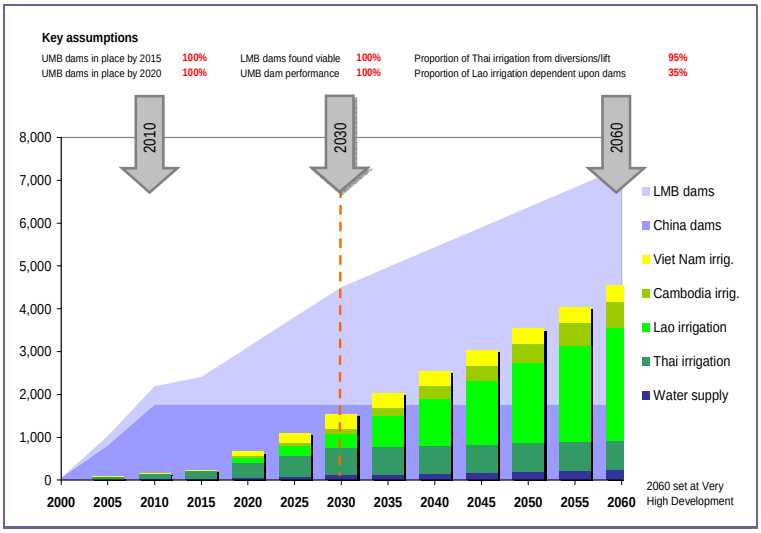
5.4 Manner and timing of implementation and operation of water resource developments

The assessment findings in Chapter 3 make clear the very significant impacts that new storage in both the UMB mainstream and LMB tributaries will have in terms of enabling increased abstractions in the LMB from the additional dry season flows over and above the "natural" flows. This major finding is self-evidently crucial to appreciating how future development of consumptive uses may be planned and requires careful examination as to the confidence that can be attached to this finding. Further assessments have therefore been conducted on the reliability that can be attached to the flow augmentation from both the UMB dams and the tributary dams.

The major new large storages of the UMB cascade - Xiaowan and Nuozhadu - will become operational in about 2011 and 2015 respectively. During the critical dry season flow month of March, the UMB dams will then provide an additional 780m^3/s of dry season flow at Kratie, according to current IKMP estimates. Under the scenario plans, by 2030 dry season abstractions in the LMB above Kratie are expected to increase over the baseline during March approximately by 530m^3/s. The UMB dams will thus be in a position to provide all of this. A similar assessment made at Tang Chau demonstrates that the UMB dams contribute 660m3/s compared to total abstractions upstream of Tang Chau of 570m3/s, again more than adequate to meet demands without recourse to additional storage from the LMB tributary dams.

Discussions held with experts from China suggest that their equivalent estimate of dry season releases is approximately 1,000m^3/s. The IKMP estimate was based on assumptions considered to be conservative, which is supported further by the Chinese estimate. Thus, there are grounds to consider the IKMP estimate to be at the low end and should be achieved if the UMB dam construction programme remains on track. The water balances at Tang Chau in March for this and other scenarios are illustrated in Figure 44.

Figure 44 Water balances in March at Tan Chau under full scenario conditions



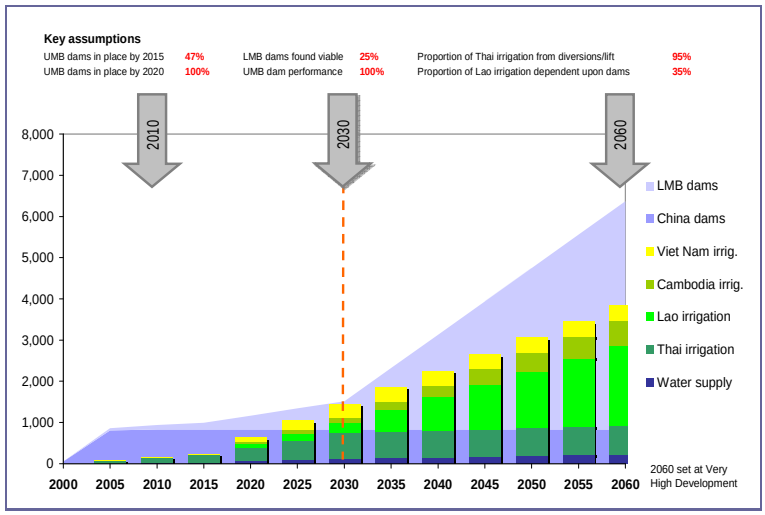
Water balance at Tang Chau for average monthly flow in March, MCM
Compared to baseline, shows incremental flow augmentation from UMB and LMB dams against incremental abstractions for irrigation and water supply

Reliance on additional storage from LMB tributaries to meet dry season natural flow requirements under these conditions does not arise until 2035 and beyond.

This raises a second risk as to whether UMB dam construction and commencement of operation

be delayed could be delayed and how this would impact on supplying new developments? Xiaowan is now storing water and there is good reason to anticipate that releases will be available in the 2012 dry season. Nuozhadu dam should be operational by 2015/16. Conversely the planned development of 1.6Mha within the basin will be spread over the next 20 years and by 2020 may be of the order of 50% of this figure. Thus it seems improbable that any reasonable delays in bringing the UMB dams in operation will cause a constraint on the supply side. Figure 45 illustrates that in an **extreme case** where Nuozhadu dam for some reason did not become operational, the water demands of the 20-year Foreseeable Future Scenario could still be met with just 25% of LMB storage in place.

Figure 45 Water balances in March at Tan Chau without Nuozhadu dam and with 25% of LMB tributary storage



Water balance at Tang Chau for average monthly flow in March, MCM

Compared to baseline, shows incremental flow augmentation from UMB and LMB dams against incremental abstractions for irrigation and water supply

A third question is whether the UMB storages will always fill in the wet season – thereby removing any need to store part of the following dry season flow to completely fill the cascade. Analysis of the historically observed flows in the Lancang shows that the storage reservoirs can be easily refilled at all times during the wet season, resulting in this being a negligible risk to LMB dry season flows from this issue.

Thus from the perspective of the maintaining at least the minimum natural flow conditions in the dry season, there appears to be little risk that the augmented flows from UMB storage will not meet the demands of the 20-year plan. Furthermore the presence of new storage on the LMB tributaries adds further safeguards against extreme risks.

Nevertheless, there will always be some risk that UMB releases do not meet expectations. These may arise from emergency situations or from operational mismanagement (during flood or normal operation periods). International experience suggests these risks to be low: modern dam flood operation, and dam safety and maintenance procedures limit the risk but there could always be unforeseen issues such as a failure of turbines, which may mean a reduced outflow from dams and lower than expected flows passing downstream. This would lead to competition amongst all LMB countries for available flows for irrigation and in-stream requirements (for environmental purposes, salinity control, navigation and power generation purposes).

These risks are minimised if all parties involved clearly understand the rights, needs and obligations of each other. This can occur at the technical level as is now occurring between

MRC and China on the exchange of data and information, or it may involve higher levels of government if a specification of international and sovereign rights and obligations are involved. A protocol at this higher level, between China and the four lower Mekong countries could:

- recognise the common water related interests that exist,
- respect the sovereign rights of all Mekong countries to develop and utilise the water,
- agree to share information on common interests that does breach national security,
- establish a process and dialogue that will clearly define the water related rights and needs, and specify obligations and responsibilities,
- delegate the roles of implementing the protocol (MRC and China MWR/Institute)

This could lead to seasonal and 3 year operation plans being exchanged and discussed, and also a process for 'advance warning' of any major operational changes or new water planning initiatives. Countries could consider the need for such a protocol which would be in line with many other international examples. It would be an issue that ultimately needs to be considered at the foreign affairs levels of government.

It is also important that these and other risk areas are carefully monitored and reviewed on a regular basis. Particular attention needs to be given not only to flow and water quality data, but also to water use monitoring particularly with regard to infrastructure development[24]. By adopting a five-year review period for the IWRM-based Basin Development Strategy, sufficient checks and balances can be undertaken to incorporate these uncertainties in future planning reviews.

[24] In this regard the Project Master Database discussed with RTWG last year would be a valuable tool. At regular intervals, say 1-or 5-yearly the developments of all countries could be updated with refreshed baselines using the Projects Database and these tested using the DSF in similar fashion as it has been used to support the current assessments reported on here

6 Implications for planning

6.1 Introduction

This chapter draws together and summarises the various observations made in this report that relate to issues that may be considered whilst formulating a basin-wide development strategy for the LMB and a project portfolio.

6.2 Sharing benefits, risks and impacts

The Foreseeable Future Scenarios will require very large investments across all countries and will produce very substantial benefits. These benefits will benefit all countries but will be spread unevenly across the four countries, depending on which of the various components of the LMB 20-Year Plan Scenario are adopted.

In general in all the Foreseeable Future Scenarios, Lao PDR will gain most as the largest hydropower operator but others will benefit also as both producers and consumers of electricity. Irrigation gains will also be significant. However, Cambodia will benefit less than other countries, due to adverse impacts on capture fisheries and, in one case, a less attractive hydropower development.

With such a variance in the distribution of benefits, it becomes important to consider the overall 'equity' between countries of basin wide developments, to look closely at how adverse impacts are also distributed. Which country suffers more than others, what type of disbenefits occur, which sectors and which groups of the basin communities are affected, how do these disbenefits relate to the longer term socio-economic plans of the countries and for regions/provinces within countries – these are all questions that must be considered and discussed in the wider context of basin wide benefit and impact sharing, and country to country trade-offs debates.

Benefit and impact sharing in international (or transboundary) water resources management is not a new concept. How it could be implemented will vary with the particular basin-wide circumstances (size, nature and spread of both benefits and impacts) and the political and socio-economic issues that apply to the countries in a basin. Many of the existing transboundary benefit sharing agreements relate more to specific development projects and how both benefits and impacts from the project are shared across governments and across affected communities.

The basin-wide development scenario approach operates above the individual project level and considers 'packages of projects' (i.e., the various scenarios), which relate more to 'cumulative development impacts' rather than those of a single project. This may lead to a much broader consideration of benefits and impacts and may need particular techniques and concepts that are more suited to a scenario-based approach.

Innovative funding approaches may also be considered in conjunction with these options for benefit and impact sharing. There are examples in other river basins where 'river basin trust funds' or 'water and environment management funds' are established to support a range of activities and projects related to impact sharing.

The countries will need to consider whether all the options and issues relating to benefit sharing and funding support need to be resolved in conjunction with, or at the same time as, selection of an agreed scenario.

6.3 Acknowledging and planning for change

The assessment of the Definite Future Scenario demonstrates that developments already in process (as a result of past decisions) will lead to a significant change in the natural flow regime and sediment transport. Apart from the potential impacts caused by the mainstream dams on fisheries in particular, the other future developments, about which choices can still be made, may have only relatively small incremental change over and above those brought about by the Definite Future Scenario.

Thus, it appears appropriate to not only acknowledge that geomorphological, environmental and social impacts are largely inevitable but also to commence taking actions now to address these. Identified disbenefits within the scenarios could be transformed to net benefits, or at least have impacts reduced, with appropriate sectoral investments, which would be fully consistent with an IWRM-based approach to basin development.

The countries may wish to consider also how the basin plan should incorporate programmes to manage proactively these and other exogenous changes through non-structural programmes to be taken into the Project Portfolio. The IWRM-based Basin Development Strategy will include a roadmap for moving forward over the next 5 years once the Strategy is approved, and this should include complementary studies that are identified now during the finalisation of the assessment process, plus a program of consultations with sub-area groups and RBO's to identify what range of activities and projects at the more local level might be considered in response to the benefits and impacts within the approved strategy.

6.4 Coping with risks and uncertainties

Key risks and uncertainties have been discussed in Chapter 5. These focus on the need to ensure that the international water dimension between China and the LMB countries is recognised in some more formal way, to ensure that complementary activities (hydropower dams and related irrigation expansion) proceed in a balanced and, as far as possible, equitable manner. They also focus on the issues of climate change, sediment trapping and the apparent need to address flood plain management in the Mekong Delta in a more holistic and comprehensive manner than has been the case hitherto.

The countries may wish to consider how the basin plan should incorporate programmes to manage these risks and uncertainties proactively through non-structural programmes also to be taken into the Development Portfolio.

6.5 Addressing knowledge gaps and strategic issues

This report has identified a number of knowledge gaps that are considered important to address to better guide future developments. These fall into three main categories, being:

(i) The need to more fully understand the processes which govern the nature and magnitude of impacts;

(ii) The need to develop strategic guidance for dealing with specific issues that this report has identified associated with near-term developments; and

(iii) The need for strategic studies relating to long term developments but with near term relevance.

Each of these three areas is elaborated below.

6.5.1 Impact processes

Key areas where greater understanding is needed about how impacts arise and how they may be managed beneficially have been identified in Section 5.2. These include:

- **Social data**: Detailed data sets are needed to understand more fully demographic patterns and social conditions in high impact areas in particular in order to assess the dependency of communities on water and related resources and their resilience to changes in these resources;

- **Fisheries data and response to changing conditions**: More information on fisheries and how the sector performs and will respond to future changes are needed;

- **Water quality, nutrients and sediments**: The MRC monitoring programmes for water quality, nutrients and sediments should be reviewed in the light of the assessments in this report and, where required, intensified.

- **Flood-related impacts upstream of Kratie**: More detailed modelling in this area would be beneficial to understanding the impacts of flow changes on the different reaches upstream of Kratie, and how mainstream dams will impact on these.

The countries may wish to consider how these knowledge gaps can best be addressed, taking into account ongoing activities of the MRC Programmes and those of line agencies and research institutions within the member countries.

6.5.2 Strategic guidance

The developments contained with the scenarios have a wide range of impacts, many of which are viewed as adverse. Within the context of IWRM, it is essential that approaches are developed to manage these impacts in a constructive manner. These naturally fall into two groups:

(i) **strategic guidance**, where specific complementary actions are deemed necessary as part of an agreed development plan, and

(ii) **best practice guidelines**, where improvements in the way the plan's components are taken up would add value to those components.

Areas where **strategic guidance** appears to be important are (depending upon the development components brought into the Basin Development Plan):

- Addressing the immediate and long term impacts arising from the Definite Future Scenario, particularly with regard to impacts on wetlands and resource dependent vulnerable households;
- Addressing the direct local impacts of tributary hydropower development and cumulative transboundary impacts of flow regulation and sediment trapping;
- Addressing the impacts on capture fisheries and bio-diversity in a coherent and proactive manner;
- Addressing the direct impacts of mainstream dam development on navigation, fish migration, wetlands, flagship and other species and resource dependent vulnerable households;

Areas where **best practice guidelines** appear to be important are:

- Managing wetlands and flooded areas under increasing pressures from development;
- Managing the impacts on flagship species and environmental hotspots
- Improving agricultural and land management practices to increase irrigation efficiency, cope with greater drought risk and minimise pollutant runoff;
- Further improving transboundary navigation; and
- Strengthening IWRM planning and linkages between different levels of planning program, including guidance on consultation processes with sub-area groups and RBOs to strengthen and harmonise local level activities with IWRM macro-planning and the approved basin-wide development strategy.

6.5.3 *Strategic studies*

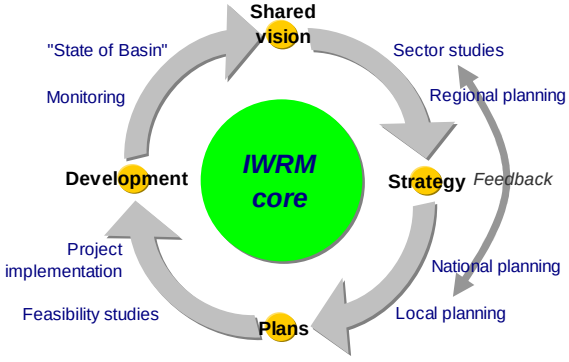
Four areas of strategic study appear necessary in order to address properly areas of key concern that emerge from this assessment. These are:

- **Climate change**: Further studies of the implications of climate change on the basin's long-term hydrology, on agriculture and food security and on ecological conditions and bio-diversity;
- **Flood plain management**: Addressing the long term challenges presented by climate change, sea level rise, economic and infrastructure development within the Cambodian and Viet Nam flood plains, including the Tonle Sap to determine a long term plan for rationalising these competing demands in a sustainable manner, and which would guide near term development choices;
- **Management of social impacts**: Investigation of alternative approaches to managing proactively and beneficially the impacts of water resource developments amongst those exposed vulnerable water resource users taking into consideration external influences on socio-economic conditions and integrating with existing national programmes;
- **Fisheries management**: Investigation of alternative approaches to better integrating fisheries management into future basin development plans in a manner that creates an appropriate balance with water resources infrastructure development and sustains fisheries production at levels that meet consumer demands and minimises impacts on the rural poor.

6.6 Monitoring and evaluation programme

The planning process in which BDP is engaged follows a cycle which is reflected in the rolling plan process which integrates basin-scale planning with national and sub-national planning. A cornerstone of this process is that each cycle includes monitoring of how the implementing the plans has impacted on the basin and whether the desired outcomes have been achieved.

Figure 46 Illustration of planning cycle

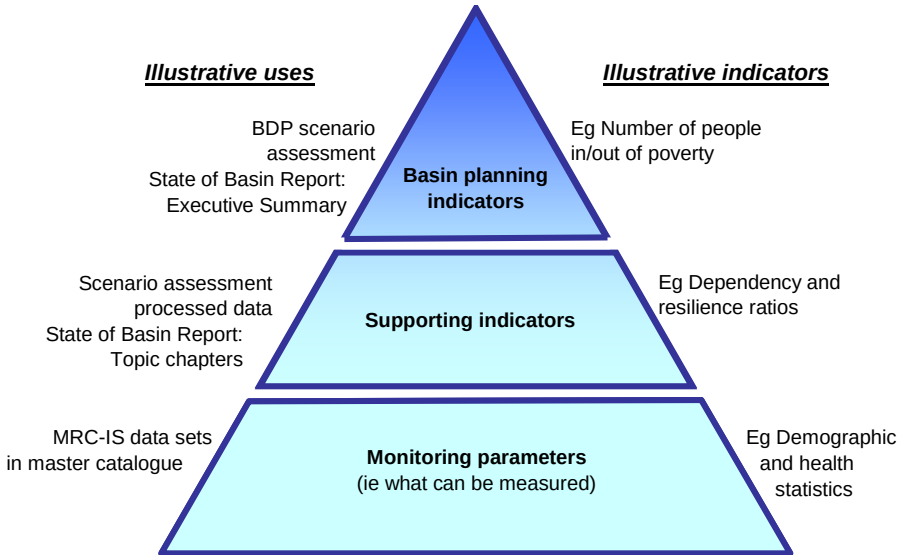


Monitoring thus represents a key instrument in the planning cycle.

The purpose of such a monitoring programme is to provide planners and decision-takers with the information necessary to judge whether their plans have been implemented and whether outcomes from the activities undertaken match with those intended. Thus a good monitoring programme embraces both actions and outcomes.

In this context actions refer to whether the plan components have been implemented. This includes generally physical works, non-structural programme activities, studies and the like. The Project Master Database previously referred to forms a part of this aspect of monitoring. Progress reports of MRC Programmes will form another.

Figure 47 Concepts behind a monitoring framework for the BDP



Outcomes, on the other hand, must relate ultimately to whether the stated goals are being achieved. To measure these normally requires a hierarchy of indicators linked ultimately to that which can be directly measured, as illustrated in Figure 47.

The assessment framework which has been developed during the current planning process provides a good starting point for designing a monitoring system to provide the necessary assurance to all stakeholders in the Basin Development Plan, but clearly will need to be elaborated as suggested by Figure 47 to provide the necessary and measurable information that will be required.

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Appendices

Contents

Scenarios under consideration

No.	Short Title	Full Title	Development Period	Interventions/Projects
Baseline situation				
1	**BS**	Baseline Scenario		Year 2000 infrastructure including existing HEP dams
Definite future situation				
2	**2015-UMD**	Upper Mekong Dam Scenario	2000 - 2015	Baseline extended to include the full HEP cascade on the Lancang
3	**2015-DF**	Definite Future Scenario	2000 - 2015	2015-UMD plus 26 additional HEP dams in LMB and 2008 irrigation and flood measures
Foreseeable future situation				
4.0	**2030-20Y**	LMB 20-Year Plan Scenario	2010 - 2030	2015 DF plus 11 LMB mainstream dams and 30 planned tributary dams, irrigation, and water supply
4.1	**2030-20Y+CC**	LMB 20-Year Plan Scenario Climate change	2010 - 2030	As above plus climate change for average year between 2010-30 and 17cm sea level rise
5	**2030-20Y-w/o MD**	LMB 20-Year Plan Scenario without mainstream dams	2010 - 2030	As above, excluding 11 LMB mainstream dams
6.1	**2030-20Y-w/o LMD**	LMB 20-Year Plan Scenario with 6 mainstream dams in Northern Lao PDR	2010 - 2030	As above plus 6 LMB mainstream dams in upper LMB
6.2	**2030-20Y-w/o TMD**	LMB 20-Year Plan Scenario with 9 mainstream dams, excl. Thailand	2010 - 2030	2030-20Y, excluding the two Thai mainstream dams
6.3	**2030-20y-w/o CMD**	LMB 20-Year Plan Scenario with 9 mainstream dams, excl. Cambodia	2010-2030	2030-20Y, excluding the two Cambodian mainstream dams
7	**2030 – 20Y Flood**	Mekong Delta Flood Management Scenario	2010 - 2030	Baseline plus 3 options for flood control in Cambodia and Viet Nam Delta
Long term future situation				
8.0	**2060-LTD**	LMB Long-term Development Scenario	2030-2060	2030-20Y plus further infrastructure developments in LMB
8.1	**2060-LTD+CC2**	LMB Long-term Development Scenario Climate change	2030-2060	As above plus climate change for average year between 2030-50 and 30cm sea level rise
9	**2060–VHD**	LMB Very High Development Scenario	2030-2060	As 2060-LTD, extended to full potential infrastructure developments

Appendix A Summary of assessment of flood management scenarios

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Summary of assessment of flood management scenarios

Introduction

Mekong Delta Flood Management Scenarios investigate flood risk reduction and drainage measures in the Mekong Delta formulated by Cambodia and Viet Nam within the context of the LMB 20-Year Plan Scenario.

In the Viet Nam Delta, technical and operational measures would control flooding of the annually deep flooded areas beyond the early floods and mitigate the increase in damaging flood frequencies that are being predicted due to climate change. Flood management measures for the Cambodian Delta would be implemented to protect the shallow flooded areas throughout the wet season and deep flooded areas against early floods only, allowing the safe harvest of a second crop. The (transboundary) impact of the loss of flood storage capacity could be mitigated by the diversion of flood waters in the border zone towards the Gulf of Thailand and/or the Vam Co River.

The main purpose of this scenario is to study the transboundary impact of regional flood management options in the Mekong Delta. The scenario comprises several sub-scenarios, which have been assessed with support of the MRC FMMP Component 2: Structural Measures and Flood Proofing. This summary is drawn from the findings of their report[1].

Foreseeable future flood management scenarios

The flood management scenarios assessments made are based on flood hazard analysis using 97 years of records from 1910 to 2006, which in effect equate to the BDP baseline conditions (in so far as no major new developments in LMB are considered).

The assessments focussed on the following areas defined in close consultation with Cambodia and Viet Nam:

- **In Cambodia**: (i) Floodplains on the West Bassac

[1] MRC Flood Management and Mitigation Programme, Component 2: Structural measures and flood proofing in the Lower Mekong Basin, December 2009, draft Final Report

(ii) floodplains between Bassac and Mekong and (iii) floodplains on the left bank of the Mekong and south of the NR #1

- **In Viet Nam:** (i) Long Xuyen Quadrangle (LXQ), (ii) area between Bassac and Mekong north of the Vam Nao, and (iii) Plain of Reeds (POR) north of the Nguyen Van Tiep Canal.

From these, three main scenarios were defined to represent the Foreseeable Future Scenario (20-year). These scenarios are:

(i) **Scenario Cam0 -** comprising early flood protection and full flood protection[2] in Cambodia and no further development in Viet Nam. The flood protection in Cambodia being (i) West Bassac with full flood protection in two zones and early flood protection in one, combined with (ii) East Mekong with full flood protection in two zones, early flood protection in one and no protection in a fourth.

Gross area of projects		*Mha*
West Bassac	0.41	
East Mekong	0.32	0.73
Plain of Reeds	0.56	
Long Xuyen Quad.	0.49	1.05
Totals		**1.78**

(ii) **Scenario VNA** – comprising early flood protection and full flood protection in Viet Nam as follows: (i) Long Xuyen Quardangle with enlargement of drainage canal, no gated sluices along Bassac river and rubber dams for early flood protection, (ii) Trans Bassac area with full flood protection as present, and (iii) Plain of Reeds with canal enlargement to improve drainage capacity.

(iii) **Scenario Cam0VNa** – comprising a combination of the two above.

The main conclusions from the FMMP-C2 study relating to the three agreed scenarios are as follows:

- In the case of **development in Cambodia alone**, the risk in Cambodia reduces (with 1:100yr protection in the full flood protection areas and 1:10yr for early protection in the deep flooded areas). However, risks increase in Viet Nam in the Trans Bassac and LXQ areas, but decrease in the Plain of Reeds.

- In the Scenario VNA, the development of flood **protection in Viet Nam alone** would have an opposite impact. Total risks in Viet Nam are expected to decrease as a result of the protection measures, whilst increasing risks in Cambodia.

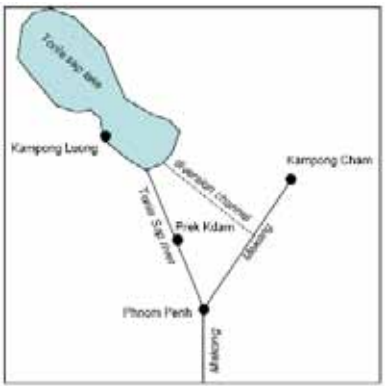
[2] Early flood protection covers protection during the start of the annual flood season between May and August for paddy season harvested during July-August. After harvest, the area is allowed to be flooded as flood zone until end of flooding in November. Full flood protection prevents inundation throughout the flood season which normally peaks in September.

- The **combined scenario Cam0+VNa** results in lower risk in both countries with the exception of LXQ, which apart from the main Mekong and Bassac rivers is more or less the only flood passage way to the sea.

- Due to the high cost of land acquisition and the short distance to the sea, these increased risks are better **mitigated by the widening of the canals** in the LXQ rather constructing new large canals elsewhere. Such projects are already underway, although further studies in engineering design are required to find optimal solutions for increasing the discharge capacity.

Long term flood management scenarios

In addition and in the run-up to defining the scenarios above, other scenarios were looked into.



These included differing levels of flood protection in Viet Nam, diversion of flood flows into Tonle Sap and diversion of flows to the Gulf of Thailand (a scheme that was not developed further after initial consideration).

The diversions to Tonle Sap were shown to have some positive effects on flooding downstream, but limited in nature compared to the massive investments required.

The review of climate change set out in section 5.4.1 underscore the long term challenges associated with flood plain management in the Mekong Delta. Current option studies under FMMP have focussed on investigating specific schemes from which considerable understanding has been gained on local flood management best practice leading to best practice guidelines have been developed.

However, as apparent, a much wider consideration of flood plain options is needed to take into account the threat of climate change and the potential massive social and economic consequences that arise. Whilst these threats are clearly evident for Viet Nam, the studies undertaken by FMMP emphasise the inter-dependence of possible solutions between Viet Nam and Cambodia. In addition, as demonstrated by the assessments made in this report of upstream developments, clearly Cambodia has a number of other major issues to address, particularly with impacts on the Tonle Sap from upstream flow modifications and barrier effects of new dam construction.

It is evident therefore that, to address these issues in an integrated manner, major further studies are needed to investigate long term issues flood management in the context of both climate change and emerging strategies for upstream development and to explore the potential for synergies between the two. The outcome of such a study should be aimed at guiding developments in a manner that leads to prudent investment in the near term that will better enable long term solutions to be achieved.

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Appendix B Summary of scenario assessment parameters

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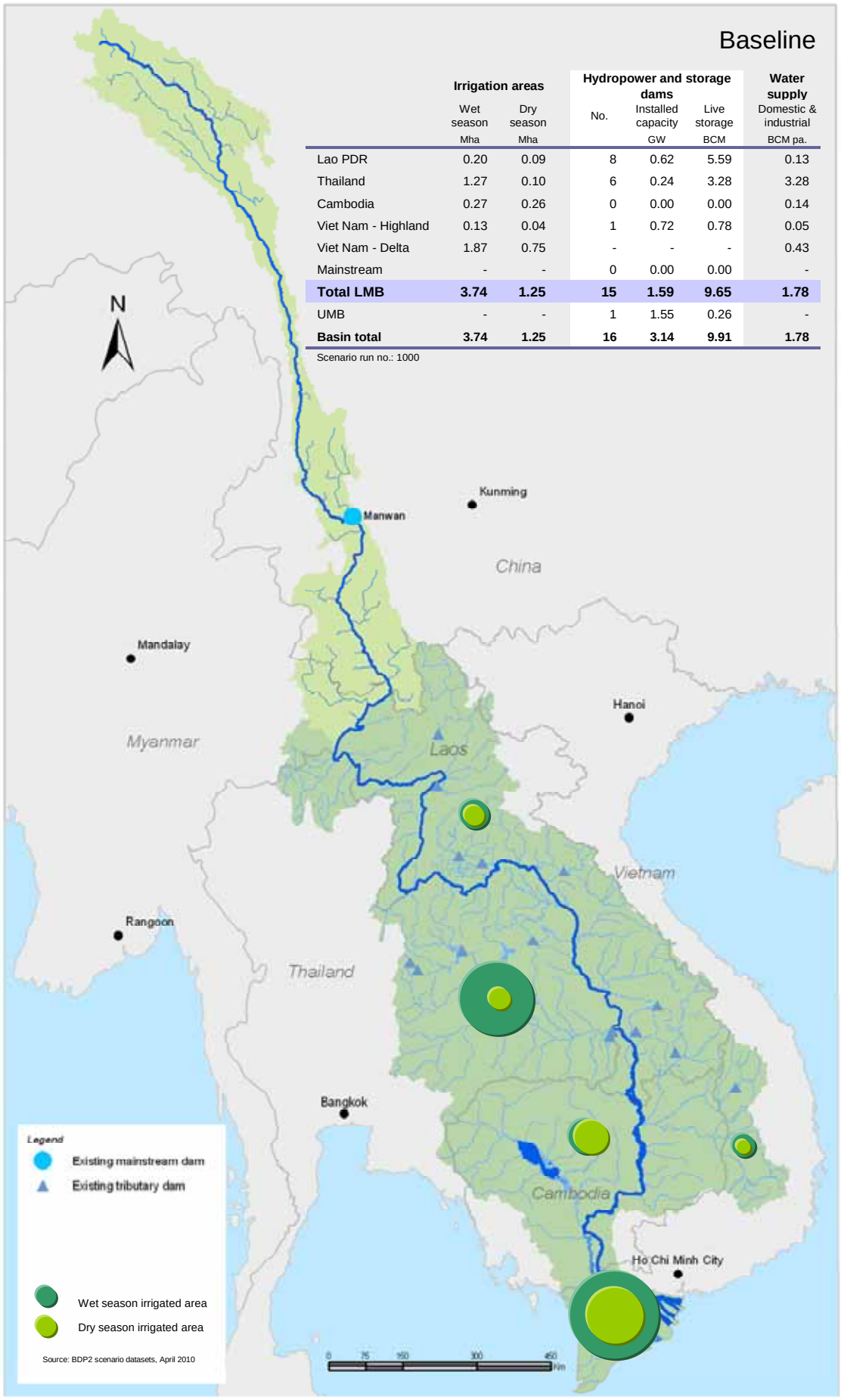
Baseline

	Irrigation areas		Hydropower and storage dams			Water supply
	Wet season	Dry season	No.	Installed capacity	Live storage	Domestic & industrial
	Mha	Mha		GW	BCM	BCM pa.
Lao PDR	0.20	0.09	8	0.62	5.59	0.13
Thailand	1.27	0.10	6	0.24	3.28	3.28
Cambodia	0.27	0.26	0	0.00	0.00	0.14
Viet Nam - Highland	0.13	0.04	1	0.72	0.78	0.05
Viet Nam - Delta	1.87	0.75	-	-	-	0.43
Mainstream	-	-	0	0.00	0.00	-
Total LMB	**3.74**	**1.25**	**15**	**1.59**	**9.65**	**1.78**
UMB	-	-	1	1.55	0.26	-
Basin total	**3.74**	**1.25**	**16**	**3.14**	**9.91**	**1.78**

Scenario run no.: 1000



Scenario assessment results

Estimated total values

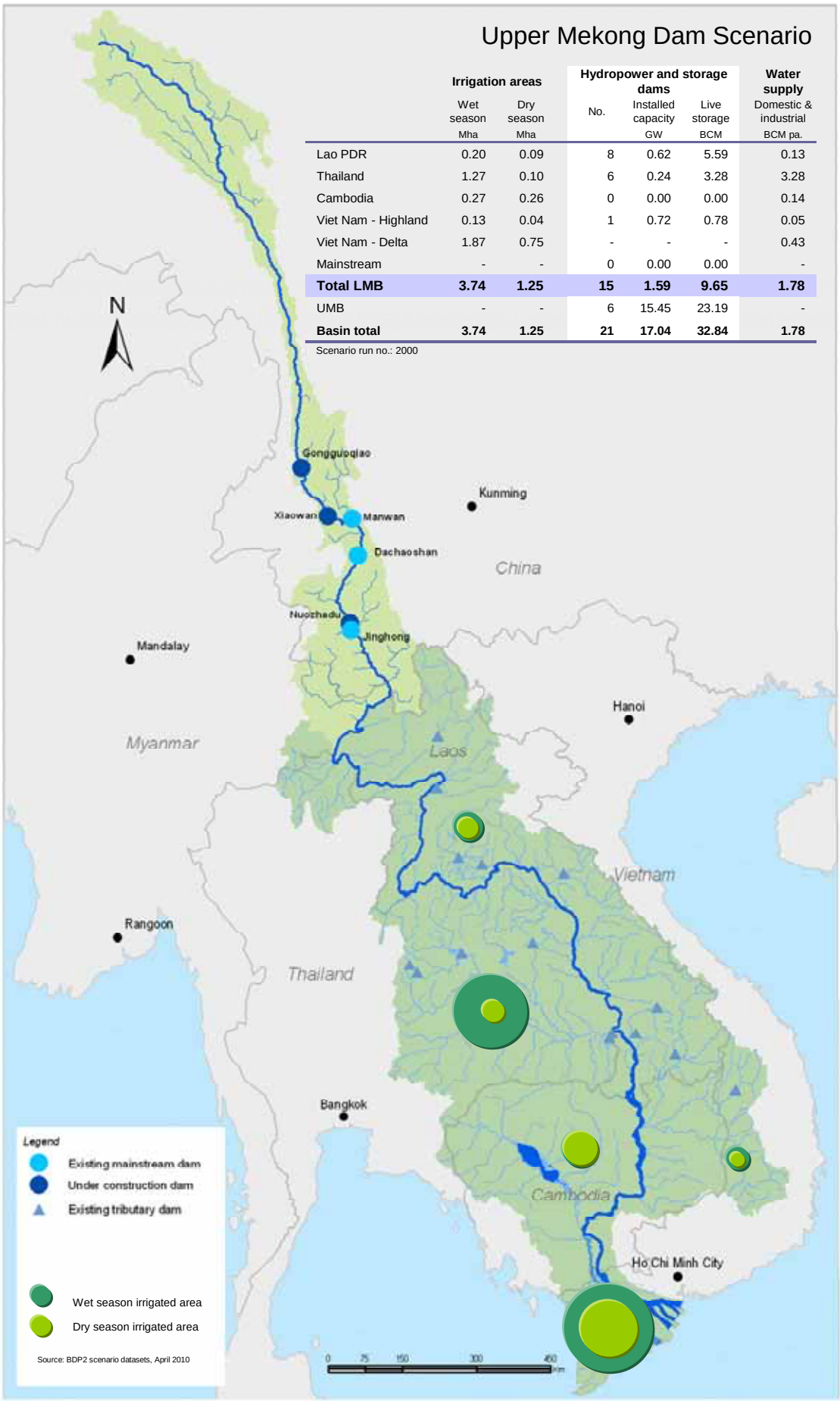
Baseline Scenario

		3	4	5	6	Scenario run no. 1000
Assessment issue	**Unit**	**Lao PDR** Amount	**Thailand** Amount	**Cambodia** Amount	**Viet Nam** Amount	**Total** Amount
Hydrological assessment						
Key hydrological parameters:	Location	Vientiane	Mudakhan	Kratie	Tan Chau	Average
Monthly average dry season flow (March)	m^3/s	1,100	1,453	2,197	3,072	1,955
Average peak daily flow in wet season	m^3/s	15,921	25,501	46,763	21,310	27,374
Flow reversal in Tonle Sap:	Location			Prek Kdam		TLS only
Average flow volume entering Tonle Sap	MCM	n/a	n/a	32,259	n/a	32,259
Average date of flow reversal (+/-)	Days	n/a	n/a	145	n/a	24-May
Land use and condition assessment						
Total irrigated area	'000ha	204	1,266	273	1,996	3,739
Total irrigated cropped area	'000ha	332	1,422	563	4,312	6,629
Average area flooded: < 0.5m	'000ha	24	23	185	334	566
Average area flooded: 0.5 - 1.0m	'000ha	24	24	231	669	948
Average area flooded: 1.0 - 3.0m	'000ha	84	90	712	795	1,680
Average area flooded: > 3.0m	'000ha	272	232	1,055	5	1,564
Area lost to bank erosion	Severity	Neutral 0	Neutral 0	Neutral 0	Neutral 0	Neutral
Area affected by salinity of > 1.3gm/l	'000ha	0	0	0	1,851	1,851
Water quality and geomorphology						
Herbicide runoff	tonnes / yr	1,463	11,761	908	22,828	36,959
Insecticide and fungicide runoff	tonnes / yr	1,939	13,665	1,455	25,720	42,780
Nitrogen runoff from agriculture	tonnes / yr	3,371	11,631	2,455	63,550	81,007
Phosphorus runoff from agriculture	tonnes / yr	308	1,239	281	8,329	10,156
Nitrogen from waste water discharge	tonnes / yr	8,629	13,977	6,633	9,896	39,135
Phosphorus from waste water discharge	tonnes / yr	2,589	4,193	1,990	2,969	11,740
BOD from waste water discharge	tonnes / yr	32,358	52,414	24,872	37,110	146,755
Impact on water quality	Severity	Neutral 0	Neutral 0	Neutral 0	Neutral 0	Neutral 0
Change in sediment supply	Severity	Neutral 0	Neutral 0	Neutral 0	Neutral 0	Neutral 0
Induced geomorphological changes	Severity	Neutral 0	Neutral 0	Neutral 0	Neutral 0	Neutral 0
Production assessment						
Hydropower generated	GWh / yr	3,032	2,403	0	3,659	9,093
Reservoir fisheries	Mtonne / yr	0	0	0	0	0
Flood damages	US$M / yr	70	67	26	56	219
Agricultural production: rice	Mtonne / yr	1	4	2	18	25
Agricultural production: non-rice	Mtonne / yr	0	1	0	2	3
Capture fisheries production	Mtonne / yr	0	1	1	0	2
Aquaculture production	Mtonne / yr	0	0	0	2	2
Environmental assessment						
Total wetland area: flooded forest	'000ha	0	0	452	46	498
Total wetland area: marshes	'000ha	8	12	518	0	538
Total wetland area: inundated grassland	'000ha	9	50	318	55	431
Tonle Sap only: flooded forest	'000ha	0	0	452	0	452
Tonle Sap only: marshes	'000ha	0	0	309	0	309
Tonle Sap only: inundated grassland	'000ha	0	0	277	0	277
Forest area in reservoir areas	'000ha	14	14	1	2	31
Number of viable deep pools	No.	20	17	5	5	47
Status of river channel habitats	Severity	Neutral 0	Neutral 0	Neutral 0	Neutral 0	Neutral 0
Flagship species	Survival	Surviving	Surviving	Surviving	Surviving	Surviving
Environmental hot spots	Severity	Neutral 0	Neutral 0	Neutral 0	Neutral 0	Neutral 0
Biodiversity condition	Severity	Neutral 0	Neutral 0	Neutral 0	Neutral 0	Neutral 0
Economic assessment *(net economic values)*						
Irrigated agricultural production	NPV US$M	0	0	0	0	0
Hydropower generated	NPV US$M	2,293	491	0	1,712	4,496
Hydropower imported/exported	NPV US$M	340	209	0	267	817
Navigation	NPV US$M	0	182	0	0	182
Flood damage mitigation	NPV US$M	0	0	0	0	0
Capture fisheries reduction	NPV US$M	0	0	0	0	0
Reservoir fisheries	NPV US$M	0	0	0	0	0
Aquaculture production	NPV US$M	0	0	0	0	0
Forest area reduction	NPV US$M	0	0	0	0	0
Recession rice	NPV US$M	0	0	0	0	0
Wetland area reduction	NPV US$M	0	0	0	0	0
Mitigation of salinity affected areas	NPV US$M	0	0	0	0	0
Reduction in eco-hotspot/biodiversity	NPV US$M	0	0	0	0	0
Total economic impacts	NPV US$M	**2,634**	**882**	**0**	**1,979**	**5,494**
Social assessment						
No. of people at risk of loss of livelihood	'000	0	0	0	0	0
Severity of impact on livelihoods	Severity	Neutral 0	Neutral 0	Neutral 0	Neutral 0	Neutral 0
No. of people employed in:						
Irrigated agriculture	'000	79	227	77	35	418
Reservoir fisheries (incremental to BS)	'000	0	0	0	0	0
Hydropower production	'000	0	0	0	0	0
Aquaculture (incremental to BS)	'000	0	0	0	0	0
Overall assessment						
Overall environment impact	Severity	Neutral 0	Neutral 0	Neutral 0	Neutral 0	Neutral 0
Livelihoods	Severity	Neutral 0	Neutral 0	Neutral 0	Neutral 0	Neutral 0
Economic production	NPV US$M	2,634	882	0	1,979	5,494
Other economic impacts	NPV US$M	0	0	0	0	0

Upper Mekong Dam Scenario

	Irrigation areas		Hydropower and storage dams			Water supply
	Wet season Mha	Dry season Mha	No.	Installed capacity GW	Live storage BCM	Domestic & industrial BCM pa.
Lao PDR	0.20	0.09	8	0.62	5.59	0.13
Thailand	1.27	0.10	6	0.24	3.28	3.28
Cambodia	0.27	0.26	0	0.00	0.00	0.14
Viet Nam - Highland	0.13	0.04	1	0.72	0.78	0.05
Viet Nam - Delta	1.87	0.75	-	-	-	0.43
Mainstream	-	-	0	0.00	0.00	-
Total LMB	**3.74**	**1.25**	**15**	**1.59**	**9.65**	**1.78**
UMB	-	-	6	15.45	23.19	-
Basin total	**3.74**	**1.25**	**21**	**17.04**	**32.84**	**1.78**

Scenario run no.: 2000



Scenario assessment results

Estimated total values

Upper Mekong Dam Scenario

Scenario run no. 2000

Assessment issue	Unit	3 Lao PDR Amount		4 Thailand Amount		5 Cambodia Amount		6 Viet Nam Amount		Total Amount	
Hydrological assessment											
Key hydrological parameters:	Location	Vientiane		Mudakhan		Kratie		Tan Chau		Average	
Monthly average dry season flow (March)	m3/s	1,874		2,231		2,977		3,731		2,703	
Average peak daily flow in wet season	m3/s	13,831		23,880		45,671		20,962		26,086	
Flow reversal in Tonle Sap:	Location					Prek Kdam				TLS only	
Average flow volume entering Tonle Sap	MCM	n/a		n/a		30,145		n/a		30,145	
Average date of flow reversal (+/-)	Days	n/a		n/a		142		n/a		21-May	
Land use and condition assessment											
Total irrigated area	'000ha	204		1,266		273		1,996		3,739	
Total irrigated cropped area	'000ha	332		1,422		563		4,312		6,629	
Average area flooded: < 0.5m	'000ha	n/a		n/a		n/a		n/a		0	
Average area flooded: 0.5 - 1.0m	'000ha	n/a		n/a		n/a		n/a		0	
Average area flooded: 1.0 - 3.0m	'000ha	n/a		n/a		n/a		n/a		0	
Average area flooded: > 3.0m	'000ha	n/a		n/a		n/a		n/a		0	
Area lost to bank erosion	Severity	Mildly positive	1	Mildly positive	1	Neutral	0	Neutral	0	Neutral	
Area affected by salinity of > 1.3gm/l	'000ha	0		0		0		1,611		1,611	
Water quality and geomorphology											
Herbicide runoff	tonnes / yr	1,463		11,761		908		22,828		36,959	
Insecticide and fungicide runoff	tonnes / yr	1,939		13,665		1,455		25,720		42,780	
Nitrogen runoff from agriculture	tonnes / yr	3,371		11,631		2,455		63,550		81,007	
Phosphorus runoff from agriculture	tonnes / yr	308		1,239		281		8,329		10,156	
Nitrogen from waste water discharge	tonnes / yr	8,629		13,977		6,633		9,896		39,135	
Phosphorus from waste water discharge	tonnes / yr	2,589		4,193		1,990		2,969		11,740	
BOD from waste water discharge	tonnes / yr	32,358		52,414		24,872		37,110		146,755	
Impact on water quality	Severity	Neutral	0	Neutral	0	Neutral	0	Neutral	0	Neutral	0
Change in sediment supply	Severity	Mildly negative	-1	Mildly negative	-1	Mildly negative	-1	Neutral	0	Mildly negative	-1
Induced geomorphological changes	Severity	Neutral	0	Neutral	0	Neutral	0	Neutral	0	Neutral	0
Production assessment											
Hydropower generated	GWh / yr	3,032		2,403		0		3,659		9,093	
Reservoir fisheries	Mtonne / yr	0		0		0		0		0	
Flood damages	US$M / yr	28		27		8		9		72	
Agricultural production: rice	Mtonne / yr	1		4		2		18		25	
Agricultural production: non-rice	Mtonne / yr	0		1		0		2		3	
Capture fisheries production	Mtonne / yr	0		1		1		0		2	
Aquaculture production	Mtonne / yr	0		0		0		2		3	
Environmental assessment											
Total wetland area: flooded forest	'000ha	0		0		0		0		0	
Total wetland area: marshes	'000ha	0		0		0		0		0	
Total wetland area: inundated grassland	'000ha	0		0		0		0		0	
Tonle Sap only: flooded forest	'000ha	0		0		0		0		0	
Tonle Sap only: marshes	'000ha	0		0		0		0		0	
Tonle Sap only: inundated grassland	'000ha	0		0		0		0		0	
Forest area in reservoir areas	'000ha	14		14		1		2		31	
Number of viable deep pools	No.	20		17		5		5		47	
Status of river channel habitats	Severity	Neutral	0	Neutral	0	Neutral	0	Neutral	0	Neutral	0
Flagship species	Survival	Surviving		Surviving		Surviving		Surviving		Surviving	
Environmental hot spots	Severity	Neutral	0	Neutral	0	Neutral	0	Neutral	0	Neutral	0
Biodiversity condition	Severity	Neutral	0	Neutral	0	Neutral	0	Neutral	0	Neutral	0
Economic assessment *(net economic values)*											
Irrigated agricultural production	NPV US$M	0		0		0		0		0	
Hydropower generated	NPV US$M	2,293		491		0		1,712		4,496	
Hydropower imported/exported	NPV US$M	340		209		0		267		817	
Navigation	NPV US$M	0		182		0		0		182	
Flood damage mitigation	NPV US$M	0		0		0		0		0	
Capture fisheries reduction	NPV US$M	0		0		0		0		0	
Reservoir fisheries	NPV US$M	0		0		0		0		0	
Aquaculture production	NPV US$M	0		0		0		0		0	
Forest area reduction	NPV US$M	0		0		0		0		0	
Recession rice	NPV US$M	0		0		0		0		0	
Wetland area reduction	NPV US$M	0		0		0		0		0	
Mitigation of salinity affected areas	NPV US$M	0		0		0		0		0	
Reduction in eco-hotspot/biodiversity	NPV US$M	0		0		0		0		0	
Total economic impacts	NPV US$M	**2,634**		**882**		**0**		**1,979**		**5,494**	
Social assessment											
No. of people at risk of loss of livelihood	'000	0		46		90		390		527	
Severity of impact on livelihoods	Severity	Mildly negative	-1	Mildly negative	-1	Mildly negative	-1	Mildly negative	-1	Mildly negative	-1
No. of people employed in:											
Irrigated agriculture	'000	79		227		77		35		418	
Reservoir fisheries (incremental to BS)	'000	0		0		0		0		0	
Hydropower production	'000	0		0		0		0		0	
Aquaculture (incremental to BS)	'000	0		0		0		0		0	
Overall assessment											
Overall environment impact	Severity	Neutral	0	Neutral	0	Neutral	0	Neutral	0	Neutral	0
Livelihoods	Severity	Mildly negative	-1	Mildly negative	-1	Mildly negative	-1	Mildly negative	-1	Mildly negative	-1
Economic production	NPV US$M	2,634		882		0		1,979		5,494	
Other economic impacts	NPV US$M	0		0		0		0		0	

Summary of scenario assessment

Incremental values relative to Baseline

Upper Mekong Dam Scenario

Scenario run no. 2000

Assessment issue	Unit	Lao PDR		Thailand		Cambodia		Viet Nam		Total	
		Amount	Percent	Amount	Percent	Amount	Percent	Amount	Percent	Amount	Percent
Hydrological assessment											
Key hydrological parameters:	Location	Vientiane		Mudakhan		Kratie		Tan Chau		Average	
Monthly average dry season flow (March)	m3/s	774	70%	778	54%	780	35%	659	21%	748	38%
Average peak daily flow in wet season	m3/s	-2,090	-13%	-1,621	-6%	-1,091	-2%	-348	-2%	-1,288	-5%
Flow reversal in Tonle Sap:	Location					Prek Kdam				TLS only	
Average flow volume entering Tonle Sap	MCM	n/a		n/a		-2,113	-7%	n/a		-2,113	-7%
Average date of flow reversal (+/-)	Days	n/a		n/a		-3	-2%	n/a		-3	-2%
Land use and condition assessment											
Total irrigated area	'000ha	0	0%	0	0%	0	0%	0	0%	0	0%
Total irrigated cropped area	'000ha	0	0%	0	0%	0	0%	0	0%	0	0%
Average area flooded: < 0.5m	'000ha	n/a		n/a		n/a		n/a		0	0%
Average area flooded: 0.5 - 1.0m	'000ha	n/a		n/a		n/a		n/a		0	0%
Average area flooded: 1.0 - 3.0m	'000ha	n/a		n/a		n/a		n/a		0	0%
Average area flooded: > 3.0m	'000ha	n/a		n/a		n/a		n/a		0	0%
Area lost to bank erosion	Severity	Mildly positive	1	Mildly positive	1	Neutral	0	Neutral	0	Neutral	1
Area affected by salinity of > 1.3gm/l	'000ha	0	0%	0	0%	0	0%	-240	-13%	-240	-13%
Water quality and geomorphology											
Herbicide runoff	tonnes / yr	0	0%	0	0%	0	0%	0	0%	0	0%
Insecticide and fungicide runoff	tonnes / yr	0	0%	0	0%	0	0%	0	0%	0	0%
Nitrogen runoff from agriculture	tonnes / yr	0	0%	0	0%	0	0%	0	0%	0	0%
Phosphorus runoff from agriculture	tonnes / yr	0	0%	0	0%	0	0%	0	0%	0	0%
Nitrogen from waste water discharge	tonnes / yr	0	0%	0	0%	0	0%	0	0%	0	0%
Phosphorus from waste water discharge	tonnes / yr	0	0%	0	0%	0	0%	0	0%	0	0%
BOD from waste water discharge	tonnes / yr	0	0%	0	0%	0	0%	0	0%	0	0%
Impact on water quality	Severity	Neutral	0	Neutral	0	Neutral	0	Neutral	0	Neutral	0
Change in sediment supply	Severity	Mildly negative	-1	Mildly negative	-1	Mildly negative	-1	Neutral	0	Mildly negative	-1
Induced geomorphological changes	Severity	Neutral	0	Neutral	0	Neutral	0	Neutral	0	Neutral	0
Production assessment											
Hydropower generated	GWh / yr	0	0%	0	0%	0	0%	0	0%	0	0%
Reservoir fisheries	Mtonne / yr	0	0%	0	0%	0	0%	0	0%	0	0%
Flood damages	US$M / yr	-42	-60%	-40	-60%	-18	-70%	-47	-83%	-147	-67%
Agricultural production: rice	Mtonne / yr	0	0%	0	0%	0	0%	0	0%	0	0%
Agricultural production: non-rice	Mtonne / yr	0	0%	0	0%	0	0%	0	0%	0	0%
Capture fisheries production	Mtonne / yr	-0	-4%	0	0%	0	0%	-0	-9%	-0	-2%
Aquaculture production	Mtonne / yr	0	92%	0	81%	0	32%	1	50%	1	52%
Environmental assessment											
Total wetland area: flooded forest	'000ha	n/a		n/a		n/a		n/a		0	0%
Total wetland area: marshes	'000ha	n/a		n/a		n/a		n/a		0	0%
Total wetland area: inundated grassland	'000ha	n/a		n/a		n/a		n/a		0	0%
Tonle Sap only: flooded forest	'000ha	n/a		n/a		n/a		n/a		0	0%
Tonle Sap only: marshes	'000ha	n/a		n/a		n/a		n/a		0	0%
Tonle Sap only: inundated grassland	'000ha	n/a		n/a		n/a		n/a		0	0%
Forest area in reservoir areas	'000ha	n/a		n/a		n/a		n/a		0	0%
Number of viable deep pools	No.	0	0%	0	0%	0	0%	0	0%	0	0%
Status of river channel habitats	Severity	Neutral	0	Neutral	0	Neutral	0	Neutral	0	Neutral	0
Flagship species	Survival	n/a		n/a		n/a		n/a		n/a	
Environmental hot spots	Severity	Neutral	0	Neutral	0	Neutral	0	Neutral	0	Neutral	0
Biodiversity condition	Severity	Neutral	0	Neutral	0	Neutral	0	Neutral	0	Neutral	0
Economic assessment *(net economic values)*											
Irrigated agricultural production	NPV US$M	0	0%	0	0%	0	0%	0	0%	0	0%
Hydropower generated	NPV US$M	0	0%	0	0%	0	0%	0	0%	0	0%
Hydropower imported/exported	NPV US$M	0	0%	0	0%	0	0%	0	0%	0	0%
Navigation	NPV US$M	0	0%	-0	0%	0	0%	0	0%	-0	0%
Flood damage mitigation	NPV US$M	0	0%	0	0%	0	0%	0	0%	0	0%
Capture fisheries reduction	NPV US$M	0	0%	0	0%	0	0%	0	0%	0	0%
Reservoir fisheries	NPV US$M	0	0%	0	0%	0	0%	0	0%	0	0%
Aquaculture production	NPV US$M	0	0%	0	0%	0	0%	0	0%	0	0%
Forest area reduction	NPV US$M	0	0%	0	0%	0	0%	0	0%	0	0%
Recession rice	NPV US$M	0	0%	0	0%	0	0%	0	0%	0	0%
Wetland area reduction	NPV US$M	0	0%	0	0%	0	0%	0	0%	0	0%
Mitigation of salinity affected areas	NPV US$M	0	0%	0	0%	0	0%	0	0%	0	0%
Reduction in eco-hotspot/biodiversity	NPV US$M	0	0%	0	0%	0	0%	0	0%	0	0%
Total economic impacts	NPV US$M	**0**	0%	**-0**	0%	**0**	0%	**0**	0%	**-0**	0%
Social assessment											
No. of people at risk of loss of livelihood	'000	0	0%	46	0%	90	0%	390	0%	527	0%
Severity of impact on livelihoods	Severity	Mildly negative	-1	Mildly negative	-1	Mildly negative	-1	Mildly negative	-1	Mildly negative	-1
No. of people employed in:											
Irrigated agriculture	'000	0	0%	0	0%	0	0%	0	0%	0	0%
Reservoir fisheries (incremental to BS)	'000	0	0%	0	0%	0	0%	0	0%	0	0%
Hydropower production	'000	0	0%	0	0%	0	0%	0	0%	0	0%
Aquaculture (incremental to BS)	'000	0	0%	0	0%	0	0%	0	0%	0	0%
Overall assessment											
Overall environment impact	Severity	Neutral	0	Neutral	0	Neutral	0	Neutral	0	Neutral	0
Livelihoods	Severity	Mildly negative	-1	Mildly negative	-1	Mildly negative	-1	Mildly negative	-1	Mildly negative	-1
Economic production	NPV US$M	0	0%	-0	0%	0	0%	0	0%	-0	0%
Other economic impacts	NPV US$M	0	0%	0	0%	0	0%	0	0%	0	0%

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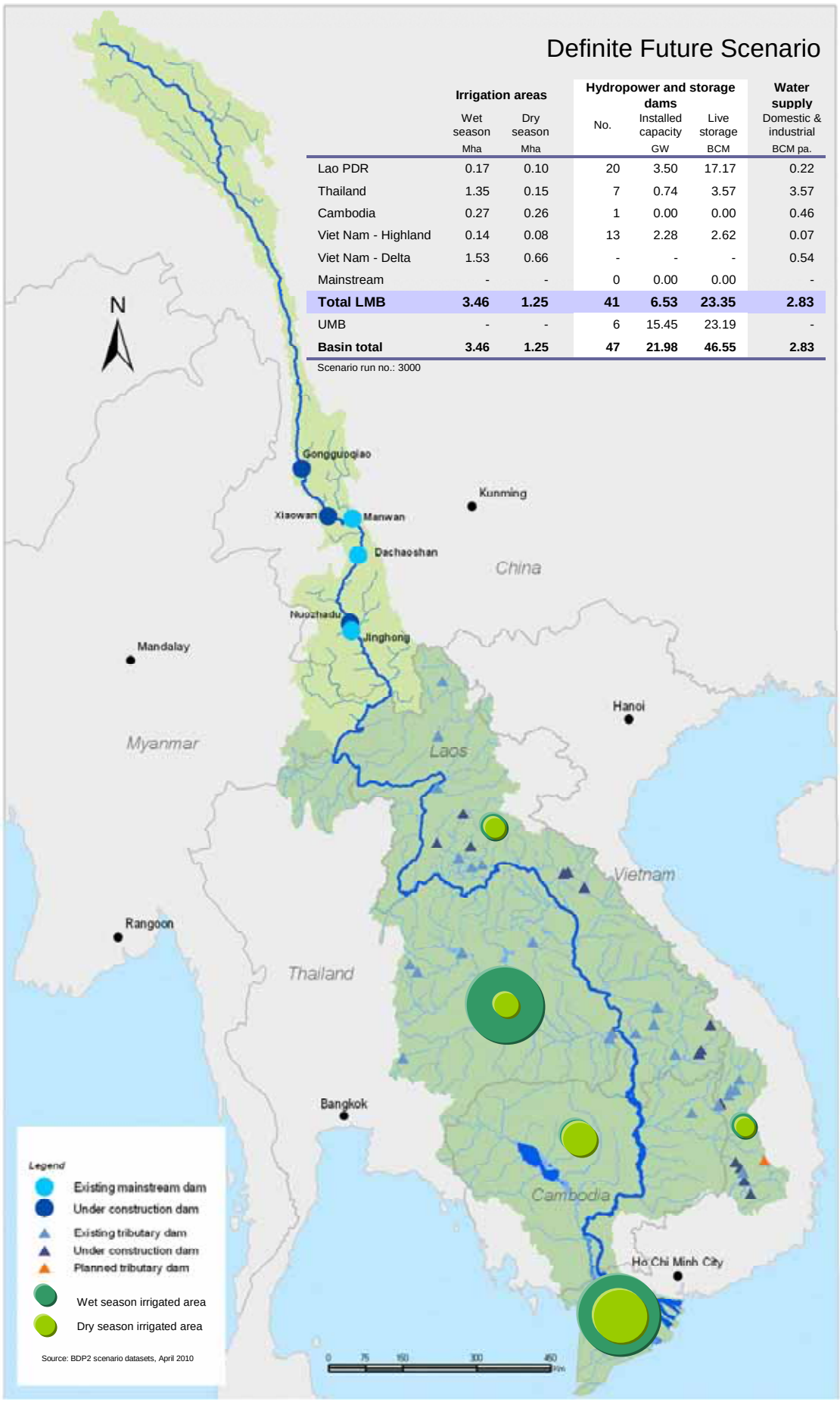
Definite Future Scenario

	Irrigation areas		Hydropower and storage dams			Water supply
	Wet season	Dry season	No.	Installed capacity	Live storage	Domestic & industrial
	Mha	Mha		GW	BCM	BCM pa.
Lao PDR	0.17	0.10	20	3.50	17.17	0.22
Thailand	1.35	0.15	7	0.74	3.57	3.57
Cambodia	0.27	0.26	1	0.00	0.00	0.46
Viet Nam - Highland	0.14	0.08	13	2.28	2.62	0.07
Viet Nam - Delta	1.53	0.66	-	-	-	0.54
Mainstream	-	-	0	0.00	0.00	-
Total LMB	**3.46**	**1.25**	**41**	**6.53**	**23.35**	**2.83**
UMB	-	-	6	15.45	23.19	-
Basin total	**3.46**	**1.25**	**47**	**21.98**	**46.55**	**2.83**

Scenario run no.: 3000



Scenario assessment results

Estimated total values

Definite Future Scenario

Scenario run no. 3000

Assessment issue	Unit	3 Lao PDR Amount		4 Thailand Amount		5 Cambodia Amount		6 Viet Nam Amount		Total Amount	
Hydrological assessment											
Key hydrological parameters:	Location	Vientiane		Mudakhan		Kratie		Tan Chau		Average	
Monthly average dry season flow (March)	m3/s	1,860		2,372		3,069		3,898		2,800	
Average peak daily flow in wet season	m3/s	13,813		24,032		45,123		20,830		25,949	
Flow reversal in Tonle Sap:	Location					Prek Kdam				TLS only	
Average flow volume entering Tonle Sap	MCM	n/a		n/a		29,740		n/a		29,740	
Average date of flow reversal (+/-)	Days	n/a		n/a		142		n/a		21-May	
Land use and condition assessment											
Total irrigated area	'000ha	166		1,355		273		1,670		3,465	
Total irrigated cropped area	'000ha	271		1,756		563		4,218		6,807	
Average area flooded: < 0.5m	'000ha	23		23		217		408		670	
Average area flooded: 0.5 - 1.0m	'000ha	20		22		208		713		962	
Average area flooded: 1.0 - 3.0m	'000ha	72		79		676		667		1,495	
Average area flooded: > 3.0m	'000ha	227		176		977		3		1,383	
Area lost to bank erosion	Severity	Mildly positive	1	Mildly positive	1	Neutral	0	Neutral	0	Neutral	
Area affected by salinity of > 1.3gm/l	'000ha	0		0		0		1,579		1,579	
Water quality and geomorphology											
Herbicide runoff	tonnes / yr	1,463		11,761		908		22,828		36,959	
Insecticide and fungicide runoff	tonnes / yr	1,939		13,665		1,455		25,720		42,780	
Nitrogen runoff from agriculture	tonnes / yr	3,371		11,631		2,455		63,550		81,007	
Phosphorus runoff from agriculture	tonnes / yr	308		1,239		281		8,329		10,156	
Nitrogen from waste water discharge	tonnes / yr	8,629		13,977		6,633		9,896		39,135	
Phosphorus from waste water discharge	tonnes / yr	2,589		4,193		1,990		2,969		11,740	
BOD from waste water discharge	tonnes / yr	32,358		52,414		24,872		37,110		146,755	
Impact on water quality	Severity	Mildly positive	1	Mildly positive	1	Mildly positive	1	Mildly positive	1	Mildly positive	1
Change in sediment supply	Severity	Negative	-2	Negative	-2	Mildly negative	-1	Neutral	0	Negative	-1
Induced geomorphological changes	Severity	Mildly negative	-1	Mildly negative	-1	Neutral	0	Neutral	0	Mildly negative	-1
Production assessment											
Hydropower generated	GWh / yr	16,403		12,179		2,335		13,594		44,510	
Reservoir fisheries	Mtonne / yr	0		0		0		0		0	
Flood damages	US$M / yr	28		27		8		9		72	
Agricultural production: rice	Mtonne / yr	1		4		2		18		25	
Agricultural production: non-rice	Mtonne / yr	0		1		0		2		3	
Capture fisheries production	Mtonne / yr	0		1		1		0		2	
Aquaculture production	Mtonne / yr	0		0		0		2		3	
Environmental assessment											
Total wetland area: flooded forest	'000ha	0		0		450		46		496	
Total wetland area: marshes	'000ha	6		10		506		0		523	
Total wetland area: inundated grassland	'000ha	6		42		311		55		413	
Tonle Sap only: flooded forest	'000ha	0		0		450		0		450	
Tonle Sap only: marshes	'000ha	0		0		307		0		307	
Tonle Sap only: inundated grassland	'000ha	0		0		271		0		271	
Forest area in reservoir areas	'000ha	38		14		2		5		60	
Number of viable deep pools	No.	20		17		5		5		47	
Status of river channel habitats	Severity	Mildly negative	-1	Mildly negative	-1	Neutral	0	Neutral	0	Mildly negative	-1
Flagship species	Survival	Surviving		Surviving		Surviving		Surviving		Surviving	
Environmental hot spots	Severity	Neutral	0	Negative	-1	Mildly negative	-1	Neutral	0	Mildly negative	-0
Biodiversity condition	Severity	Mildly negative	-1	Mildly negative	-1	Mildly negative	-1	Mildly negative	-1	Mildly negative	-1
Economic assessment *(net economic values)*											
Irrigated agricultural production	NPV US$M	0		0		0		0		0	
Hydropower generated	NPV US$M	7,686		591		748		3,821		12,845	
Hydropower imported/exported	NPV US$M	1,567		1,060		457		874		3,958	
Navigation	NPV US$M	0		246		0		0		246	
Flood damage mitigation	NPV US$M	179		172		51		60		462	
Capture fisheries reduction	NPV US$M	-228		-188		-324		-207		-946	
Reservoir fisheries	NPV US$M	74		0		3		13		91	
Aquaculture production	NPV US$M	126		174		88		741		1,129	
Forest area reduction	NPV US$M	-130		0		-6		-17		-153	
Recession rice	NPV US$M	-19		-10		-106		-9		-144	
Wetland area reduction	NPV US$M	-27		-47		-153		-1		-228	
Mitigation of salinity affected areas	NPV US$M	0		0		0		20		20	
Reduction in eco-hotspot/biodiversity	NPV US$M	0		-20		-65		0		-85	
Total economic impacts	NPV US$M	**9,229**		**1,977**		**693**		**5,296**		**17,195**	
Social assessment											
No. of people at risk of loss of livelihood	'000	297		46		102		442		887	
Severity of impact on livelihoods	Severity	Negative	-2	Mildly negative	-1	Mildly negative	-1	Mildly negative	-1	Negative	-1
No. of people employed in:											
Irrigated agriculture	'000	79		227		77		35		418	
Reservoir fisheries (incremental to BS)	'000	12		0		1		2		15	
Hydropower production	'000	52		5		15		31		104	
Aquaculture (incremental to BS)	'000	28		39		20		164		251	
Overall assessment											
Overall environment impact	Severity	Mildly negative	-1	Mildly negative	-1	Mildly negative	-1	Mildly negative	-1	Mildly negative	-1
Livelihoods	Severity	Negative	-2	Mildly negative	-1	Mildly negative	-1	Mildly negative	-1	Negative	-1
Economic production	NPV US$M	9,453		2,071		1,297		5,449		18,270	
Other economic impacts	NPV US$M	-224		-93		-603		-154		-1,075	

Summary of scenario assessment

Incremental values relative to Baseline

Definite Future Scenario

Scenario run no. 3000

Assessment issue	Unit	Lao PDR Amount	Lao PDR Percent	Thailand Amount	Thailand Percent	Cambodia Amount	Cambodia Percent	Viet Nam Amount	Viet Nam Percent	Total Amount	Total Percent
Hydrological assessment											
Key hydrological parameters:	Location	Vientiane		Mudakhan		Kratie		Tan Chau		Average	
Monthly average dry season flow (March)	m3/s	760	69%	920	63%	871	40%	826	27%	844	43%
Average peak daily flow in wet season	m3/s	-2,108	-13%	-1,469	-6%	-1,640	-4%	-480	-2%	-1,424	-5%
Flow reversal in Tonle Sap:	Location					Prek Kdam				TLS only	
Average flow volume entering Tonle Sap	MCM	n/a		n/a		-2,518	-8%	n/a		-2,518	-8%
Average date of flow reversal (+/-)	Days	n/a		n/a		-3	-2%	n/a		-3	-2%
Land use and condition assessment											
Total irrigated area	'000ha	-38	-18%	89	7%	0	0%	-326	-16%	-275	-7%
Total irrigated cropped area	'000ha	-61	-18%	334	23%	0	0%	-94	-2%	179	3%
Average area flooded: < 0.5m	'000ha	-1	-6%	-0	-1%	32	17%	74	22%	104	18%
Average area flooded: 0.5 - 1.0m	'000ha	-5	-20%	-2	-9%	-23	-10%	45	7%	14	1%
Average area flooded: 1.0 - 3.0m	'000ha	-12	-14%	-10	-11%	-36	-5%	-127	-16%	-186	-11%
Average area flooded: > 3.0m	'000ha	-46	-17%	-56	-24%	-77	-7%	-2	-38%	-181	-12%
Area lost to bank erosion	Severity	Mildly positive	1	Mildly positive	1	Neutral	0	Neutral	0	Neutral	1
Area affected by salinity of > 1.3gm/l	'000ha	0	0%	0	0%	0	0%	-272	-15%	-272	-15%
Water quality and geomorphology											
Herbicide runoff	tonnes / yr	0	0%	0	0%	0	0%	0	0%	0	0%
Insecticide and fungicide runoff	tonnes / yr	0	0%	0	0%	0	0%	0	0%	0	0%
Nitrogen runoff from agriculture	tonnes / yr	0	0%	0	0%	0	0%	0	0%	0	0%
Phosphorus runoff from agriculture	tonnes / yr	0	0%	0	0%	0	0%	0	0%	0	0%
Nitrogen from waste water discharge	tonnes / yr	0	0%	0	0%	0	0%	0	0%	0	0%
Phosphorus from waste water discharge	tonnes / yr	0	0%	0	0%	0	0%	0	0%	0	0%
BOD from waste water discharge	tonnes / yr	0	0%	0	0%	0	0%	0	0%	0	0%
Impact on water quality	Severity	Mildly positive	1	Mildly positive	1	Mildly positive	1	Mildly positive	1	Mildly positive	1
Change in sediment supply	Severity	Negative	-2	Negative	-2	Mildly negative	-1	Neutral	0	Negative	-1
Induced geomorphological changes	Severity	Mildly negative	-1	Mildly negative	-1	Neutral	0	Neutral	0	Mildly negative	-1
Production assessment											
Hydropower generated	GWh / yr	13,371	441%	9,776	407%	2,335	0%	9,935	272%	35,417	389%
Reservoir fisheries	Mtonne / yr	0	19%	0	0%	0	2%	0	7%	0	7%
Flood damages	US$M / yr	-42	-60%	-40	-60%	-18	-70%	-47	-83%	-147	-67%
Agricultural production: rice	Mtonne / yr	0	0%	0	0%	0	0%	0	0%	0	0%
Agricultural production: non-rice	Mtonne / yr	0	0%	0	0%	0	0%	0	0%	0	0%
Capture fisheries production	Mtonne / yr	-0	-15%	-0	-3%	-0	-7%	-0	-9%	-0	-7%
Aquaculture production	Mtonne / yr	0	92%	0	81%	0	32%	1	50%	1	52%
Environmental assessment											
Total wetland area: flooded forest	'000ha	0	0%	0	0%	-2	0%	-0	0%	-2	0%
Total wetland area: marshes	'000ha	-2	-21%	-2	-15%	-12	-2%	-0	0%	-15	-3%
Total wetland area: inundated grassland	'000ha	-3	-36%	-7	-15%	-7	-2%	0	0%	-18	-4%
Tonle Sap only: flooded forest	'000ha	0	0%	0	0%	-2	0%	0	0%	-2	0%
Tonle Sap only: marshes	'000ha	0	0%	0	0%	-2	-1%	0	0%	-2	-1%
Tonle Sap only: inundated grassland	'000ha	0	0%	0	0%	-5	-2%	0	0%	-5	-2%
Forest area in reservoir areas	'000ha	25	182%	0	0%	1	92%	3	162%	29	95%
Number of viable deep pools	No.	0	0%	0	0%	0	0%	0	0%	0	0%
Status of river channel habitats	Severity	Mildly negative	-1	Mildly negative	-1	Neutral	0	Neutral	0	Mildly negative	-1
Flagship species	Survival	n/a		n/a		n/a		n/a		n/a	
Environmental hot spots	Severity	Neutral	0	Negative	-1	Mildly negative	-1	Neutral	0	Mildly negative	-0
Biodiversity condition	Severity	Mildly negative	-1	Mildly negative	-1	Mildly negative	-1	Mildly negative	-1	Mildly negative	-1
Economic assessment *(net economic values)*											
Irrigated agricultural production	NPV US$M	0	0%	0	0%	0	0%	0	0%	0	0%
Hydropower generated	NPV US$M	5,393	235%	100	20%	748	0%	2,109	123%	8,350	186%
Hydropower imported/exported	NPV US$M	1,227	360%	851	407%	457	0%	607	227%	3,142	385%
Navigation	NPV US$M	0	0%	64	35%	0	0%	0	0%	64	35%
Flood damage mitigation	NPV US$M	179	0%	172	0%	51	0%	60	0%	462	0%
Capture fisheries reduction	NPV US$M	-228	0%	-188	0%	-324	0%	-207	0%	-946	0%
Reservoir fisheries	NPV US$M	74	0%	0	0%	3	0%	13	0%	91	0%
Aquaculture production	NPV US$M	126	0%	174	0%	88	0%	741	0%	1,129	0%
Forest area reduction	NPV US$M	-130	0%	0	0%	-6	0%	-17	0%	-153	0%
Recession rice	NPV US$M	-19	0%	-10	0%	-106	0%	-9	0%	-144	0%
Wetland area reduction	NPV US$M	-27	0%	-47	0%	-153	0%	-1	0%	-228	0%
Mitigation of salinity affected areas	NPV US$M	0	0%	0	0%	0	0%	20	0%	20	0%
Reduction in eco-hotspot/biodiversity	NPV US$M	0	0%	-20	0%	-65	0%	0	0%	-85	0%
Total economic impacts	NPV US$M	**6,595**	250%	**1,095**	124%	**693**	0%	**3,317**	168%	**11,700**	213%
Social assessment											
No. of people at risk of loss of livelihood	'000	297	0%	46	0%	102	0%	442	0%	887	0%
Severity of impact on livelihoods	Severity	Negative	-2	Mildly negative	-1	Mildly negative	-1	Mildly negative	-1	Negative	-1
No. of people employed in:											
Irrigated agriculture	'000	0	0%	0	0%	0	0%	0	0%	0	0%
Reservoir fisheries (incremental to BS)	'000	12	0%	0	0%	1	0%	2	0%	15	0%
Hydropower production	'000	52	0%	5	0%	15	0%	31	0%	104	0%
Aquaculture (incremental to BS)	'000	28	0%	39	0%	20	0%	164	0%	251	0%
Overall assessment											
Overall environment impact	Severity	Mildly negative	-1	Mildly negative	-1	Mildly negative	-1	Mildly negative	-1	Mildly negative	-1
Livelihoods	Severity	Negative	-2	Mildly negative	-1	Mildly negative	-1	Mildly negative	-1	Negative	-1
Economic production	NPV US$M	6,819	259%	1,189	135%	1,297	0%	3,471	175%	12,775	233%
Other economic impacts	NPV US$M	-224	0%	-93	0%	-603	0%	-154	0%	-1,075	0%

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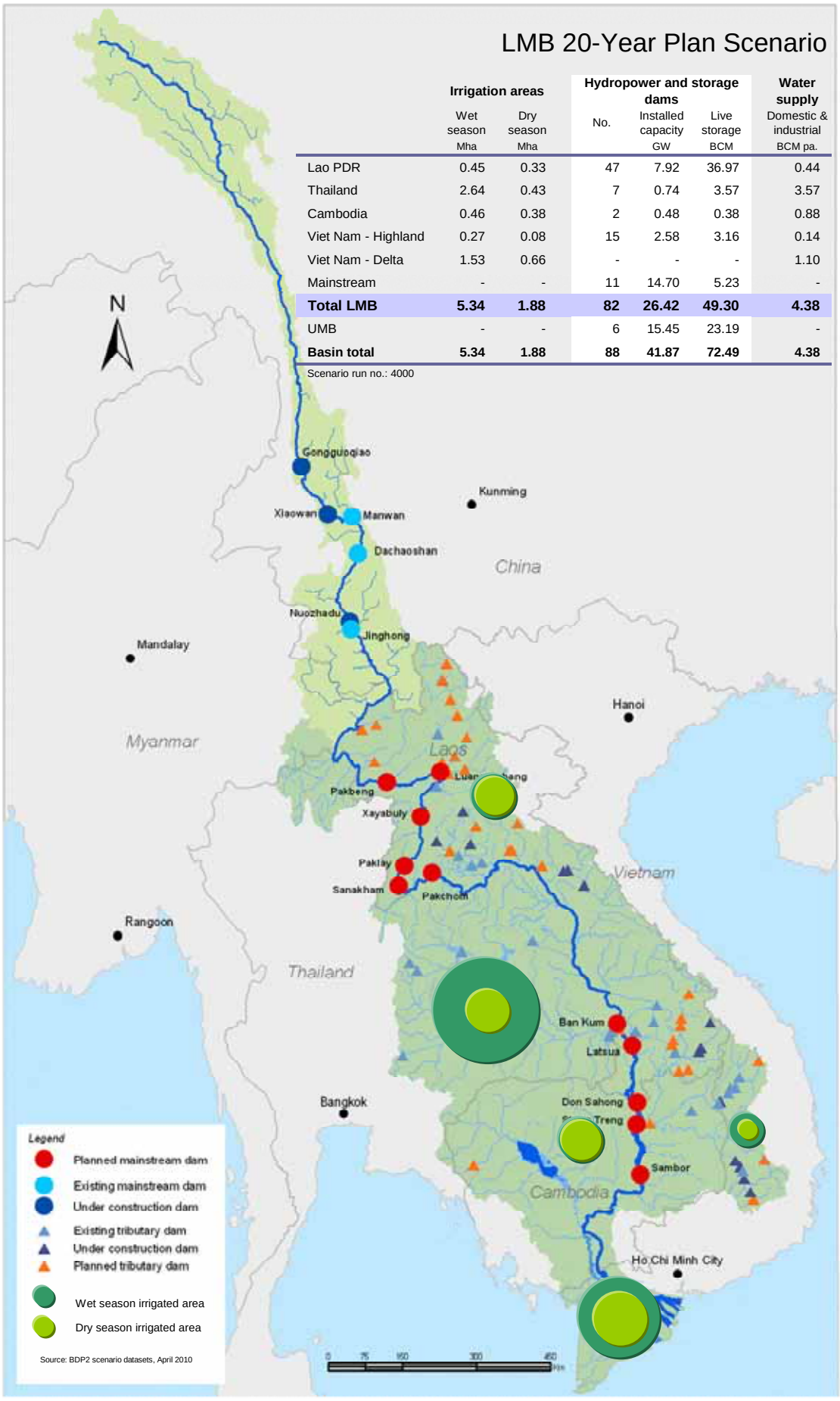
LMB 20-Year Plan Scenario

	Irrigation areas		Hydropower and storage dams			Water supply
	Wet season Mha	Dry season Mha	No.	Installed capacity GW	Live storage BCM	Domestic & industrial BCM pa.
Lao PDR	0.45	0.33	47	7.92	36.97	0.44
Thailand	2.64	0.43	7	0.74	3.57	3.57
Cambodia	0.46	0.38	2	0.48	0.38	0.88
Viet Nam - Highland	0.27	0.08	15	2.58	3.16	0.14
Viet Nam - Delta	1.53	0.66	-	-	-	1.10
Mainstream	-	-	11	14.70	5.23	-
Total LMB	**5.34**	**1.88**	**82**	**26.42**	**49.30**	**4.38**
UMB	-	-	6	15.45	23.19	-
Basin total	**5.34**	**1.88**	**88**	**41.87**	**72.49**	**4.38**

Scenario run no.: 4000



Scenario assessment results

Estimated total values

LMB 20-Year Plan Scenario

Scenario run no. 4000

Assessment issue	Unit	3 Lao PDR Amount		4 Thailand Amount		5 Cambodia Amount		6 Viet Nam Amount		Total Amount	
Hydrological assessment											
Key hydrological parameters:	Location	Vientiane		Mudakhan		Kratie		Tan Chau		Average	
Monthly average dry season flow (March)	m3/s	2,218		2,698		3,546		4,179		3,160	
Average peak daily flow in wet season	m3/s	13,540		23,417		43,307		20,455		25,180	
Flow reversal in Tonle Sap:	Location					Prek Kdam				TLS only	
Average flow volume entering Tonle Sap	MCM	n/a		n/a		27,993		n/a		27,993	
Average date of flow reversal (+/-)	Days	n/a		n/a		137		n/a		16-May	
Land use and condition assessment											
Total irrigated area	'000ha	450		2,635		457		1,795		5,337	
Total irrigated cropped area	'000ha	820		3,624		877		4,404		9,725	
Average area flooded: < 0.5m	'000ha	21		23		221		432		697	
Average area flooded: 0.5 - 1.0m	'000ha	19		22		211		717		969	
Average area flooded: 1.0 - 3.0m	'000ha	70		77		666		634		1,448	
Average area flooded: > 3.0m	'000ha	219		167		943		3		1,331	
Area lost to bank erosion	Severity	Mildly negative	-1	Mildly negative	-1	Mildly negative	-1	Neutral	0	Neutral	
Area affected by salinity of > 1.3gm/l	'000ha	0		0		0		1,543		1,543	
Water quality and geomorphology											
Herbicide runoff	tonnes / yr	6,721		29,874		3,483		26,352		66,430	
Insecticide and fungicide runoff	tonnes / yr	6,723		31,752		3,192		27,098		68,765	
Nitrogen runoff from agriculture	tonnes / yr	18,039		51,700		9,377		71,019		150,135	
Phosphorus runoff from agriculture	tonnes / yr	1,954		6,487		1,219		10,683		20,344	
Nitrogen from waste water discharge	tonnes / yr	13,209		14,974		9,396		14,435		52,014	
Phosphorus from waste water discharge	tonnes / yr	3,963		4,492		2,819		4,330		15,604	
BOD from waste water discharge	tonnes / yr	49,534		56,152		24,872		54,130		184,689	
Impact on water quality	Severity	Negative	-2	Mildly negative	-1	Negative	-2	Mildly negative	-1	Negative	-2
Change in sediment supply	Severity	Negative	-2	Negative	-2	Negative	-2	Negative	-2	Negative	-2
Induced geomorphological changes	Severity	Negative	-2	Negative	-2	Mildly negative	-1	Neutral	0	Negative	-1
Production assessment											
Hydropower generated	GWh / yr	84,416		60,694		23,061		35,058		203,229	
Reservoir fisheries	Mtonne / yr	0		0		0		0		0	
Flood damages	US$M / yr	31		30		12		16		88	
Agricultural production: rice	Mtonne / yr	4		13		5		25		48	
Agricultural production: non-rice	Mtonne / yr	0		4		0		3		8	
Capture fisheries production	Mtonne / yr	0		1		0		0		2	
Aquaculture production	Mtonne / yr	0		0		0		3		4	
Environmental assessment											
Total wetland area: flooded forest	'000ha	0		0		448		46		494	
Total wetland area: marshes	'000ha	6		10		501		0		517	
Total wetland area: inundated grassland	'000ha	5		41		307		55		408	
Tonle Sap only: flooded forest	'000ha	0		0		448		0		448	
Tonle Sap only: marshes	'000ha	0		0		307		0		307	
Tonle Sap only: inundated grassland	'000ha	0		0		269		0		269	
Forest area in reservoir areas	'000ha	94		14		43		7		158	
Number of viable deep pools	No.	12		7		3		5		27	
Status of river channel habitats	Severity	Negative	-2	Negative	-2	Mildly negative	-1	Mildly negative	-1	Negative	-2
Flagship species	Survival	Extinct		Extinct		Surviving		Surviving		Extinct	
Environmental hot spots	Severity	Extremely negative	-3	Severely negative	-3	Extremely negative	-3	Neutral	0	Severely negative	-2
Biodiversity condition	Severity	Severely negative	-3	Severely negative	-3	Severely negative	-3	Mildly negative	-1	Severely negative	-3
Economic assessment *(net economic values)*											
Irrigated agricultural production	NPV US$M	322		885		344		108		1,659	
Hydropower generated	NPV US$M	14,585		964		1,315		4,659		21,523	
Hydropower imported/exported	NPV US$M	10,407		3,108		2,031		1,066		16,612	
Navigation	NPV US$M	0		246		0		0		246	
Flood damage mitigation	NPV US$M	130		130		50		67		377	
Capture fisheries reduction	NPV US$M	-174		-162		-1,139		-461		-1,936	
Reservoir fisheries	NPV US$M	135		0		70		11		215	
Aquaculture production	NPV US$M	168		235		174		684		1,261	
Forest area reduction	NPV US$M	-236		0		-122		-14		-372	
Recession rice	NPV US$M	-21		-22		-122		-13		-178	
Wetland area reduction	NPV US$M	-18		-34		-169		-4		-225	
Mitigation of salinity affected areas	NPV US$M	0		0		0		27		27	
Reduction in eco-hotspot/biodiversity	NPV US$M	-75		-60		-195		0		-330	
Total economic impacts	NPV US$M	**25,222**		**5,292**		**2,237**		**6,129**		**38,880**	
Social assessment											
No. of people at risk of loss of livelihood	'000	907		516		1,212		1,725		4,360	
Severity of impact on livelihoods	Severity	Severely negative	-3	Severely negative	-3	Extremely negative	-4	Negative	-2	Severely negative	-3
No. of people employed in:											
Irrigated agriculture	'000	150		346		84		49		629	
Reservoir fisheries (incremental to BS)	'000	40		0		21		3		64	
Hydropower production	'000	382		38		163		29		612	
Aquaculture (incremental to BS)	'000	55		77		57		164		352	
Overall assessment											
Overall environment impact	Severity	Severely negative	-3	Severely negative	-3	Severely negative	-3	Mildly negative	-1	Severely negative	-3
Livelihoods	Severity	Severely negative	-3	Severely negative	-3	Extremely negative	-4	Negative	-2	Severely negative	-3
Economic production	NPV US$M	25,617		5,439		3,934		6,527		41,517	
Other economic impacts	NPV US$M	-395		-147		-1,697		-398		-2,637	

Summary of scenario assessment

Incremental values relative to Baseline

LMB 20-Year Plan Scenario

Scenario run no. 4000

Assessment issue	Unit	Lao PDR Amount	Lao PDR Percent	Thailand Amount	Thailand Percent	Cambodia Amount	Cambodia Percent	Viet Nam Amount	Viet Nam Percent	Total Amount	Total Percent
Hydrological assessment											
Key hydrological parameters:	Location	Vientiane		Mudakhan		Kratie		Tan Chau		Average	
Monthly average dry season flow (March)	m3/s	1,118	102%	1,246	86%	1,348	61%	1,107	36%	1,205	62%
Average peak daily flow in wet season	m3/s	-2,381	-15%	-2,084	-8%	-3,456	-7%	-855	-4%	-2,194	-8%
Flow reversal in Tonle Sap:	Location					Prek Kdam				TLS only	
Average flow volume entering Tonle Sap	MCM	n/a		n/a		-4,265	-13%	n/a		-4,265	-13%
Average date of flow reversal (+/-)	Days	n/a		n/a		-8	-5%	n/a		-8	-5%
Land use and condition assessment											
Total irrigated area	'000ha	245	120%	1,370	108%	183	67%	-201	-10%	1,597	43%
Total irrigated cropped area	'000ha	488	147%	2,202	155%	314	56%	93	2%	3,096	47%
Average area flooded: < 0.5m	'000ha	-3	-12%	-1	-3%	36	19%	98	29%	130	23%
Average area flooded: 0.5 - 1.0m	'000ha	-5	-21%	-2	-9%	-20	-9%	48	7%	21	2%
Average area flooded: 1.0 - 3.0m	'000ha	-14	-16%	-13	-14%	-46	-6%	-160	-20%	-232	-14%
Average area flooded: > 3.0m	'000ha	-53	-20%	-65	-28%	-112	-11%	-2	-45%	-233	-15%
Area lost to bank erosion	Severity	Mildly negative	-1	Mildly negative	-1	Mildly negative	-1	Neutral	0	Mildly negative	-1
Area affected by salinity of > 1.3gm/l	'000ha	0	0%	0	0%	0	0%	-309	-17%	-309	-17%
Water quality and geomorphology											
Herbicide runoff	tonnes / yr	5,258	359%	18,113	154%	2,575	284%	3,524	15%	29,470	80%
Insecticide and fungicide runoff	tonnes / yr	4,783	247%	18,087	132%	1,737	119%	1,378	5%	25,985	61%
Nitrogen runoff from agriculture	tonnes / yr	14,668	435%	40,070	345%	6,922	282%	7,469	12%	69,128	85%
Phosphorus runoff from agriculture	tonnes / yr	1,647	535%	5,248	424%	938	334%	2,354	28%	10,187	100%
Nitrogen from waste water discharge	tonnes / yr	4,580	53%	997	7%	2,763	42%	4,539	46%	12,879	33%
Phosphorus from waste water discharge	tonnes / yr	1,374	53%	299	7%	829	42%	1,362	46%	3,864	33%
BOD from waste water discharge	tonnes / yr	17,175	53%	3,738	7%	0	0%	17,020	46%	37,934	26%
Impact on water quality	Severity	Negative	-2	Mildly negative	-1	Negative	-2	Mildly negative	-1	Negative	-2
Change in sediment supply	Severity	Negative	-2	Negative	-2	Negative	-2	Negative	-2	Negative	-2
Induced geomorphological changes	Severity	Negative	-2	Negative	-2	Mildly negative	-1	Neutral	0	Negative	-1
Production assessment											
Hydropower generated	GWh / yr	81,384	2684%	58,291	2426%	23,061	0%	31,399	858%	194,136	2135%
Reservoir fisheries	Mtonne / yr	0	63%	0	0%	0	81%	0	11%	0	29%
Flood damages	US$M / yr	-39	-56%	-37	-55%	-15	-56%	-40	-72%	-131	-60%
Agricultural production: rice	Mtonne / yr	3	370%	9	220%	3	176%	7	42%	23	92%
Agricultural production: non-rice	Mtonne / yr	0	744%	3	226%	0	140%	1	56%	4	132%
Capture fisheries production	Mtonne / yr	-0	-21%	-0	-5%	-0	-44%	-0	-37%	-1	-25%
Aquaculture production	Mtonne / yr	0	161%	0	158%	0	91%	2	100%	2	105%
Environmental assessment											
Total wetland area: flooded forest	'000ha	0	0%	0	0%	-4	-1%	-0	0%	-4	-1%
Total wetland area: marshes	'000ha	-2	-24%	-2	-19%	-17	-3%	-0	0%	-21	-4%
Total wetland area: inundated grassland	'000ha	-4	-44%	-9	-18%	-10	-3%	-0	0%	-23	-5%
Tonle Sap only: flooded forest	'000ha	0	0%	0	0%	-4	-1%	0	0%	-4	-1%
Tonle Sap only: marshes	'000ha	0	0%	0	0%	-3	-1%	0	0%	-3	-1%
Tonle Sap only: inundated grassland	'000ha	0	0%	0	0%	-8	-3%	0	0%	-8	-3%
Forest area in reservoir areas	'000ha	81	595%	0	0%	42	3346%	5	236%	127	416%
Number of viable deep pools	No.	-8	-40%	-10	-59%	-2	-40%	0	0%	-20	-43%
Status of river channel habitats	Severity	Negative	-2	Negative	-2	Mildly negative	-1	Mildly negative	-1	Negative	-2
Flagship species	Survival	n/a		n/a		n/a		n/a		n/a	
Environmental hot spots	Severity	Extremely negative	-3	Severely negative	-3	Extremely negative	-3	Neutral	0	Severely negative	-2
Biodiversity condition	Severity	Severely negative	-3	Severely negative	-3	Severely negative	-3	Mildly negative	-1	Severely negative	-3
Economic assessment *(net economic values)*											
Irrigated agricultural production	NPV US$M	322	0%	885	0%	344	0%	108	0%	1,659	0%
Hydropower generated	NPV US$M	12,292	536%	473	96%	1,315	0%	2,948	172%	17,028	379%
Hydropower imported/exported	NPV US$M	10,066	2957%	2,899	1386%	2,031	0%	799	299%	15,796	1934%
Navigation	NPV US$M	0	0%	64	35%	0	0%	0	0%	64	35%
Flood damage mitigation	NPV US$M	130	0%	130	0%	50	0%	67	0%	377	0%
Capture fisheries reduction	NPV US$M	-174	0%	-162	0%	-1,139	0%	-461	0%	-1,936	0%
Reservoir fisheries	NPV US$M	135	0%	0	0%	70	0%	11	0%	215	0%
Aquaculture production	NPV US$M	168	0%	235	0%	174	0%	684	0%	1,261	0%
Forest area reduction	NPV US$M	-236	0%	0	0%	-122	0%	-14	0%	-372	0%
Recession rice	NPV US$M	-21	0%	-22	0%	-122	0%	-13	0%	-178	0%
Wetland area reduction	NPV US$M	-18	0%	-34	0%	-169	0%	-4	0%	-225	0%
Mitigation of salinity affected areas	NPV US$M	0	0%	0	0%	0	0%	27	0%	27	0%
Reduction in eco-hotspot/biodiversity	NPV US$M	-75	0%	-60	0%	-195	0%	0	0%	-330	0%
Total economic impacts	NPV US$M	**22,588**	858%	**4,410**	500%	**2,237**	0%	**4,151**	210%	**33,386**	608%
Social assessment											
No. of people at risk of loss of livelihood	'000	907	0%	516	0%	1,212	0%	1,725	0%	4,360	0%
Severity of impact on livelihoods	Severity	Severely negative	-3	Severely negative	-3	Extremely negative	-4	Negative	-2	Severely negative	-3
No. of people employed in:											
Irrigated agriculture	'000	72	91%	119	53%	6	8%	14	41%	212	51%
Reservoir fisheries (incremental to BS)	'000	40	0%	0	0%	21	0%	3	0%	64	0%
Hydropower production	'000	382	0%	38	0%	163	0%	29	0%	612	0%
Aquaculture (incremental to BS)	'000	55	0%	77	0%	57	0%	164	0%	352	0%
Overall assessment											
Overall environment impact	Severity	Severely negative	-3	Severely negative	-3	Severely negative	-3	Mildly negative	-1	Severely negative	-3
Livelihoods	Severity	Severely negative	-3	Severely negative	-3	Extremely negative	-4	Negative	-2	Severely negative	-3
Economic production	NPV US$M	22,983	873%	4,557	517%	3,934	0%	4,549	230%	36,023	656%
Other economic impacts	NPV US$M	-395	0%	-147	0%	-1,697	0%	-398	0%	-2,637	0%

Summary of scenario assessment

Incremental values relative to Definite Future Scenario

LMB 20-Year Plan Scenario

Scenario run no. 4000

Assessment issue	Unit	Lao PDR		Thailand		Cambodia		Viet Nam		Total	
		Amount	Percent	Amount	Percent	Amount	Percent	Amount	Percent	Amount	Percent
Hydrological assessment											
Key hydrological parameters:	Location	Vientiane		Mudakhan		Kratie		Tan Chau		Average	
Monthly average dry season flow (March)	m3/s	358	19%	326	14%	477	16%	281	7%	361	13%
Average peak daily flow in wet season	m3/s	-273	-2%	-615	-3%	-1,816	-4%	-374	-2%	-770	-3%
Flow reversal in Tonle Sap:	Location					Prek Kdam				TLS only	
Average flow volume entering Tonle Sap	MCM	n/a		n/a		-1,747	-6%	n/a		-1,747	
Average date of flow reversal (+/-)	Days	n/a		n/a		-5	-3%	n/a		-5	
Land use and condition assessment											
Total irrigated area	'000ha	283	170%	1,281	95%	183	67%	125	7%	1,872	54%
Total irrigated cropped area	'000ha	549	203%	1,868	106%	314	56%	186	4%	2,918	43%
Average area flooded: < 0.5m	'000ha	-1	-6%	-0	-2%	4	2%	24	6%	26	4%
Average area flooded: 0.5 - 1.0m	'000ha	-0	-1%	0	0%	3	2%	4	1%	7	1%
Average area flooded: 1.0 - 3.0m	'000ha	-2	-3%	-3	-3%	-9	-1%	-33	-5%	-46	-3%
Average area flooded: > 3.0m	'000ha	-8	-3%	-9	-5%	-35	-4%	-0	-11%	-52	-4%
Area lost to bank erosion	Severity	Negative	-2	Negative	-2	Mildly negative	-1	Neutral	0	Negative	-1
Area affected by salinity of > 1.3gm/l	'000ha	0	0%	0	0%	0	0%	-37	-2%	-37	-2%
Water quality and geomorphology											
Herbicide runoff	tonnes / yr	5,258	359%	18,113	154%	2,575	284%	3,524	15%	29,470	80%
Insecticide and fungicide runoff	tonnes / yr	4,783	247%	18,087	132%	1,737	119%	1,378	5%	25,985	61%
Nitrogen runoff from agriculture	tonnes / yr	14,668	435%	40,070	345%	6,922	282%	7,469	12%	69,128	85%
Phosphorus runoff from agriculture	tonnes / yr	1,647	535%	5,248	424%	938	334%	2,354	28%	10,187	100%
Nitrogen from waste water discharge	tonnes / yr	4,580	53%	997	7%	2,763	42%	4,539	46%	12,879	33%
Phosphorus from waste water discharge	tonnes / yr	1,374	53%	299	7%	829	42%	1,362	46%	3,864	33%
BOD from waste water discharge	tonnes / yr	17,175	53%	3,738	7%	0	0%	17,020	46%	37,934	26%
Impact on water quality	Severity	Severely negative	-3	Negative	-2	Severely negative	-3	Negative	-2	Severely negative	-3
Change in sediment supply	Severity	Neutral	0	Neutral	0	Mildly negative	-1	Negative	-2	Mildly negative	-1
Induced geomorphological changes	Severity	Mildly negative	-1	Mildly negative	-1	Mildly negative	-1	Neutral	0	Mildly negative	-1
Production assessment											
Hydropower generated	GWh / yr	68,013	415%	48,515	398%	20,726	888%	21,465	158%	158,719	357%
Reservoir fisheries	Mtonne / yr	0	37%	0	0%	0	78%	0	3%	0	20%
Flood damages	US$M / yr	3	10%	3	13%	4	46%	6	70%	16	23%
Agricultural production: rice	Mtonne / yr	3	370%	9	220%	3	176%	7	42%	23	92%
Agricultural production: non-rice	Mtonne / yr	0	744%	3	226%	0	140%	1	56%	4	132%
Capture fisheries production	Mtonne / yr	-0	-7%	-0	-2%	-0	-40%	-0	-31%	-0	-20%
Aquaculture production	Mtonne / yr	0	36%	0	42%	0	45%	1	33%	1	35%
Environmental assessment											
Total wetland area: flooded forest	'000ha	0	0%	0	0%	-2	0%	-0	0%	-2	0%
Total wetland area: marshes	'000ha	-0	-4%	-0	-4%	-5	-1%	-0	0%	-6	-1%
Total wetland area: inundated grassland	'000ha	-1	-13%	-1	-3%	-3	-1%	-0	0%	-6	-1%
Tonle Sap only: flooded forest	'000ha	0	0%	0	0%	-2	0%	0	0%	-2	0%
Tonle Sap only: marshes	'000ha	0	0%	0	0%	-1	0%	0	0%	-1	0%
Tonle Sap only: inundated grassland	'000ha	0	0%	0	0%	-3	-1%	0	0%	-3	-1%
Forest area in reservoir areas	'000ha	56	146%	0	0%	41	1693%	2	29%	98	164%
Number of viable deep pools	No.	-8	-40%	-10	-59%	-2	-40%	0	0%	-20	-43%
Status of river channel habitats	Severity	Mildly negative	-1	Mildly negative	-1	Mildly negative	-1	Mildly negative	-1	Mildly negative	-1
Flagship species	Survival	n/a		n/a		n/a		n/a		n/a	
Environmental hot spots	Severity	Extremely negative	-3	Negative	-2	Severely negative	-2	Neutral	0	Negative	-2
Biodiversity condition	Severity	Negative	-2	Negative	-2	Negative	-2	Neutral	0	Negative	-2
Economic assessment *(net economic values)*											
Irrigated agricultural production	NPV US$M	322	0%	885	0%	344	0%	108	0%	1,659	0%
Hydropower generated	NPV US$M	6,899	90%	373	63%	567	76%	839	22%	8,678	68%
Hydropower imported/exported	NPV US$M	8,840	564%	2,048	193%	1,574	345%	192	22%	12,654	320%
Navigation	NPV US$M	0	0%	0	0%	0	0%	0	0%	0	0%
Flood damage mitigation	NPV US$M	-49	-27%	-42	-24%	-1	-2%	7	12%	-85	-18%
Capture fisheries reduction	NPV US$M	54	-24%	26	-14%	-816	252%	-254	123%	-990	105%
Reservoir fisheries	NPV US$M	61	82%	0	0%	66	1920%	-2	-19%	125	137%
Aquaculture production	NPV US$M	42	33%	61	35%	86	98%	-58	-8%	132	12%
Forest area reduction	NPV US$M	-106	82%	0	0%	-116	1840%	3	-19%	-219	143%
Recession rice	NPV US$M	-2	12%	-11	112%	-16	15%	-4	51%	-34	23%
Wetland area reduction	NPV US$M	8	-31%	14	-29%	-15	10%	-4	587%	3	-1%
Mitigation of salinity affected areas	NPV US$M	0	0%	0	0%	0	0%	7	35%	7	35%
Reduction in eco-hotspot/biodiversity	NPV US$M	-75	0%	-40	200%	-130	200%	0	0%	-245	288%
Total economic impacts	NPV US$M	**15,993**	173%	**3,315**	168%	**1,544**	223%	**834**	16%	**21,685**	126%
Social assessment											
No. of people at risk of loss of livelihood	'000	610	205%	470	1022%	1,110	1088%	1,283	290%	3,473	392%
Severity of impact on livelihoods	Severity	Mildly negative	-1	Negative	-2	Severely negative	-3	Mildly negative	-1	Negative	-2
No. of people employed in:											
Irrigated agriculture	'000	72	91%	119	53%	6	8%	14	41%	212	51%
Reservoir fisheries (incremental to BS)	'000	28	226%	0	0%	20	3497%	1	46%	49	325%
Hydropower production	'000	330	635%	33	636%	148	963%	-3	-8%	508	490%
Aquaculture (incremental to BS)	'000	26	94%	38	96%	37	188%	0	0%	101	40%
Overall assessment											
Overall environment impact	Severity	Negative	-2	Negative	-2	Negative	-2	Neutral	0	Negative	-2
Livelihoods	Severity	Mildly negative	-1	Negative	-2	Severely negative	-3	Mildly negative	-1	Negative	-2
Economic production	NPV US$M	16,163	171%	3,368	163%	2,638	203%	1,078	20%	23,248	127%
Other economic impacts	NPV US$M	-171	76%	-54	58%	-1,094	181%	-244	159%	-1,562	145%

Scenario assessment results

Estimated total values

LMB 20-Year Plan Scenario
Climate change

Scenario run no. 4001

Assessment issue	Unit	3 Lao PDR		4 Thailand		5 Cambodia		6 Viet Nam		Total	
		Amount		Amount		Amount		Amount		Amount	
Hydrological assessment											
Key hydrological parameters:	Location	Vientiane		Mudakhan		Kratie		Tan Chau		Average	
Monthly average dry season flow (March)	m3/s	2,265		2,759		3,577		4,077		3,170	
Average peak daily flow in wet season	m3/s	13,691		25,919		50,515		21,529		27,914	
Flow reversal in Tonle Sap:	Location					Prek Kdam				TLS only	
Average flow volume entering Tonle Sap	MCM	n/a		n/a		30,663		n/a		30,663	
Average date of flow reversal (+/-)	Days	n/a		n/a		128		n/a		7-May	
Land use and condition assessment											
Total irrigated area	'000ha	450		2,635		457		1,795		5,337	
Total irrigated cropped area	'000ha	820		3,624		877		4,404		9,725	
Average area flooded: < 0.5m	'000ha	24		23		225		117		389	
Average area flooded: 0.5 - 1.0m	'000ha	25		22		192		708		946	
Average area flooded: 1.0 - 3.0m	'000ha	86		86		758		1,016		1,945	
Average area flooded: > 3.0m	'000ha	265		210		1,294		14		1,784	
Area lost to bank erosion	Severity	Negative	-2	Negative	-2	Negative	-2	Mildly negative	-1	Neutral	
Area affected by salinity of > 1.3gm/l	'000ha	0		0		0		1,874		1,874	
Water quality and geomorphology											
Herbicide runoff	tonnes / yr	6,721		29,874		3,483		26,352		66,430	
Insecticide and fungicide runoff	tonnes / yr	6,723		31,752		3,192		27,098		68,765	
Nitrogen runoff from agriculture	tonnes / yr	18,039		51,700		9,377		71,019		150,135	
Phosphorus runoff from agriculture	tonnes / yr	1,954		6,487		1,219		10,683		20,344	
Nitrogen from waste water discharge	tonnes / yr	13,209		14,974		9,396		14,435		52,014	
Phosphorus from waste water discharge	tonnes / yr	3,963		4,492		2,819		4,330		15,604	
BOD from waste water discharge	tonnes / yr	49,534		56,152		35,234		54,130		195,051	
Impact on water quality	Severity	Mildly negative	-1	Mildly negative	-1	Mildly negative	-1	Mildly negative	-1	Mildly negative	-1
Change in sediment supply	Severity	Severely negative	-3	Severely negative	-3	Negative	-2	Negative	-2	Severely negative	-3
Induced geomorphological changes	Severity	Negative	-2	Negative	-2	Mildly negative	-1	Mildly negative	-1	Negative	-2
Production assessment											
Hydropower generated	GWh / yr	84,416		60,694		23,061		35,058		203,229	
Reservoir fisheries	Mtonne / yr	0		0		0		0		0	
Flood damages	US$M / yr	31		30		17		31		109	
Agricultural production: rice	Mtonne / yr	4		13		5		25		48	
Agricultural production: non-rice	Mtonne / yr	0		4		0		3		8	
Capture fisheries production	Mtonne / yr	0		0		0		0		0	
Aquaculture production	Mtonne / yr	0		0		0		3		4	
Environmental assessment											
Total wetland area: flooded forest	'000ha	0		0		456		46		502	
Total wetland area: marshes	'000ha	8		11		540		0		559	
Total wetland area: inundated grassland	'000ha	9		47		331		55		441	
Tonle Sap only: flooded forest	'000ha	0		0		456		0		456	
Tonle Sap only: marshes	'000ha	0		0		313		0		313	
Tonle Sap only: inundated grassland	'000ha	0		0		284		0		284	
Forest area in reservoir areas	'000ha	94		14		43		7		158	
Number of viable deep pools	No.	12		7		3		5		27	
Status of river channel habitats	Severity	Negative	-2	Negative	-2	Mildly negative	-1	Negative	-2	Negative	-2
Flagship species	Survival	Extinct		Extinct		Surviving		Surviving		Extinct	
Environmental hot spots	Severity	Catastrophic	-4	Extremely negative	-3	Extremely negative	-3	Negative	-2	Extremely negative	-3
Biodiversity condition	Severity	Severely negative	-3	Severely negative	-3	Negative	-2	Mildly negative	-1	Severely negative	-2
Economic assessment *(net economic values)*											
Irrigated agricultural production	NPV US$M	322		885		344		108		1,659	
Hydropower generated	NPV US$M	14,585		964		1,315		4,659		21,523	
Hydropower imported/exported	NPV US$M	10,407		3,108		2,031		1,066		16,612	
Navigation	NPV US$M	0		246		0		0		246	
Flood damage mitigation	NPV US$M	130		130		-226		-307		-273	
Capture fisheries reduction	NPV US$M	-174		-162		-1,139		-461		-1,936	
Reservoir fisheries	NPV US$M	135		0		70		11		215	
Aquaculture production	NPV US$M	168		235		174		684		1,261	
Forest area reduction	NPV US$M	-236		0		-122		-14		-372	
Recession rice	NPV US$M	5		-7		256		24		278	
Wetland area reduction	NPV US$M	-3		-13		120		-3		101	
Mitigation of salinity affected areas	NPV US$M	0		0		0		-2		-2	
Reduction in eco-hotspot/biodiversity	NPV US$M	-100		-60		-195		-60		-415	
Total economic impacts	NPV US$M	**25,238**		**5,327**		**2,627**		**5,705**		**38,898**	
Social assessment											
No. of people at risk of loss of livelihood	'000	907		516		1,212		1,725		4,360	
Severity of impact on livelihoods	Severity	Severely negative	-3	Severely negative	-3	Extremely negative	-4	Negative	-2	Severely negative	-3
No. of people employed in:											
Irrigated agriculture	'000	150		346		84		49		629	
Reservoir fisheries (incremental to BS)	'000	40		0		28		4		72	
Hydropower production	'000	382		38		163		29		612	
Aquaculture (incremental to BS)	'000	55		77		57		164		352	
Overall assessment											
Overall environment impact	Severity	Severely negative	-3	Severely negative	-3	Negative	-2	Negative	-2	Severely negative	-3
Livelihoods	Severity	Severely negative	-3	Severely negative	-3	Extremely negative	-4	Negative	-2	Severely negative	-3
Economic production	NPV US$M	25,617		5,439		3,934		6,527		41,517	
Other economic impacts	NPV US$M	-378		-112		-1,307		-822		-2,619	

Summary of scenario assessment

Incremental values relative to Baseline

LMB 20-Year Plan Scenario
Climate change

Scenario run no. 4001

Assessment issue	Unit	Lao PDR		Thailand		Cambodia		Viet Nam		Total	
		Amount	Percent	Amount	Percent	Amount	Percent	Amount	Percent	Amount	Percent
Hydrological assessment											
Key hydrological parameters:	Location	Vientiane		Mudakhan		Kratie		Tan Chau		Average	
Monthly average dry season flow (March)	m3/s	1,165	106%	1,306	90%	1,380	63%	1,006	33%	1,214	62%
Average peak daily flow in wet season	m3/s	-2,230	-14%	418	2%	3,752	8%	219	1%	540	2%
Flow reversal in Tonle Sap:	Location					Prek Kdam				TLS only	
Average flow volume entering Tonle Sap	MCM	n/a		n/a		-1,596	-5%	n/a		-1,596	-5%
Average date of flow reversal (+/-)	Days	n/a		n/a		-17	-12%	n/a		-17	-12%
Land use and condition assessment											
Total irrigated area	'000ha	245	120%	1,370	108%	183	67%	-201	-10%	1,597	43%
Total irrigated cropped area	'000ha	488	147%	2,202	155%	314	56%	93	2%	3,096	47%
Average area flooded: < 0.5m	'000ha	-0	-2%	0	1%	40	22%	-217	-65%	-177	-31%
Average area flooded: 0.5 - 1.0m	'000ha	1	2%	-2	-7%	-39	-17%	39	6%	-2	0%
Average area flooded: 1.0 - 3.0m	'000ha	1	2%	-3	-4%	46	6%	221	28%	265	16%
Average area flooded: > 3.0m	'000ha	-7	-3%	-22	-9%	239	23%	9	189%	220	14%
Area lost to bank erosion	Severity	Negative	-2	Negative	-2	Negative	-2	Mildly negative	-1	Negative	-2
Area affected by salinity of > 1.3gm/l	'000ha	0	0%	0	0%	0	0%	23	1%	23	1%
Water quality and geomorphology											
Herbicide runoff	tonnes / yr	5,258	359%	18,113	154%	2,575	284%	3,524	15%	29,470	80%
Insecticide and fungicide runoff	tonnes / yr	4,783	247%	18,087	132%	1,737	119%	1,378	5%	25,985	61%
Nitrogen runoff from agriculture	tonnes / yr	14,668	435%	40,070	345%	6,922	282%	7,469	12%	69,128	85%
Phosphorus runoff from agriculture	tonnes / yr	1,647	535%	5,248	424%	938	334%	2,354	28%	10,187	100%
Nitrogen from waste water discharge	tonnes / yr	4,580	53%	997	7%	2,763	42%	4,539	46%	12,879	33%
Phosphorus from waste water discharge	tonnes / yr	1,374	53%	299	7%	829	42%	1,362	46%	3,864	33%
BOD from waste water discharge	tonnes / yr	17,175	53%	3,738	7%	10,362	42%	17,020	46%	48,296	33%
Impact on water quality	Severity	Mildly negative	-1	Mildly negative	-1	Mildly negative	-1	Mildly negative	-1	Mildly negative	-1
Change in sediment supply	Severity	Severely negative	-3	Severely negative	-3	Negative	-2	Negative	-2	Severely negative	-3
Induced geomorphological changes	Severity	Negative	-2	Negative	-2	Mildly negative	-1	Mildly negative	-1	Negative	-2
Production assessment											
Hydropower generated	GWh / yr	81,384	2684%	58,291	2426%	23,061	0%	31,399	858%	194,136	2135%
Reservoir fisheries	Mtonne / yr	-0	-100%	-0	-100%	-0	-100%	-0	-100%	-0	-100%
Flood damages	US$M / yr	-39	-56%	-37	-55%	-9	-34%	-25	-44%	-109	-50%
Agricultural production: rice	Mtonne / yr	3	370%	9	220%	3	176%	7	42%	23	92%
Agricultural production: non-rice	Mtonne / yr	0	744%	3	226%	0	140%	1	56%	4	132%
Capture fisheries production	Mtonne / yr	-0	-100%	-1	-100%	-1	-100%	-0	-100%	-2	-100%
Aquaculture production	Mtonne / yr	0	161%	0	158%	0	91%	2	100%	2	105%
Environmental assessment											
Total wetland area: flooded forest	'000ha	0	0%	0	0%	4	1%	0	0%	4	1%
Total wetland area: marshes	'000ha	-1	-7%	-1	-6%	22	4%	0	0%	21	4%
Total wetland area: inundated grassland	'000ha	-0	-1%	-3	-6%	13	4%	-0	0%	10	2%
Tonle Sap only: flooded forest	'000ha	0	0%	0	0%	4	1%	0	0%	4	1%
Tonle Sap only: marshes	'000ha	0	0%	0	0%	4	1%	0	0%	4	1%
Tonle Sap only: inundated grassland	'000ha	0	0%	0	0%	7	3%	0	0%	7	3%
Forest area in reservoir areas	'000ha	81	595%	0	0%	42	3346%	5	236%	127	416%
Number of viable deep pools	No.	-8	-40%	-10	-59%	-2	-40%	0	0%	-20	-43%
Status of river channel habitats	Severity	Negative	-2	Negative	-2	Mildly negative	-1	Negative	-2	Negative	-2
Flagship species	Survival	n/a		n/a		n/a		n/a		n/a	
Environmental hot spots	Severity	Catastrophic	-4	Extremely negative	-3	Extremely negative	-3	Negative	-2	Extremely negative	-3
Biodiversity condition	Severity	Severely negative	-3	Severely negative	-3	Negative	-2	Mildly negative	-1	Severely negative	-2
Economic assessment *(net economic values)*											
Irrigated agricultural production	NPV US$M	322	0%	885	0%	344	0%	108	0%	1,659	0%
Hydropower generated	NPV US$M	12,292	536%	473	96%	1,315	0%	2,948	172%	17,028	379%
Hydropower imported/exported	NPV US$M	10,066	2957%	2,899	1386%	2,031	0%	799	299%	15,796	1934%
Navigation	NPV US$M	0	0%	64	35%	0	0%	0	0%	64	35%
Flood damage mitigation	NPV US$M	130	0%	130	0%	-226	0%	-307	0%	-273	0%
Capture fisheries reduction	NPV US$M	-174	0%	-162	0%	-1,139	0%	-461	0%	-1,936	0%
Reservoir fisheries	NPV US$M	135	0%	0	0%	70	0%	11	0%	215	0%
Aquaculture production	NPV US$M	168	0%	235	0%	174	0%	684	0%	1,261	0%
Forest area reduction	NPV US$M	-236	0%	0	0%	-122	0%	-14	0%	-372	0%
Recession rice	NPV US$M	5	0%	-7	0%	256	0%	24	0%	278	0%
Wetland area reduction	NPV US$M	-3	0%	-13	0%	120	0%	-3	0%	101	0%
Mitigation of salinity affected areas	NPV US$M	0	0%	0	0%	0	0%	-2	0%	-2	0%
Reduction in eco-hotspot/biodiversity	NPV US$M	-100	0%	-60	0%	-195	0%	-60	0%	-415	0%
Total economic impacts	NPV US$M	**22,605**	858%	**4,445**	504%	**2,627**	0%	**3,726**	188%	**33,403**	608%
Social assessment											
No. of people at risk of loss of livelihood	'000	907	0%	516	0%	1,212	0%	1,725	0%	4,360	0%
Severity of impact on livelihoods	Severity	Severely negative	-3	Severely negative	-3	Extremely negative	-4	Negative	-2	Severely negative	-3
No. of people employed in:											
Irrigated agriculture	'000	72	91%	119	53%	6	8%	14	41%	212	51%
Reservoir fisheries (incremental to BS)	'000	40	0%	0	0%	28	0%	4	0%	72	0%
Hydropower production	'000	382	0%	38	0%	163	0%	29	0%	612	0%
Aquaculture (incremental to BS)	'000	55	0%	77	0%	57	0%	164	0%	352	0%
Overall assessment											
Overall environment impact	Severity	Severely negative	-3	Severely negative	-3	Negative	-2	Negative	-2	Severely negative	-3
Livelihoods	Severity	Severely negative	-3	Severely negative	-3	Extremely negative	-4	Negative	-2	Severely negative	-3
Economic production	NPV US$M	22,983	873%	4,557	517%	3,934	0%	4,549	230%	36,023	656%
Other economic impacts	NPV US$M	-378	0%	-112	0%	-1,307	0%	-822	0%	-2,619	0%

Summary of scenario assessment

Incremental values relative to Definite Future Scenario

LMB 20-Year Plan Scenario
Climate change

Scenario run no. 4001

Assessment issue	Unit	Lao PDR Amount	Lao PDR Percent	Thailand Amount	Thailand Percent	Cambodia Amount	Cambodia Percent	Viet Nam Amount	Viet Nam Percent	Total Amount	Total Percent
Hydrological assessment											
Key hydrological parameters:	Location	Vientiane		Mudakhan		Kratie		Tan Chau		Average	
Monthly average dry season flow (March)	m3/s	405	22%	387	16%	508	17%	179	5%	370	13%
Average peak daily flow in wet season	m3/s	-122	-1%	1,887	8%	5,393	12%	699	3%	1,964	8%
Flow reversal in Tonle Sap:	Location					Prek Kdam				TLS only	
Average flow volume entering Tonle Sap	MCM	n/a		n/a		922	3%	n/a		922	
Average date of flow reversal (+/-)	Days	n/a		n/a		-14	-10%	n/a		-14	
Land use and condition assessment											
Total irrigated area	'000ha	283	170%	1,281	95%	183	67%	125	7%	1,872	54%
Total irrigated cropped area	'000ha	549	203%	1,868	106%	314	56%	186	4%	2,918	43%
Average area flooded: < 0.5m	'000ha	1	5%	0	2%	9	4%	-291	-71%	-281	-42%
Average area flooded: 0.5 - 1.0m	'000ha	5	27%	0	2%	-16	-8%	-6	-1%	-16	-2%
Average area flooded: 1.0 - 3.0m	'000ha	13	18%	7	8%	83	12%	348	52%	451	30%
Average area flooded: > 3.0m	'000ha	39	17%	34	19%	317	32%	11	367%	401	29%
Area lost to bank erosion	Severity	Severely negative	-3	Severely negative	-3	Negative	-2	Mildly negative	-1	Severely negative	-2
Area affected by salinity of > 1.3gm/l	'000ha	0	0%	0	0%	0	0%	295	19%	295	19%
Water quality and geomorphology											
Herbicide runoff	tonnes / yr	5,258	359%	18,113	154%	2,575	284%	3,524	15%	29,470	80%
Insecticide and fungicide runoff	tonnes / yr	4,783	247%	18,087	132%	1,737	119%	1,378	5%	25,985	61%
Nitrogen runoff from agriculture	tonnes / yr	14,668	435%	40,070	345%	6,922	282%	7,469	12%	69,128	85%
Phosphorus runoff from agriculture	tonnes / yr	1,647	535%	5,248	424%	938	334%	2,354	28%	10,187	100%
Nitrogen from waste water discharge	tonnes / yr	4,580	53%	997	7%	2,763	42%	4,539	46%	12,879	33%
Phosphorus from waste water discharge	tonnes / yr	1,374	53%	299	7%	829	42%	1,362	46%	3,864	33%
BOD from waste water discharge	tonnes / yr	17,175	53%	3,738	7%	10,362	42%	17,020	46%	48,296	33%
Impact on water quality	Severity	Negative	-2	Negative	-2	Negative	-2	Negative	-2	Negative	-2
Change in sediment supply	Severity	Mildly negative	-1	Mildly negative	-1	Mildly negative	-1	Negative	-2	Negative	-1
Induced geomorphological changes	Severity	Mildly negative	-1	Mildly negative	-1	Mildly negative	-1	Mildly negative	-1	Mildly negative	-1
Production assessment											
Hydropower generated	GWh / yr	68,013	415%	48,515	398%	20,726	888%	21,465	158%	158,719	357%
Reservoir fisheries	Mtonne / yr	-0	-100%	-0	-100%	-0	-100%	-0	-100%	-0	-100%
Flood damages	US$M / yr	3	10%	3	13%	9	119%	22	239%	38	53%
Agricultural production: rice	Mtonne / yr	3	370%	9	220%	3	176%	7	42%	23	92%
Agricultural production: non-rice	Mtonne / yr	0	744%	3	226%	0	140%	1	56%	4	132%
Capture fisheries production	Mtonne / yr	-0	-100%	-1	-100%	-1	-100%	-0	-100%	-2	-100%
Aquaculture production	Mtonne / yr	0	36%	0	42%	0	45%	1	33%	1	35%
Environmental assessment											
Total wetland area: flooded forest	'000ha	0	0%	0	0%	6	1%	0	0%	6	1%
Total wetland area: marshes	'000ha	1	17%	1	11%	34	7%	0	0%	36	7%
Total wetland area: inundated grassland	'000ha	3	54%	4	10%	20	7%	-0	0%	28	7%
Tonle Sap only: flooded forest	'000ha	0	0%	0	0%	6	1%	0	0%	6	1%
Tonle Sap only: marshes	'000ha	0	0%	0	0%	6	2%	0	0%	6	2%
Tonle Sap only: inundated grassland	'000ha	0	0%	0	0%	13	5%	0	0%	13	5%
Forest area in reservoir areas	'000ha	56	146%	0	0%	41	1693%	2	29%	98	164%
Number of viable deep pools	No.	-8	-40%	-10	-59%	-2	-40%	0	0%	-20	-43%
Status of river channel habitats	Severity	Mildly negative	-1	Mildly negative	-1	Mildly negative	-1	Negative	-2	Negative	-1
Flagship species	Survival	n/a		n/a		n/a		n/a		n/a	
Environmental hot spots	Severity	Catastrophic	-4	Negative	-2	Severely negative	-3	Negative	-2	Severely negative	-3
Biodiversity condition	Severity	Negative	-2	Negative	-2	Mildly negative	-1	Neutral	0	Negative	-1
Economic assessment *(net economic values)*											
Irrigated agricultural production	NPV US$M	322	0%	885	0%	344	0%	108	0%	1,659	0%
Hydropower generated	NPV US$M	6,899	90%	373	63%	567	76%	839	22%	8,678	68%
Hydropower imported/exported	NPV US$M	8,840	564%	2,048	193%	1,574	345%	192	22%	12,654	320%
Navigation	NPV US$M	0	0%	0	0%	0	0%	0	0%	0	0%
Flood damage mitigation	NPV US$M	-49	-27%	-42	-24%	-277	-543%	-367	-612%	-735	-159%
Capture fisheries reduction	NPV US$M	54	-24%	26	-14%	-816	252%	-254	123%	-990	105%
Reservoir fisheries	NPV US$M	61	82%	0	0%	66	1920%	-2	-19%	125	137%
Aquaculture production	NPV US$M	42	33%	61	35%	86	98%	-58	-8%	132	12%
Forest area reduction	NPV US$M	-106	82%	0	0%	-116	1840%	3	-19%	-219	143%
Recession rice	NPV US$M	24	-127%	3	-32%	362	-341%	33	-378%	422	-293%
Wetland area reduction	NPV US$M	24	-88%	35	-73%	273	-178%	-3	416%	329	-144%
Mitigation of salinity affected areas	NPV US$M	0	0%	0	0%	0	0%	-22	-110%	-22	-110%
Reduction in eco-hotspot/biodiversity	NPV US$M	-100	0%	-40	200%	-130	200%	-60	0%	-330	388%
Total economic impacts	NPV US$M	**16,010**	173%	**3,350**	169%	**1,934**	279%	**409**	8%	**21,703**	126%
Social assessment											
No. of people at risk of loss of livelihood	'000	610	205%	470	1022%	1,110	1088%	1,283	290%	3,473	392%
Severity of impact on livelihoods	Severity	Mildly negative	-1	Negative	-2	Severely negative	-3	Mildly negative	-1	Negative	-2
No. of people employed in:											
Irrigated agriculture	'000	72	91%	119	53%	6	8%	14	41%	212	51%
Reservoir fisheries (incremental to BS)	'000	28	226%	0	0%	27	4703%	2	74%	57	375%
Hydropower production	'000	330	635%	33	636%	148	963%	-3	-8%	508	490%
Aquaculture (incremental to BS)	'000	26	94%	38	96%	37	188%	0	0%	101	40%
Overall assessment											
Overall environment impact	Severity	Negative	-2	Negative	-2	Mildly negative	-1	Mildly negative	-1	Negative	-2
Livelihoods	Severity	Mildly negative	-1	Negative	-2	Severely negative	-3	Mildly negative	-1	Negative	-2
Economic production	NPV US$M	16,163	171%	3,368	163%	2,638	203%	1,078	20%	23,248	127%
Other economic impacts	NPV US$M	-154	69%	-18	20%	-704	117%	-669	435%	-1,545	144%

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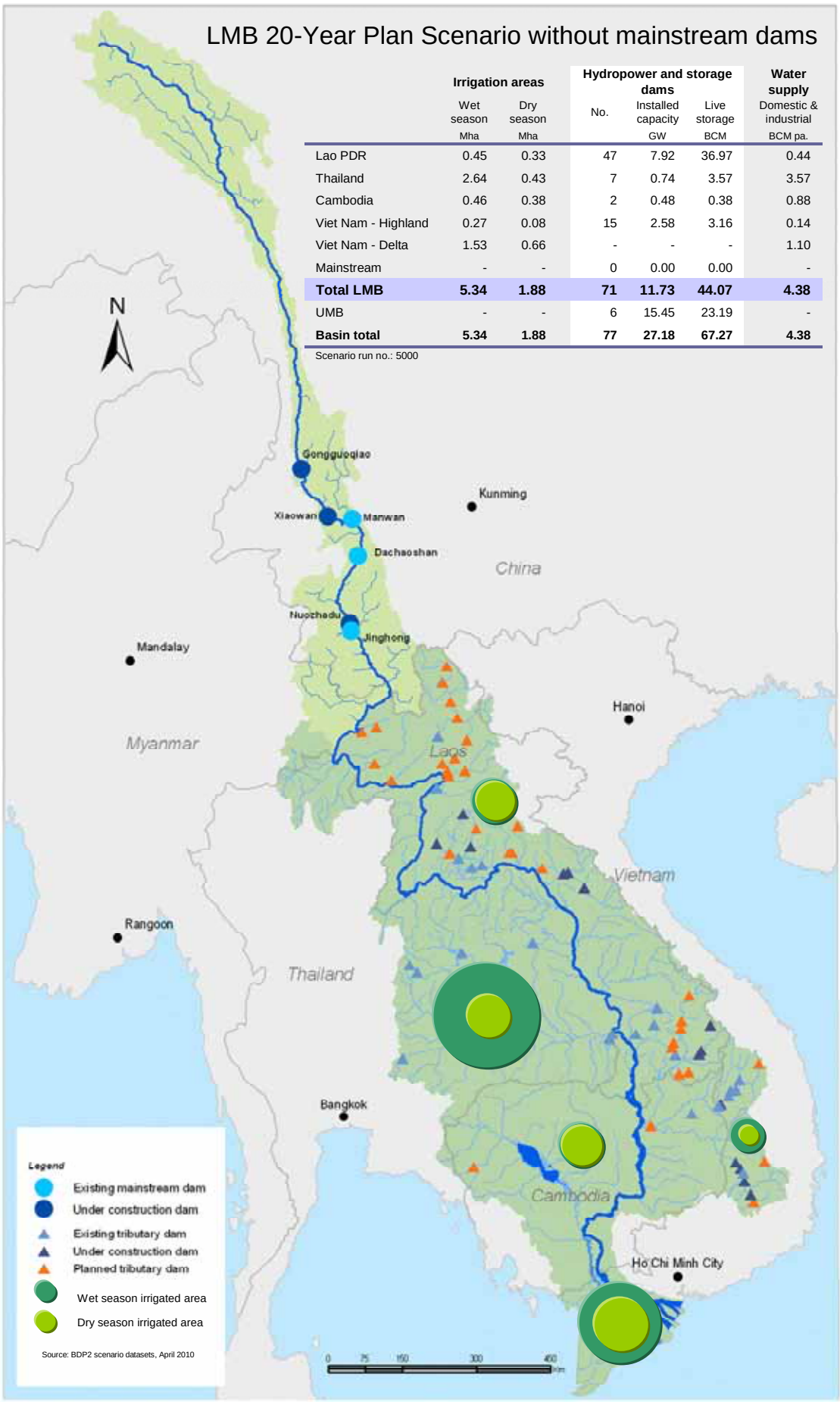
LMB 20-Year Plan Scenario without mainstream dams

	Irrigation areas		Hydropower and storage dams			Water supply
	Wet season	Dry season	No.	Installed capacity	Live storage	Domestic & industrial
	Mha	Mha		GW	BCM	BCM pa.
Lao PDR	0.45	0.33	47	7.92	36.97	0.44
Thailand	2.64	0.43	7	0.74	3.57	3.57
Cambodia	0.46	0.38	2	0.48	0.38	0.88
Viet Nam - Highland	0.27	0.08	15	2.58	3.16	0.14
Viet Nam - Delta	1.53	0.66	-	-	-	1.10
Mainstream	-	-	0	0.00	0.00	-
Total LMB	**5.34**	**1.88**	**71**	**11.73**	**44.07**	**4.38**
UMB	-	-	6	15.45	23.19	-
Basin total	**5.34**	**1.88**	**77**	**27.18**	**67.27**	**4.38**

Scenario run no.: 5000



Scenario assessment results

Estimated total values

LMB 20-Year Plan Scenario without mainstream dams

Scenario run no. 5000

Assessment issue	Unit	3 Lao PDR Amount		4 Thailand Amount		5 Cambodia Amount		6 Viet Nam Amount		Total Amount	
Hydrological assessment											
Key hydrological parameters:	Location	Vientiane		Mudakhan		Kratie		Tan Chau		Average	
Monthly average dry season flow (March)	m3/s	2,106		2,586		3,451		4,097		3,060	
Average peak daily flow in wet season	m3/s	13,564		23,421		43,347		20,464		25,199	
Flow reversal in Tonle Sap:	Location					Prek Kdam				TLS only	
Average flow volume entering Tonle Sap	MCM	n/a		n/a		28,358		n/a		28,358	
Average date of flow reversal (+/-)	Days	n/a		n/a		139		n/a		18-May	
Land use and condition assessment											
Total irrigated area	'000ha	450		2,635		457		1,795		5,337	
Total irrigated cropped area	'000ha	820		3,624		877		4,404		9,725	
Average area flooded: < 0.5m	'000ha	22		23		222		431		697	
Average area flooded: 0.5 - 1.0m	'000ha	19		22		212		717		970	
Average area flooded: 1.0 - 3.0m	'000ha	71		77		669		635		1,451	
Average area flooded: > 3.0m	'000ha	219		167		951		3		1,340	
Area lost to bank erosion	Severity	Positive	2	Positive	2	Mildly positive	1	Neutral	0	Neutral	
Area affected by salinity of > 1.3gm/l	'000ha	0		0		0		1,547		1,547	
Water quality and geomorphology											
Herbicide runoff	tonnes / yr	6,721		29,874		3,483		26,352		66,430	
Insecticide and fungicide runoff	tonnes / yr	6,723		31,752		3,192		27,098		68,765	
Nitrogen runoff from agriculture	tonnes / yr	18,039		51,700		9,377		71,019		150,135	
Phosphorus runoff from agriculture	tonnes / yr	1,954		6,487		1,219		10,683		20,344	
Nitrogen from waste water discharge	tonnes / yr	13,209		14,974		9,396		14,435		52,014	
Phosphorus from waste water discharge	tonnes / yr	3,963		4,492		2,819		4,330		15,604	
BOD from waste water discharge	tonnes / yr	49,534		56,152		35,234		54,130		195,051	
Impact on water quality	Severity	Negative	-2	Mildly negative	-1	Negative	-2	Mildly negative	-1	Negative	-2
Change in sediment supply	Severity	Negative	-2	Negative	-2	Negative	-2	Mildly negative	-1	Negative	-2
Induced geomorphological changes	Severity	Negative	-2	Mildly negative	-1	Neutral	0	Neutral	0	Mildly negative	-1
Production assessment											
Hydropower generated	GWh / yr	37,609		26,206		3,321		16,346		83,483	
Reservoir fisheries	Mtonne / yr	0.093		0.106		0.026		0.033		0.258	
Flood damages	US$M / yr	31		30		12		16		88	
Agricultural production: rice	Mtonne / yr	3.925		13.165		5.079		25.411		47.580	
Agricultural production: non-rice	Mtonne / yr	0.300		4.206		0.149		2.935		7.590	
Capture fisheries production	Mtonne / yr	0.209		0.887		0.654		0.335		2.085	
Aquaculture production	Mtonne / yr	0.204		0.259		0.243		3.326		4.031	
Environmental assessment											
Total wetland area: flooded forest	'000ha	0		0		449		46		494	
Total wetland area: marshes	'000ha	6		10		502		0		518	
Total wetland area: inundated grassland	'000ha	5		41		307		55		408	
Tonle Sap only: flooded forest	'000ha	0		0		448		0		448	
Tonle Sap only: marshes	'000ha	0		0		307		0		307	
Tonle Sap only: inundated grassland	'000ha	0		0		269		0		269	
Forest area in reservoir areas	'000ha	70		14		2		7		93	
Number of viable deep pools	No.	20		17		5		5		47	
Status of river channel habitats	Severity	Negative	-2	Mildly negative	-1	Neutral	0	Neutral	0	Mildly negative	-1
Flagship species	Survival	Surviving		Surviving		Surviving		Surviving		Surviving	
Environmental hot spots	Severity	Severely negative	-2	Negative	-2	Negative	-2	Neutral	0	Negative	-1
Biodiversity condition	Severity	Negative	-2	Negative	-2	Mildly negative	-1	Mildly negative	-1	Negative	-2
Economic assessment *(net economic values)*											
Irrigated agricultural production	NPV US$M	322		885		344		108		1,659	
Hydropower generated	NPV US$M	9,783		591		1,168		4,022		15,564	
Hydropower imported/exported	NPV US$M	4,208		1,760		462		920		7,351	
Navigation	NPV US$M	0		246		0		0		246	
Flood damage mitigation	NPV US$M	124		124		47		65		360	
Capture fisheries reduction	NPV US$M	-124		-116		-377		-116		-732	
Reservoir fisheries	NPV US$M	94		0		2		11		107	
Aquaculture production	NPV US$M	168		235		174		684		1,261	
Forest area reduction	NPV US$M	-165		0		-4		-14		-183	
Recession rice	NPV US$M	-21		-22		-117		-13		-173	
Wetland area reduction	NPV US$M	-18		-32		-125		-1		-176	
Mitigation of salinity affected areas	NPV US$M	0		0		0		25		25	
Reduction in eco-hotspot/biodiversity	NPV US$M	-50		-40		-130		0		-220	
Total economic impacts	NPV US$M	**14,322**		**3,632**		**1,446**		**5,690**		**25,090**	
Social assessment											
No. of people at risk of loss of livelihood	'000	699		201		212		452		1,564	
Severity of impact on livelihoods	Severity	Severely negative	-3	Mildly negative	-1	Negative	-2	Mildly negative	-1	Negative	-2
No. of people employed in:											
Irrigated agriculture	'000	150		346		84		49		629	
Reservoir fisheries (incremental to BS)	'000	28		0		1		3		32	
Hydropower production	'000	168		7		20		29		224	
Aquaculture (incremental to BS)	'000	55		77		57		164		352	
Overall assessment											
Overall environment impact	Severity	Negative	-2	Negative	-2	Mildly negative	-1	Mildly negative	-1	Negative	-2
Livelihoods	Severity	Severely negative	-3	Mildly negative	-1	Negative	-2	Mildly negative	-1	Negative	-2
Economic production	NPV US$M	14,576		3,718		2,151		5,744		26,189	
Other economic impacts	NPV US$M	-254		-85		-705		-54		-1,098	

Summary of scenario assessment

Incremental values relative to Baseline

LMB 20-Year Plan Scenario without mainstream dams

Scenario run no. 5000

Assessment issue	Unit	Lao PDR Amount	Lao PDR Percent	Thailand Amount	Thailand Percent	Cambodia Amount	Cambodia Percent	Viet Nam Amount	Viet Nam Percent	Total Amount	Total Percent
Hydrological assessment											
Key hydrological parameters:	Location	Vientiane		Mudakhan		Kratie		Tan Chau		Average	
Monthly average dry season flow (March)	m3/s	1,006	91%	1,133	78%	1,253	57%	1,026	33%	1,105	56%
Average peak daily flow in wet season	m3/s	-2,357	-15%	-2,080	-8%	-3,415	-7%	-846	-4%	-2,175	-8%
Flow reversal in Tonle Sap:	Location					Prek Kdam				TLS only	
Average flow volume entering Tonle Sap	MCM	n/a		n/a		-3,900	-12%	n/a		-3,900	-12%
Average date of flow reversal (+/-)	Days	n/a		n/a		-6	-4%	n/a		-6	-4%
Land use and condition assessment											
Total irrigated area	'000ha	245	120%	1,370	108%	183	67%	-201	-10%	1,597	43%
Total irrigated cropped area	'000ha	488	147%	2,202	155%	314	56%	93	2%	3,096	47%
Average area flooded: < 0.5m	'000ha	-3	-11%	-1	-2%	37	20%	97	29%	131	23%
Average area flooded: 0.5 - 1.0m	'000ha	-5	-21%	-2	-9%	-19	-8%	48	7%	22	2%
Average area flooded: 1.0 - 3.0m	'000ha	-14	-16%	-13	-14%	-43	-6%	-159	-20%	-229	-14%
Average area flooded: > 3.0m	'000ha	-53	-19%	-65	-28%	-104	-10%	-2	-45%	-223	-14%
Area lost to bank erosion	Severity	Positive	2	Positive	2	Mildly positive	1	Neutral	0	Mildly positive	1
Area affected by salinity of > 1.3gm/l	'000ha	0	0%	0	0%	0	0%	-305	-16%	-305	-16%
Water quality and geomorphology											
Herbicide runoff	tonnes / yr	5,258	359%	18,113	154%	2,575	284%	3,524	15%	29,470	80%
Insecticide and fungicide runoff	tonnes / yr	4,783	247%	18,087	132%	1,737	119%	1,378	5%	25,985	61%
Nitrogen runoff from agriculture	tonnes / yr	14,668	435%	40,070	345%	6,922	282%	7,469	12%	69,128	85%
Phosphorus runoff from agriculture	tonnes / yr	1,647	535%	5,248	424%	938	334%	2,354	28%	10,187	100%
Nitrogen from waste water discharge	tonnes / yr	4,580	53%	997	7%	2,763	42%	4,539	46%	12,879	33%
Phosphorus from waste water discharge	tonnes / yr	1,374	53%	299	7%	829	42%	1,362	46%	3,864	33%
BOD from waste water discharge	tonnes / yr	17,175	53%	3,738	7%	10,362	42%	17,020	46%	48,296	33%
Impact on water quality	Severity	Negative	-2	Mildly negative	-1	Negative	-2	Mildly negative	-1	Negative	-2
Change in sediment supply	Severity	Negative	-2	Negative	-2	Negative	-2	Mildly negative	-1	Negative	-2
Induced geomorphological changes	Severity	Negative	-2	Mildly negative	-1	Neutral	0	Neutral	0	Mildly negative	-1
Production assessment											
Hydropower generated	GWh / yr	34,577	1140%	23,804	991%	3,321	0%	12,688	347%	74,389	818%
Reservoir fisheries	Mtonne / yr	0.028	44%	0.000	0%	0.001	2%	0.003	11%	0.032	14%
Flood damages	US$M / yr	-39	-56%	-37	-55%	-15	-56%	-40	-72%	-131	-60%
Agricultural production: rice	Mtonne / yr	3.089	370%	9.047	220%	3.237	176%	7.456	42%	22.829	92%
Agricultural production: non-rice	Mtonne / yr	0.265	744%	2.917	226%	0.087	140%	1.055	56%	4.324	132%
Capture fisheries production	Mtonne / yr	-0.037	-15%	-0.035	-4%	-0.113	-15%	-0.035	-9%	-0.219	-10%
Aquaculture production	Mtonne / yr	0.126	161%	0.158	158%	0.116	91%	1.662	100%	2.063	105%
Environmental assessment											
Total wetland area: flooded forest	'000ha	0	0%	0	0%	-4	-1%	-0	0%	-4	-1%
Total wetland area: marshes	'000ha	-2	-24%	-2	-19%	-16	-3%	-0	0%	-20	-4%
Total wetland area: inundated grassland	'000ha	-4	-43%	-9	-18%	-10	-3%	-0	0%	-23	-5%
Tonle Sap only: flooded forest	'000ha	0	0%	0	0%	-4	-1%	0	0%	-4	-1%
Tonle Sap only: marshes	'000ha	0	0%	0	0%	-3	-1%	0	0%	-3	-1%
Tonle Sap only: inundated grassland	'000ha	0	0%	0	0%	-8	-3%	0	0%	-8	-3%
Forest area in reservoir areas	'000ha	57	417%	0	0%	1	92%	5	236%	63	204%
Number of viable deep pools	No.	0	0%	0	0%	0	0%	0	0%	0	0%
Status of river channel habitats	Severity	Negative	-2	Mildly negative	-1	Neutral	0	Neutral	0	Mildly negative	-1
Flagship species	Survival	n/a		n/a		n/a		n/a		n/a	
Environmental hot spots	Severity	Severely negative	-2	Negative	-2	Negative	-2	Neutral	0	Negative	-1
Biodiversity condition	Severity	Negative	-2	Negative	-2	Mildly negative	-1	Mildly negative	-1	Negative	-2
Economic assessment *(net economic values)*											
Irrigated agricultural production	NPV US$M	322	0%	885	0%	344	0%	108	0%	1,659	0%
Hydropower generated	NPV US$M	7,490	327%	100	20%	1,168	0%	2,310	135%	11,069	246%
Hydropower imported/exported	NPV US$M	3,868	1136%	1,551	742%	462	0%	653	245%	6,534	800%
Navigation	NPV US$M	0	0%	64	35%	0	0%	0	0%	64	35%
Flood damage mitigation	NPV US$M	124	0%	124	0%	47	0%	65	0%	360	0%
Capture fisheries reduction	NPV US$M	-124	0%	-116	0%	-377	0%	-116	0%	-732	0%
Reservoir fisheries	NPV US$M	94	0%	0	0%	2	0%	11	0%	107	0%
Aquaculture production	NPV US$M	168	0%	235	0%	174	0%	684	0%	1,261	0%
Forest area reduction	NPV US$M	-165	0%	0	0%	-4	0%	-14	0%	-183	0%
Recession rice	NPV US$M	-21	0%	-22	0%	-117	0%	-13	0%	-173	0%
Wetland area reduction	NPV US$M	-18	0%	-32	0%	-125	0%	-1	0%	-176	0%
Mitigation of salinity affected areas	NPV US$M	0	0%	0	0%	0	0%	25	0%	25	0%
Reduction in eco-hotspot/biodiversity	NPV US$M	-50	0%	-40	0%	-130	0%	0	0%	-220	0%
Total economic impacts	NPV US$M	**11,688**	444%	**2,750**	312%	**1,446**	0%	**3,712**	188%	**19,596**	357%
Social assessment											
No. of people at risk of loss of livelihood	'000	699	0%	201	0%	212	0%	452	0%	1,564	0%
Severity of impact on livelihoods	Severity	Severely negative	-3	Mildly negative	-1	Negative	-2	Mildly negative	-1	Negative	-2
No. of people employed in:											
Irrigated agriculture	'000	72	91%	119	53%	6	8%	14	41%	212	51%
Reservoir fisheries (incremental to BS)	'000	28	0%	0	0%	1	0%	3	0%	32	0%
Hydropower production	'000	168	0%	7	0%	20	0%	29	0%	224	0%
Aquaculture (incremental to BS)	'000	55	0%	77	0%	57	0%	164	0%	352	0%
Overall assessment											
Overall environment impact	Severity	Negative	-2	Negative	-2	Mildly negative	-1	Mildly negative	-1	Negative	-2
Livelihoods	Severity	Severely negative	-3	Mildly negative	-1	Negative	-2	Mildly negative	-1	Negative	-2
Economic production	NPV US$M	11,942	453%	2,835	321%	2,151	0%	3,766	190%	20,694	377%
Other economic impacts	NPV US$M	-254	0%	-85	0%	-705	0%	-54	0%	-1,098	0%

Summary of scenario assessment

Incremental values relative to Definite Future Scenario

LMB 20-Year Plan Scenario without mainstream dams

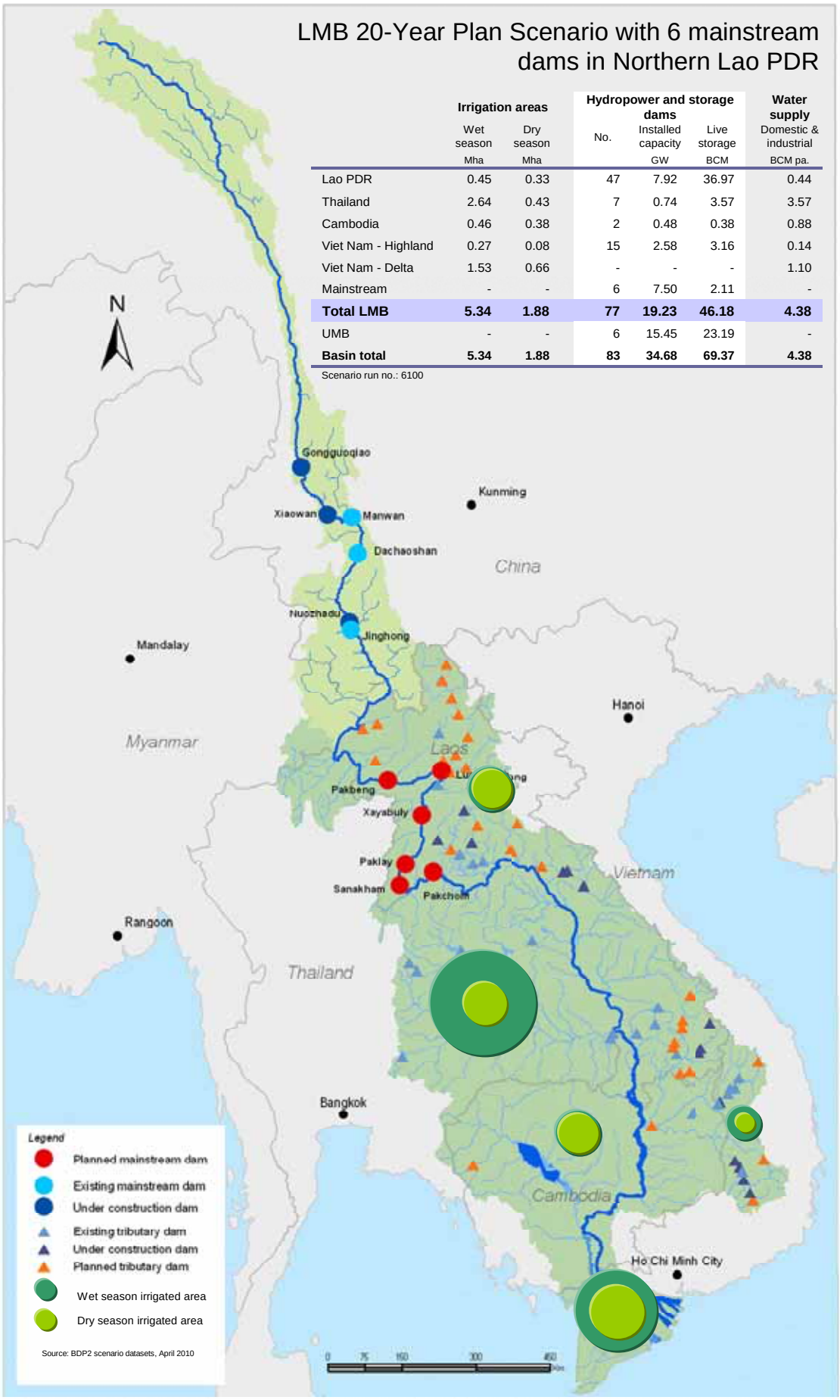
Scenario run no. 5000

Assessment issue	Unit	Lao PDR		Thailand		Cambodia		Viet Nam		Total	
		Amount	Percent	Amount	Percent	Amount	Percent	Amount	Percent	Amount	Percent
Hydrological assessment											
Key hydrological parameters:	Location	Vientiane		Mudakhan		Kratie		Tan Chau		Average	
Monthly average dry season flow (March)	m3/s	246	13%	214	9%	382	12%	200	5%	260	9%
Average peak daily flow in wet season	m3/s	-249	-2%	-611	-3%	-1,775	-4%	-366	-2%	-750	-3%
Flow reversal in Tonle Sap:	Location					Prek Kdam				TLS only	
Average flow volume entering Tonle Sap	MCM	n/a		n/a		-1,382	-5%	n/a		-1,382	-5%
Average date of flow reversal (+/-)	Days	n/a		n/a		-3	-2%	n/a		-3	-2%
Land use and condition assessment											
Total irrigated area	'000ha	283	170%	1,281	95%	183	67%	125	7%	1,872	54%
Total irrigated cropped area	'000ha	549	203%	1,868	106%	314	56%	186	4%	2,918	43%
Average area flooded: < 0.5m	'000ha	-1	-5%	-0	-1%	5	2%	23	6%	27	4%
Average area flooded: 0.5 - 1.0m	'000ha	-0	-2%	-0	0%	5	2%	4	1%	8	1%
Average area flooded: 1.0 - 3.0m	'000ha	-2	-2%	-3	-3%	-7	-1%	-32	-5%	-43	-3%
Average area flooded: > 3.0m	'000ha	-7	-3%	-9	-5%	-26	-3%	-0	-11%	-43	-3%
Area lost to bank erosion	Severity	Mildly positive	1	Mildly positive	1	Mildly positive	1	Neutral	0	Neutral	1
Area affected by salinity of > 1.3gm/l	'000ha	0	0%	0	0%	0	0%	-33	-2%	-33	-2%
Water quality and geomorphology											
Herbicide runoff	tonnes / yr	5,258	359%	18,113	154%	2,575	284%	3,524	15%	29,470	80%
Insecticide and fungicide runoff	tonnes / yr	4,783	247%	18,087	132%	1,737	119%	1,378	5%	25,985	61%
Nitrogen runoff from agriculture	tonnes / yr	14,668	435%	40,070	345%	6,922	282%	7,469	12%	69,128	85%
Phosphorus runoff from agriculture	tonnes / yr	1,647	535%	5,248	424%	938	334%	2,354	28%	10,187	100%
Nitrogen from waste water discharge	tonnes / yr	4,580	53%	997	7%	2,763	42%	4,539	46%	12,879	33%
Phosphorus from waste water discharge	tonnes / yr	1,374	53%	299	7%	829	42%	1,362	46%	3,864	33%
BOD from waste water discharge	tonnes / yr	17,175	53%	3,738	7%	10,362	42%	17,020	46%	48,296	33%
Impact on water quality	Severity	Severely negative	-3	Negative	-2	Severely negative	-3	Negative	-2	Severely negative	-3
Change in sediment supply	Severity	Neutral	0	Neutral	0	Mildly negative	-1	Mildly negative	-1	Mildly negative	-1
Induced geomorphological changes	Severity	Mildly negative	-1	Neutral	0	Neutral	0	Neutral	0	Mildly negative	-0
Production assessment											
Hydropower generated	GWh / yr	21,206	129%	14,028	115%	986	42%	2,753	20%	38,973	88%
Reservoir fisheries	Mtonne / yr	0.016	21%	0.000	0%	0.000	0%	0.001	3%	0.017	7%
Flood damages	US$M / yr	3	10%	3	13%	4	46%	6	70%	16	23%
Agricultural production: rice	Mtonne / yr	3.089	370%	9.047	220%	3.237	176%	7.456	42%	22.829	92%
Agricultural production: non-rice	Mtonne / yr	0.265	744%	2.917	226%	0.087	140%	1.055	56%	4.324	132%
Capture fisheries production	Mtonne / yr	0.001	0%	-0.003	0%	-0.059	-8%	-0.000	0%	-0.061	-3%
Aquaculture production	Mtonne / yr	0.054	36%	0.077	42%	0.076	45%	0.831	33%	1.037	35%
Environmental assessment											
Total wetland area: flooded forest	'000ha	0	0%	0	0%	-2	0%	-0	0%	-2	0%
Total wetland area: marshes	'000ha	-0	-4%	-0	-4%	-4	-1%	-0	0%	-5	-1%
Total wetland area: inundated grassland	'000ha	-1	-12%	-1	-3%	-3	-1%	-0	0%	-5	-1%
Tonle Sap only: flooded forest	'000ha	0	0%	0	0%	-2	0%	0	0%	-2	0%
Tonle Sap only: marshes	'000ha	0	0%	0	0%	-1	0%	0	0%	-1	0%
Tonle Sap only: inundated grassland	'000ha	0	0%	0	0%	-2	-1%	0	0%	-2	-1%
Forest area in reservoir areas	'000ha	32	83%	0	0%	0	0%	2	29%	33	56%
Number of viable deep pools	No.	0	0%	0	0%	0	0%	0	0%	0	0%
Status of river channel habitats	Severity	Mildly negative	-1	Neutral	0	Neutral	0	Neutral	0	Mildly negative	-0
Flagship species	Survival	n/a		n/a		n/a		n/a		n/a	
Environmental hot spots	Severity	Severely negative	-2	Mildly negative	-1	Negative	-1	Neutral	0	Mildly negative	-1
Biodiversity condition	Severity	Mildly negative	-1	Mildly negative	-1	Neutral	0	Neutral	0	Mildly negative	-1
Economic assessment *(net economic values)*											
Irrigated agricultural production	NPV US$M	322	0%	885	0%	344	0%	108	0%	1,659	0%
Hydropower generated	NPV US$M	2,097	27%	0	0%	420	56%	201	5%	2,719	21%
Hydropower imported/exported	NPV US$M	2,641	169%	700	66%	5	1%	46	5%	3,393	86%
Navigation	NPV US$M	0	0%	0	0%	0	0%	0	0%	0	0%
Flood damage mitigation	NPV US$M	-55	-31%	-48	-28%	-4	-8%	5	8%	-102	-22%
Capture fisheries reduction	NPV US$M	104	-46%	72	-38%	-54	17%	91	-44%	214	-23%
Reservoir fisheries	NPV US$M	20	27%	0	0%	-2	-44%	-2	-19%	16	18%
Aquaculture production	NPV US$M	42	33%	61	35%	86	98%	-58	-8%	132	12%
Forest area reduction	NPV US$M	-36	27%	0	0%	3	-44%	3	-19%	-29	19%
Recession rice	NPV US$M	-2	10%	-11	112%	-11	10%	-4	50%	-29	20%
Wetland area reduction	NPV US$M	9	-34%	16	-33%	28	-19%	-1	82%	53	-23%
Mitigation of salinity affected areas	NPV US$M	0	0%	0	0%	0	0%	5	25%	5	25%
Reduction in eco-hotspot/biodiversity	NPV US$M	-50	0%	-20	100%	-65	100%	0	0%	-135	159%
Total economic impacts	NPV US$M	**5,093**	55%	**1,655**	84%	**753**	109%	**395**	7%	**7,896**	46%
Social assessment											
No. of people at risk of loss of livelihood	'000	402	135%	155	337%	110	108%	10	2%	677	76%
Severity of impact on livelihoods	Severity	Mildly negative	-1	Neutral	0	Mildly negative	-1	Neutral	0	Mildly negative	-1
No. of people employed in:											
Irrigated agriculture	'000	72	91%	119	53%	6	8%	14	41%	212	51%
Reservoir fisheries (incremental to BS)	'000	16	129%	0	0%	0	0%	1	46%	17	112%
Hydropower production	'000	116	223%	2	33%	5	32%	-3	-8%	120	116%
Aquaculture (incremental to BS)	'000	26	94%	38	96%	37	188%	0	0%	101	40%
Overall assessment											
Overall environment impact	Severity	Mildly negative	-1	Mildly negative	-1	Neutral	0	Neutral	0	Mildly negative	-1
Livelihoods	Severity	Mildly negative	-1	Neutral	0	Mildly negative	-1	Neutral	0	Mildly negative	-1
Economic production	NPV US$M	5,122	54%	1,647	80%	855	66%	295	5%	7,919	43%
Other economic impacts	NPV US$M	-29	13%	8	-9%	-102	17%	100	-65%	-24	2%

LMB 20-Year Plan Scenario with 6 mainstream dams in Northern Lao PDR

	Irrigation areas		Hydropower and storage dams			Water supply
	Wet season	Dry season	No.	Installed capacity	Live storage	Domestic & industrial
	Mha	Mha		GW	BCM	BCM pa.
Lao PDR	0.45	0.33	47	7.92	36.97	0.44
Thailand	2.64	0.43	7	0.74	3.57	3.57
Cambodia	0.46	0.38	2	0.48	0.38	0.88
Viet Nam - Highland	0.27	0.08	15	2.58	3.16	0.14
Viet Nam - Delta	1.53	0.66	-	-	-	1.10
Mainstream	-	-	6	7.50	2.11	-
Total LMB	**5.34**	**1.88**	**77**	**19.23**	**46.18**	**4.38**
UMB	-	-	6	15.45	23.19	-
Basin total	**5.34**	**1.88**	**83**	**34.68**	**69.37**	**4.38**

Scenario run no.: 6100



Scenario assessment results

Estimated total values

LMB 20-Year Plan Scenario with 6 mainstream dams in Northern Lao PDR

Scenario run no. 6100

Assessment issue	Unit	3 Lao PDR Amount		4 Thailand Amount		5 Cambodia Amount		6 Viet Nam Amount		Total Amount	
Hydrological assessment											
Key hydrological parameters:	Location	Vientiane		Mudakhan		Kratie		Tan Chau		Average	
Monthly average dry season flow (March)	m3/s	2,193		2,674		3,540		4,175		3,146	
Average peak daily flow in wet season	m3/s	13,713		23,590		43,405		20,466		25,293	
Flow reversal in Tonle Sap:	Location					Prek Kdam				TLS only	
Average flow volume entering Tonle Sap	MCM	n/a		n/a		28,339		n/a		28,339	
Average date of flow reversal (+/-)	Days	n/a		n/a		138		n/a		17-May	
Land use and condition assessment											
Total irrigated area	'000ha	450		2,635		457		1,795		5,337	
Total irrigated cropped area	'000ha	820		3,624		877		4,404		9,725	
Average area flooded: < 0.5m	'000ha	21		23		221		431		697	
Average area flooded: 0.5 - 1.0m	'000ha	19		22		212		717		970	
Average area flooded: 1.0 - 3.0m	'000ha	71		77		668		635		1,450	
Average area flooded: > 3.0m	'000ha	219		167		947		3		1,336	
Area lost to bank erosion	Severity	Positive	2	Positive	2	Mildly negative	-1	Neutral	0	Neutral	
Area affected by salinity of > 1.3gm/l	'000ha	0		0		0		1,532		1,532	
Water quality and geomorphology											
Herbicide runoff	tonnes / yr	6,721		29,874		3,483		26,352		66,430	
Insecticide and fungicide runoff	tonnes / yr	6,723		31,752		3,192		27,098		68,765	
Nitrogen runoff from agriculture	tonnes / yr	18,039		51,700		9,377		71,019		150,135	
Phosphorus runoff from agriculture	tonnes / yr	1,954		6,487		1,219		10,683		20,344	
Nitrogen from waste water discharge	tonnes / yr	13,209		14,974		9,396		14,435		52,014	
Phosphorus from waste water discharge	tonnes / yr	3,963		4,492		2,819		4,330		15,604	
BOD from waste water discharge	tonnes / yr	49,534		56,152		35,234		54,130		195,051	
Impact on water quality	Severity	Negative	-2	Mildly negative	-1	Negative	-2	Mildly negative	-1	Negative	-2
Change in sediment supply	Severity	Negative	-2	Negative	-2	Mildly negative	-1	Mildly negative	-1	Negative	-2
Induced geomorphological changes	Severity	Mildly negative	-1	Mildly negative	-1	Neutral	0	Neutral	0	Mildly negative	-1
Production assessment											
Hydropower generated	GWh / yr	70,103		50,558		3,321		21,240		145,222	
Reservoir fisheries	Mtonne / yr	0		0		0		0		0	
Flood damages	US$M / yr	31		30		12		16		88	
Agricultural production: rice	Mtonne / yr	4		13		5		25		48	
Agricultural production: non-rice	Mtonne / yr	0		4		0		3		8	
Capture fisheries production	Mtonne / yr	0		1		1		0		2	
Aquaculture production	Mtonne / yr	0		0		0		3		4	
Environmental assessment											
Total wetland area: flooded forest	'000ha	0		0		448		46		494	
Total wetland area: marshes	'000ha	6		10		501		0		517	
Total wetland area: inundated grassland	'000ha	5		41		307		55		408	
Tonle Sap only: flooded forest	'000ha	0		0		448		0		448	
Tonle Sap only: marshes	'000ha	0		0		307		0		307	
Tonle Sap only: inundated grassland	'000ha	0		0		269		0		269	
Forest area in reservoir areas	'000ha	85		14		2		7		108	
Number of viable deep pools	No.	15		11		3		5		34	
Status of river channel habitats	Severity	Negative	-2	Negative	-2	Neutral	0	Mildly negative	-1	Negative	-1
Flagship species	Survival	Surviving		Extinct		Surviving		Surviving		Extinct	
Environmental hot spots	Severity	Negative	-2	Severely negative	-3	Negative	-2	Neutral	0	Negative	-2
Biodiversity condition	Severity	Severely negative	-3	Negative	-2	Negative	-2	Mildly negative	-1	Negative	-2
Economic assessment *(net economic values)*											
Irrigated agricultural production	NPV US$M	322		885		344		108		1,659	
Hydropower generated	NPV US$M	12,186		591		1,168		4,189		18,133	
Hydropower imported/exported	NPV US$M	7,784		2,976		462		958		12,180	
Navigation	NPV US$M	0		246		0		0		246	
Flood damage mitigation	NPV US$M	124		124		47		65		360	
Capture fisheries reduction	NPV US$M	-133		-146		-471		-202		-952	
Reservoir fisheries	NPV US$M	120		0		2		11		132	
Aquaculture production	NPV US$M	168		235		174		684		1,261	
Forest area reduction	NPV US$M	-210		0		-4		-14		-228	
Recession rice	NPV US$M	-21		-22		-119		-13		-175	
Wetland area reduction	NPV US$M	-18		-34		-125		-1		-178	
Mitigation of salinity affected areas	NPV US$M	0		0		0		23		23	
Reduction in eco-hotspot/biodiversity	NPV US$M	-50		-60		-130		0		-240	
Total economic impacts	NPV US$M	**20,270**		**4,795**		**1,351**		**5,807**		**32,223**	
Social assessment											
No. of people at risk of loss of livelihood	'000	782		201		262		770		2,015	
Severity of impact on livelihoods	Severity	Severely negative	-3	Negative	-2	Severely negative	-3	Negative	-2	Severely negative	-3
No. of people employed in:											
Irrigated agriculture	'000	150		346		84		49		629	
Reservoir fisheries (incremental to BS)	'000	36		0		1		3		40	
Hydropower production	'000	318		20		20		29		387	
Aquaculture (incremental to BS)	'000	55		77		57		164		352	
Overall assessment											
Overall environment impact	Severity	Severely negative	-3	Negative	-2	Negative	-2	Mildly negative	-1	Negative	-2
Livelihoods	Severity	Severely negative	-3	Negative	-2	Severely negative	-3	Negative	-2	Severely negative	-3
Economic production	NPV US$M	20,579		4,933		2,151		5,949		33,612	
Other economic impacts	NPV US$M	-309		-138		-801		-142		-1,390	

Summary of scenario assessment

Incremental values relative to Baseline

LMB 20-Year Plan Scenario with 6 mainstream dams in Northern Lao PDR

Scenario run no. 6100

Assessment issue	Unit	Lao PDR Amount	Lao PDR Percent	Thailand Amount	Thailand Percent	Cambodia Amount	Cambodia Percent	Viet Nam Amount	Viet Nam Percent	Total Amount	Total Percent
Hydrological assessment											
Key hydrological parameters:	Location	Vientiane		Mudakhan		Kratie		Tan Chau		Average	
Monthly average dry season flow (March)	m3/s	1,093	99%	1,221	84%	1,343	61%	1,104	36%	1,190	61%
Average peak daily flow in wet season	m3/s	-2,208	-14%	-1,911	-7%	-3,358	-7%	-844	-4%	-2,080	-8%
Flow reversal in Tonle Sap:	Location					Prek Kdam				TLS only	
Average flow volume entering Tonle Sap	MCM	n/a		n/a		-3,920	-12%	n/a		-3,920	-12%
Average date of flow reversal (+/-)	Days	n/a		n/a		-7	-5%	n/a		-7	-5%
Land use and condition assessment											
Total irrigated area	'000ha	245	120%	1,370	108%	183	67%	-201	-10%	1,597	43%
Total irrigated cropped area	'000ha	488	147%	2,202	155%	314	56%	93	2%	3,096	47%
Average area flooded: < 0.5m	'000ha	-3	-11%	-1	-3%	36	20%	98	29%	131	23%
Average area flooded: 0.5 - 1.0m	'000ha	-5	-21%	-2	-9%	-20	-8%	48	7%	21	2%
Average area flooded: 1.0 - 3.0m	'000ha	-14	-16%	-13	-14%	-44	-6%	-160	-20%	-231	-14%
Average area flooded: > 3.0m	'000ha	-53	-20%	-65	-28%	-108	-10%	-2	-45%	-228	-15%
Area lost to bank erosion	Severity	Positive	2	Positive	2	Mildly negative	-1	Neutral	0	Neutral	1
Area affected by salinity of > 1.3gm/l	'000ha	0	0%	0	0%	0	0%	-319	-17%	-319	-17%
Water quality and geomorphology											
Herbicide runoff	tonnes / yr	5,258	359%	18,113	154%	2,575	284%	3,524	15%	29,470	80%
Insecticide and fungicide runoff	tonnes / yr	4,783	247%	18,087	132%	1,737	119%	1,378	5%	25,985	61%
Nitrogen runoff from agriculture	tonnes / yr	14,668	435%	40,070	345%	6,922	282%	7,469	12%	69,128	85%
Phosphorus runoff from agriculture	tonnes / yr	1,647	535%	5,248	424%	938	334%	2,354	28%	10,187	100%
Nitrogen from waste water discharge	tonnes / yr	4,580	53%	997	7%	2,763	42%	4,539	46%	12,879	33%
Phosphorus from waste water discharge	tonnes / yr	1,374	53%	299	7%	829	42%	1,362	46%	3,864	33%
BOD from waste water discharge	tonnes / yr	17,175	53%	3,738	7%	10,362	42%	17,020	46%	48,296	33%
Impact on water quality	Severity	Negative	-2	Mildly negative	-1	Negative	-2	Mildly negative	-1	Negative	-2
Change in sediment supply	Severity	Negative	-2	Negative	-2	Mildly negative	-1	Mildly negative	-1	Negative	-2
Induced geomorphological changes	Severity	Mildly negative	-1	Mildly negative	-1	Neutral	0	Neutral	0	Mildly negative	-1
Production assessment											
Hydropower generated	GWh / yr	67,071	2212%	48,155	2004%	3,321	0%	17,581	481%	136,129	1497%
Reservoir fisheries	Mtonne / yr	0	56%	0	0%	0	2%	0	11%	0	18%
Flood damages	US$M / yr	-39	-56%	-37	-55%	-15	-56%	-40	-72%	-131	-60%
Agricultural production: rice	Mtonne / yr	3	370%	9	220%	3	176%	7	42%	23	92%
Agricultural production: non-rice	Mtonne / yr	0	744%	3	226%	0	140%	1	56%	4	132%
Capture fisheries production	Mtonne / yr	-0	-16%	-0	-5%	-0	-18%	-0	-16%	-0	-12%
Aquaculture production	Mtonne / yr	0	161%	0	158%	0	91%	2	100%	2	105%
Environmental assessment											
Total wetland area: flooded forest	'000ha	0	0%	0	0%	-4	-1%	-0	0%	-4	-1%
Total wetland area: marshes	'000ha	-2	-24%	-2	-19%	-16	-3%	-0	0%	-21	-4%
Total wetland area: inundated grassland	'000ha	-4	-44%	-9	-18%	-10	-3%	-0	0%	-23	-5%
Tonle Sap only: flooded forest	'000ha	0	0%	0	0%	-4	-1%	0	0%	-4	-1%
Tonle Sap only: marshes	'000ha	0	0%	0	0%	-3	-1%	0	0%	-3	-1%
Tonle Sap only: inundated grassland	'000ha	0	0%	0	0%	-8	-3%	0	0%	-8	-3%
Forest area in reservoir areas	'000ha	72	528%	0	0%	1	92%	5	236%	78	253%
Number of viable deep pools	No.	-5	-25%	-6	-35%	-2	-40%	0	0%	-13	-28%
Status of river channel habitats	Severity	Negative	-2	Negative	-2	Neutral	0	Mildly negative	-1	Negative	-1
Flagship species	Survival	n/a		n/a		n/a		n/a		n/a	
Environmental hot spots	Severity	Negative	-2	Severely negative	-3	Negative	-2	Neutral	0	Negative	-2
Biodiversity condition	Severity	Severely negative	-3	Negative	-2	Negative	-2	Mildly negative	-1	Negative	-2
Economic assessment *(net economic values)*											
Irrigated agricultural production	NPV US$M	322	0%	885	0%	344	0%	108	0%	1,659	0%
Hydropower generated	NPV US$M	9,892	431%	100	20%	1,168	0%	2,477	145%	13,638	303%
Hydropower imported/exported	NPV US$M	7,443	2186%	2,767	1323%	462	0%	691	259%	11,364	1392%
Navigation	NPV US$M	0	0%	64	35%	0	0%	0	0%	64	35%
Flood damage mitigation	NPV US$M	124	0%	124	0%	47	0%	65	0%	360	0%
Capture fisheries reduction	NPV US$M	-133	0%	-146	0%	-471	0%	-202	0%	-952	0%
Reservoir fisheries	NPV US$M	120	0%	0	0%	2	0%	11	0%	132	0%
Aquaculture production	NPV US$M	168	0%	235	0%	174	0%	684	0%	1,261	0%
Forest area reduction	NPV US$M	-210	0%	0	0%	-4	0%	-14	0%	-228	0%
Recession rice	NPV US$M	-21	0%	-22	0%	-119	0%	-13	0%	-175	0%
Wetland area reduction	NPV US$M	-18	0%	-34	0%	-125	0%	-1	0%	-178	0%
Mitigation of salinity affected areas	NPV US$M	0	0%	0	0%	0	0%	23	0%	23	0%
Reduction in eco-hotspot/biodiversity	NPV US$M	-50	0%	-60	0%	-130	0%	0	0%	-240	0%
Total economic impacts	NPV US$M	**17,636**	670%	**3,913**	444%	**1,351**	0%	**3,828**	193%	**26,728**	486%
Social assessment											
No. of people at risk of loss of livelihood	'000	782	0%	201	0%	262	0%	770	0%	2,015	0%
Severity of impact on livelihoods	Severity	Severely negative	-3	Negative	-2	Severely negative	-3	Negative	-2	Severely negative	-3
No. of people employed in:											
Irrigated agriculture	'000	72	91%	119	53%	6	8%	14	41%	212	51%
Reservoir fisheries (incremental to BS)	'000	36	0%	0	0%	1	0%	3	0%	40	0%
Hydropower production	'000	318	0%	20	0%	20	0%	29	0%	387	0%
Aquaculture (incremental to BS)	'000	55	0%	77	0%	57	0%	164	0%	352	0%
Overall assessment											
Overall environment impact	Severity	Severely negative	-3	Negative	-2	Negative	-2	Mildly negative	-1	Negative	-2
Livelihoods	Severity	Severely negative	-3	Negative	-2	Severely negative	-3	Negative	-2	Severely negative	-3
Economic production	NPV US$M	17,945	681%	4,051	459%	2,151	0%	3,970	201%	28,118	512%
Other economic impacts	NPV US$M	-309	0%	-138	0%	-801	0%	-142	0%	-1,390	0%

Summary of scenario assessment

Incremental values relative to Definite Future Scenario

LMB 20-Year Plan Scenario with 6 mainstream dams in Northern Lao PDR

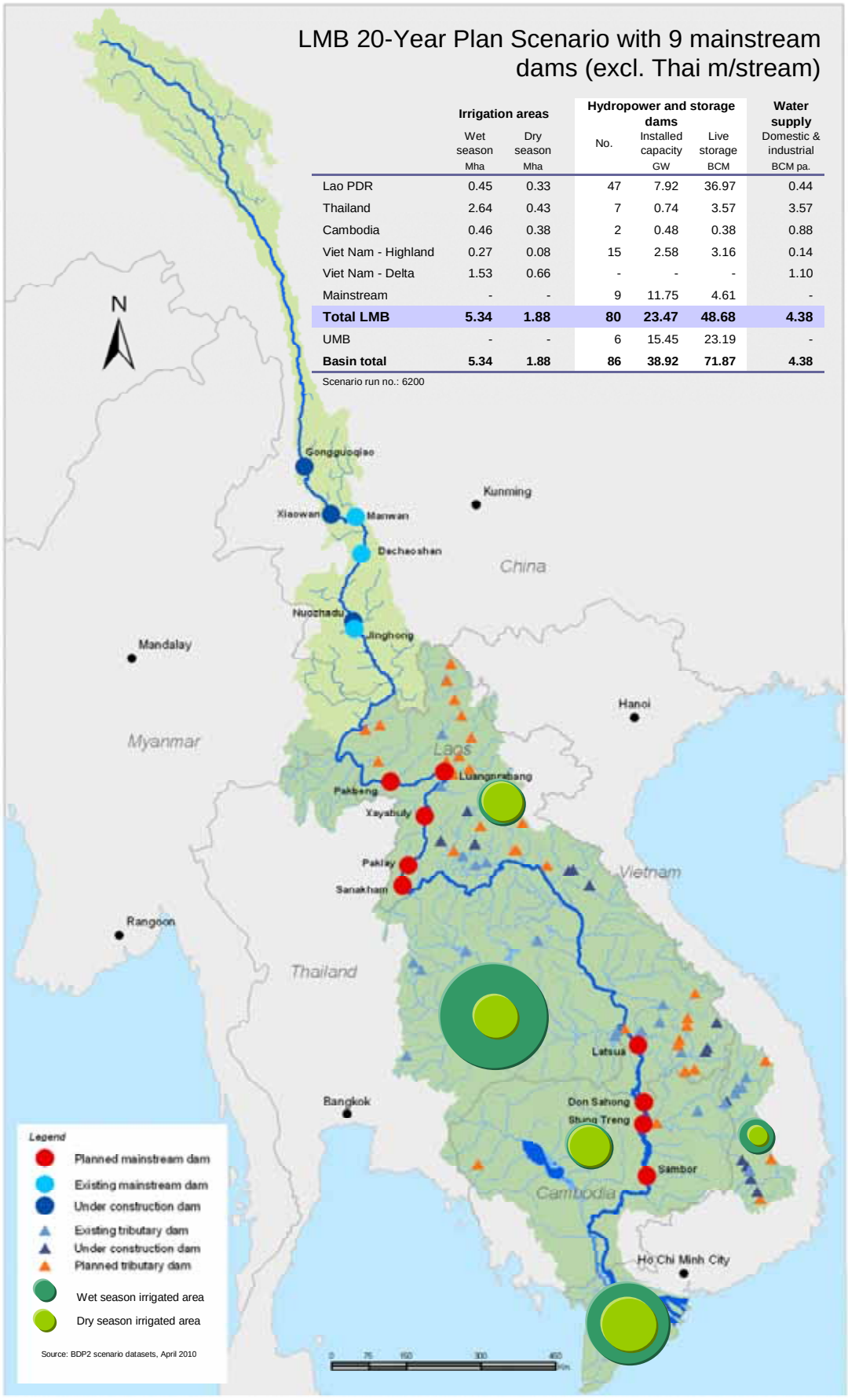
Scenario run no. 6100

Assessment issue	Unit	Lao PDR		Thailand		Cambodia		Viet Nam		Total	
		Amount	Percent	Amount	Percent	Amount	Percent	Amount	Percent	Amount	Percent
Hydrological assessment											
Key hydrological parameters:	Location	Vientiane		Mudakhan		Kratie		Tan Chau		Average	
Monthly average dry season flow (March)	m3/s	333	18%	302	13%	471	15%	278	7%	346	12%
Average peak daily flow in wet season	m3/s	-100	-1%	-443	-2%	-1,718	-4%	-364	-2%	-656	-3%
Flow reversal in Tonle Sap:	Location					Prek Kdam				TLS only	
Average flow volume entering Tonle Sap	MCM	n/a		n/a		-1,402	-5%	n/a		-1,402	
Average date of flow reversal (+/-)	Days	n/a		n/a		-4	-3%	n/a		-4	
Land use and condition assessment											
Total irrigated area	'000ha	283	170%	1,281	95%	183	67%	125	7%	1,872	54%
Total irrigated cropped area	'000ha	549	203%	1,868	106%	314	56%	186	4%	2,918	43%
Average area flooded: < 0.5m	'000ha	-1	-5%	-0	-1%	5	2%	23	6%	27	4%
Average area flooded: 0.5 - 1.0m	'000ha	-0	-2%	0	0%	4	2%	4	1%	7	1%
Average area flooded: 1.0 - 3.0m	'000ha	-2	-3%	-3	-3%	-8	-1%	-32	-5%	-45	-3%
Average area flooded: > 3.0m	'000ha	-8	-3%	-9	-5%	-30	-3%	-0	-11%	-47	-3%
Area lost to bank erosion	Severity	Mildly positive	1	Mildly positive	1	Mildly negative	-1	Neutral	0	Neutral	0
Area affected by salinity of > 1.3gm/l	'000ha	0	0%	0	0%	0	0%	-47	-3%	-47	-3%
Water quality and geomorphology											
Herbicide runoff	tonnes / yr	5,258	359%	18,113	154%	2,575	284%	3,524	15%	29,470	80%
Insecticide and fungicide runoff	tonnes / yr	4,783	247%	18,087	132%	1,737	119%	1,378	5%	25,985	61%
Nitrogen runoff from agriculture	tonnes / yr	14,668	435%	40,070	345%	6,922	282%	7,469	12%	69,128	85%
Phosphorus runoff from agriculture	tonnes / yr	1,647	535%	5,248	424%	938	334%	2,354	28%	10,187	100%
Nitrogen from waste water discharge	tonnes / yr	4,580	53%	997	7%	2,763	42%	4,539	46%	12,879	33%
Phosphorus from waste water discharge	tonnes / yr	1,374	53%	299	7%	829	42%	1,362	46%	3,864	33%
BOD from waste water discharge	tonnes / yr	17,175	53%	3,738	7%	10,362	42%	17,020	46%	48,296	33%
Impact on water quality	Severity	Severely negative	-3	Negative	-2	Severely negative	-3	Negative	-2	Severely negative	-3
Change in sediment supply	Severity	Neutral	0	Neutral	0	Neutral	0	Mildly negative	-1	Mildly negative	-0
Induced geomorphological changes	Severity	Neutral	0	Neutral	0	Neutral	0	Neutral	0	Neutral	0
Production assessment											
Hydropower generated	GWh / yr	53,700	327%	38,379	315%	986	42%	7,647	56%	100,712	226%
Reservoir fisheries	Mtonne / yr	0	31%	0	0%	0	0%	0	3%	0	10%
Flood damages	US$M / yr	3	10%	3	13%	4	46%	6	70%	16	23%
Agricultural production: rice	Mtonne / yr	3	370%	9	220%	3	176%	7	42%	23	92%
Agricultural production: non-rice	Mtonne / yr	0	744%	3	226%	0	140%	1	56%	4	132%
Capture fisheries production	Mtonne / yr	-0	-1%	-0	-1%	-0	-12%	-0	-8%	-0	-6%
Aquaculture production	Mtonne / yr	0	36%	0	42%	0	45%	1	33%	1	35%
Environmental assessment											
Total wetland area: flooded forest	'000ha	0	0%	0	0%	-2	0%	-0	0%	-2	0%
Total wetland area: marshes	'000ha	-0	-4%	-0	-4%	-5	-1%	-0	0%	-5	-1%
Total wetland area: inundated grassland	'000ha	-1	-12%	-1	-3%	-3	-1%	-0	0%	-5	-1%
Tonle Sap only: flooded forest	'000ha	0	0%	0	0%	-2	0%	0	0%	-2	0%
Tonle Sap only: marshes	'000ha	0	0%	0	0%	-1	0%	0	0%	-1	0%
Tonle Sap only: inundated grassland	'000ha	0	0%	0	0%	-3	-1%	0	0%	-3	-1%
Forest area in reservoir areas	'000ha	47	123%	0	0%	0	0%	2	29%	48	81%
Number of viable deep pools	No.	-5	-25%	-6	-35%	-2	-40%	0	0%	-13	-28%
Status of river channel habitats	Severity	Mildly negative	-1	Mildly negative	-1	Neutral	0	Mildly negative	-1	Mildly negative	-1
Flagship species	Survival	n/a		n/a		n/a		n/a		n/a	
Environmental hot spots	Severity	Negative	-2	Negative	-2	Negative	-1	Neutral	0	Negative	-1
Biodiversity condition	Severity	Negative	-2	Mildly negative	-1	Mildly negative	-1	Neutral	0	Mildly negative	-1
Economic assessment *(net economic values)*											
Irrigated agricultural production	NPV US$M	322	0%	885	0%	344	0%	108	0%	1,659	0%
Hydropower generated	NPV US$M	4,500	59%	0	0%	420	56%	368	10%	5,288	41%
Hydropower imported/exported	NPV US$M	6,217	397%	1,916	181%	5	1%	84	10%	8,222	208%
Navigation	NPV US$M	0	0%	0	0%	0	0%	0	0%	0	0%
Flood damage mitigation	NPV US$M	-55	-31%	-48	-28%	-4	-8%	5	8%	-102	-22%
Capture fisheries reduction	NPV US$M	95	-42%	41	-22%	-147	45%	5	-2%	-6	1%
Reservoir fisheries	NPV US$M	46	61%	0	0%	-2	-44%	-2	-19%	42	46%
Aquaculture production	NPV US$M	42	33%	61	35%	86	98%	-58	-8%	132	12%
Forest area reduction	NPV US$M	-80	62%	0	0%	3	-44%	3	-19%	-74	48%
Recession rice	NPV US$M	-2	12%	-11	112%	-13	12%	-4	50%	-31	22%
Wetland area reduction	NPV US$M	8	-31%	14	-29%	28	-19%	-1	82%	50	-22%
Mitigation of salinity affected areas	NPV US$M	0	0%	0	0%	0	0%	3	15%	3	15%
Reduction in eco-hotspot/biodiversity	NPV US$M	-50	0%	-40	200%	-65	100%	0	0%	-155	182%
Total economic impacts	NPV US$M	**11,041**	120%	**2,818**	143%	**657**	95%	**511**	10%	**15,028**	87%
Social assessment											
No. of people at risk of loss of livelihood	'000	485	163%	155	337%	160	157%	328	74%	1,128	127%
Severity of impact on livelihoods	Severity	Mildly negative	-1	Mildly negative	-1	Negative	-2	Mildly negative	-1	Negative	-1
No. of people employed in:											
Irrigated agriculture	'000	72	91%	119	53%	6	8%	14	41%	212	51%
Reservoir fisheries (incremental to BS)	'000	23	190%	0	0%	0	0%	1	46%	24	161%
Hydropower production	'000	266	512%	14	279%	5	32%	-3	-8%	283	273%
Aquaculture (incremental to BS)	'000	26	94%	38	96%	37	188%	0	0%	101	40%
Overall assessment											
Overall environment impact	Severity	Negative	-2	Mildly negative	-1	Mildly negative	-1	Neutral	0	Mildly negative	-1
Livelihoods	Severity	Mildly negative	-1	Mildly negative	-1	Negative	-2	Mildly negative	-1	Negative	-1
Economic production	NPV US$M	11,126	118%	2,862	138%	855	66%	500	9%	15,343	84%
Other economic impacts	NPV US$M	-85	38%	-44	48%	-198	33%	11	-7%	-315	29%

LMB 20-Year Plan Scenario with 9 mainstream dams (excl. Thai m/stream)

	Irrigation areas		Hydropower and storage dams			Water supply
	Wet season Mha	Dry season Mha	No.	Installed capacity GW	Live storage BCM	Domestic & industrial BCM pa.
Lao PDR	0.45	0.33	47	7.92	36.97	0.44
Thailand	2.64	0.43	7	0.74	3.57	3.57
Cambodia	0.46	0.38	2	0.48	0.38	0.88
Viet Nam - Highland	0.27	0.08	15	2.58	3.16	0.14
Viet Nam - Delta	1.53	0.66	-	-	-	1.10
Mainstream	-	-	9	11.75	4.61	-
Total LMB	**5.34**	**1.88**	**80**	**23.47**	**48.68**	**4.38**
UMB	-	-	6	15.45	23.19	-
Basin total	**5.34**	**1.88**	**86**	**38.92**	**71.87**	**4.38**

Scenario run no.: 6200



Scenario assessment results

Estimated total values

LMB 20-Year Plan Scenario with 9 mainstream dams, excl Thailand

Scenario run no. 6200

Assessment issue	Unit	3 Lao PDR Amount		4 Thailand Amount		5 Cambodia Amount		6 Viet Nam Amount		Total Amount	
Hydrological assessment											
Key hydrological parameters:	Location	Vientiane		Mudakhan		Kratie		Tan Chau		Average	
Monthly average dry season flow (March)	m3/s	2,195		2,675		3,531		4,175		3,144	
Average peak daily flow in wet season	m3/s	13,540		23,417		43,307		20,466		25,182	
Flow reversal in Tonle Sap:	Location					Prek Kdam				TLS only	
Average flow volume entering Tonle Sap	MCM	n/a		n/a		28,340		n/a		28,340	
Average date of flow reversal (+/-)	Days	n/a		n/a		138		n/a		17-May	
Land use and condition assessment											
Total irrigated area	'000ha	450		2,635		457		1,795		5,337	
Total irrigated cropped area	'000ha	820		3,624		877		4,404		9,725	
Average area flooded: < 0.5m	'000ha	21		23		221		431		697	
Average area flooded: 0.5 - 1.0m	'000ha	19		22		212		717		970	
Average area flooded: 1.0 - 3.0m	'000ha	71		77		668		635		1,450	
Average area flooded: > 3.0m	'000ha	219		167		947		3		1,336	
Area lost to bank erosion	Severity	Mildly negative	-1	Mildly negative	-1	Mildly negative	-1	Neutral	0	Neutral	
Area affected by salinity of > 1.3gm/l	'000ha	0		0		0		1,563		1,563	
Water quality and geomorphology											
Herbicide runoff	tonnes / yr	6,721		29,874		3,483		26,352		66,430	
Insecticide and fungicide runoff	tonnes / yr	6,723		31,752		3,192		27,098		68,765	
Nitrogen runoff from agriculture	tonnes / yr	18,039		51,700		9,377		71,019		150,135	
Phosphorus runoff from agriculture	tonnes / yr	1,954		6,487		1,219		10,683		20,344	
Nitrogen from waste water discharge	tonnes / yr	13,209		14,974		9,396		14,435		52,014	
Phosphorus from waste water discharge	tonnes / yr	3,963		4,492		2,819		4,330		15,604	
BOD from waste water discharge	tonnes / yr	49,534		56,152		35,234		54,130		195,051	
Impact on water quality	Severity	Negative	-2	Mildly negative	-1	Negative	-2	Mildly negative	-1	Negative	-2
Change in sediment supply	Severity	Severely negative	-3	Severely negative	-3	Negative	-2	Negative	-2	Severely negative	-3
Induced geomorphological changes	Severity	Negative	-2	Negative	-2	Mildly negative	-1	Mildly negative	-1	Negative	-2
Production assessment											
Hydropower generated	GWh / yr	70,664		51,691		23,061		35,058		180,474	
Reservoir fisheries	Mtonne / yr	0		0		0		0		0	
Flood damages	US$M / yr	31		30		12		16		88	
Agricultural production: rice	Mtonne / yr	4		13		5		25		48	
Agricultural production: non-rice	Mtonne / yr	0		4		0		3		8	
Capture fisheries production	Mtonne / yr	0		1		0		0		2	
Aquaculture production	Mtonne / yr	0		0		0		3		4	
Environmental assessment											
Total wetland area: flooded forest	'000ha	0		0		448		46		494	
Total wetland area: marshes	'000ha	6		10		501		0		517	
Total wetland area: inundated grassland	'000ha	5		41		307		55		408	
Tonle Sap only: flooded forest	'000ha	0		0		448		0		448	
Tonle Sap only: marshes	'000ha	0		0		307		0		307	
Tonle Sap only: inundated grassland	'000ha	0		0		269		0		269	
Forest area in reservoir areas	'000ha	86		14		43		7		150	
Number of viable deep pools	No.	12		13		3		5		33	
Status of river channel habitats	Severity	Negative	-2	Negative	-2	Mildly negative	-1	Mildly negative	-1	Negative	-2
Flagship species	Survival	Extinct		Extinct		Surviving		Surviving		Extinct	
Environmental hot spots	Severity	Severely negative	-3	Severely negative	-3	Severely negative	-3	Neutral	0	Severely negative	-2
Biodiversity condition	Severity	Severely negative	-3	Severely negative	-3	Severely negative	-3	Mildly negative	-1	Severely negative	-3
Economic assessment *(net economic values)*											
Irrigated agricultural production	NPV US$M	322		885		344		108		1,659	
Hydropower generated	NPV US$M	13,118		591		1,315		4,659		19,682	
Hydropower imported/exported	NPV US$M	8,206		3,032		2,031		1,066		14,335	
Navigation	NPV US$M	0		246		0		0		246	
Flood damage mitigation	NPV US$M	124		124		47		65		360	
Capture fisheries reduction	NPV US$M	-170		-146		-1,137		-460		-1,914	
Reservoir fisheries	NPV US$M	121		0		70		11		202	
Aquaculture production	NPV US$M	168		235		174		684		1,261	
Forest area reduction	NPV US$M	-212		0		-122		-14		-349	
Recession rice	NPV US$M	-21		-22		-122		-13		-178	
Wetland area reduction	NPV US$M	-18		-34		-169		-4		-225	
Mitigation of salinity affected areas	NPV US$M	0		0		0		21		21	
Reduction in eco-hotspot/biodiversity	NPV US$M	-75		-60		-195		0		-330	
Total economic impacts	NPV US$M	**21,561**		**4,852**		**2,237**		**6,121**		**34,771**	
Social assessment											
No. of people at risk of loss of livelihood	'000	907		515		1,212		1,725		4,359	
Severity of impact on livelihoods	Severity	Severely negative	-3	Negative	-2	Extremely negative	-4	Negative	-2	Severely negative	-3
No. of people employed in:											
Irrigated agriculture	'000	150		346		84		49		629	
Reservoir fisheries (incremental to BS)	'000	36		0		21		3		60	
Hydropower production	'000	336		6		163		29		534	
Aquaculture (incremental to BS)	'000	55		77		57		164		352	
Overall assessment											
Overall environment impact	Severity	Severely negative	-3	Severely negative	-3	Severely negative	-3	Mildly negative	-1	Severely negative	-3
Livelihoods	Severity	Severely negative	-3	Negative	-2	Extremely negative	-4	Negative	-2	Severely negative	-3
Economic production	NPV US$M	21,934		4,990		3,934		6,527		37,386	
Other economic impacts	NPV US$M	-373		-138		-1,698		-406		-2,615	

Summary of scenario assessment

Incremental values relative to Baseline

LMB 20-Year Plan Scenario with 9 mainstream dams, excl Thailand

Scenario run no. 6200

Assessment issue	Unit	Lao PDR		Thailand		Cambodia		Viet Nam		Total	
		Amount	Percent	Amount	Percent	Amount	Percent	Amount	Percent	Amount	Percent
Hydrological assessment											
Key hydrological parameters:	Location	Vientiane		Mudakhan		Kratie		Tan Chau		Average	
Monthly average dry season flow (March)	m3/s	1,095	100%	1,223	84%	1,333	61%	1,104	36%	1,189	61%
Average peak daily flow in wet season	m3/s	-2,381	-15%	-2,084	-8%	-3,456	-7%	-844	-4%	-2,191	-8%
Flow reversal in Tonle Sap:	Location					Prek Kdam				TLS only	
Average flow volume entering Tonle Sap	MCM	n/a		n/a		-3,918	-12%	n/a		-3,918	-12%
Average date of flow reversal (+/-)	Days	n/a		n/a		-7	-5%	n/a		-7	-5%
Land use and condition assessment											
Total irrigated area	'000ha	245	120%	1,370	108%	183	67%	-201	-10%	1,597	43%
Total irrigated cropped area	'000ha	488	147%	2,202	155%	314	56%	93	2%	3,096	47%
Average area flooded: < 0.5m	'000ha	-3	-11%	-1	-3%	36	20%	98	29%	131	23%
Average area flooded: 0.5 - 1.0m	'000ha	-5	-21%	-2	-9%	-20	-8%	48	7%	21	2%
Average area flooded: 1.0 - 3.0m	'000ha	-14	-16%	-13	-14%	-44	-6%	-160	-20%	-231	-14%
Average area flooded: > 3.0m	'000ha	-53	-20%	-65	-28%	-108	-10%	-2	-45%	-228	-15%
Area lost to bank erosion	Severity	Mildly negative	-1	Mildly negative	-1	Mildly negative	-1	Neutral	0	Mildly negative	-1
Area affected by salinity of > 1.3gm/l	'000ha	0	0%	0	0%	0	0%	-288	-16%	-288	-16%
Water quality and geomorphology											
Herbicide runoff	tonnes / yr	5,258	359%	18,113	154%	2,575	284%	3,524	15%	29,470	80%
Insecticide and fungicide runoff	tonnes / yr	4,783	247%	18,087	132%	1,737	119%	1,378	5%	25,985	61%
Nitrogen runoff from agriculture	tonnes / yr	14,668	435%	40,070	345%	6,922	282%	7,469	12%	69,128	85%
Phosphorus runoff from agriculture	tonnes / yr	1,647	535%	5,248	424%	938	334%	2,354	28%	10,187	100%
Nitrogen from waste water discharge	tonnes / yr	4,580	53%	997	7%	2,763	42%	4,539	46%	12,879	33%
Phosphorus from waste water discharge	tonnes / yr	1,374	53%	299	7%	829	42%	1,362	46%	3,864	33%
BOD from waste water discharge	tonnes / yr	17,175	53%	3,738	7%	10,362	42%	17,020	46%	48,296	33%
Impact on water quality	Severity	Negative	-2	Mildly negative	-1	Negative	-2	Mildly negative	-1	Negative	-2
Change in sediment supply	Severity	Severely negative	-3	Severely negative	-3	Negative	-2	Negative	-2	Severely negative	-3
Induced geomorphological changes	Severity	Negative	-2	Negative	-2	Mildly negative	-1	Mildly negative	-1	Negative	-2
Production assessment											
Hydropower generated	GWh / yr	67,632	2231%	49,288	2051%	23,061	0%	31,399	858%	171,381	1885%
Reservoir fisheries	Mtonne / yr	0	56%	0	0%	0	81%	0	11%	0	27%
Flood damages	US$M / yr	-39	-56%	-37	-55%	-15	-56%	-40	-72%	-131	-60%
Agricultural production: rice	Mtonne / yr	3	370%	9	220%	3	176%	7	42%	23	92%
Agricultural production: non-rice	Mtonne / yr	0	744%	3	226%	0	140%	1	56%	4	132%
Capture fisheries production	Mtonne / yr	-0	-21%	-0	-5%	-0	-44%	-0	-37%	-1	-25%
Aquaculture production	Mtonne / yr	0	161%	0	158%	0	91%	2	100%	2	105%
Environmental assessment											
Total wetland area: flooded forest	'000ha	0	0%	0	0%	-4	-1%	-0	0%	-4	-1%
Total wetland area: marshes	'000ha	-2	-24%	-2	-19%	-16	-3%	-0	0%	-21	-4%
Total wetland area: inundated grassland	'000ha	-4	-44%	-9	-18%	-10	-3%	-0	0%	-23	-5%
Tonle Sap only: flooded forest	'000ha	0	0%	0	0%	-4	-1%	0	0%	-4	-1%
Tonle Sap only: marshes	'000ha	0	0%	0	0%	-3	-1%	0	0%	-3	-1%
Tonle Sap only: inundated grassland	'000ha	0	0%	0	0%	-8	-3%	0	0%	-8	-3%
Forest area in reservoir areas	'000ha	72	534%	0	0%	42	3346%	5	236%	119	389%
Number of viable deep pools	No.	-8	-40%	-4	-24%	-2	-40%	0	0%	-14	-30%
Status of river channel habitats	Severity	Negative	-2	Negative	-2	Mildly negative	-1	Mildly negative	-1	Negative	-2
Flagship species	Survival	n/a		n/a		n/a		n/a		n/a	
Environmental hot spots	Severity	Severely negative	-3	Severely negative	-3	Severely negative	-3	Neutral	0	Severely negative	-2
Biodiversity condition	Severity	Severely negative	-3	Severely negative	-3	Severely negative	-3	Mildly negative	-1	Severely negative	-3
Economic assessment *(net economic values)*											
Irrigated agricultural production	NPV US$M	322	0%	885	0%	344	0%	108	0%	1,659	0%
Hydropower generated	NPV US$M	10,825	472%	100	20%	1,315	0%	2,948	172%	15,187	338%
Hydropower imported/exported	NPV US$M	7,865	2310%	2,823	1350%	2,031	0%	799	299%	13,519	1655%
Navigation	NPV US$M	0	0%	64	35%	0	0%	0	0%	64	35%
Flood damage mitigation	NPV US$M	124	0%	124	0%	47	0%	65	0%	360	0%
Capture fisheries reduction	NPV US$M	-170	0%	-146	0%	-1,137	0%	-460	0%	-1,914	0%
Reservoir fisheries	NPV US$M	121	0%	0	0%	70	0%	11	0%	202	0%
Aquaculture production	NPV US$M	168	0%	235	0%	174	0%	684	0%	1,261	0%
Forest area reduction	NPV US$M	-212	0%	0	0%	-122	0%	-14	0%	-349	0%
Recession rice	NPV US$M	-21	0%	-22	0%	-122	0%	-13	0%	-178	0%
Wetland area reduction	NPV US$M	-18	0%	-34	0%	-169	0%	-4	0%	-225	0%
Mitigation of salinity affected areas	NPV US$M	0	0%	0	0%	0	0%	21	0%	21	0%
Reduction in eco-hotspot/biodiversity	NPV US$M	-75	0%	-60	0%	-195	0%	0	0%	-330	0%
Total economic impacts	NPV US$M	**18,927**	719%	**3,970**	450%	**2,237**	0%	**4,143**	209%	**29,276**	533%
Social assessment											
No. of people at risk of loss of livelihood	'000	907	0%	515	0%	1,212	0%	1,725	0%	4,359	0%
Severity of impact on livelihoods	Severity	Severely negative	-3	Negative	-2	Extremely negative	-4	Negative	-2	Severely negative	-3
No. of people employed in:											
Irrigated agriculture	'000	72	91%	119	53%	6	8%	14	41%	212	51%
Reservoir fisheries (incremental to BS)	'000	36	0%	0	0%	21	0%	3	0%	60	0%
Hydropower production	'000	336	0%	6	0%	163	0%	29	0%	534	0%
Aquaculture (incremental to BS)	'000	55	0%	77	0%	57	0%	164	0%	352	0%
Overall assessment											
Overall environment impact	Severity	Severely negative	-3	Severely negative	-3	Severely negative	-3	Mildly negative	-1	Severely negative	-3
Livelihoods	Severity	Severely negative	-3	Negative	-2	Extremely negative	-4	Negative	-2	Severely negative	-3
Economic production	NPV US$M	19,301	733%	4,107	466%	3,934	0%	4,549	230%	31,891	580%
Other economic impacts	NPV US$M	-373	0%	-138	0%	-1,698	0%	-406	0%	-2,615	0%

Summary of scenario assessment

Incremental values relative to Definite Future Scenario

LMB 20-Year Plan Scenario with 9 mainstream dams, excl Thailand

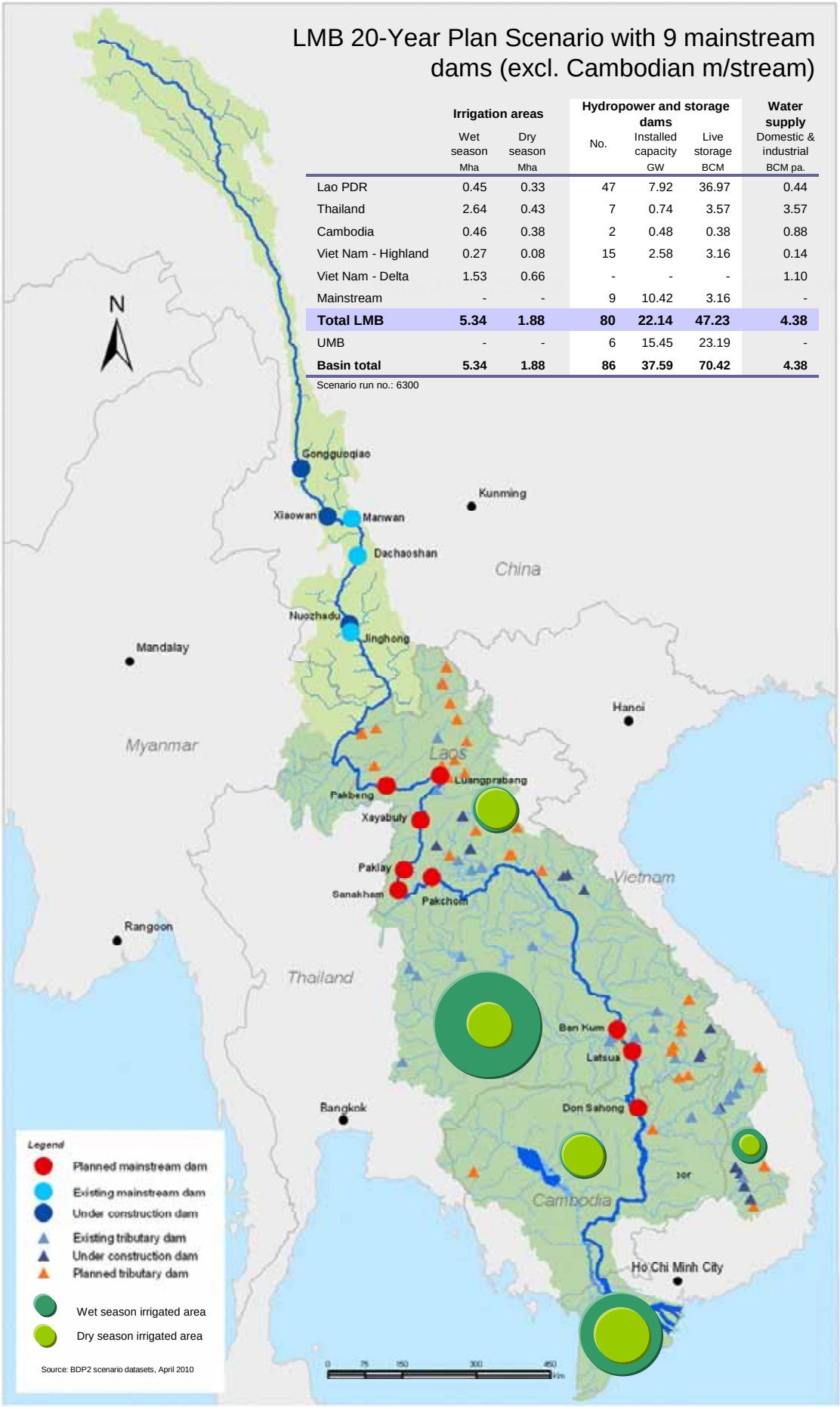
Scenario run no. 6200

Assessment issue	Unit	Lao PDR		Thailand		Cambodia		Viet Nam		Total	
		Amount	Percent	Amount	Percent	Amount	Percent	Amount	Percent	Amount	Percent
Hydrological assessment											
Key hydrological parameters:	Location	Vientiane		Mudakhan		Kratie		Tan Chau		Average	
Monthly average dry season flow (March)	m3/s	335	18%	303	13%	462	15%	278	7%	344	12%
Average peak daily flow in wet season	m3/s	-273	-2%	-615	-3%	-1,816	-4%	-364	-2%	-767	-3%
Flow reversal in Tonle Sap:	Location					Prek Kdam				TLS only	
Average flow volume entering Tonle Sap	MCM	n/a		n/a		-1,400	-5%	n/a		-1,400	
Average date of flow reversal (+/-)	Days	n/a		n/a		-4	-3%	n/a		-4	
Land use and condition assessment											
Total irrigated area	'000ha	283	170%	1,281	95%	183	67%	125	7%	1,872	54%
Total irrigated cropped area	'000ha	549	203%	1,868	106%	314	56%	186	4%	2,918	43%
Average area flooded: < 0.5m	'000ha	-1	-5%	-0	-1%	5	2%	23	6%	27	4%
Average area flooded: 0.5 - 1.0m	'000ha	-0	-2%	0	0%	4	2%	4	1%	7	1%
Average area flooded: 1.0 - 3.0m	'000ha	-2	-3%	-3	-3%	-8	-1%	-32	-5%	-45	-3%
Average area flooded: > 3.0m	'000ha	-8	-3%	-9	-5%	-30	-3%	-0	-11%	-47	-3%
Area lost to bank erosion	Severity	Negative	-2	Negative	-2	Mildly negative	-1	Neutral	0	Negative	-1
Area affected by salinity of > 1.3gm/l	'000ha	0	0%	0	0%	0	0%	-16	-1%	-16	-1%
Water quality and geomorphology											
Herbicide runoff	tonnes / yr	5,258	359%	18,113	154%	2,575	284%	3,524	15%	29,470	80%
Insecticide and fungicide runoff	tonnes / yr	4,783	247%	18,087	132%	1,737	119%	1,378	5%	25,985	61%
Nitrogen runoff from agriculture	tonnes / yr	14,668	435%	40,070	345%	6,922	282%	7,469	12%	69,128	85%
Phosphorus runoff from agriculture	tonnes / yr	1,647	535%	5,248	424%	938	334%	2,354	28%	10,187	100%
Nitrogen from waste water discharge	tonnes / yr	4,580	53%	997	7%	2,763	42%	4,539	46%	12,879	33%
Phosphorus from waste water discharge	tonnes / yr	1,374	53%	299	7%	829	42%	1,362	46%	3,864	33%
BOD from waste water discharge	tonnes / yr	17,175	53%	3,738	7%	10,362	42%	17,020	46%	48,296	33%
Impact on water quality	Severity	Severely negative	-3	Negative	-2	Severely negative	-3	Negative	-2	Severely negative	-3
Change in sediment supply	Severity	Mildly negative	-1	Mildly negative	-1	Mildly negative	-1	Negative	-2	Negative	-1
Induced geomorphological changes	Severity	Mildly negative	-1	Mildly negative	-1	Mildly negative	-1	Mildly negative	-1	Mildly negative	-1
Production assessment											
Hydropower generated	GWh / yr	54,261	331%	39,512	324%	20,726	888%	21,465	158%	135,964	305%
Reservoir fisheries	Mtonne / yr	0	31%	0	0%	0	78%	0	3%	0	19%
Flood damages	US$M / yr	3	10%	3	13%	4	46%	6	70%	16	23%
Agricultural production: rice	Mtonne / yr	3	370%	9	220%	3	176%	7	42%	23	92%
Agricultural production: non-rice	Mtonne / yr	0	744%	3	226%	0	140%	1	56%	4	132%
Capture fisheries production	Mtonne / yr	-0	-6%	-0	-1%	-0	-40%	-0	-31%	-0	-19%
Aquaculture production	Mtonne / yr	0	36%	0	42%	0	45%	1	33%	1	35%
Environmental assessment											
Total wetland area: flooded forest	'000ha	0	0%	0	0%	-2	0%	-0	0%	-2	0%
Total wetland area: marshes	'000ha	-0	-4%	-0	-4%	-5	-1%	-0	0%	-5	-1%
Total wetland area: inundated grassland	'000ha	-1	-12%	-1	-3%	-3	-1%	-0	0%	-5	-1%
Tonle Sap only: flooded forest	'000ha	0	0%	0	0%	-2	0%	0	0%	-2	0%
Tonle Sap only: marshes	'000ha	0	0%	0	0%	-1	0%	0	0%	-1	0%
Tonle Sap only: inundated grassland	'000ha	0	0%	0	0%	-3	-1%	0	0%	-3	-1%
Forest area in reservoir areas	'000ha	48	125%	0	0%	41	1693%	2	29%	90	150%
Number of viable deep pools	No.	-8	-40%	-4	-24%	-2	-40%	0	0%	-14	-30%
Status of river channel habitats	Severity	Mildly negative	-1	Mildly negative	-1	Mildly negative	-1	Mildly negative	-1	Mildly negative	-1
Flagship species	Survival	n/a		n/a		n/a		n/a		n/a	
Environmental hot spots	Severity	Severely negative	-3	Negative	-2	Severely negative	-2	Neutral	0	Negative	-2
Biodiversity condition	Severity	Negative	-2	Negative	-2	Negative	-2	Neutral	0	Negative	-2
Economic assessment *(net economic values)*											
Irrigated agricultural production	NPV US$M	322	0%	885	0%	344	0%	108	0%	1,659	0%
Hydropower generated	NPV US$M	5,432	71%	0	0%	567	76%	839	22%	6,837	53%
Hydropower imported/exported	NPV US$M	6,638	424%	1,972	186%	1,574	345%	192	22%	10,377	262%
Navigation	NPV US$M	0	0%	0	0%	0	0%	0	0%	0	0%
Flood damage mitigation	NPV US$M	-55	-31%	-48	-28%	-4	-8%	5	8%	-102	-22%
Capture fisheries reduction	NPV US$M	58	-25%	41	-22%	-814	251%	-254	123%	-968	102%
Reservoir fisheries	NPV US$M	47	63%	0	0%	66	1920%	-2	-19%	111	122%
Aquaculture production	NPV US$M	42	33%	61	35%	86	98%	-58	-8%	132	12%
Forest area reduction	NPV US$M	-83	64%	0	0%	-116	1840%	3	-19%	-195	127%
Recession rice	NPV US$M	-2	12%	-11	112%	-16	15%	-4	51%	-34	23%
Wetland area reduction	NPV US$M	8	-31%	14	-29%	-15	10%	-4	587%	3	-1%
Mitigation of salinity affected areas	NPV US$M	0	0%	0	0%	0	0%	1	5%	1	5%
Reduction in eco-hotspot/biodiversity	NPV US$M	-75	0%	-40	200%	-130	200%	0	0%	-245	288%
Total economic impacts	NPV US$M	**12,332**	134%	**2,874**	145%	**1,543**	223%	**826**	16%	**17,576**	102%
Social assessment											
No. of people at risk of loss of livelihood	'000	610	205%	469	1020%	1,110	1088%	1,283	290%	3,472	391%
Severity of impact on livelihoods	Severity	Mildly negative	-1	Mildly negative	-1	Severely negative	-3	Mildly negative	-1	Negative	-2
No. of people employed in:											
Irrigated agriculture	'000	72	91%	119	53%	6	8%	14	41%	212	51%
Reservoir fisheries (incremental to BS)	'000	24	193%	0	0%	20	3497%	1	46%	45	298%
Hydropower production	'000	284	545%	1	21%	148	963%	-3	-8%	430	415%
Aquaculture (incremental to BS)	'000	26	94%	38	96%	37	188%	0	0%	101	40%
Overall assessment											
Overall environment impact	Severity	Negative	-2	Negative	-2	Negative	-2	Neutral	0	Negative	-2
Livelihoods	Severity	Mildly negative	-1	Mildly negative	-1	Severely negative	-3	Mildly negative	-1	Negative	-2
Economic production	NPV US$M	12,481	132%	2,919	141%	2,638	203%	1,078	20%	19,116	105%
Other economic impacts	NPV US$M	-149	66%	-44	48%	-1,094	181%	-252	164%	-1,540	143%

LMB 20-Year Plan Scenario with 9 mainstream dams (excl. Cambodian m/stream)

	Irrigation areas		Hydropower and storage dams			Water supply
	Wet season Mha	Dry season Mha	No.	Installed capacity GW	Live storage BCM	Domestic & industrial BCM pa.
Lao PDR	0.45	0.33	47	7.92	36.97	0.44
Thailand	2.64	0.43	7	0.74	3.57	3.57
Cambodia	0.46	0.38	2	0.48	0.38	0.88
Viet Nam - Highland	0.27	0.08	15	2.58	3.16	0.14
Viet Nam - Delta	1.53	0.66	-	-	-	1.10
Mainstream	-	-	9	10.42	3.16	-
Total LMB	**5.34**	**1.88**	**80**	**22.14**	**47.23**	**4.38**
UMB	-	-	6	15.45	23.19	-
Basin total	**5.34**	**1.88**	**86**	**37.59**	**70.42**	**4.38**

Scenario run no.: 6300



Scenario assessment results

Estimated total values

LMB 20-Year Plan Scenario with 9 mainstream dams, excl Cambodia

Scenario run no. 6300

Assessment issue	Unit	3 Lao PDR Amount		4 Thailand Amount		5 Cambodia Amount		6 Viet Nam Amount		Total Amount	
Hydrological assessment											
Key hydrological parameters:	Location	Vientiane		Mudakhan		Kratie		Tan Chau		Average	
Monthly average dry season flow (March)	m3/s	2,194		2,675		3,535		4,175		3,145	
Average peak daily flow in wet season	m3/s	13,627		23,503		43,356		20,466		25,238	
Flow reversal in Tonle Sap:	Location					Prek Kdam				TLS only	
Average flow volume entering Tonle Sap	MCM	n/a		n/a		28,339		n/a		28,339	
Average date of flow reversal (+/-)	Days	n/a		n/a		138		n/a		17-May	
Land use and condition assessment											
Total irrigated area	'000ha	450		2,635		457		1,795		5,337	
Total irrigated cropped area	'000ha	820		3,624		877		4,404		9,725	
Average area flooded: < 0.5m	'000ha	21		23		221		431		697	
Average area flooded: 0.5 - 1.0m	'000ha	19		22		212		717		970	
Average area flooded: 1.0 - 3.0m	'000ha	71		77		668		635		1,450	
Average area flooded: > 3.0m	'000ha	219		167		947		3		1,336	
Area lost to bank erosion	Severity	Mildly negative	-1	Mildly negative	-1	Neutral	0	Neutral	0	Neutral	
Area affected by salinity of > 1.3gm/l	'000ha	0		0		0		1,563		1,563	
Water quality and geomorphology											
Herbicide runoff	tonnes / yr	6,721		29,874		3,483		26,352		66,430	
Insecticide and fungicide runoff	tonnes / yr	6,723		31,752		3,192		27,098		68,765	
Nitrogen runoff from agriculture	tonnes / yr	18,039		51,700		9,377		71,019		150,135	
Phosphorus runoff from agriculture	tonnes / yr	1,954		6,487		1,219		10,683		20,344	
Nitrogen from waste water discharge	tonnes / yr	13,209		14,974		9,396		14,435		52,014	
Phosphorus from waste water discharge	tonnes / yr	3,963		4,492		2,819		4,330		15,604	
BOD from waste water discharge	tonnes / yr	49,534		56,152		35,234		54,130		195,051	
Impact on water quality	Severity	Negative	-2	Mildly negative	-1	Negative	-2	Mildly negative	-1	Negative	-2
Change in sediment supply	Severity	Severely negative	-3	Severely negative	-3	Mildly negative	-1	Mildly negative	-1	Negative	-2
Induced geomorphological changes	Severity	Negative	-2	Negative	-2	Mildly negative	-1	Mildly negative	-1	Negative	-2
Production assessment											
Hydropower generated	GWh / yr	84,416		56,746		3,321		21,240		165,723	
Reservoir fisheries	Mtonne / yr	0		0		0		0		0	
Flood damages	US$M / yr	31		30		12		16		88	
Agricultural production: rice	Mtonne / yr	4		13		5		25		48	
Agricultural production: non-rice	Mtonne / yr	0		4		0		3		8	
Capture fisheries production	Mtonne / yr	0		1		1		0		2	
Aquaculture production	Mtonne / yr	0		0		0		3		4	
Environmental assessment											
Total wetland area: flooded forest	'000ha	0		0		448		46		494	
Total wetland area: marshes	'000ha	6		10		501		0		517	
Total wetland area: inundated grassland	'000ha	5		41		307		55		408	
Tonle Sap only: flooded forest	'000ha	0		0		448		0		448	
Tonle Sap only: marshes	'000ha	0		0		307		0		307	
Tonle Sap only: inundated grassland	'000ha	0		0		269		0		269	
Forest area in reservoir areas	'000ha	94		14		2		7		117	
Number of viable deep pools	No.	12		7		5		5		29	
Status of river channel habitats	Severity	Negative	-2	Negative	-2	Mildly negative	-1	Mildly negative	-1	Negative	-2
Flagship species	Survival	Surviving		Extinct		Surviving		Surviving		Extinct	
Environmental hot spots	Severity	Negative	-2	Severely negative	-3	Severely negative	-3	Neutral	0	Negative	-2
Biodiversity condition	Severity	Severely negative	-3	Severely negative	-3	Mildly negative	-1	Mildly negative	-1	Negative	-2
Economic assessment *(net economic values)*											
Irrigated agricultural production	NPV US$M	322		885		344		108		1,659	
Hydropower generated	NPV US$M	14,585		964		1,168		4,189		20,906	
Hydropower imported/exported	NPV US$M	10,407		2,911		462		958		14,739	
Navigation	NPV US$M	0		246		0		0		246	
Flood damage mitigation	NPV US$M	124		124		47		65		360	
Capture fisheries reduction	NPV US$M	-149		-146		-634		-288		-1,218	
Reservoir fisheries	NPV US$M	135		0		23		10		169	
Aquaculture production	NPV US$M	168		235		174		684		1,261	
Forest area reduction	NPV US$M	-236		0		-4		-14		-254	
Recession rice	NPV US$M	-21		-22		-120		-13		-176	
Wetland area reduction	NPV US$M	-18		-34		-125		-1		-178	
Mitigation of salinity affected areas	NPV US$M	0		0		0		23		23	
Reduction in eco-hotspot/biodiversity	NPV US$M	-50		-60		-195		0		-305	
Total economic impacts	NPV US$M	**25,266**		**5,105**		**1,142**		**5,720**		**37,233**	
Social assessment											
No. of people at risk of loss of livelihood	'000	782		516		352		1,088		2,738	
Severity of impact on livelihoods	Severity	Severely negative	-3	Mildly negative	-1	Severely negative	-3	Negative	-2	Severely negative	-2
No. of people employed in:											
Irrigated agriculture	'000	150		346		84		49		629	
Reservoir fisheries (incremental to BS)	'000	40		0		7		3		51	
Hydropower production	'000	379		42		20		29		469	
Aquaculture (incremental to BS)	'000	55		77		57		164		352	
Overall assessment											
Overall environment impact	Severity	Severely negative	-3	Severely negative	-3	Negative	-2	Mildly negative	-1	Severely negative	-2
Livelihoods	Severity	Severely negative	-3	Mildly negative	-1	Severely negative	-3	Negative	-2	Severely negative	-2
Economic production	NPV US$M	25,617		5,242		2,173		5,949		38,980	
Other economic impacts	NPV US$M	-351		-137		-1,031		-229		-1,748	

Summary of scenario assessment

Incremental values relative to Baseline

LMB 20-Year Plan Scenario with 9 mainstream dams, excl Cambodia

Scenario run no. 6300

Assessment issue	Unit	Lao PDR		Thailand		Cambodia		Viet Nam		Total	
		Amount	Percent	Amount	Percent	Amount	Percent	Amount	Percent	Amount	Percent
Hydrological assessment											
Key hydrological parameters:	Location	Vientiane		Mudakhan		Kratie		Tan Chau		Average	
Monthly average dry season flow (March)	m3/s	1,094	99%	1,222	84%	1,338	61%	1,104	36%	1,189	61%
Average peak daily flow in wet season	m3/s	-2,295	-14%	-1,998	-8%	-3,407	-7%	-844	-4%	-2,136	-8%
Flow reversal in Tonle Sap:	Location					Prek Kdam				TLS only	
Average flow volume entering Tonle Sap	MCM	n/a		n/a		-3,919	-12%	n/a		-3,919	-12%
Average date of flow reversal (+/-)	Days	n/a		n/a		-7	-5%	n/a		-7	-5%
Land use and condition assessment											
Total irrigated area	'000ha	245	120%	1,370	108%	183	67%	-201	-10%	1,597	43%
Total irrigated cropped area	'000ha	488	147%	2,202	155%	314	56%	93	2%	3,096	47%
Average area flooded: < 0.5m	'000ha	-3	-11%	-1	-3%	36	20%	98	29%	131	23%
Average area flooded: 0.5 - 1.0m	'000ha	-5	-21%	-2	-9%	-20	-8%	48	7%	21	2%
Average area flooded: 1.0 - 3.0m	'000ha	-14	-16%	-13	-14%	-44	-6%	-160	-20%	-231	-14%
Average area flooded: > 3.0m	'000ha	-53	-20%	-65	-28%	-108	-10%	-2	-45%	-228	-15%
Area lost to bank erosion	Severity	Mildly negative	-1	Mildly negative	-1	Neutral	0	Neutral	0	Mildly negative	-1
Area affected by salinity of > 1.3gm/l	'000ha	0	0%	0	0%	0	0%	-288	-16%	-288	-16%
Water quality and geomorphology											
Herbicide runoff	tonnes / yr	5,258	359%	18,113	154%	2,575	284%	3,524	15%	29,470	80%
Insecticide and fungicide runoff	tonnes / yr	4,783	247%	18,087	132%	1,737	119%	1,378	5%	25,985	61%
Nitrogen runoff from agriculture	tonnes / yr	14,668	435%	40,070	345%	6,922	282%	7,469	12%	69,128	85%
Phosphorus runoff from agriculture	tonnes / yr	1,647	535%	5,248	424%	938	334%	2,354	28%	10,187	100%
Nitrogen from waste water discharge	tonnes / yr	4,580	53%	997	7%	2,763	42%	4,539	46%	12,879	33%
Phosphorus from waste water discharge	tonnes / yr	1,374	53%	299	7%	829	42%	1,362	46%	3,864	33%
BOD from waste water discharge	tonnes / yr	17,175	53%	3,738	7%	10,362	42%	17,020	46%	48,296	33%
Impact on water quality	Severity	Negative	-2	Mildly negative	-1	Negative	-2	Mildly negative	-1	Negative	-2
Change in sediment supply	Severity	Severely negative	-3	Severely negative	-3	Mildly negative	-1	Mildly negative	-1	Negative	-2
Induced geomorphological changes	Severity	Negative	-2	Negative	-2	Mildly negative	-1	Mildly negative	-1	Negative	-2
Production assessment											
Hydropower generated	GWh / yr	81,384	2684%	54,343	2262%	3,321	0%	17,581	481%	156,630	1723%
Reservoir fisheries	Mtonne / yr	0	63%	0	0%	0	27%	0	11%	0	22%
Flood damages	US$M / yr	-39	-56%	-37	-55%	-15	-56%	-40	-72%	-131	-60%
Agricultural production: rice	Mtonne / yr	3	370%	9	220%	3	176%	7	42%	23	92%
Agricultural production: non-rice	Mtonne / yr	0	744%	3	226%	0	140%	1	56%	4	132%
Capture fisheries production	Mtonne / yr	-0	-18%	-0	-5%	-0	-25%	-0	-23%	-0	-16%
Aquaculture production	Mtonne / yr	0	161%	0	158%	0	91%	2	100%	2	105%
Environmental assessment											
Total wetland area: flooded forest	'000ha	0	0%	0	0%	-4	-1%	-0	0%	-4	-1%
Total wetland area: marshes	'000ha	-2	-24%	-2	-19%	-16	-3%	-0	0%	-21	-4%
Total wetland area: inundated grassland	'000ha	-4	-44%	-9	-18%	-10	-3%	-0	0%	-23	-5%
Tonle Sap only: flooded forest	'000ha	0	0%	0	0%	-4	-1%	0	0%	-4	-1%
Tonle Sap only: marshes	'000ha	0	0%	0	0%	-3	-1%	0	0%	-3	-1%
Tonle Sap only: inundated grassland	'000ha	0	0%	0	0%	-8	-3%	0	0%	-8	-3%
Forest area in reservoir areas	'000ha	81	595%	0	0%	1	92%	5	236%	87	283%
Number of viable deep pools	No.	-8	-40%	-10	-59%	0	0%	0	0%	-18	-38%
Status of river channel habitats	Severity	Negative	-2	Negative	-2	Mildly negative	-1	Mildly negative	-1	Negative	-2
Flagship species	Survival	n/a		n/a		n/a		n/a		n/a	
Environmental hot spots	Severity	Negative	-2	Severely negative	-3	Severely negative	-3	Neutral	0	Negative	-2
Biodiversity condition	Severity	Severely negative	-3	Severely negative	-3	Mildly negative	-1	Mildly negative	-1	Negative	-2
Economic assessment *(net economic values)*											
Irrigated agricultural production	NPV US$M	322	0%	885	0%	344	0%	108	0%	1,659	0%
Hydropower generated	NPV US$M	12,292	536%	473	96%	1,168	0%	2,477	145%	16,410	365%
Hydropower imported/exported	NPV US$M	10,067	2957%	2,702	1292%	462	0%	691	259%	13,922	1705%
Navigation	NPV US$M	0	0%	64	35%	0	0%	0	0%	64	35%
Flood damage mitigation	NPV US$M	124	0%	124	0%	47	0%	65	0%	360	0%
Capture fisheries reduction	NPV US$M	-149	0%	-146	0%	-634	0%	-288	0%	-1,218	0%
Reservoir fisheries	NPV US$M	135	0%	0	0%	23	0%	10	0%	169	0%
Aquaculture production	NPV US$M	168	0%	235	0%	174	0%	684	0%	1,261	0%
Forest area reduction	NPV US$M	-236	0%	0	0%	-4	0%	-14	0%	-254	0%
Recession rice	NPV US$M	-21	0%	-22	0%	-120	0%	-13	0%	-176	0%
Wetland area reduction	NPV US$M	-18	0%	-34	0%	-125	0%	-1	0%	-178	0%
Mitigation of salinity affected areas	NPV US$M	0	0%	0	0%	0	0%	23	0%	23	0%
Reduction in eco-hotspot/biodiversity	NPV US$M	-50	0%	-60	0%	-195	0%	0	0%	-305	0%
Total economic impacts	NPV US$M	**22,632**	859%	**4,223**	479%	**1,142**	0%	**3,741**	189%	**31,738**	578%
Social assessment											
No. of people at risk of loss of livelihood	'000	782	0%	516	0%	352	0%	1,088	0%	2,738	0%
Severity of impact on livelihoods	Severity	Severely negative	-3	Mildly negative	-1	Severely negative	-3	Negative	-2	Severely negative	-2
No. of people employed in:											
Irrigated agriculture	'000	72	91%	119	53%	6	8%	14	41%	212	51%
Reservoir fisheries (incremental to BS)	'000	40	0%	0	0%	7	0%	3	0%	51	0%
Hydropower production	'000	379	0%	42	0%	20	0%	29	0%	469	0%
Aquaculture (incremental to BS)	'000	55	0%	77	0%	57	0%	164	0%	352	0%
Overall assessment											
Overall environment impact	Severity	Severely negative	-3	Severely negative	-3	Negative	-2	Mildly negative	-1	Severely negative	-2
Livelihoods	Severity	Severely negative	-3	Mildly negative	-1	Severely negative	-3	Negative	-2	Severely negative	-2
Economic production	NPV US$M	22,983	873%	4,360	494%	2,173	0%	3,970	201%	33,486	609%
Other economic impacts	NPV US$M	-351	0%	-137	0%	-1,031	0%	-229	0%	-1,748	0%

Summary of scenario assessment

Incremental values relative to Definite Future Scenario

LMB 20-Year Plan Scenario with 9 mainstream dams, excl Cambodia

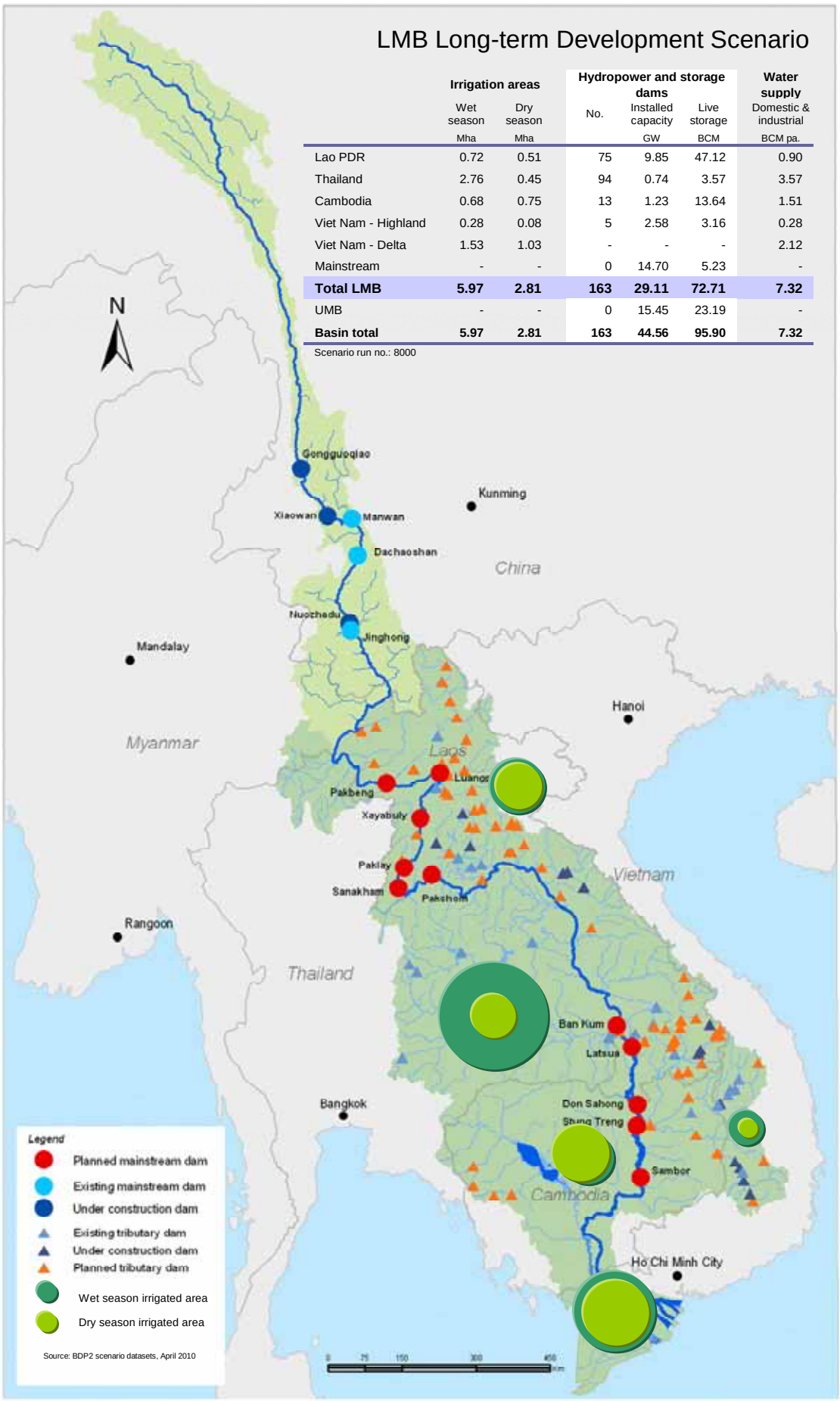
Scenario run no. 6300

Assessment issue	Unit	Lao PDR Amount	Lao PDR Percent	Thailand Amount	Thailand Percent	Cambodia Amount	Cambodia Percent	Viet Nam Amount	Viet Nam Percent	Total Amount	Total Percent
Hydrological assessment											
Key hydrological parameters:	Location	Vientiane		Mudakhan		Kratie		Tan Chau		Average	
Monthly average dry season flow (March)	m3/s	334	18%	303	13%	466	15%	278	7%	345	12%
Average peak daily flow in wet season	m3/s	-187	-1%	-529	-2%	-1,767	-4%	-364	-2%	-712	-3%
Flow reversal in Tonle Sap:	Location					Prek Kdam				TLS only	
Average flow volume entering Tonle Sap	MCM	n/a		n/a		-1,401	-5%	n/a		-1,401	
Average date of flow reversal (+/-)	Days	n/a		n/a		-4	-3%	n/a		-4	
Land use and condition assessment											
Total irrigated area	'000ha	283	170%	1,281	95%	183	67%	125	7%	1,872	54%
Total irrigated cropped area	'000ha	549	203%	1,868	106%	314	56%	186	4%	2,918	43%
Average area flooded: < 0.5m	'000ha	-1	-5%	-0	-1%	5	2%	23	6%	27	4%
Average area flooded: 0.5 - 1.0m	'000ha	-0	-2%	0	0%	4	2%	4	1%	7	1%
Average area flooded: 1.0 - 3.0m	'000ha	-2	-3%	-3	-3%	-8	-1%	-32	-5%	-45	-3%
Average area flooded: > 3.0m	'000ha	-8	-3%	-9	-5%	-30	-3%	-0	-11%	-47	-3%
Area lost to bank erosion	Severity	Negative	-2	Negative	-2	Neutral	0	Neutral	0	Mildly negative	-1
Area affected by salinity of > 1.3gm/l	'000ha	0	0%	0	0%	0	0%	-16	-1%	-16	-1%
Water quality and geomorphology											
Herbicide runoff	tonnes / yr	5,258	359%	18,113	154%	2,575	284%	3,524	15%	29,470	80%
Insecticide and fungicide runoff	tonnes / yr	4,783	247%	18,087	132%	1,737	119%	1,378	5%	25,985	61%
Nitrogen runoff from agriculture	tonnes / yr	14,668	435%	40,070	345%	6,922	282%	7,469	12%	69,128	85%
Phosphorus runoff from agriculture	tonnes / yr	1,647	535%	5,248	424%	938	334%	2,354	28%	10,187	100%
Nitrogen from waste water discharge	tonnes / yr	4,580	53%	997	7%	2,763	42%	4,539	46%	12,879	33%
Phosphorus from waste water discharge	tonnes / yr	1,374	53%	299	7%	829	42%	1,362	46%	3,864	33%
BOD from waste water discharge	tonnes / yr	17,175	53%	3,738	7%	10,362	42%	17,020	46%	48,296	33%
Impact on water quality	Severity	Severely negative	-3	Negative	-2	Severely negative	-3	Negative	-2	Severely negative	-3
Change in sediment supply	Severity	Mildly negative	-1	Mildly negative	-1	Neutral	0	Mildly negative	-1	Mildly negative	-1
Induced geomorphological changes	Severity	Mildly negative	-1	Mildly negative	-1	Mildly negative	-1	Mildly negative	-1	Mildly negative	-1
Production assessment											
Hydropower generated	GWh / yr	68,013	415%	44,567	366%	986	42%	7,647	56%	121,213	272%
Reservoir fisheries	Mtonne / yr	0	37%	0	0%	0	24%	0	3%	0	15%
Flood damages	US$M / yr	3	10%	3	13%	4	46%	6	70%	16	23%
Agricultural production: rice	Mtonne / yr	3	370%	9	220%	3	176%	7	42%	23	92%
Agricultural production: non-rice	Mtonne / yr	0	744%	3	226%	0	140%	1	56%	4	132%
Capture fisheries production	Mtonne / yr	-0	-3%	-0	-1%	-0	-19%	-0	-15%	-0	-10%
Aquaculture production	Mtonne / yr	0	36%	0	42%	0	45%	1	33%	1	35%
Environmental assessment											
Total wetland area: flooded forest	'000ha	0	0%	0	0%	-2	0%	-0	0%	-2	0%
Total wetland area: marshes	'000ha	-0	-4%	-0	-4%	-5	-1%	-0	0%	-5	-1%
Total wetland area: inundated grassland	'000ha	-1	-12%	-1	-3%	-3	-1%	-0	0%	-5	-1%
Tonle Sap only: flooded forest	'000ha	0	0%	0	0%	-2	0%	0	0%	-2	0%
Tonle Sap only: marshes	'000ha	0	0%	0	0%	-1	0%	0	0%	-1	0%
Tonle Sap only: inundated grassland	'000ha	0	0%	0	0%	-3	-1%	0	0%	-3	-1%
Forest area in reservoir areas	'000ha	56	146%	0	0%	0	0%	2	29%	58	96%
Number of viable deep pools	No.	-8	-40%	-10	-59%	0	0%	0	0%	-18	-38%
Status of river channel habitats	Severity	Mildly negative	-1	Mildly negative	-1	Mildly negative	-1	Mildly negative	-1	Mildly negative	-1
Flagship species	Survival	n/a		n/a		n/a		n/a		n/a	
Environmental hot spots	Severity	Negative	-2	Negative	-2	Severely negative	-2	Neutral	0	Negative	-2
Biodiversity condition	Severity	Negative	-2	Negative	-2	Neutral	0	Neutral	0	Mildly negative	-1
Economic assessment *(net economic values)*											
Irrigated agricultural production	NPV US$M	322	0%	885	0%	344	0%	108	0%	1,659	0%
Hydropower generated	NPV US$M	6,899	90%	373	63%	420	56%	368	10%	8,061	63%
Hydropower imported/exported	NPV US$M	8,840	564%	1,851	175%	5	1%	84	10%	10,781	272%
Navigation	NPV US$M	0	0%	0	0%	0	0%	0	0%	0	0%
Flood damage mitigation	NPV US$M	-55	-31%	-48	-28%	-4	-8%	5	8%	-102	-22%
Capture fisheries reduction	NPV US$M	79	-35%	42	-22%	-311	96%	-81	39%	-272	29%
Reservoir fisheries	NPV US$M	61	82%	0	0%	20	575%	-3	-21%	78	86%
Aquaculture production	NPV US$M	42	33%	61	35%	86	98%	-58	-8%	132	12%
Forest area reduction	NPV US$M	-106	82%	0	0%	3	-44%	3	-19%	-100	65%
Recession rice	NPV US$M	-2	12%	-11	112%	-14	13%	-4	50%	-32	22%
Wetland area reduction	NPV US$M	8	-31%	14	-29%	28	-19%	-1	82%	50	-22%
Mitigation of salinity affected areas	NPV US$M	0	0%	0	0%	0	0%	3	15%	3	15%
Reduction in eco-hotspot/biodiversity	NPV US$M	-50	0%	-40	200%	-130	200%	0	0%	-220	259%
Total economic impacts	NPV US$M	**16,037**	174%	**3,128**	158%	**449**	65%	**424**	8%	**20,038**	117%
Social assessment											
No. of people at risk of loss of livelihood	'000	485	163%	470	1022%	250	245%	646	146%	1,851	209%
Severity of impact on livelihoods	Severity	Mildly negative	-1	Neutral	0	Negative	-2	Mildly negative	-1	Mildly negative	-1
No. of people employed in:											
Irrigated agriculture	'000	72	91%	119	53%	6	8%	14	41%	212	51%
Reservoir fisheries (incremental to BS)	'000	28	226%	0	0%	6	1100%	1	46%	35	233%
Hydropower production	'000	327	628%	37	711%	5	32%	-3	-8%	366	353%
Aquaculture (incremental to BS)	'000	26	94%	38	96%	37	188%	0	0%	101	40%
Overall assessment											
Overall environment impact	Severity	Negative	-2	Negative	-2	Mildly negative	-1	Neutral	0	Negative	-1
Livelihoods	Severity	Mildly negative	-1	Neutral	0	Negative	-2	Mildly negative	-1	Mildly negative	-1
Economic production	NPV US$M	16,163	171%	3,172	153%	876	68%	499	9%	20,711	113%
Other economic impacts	NPV US$M	-126	56%	-44	47%	-427	71%	-75	49%	-673	63%

LMB Long-term Development Scenario

	Irrigation areas		Hydropower and storage dams			Water supply
	Wet season	Dry season	No.	Installed capacity	Live storage	Domestic & industrial
	Mha	Mha		GW	BCM	BCM pa.
Lao PDR	0.72	0.51	75	9.85	47.12	0.90
Thailand	2.76	0.45	94	0.74	3.57	3.57
Cambodia	0.68	0.75	13	1.23	13.64	1.51
Viet Nam - Highland	0.28	0.08	5	2.58	3.16	0.28
Viet Nam - Delta	1.53	1.03	-	-	-	2.12
Mainstream	-	-	0	14.70	5.23	-
Total LMB	**5.97**	**2.81**	**163**	**29.11**	**72.71**	**7.32**
UMB	-	-	0	15.45	23.19	-
Basin total	**5.97**	**2.81**	**163**	**44.56**	**95.90**	**7.32**

Scenario run no.: 8000



Scenario assessment results

Estimated total values

LMB Long-term Development Scenario

Scenario run no. 8000

Assessment issue	Unit	3 Lao PDR Amount		4 Thailand Amount		5 Cambodia Amount		6 Viet Nam Amount		Total Amount	
Hydrological assessment											
Key hydrological parameters:	Location	Vientiane		Mudakhan		Kratie		Tan Chau		Average	
Monthly average dry season flow (March)	m3/s	2,200		2,608		3,708		4,103		3,155	
Average peak daily flow in wet season	m3/s	13,597		23,574		41,698		20,160		24,757	
Flow reversal in Tonle Sap:	Location					Prek Kdam				TLS only	
Average flow volume entering Tonle Sap	MCM	n/a		n/a		26,937		n/a		26,937	
Average date of flow reversal (+/-)	Days	n/a		n/a		133		n/a		12-May	
Land use and condition assessment											
Total irrigated area	'000ha	715		2,760		678		1,813		5,966	
Total irrigated cropped area	'000ha	1,335		3,896		1,833		4,890		11,953	
Average area flooded: < 0.5m	'000ha	21		23		221		458		723	
Average area flooded: 0.5 - 1.0m	'000ha	20		22		216		718		975	
Average area flooded: 1.0 - 3.0m	'000ha	70		78		658		595		1,401	
Average area flooded: > 3.0m	'000ha	219		169		920		3		1,311	
Area lost to bank erosion	Severity	Negative	-2	Negative	-2	Severely negative	-3	Severely negative	-3	Neutral	
Area affected by salinity of > 1.3gm/l	'000ha	0		0		0		1,553		1,553	
Water quality and geomorphology											
Herbicide runoff	tonnes / yr	9,789		32,504		3,818		35,445		81,556	
Insecticide and fungicide runoff	tonnes / yr	10,198		35,366		3,562		35,646		84,772	
Nitrogen runoff from agriculture	tonnes / yr	26,440		57,225		10,417		96,963		191,045	
Phosphorus runoff from agriculture	tonnes / yr	2,897		7,191		1,357		14,792		26,238	
Nitrogen from waste water discharge	tonnes / yr	23,268		16,382		14,549		20,748		74,947	
Phosphorus from waste water discharge	tonnes / yr	6,980		4,915		4,365		6,224		22,484	
BOD from waste water discharge	tonnes / yr	87,253		61,432		54,560		77,804		281,049	
Impact on water quality	Severity	Negative	-2	Mildly negative	-1	Negative	-2	Negative	-2	Negative	-2
Change in sediment supply	Severity	Severely negative	-3	Severely negative	-3	Extremely negative	-4	Extremely negative	-4	Extremely negative	-4
Induced geomorphological changes	Severity	Severely negative	-3	Severely negative	-3	Extremely negative	-4	Severely negative	-3	Extremely negative	-3
Production assessment											
Hydropower generated	GWh / yr	92,156		60,865		26,912		35,961		215,893	
Reservoir fisheries	Mtonne / yr	0		0		0		0		0	
Flood damages	US$M / yr	33		32		12		17		95	
Agricultural production: rice	Mtonne / yr	7		15		11		29		62	
Agricultural production: non-rice	Mtonne / yr	1		6		0		3		10	
Capture fisheries production	Mtonne / yr	0		1		0		0		2	
Aquaculture production	Mtonne / yr	0		0		0		5		6	
Environmental assessment											
Total wetland area: flooded forest	'000ha	0		0		447		45		492	
Total wetland area: marshes	'000ha	6		10		497		0		514	
Total wetland area: inundated grassland	'000ha	5		41		305		55		406	
Tonle Sap only: flooded forest	'000ha	0		0		446		0		446	
Tonle Sap only: marshes	'000ha	0		0		306		0		306	
Tonle Sap only: inundated grassland	'000ha	0		0		267		0		267	
Forest area in reservoir areas	'000ha	117		14		142		7		280	
Number of viable deep pools	No.	12		7		3		5		27	
Status of river channel habitats	Severity	Severely negative	-3	Severely negative	-3	Extremely negative	-4	Severely negative	-3	Extremely negative	-3
Flagship species	Survival	Extinct		Extinct		Extinct		Surviving		Extinct	
Environmental hot spots	Severity	Catastrophic	-4	Extremely negative	-4	Extremely negative	-3	Negative	-2	Extremely negative	-3
Biodiversity condition	Severity	Severely negative	-3	Severely negative	-3	Severely negative	-3	Severely negative	-3	Severely negative	-3
Economic assessment *(net economic values)*											
Irrigated agricultural production	NPV US$M	796		1,367		1,694		411		4,267	
Hydropower generated	NPV US$M	17,734		972		2,876		4,696		26,278	
Hydropower imported/exported	NPV US$M	10,533		3,109		2,190		1,066		16,898	
Navigation	NPV US$M	0		246		0		0		246	
Flood damage mitigation	NPV US$M	141		140		54		73		408	
Capture fisheries reduction	NPV US$M	-150		-159		-1,045		-464		-1,818	
Reservoir fisheries	NPV US$M	174		0		236		11		420	
Aquaculture production	NPV US$M	252		353		262		1,025		1,892	
Forest area reduction	NPV US$M	-304		0		-413		-14		-731	
Recession rice	NPV US$M	-24		-23		-155		-25		-226	
Wetland area reduction	NPV US$M	-18		-32		-202		-8		-260	
Mitigation of salinity affected areas	NPV US$M	0		0		0		22		22	
Reduction in eco-hotspot/biodiversity	NPV US$M	-100		-80		-195		-60		-435	
Total economic impacts	NPV US$M	**29,035**		**5,892**		**5,302**		**6,733**		**46,963**	
Social assessment											
No. of people at risk of loss of livelihood	'000	1,029		516		1,224		1,737		4,506	
Severity of impact on livelihoods	Severity	Severely negative	-3	Severely negative	-3	Extremely negative	-4	Negative	-2	Severely negative	-3
No. of people employed in:											
Irrigated agriculture	'000	286		449		286		53		1,076	
Reservoir fisheries (incremental to BS)	'000	52		0		71		3		126	
Hydropower production	'000	360		0		149		18		527	
Aquaculture (incremental to BS)	'000	82		115		85		246		528	
Overall assessment											
Overall environment impact	Severity	Severely negative	-3	Severely negative	-3	Severely negative	-3	Severely negative	-3	Severely negative	-3
Livelihoods	Severity	Severely negative	-3	Severely negative	-3	Extremely negative	-4	Negative	-2	Severely negative	-3
Economic production	NPV US$M	29,489		6,046		7,257		7,209		50,002	
Other economic impacts	NPV US$M	-454		-155		-1,955		-476		-3,040	

Summary of scenario assessment

Incremental values relative to Baseline

LMB Long-term Development Scenario

Scenario run no. 8000

Assessment issue	Unit	Lao PDR		Thailand		Cambodia		Viet Nam		Total	
		Amount	Percent	Amount	Percent	Amount	Percent	Amount	Percent	Amount	Percent
Hydrological assessment											
Key hydrological parameters:	Location	Vientiane		Mudakhan		Kratie		Tan Chau		Average	
Monthly average dry season flow (March)	m3/s	1,100	100%	1,155	80%	1,510	69%	1,031	34%	1,199	61%
Average peak daily flow in wet season	m3/s	-2,324	-15%	-1,927	-8%	-5,065	-11%	-1,150	-5%	-2,617	-10%
Flow reversal in Tonle Sap:	Location					Prek Kdam				TLS only	
Average flow volume entering Tonle Sap	MCM	n/a		n/a		-5,322	-16%	n/a		-5,322	-16%
Average date of flow reversal (+/-)	Days	n/a		n/a		-12	-8%	n/a		-12	-8%
Land use and condition assessment											
Total irrigated area	'000ha	511	250%	1,494	118%	405	148%	-183	-9%	2,226	60%
Total irrigated cropped area	'000ha	1,003	302%	2,474	174%	1,270	226%	578	13%	5,324	80%
Average area flooded: < 0.5m	'000ha	-3	-13%	-1	-3%	36	20%	124	37%	157	28%
Average area flooded: 0.5 - 1.0m	'000ha	-5	-19%	-2	-9%	-16	-7%	49	7%	27	3%
Average area flooded: 1.0 - 3.0m	'000ha	-14	-16%	-12	-13%	-54	-8%	-199	-25%	-279	-17%
Average area flooded: > 3.0m	'000ha	-53	-19%	-63	-27%	-135	-13%	-2	-46%	-253	-16%
Area lost to bank erosion	Severity	Negative	-2	Negative	-2	Severely negative	-3	Severely negative	-3	Severely negative	-3
Area affected by salinity of > 1.3gm/l	'000ha	0	0%	0	0%	0	0%	-299	-16%	-299	-16%
Water quality and geomorphology											
Herbicide runoff	tonnes / yr	8,326	569%	20,743	176%	2,910	321%	12,618	55%	44,597	121%
Insecticide and fungicide runoff	tonnes / yr	8,259	426%	21,701	159%	2,107	145%	9,925	39%	41,992	98%
Nitrogen runoff from agriculture	tonnes / yr	23,068	684%	45,595	392%	7,962	324%	33,412	53%	110,037	136%
Phosphorus runoff from agriculture	tonnes / yr	2,589	842%	5,952	480%	1,077	383%	6,464	78%	16,082	158%
Nitrogen from waste water discharge	tonnes / yr	14,639	170%	2,405	17%	7,917	119%	10,852	110%	35,812	92%
Phosphorus from waste water discharge	tonnes / yr	4,392	170%	721	17%	2,375	119%	3,256	110%	10,744	92%
BOD from waste water discharge	tonnes / yr	54,895	170%	9,018	17%	29,688	119%	40,694	110%	134,295	92%
Impact on water quality	Severity	Negative	-2	Mildly negative	-1	Negative	-2	Negative	-2	Negative	-2
Change in sediment supply	Severity	Severely negative	-3	Severely negative	-3	Extremely negative	-4	Extremely negative	-4	Extremely negative	-4
Induced geomorphological changes	Severity	Severely negative	-3	Severely negative	-3	Extremely negative	-4	Severely negative	-3	Extremely negative	-3
Production assessment											
Hydropower generated	GWh / yr	89,124	2940%	58,462	2433%	26,912	0%	32,302	883%	206,800	2274%
Reservoir fisheries	Mtonne / yr	0	81%	0	0%	0	276%	0	11%	0	56%
Flood damages	US$M / yr	-37	-52%	-34	-51%	-14	-53%	-39	-70%	-124	-57%
Agricultural production: rice	Mtonne / yr	6	709%	11	269%	9	475%	11	63%	37	150%
Agricultural production: non-rice	Mtonne / yr	1	2484%	4	336%	0	173%	1	49%	6	191%
Capture fisheries production	Mtonne / yr	-0	-18%	-0	-5%	-0	-41%	-0	-38%	-1	-24%
Aquaculture production	Mtonne / yr	0	292%	0	287%	0	187%	3	200%	4	207%
Environmental assessment											
Total wetland area: flooded forest	'000ha	0	0%	0	0%	-5	-1%	-1	-1%	-6	-1%
Total wetland area: marshes	'000ha	-2	-23%	-2	-18%	-20	-4%	-0	0%	-24	-5%
Total wetland area: inundated grassland	'000ha	-4	-42%	-9	-17%	-13	-4%	-0	0%	-25	-6%
Tonle Sap only: flooded forest	'000ha	0	0%	0	0%	-5	-1%	0	0%	-5	-1%
Tonle Sap only: marshes	'000ha	0	0%	0	0%	-3	-1%	0	0%	-3	-1%
Tonle Sap only: inundated grassland	'000ha	0	0%	0	0%	-10	-4%	0	0%	-10	-4%
Forest area in reservoir areas	'000ha	104	765%	0	0%	141	11319%	5	236%	250	816%
Number of viable deep pools	No.	-8	-40%	-10	-59%	-2	-40%	0	0%	-20	-43%
Status of river channel habitats	Severity	Severely negative	-3	Severely negative	-3	Extremely negative	-4	Severely negative	-3	Extremely negative	-3
Flagship species	Survival	n/a		n/a		n/a		n/a		n/a	
Environmental hot spots	Severity	Catastrophic	-4	Extremely negative	-4	Extremely negative	-3	Negative	-2	Extremely negative	-3
Biodiversity condition	Severity	Severely negative	-3	Severely negative	-3	Severely negative	-3	Severely negative	-3	Severely negative	-3
Economic assessment *(net economic values)*											
Irrigated agricultural production	NPV US$M	796	0%	1,367	0%	1,694	0%	411	0%	4,267	0%
Hydropower generated	NPV US$M	15,441	673%	481	98%	2,876	0%	2,985	174%	21,783	485%
Hydropower imported/exported	NPV US$M	10,193	2994%	2,900	1386%	2,190	0%	799	299%	16,082	1969%
Navigation	NPV US$M	0	0%	64	35%	0	0%	0	0%	64	35%
Flood damage mitigation	NPV US$M	141	0%	140	0%	54	0%	73	0%	408	0%
Capture fisheries reduction	NPV US$M	-150	0%	-159	0%	-1,045	0%	-464	0%	-1,818	0%
Reservoir fisheries	NPV US$M	174	0%	0	0%	236	0%	11	0%	420	0%
Aquaculture production	NPV US$M	252	0%	353	0%	262	0%	1,025	0%	1,892	0%
Forest area reduction	NPV US$M	-304	0%	0	0%	-413	0%	-14	0%	-731	0%
Recession rice	NPV US$M	-24	0%	-23	0%	-155	0%	-25	0%	-226	0%
Wetland area reduction	NPV US$M	-18	0%	-32	0%	-202	0%	-8	0%	-260	0%
Mitigation of salinity affected areas	NPV US$M	0	0%	0	0%	0	0%	22	0%	22	0%
Reduction in eco-hotspot/biodiversity	NPV US$M	-100	0%	-80	0%	-195	0%	-60	0%	-435	0%
Total economic impacts	NPV US$M	**26,401**	1002%	**5,010**	568%	**5,302**	0%	**4,755**	240%	**41,468**	755%
Social assessment											
No. of people at risk of loss of livelihood	'000	1,029	0%	516	0%	1,224	0%	1,737	0%	4,506	0%
Severity of impact on livelihoods	Severity	Severely negative	-3	Severely negative	-3	Extremely negative	-4	Negative	-2	Severely negative	-3
No. of people employed in:											
Irrigated agriculture	'000	208	264%	223	98%	209	270%	19	53%	658	157%
Reservoir fisheries (incremental to BS)	'000	52	0%	0	0%	71	0%	3	0%	126	0%
Hydropower production	'000	360	0%	0	0%	149	0%	18	0%	527	0%
Aquaculture (incremental to BS)	'000	82	0%	115	0%	85	0%	246	0%	528	0%
Overall assessment											
Overall environment impact	Severity	Severely negative	-3	Severely negative	-3	Severely negative	-3	Severely negative	-3	Severely negative	-3
Livelihoods	Severity	Severely negative	-3	Severely negative	-3	Extremely negative	-4	Negative	-2	Severely negative	-3
Economic production	NPV US$M	26,855	1020%	5,164	585%	7,257	0%	5,231	264%	44,508	810%
Other economic impacts	NPV US$M	-454	0%	-155	0%	-1,955	0%	-476	0%	-3,040	0%

Summary of scenario assessment

Incremental values relative to Definite Future Scenario

LMB Long-term Development Scenario

Scenario run no. 8000

Assessment issue	Unit	Lao PDR		Thailand		Cambodia		Viet Nam		Total	
		Amount	Percent	Amount	Percent	Amount	Percent	Amount	Percent	Amount	Percent
Hydrological assessment											
Key hydrological parameters:	Location	Vientiane		Mudakhan		Kratie		Tan Chau		Average	
Monthly average dry season flow (March)	m3/s	340	18%	236	10%	639	21%	205	5%	355	13%
Average peak daily flow in wet season	m3/s	-217	-2%	-458	-2%	-3,425	-8%	-670	-3%	-1,192	-5%
Flow reversal in Tonle Sap:	Location					Prek Kdam				TLS only	
Average flow volume entering Tonle Sap	MCM	n/a		n/a		-2,803	-9%	n/a		-2,803	
Average date of flow reversal (+/-)	Days	n/a		n/a		-9	-6%	n/a		-9	
Land use and condition assessment											
Total irrigated area	'000ha	549	330%	1,405	104%	405	148%	143	9%	2,501	72%
Total irrigated cropped area	'000ha	1,064	393%	2,140	122%	1,270	226%	672	16%	5,146	76%
Average area flooded: < 0.5m	'000ha	-2	-7%	-0	-2%	5	2%	50	12%	53	8%
Average area flooded: 0.5 - 1.0m	'000ha	0	1%	0	0%	8	4%	5	1%	13	1%
Average area flooded: 1.0 - 3.0m	'000ha	-2	-3%	-2	-2%	-18	-3%	-72	-11%	-93	-6%
Average area flooded: > 3.0m	'000ha	-7	-3%	-7	-4%	-57	-6%	-0	-13%	-72	-5%
Area lost to bank erosion	Severity	Severely negative	-3	Severely negative	-3	Severely negative	-3	Severely negative	-3	Severely negative	-3
Area affected by salinity of > 1.3gm/l	'000ha	0	0%	0	0%	0	0%	-27	-2%	-27	-2%
Water quality and geomorphology											
Herbicide runoff	tonnes / yr	8,326	569%	20,743	176%	2,910	321%	12,618	55%	44,597	121%
Insecticide and fungicide runoff	tonnes / yr	8,259	426%	21,701	159%	2,107	145%	9,925	39%	41,992	98%
Nitrogen runoff from agriculture	tonnes / yr	23,068	684%	45,595	392%	7,962	324%	33,412	53%	110,037	136%
Phosphorus runoff from agriculture	tonnes / yr	2,589	842%	5,952	480%	1,077	383%	6,464	78%	16,082	158%
Nitrogen from waste water discharge	tonnes / yr	14,639	170%	2,405	17%	7,917	119%	10,852	110%	35,812	92%
Phosphorus from waste water discharge	tonnes / yr	4,392	170%	721	17%	2,375	119%	3,256	110%	10,744	92%
BOD from waste water discharge	tonnes / yr	54,895	170%	9,018	17%	29,688	119%	40,694	110%	134,295	92%
Impact on water quality	Severity	Severely negative	-3	Negative	-2	Severely negative	-3	Severely negative	-3	Severely negative	-3
Change in sediment supply	Severity	Mildly negative	-1	Mildly negative	-1	Severely negative	-3	Extremely negative	-4	Severely negative	-2
Induced geomorphological changes	Severity	Negative	-2	Negative	-2	Extremely negative	-4	Severely negative	-3	Severely negative	-3
Production assessment											
Hydropower generated	GWh / yr	75,753	462%	48,686	400%	24,577	1053%	22,367	165%	171,383	385%
Reservoir fisheries	Mtonne / yr	0	52%	0	0%	0	267%	0	3%	0	46%
Flood damages	US$M / yr	5	19%	6	22%	5	58%	8	83%	23	33%
Agricultural production: rice	Mtonne / yr	6	709%	11	269%	9	475%	11	63%	37	150%
Agricultural production: non-rice	Mtonne / yr	1	2484%	4	336%	0	173%	1	49%	6	191%
Capture fisheries production	Mtonne / yr	-0	-3%	-0	-2%	-0	-36%	-0	-31%	-0	-18%
Aquaculture production	Mtonne / yr	0	104%	0	113%	0	118%	2	100%	3	102%
Environmental assessment											
Total wetland area: flooded forest	'000ha	0	0%	0	0%	-3	-1%	-1	-1%	-4	-1%
Total wetland area: marshes	'000ha	-0	-3%	-0	-3%	-9	-2%	0	0%	-9	-2%
Total wetland area: inundated grassland	'000ha	-1	-9%	-1	-2%	-6	-2%	-0	0%	-7	-2%
Tonle Sap only: flooded forest	'000ha	0	0%	0	0%	-3	-1%	0	0%	-3	-1%
Tonle Sap only: marshes	'000ha	0	0%	0	0%	-1	0%	0	0%	-1	0%
Tonle Sap only: inundated grassland	'000ha	0	0%	0	0%	-5	-2%	0	0%	-5	-2%
Forest area in reservoir areas	'000ha	79	207%	0	0%	140	5841%	2	29%	221	369%
Number of viable deep pools	No.	-8	-40%	-10	-59%	-2	-40%	0	0%	-20	-43%
Status of river channel habitats	Severity	Negative	-2	Negative	-2	Extremely negative	-4	Severely negative	-3	Severely negative	-3
Flagship species	Survival	n/a		n/a		n/a		n/a		n/a	
Environmental hot spots	Severity	Catastrophic	-4	Severely negative	-2	Severely negative	-3	Negative	-2	Severely negative	-3
Biodiversity condition	Severity	Negative	-2	Negative	-2	Negative	-2	Negative	-2	Negative	-2
Economic assessment *(net economic values)*											
Irrigated agricultural production	NPV US$M	796	0%	1,367	0%	1,694	0%	411	0%	4,267	0%
Hydropower generated	NPV US$M	10,048	131%	381	65%	2,128	285%	875	23%	13,433	105%
Hydropower imported/exported	NPV US$M	8,966	572%	2,049	193%	1,733	379%	192	22%	12,940	327%
Navigation	NPV US$M	0	0%	0	0%	0	0%	0	0%	0	0%
Flood damage mitigation	NPV US$M	-38	-21%	-32	-19%	3	6%	13	22%	-54	-12%
Capture fisheries reduction	NPV US$M	78	-34%	28	-15%	-721	223%	-257	124%	-872	92%
Reservoir fisheries	NPV US$M	99	134%	0	0%	232	6732%	-2	-19%	329	362%
Aquaculture production	NPV US$M	126	100%	179	103%	174	197%	284	38%	762	68%
Forest area reduction	NPV US$M	-174	134%	0	0%	-406	6449%	3	-19%	-577	376%
Recession rice	NPV US$M	-5	25%	-13	125%	-49	46%	-16	183%	-82	57%
Wetland area reduction	NPV US$M	9	-35%	15	-32%	-48	32%	-8	1237%	-32	14%
Mitigation of salinity affected areas	NPV US$M	0	0%	0	0%	0	0%	2	10%	2	10%
Reduction in eco-hotspot/biodiversity	NPV US$M	-100	0%	-60	300%	-130	200%	-60	0%	-350	412%
Total economic impacts	NPV US$M	**19,806**	215%	**3,914**	198%	**4,609**	665%	**1,438**	27%	**29,768**	173%
Social assessment											
No. of people at risk of loss of livelihood	'000	732	246%	470	1022%	1,122	1100%	1,295	293%	3,619	408%
Severity of impact on livelihoods	Severity	Mildly negative	-1	Negative	-2	Severely negative	-3	Mildly negative	-1	Negative	-2
No. of people employed in:											
Irrigated agriculture	'000	208	264%	223	98%	209	270%	19	53%	658	157%
Reservoir fisheries (incremental to BS)	'000	40	320%	0	0%	70	12065%	1	46%	111	729%
Hydropower production	'000	308	592%	-5	-100%	134	873%	-13	-42%	424	409%
Aquaculture (incremental to BS)	'000	54	190%	76	194%	65	331%	82	50%	277	110%
Overall assessment											
Overall environment impact	Severity	Negative	-2	Negative	-2	Negative	-2	Negative	-2	Negative	-2
Livelihoods	Severity	Mildly negative	-1	Negative	-2	Severely negative	-3	Mildly negative	-1	Negative	-2
Economic production	NPV US$M	20,036	212%	3,976	192%	5,961	460%	1,760	32%	31,733	174%
Other economic impacts	NPV US$M	-229	102%	-61	66%	-1,352	224%	-322	210%	-1,965	183%

Scenario assessment results

Estimated total values

LMB Long-term Development Scenario
Climate change

Scenario run no. 8001

Assessment issue	Unit	3 Lao PDR Amount	4 Thailand Amount	5 Cambodia Amount	6 Viet Nam Amount	Total Amount
Hydrological assessment						
Key hydrological parameters:	Location	Vientiane	Mudakhan	Kratie	Tan Chau	Average
Monthly average dry season flow (March)	m3/s	2,250	2,664	3,716	4,107	3,184
Average peak daily flow in wet season	m3/s	13,738	26,083	48,886	21,154	27,465
Flow reversal in Tonle Sap:	Location			Prek Kdam		TLS only
Average flow volume entering Tonle Sap	MCM	n/a	n/a	29,781	n/a	29,781
Average date of flow reversal (+/-)	Days	n/a	n/a	126	n/a	5-May
Land use and condition assessment						
Total irrigated area	'000ha	715	2,760	678	1,813	5,966
Total irrigated cropped area	'000ha	1,335	3,896	1,833	4,890	11,953
Average area flooded: < 0.5m	'000ha	27	27	230	84	368
Average area flooded: 0.5 - 1.0m	'000ha	25	28	203	629	886
Average area flooded: 1.0 - 3.0m	'000ha	105	107	745	1,134	2,091
Average area flooded: > 3.0m	'000ha	303	262	1,122	8	1,696
Area lost to bank erosion	Severity	Negative -2	Negative -2	Severely negative -3	Severely negative -3	Neutral
Area affected by salinity of > 1.3gm/l	'000ha	0	0	0	2,149	2,149
Water quality and geomorphology						
Herbicide runoff	tonnes / yr	6,721	29,874	3,483	26,352	66,430
Insecticide and fungicide runoff	tonnes / yr	6,723	31,752	3,192	27,098	68,765
Nitrogen runoff from agriculture	tonnes / yr	18,039	51,700	9,377	71,019	150,135
Phosphorus runoff from agriculture	tonnes / yr	1,954	6,487	1,219	10,683	20,344
Nitrogen from waste water discharge	tonnes / yr	13,209	14,974	9,396	14,435	52,014
Phosphorus from waste water discharge	tonnes / yr	3,963	4,492	2,819	4,330	15,604
BOD from waste water discharge	tonnes / yr	49,534	56,152	35,234	54,130	195,051
Impact on water quality	Severity	Negative -2	Mildly negative -1	Negative -2	Mildly negative -1	Negative -2
Change in sediment supply	Severity	Severely negative -3	Severely negative -3	Severely negative -3	Severely negative -3	Severely negative -3
Induced geomorphological changes	Severity	Severely negative -3	Severely negative -3	Extremely negative -4	Severely negative -3	Extremely negative -3
Production assessment						
Hydropower generated	GWh / yr	92,156	60,865	26,912	35,961	215,893
Reservoir fisheries	Mtonne / yr	0	0	0	0	0
Flood damages	US$M / yr	33	32	19	34	118
Agricultural production: rice	Mtonne / yr	7	15	11	29	62
Agricultural production: non-rice	Mtonne / yr	1	6	0	3	10
Capture fisheries production	Mtonne / yr	0	0	0	0	0
Aquaculture production	Mtonne / yr	0	0	0	5	6
Environmental assessment						
Total wetland area: flooded forest	'000ha	0	0	451	46	497
Total wetland area: marshes	'000ha	11	13	530	0	555
Total wetland area: inundated grassland	'000ha	12	54	319	55	440
Tonle Sap only: flooded forest	'000ha	0	0	450	0	450
Tonle Sap only: marshes	'000ha	0	0	308	0	308
Tonle Sap only: inundated grassland	'000ha	0	0	273	0	273
Forest area in reservoir areas	'000ha	0	0	0	0	0
Number of viable deep pools	No.	12	7	3	5	27
Status of river channel habitats	Severity	Severely negative -3	Severely negative -3	Extremely negative -4	Extremely negative -4	Extremely negative -4
Flagship species	Survival	Extinct	Extinct	Extinct	Surviving	Extinct
Environmental hot spots	Severity	Catastrophic -4	Extremely negative -4	Extremely negative -3	Catastrophic -5	Catastrophic -4
Biodiversity condition	Severity	Severely negative -3	Severely negative -3	Negative -2	Negative -2	Severely negative -3
Economic assessment *(net economic values)*						
Irrigated agricultural production	NPV US$M	796	1,367	1,694	411	4,267
Hydropower generated	NPV US$M	17,734	972	2,876	4,696	26,278
Hydropower imported/exported	NPV US$M	10,533	3,109	2,190	1,066	16,898
Navigation	NPV US$M	0	246	0	0	246
Flood damage mitigation	NPV US$M	141	140	-244	-332	-296
Capture fisheries reduction	NPV US$M	-150	-159	-1,045	-464	-1,818
Reservoir fisheries	NPV US$M	174	0	236	11	420
Aquaculture production	NPV US$M	252	353	262	1,025	1,892
Forest area reduction	NPV US$M	-304	0	-413	-14	-731
Recession rice	NPV US$M	37	17	105	27	185
Wetland area reduction	NPV US$M	21	14	5	-4	36
Mitigation of salinity affected areas	NPV US$M	0	0	0	-2	-2
Reduction in eco-hotspot/biodiversity	NPV US$M	-100	-80	-195	-150	-525
Total economic impacts	NPV US$M	**29,134**	**5,978**	**5,470**	**6,270**	**46,852**
Social assessment						
No. of people at risk of loss of livelihood	'000	1,029	516	1,280	1,985	4,810
Severity of impact on livelihoods	Severity	Severely negative -3	Severely negative -3	Extremely negative -4	Extremely negative -4	Extremely negative -4
No. of people employed in:						
Irrigated agriculture	'000	286	449	286	53	1,076
Reservoir fisheries (incremental to BS)	'000	52	0	71	3	126
Hydropower production	'000	360	0	149	18	527
Aquaculture (incremental to BS)	'000	82	115	85	246	528
Overall assessment						
Overall environment impact	Severity	Severely negative -3	Severely negative -3	Negative -2	Severely negative -3	Severely negative -3
Livelihoods	Severity	Severely negative -3	Severely negative -3	Extremely negative -4	Extremely negative -4	Extremely negative -4
Economic production	NPV US$M	29,489	6,046	7,257	7,209	50,002
Other economic impacts	NPV US$M	-354	-69	-1,787	-939	-3,150

Summary of scenario assessment

Incremental values relative to Baseline

LMB Long-term Development Scenario
Climate change

Scenario run no. 8001

Assessment issue	Unit	Lao PDR Amount	Lao PDR Percent	Thailand Amount	Thailand Percent	Cambodia Amount	Cambodia Percent	Viet Nam Amount	Viet Nam Percent	Total Amount	Total Percent
Hydrological assessment											
Key hydrological parameters:	Location	Vientiane		Mudakhan		Kratie		Tan Chau		Average	
Monthly average dry season flow (March)	m3/s	1,150	105%	1,212	83%	1,518	69%	1,035	34%	1,229	63%
Average peak daily flow in wet season	m3/s	-2,183	-14%	582	2%	2,123	5%	-156	-1%	91	0%
Flow reversal in Tonle Sap:	Location					Prek Kdam				TLS only	
Average flow volume entering Tonle Sap	MCM	n/a		n/a		-2,477	-8%	n/a		-2,477	-8%
Average date of flow reversal (+/-)	Days	n/a		n/a		-19	-13%	n/a		-19	-13%
Land use and condition assessment											
Total irrigated area	'000ha	511	250%	1,494	118%	405	148%	-183	-9%	2,226	60%
Total irrigated cropped area	'000ha	1,003	302%	2,474	174%	1,270	226%	578	13%	5,324	80%
Average area flooded: < 0.5m	'000ha	2	10%	3	15%	45	24%	-250	-75%	-199	-35%
Average area flooded: 0.5 - 1.0m	'000ha	1	5%	4	18%	-28	-12%	-40	-6%	-63	-7%
Average area flooded: 1.0 - 3.0m	'000ha	20	24%	17	20%	33	5%	340	43%	410	24%
Average area flooded: > 3.0m	'000ha	31	11%	29	13%	68	6%	4	73%	132	8%
Area lost to bank erosion	Severity	Negative	-2	Negative	-2	Severely negative	-3	Severely negative	-3	Severely negative	-3
Area affected by salinity of > 1.3gm/l	'000ha	0	0%	0	0%	0	0%	297	16%	297	16%
Water quality and geomorphology											
Herbicide runoff	tonnes / yr	5,258	359%	18,113	154%	2,575	284%	3,524	15%	29,470	80%
Insecticide and fungicide runoff	tonnes / yr	4,783	247%	18,087	132%	1,737	119%	1,378	5%	25,985	61%
Nitrogen runoff from agriculture	tonnes / yr	14,668	435%	40,070	345%	6,922	282%	7,469	12%	69,128	85%
Phosphorus runoff from agriculture	tonnes / yr	1,647	535%	5,248	424%	938	334%	2,354	28%	10,187	100%
Nitrogen from waste water discharge	tonnes / yr	4,580	53%	997	7%	2,763	42%	4,539	46%	12,879	33%
Phosphorus from waste water discharge	tonnes / yr	1,374	53%	299	7%	829	42%	1,362	46%	3,864	33%
BOD from waste water discharge	tonnes / yr	17,175	53%	3,738	7%	10,362	42%	17,020	46%	48,296	33%
Impact on water quality	Severity	Negative	-2	Mildly negative	-1	Negative	-2	Mildly negative	-1	Negative	-2
Change in sediment supply	Severity	Severely negative	-3	Severely negative	-3	Severely negative	-3	Severely negative	-3	Severely negative	-3
Induced geomorphological changes	Severity	Severely negative	-3	Severely negative	-3	Extremely negative	-4	Severely negative	-3	Extremely negative	-3
Production assessment											
Hydropower generated	GWh / yr	89,124	2940%	58,462	2433%	26,912	0%	32,302	883%	206,800	2274%
Reservoir fisheries	Mtonne / yr	-0	-100%	-0	-100%	-0	-100%	-0	-100%	-0	-100%
Flood damages	US$M / yr	-37	-52%	-34	-51%	-8	-29%	-22	-40%	-101	-46%
Agricultural production: rice	Mtonne / yr	6	709%	11	269%	9	475%	11	63%	37	150%
Agricultural production: non-rice	Mtonne / yr	1	2484%	4	336%	0	173%	1	49%	6	191%
Capture fisheries production	Mtonne / yr	-0	-100%	-1	-100%	-1	-100%	-0	-100%	-2	-100%
Aquaculture production	Mtonne / yr	0	292%	0	287%	0	187%	3	200%	4	207%
Environmental assessment											
Total wetland area: flooded forest	'000ha	0	0%	0	0%	-1	0%	-0	0%	-1	0%
Total wetland area: marshes	'000ha	3	42%	1	8%	13	2%	0	0%	17	3%
Total wetland area: inundated grassland	'000ha	3	32%	5	9%	1	0%	-0	0%	9	2%
Tonle Sap only: flooded forest	'000ha	0	0%	0	0%	-1	0%	0	0%	-1	0%
Tonle Sap only: marshes	'000ha	0	0%	0	0%	-1	0%	0	0%	-1	0%
Tonle Sap only: inundated grassland	'000ha	0	0%	0	0%	-4	-1%	0	0%	-4	-1%
Forest area in reservoir areas	'000ha	-14	-100%	-14	-100%	-1	-100%	-2	-100%	-31	-100%
Number of viable deep pools	No.	-8	-40%	-10	-59%	-2	-40%	0	0%	-20	-43%
Status of river channel habitats	Severity	Severely negative	-3	Severely negative	-3	Extremely negative	-4	Extremely negative	-4	Extremely negative	-4
Flagship species	Survival	n/a		n/a		n/a		n/a		n/a	
Environmental hot spots	Severity	Catastrophic	-4	Extremely negative	-4	Extremely negative	-3	Catastrophic	-5	Catastrophic	-4
Biodiversity condition	Severity	Severely negative	-3	Severely negative	-3	Negative	-2	Negative	-2	Severely negative	-3
Economic assessment *(net economic values)*											
Irrigated agricultural production	NPV US$M	796	0%	1,367	0%	1,694	0%	411	0%	4,267	0%
Hydropower generated	NPV US$M	15,441	673%	481	98%	2,876	0%	2,985	174%	21,783	485%
Hydropower imported/exported	NPV US$M	10,193	2994%	2,900	1386%	2,190	0%	799	299%	16,082	1969%
Navigation	NPV US$M	0	0%	64	35%	0	0%	0	0%	64	35%
Flood damage mitigation	NPV US$M	141	0%	140	0%	-244	0%	-332	0%	-296	0%
Capture fisheries reduction	NPV US$M	-150	0%	-159	0%	-1,045	0%	-464	0%	-1,818	0%
Reservoir fisheries	NPV US$M	174	0%	0	0%	236	0%	11	0%	420	0%
Aquaculture production	NPV US$M	252	0%	353	0%	262	0%	1,025	0%	1,892	0%
Forest area reduction	NPV US$M	-304	0%	0	0%	-413	0%	-14	0%	-731	0%
Recession rice	NPV US$M	37	0%	17	0%	105	0%	27	0%	185	0%
Wetland area reduction	NPV US$M	21	0%	14	0%	5	0%	-4	0%	36	0%
Mitigation of salinity affected areas	NPV US$M	0	0%	0	0%	0	0%	-2	0%	-2	0%
Reduction in eco-hotspot/biodiversity	NPV US$M	-100	0%	-80	0%	-195	0%	-150	0%	-525	0%
Total economic impacts	NPV US$M	**26,501**	1006%	**5,096**	578%	**5,470**	0%	**4,292**	217%	**41,358**	753%
Social assessment											
No. of people at risk of loss of livelihood	'000	1,029	0%	516	0%	1,280	0%	1,985	0%	4,810	0%
Severity of impact on livelihoods	Severity	Severely negative	-3	Severely negative	-3	Extremely negative	-4	Extremely negative	-4	Extremely negative	-4
No. of people employed in:											
Irrigated agriculture	'000	208	264%	223	98%	209	270%	19	53%	658	157%
Reservoir fisheries (incremental to BS)	'000	52	0%	0	0%	71	0%	3	0%	126	0%
Hydropower production	'000	360	0%	0	0%	149	0%	18	0%	527	0%
Aquaculture (incremental to BS)	'000	82	0%	115	0%	85	0%	246	0%	528	0%
Overall assessment											
Overall environment impact	Severity	Severely negative	-3	Severely negative	-3	Negative	-2	Severely negative	-3	Severely negative	-3
Livelihoods	Severity	Severely negative	-3	Severely negative	-3	Extremely negative	-4	Extremely negative	-4	Extremely negative	-4
Economic production	NPV US$M	26,855	1020%	5,164	585%	7,257	0%	5,231	264%	44,508	810%
Other economic impacts	NPV US$M	-354	0%	-69	0%	-1,787	0%	-939	0%	-3,150	0%

Summary of scenario assessment

Incremental values relative to Definite Future Scenario

LMB Long-term Development Scenario
Climate change

Scenario run no. 8001

Assessment issue	Unit	Lao PDR Amount	Lao PDR Percent	Thailand Amount	Thailand Percent	Cambodia Amount	Cambodia Percent	Viet Nam Amount	Viet Nam Percent	Total Amount	Total Percent
Hydrological assessment											
Key hydrological parameters:	Location	Vientiane		Mudakhan		Kratie		Tan Chau		Average	
Monthly average dry season flow (March)	m3/s	390	21%	292	12%	647	21%	209	5%	384	14%
Average peak daily flow in wet season	m3/s	-75	-1%	2,050	9%	3,763	8%	324	2%	1,516	6%
Flow reversal in Tonle Sap:	Location					Prek Kdam				TLS only	
Average flow volume entering Tonle Sap	MCM	n/a		n/a		41	0%	n/a		41	
Average date of flow reversal (+/-)	Days	n/a		n/a		-16	-11%	n/a		-16	
Land use and condition assessment											
Total irrigated area	'000ha	549	330%	1,405	104%	405	148%	143	9%	2,501	72%
Total irrigated cropped area	'000ha	1,064	393%	2,140	122%	1,270	226%	672	16%	5,146	76%
Average area flooded: < 0.5m	'000ha	4	17%	4	16%	14	6%	-324	-79%	-303	-45%
Average area flooded: 0.5 - 1.0m	'000ha	6	30%	6	30%	-5	-2%	-84	-12%	-77	-8%
Average area flooded: 1.0 - 3.0m	'000ha	32	45%	28	35%	69	10%	467	70%	596	40%
Average area flooded: > 3.0m	'000ha	77	34%	85	49%	145	15%	5	180%	313	23%
Area lost to bank erosion	Severity	Severely negative	-3	Severely negative	-3	Severely negative	-3	Severely negative	-3	Severely negative	-3
Area affected by salinity of > 1.3gm/l	'000ha	0	0%	0	0%	0	0%	569	36%	569	36%
Water quality and geomorphology											
Herbicide runoff	tonnes / yr	5,258	359%	18,113	154%	2,575	284%	3,524	15%	29,470	80%
Insecticide and fungicide runoff	tonnes / yr	4,783	247%	18,087	132%	1,737	119%	1,378	5%	25,985	61%
Nitrogen runoff from agriculture	tonnes / yr	14,668	435%	40,070	345%	6,922	282%	7,469	12%	69,128	85%
Phosphorus runoff from agriculture	tonnes / yr	1,647	535%	5,248	424%	938	334%	2,354	28%	10,187	100%
Nitrogen from waste water discharge	tonnes / yr	4,580	53%	997	7%	2,763	42%	4,539	46%	12,879	33%
Phosphorus from waste water discharge	tonnes / yr	1,374	53%	299	7%	829	42%	1,362	46%	3,864	33%
BOD from waste water discharge	tonnes / yr	17,175	53%	3,738	7%	10,362	42%	17,020	46%	48,296	33%
Impact on water quality	Severity	Severely negative	-3	Negative	-2	Severely negative	-3	Negative	-2	Severely negative	-3
Change in sediment supply	Severity	Mildly negative	-1	Mildly negative	-1	Negative	-2	Severely negative	-3	Negative	-2
Induced geomorphological changes	Severity	Negative	-2	Negative	-2	Extremely negative	-4	Severely negative	-3	Severely negative	-3
Production assessment											
Hydropower generated	GWh / yr	75,753	462%	48,686	400%	24,577	1053%	22,367	165%	171,383	385%
Reservoir fisheries	Mtonne / yr	-0	-100%	-0	-100%	-0	-100%	-0	-100%	-0	-100%
Flood damages	US$M / yr	5	19%	6	22%	11	136%	25	266%	47	65%
Agricultural production: rice	Mtonne / yr	6	709%	11	269%	9	475%	11	63%	37	150%
Agricultural production: non-rice	Mtonne / yr	1	2484%	4	336%	0	173%	1	49%	6	191%
Capture fisheries production	Mtonne / yr	-0	-100%	-1	-100%	-1	-100%	-0	-100%	-2	-100%
Aquaculture production	Mtonne / yr	0	104%	0	113%	0	118%	2	100%	3	102%
Environmental assessment											
Total wetland area: flooded forest	'000ha	0	0%	0	0%	1	0%	0	0%	1	0%
Total wetland area: marshes	'000ha	5	79%	3	28%	24	5%	0	0%	32	6%
Total wetland area: inundated grassland	'000ha	6	105%	12	29%	8	3%	-0	0%	26	6%
Tonle Sap only: flooded forest	'000ha	0	0%	0	0%	1	0%	0	0%	1	0%
Tonle Sap only: marshes	'000ha	0	0%	0	0%	1	0%	0	0%	1	0%
Tonle Sap only: inundated grassland	'000ha	0	0%	0	0%	2	1%	0	0%	2	1%
Forest area in reservoir areas	'000ha	-38	-100%	-14	-100%	-2	-100%	-5	-100%	-60	-100%
Number of viable deep pools	No.	-8	-40%	-10	-59%	-2	-40%	0	0%	-20	-43%
Status of river channel habitats	Severity	Negative	-2	Negative	-2	Extremely negative	-4	Extremely negative	-4	Severely negative	-3
Flagship species	Survival	n/a		n/a		n/a		n/a		n/a	
Environmental hot spots	Severity	Catastrophic	-4	Severely negative	-2	Severely negative	-3	Catastrophic	-5	Extremely negative	-4
Biodiversity condition	Severity	Negative	-2	Negative	-2	Mildly negative	-1	Mildly negative	-1	Negative	-2
Economic assessment *(net economic values)*											
Irrigated agricultural production	NPV US$M	796	0%	1,367	0%	1,694	0%	411	0%	4,267	0%
Hydropower generated	NPV US$M	10,048	131%	381	65%	2,128	285%	875	23%	13,433	105%
Hydropower imported/exported	NPV US$M	8,966	572%	2,049	193%	1,733	379%	192	22%	12,940	327%
Navigation	NPV US$M	0	0%	0	0%	0	0%	0	0%	0	0%
Flood damage mitigation	NPV US$M	-38	-21%	-32	-19%	-295	-579%	-392	-654%	-758	-164%
Capture fisheries reduction	NPV US$M	78	-34%	28	-15%	-721	223%	-257	124%	-872	92%
Reservoir fisheries	NPV US$M	99	134%	0	0%	232	6732%	-2	-19%	329	362%
Aquaculture production	NPV US$M	126	100%	179	103%	174	197%	284	38%	762	68%
Forest area reduction	NPV US$M	-174	134%	0	0%	-406	6449%	3	-19%	-577	376%
Recession rice	NPV US$M	56	-295%	27	-265%	211	-199%	36	-405%	330	-229%
Wetland area reduction	NPV US$M	48	-177%	61	-129%	158	-103%	-3	479%	264	-116%
Mitigation of salinity affected areas	NPV US$M	0	0%	0	0%	0	0%	-22	-110%	-22	-110%
Reduction in eco-hotspot/biodiversity	NPV US$M	-100	0%	-60	300%	-130	200%	-150	0%	-440	518%
Total economic impacts	NPV US$M	**19,906**	216%	**4,000**	202%	**4,777**	689%	**975**	18%	**29,658**	172%
Social assessment											
No. of people at risk of loss of livelihood	'000	732	246%	470	1022%	1,178	1155%	1,543	349%	3,923	442%
Severity of impact on livelihoods	Severity	Mildly negative	-1	Negative	-2	Severely negative	-3	Severely negative	-3	Severely negative	-2
No. of people employed in:											
Irrigated agriculture	'000	208	264%	223	98%	209	270%	19	53%	658	157%
Reservoir fisheries (incremental to BS)	'000	40	320%	0	0%	70	12065%	1	46%	111	729%
Hydropower production	'000	308	592%	-5	-100%	134	873%	-13	-42%	424	409%
Aquaculture (incremental to BS)	'000	54	190%	76	194%	65	331%	82	50%	277	110%
Overall assessment											
Overall environment impact	Severity	Negative	-2	Negative	-2	Mildly negative	-1	Negative	-2	Negative	-2
Livelihoods	Severity	Mildly negative	-1	Negative	-2	Severely negative	-3	Severely negative	-3	Severely negative	-2
Economic production	NPV US$M	20,036	212%	3,976	192%	5,961	460%	1,760	32%	31,733	174%
Other economic impacts	NPV US$M	-130	58%	25	-26%	-1,184	196%	-785	511%	-2,075	193%

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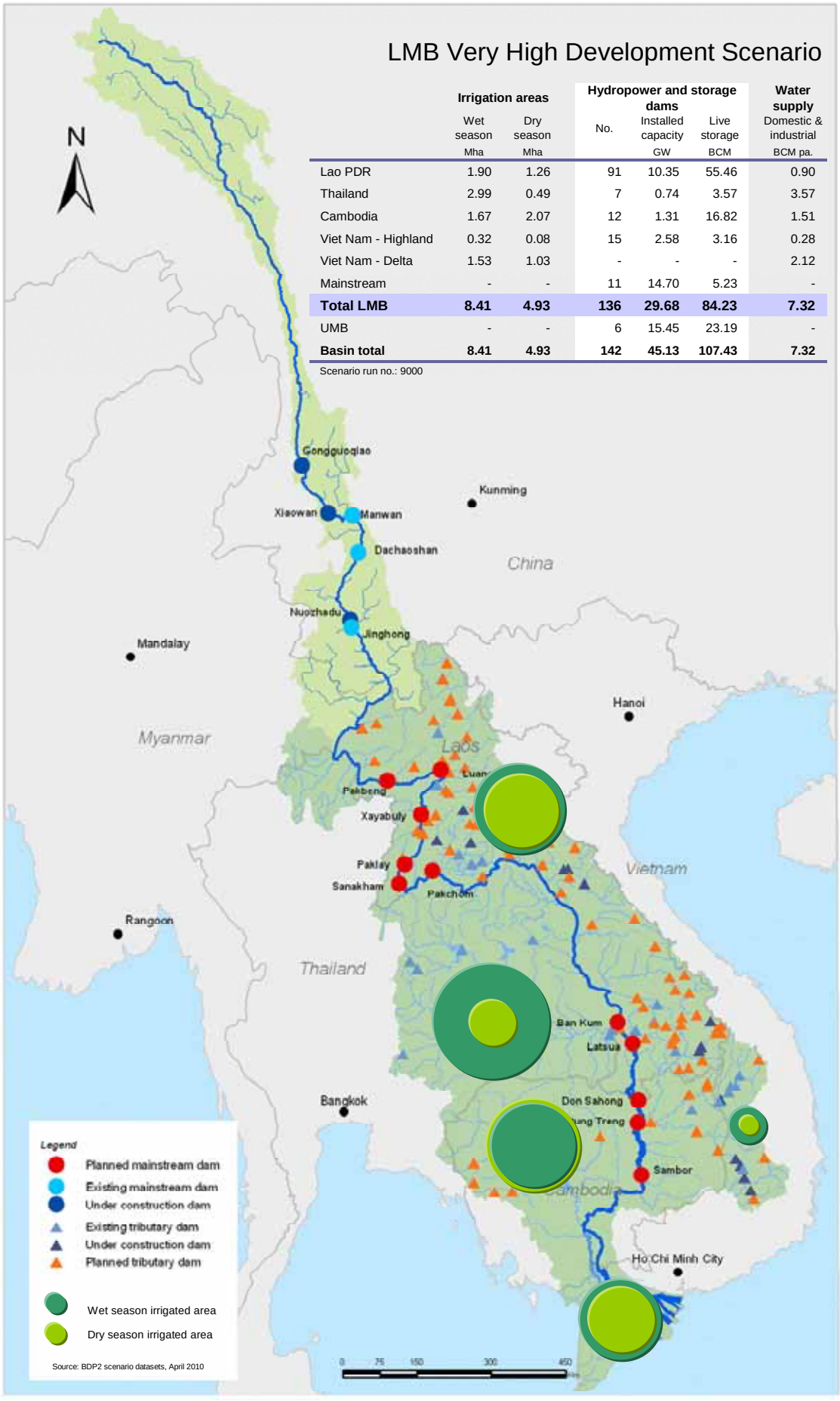
LMB Very High Development Scenario

	Irrigation areas		Hydropower and storage dams			Water supply
	Wet season	Dry season	No.	Installed capacity	Live storage	Domestic & industrial
	Mha	Mha		GW	BCM	BCM pa.
Lao PDR	1.90	1.26	91	10.35	55.46	0.90
Thailand	2.99	0.49	7	0.74	3.57	3.57
Cambodia	1.67	2.07	12	1.31	16.82	1.51
Viet Nam - Highland	0.32	0.08	15	2.58	3.16	0.28
Viet Nam - Delta	1.53	1.03	-	-	-	2.12
Mainstream	-	-	11	14.70	5.23	-
Total LMB	**8.41**	**4.93**	**136**	**29.68**	**84.23**	**7.32**
UMB	-	-	6	15.45	23.19	-
Basin total	**8.41**	**4.93**	**142**	**45.13**	**107.43**	**7.32**

Scenario run no.: 9000



Scenario assessment results

Estimated total values

LMB Very High Development Scenario

Scenario run no. 9000

Assessment issue	Unit	3 Lao PDR Amount	4 Thailand Amount	5 Cambodia Amount	6 Viet Nam Amount	Total Amount
Hydrological assessment						
Key hydrological parameters:	Location	Vientiane	Mudakhan	Kratie	Tan Chau	Average
Monthly average dry season flow (March)	m3/s	2,093	2,277	2,942	3,386	2,675
Average peak daily flow in wet season	m3/s	13,410	23,341	41,241	20,039	24,508
Flow reversal in Tonle Sap:	Location			Prek Kdam		TLS only
Average flow volume entering Tonle Sap	MCM	n/a	n/a	27,008	n/a	27,008
Average date of flow reversal (+/-)	Days	n/a	n/a	132	n/a	11-May
Land use and condition assessment						
Total irrigated area	'000ha	1,896	2,994	1,667	1,848	8,406
Total irrigated cropped area	'000ha	3,686	4,434	5,407	5,061	18,587
Average area flooded: < 0.5m	'000ha	21	23	206	468	718
Average area flooded: 0.5 - 1.0m	'000ha	19	21	235	719	995
Average area flooded: 1.0 - 3.0m	'000ha	70	77	660	580	1,388
Average area flooded: > 3.0m	'000ha	217	167	880	3	1,267
Area lost to bank erosion	Severity	Negative -2	Negative -2	Severely negative -3	Severely negative -3	Neutral
Area affected by salinity of > 1.3gm/l	'000ha	0	0	0	1,631	1,631
Water quality and geomorphology						
Herbicide runoff	tonnes / yr	23,615	38,585	8,457	44,184	114,840
Insecticide and fungicide runoff	tonnes / yr	26,413	43,790	9,648	43,943	123,794
Nitrogen runoff from agriculture	tonnes / yr	64,346	70,096	27,397	121,544	283,384
Phosphorus runoff from agriculture	tonnes / yr	7,174	8,832	3,656	18,653	38,315
Nitrogen from waste water discharge	tonnes / yr	23,268	16,382	14,549	20,748	74,947
Phosphorus from waste water discharge	tonnes / yr	6,980	4,915	4,365	6,224	22,484
BOD from waste water discharge	tonnes / yr	87,253	61,432	54,560	77,804	281,049
Impact on water quality	Severity	Severely negative -3	Negative -2	Severely negative -3	Severely negative -3	Severely negative -3
Change in sediment supply	Severity	Severely negative -3	Severely negative -3	Extremely negative -4	Extremely negative -4	Extremely negative -4
Induced geomorphological changes	Severity	Severely negative -3	Severely negative -3	Extremely negative -4	Severely negative -3	Extremely negative -3
Production assessment						
Hydropower generated	GWh / yr	94,487	60,865	27,411	36,065	218,828
Reservoir fisheries	Mtonne / yr	0	0	0	0	0
Flood damages	US$M / yr	33	32	12	17	95
Agricultural production: rice	Mtonne / yr	19	18	35	32	104
Agricultural production: non-rice	Mtonne / yr	5	9	0	4	17
Capture fisheries production	Mtonne / yr	0	1	0	0	2
Aquaculture production	Mtonne / yr	0	1	0	7	8
Environmental assessment						
Total wetland area: flooded forest	'000ha	0	0	443	45	489
Total wetland area: marshes	'000ha	6	10	496	0	512
Total wetland area: inundated grassland	'000ha	5	41	301	55	401
Tonle Sap only: flooded forest	'000ha	0	0	442	0	442
Tonle Sap only: marshes	'000ha	0	0	305	0	305
Tonle Sap only: inundated grassland	'000ha	0	0	262	0	262
Forest area in reservoir areas	'000ha	135	14	157	7	312
Number of viable deep pools	No.	12	7	3	5	27
Status of river channel habitats	Severity	Severely negative -3	Severely negative -3	Extremely negative -4	Severely negative -3	Extremely negative -3
Flagship species	Survival	Extinct	Extinct	Extinct	Surviving	Extinct
Environmental hot spots	Severity	Catastrophic -5	Catastrophic -5	Catastrophic -5	Catastrophic -5	Catastrophic -5
Biodiversity condition	Severity	Severely negative -3	Severely negative -3	Extremely negative -4	Severely negative -3	Extremely negative -3
Economic assessment *(net economic values)*						
Irrigated agricultural production	NPV US$M	3,207	2,608	9,484	830	16,129
Hydropower generated	NPV US$M	18,443	972	3,091	4,701	27,207
Hydropower imported/exported	NPV US$M	10,562	3,109	2,155	1,067	16,893
Navigation	NPV US$M	0	246	0	0	246
Flood damage mitigation	NPV US$M	149	149	57	77	432
Capture fisheries reduction	NPV US$M	-132	-162	-1,042	-465	-1,801
Reservoir fisheries	NPV US$M	202	0	260	11	473
Aquaculture production	NPV US$M	336	470	349	1,367	2,522
Forest area reduction	NPV US$M	-354	0	-454	-14	-822
Recession rice	NPV US$M	-27	-26	-191	-30	-274
Wetland area reduction	NPV US$M	-18	-34	-249	-9	-310
Mitigation of salinity affected areas	NPV US$M	0	0	0	16	16
Reduction in eco-hotspot/biodiversity	NPV US$M	-125	-100	-325	-150	-700
Total economic impacts	NPV US$M	**32,241**	**7,233**	**13,135**	**7,401**	**60,011**
Social assessment						
No. of people at risk of loss of livelihood	'000	1,106	516	1,231	1,741	4,594
Severity of impact on livelihoods	Severity	Severely negative -3	Severely negative -3	Extremely negative -4	Negative -2	Severely negative -3
No. of people employed in:						
Irrigated agriculture	'000	586	460	828	79	1,953
Reservoir fisheries (incremental to BS)	'000	61	0	78	3	141
Hydropower production	'000	384	0	171	18	573
Aquaculture (incremental to BS)	'000	109	153	114	328	704
Overall assessment						
Overall environment impact	Severity	Severely negative -3	Severely negative -3	Extremely negative -4	Severely negative -3	Extremely negative -3
Livelihoods	Severity	Severely negative -3	Severely negative -3	Extremely negative -4	Negative -2	Severely negative -3
Economic production	NPV US$M	32,749	7,406	15,339	7,976	63,470
Other economic impacts	NPV US$M	-508	-172	-2,204	-575	-3,459

Summary of scenario assessment

Incremental values relative to Baseline

LMB Very High Development Scenario

Scenario run no. 9000

Assessment issue	Unit	Lao PDR Amount	Lao PDR Percent	Thailand Amount	Thailand Percent	Cambodia Amount	Cambodia Percent	Viet Nam Amount	Viet Nam Percent	Total Amount	Total Percent
Hydrological assessment											
Key hydrological parameters:	Location	Vientiane		Mudakhan		Kratie		Tan Chau		Average	
Monthly average dry season flow (March)	m3/s	993	90%	825	57%	745	34%	315	10%	719	37%
Average peak daily flow in wet season	m3/s	-2,511	-16%	-2,160	-8%	-5,521	-12%	-1,271	-6%	-2,866	-10%
Flow reversal in Tonle Sap:	Location					Prek Kdam				TLS only	
Average flow volume entering Tonle Sap	MCM	n/a		n/a		-5,250	-16%	n/a		-5,250	-16%
Average date of flow reversal (+/-)	Days	n/a		n/a		-13	-9%	n/a		-13	-9%
Land use and condition assessment											
Total irrigated area	'000ha	1,692	829%	1,728	137%	1,394	510%	-148	-7%	4,666	125%
Total irrigated cropped area	'000ha	3,354	1010%	3,012	212%	4,844	860%	749	17%	11,958	180%
Average area flooded: < 0.5m	'000ha	-3	-13%	-0	-2%	21	12%	134	40%	152	27%
Average area flooded: 0.5 - 1.0m	'000ha	-5	-21%	-2	-9%	3	1%	51	8%	46	5%
Average area flooded: 1.0 - 3.0m	'000ha	-14	-17%	-13	-14%	-52	-7%	-214	-27%	-293	-17%
Average area flooded: > 3.0m	'000ha	-55	-20%	-65	-28%	-175	-17%	-2	-47%	-297	-19%
Area lost to bank erosion	Severity	Negative	-2	Negative	-2	Severely negative	-3	Severely negative	-3	Severely negative	-3
Area affected by salinity of > 1.3gm/l	'000ha	0	0%	0	0%	0	0%	-221	-12%	-221	-12%
Water quality and geomorphology											
Herbicide runoff	tonnes / yr	22,152	1514%	26,824	228%	7,549	832%	21,357	94%	77,881	211%
Insecticide and fungicide runoff	tonnes / yr	24,474	1262%	30,124	220%	8,193	563%	18,223	71%	81,014	189%
Nitrogen runoff from agriculture	tonnes / yr	60,975	1809%	58,466	503%	24,942	1016%	57,994	91%	202,377	250%
Phosphorus runoff from agriculture	tonnes / yr	6,867	2232%	7,593	613%	3,375	1202%	10,324	124%	28,159	277%
Nitrogen from waste water discharge	tonnes / yr	14,639	170%	2,405	17%	7,917	119%	10,852	110%	35,812	92%
Phosphorus from waste water discharge	tonnes / yr	4,392	170%	721	17%	2,375	119%	3,256	110%	10,744	92%
BOD from waste water discharge	tonnes / yr	54,895	170%	9,018	17%	29,688	119%	40,694	110%	134,295	92%
Impact on water quality	Severity	Severely negative	-3	Negative	-2	Severely negative	-3	Severely negative	-3	Severely negative	-3
Change in sediment supply	Severity	Severely negative	-3	Severely negative	-3	Extremely negative	-4	Extremely negative	-4	Extremely negative	-4
Induced geomorphological changes	Severity	Severely negative	-3	Severely negative	-3	Extremely negative	-4	Severely negative	-3	Extremely negative	-3
Production assessment											
Hydropower generated	GWh / yr	91,455	3017%	58,462	2433%	27,411	0%	32,406	886%	209,735	2307%
Reservoir fisheries	Mtonne / yr	0	94%	0	0%	0	303%	0	11%	0	63%
Flood damages	US$M / yr	-37	-52%	-34	-51%	-14	-53%	-39	-70%	-124	-57%
Agricultural production: rice	Mtonne / yr	18	2167%	14	336%	33	1780%	15	81%	79	320%
Agricultural production: non-rice	Mtonne / yr	5	13245%	7	563%	0	214%	2	103%	14	430%
Capture fisheries production	Mtonne / yr	-0	-16%	-0	-5%	-0	-41%	-0	-38%	-1	-23%
Aquaculture production	Mtonne / yr	0	422%	0	416%	0	282%	5	300%	6	310%
Environmental assessment											
Total wetland area: flooded forest	'000ha	0	0%	0	0%	-9	-2%	-1	-1%	-10	-2%
Total wetland area: marshes	'000ha	-2	-24%	-2	-19%	-22	-4%	-0	0%	-26	-5%
Total wetland area: inundated grassland	'000ha	-4	-44%	-9	-18%	-17	-5%	-0	0%	-30	-7%
Tonle Sap only: flooded forest	'000ha	0	0%	0	0%	-10	-2%	0	0%	-10	-2%
Tonle Sap only: marshes	'000ha	0	0%	0	0%	-4	-1%	0	0%	-4	-1%
Tonle Sap only: inundated grassland	'000ha	0	0%	0	0%	-15	-5%	0	0%	-15	-5%
Forest area in reservoir areas	'000ha	121	893%	0	0%	155	12458%	5	236%	281	918%
Number of viable deep pools	No.	-8	-40%	-10	-59%	-2	-40%	0	0%	-20	-43%
Status of river channel habitats	Severity	Severely negative	-3	Severely negative	-3	Extremely negative	-4	Severely negative	-3	Extremely negative	-3
Flagship species	Survival	n/a		n/a		n/a		n/a		n/a	
Environmental hot spots	Severity	Catastrophic	-5	Catastrophic	-5	Catastrophic	-5	Catastrophic	-5	Catastrophic	-5
Biodiversity condition	Severity	Severely negative	-3	Severely negative	-3	Extremely negative	-4	Severely negative	-3	Extremely negative	-3
Economic assessment *(net economic values)*											
Irrigated agricultural production	NPV US$M	3,207	0%	2,608	0%	9,484	0%	830	0%	16,129	0%
Hydropower generated	NPV US$M	16,149	704%	481	98%	3,091	0%	2,990	175%	22,711	505%
Hydropower imported/exported	NPV US$M	10,221	3002%	2,900	1386%	2,155	0%	800	299%	16,076	1969%
Navigation	NPV US$M	0	0%	64	35%	0	0%	0	0%	64	35%
Flood damage mitigation	NPV US$M	149	0%	149	0%	57	0%	77	0%	432	0%
Capture fisheries reduction	NPV US$M	-132	0%	-162	0%	-1,042	0%	-465	0%	-1,801	0%
Reservoir fisheries	NPV US$M	202	0%	0	0%	260	0%	11	0%	473	0%
Aquaculture production	NPV US$M	336	0%	470	0%	349	0%	1,367	0%	2,522	0%
Forest area reduction	NPV US$M	-354	0%	0	0%	-454	0%	-14	0%	-822	0%
Recession rice	NPV US$M	-27	0%	-26	0%	-191	0%	-30	0%	-274	0%
Wetland area reduction	NPV US$M	-18	0%	-34	0%	-249	0%	-9	0%	-310	0%
Mitigation of salinity affected areas	NPV US$M	0	0%	0	0%	0	0%	16	0%	16	0%
Reduction in eco-hotspot/biodiversity	NPV US$M	-125	0%	-100	0%	-325	0%	-150	0%	-700	0%
Total economic impacts	NPV US$M	**29,608**	1124%	**6,351**	720%	**13,135**	0%	**5,423**	274%	**54,517**	992%
Social assessment											
No. of people at risk of loss of livelihood	'000	1,106	0%	516	0%	1,231	0%	1,741	0%	4,594	0%
Severity of impact on livelihoods	Severity	Severely negative	-3	Severely negative	-3	Extremely negative	-4	Negative	-2	Severely negative	-3
No. of people employed in:											
Irrigated agriculture	'000	507	644%	234	103%	750	968%	44	126%	1,535	367%
Reservoir fisheries (incremental to BS)	'000	61	0%	0	0%	78	0%	3	0%	141	0%
Hydropower production	'000	384	0%	0	0%	171	0%	18	0%	573	0%
Aquaculture (incremental to BS)	'000	109	0%	153	0%	114	0%	328	0%	704	0%
Overall assessment											
Overall environment impact	Severity	Severely negative	-3	Severely negative	-3	Extremely negative	-4	Severely negative	-3	Extremely negative	-3
Livelihoods	Severity	Severely negative	-3	Severely negative	-3	Extremely negative	-4	Negative	-2	Severely negative	-3
Economic production	NPV US$M	30,115	1143%	6,523	739%	15,339	0%	5,997	303%	57,975	1055%
Other economic impacts	NPV US$M	-508	0%	-172	0%	-2,204	0%	-575	0%	-3,459	0%

Summary of scenario assessment

Incremental values relative to Definite Future Scenario

LMB Very High Development Scenario

Scenario run no. 9000

Assessment issue	Unit	Lao PDR		Thailand		Cambodia		Viet Nam		Total	
		Amount	Percent	Amount	Percent	Amount	Percent	Amount	Percent	Amount	Percent
Hydrological assessment											
Key hydrological parameters:	Location	Vientiane		Mudakhan		Kratie		Tan Chau		Average	
Monthly average dry season flow (March)	m3/s	233	13%	-95	-4%	-127	-4%	-512	-13%	-125	-4%
Average peak daily flow in wet season	m3/s	-403	-3%	-691	-3%	-3,881	-9%	-791	-4%	-1,441	-6%
Flow reversal in Tonle Sap:	Location					Prek Kdam				TLS only	
Average flow volume entering Tonle Sap	MCM	n/a		n/a		-2,732	-9%	n/a		-2,732	
Average date of flow reversal (+/-)	Days	n/a		n/a		-10	-7%	n/a		-10	
Land use and condition assessment											
Total irrigated area	'000ha	1,729	1039%	1,639	121%	1,394	510%	178	11%	4,941	143%
Total irrigated cropped area	'000ha	3,415	1262%	2,678	153%	4,844	860%	843	20%	11,780	173%
Average area flooded: < 0.5m	'000ha	-2	-8%	-0	-1%	-10	-5%	60	15%	48	7%
Average area flooded: 0.5 - 1.0m	'000ha	-0	-2%	-0	-1%	27	13%	6	1%	32	3%
Average area flooded: 1.0 - 3.0m	'000ha	-3	-3%	-3	-3%	-15	-2%	-87	-13%	-107	-7%
Average area flooded: > 3.0m	'000ha	-9	-4%	-9	-5%	-98	-10%	-0	-15%	-116	-8%
Area lost to bank erosion	Severity	Severely negative	-3	Severely negative	-3	Severely negative	-3	Severely negative	-3	Severely negative	-3
Area affected by salinity of > 1.3gm/l	'000ha	0	0%	0	0%	0	0%	51	3%	51	3%
Water quality and geomorphology											
Herbicide runoff	tonnes / yr	22,152	1514%	26,824	228%	7,549	832%	21,357	94%	77,881	211%
Insecticide and fungicide runoff	tonnes / yr	24,474	1262%	30,124	220%	8,193	563%	18,223	71%	81,014	189%
Nitrogen runoff from agriculture	tonnes / yr	60,975	1809%	58,466	503%	24,942	1016%	57,994	91%	202,377	250%
Phosphorus runoff from agriculture	tonnes / yr	6,867	2232%	7,593	613%	3,375	1202%	10,324	124%	28,159	277%
Nitrogen from waste water discharge	tonnes / yr	14,639	170%	2,405	17%	7,917	119%	10,852	110%	35,812	92%
Phosphorus from waste water discharge	tonnes / yr	4,392	170%	721	17%	2,375	119%	3,256	110%	10,744	92%
BOD from waste water discharge	tonnes / yr	54,895	170%	9,018	17%	29,688	119%	40,694	110%	134,295	92%
Impact on water quality	Severity	Extremely negative	-4	Severely negative	-3	Extremely negative	-4	Extremely negative	-4	Extremely negative	-4
Change in sediment supply	Severity	Mildly negative	-1	Mildly negative	-1	Severely negative	-3	Extremely negative	-4	Severely negative	-2
Induced geomorphological changes	Severity	Negative	-2	Negative	-2	Extremely negative	-4	Severely negative	-3	Severely negative	-3
Production assessment											
Hydropower generated	GWh / yr	78,084	476%	48,686	400%	25,077	1074%	22,471	165%	174,318	392%
Reservoir fisheries	Mtonne / yr	0	63%	0	0%	0	295%	0	3%	0	52%
Flood damages	US$M / yr	5	19%	6	22%	5	58%	8	83%	23	33%
Agricultural production: rice	Mtonne / yr	18	2167%	14	336%	33	1780%	15	81%	79	320%
Agricultural production: non-rice	Mtonne / yr	5	13245%	7	563%	0	214%	2	103%	14	430%
Capture fisheries production	Mtonne / yr	-0	-1%	-0	-2%	-0	-36%	-0	-31%	-0	-18%
Aquaculture production	Mtonne / yr	0	172%	0	184%	0	190%	4	167%	5	169%
Environmental assessment											
Total wetland area: flooded forest	'000ha	0	0%	0	0%	-7	-1%	-1	-1%	-7	-1%
Total wetland area: marshes	'000ha	-0	-4%	-0	-4%	-10	-2%	0	0%	-11	-2%
Total wetland area: inundated grassland	'000ha	-1	-12%	-1	-3%	-10	-3%	-0	0%	-12	-3%
Tonle Sap only: flooded forest	'000ha	0	0%	0	0%	-7	-2%	0	0%	-7	-2%
Tonle Sap only: marshes	'000ha	0	0%	0	0%	-3	-1%	0	0%	-3	-1%
Tonle Sap only: inundated grassland	'000ha	0	0%	0	0%	-10	-4%	0	0%	-10	-4%
Forest area in reservoir areas	'000ha	96	252%	0	0%	154	6434%	2	29%	252	421%
Number of viable deep pools	No.	-8	-40%	-10	-59%	-2	-40%	0	0%	-20	-43%
Status of river channel habitats	Severity	Negative	-2	Negative	-2	Extremely negative	-4	Severely negative	-3	Severely negative	-3
Flagship species	Survival	n/a		n/a		n/a		n/a		n/a	
Environmental hot spots	Severity	Catastrophic	-5	Extremely negative	-4	Catastrophic	-4	Catastrophic	-5	Catastrophic	-5
Biodiversity condition	Severity	Negative	-2	Negative	-2	Severely negative	-3	Negative	-2	Severely negative	-2
Economic assessment *(net economic values)*											
Irrigated agricultural production	NPV US$M	3,207	0%	2,608	0%	9,484	0%	830	0%	16,129	0%
Hydropower generated	NPV US$M	10,757	140%	381	65%	2,343	313%	881	23%	14,362	112%
Hydropower imported/exported	NPV US$M	8,994	574%	2,049	193%	1,698	372%	193	22%	12,934	327%
Navigation	NPV US$M	0	0%	-0	0%	0	0%	0	0%	-0	0%
Flood damage mitigation	NPV US$M	-30	-17%	-23	-13%	6	12%	17	28%	-30	-6%
Capture fisheries reduction	NPV US$M	95	-42%	26	-14%	-718	222%	-258	125%	-855	90%
Reservoir fisheries	NPV US$M	128	173%	0	0%	256	7420%	-2	-19%	382	420%
Aquaculture production	NPV US$M	210	167%	296	170%	261	296%	626	84%	1,393	123%
Forest area reduction	NPV US$M	-224	173%	0	0%	-448	7108%	3	-19%	-669	436%
Recession rice	NPV US$M	-8	42%	-16	154%	-85	80%	-21	239%	-130	90%
Wetland area reduction	NPV US$M	9	-32%	14	-29%	-96	63%	-8	1327%	-81	36%
Mitigation of salinity affected areas	NPV US$M	0	0%	0	0%	0	0%	-4	-20%	-4	-20%
Reduction in eco-hotspot/biodiversity	NPV US$M	-125	0%	-80	400%	-260	400%	-150	0%	-615	724%
Total economic impacts	NPV US$M	**23,013**	249%	**5,256**	266%	**12,442**	1795%	**2,106**	40%	**42,816**	249%
Social assessment											
No. of people at risk of loss of livelihood	'000	809	272%	470	1022%	1,129	1107%	1,299	294%	3,707	418%
Severity of impact on livelihoods	Severity	Mildly negative	-1	Negative	-2	Severely negative	-3	Mildly negative	-1	Negative	-2
No. of people employed in:											
Irrigated agriculture	'000	507	644%	234	103%	750	968%	44	126%	1,535	367%
Reservoir fisheries (incremental to BS)	'000	48	390%	0	0%	77	13289%	1	46%	126	833%
Hydropower production	'000	332	638%	-5	-100%	156	1018%	-13	-42%	470	453%
Aquaculture (incremental to BS)	'000	81	287%	114	292%	94	475%	164	100%	453	181%
Overall assessment											
Overall environment impact	Severity	Negative	-2	Negative	-2	Severely negative	-3	Negative	-2	Severely negative	-2
Livelihoods	Severity	Mildly negative	-1	Negative	-2	Severely negative	-3	Mildly negative	-1	Negative	-2
Economic production	NPV US$M	23,296	246%	5,335	258%	14,043	1083%	2,527	46%	45,200	247%
Other economic impacts	NPV US$M	-283	126%	-79	84%	-1,601	265%	-421	274%	-2,384	222%

Appendix C Summary of scenario assessment indicators

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Summary of scenario assessment

Estimated total values

Baseline Scenario

Scenario run no. 1000

Specific development objective	Issue	Assessment criteria	Unit	Lao PDR Amount	Lao PDR Percent	Thailand Amount	Thailand Percent	Cambodia Amount	Cambodia Percent	Viet Nam Amount	Viet Nam Percent	Total Amount	Total Percent
1. Economic development													
1.1 Increase irrigated agricultural production	Irrigable area, production tonnage and value	Incremental area	'000 ha	204		1,266		273		1,996		3,739	
		Crop production	Mtonne / yr	0.871		5.406		1.905		19.834		28.017	
		Net economic value	NPV US$M										
1.2 Increase hydropower production	Hydropower capacity, power generated and value	Installed capacity	MW	621		245				720		1,586	
		Power generated	GWh/yr	3,032		2,403				3,659		9,093	
		Net economic value from generation	NPV US$M	2,293		491				1,712		4,496	
		Net economic value from purchased	NPV US$M	340		209				267		817	
1.3 Improve navigation	River transport	Navigable days by class	'000 boat-days	n/a		n/a		n/a		n/a		n/a	
		Net economic value	NPV US$M			182						182	
1.4 Decrease damages by floods	Extent and duration of annual flooding by class	Average area flooded annually to max 1.0m depth	'000 ha	49		47		416		1,003		1,515	
		Average area flooded annually > 1.0m depth	'000 ha	357		322		1,767		799		3,244	
		Net economic value of flood damage	NPV US$M										
1.5 Maintain productivity of fishery sector	Capture fisheries and aquaculture production	Annual average capture fish availability	Mtonne / yr	0.311		1.027		0.792		0.400		2.530	
		Annual average aquaculture production	Mtonne / yr	0.078		0.100		0.127		1.663		1.969	
		Net economic value of capture fish	NPV US$M										
2. Environmental protection													
2.1 Maintain water quality and acceptable flow conditions	Water quality	Total pollutant discharge	tonnes / yr	50,658		108,880		38,593		170,402		368,532	
		Water quality conditions	Severity										
	Flow characteristics	Average flow in March	m3/s	1,100		1,453		2,197		3,072		1,955	
		Average wet season peak daily flow	m3/s	15,921		25,501		46,763		21,310		27,374	
		Average flow volume entering Tonle Sap	MCM	n/a		n/a		32,259		n/a		32,259	
	Protection of forests around Tonle Sap	Forest, marshes and grasslands flooded at Tonle Sap	'000 ha					1,038				1,038	
		Net economic value	NPV US$M										
2.2 Maintain wetland productivity and	Productivity of wetland ecosystems	Are of wetlands (forest, marshes, wetland)	'000 ha	17		62		1,288		101		1,467	
		Net economic value	NPV US$M										
2.3 Manage salinity intrusion in the Mekong	Impact of salinity intrusion on land use	Area within delta within threshold level of salinity	'000 ha							1,851		1,851	
		Net economic value	NPV US$M										
2.4 Minimize channel effects on bank erosion and deep pools	River bank erosion	Area at risk to erosion	Severity	Neutral		Neutral		Neutral		Neutral		Neutral	
		Net economic value	NPV US$M										
	Flow and sediment transport changes	Functioning deep pools	No.	20		17		5		5		47	
		Induced geomorphological changes	Severity	Neutral		Neutral		Neutral		Neutral		Neutral	
2.5 Conservation of biodiversity	Impacts of flow management changes on endangered species	Status of river channel habitats	Severity	Neutral		Neutral		Neutral		Neutral		Neutral	
		Flagship species	Survival	Surviving		Surviving		Surviving		Surviving		Surviving	
		Unaffected environmental hot spots	Severity	Neutral		Neutral		Neutral		Neutral		Neutral	
		Biodiversity condition	Severity	Neutral		Neutral		Neutral		Neutral		Neutral	
		Incremental net economic value of habitat areas	NPV US$M										
3. Social development													
3.1 Maintain livelihoods of vulnerable resource-users	Health, food and income security	No. of people affected	'000										
		Severity of impact on health, food and income security	Severity	Neutral		Neutral		Neutral		Neutral		Neutral	
3.4 Increased employment generation in water related sectors	Incremental sustainable employment from water resource interventions	Incremental number of people engaged in:											
		Irrigated agriculture	'000	79		227		77		35		418	
		Reservoir fisheries (incremental to BS)	'000										
		Hydropower production	'000										
		Aquaculture (incremental to BS)	'000										
4 Equitable development													
4.1 Ensure that all four LMB countries benefit from the development of water and related resources	Aggregate benefits by country	Total net economic value	NPV US$M	2,634		882				1,979		5,494	
		No. of people affected vulnerable to changes	'000										
		No. of jobs generated	'000	79		227		77		35		418	
		Overall environment impact	Severity	Neutral		Neutral		Neutral		Neutral		Neutral	

Summary of scenario assessment

Estimated total values

Upper Mekong Dam Scenario

Scenario run no. 2000

Specific development objective	Issue	Assessment criteria	Unit	Lao PDR Amount	Lao PDR Percent	Thailand Amount	Thailand Percent	Cambodia Amount	Cambodia Percent	Viet Nam Amount	Viet Nam Percent	Total Amount	Total Percent
1. Economic development													
1.1 Increase irrigated agricultural production	Irrigable area, production tonnage and value	Incremental area	'000 ha	204		1,266		273		1,996		3,739	
		Crop production	Mtonne / yr	0.871		5.406		1.905		19.834		28.017	
		Net economic value	NPV US$M										
1.2 Increase hydropower production	Hydropower capacity, power generated and value	Installed capacity	MW	621		245				720		1,586	
		Power generated	GWh/yr	3,032		2,403				3,659		9,093	
		Net economic value from generation	NPV US$M	2,293		491				1,712		4,496	
		Net economic value from purchased	NPV US$M	340		209				267		817	
1.3 Improve navigation	River transport	Navigable days by class	'000 boat-days	n/a		n/a		n/a		n/a		n/a	
		Net economic value	NPV US$M			182						182	
1.4 Decrease damages by floods	Extent and duration of annual flooding by class	Average area flooded annually to max 1.0m depth	'000 ha	n/a		n/a		n/a		n/a			
		Average area flooded annually > 1.0m depth	'000 ha	n/a		n/a		n/a		n/a			
		Net economic value of flood damage	NPV US$M										
1.5 Maintain productivity of fishery sector	Capture fisheries and aquaculture production	Annual average capture fish availability	Mtonne / yr	0.301		1.027		0.792		0.365		2.486	
		Annual average aquaculture production	Mtonne / yr	0.150		0.182		0.167		2.494		2.994	
		Net economic value of capture fish	NPV US$M										
2. Environmental protection													
2.1 Maintain water quality and acceptable flow conditions	Water quality	Total pollutant discharge	tonnes / yr	50,658		108,880		38,593		170,402		368,532	
		Water quality conditions	Severity										
	Flow characteristics	Average flow in March	m3/s	1,874		2,231		2,977		3,731		2,703	
		Average wet season peak daily flow	m3/s	13,831		23,880		45,671		20,962		26,086	
		Average flow volume entering Tonle Sap	MCM	n/a		n/a		30,145		n/a		30,145	
	Protection of forests around Tonle Sap	Forest, marshes and grasslands flooded at Tonle Sap	'000 ha										
		Net economic value	NPV US$M										
2.2 Maintain wetland productivity and	Productivity of wetland ecosystems	Are of wetlands (forest, marshes, wetland)	'000 ha										
		Net economic value	NPV US$M										
2.3 Manage salinity intrusion in the Mekong	Impact of salinity intrusion on land use	Area within delta within threshold level of salinity	'000 ha							1,611		1,611	
		Net economic value	NPV US$M										
2.4 Minimize channel effects on bank erosion and deep pools	River bank erosion	Area at risk to erosion	Severity	Mildly positive		Mildly positive		Neutral		Neutral		Neutral	
		Net economic value	NPV US$M										
	Flow and sediment transport changes	Functioning deep pools	No.	20		17		5		5		47	
		Induced geomorphological changes	Severity	Neutral		Neutral		Neutral		Neutral		Neutral	
2.5 Conservation of biodiversity	Impacts of flow management changes on endangered species	Status of river channel habitats	Severity	Neutral		Neutral		Neutral		Neutral		Neutral	
		Flagship species	Survival	Surviving		Surviving		Surviving		Surviving		Surviving	
		Unaffected environmental hot spots	Severity	Neutral		Neutral		Neutral		Neutral		Neutral	
		Biodiversity condition	Severity	Neutral		Neutral		Neutral		Neutral		Neutral	
		Incremental net economic value of habitat areas	NPV US$M										
3. Social development													
3.1 Maintain livelihoods of vulnerable resource-users	Health, food and income security	No. of people affected	'000			46		90		390		527	
		Severity of impact on health, food and income security	Severity	Mildly negative		Mildly negative		Mildly negative		Mildly negative		Mildly negative	
3.4 Increased employment generation in water related sectors	Incremental sustainable employment from water resource interventions	Incremental number of people engaged in:											
		Irrigated agriculture	'000	79		227		77		35		418	
		Reservoir fisheries (incremental to BS)	'000										
		Hydropower production	'000										
		Aquaculture (incremental to BS)	'000										
4 Equitable development													
4.1 Ensure that all four LMB countries benefit from the development of water and related resources	Aggregate benefits by country	Total net economic value	NPV US$M	2,634		882				1,979		5,494	
		No. of people affected vulnerable to changes	'000			46		90		390		527	
		No. of jobs generated	'000	79		227		77		35		418	
		Overall environment impact	Severity	Neutral		Neutral		Neutral		Neutral		Neutral	

Summary of scenario assessment

Incremental values relative to Baseline

Upper Mekong Dam Scenario

Scenario run no. 2000

Specific development objective	Issue	Assessment criteria	Unit	Lao PDR Amount	Lao PDR Percent	Thailand Amount	Thailand Percent	Cambodia Amount	Cambodia Percent	Viet Nam Amount	Viet Nam Percent	Total Amount	Total Percent
1. Economic development													
1.1 Increase irrigated agricultural production	Irrigable area, production tonnage and value	Incremental area	'000 ha										
		Crop production	Mtonne / yr										
		Net economic value	NPV US$M										
1.2 Increase hydropower production	Hydropower capacity, power generated and value	Installed capacity	MW										
		Power generated	GWh/yr										
		Net economic value from generation	NPV US$M										
		Net economic value from purchased	NPV US$M										
1.3 Improve navigation	River transport	Navigable days by class	'000 boat-days	n/a		n/a		n/a		n/a		n/a	
		Net economic value	NPV US$M			-0	0%					-0	0%
1.4 Decrease damages by floods	Extent and duration of annual flooding by class	Average area flooded annually to max 1.0m depth	'000 ha	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
		Average area flooded annually > 1.0m depth	'000 ha	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
		Net economic value of flood damage	NPV US$M										
1.5 Maintain productivity of fishery sector	Capture fisheries and aquaculture production	Annual average capture fish availability	Mtonne / yr	-0.009	-3%					-0.034	-9%	-0.044	-2%
		Annual average aquaculture production	Mtonne / yr	0.072	92%	0.082	81%	0.040	32%	0.831	50%	1.025	52%
		Net economic value of capture fish	NPV US$M										
2. Environmental protection													
2.1 Maintain water quality and acceptable flow conditions	Water quality	Total pollutant discharge	tonnes / yr										
		Water quality conditions	Severity										
	Flow characteristics	Average flow in March	m3/s	774	70%	778	54%	780	35%	659	21%	748	38%
		Average wet season peak daily flow	m3/s	-2,090	-13%	-1,621	-6%	-1,091	-2%	-348	-2%	-1,288	-5%
		Average flow volume entering Tonle Sap	MCM	n/a		n/a		-2,113	-7%	n/a		-2,113	-7%
	Protection of forests around Tonle Sap	Forest, marshes and grasslands flooded at Tonle Sap	'000 ha										
		Net economic value	NPV US$M										
2.2 Maintain wetland productivity and	Productivity of wetland ecosystems	Are of wetlands (forest, marshes, wetland)	'000 ha										
		Net economic value	NPV US$M										
2.3 Manage salinity intrusion in the Mekong	Impact of salinity intrusion on land use	Area within delta within threshold level of salinity	'000 ha							-240	-13%	-240	-13%
		Net economic value	NPV US$M										
2.4 Minimize channel effects on bank erosion and deep pools	River bank erosion	Area at risk to erosion	Severity	Mildly positive		Mildly positive		Neutral		Neutral		Neutral	
		Net economic value	NPV US$M										
	Flow and sediment transport changes	Functioning deep pools	No.										
		Induced geomorphological changes	Severity	Neutral		Neutral		Neutral		Neutral		Neutral	
2.5 Conservation of biodiversity	Impacts of flow management changes on endangered species	Status of river channel habitats	Severity	Neutral		Neutral		Neutral		Neutral		Neutral	
		Flagship species	Survival	n/a		n/a		n/a		n/a		n/a	
		Unaffected environmental hot spots	Severity	Neutral		Neutral		Neutral		Neutral		Neutral	
		Biodiversity condition	Severity	Neutral		Neutral		Neutral		Neutral		Neutral	
		Incremental net economic value of habitat areas	NPV US$M										
3. Social development													
3.1 Maintain livelihoods of vulnerable resource-users	Health, food and income security	No. of people affected	'000			46		90		390		527	
		Severity of impact on health, food and income security	Severity	Mildly negative		Mildly negative		Mildly negative		Mildly negative		Mildly negative	
3.4 Increased employment generation in water related sectors	Incremental sustainable employment from water resource interventions	Incremental number of people engaged in:											
		Irrigated agriculture	'000										
		Reservoir fisheries (incremental to BS)	'000										
		Hydropower production	'000										
		Aquaculture (incremental to BS)	'000										
4 Equitable development													
4.1 Ensure that all four LMB countries benefit from the development of water and related resources	Aggregate benefits by country	Total net economic value	NPV US$M			-0	0%					-0	0%
		No. of people affected vulnerable to changes	'000			46		90		390		527	
		No. of jobs generated	'000										
		Overall environment impact	Severity										

Summary of scenario assessment

Estimated total values

Definite Future Scenario

Scenario run no. 3000

Specific development objective	Issue	Assessment criteria	Unit	Lao PDR Amount	Lao PDR Percent	Thailand Amount	Thailand Percent	Cambodia Amount	Cambodia Percent	Viet Nam Amount	Viet Nam Percent	Total Amount	Total Percent
1. Economic development													
1.1 Increase irrigated agricultural production	Irrigable area, production tonnage and value	Incremental area	'000 ha	166		1,355		273		1,670		3,465	
		Crop production	Mtonne / yr	0.871		5.406		1.905		19.834		28.017	
		Net economic value	NPV US$M	-19		-10		-106		-9		-144	
1.2 Increase hydropower production	Hydropower capacity, power generated and value	Installed capacity	MW	3,502		745		1		2,284		6,532	
		Power generated	GWh/yr	16,403		12,179		2,335		13,594		44,510	
		Net economic value from generation	NPV US$M	7,686		591		748		3,821		12,845	
		Net economic value from purchased	NPV US$M	1,567		1,060		457		874		3,958	
1.3 Improve navigation	River transport	Navigable days by class	'000 boat-days	n/a		n/a		n/a		n/a		n/a	
		Net economic value	NPV US$M			246						246	
1.4 Decrease damages by floods	Extent and duration of annual flooding by class	Average area flooded annually to max 1.0m depth	'000 ha	42		45		424		1,121		1,633	
		Average area flooded annually > 1.0m depth	'000 ha	299		256		1,653		670		2,878	
		Net economic value of flood damage	NPV US$M	179		172		51		60		462	
1.5 Maintain productivity of fishery sector	Capture fisheries and aquaculture production	Annual average capture fish availability	Mtonne / yr	0.285		0.996		0.739		0.367		2.387	
		Annual average aquaculture production	Mtonne / yr	0.150		0.182		0.167		2.494		2.994	
		Net economic value of capture fish	NPV US$M	-28		-14		-232		548		274	
2. Environmental protection													
2.1 Maintain water quality and acceptable flow conditions	Water quality	Total pollutant discharge	tonnes / yr	50,658		108,880		38,593		170,402		368,532	
		Water quality conditions	Severity										
	Flow characteristics	Average flow in March	m3/s	1,860		2,372		3,069		3,898		2,800	
		Average wet season peak daily flow	m3/s	13,813		24,032		45,123		20,830		25,949	
		Average flow volume entering Tonle Sap	MCM	n/a		n/a		29,740		n/a		29,740	
	Protection of forests around Tonle Sap	Forest, marshes and grasslands flooded at Tonle Sap	'000 ha					1,028				1,028	
		Net economic value	NPV US$M	-130				-6		-17		-153	
2.2 Maintain wetland productivity and	Productivity of wetland ecosystems	Are of wetlands (forest, marshes, wetland)	'000 ha	12		52		1,267		101		1,432	
		Net economic value	NPV US$M	-27		-47		-153		-1		-228	
2.3 Manage salinity intrusion in the Mekong	Impact of salinity intrusion on land use	Area within delta within threshold level of salinity	'000 ha							1,579		1,579	
		Net economic value	NPV US$M							20		20	
2.4 Minimize channel effects on bank erosion and deep pools	River bank erosion	Area at risk to erosion	Severity	Mildly positive		Mildly positive		Neutral		Neutral		Neutral	
		Net economic value	NPV US$M										
	Flow and sediment transport changes	Functioning deep pools	No.	20		17		5		5		47	
		Induced geomorphological changes	Severity	Mildly negative		Mildly negative		Neutral		Neutral		Mildly negative	
2.5 Conservation of biodiversity	Impacts of flow management changes on endangered species	Status of river channel habitats	Severity	Mildly negative		Mildly negative		Neutral		Neutral		Mildly negative	
		Flagship species	Survival	Surviving		Surviving		Surviving		Surviving		Surviving	
		Unaffected environmental hot spots	Severity	Neutral		Negative		Mildly negative		Neutral		Mildly negative	
		Biodiversity condition	Severity	Mildly negative		Mildly negative		Mildly negative		Mildly negative		Mildly negative	
		Incremental net economic value of habitat areas	NPV US$M			-20		-65				-85	
3. Social development													
3.1 Maintain livelihoods of vulnerable resource-users	Health, food and income security	No. of people affected	'000	297		46		102		442		887	
		Severity of impact on health, food and income security	Severity	Negative		Mildly negative		Mildly negative		Mildly negative		Negative	
3.4 Increased employment generation in water related sectors	Incremental sustainable employment from water resource interventions	Incremental number of people engaged in:											
		Irrigated agriculture	'000	79		227		77		35		418	
		Reservoir fisheries (incremental to BS)	'000	12				1		2		15	
		Hydropower production	'000	52		5		15		31		104	
		Aquaculture (incremental to BS)	'000	28		39		20		164		251	
4 Equitable development													
4.1 Ensure that all four LMB countries benefit from the development of water and related resources	Aggregate benefits by country	Total net economic value	NPV US$M	9,229		1,977		693		5,296		17,195	
		No. of people affected vulnerable to changes	'000	297		46		102		442		887	
		No. of jobs generated	'000	171		271		113		232		788	
		Overall environment impact	Severity	Mildly negative		Mildly negative		Mildly negative		Mildly negative		Mildly negative	

Summary of scenario assessment

Incremental values relative to Baseline

Definite Future Scenario

Scenario run no. 3000

Specific development objective	Issue	Assessment criteria	Unit	Lao PDR		Thailand		Cambodia		Viet Nam		Total	
				Amount	Percent	Amount	Percent	Amount	Percent	Amount	Percent	Amount	Percent
1. Economic development													
1.1 Increase irrigated agricultural production	Irrigable area, production tonnage and value	Incremental area	'000 ha	-38	-18%	89	7%			-326	-16%	-275	-7%
		Crop production	Mtonne / yr										
		Net economic value	NPV US$M	-19		-10		-106		-9		-144	
1.2 Increase hydropower production	Hydropower capacity, power generated and value	Installed capacity	MW	2,881	464%	500	204%	1		1,564	217%	4,946	312%
		Power generated	GWh/yr	13,371	441%	9,776	407%	2,335		9,935	272%	35,417	389%
		Net economic value from generation	NPV US$M	5,393	235%	100	20%	748		2,109	123%	8,350	186%
		Net economic value from purchased	NPV US$M	1,227	360%	851	407%	457		607	227%	3,142	385%
1.3 Improve navigation	River transport	Navigable days by class	'000 boat-days	n/a		n/a		n/a		n/a		n/a	
		Net economic value	NPV US$M			64	35%					64	35%
1.4 Decrease damages by floods	Extent and duration of annual flooding by class	Average area flooded annually to max 1.0m depth	'000 ha	-6	-13%	-2	-5%	8	2%	119	12%	118	8%
		Average area flooded annually > 1.0m depth	'000 ha	-57	-16%	-66	-21%	-114	-6%	-129	-16%	-367	-11%
		Net economic value of flood damage	NPV US$M	179		172		51		60		462	
1.5 Maintain productivity of fishery sector	Capture fisheries and aquaculture production	Annual average capture fish availability	Mtonne / yr	-0.026	-8%	-0.031	-3%	-0.053	-7%	-0.032	-8%	-0.142	-6%
		Annual average aquaculture production	Mtonne / yr	0.072	92%	0.082	81%	0.040	32%	0.831	50%	1.025	52%
		Net economic value of capture fish	NPV US$M	-28		-14		-232		548		274	
2. Environmental protection													
2.1 Maintain water quality and acceptable flow conditions	Water quality	Total pollutant discharge	tonnes / yr										
		Water quality conditions	Severity										
	Flow characteristics	Average flow in March	m3/s	760	69%	920	63%	871	40%	826	27%	844	43%
		Average wet season peak daily flow	m3/s	-2,108	-13%	-1,469	-6%	-1,640	-4%	-480	-2%	-1,424	-5%
		Average flow volume entering Tonle Sap	MCM	n/a		n/a		-2,518	-8%	n/a		-2,518	-8%
	Protection of forests around Tonle Sap	Forest, marshes and grasslands flooded at Tonle Sap	'000 ha					-9	-1%			-9	-1%
		Net economic value	NPV US$M	-130				-6		-17		-153	
2.2 Maintain wetland productivity and	Productivity of wetland ecosystems	Are of wetlands (forest, marshes, wetland)	'000 ha	-5	-29%	-9	-15%	-21	-2%	-0	0%	-35	-2%
		Net economic value	NPV US$M	-27		-47		-153		-1		-228	
2.3 Manage salinity intrusion in the Mekong	Impact of salinity intrusion on land use	Area within delta within threshold level of salinity	'000 ha							-272	-15%	-272	-15%
		Net economic value	NPV US$M							20		20	
2.4 Minimize channel effects on bank erosion and deep pools	River bank erosion	Area at risk to erosion	Severity	Mildly positive		Mildly positive		Neutral		Neutral		Neutral	
		Net economic value	NPV US$M										
	Flow and sediment transport changes	Functioning deep pools	No.										
		Induced geomorphological changes	Severity	Mildly negative		Mildly negative		Neutral		Neutral		Mildly negative	
2.5 Conservation of biodiversity	Impacts of flow management changes on endangered species	Status of river channel habitats	Severity	Mildly negative		Mildly negative		Neutral		Neutral		Mildly negative	
		Flagship species	Survival	n/a		n/a		n/a		n/a		n/a	
		Unaffected environmental hot spots	Severity	Neutral		Negative		Mildly negative		Neutral		Mildly negative	
		Biodiversity condition	Severity	Mildly negative		Mildly negative		Mildly negative		Mildly negative		Mildly negative	
		Incremental net economic value of habitat areas	NPV US$M			-20		-65				-85	
3. Social development													
3.1 Maintain livelihoods of vulnerable resource-users	Health, food and income security	No. of people affected	'000	297		46		102		442		887	
		Severity of impact on health, food and income security	Severity	Negative		Mildly negative		Mildly negative		Mildly negative		Negative	
3.4 Increased employment generation in water related sectors	Incremental sustainable employment from water resource interventions	Incremental number of people engaged in:											
		Irrigated agriculture	'000										
		Reservoir fisheries (incremental to BS)	'000	12				1		2		15	
		Hydropower production	'000	52		5		15		31		104	
		Aquaculture (incremental to BS)	'000	28		39		20		164		251	
4 Equitable development													
4.1 Ensure that all four LMB countries benefit from the development of water and related resources	Aggregate benefits by country	Total net economic value	NPV US$M	6,595	250%	1,095	124%	693		3,317	168%	11,700	213%
		No. of people affected vulnerable to changes	'000	297		46		102		442		887	
		No. of jobs generated	'000	93	118%	44	20%	36	46%	197	565%	370	89%
		Overall environment impact	Severity	Mildly negative		Mildly negative		Mildly negative		Mildly negative		Mildly negative	

Summary of scenario assessment

Estimated total values

LMB 20-Year Plan Scenario

Scenario run no. 4000

Specific development objective	Issue	Assessment criteria	Unit	Lao PDR Amount	Lao PDR Percent	Thailand Amount	Thailand Percent	Cambodia Amount	Cambodia Percent	Viet Nam Amount	Viet Nam Percent	Total Amount	Total Percent
1. Economic development													
1.1 Increase irrigated agricultural production	Irrigable area, production tonnage and value	Incremental area	'000 ha	450		2,635		457		1,795		5,337	
		Crop production	Mtonne / yr	4.225		17.371		5.228		28.345		55.170	
		Net economic value	NPV US$M	300		864		223		94		1,481	
1.2 Increase hydropower production	Hydropower capacity, power generated and value	Installed capacity	MW	15,385		3,696		4,761		2,583		26,424	
		Power generated	GWh/yr	84,416		60,694		23,061		35,058		203,229	
		Net economic value from generation	NPV US$M	14,585		964		1,315		4,659		21,523	
		Net economic value from purchased	NPV US$M	10,407		3,108		2,031		1,066		16,612	
1.3 Improve navigation	River transport	Navigable days by class	'000 boat-days	n/a		n/a		n/a		n/a		n/a	
		Net economic value	NPV US$M			246						246	
1.4 Decrease damages by floods	Extent and duration of annual flooding by class	Average area flooded annually to max 1.0m depth	'000 ha	41		44		432		1,149		1,666	
		Average area flooded annually > 1.0m depth	'000 ha	289		244		1,609		637		2,779	
		Net economic value of flood damage	NPV US$M	130		130		50		67		377	
1.5 Maintain productivity of fishery sector	Capture fisheries and aquaculture production	Annual average capture fish availability	Mtonne / yr	0.299		0.979		0.473		0.265		2.015	
		Annual average aquaculture production	Mtonne / yr	0.204		0.259		0.243		3.326		4.031	
		Net economic value of capture fish	NPV US$M	129		74		-895		234		-459	
2. Environmental protection													
2.1 Maintain water quality and acceptable flow conditions	Water quality	Total pollutant discharge	tonnes / yr	100,143		195,432		54,357		208,047		557,979	
		Water quality conditions	Severity										
	Flow characteristics	Average flow in March	m3/s	2,218		2,698		3,546		4,179		3,160	
		Average wet season peak daily flow	m3/s	13,540		23,417		43,307		20,455		25,180	
		Average flow volume entering Tonle Sap	MCM	n/a		n/a		27,993		n/a		27,993	
	Protection of forests around Tonle Sap	Forest, marshes and grasslands flooded at Tonle Sap	'000 ha					1,024				1,024	
		Net economic value	NPV US$M	-236				-122		-14		-372	
2.2 Maintain wetland productivity and	Productivity of wetland ecosystems	Are of wetlands (forest, marshes, wetland)	'000 ha	11		51		1,257		100		1,419	
		Net economic value	NPV US$M	-18		-34		-169		-4		-225	
2.3 Manage salinity intrusion in the Mekong	Impact of salinity intrusion on land use	Area within delta within threshold level of salinity	'000 ha							1,543		1,543	
		Net economic value	NPV US$M							27		27	
2.4 Minimize channel effects on bank erosion and deep pools	River bank erosion	Area at risk to erosion	Severity	Mildly negative		Mildly negative		Mildly negative		Neutral		Neutral	
		Net economic value	NPV US$M										
	Flow and sediment transport changes	Functioning deep pools	No.	12		7		3		5		27	
		Induced geomorphological changes	Severity	Negative		Negative		Mildly negative		Neutral		Negative	
2.5 Conservation of biodiversity	Impacts of flow management changes on endangered species	Status of river channel habitats	Severity	Negative		Negative		Mildly negative		Mildly negative		Negative	
		Flagship species	Survival	Extinct		Extinct		Surviving		Surviving		Extinct	
		Unaffected environmental hot spots	Severity	Extremely negative		Severely negative		Extremely negative		Neutral		Severely negative	
		Biodiversity condition	Severity	Severely negative		Severely negative		Severely negative		Mildly negative		Severely negative	
		Incremental net economic value of habitat areas	NPV US$M	-75		-60		-195				-330	
3. Social development													
3.1 Maintain livelihoods of vulnerable resource-users	Health, food and income security	No. of people affected	'000	907		516		1,212		1,725		4,360	
		Severity of impact on health, food and income security	Severity	Severely negative		Severely negative		Extremely negative		Negative		Severely negative	
3.4 Increased employment generation in water related sectors	Incremental sustainable employment from water resource interventions	Incremental number of people engaged in:											
		Irrigated agriculture	'000	150		346		84		49		629	
		Reservoir fisheries (incremental to BS)	'000	40				21		3		64	
		Hydropower production	'000	382		38		163		29		612	
		Aquaculture (incremental to BS)	'000	55		77		57		164		352	
4 Equitable development													
4.1 Ensure that all four LMB countries benefit from the development of water and related resources	Aggregate benefits by country	Total net economic value	NPV US$M	25,222		5,292		2,237		6,129		38,880	
		No. of people affected vulnerable to changes	'000	907		516		1,212		1,725		4,360	
		No. of jobs generated	'000	628		461		324		245		1,658	
		Overall environment impact	Severity	Severely negative		Severely negative		Severely negative		Mildly negative		Severely negative	

Summary of scenario assessment

Incremental values relative to Baseline

LMB 20-Year Plan Scenario

Scenario run no. 4000

Specific development objective	Issue	Assessment criteria	Unit	Lao PDR		Thailand		Cambodia		Viet Nam		Total	
				Amount	Percent	Amount	Percent	Amount	Percent	Amount	Percent	Amount	Percent
1. Economic development													
1.1 Increase irrigated agricultural production	Irrigable area, production tonnage and value	Incremental area	'000 ha	245	120%	1,370	108%	183	67%	-201	-10%	1,597	43%
		Crop production	Mtonne / yr	3.354	385%	11.964	221%	3.324	174%	8.511	43%	27.153	97%
		Net economic value	NPV US$M	300		864		223		94		1,481	
1.2 Increase hydropower production	Hydropower capacity, power generated and value	Installed capacity	MW	14,764	2377%	3,451	1410%	4,761		1,863	259%	24,839	1566%
		Power generated	GWh/yr	81,384	2684%	58,291	2426%	23,061		31,399	858%	194,136	2135%
		Net economic value from generation	NPV US$M	12,292	536%	473	96%	1,315		2,948	172%	17,028	379%
		Net economic value from purchased	NPV US$M	10,066	2957%	2,899	1386%	2,031		799	299%	15,796	1934%
1.3 Improve navigation	River transport	Navigable days by class	'000 boat-days	n/a		n/a		n/a		n/a		n/a	
		Net economic value	NPV US$M			64	35%					64	35%
1.4 Decrease damages by floods	Extent and duration of annual flooding by class	Average area flooded annually to max 1.0m depth	'000 ha	-8	-16%	-3	-6%	16	4%	146	15%	151	10%
		Average area flooded annually > 1.0m depth	'000 ha	-67	-19%	-78	-24%	-158	-9%	-162	-20%	-465	-14%
		Net economic value of flood damage	NPV US$M	130		130		50		67		377	
1.5 Maintain productivity of fishery sector	Capture fisheries and aquaculture production	Annual average capture fish availability	Mtonne / yr	-0.012	-4%	-0.048	-5%	-0.320	-40%	-0.135	-34%	-0.515	-20%
		Annual average aquaculture production	Mtonne / yr	0.126	161%	0.158	158%	0.116	91%	1.662	100%	2.063	105%
		Net economic value of capture fish	NPV US$M	129		74		-895		234		-459	
2. Environmental protection													
2.1 Maintain water quality and acceptable flow conditions	Water quality	Total pollutant discharge	tonnes / yr	49,486	98%	86,552	79%	15,764	41%	37,646	22%	189,447	51%
		Water quality conditions	Severity										
	Flow characteristics	Average flow in March	m3/s	1,118	102%	1,246	86%	1,348	61%	1,107	36%	1,205	62%
		Average wet season peak daily flow	m3/s	-2,381	-15%	-2,084	-8%	-3,456	-7%	-855	-4%	-2,194	-8%
		Average flow volume entering Tonle Sap	MCM	n/a		n/a		-4,265	-13%	n/a		-4,265	-13%
	Protection of forests around Tonle Sap	Forest, marshes and grasslands flooded at Tonle Sap	'000 ha					-14	-1%			-14	-1%
		Net economic value	NPV US$M	-236				-122		-14		-372	
2.2 Maintain wetland productivity and	Productivity of wetland ecosystems	Are of wetlands (forest, marshes, wetland)	'000 ha	-6	-34%	-11	-18%	-31	-2%	-0	0%	-48	-3%
		Net economic value	NPV US$M	-18		-34		-169		-4		-225	
2.3 Manage salinity intrusion in the Mekong	Impact of salinity intrusion on land use	Area within delta within threshold level of salinity	'000 ha							-309	-17%	-309	-17%
		Net economic value	NPV US$M							27		27	
2.4 Minimize channel effects on bank erosion and deep pools	River bank erosion	Area at risk to erosion	Severity	Mildly negative		Mildly negative		Mildly negative		Neutral		Mildly negative	
		Net economic value	NPV US$M										
	Flow and sediment transport changes	Functioning deep pools	No.	-8	-40%	-10	-59%	-2	-40%			-20	-43%
		Induced geomorphological changes	Severity	Negative		Negative		Mildly negative		Neutral		Negative	
2.5 Conservation of biodiversity	Impacts of flow management changes on endangered species	Status of river channel habitats	Severity	Negative		Negative		Mildly negative		Mildly negative		Negative	
		Flagship species	Survival	n/a		n/a		n/a		n/a		n/a	
		Unaffected environmental hot spots	Severity	Extremely negative		Severely negative		Extremely negative		Neutral		Severely negative	
		Biodiversity condition	Severity	Severely negative		Severely negative		Severely negative		Mildly negative		Severely negative	
		Incremental net economic value of habitat areas	NPV US$M	-75		-60		-195				-330	
3. Social development													
3.1 Maintain livelihoods of vulnerable resource-users	Health, food and income security	No. of people affected	'000	907		516		1,212		1,725		4,360	
		Severity of impact on health, food and income security	Severity	Severely negative		Severely negative		Extremely negative		Negative		Severely negative	
3.4 Increased employment generation in water related sectors	Incremental sustainable employment from water resource interventions	Incremental number of people engaged in:											
		Irrigated agriculture	'000	72	91%	119	53%	6	8%	14	41%	212	51%
		Reservoir fisheries (incremental to BS)	'000	40				21		3		64	
		Hydropower production	'000	382		38		163		29		612	
		Aquaculture (incremental to BS)	'000	55		77		57		164		352	
4 Equitable development													
4.1 Ensure that all four LMB countries benefit from the development of water and related resources	Aggregate benefits by country	Total net economic value	NPV US$M	22,588	858%	4,410	500%	2,237		4,151	210%	33,386	608%
		No. of people affected vulnerable to changes	'000	907		516		1,212		1,725		4,360	
		No. of jobs generated	'000	549	698%	234	103%	247	319%	210	602%	1,240	297%
		Overall environment impact	Severity	Severely negative		Severely negative		Severely negative		Mildly negative		Severely negative	

Summary of scenario assessment

Incremental values relative to Definite Future Scenario

LMB 20-Year Plan Scenario

Scenario run no. 4000

Specific development objective	Issue	Assessment criteria	Unit	Lao PDR		Thailand		Cambodia		Viet Nam		Total	
				Amount	Percent	Amount	Percent	Amount	Percent	Amount	Percent	Amount	Percent
1. Economic development													
1.1 Increase irrigated agricultural production	Irrigable area, production tonnage and value	Incremental area	'000 ha	283	170%	1,281	95%	183	67%	125	7%	1,872	54%
		Crop production	Mtonne / yr	3.354	385%	11.964	221%	3.324	174%	8.511	43%	27.153	97%
		Net economic value	NPV US$M	320	-1678%	874	-8528%	329	-310%	103	-1177%	1,625	-1128%
1.2 Increase hydropower production	Hydropower capacity, power generated and value	Installed capacity	MW	11,882	339%	2,951	396%	4,760	476000%	299	13%	19,892	305%
		Power generated	GWh/yr	68,013	415%	48,515	398%	20,726	888%	21,465	158%	158,719	357%
		Net economic value from generation	NPV US$M	6,899	90%	373	63%	567	76%	839	22%	8,678	68%
		Net economic value from purchased	NPV US$M	8,840	564%	2,048	193%	1,574	345%	192	22%	12,654	320%
1.3 Improve navigation	River transport	Navigable days by class	'000 boat-days	n/a		n/a		n/a		n/a		n/a	
		Net economic value	NPV US$M										
1.4 Decrease damages by floods	Extent and duration of annual flooding by class	Average area flooded annually to max 1.0m depth	'000 ha	-2	-4%	-0	-1%	8	2%	27	2%	33	2%
		Average area flooded annually > 1.0m depth	'000 ha	-10	-3%	-12	-5%	-44	-3%	-33	-5%	-98	-3%
		Net economic value of flood damage	NPV US$M	-49	-27%	-42	-24%	-1	-2%	7	12%	-85	-18%
1.5 Maintain productivity of fishery sector	Capture fisheries and aquaculture production	Annual average capture fish availability	Mtonne / yr	0.014	5%	-0.017	-2%	-0.267	-36%	-0.102	-28%	-0.372	-16%
		Annual average aquaculture production	Mtonne / yr	0.054	36%	0.077	42%	0.076	45%	0.831	33%	1.037	35%
		Net economic value of capture fish	NPV US$M	156	-565%	87	-640%	-663	286%	-314	-57%	-734	-268%
2. Environmental protection													
2.1 Maintain water quality and acceptable flow conditions	Water quality	Total pollutant discharge	tonnes / yr	49,486	98%	86,552	79%	15,764	41%	37,646	22%	189,447	51%
		Water quality conditions	Severity										
	Flow characteristics	Average flow in March	m3/s	358	19%	326	14%	477	16%	281	7%	361	13%
		Average wet season peak daily flow	m3/s	-273	-2%	-615	-3%	-1,816	-4%	-374	-2%	-770	-3%
		Average flow volume entering Tonle Sap	MCM	n/a		n/a		-1,747	-6%	n/a		-1,747	-6%
	Protection of forests around Tonle Sap	Forest, marshes and grasslands flooded at Tonle Sap	'000 ha					-5	0%			-5	0%
		Net economic value	NPV US$M	-106	82%			-116	1840%	3	-19%	-219	143%
2.2 Maintain wetland productivity and	Productivity of wetland ecosystems	Are of wetlands (forest, marshes, wetland)	'000 ha	-1	-8%	-2	-4%	-10	-1%	-0	0%	-13	-1%
		Net economic value	NPV US$M	8	-31%	14	-29%	-15	10%	-4	587%	3	-1%
2.3 Manage salinity intrusion in the Mekong	Impact of salinity intrusion on land use	Area within delta within threshold level of salinity	'000 ha							-37	-2%	-37	-2%
		Net economic value	NPV US$M							7	35%	7	35%
2.4 Minimize channel effects on bank erosion and deep pools	River bank erosion	Area at risk to erosion	Severity	Negative		Negative		Mildly negative		Neutral		Negative	
		Net economic value	NPV US$M										
	Flow and sediment transport changes	Functioning deep pools	No.	-8	-40%	-10	-59%	-2	-40%			-20	-43%
		Induced geomorphological changes	Severity	Mildly negative		Mildly negative		Mildly negative		Neutral		Mildly negative	
2.5 Conservation of biodiversity	Impacts of flow management changes on endangered species	Status of river channel habitats	Severity	Mildly negative		Mildly negative		Mildly negative		Mildly negative		Mildly negative	
		Flagship species	Survival	n/a		n/a		n/a		n/a		n/a	
		Unaffected environmental hot spots	Severity	Extremely negative		Negative		Severely negative		Neutral		Negative	
		Biodiversity condition	Severity	Negative		Negative		Negative		Neutral		Negative	
		Incremental net economic value of habitat areas	NPV US$M	-75		-40	200%	-130	200%			-245	288%
3. Social development													
3.1 Maintain livelihoods of vulnerable resource-users	Health, food and income security	No. of people affected	'000	610	205%	470	1022%	1,110	1088%	1,283	290%	3,473	392%
		Severity of impact on health, food and income security	Severity	Mildly negative		Negative		Severely negative		Mildly negative		Negative	
3.4 Increased employment generation in water related sectors	Incremental sustainable employment from water resource interventions	Incremental number of people engaged in:											
		Irrigated agriculture	'000	72	91%	119	53%	6	8%	14	41%	212	51%
		Reservoir fisheries (incremental to BS)	'000	28	226%			20	3497%	1	46%	49	325%
		Hydropower production	'000	330	635%	33	636%	148	963%	-3	-8%	508	490%
		Aquaculture (incremental to BS)	'000	26	94%	38	96%	37	188%			101	40%
4 Equitable development													
4.1 Ensure that all four LMB countries benefit from the development of water and related resources	Aggregate benefits by country	Total net economic value	NPV US$M	15,993	173%	3,315	168%	1,544	223%	834	16%	21,685	126%
		No. of people affected vulnerable to changes	'000	610	205%	470	1022%	1,110	1088%	1,283	290%	3,473	392%
		No. of jobs generated	'000	456	266%	190	70%	211	187%	13	6%	870	111%
		Overall environment impact	Severity	Negative		Negative		Negative		Neutral		Negative	

Summary of scenario assessment

Estimated total values

LMB 20-Year Plan Scenario
Climate change

Scenario run no. 4001

Specific development objective	Issue	Assessment criteria	Unit	Lao PDR Amount	Lao PDR Percent	Thailand Amount	Thailand Percent	Cambodia Amount	Cambodia Percent	Viet Nam Amount	Viet Nam Percent	Total Amount	Total Percent
1. Economic development													
1.1 Increase irrigated agricultural production	Irrigable area, production tonnage and value	Incremental area	'000 ha	450		2,635		457		1,795		5,337	
		Crop production	Mtonne / yr	4.225		17.371		5.228		28.345		55.170	
		Net economic value	NPV US$M	327		878		600		132		1,938	
1.2 Increase hydropower production	Hydropower capacity, power generated and value	Installed capacity	MW	15,385		3,696		4,761		2,583		26,424	
		Power generated	GWh/yr	84,416		60,694		23,061		35,058		203,229	
		Net economic value from generation	NPV US$M	14,585		964		1,315		4,659		21,523	
		Net economic value from purchased	NPV US$M	10,407		3,108		2,031		1,066		16,612	
1.3 Improve navigation	River transport	Navigable days by class	'000 boat-days	n/a		n/a		n/a		n/a		n/a	
		Net economic value	NPV US$M			246						246	
1.4 Decrease damages by floods	Extent and duration of annual flooding by class	Average area flooded annually to max 1.0m depth	'000 ha	49		45		417		825		1,336	
		Average area flooded annually > 1.0m depth	'000 ha	351		296		2,052		1,030		3,729	
		Net economic value of flood damage	NPV US$M	130		130		-226		-307		-273	
1.5 Maintain productivity of fishery sector	Capture fisheries and aquaculture production	Annual average capture fish availability	Mtonne / yr										
		Annual average aquaculture production	Mtonne / yr	0.204		0.259		0.243		3.326		4.031	
		Net economic value of capture fish	NPV US$M	129		74		-895		234		-459	
2. Environmental protection													
2.1 Maintain water quality and acceptable flow conditions	Water quality	Total pollutant discharge	tonnes / yr	100,143		195,432		64,719		208,047		568,341	
		Water quality conditions	Severity										
	Flow characteristics	Average flow in March	m3/s	2,265		2,759		3,577		4,077		3,170	
		Average wet season peak daily flow	m3/s	13,691		25,919		50,515		21,529		27,914	
		Average flow volume entering Tonle Sap	MCM	n/a		n/a		30,663		n/a		30,663	
	Protection of forests around Tonle Sap	Forest, marshes and grasslands flooded at Tonle Sap	'000 ha					1,053				1,053	
		Net economic value	NPV US$M	-236				-122		-14		-372	
2.2 Maintain wetland productivity and	Productivity of wetland ecosystems	Are of wetlands (forest, marshes, wetland)	'000 ha	16		58		1,327		101		1,502	
		Net economic value	NPV US$M	-3		-13		120		-3		101	
2.3 Manage salinity intrusion in the Mekong	Impact of salinity intrusion on land use	Area within delta within threshold level of salinity	'000 ha							1,874		1,874	
		Net economic value	NPV US$M							-2		-2	
2.4 Minimize channel effects on bank erosion and deep pools	River bank erosion	Area at risk to erosion	Severity	Negative		Negative		Negative		Mildly negative		Neutral	
		Net economic value	NPV US$M										
	Flow and sediment transport changes	Functioning deep pools	No.	12		7		3		5		27	
		Induced geomorphological changes	Severity	Negative		Negative		Mildly negative		Mildly negative		Negative	
2.5 Conservation of biodiversity	Impacts of flow management changes on endangered species	Status of river channel habitats	Severity	Negative		Negative		Mildly negative		Negative		Negative	
		Flagship species	Survival	Extinct		Extinct		Surviving		Surviving		Extinct	
		Unaffected environmental hot spots	Severity	Catastrophic		Extremely negative		Extremely negative		Negative		Extremely negative	
		Biodiversity condition	Severity	Severely negative		Severely negative		Negative		Mildly negative		Severely negative	
		Incremental net economic value of habitat areas	NPV US$M	-100		-60		-195		-60		-415	
3. Social development													
3.1 Maintain livelihoods of vulnerable resource-users	Health, food and income security	No. of people affected	'000	907		516		1,212		1,725		4,360	
		Severity of impact on health, food and income security	Severity	Severely negative		Severely negative		Extremely negative		Negative		Severely negative	
3.4 Increased employment generation in water related sectors	Incremental sustainable employment from water resource interventions	Incremental number of people engaged in:											
		Irrigated agriculture	'000	150		346		84		49		629	
		Reservoir fisheries (incremental to BS)	'000	40				28		4		72	
		Hydropower production	'000	382		38		163		29		612	
		Aquaculture (incremental to BS)	'000	55		77		57		164		352	
4 Equitable development													
4.1 Ensure that all four LMB countries benefit from the development of water and related resources	Aggregate benefits by country	Total net economic value	NPV US$M	25,238		5,327		2,627		5,705		38,898	
		No. of people affected vulnerable to changes	'000	907		516		1,212		1,725		4,360	
		No. of jobs generated	'000	628		461		331		246		1,666	
		Overall environment impact	Severity	Severely negative		Severely negative		Negative		Negative		Severely negative	

Summary of scenario assessment

Incremental values relative to Baseline

LMB 20-Year Plan Scenario
Climate change

Scenario run no. 4001

Specific development objective	Issue	Assessment criteria	Unit	Lao PDR		Thailand		Cambodia		Viet Nam		Total	
				Amount	Percent	Amount	Percent	Amount	Percent	Amount	Percent	Amount	Percent
1. Economic development													
1.1 Increase irrigated agricultural production	Irrigable area, production tonnage and value	Incremental area	'000 ha	245	120%	1,370	108%	183	67%	-201	-10%	1,597	43%
		Crop production	Mtonne / yr	3.354	385%	11.964	221%	3.324	174%	8.511	43%	27.153	97%
		Net economic value	NPV US$M	327		878		600		132		1,938	
1.2 Increase hydropower production	Hydropower capacity, power generated and value	Installed capacity	MW	14,764	2377%	3,451	1410%	4,761		1,863	259%	24,839	1566%
		Power generated	GWh/yr	81,384	2684%	58,291	2426%	23,061		31,399	858%	194,136	2135%
		Net economic value from generation	NPV US$M	12,292	536%	473	96%	1,315		2,948	172%	17,028	379%
		Net economic value from purchased	NPV US$M	10,066	2957%	2,899	1386%	2,031		799	299%	15,796	1934%
1.3 Improve navigation	River transport	Navigable days by class	'000 boat-days	n/a		n/a		n/a		n/a		n/a	
		Net economic value	NPV US$M			64	35%					64	35%
1.4 Decrease damages by floods	Extent and duration of annual flooding by class	Average area flooded annually to max 1.0m depth	'000 ha	0	0%	-2	-3%	1	0%	-178	-18%	-179	-12%
		Average area flooded annually > 1.0m depth	'000 ha	-6	-2%	-25	-8%	285	16%	230	29%	485	15%
		Net economic value of flood damage	NPV US$M	130		130		-226		-307		-273	
1.5 Maintain productivity of fishery sector	Capture fisheries and aquaculture production	Annual average capture fish availability	Mtonne / yr	-0.311	-100%	-1.027	-100%	-0.792	-100%	-0.400	-100%	-2.530	-100%
		Annual average aquaculture production	Mtonne / yr	0.126	161%	0.158	158%	0.116	91%	1.662	100%	2.063	105%
		Net economic value of capture fish	NPV US$M	129		74		-895		234		-459	
2. Environmental protection													
2.1 Maintain water quality and acceptable flow conditions	Water quality	Total pollutant discharge	tonnes / yr	49,486	98%	86,552	79%	26,125	68%	37,646	22%	199,809	54%
		Water quality conditions	Severity										
	Flow characteristics	Average flow in March	m3/s	1,165	106%	1,306	90%	1,380	63%	1,006	33%	1,214	62%
		Average wet season peak daily flow	m3/s	-2,230	-14%	418	2%	3,752	8%	219	1%	540	2%
		Average flow volume entering Tonle Sap	MCM	n/a		n/a		-1,596	-5%	n/a		-1,596	-5%
	Protection of forests around Tonle Sap	Forest, marshes and grasslands flooded at Tonle Sap	'000 ha					15	1%			15	1%
		Net economic value	NPV US$M	-236				-122		-14		-372	
2.2 Maintain wetland productivity and	Productivity of wetland ecosystems	Are of wetlands (forest, marshes, wetland)	'000 ha	-1	-4%	-4	-6%	40	3%	-0	0%	35	2%
		Net economic value	NPV US$M	-3		-13		120		-3		101	
2.3 Manage salinity intrusion in the Mekong	Impact of salinity intrusion on land use	Area within delta within threshold level of salinity	'000 ha							23	1%	23	1%
		Net economic value	NPV US$M							-2		-2	
2.4 Minimize channel effects on bank erosion and deep pools	River bank erosion	Area at risk to erosion	Severity	Negative		Negative		Negative		Mildly negative		Negative	
		Net economic value	NPV US$M										
	Flow and sediment transport changes	Functioning deep pools	No.	-8	-40%	-10	-59%	-2	-40%			-20	-43%
		Induced geomorphological changes	Severity	Negative		Negative		Mildly negative		Mildly negative		Negative	
2.5 Conservation of biodiversity	Impacts of flow management changes on endangered species	Status of river channel habitats	Severity	Negative		Negative		Mildly negative		Negative		Negative	
		Flagship species	Survival	n/a		n/a		n/a		n/a		n/a	
		Unaffected environmental hot spots	Severity	Catastrophic		Extremely negative		Extremely negative		Negative		Extremely negative	
		Biodiversity condition	Severity	Severely negative		Severely negative		Negative		Mildly negative		Severely negative	
		Incremental net economic value of habitat areas	NPV US$M	-100		-60		-195		-60		-415	
3. Social development													
3.1 Maintain livelihoods of vulnerable resource-users	Health, food and income security	No. of people affected	'000	907		516		1,212		1,725		4,360	
		Severity of impact on health, food and income security	Severity	Severely negative		Severely negative		Extremely negative		Negative		Severely negative	
3.4 Increased employment generation in water related sectors	Incremental sustainable employment from water resource interventions	Incremental number of people engaged in:											
		Irrigated agriculture	'000	72	91%	119	53%	6	8%	14	41%	212	51%
		Reservoir fisheries (incremental to BS)	'000	40				28		4		72	
		Hydropower production	'000	382		38		163		29		612	
		Aquaculture (incremental to BS)	'000	55		77		57		164		352	
4 Equitable development													
4.1 Ensure that all four LMB countries benefit from the development of water and related resources	Aggregate benefits by country	Total net economic value	NPV US$M	22,605	858%	4,445	504%	2,627		3,726	188%	33,403	608%
		No. of people affected vulnerable to changes	'000	907		516		1,212		1,725		4,360	
		No. of jobs generated	'000	549	698%	234	103%	254	328%	211	604%	1,248	299%
		Overall environment impact	Severity	Severely negative		Severely negative		Negative		Negative		Severely negative	

Summary of scenario assessment

Incremental values relative to Definite Future Scenario

LMB 20-Year Plan Scenario
Climate change

Scenario run no. 4001

Specific development objective	Issue	Assessment criteria	Unit	Lao PDR		Thailand		Cambodia		Viet Nam		Total	
				Amount	Percent	Amount	Percent	Amount	Percent	Amount	Percent	Amount	Percent
1. Economic development													
1.1 Increase irrigated agricultural production	Irrigable area, production tonnage and value	Incremental area	'000 ha	283	170%	1,281	95%	183	67%	125	7%	1,872	54%
		Crop production	Mtonne / yr	3.354	385%	11.964	221%	3.324	174%	8.511	43%	27.153	97%
		Net economic value	NPV US$M	346	-1816%	889	-8672%	706	-666%	141	-1605%	2,082	-1445%
1.2 Increase hydropower production	Hydropower capacity, power generated and value	Installed capacity	MW	11,882	339%	2,951	396%	4,760	476000%	299	13%	19,892	305%
		Power generated	GWh/yr	68,013	415%	48,515	398%	20,726	888%	21,465	158%	158,719	357%
		Net economic value from generation	NPV US$M	6,899	90%	373	63%	567	76%	839	22%	8,678	68%
		Net economic value from purchased	NPV US$M	8,840	564%	2,048	193%	1,574	345%	192	22%	12,654	320%
1.3 Improve navigation	River transport	Navigable days by class	'000 boat-days	n/a		n/a		n/a		n/a		n/a	
		Net economic value	NPV US$M										
1.4 Decrease damages by floods	Extent and duration of annual flooding by class	Average area flooded annually to max 1.0m depth	'000 ha	6	15%	1	2%	-7	-2%	-297	-26%	-297	-18%
		Average area flooded annually > 1.0m depth	'000 ha	52	17%	41	16%	399	24%	359	54%	851	30%
		Net economic value of flood damage	NPV US$M	-49	-27%	-42	-24%	-277	-543%	-367	-612%	-735	-159%
1.5 Maintain productivity of fishery sector	Capture fisheries and aquaculture production	Annual average capture fish availability	Mtonne / yr	-0.285	-100%	-0.996	-100%	-0.739	-100%	-0.367	-100%	-2.387	-100%
		Annual average aquaculture production	Mtonne / yr	0.054	36%	0.077	42%	0.076	45%	0.831	33%	1.037	35%
		Net economic value of capture fish	NPV US$M	156	-565%	87	-640%	-663	286%	-314	-57%	-734	-268%
2. Environmental protection													
2.1 Maintain water quality and acceptable flow conditions	Water quality	Total pollutant discharge	tonnes / yr	49,486	98%	86,552	79%	26,125	68%	37,646	22%	199,809	54%
		Water quality conditions	Severity										
	Flow characteristics	Average flow in March	m3/s	405	22%	387	16%	508	17%	179	5%	370	13%
		Average wet season peak daily flow	m3/s	-122	-1%	1,887	8%	5,393	12%	699	3%	1,964	8%
		Average flow volume entering Tonle Sap	MCM	n/a		n/a		922	3%	n/a		922	3%
	Protection of forests around Tonle Sap	Forest, marshes and grasslands flooded at Tonle Sap	'000 ha					24	2%			24	2%
		Net economic value	NPV US$M	-106	82%			-116	1840%	3	-19%	-219	143%
2.2 Maintain wetland productivity and	Productivity of wetland ecosystems	Are of wetlands (forest, marshes, wetland)	'000 ha	4	35%	5	10%	61	5%	0	0%	70	5%
		Net economic value	NPV US$M	24	-88%	35	-73%	273	-178%	-3	416%	329	-144%
2.3 Manage salinity intrusion in the Mekong	Impact of salinity intrusion on land use	Area within delta within threshold level of salinity	'000 ha							295	19%	295	19%
		Net economic value	NPV US$M							-22	-110%	-22	-110%
2.4 Minimize channel effects on bank erosion and deep pools	River bank erosion	Area at risk to erosion	Severity	Severely negative		Severely negative		Negative		Mildly negative		Severely negative	
		Net economic value	NPV US$M										
	Flow and sediment transport changes	Functioning deep pools	No.	-8	-40%	-10	-59%	-2	-40%			-20	-43%
		Induced geomorphological changes	Severity	Mildly negative		Mildly negative		Mildly negative		Mildly negative		Mildly negative	
2.5 Conservation of biodiversity	Impacts of flow management changes on endangered species	Status of river channel habitats	Severity	Mildly negative		Mildly negative		Mildly negative		Negative		Negative	
		Flagship species	Survival	n/a		n/a		n/a		n/a		n/a	
		Unaffected environmental hot spots	Severity	Catastrophic		Negative		Severely negative		Negative		Severely negative	
		Biodiversity condition	Severity	Negative		Negative		Mildly negative		Neutral		Negative	
		Incremental net economic value of habitat areas	NPV US$M	-100		-40	200%	-130	200%	-60		-330	388%
3. Social development													
3.1 Maintain livelihoods of vulnerable resource-users	Health, food and income security	No. of people affected	'000	610	205%	470	1022%	1,110	1088%	1,283	290%	3,473	392%
		Severity of impact on health, food and income security	Severity	Mildly negative		Negative		Severely negative		Mildly negative		Negative	
3.4 Increased employment generation in water related sectors	Incremental sustainable employment from water resource interventions	Incremental number of people engaged in:											
		Irrigated agriculture	'000	72	91%	119	53%	6	8%	14	41%	212	51%
		Reservoir fisheries (incremental to BS)	'000	28	226%			27	4703%	2	74%	57	375%
		Hydropower production	'000	330	635%	33	636%	148	963%	-3	-8%	508	490%
		Aquaculture (incremental to BS)	'000	26	94%	38	96%	37	188%			101	40%
4 Equitable development													
4.1 Ensure that all four LMB countries benefit from the development of water and related resources	Aggregate benefits by country	Total net economic value	NPV US$M	16,010	173%	3,350	169%	1,934	279%	409	8%	21,703	126%
		No. of people affected vulnerable to changes	'000	610	205%	470	1022%	1,110	1088%	1,283	290%	3,473	392%
		No. of jobs generated	'000	456	266%	190	70%	218	193%	13	6%	878	111%
		Overall environment impact	Severity	Negative		Negative		Mildly negative		Mildly negative		Negative	

Summary of scenario assessment

Estimated total values

LMB 20-Year Plan Scenario without mainstream dams

Scenario run no. 5000

Specific development objective	Issue	Assessment criteria	Unit	Lao PDR Amount	Lao PDR Percent	Thailand Amount	Thailand Percent	Cambodia Amount	Cambodia Percent	Viet Nam Amount	Viet Nam Percent	Total Amount	Total Percent
1. Economic development													
1.1 Increase irrigated agricultural production	Irrigable area, production tonnage and value	Incremental area	'000 ha	450		2,635		457		1,795		5,337	
		Crop production	Mtonne / yr	4.225		17.371		5.228		28.345		55.170	
		Net economic value	NPV US$M	301		864		227		95		1,487	
1.2 Increase hydropower production	Hydropower capacity, power generated and value	Installed capacity	MW	7,919		745		481		2,583		11,727	
		Power generated	GWh/yr	37,609		26,206		3,321		16,346		83,483	
		Net economic value from generation	NPV US$M	9,783		591		1,168		4,022		15,564	
		Net economic value from purchased	NPV US$M	4,208		1,760		462		920		7,351	
1.3 Improve navigation	River transport	Navigable days by class	'000 boat-days	n/a		n/a		n/a		n/a		n/a	
		Net economic value	NPV US$M			246						246	
1.4 Decrease damages by floods	Extent and duration of annual flooding by class	Average area flooded annually to max 1.0m depth	'000 ha	41		44		434		1,148		1,668	
		Average area flooded annually > 1.0m depth	'000 ha	290		244		1,620		638		2,792	
		Net economic value of flood damage	NPV US$M	124		124		47		65		360	
1.5 Maintain productivity of fishery sector	Capture fisheries and aquaculture production	Annual average capture fish availability	Mtonne / yr	0.302		0.993		0.680		0.368		2.343	
		Annual average aquaculture production	Mtonne / yr	0.204		0.259		0.243		3.326		4.031	
		Net economic value of capture fish	NPV US$M	139		119		-201		579		636	
2. Environmental protection													
2.1 Maintain water quality and acceptable flow conditions	Water quality	Total pollutant discharge	tonnes / yr	100,143		195,432		64,719		208,047		568,341	
		Water quality conditions	Severity										
	Flow characteristics	Average flow in March	m3/s	2,106		2,586		3,451		4,097		3,060	
		Average wet season peak daily flow	m3/s	13,564		23,421		43,347		20,464		25,199	
		Average flow volume entering Tonle Sap	MCM	n/a		n/a		28,358		n/a		28,358	
	Protection of forests around Tonle Sap	Forest, marshes and grasslands flooded at Tonle Sap	'000 ha					1,024				1,024	
		Net economic value	NPV US$M	-165				-4		-14		-183	
2.2 Maintain wetland productivity and	Productivity of wetland ecosystems	Are of wetlands (forest, marshes, wetland)	'000 ha	11		51		1,258		100		1,420	
		Net economic value	NPV US$M	-18		-32		-125		-1		-176	
2.3 Manage salinity intrusion in the Mekong	Impact of salinity intrusion on land use	Area within delta within threshold level of salinity	'000 ha							1,547		1,547	
		Net economic value	NPV US$M							25		25	
2.4 Minimize channel effects on bank erosion and deep pools	River bank erosion	Area at risk to erosion	Severity	Positive		Positive		Mildly positive		Neutral		Neutral	
		Net economic value	NPV US$M										
	Flow and sediment transport changes	Functioning deep pools	No.	20		17		5		5		47	
		Induced geomorphological changes	Severity	Negative		Mildly negative		Neutral		Neutral		Mildly negative	
2.5 Conservation of biodiversity	Impacts of flow management changes on endangered species	Status of river channel habitats	Severity	Negative		Mildly negative		Neutral		Neutral		Mildly negative	
		Flagship species	Survival	Surviving		Surviving		Surviving		Surviving		Surviving	
		Unaffected environmental hot spots	Severity	Severely negative		Negative		Negative		Neutral		Negative	
		Biodiversity condition	Severity	Negative		Negative		Mildly negative		Mildly negative		Negative	
		Incremental net economic value of habitat areas	NPV US$M	-50		-40		-130				-220	
3. Social development													
3.1 Maintain livelihoods of vulnerable resource-users	Health, food and income security	No. of people affected	'000	699		201		212		452		1,564	
		Severity of impact on health, food and income security	Severity	Severely negative		Mildly negative		Negative		Mildly negative		Negative	
3.4 Increased employment generation in water related sectors	Incremental sustainable employment from water resource interventions	Incremental number of people engaged in:											
		Irrigated agriculture	'000	150		346		84		49		629	
		Reservoir fisheries (incremental to BS)	'000	28				1		3		32	
		Hydropower production	'000	168		7		20		29		224	
		Aquaculture (incremental to BS)	'000	55		77		57		164		352	
4 Equitable development													
4.1 Ensure that all four LMB countries benefit from the development of water and related resources	Aggregate benefits by country	Total net economic value	NPV US$M	14,322		3,632		1,446		5,690		25,090	
		No. of people affected vulnerable to changes	'000	699		201		212		452		1,564	
		No. of jobs generated	'000	402		430		161		245		1,238	
		Overall environment impact	Severity	Negative		Negative		Mildly negative		Mildly negative		Negative	

Summary of scenario assessment

Incremental values relative to Baseline

LMB 20-Year Plan Scenario without mainstream dams

Scenario run no. 5000

Specific development objective	Issue	Assessment criteria	Unit	Lao PDR		Thailand		Cambodia		Viet Nam		Total	
				Amount	Percent	Amount	Percent	Amount	Percent	Amount	Percent	Amount	Percent
1. Economic development													
1.1 Increase irrigated agricultural production	Irrigable area, production tonnage and value	Incremental area	'000 ha	245	120%	1,370	108%	183	67%	-201	-10%	1,597	43%
		Crop production	Mtonne / yr	3.354	385%	11.964	221%	3.324	174%	8.511	43%	27.153	97%
		Net economic value	NPV US$M	301		864		227		95		1,487	
1.2 Increase hydropower production	Hydropower capacity, power generated and value	Installed capacity	MW	7,298	1175%	500	204%	481		1,863	259%	10,142	639%
		Power generated	GWh/yr	34,577	1140%	23,804	991%	3,321		12,688	347%	74,389	818%
		Net economic value from generation	NPV US$M	7,490	327%	100	20%	1,168		2,310	135%	11,069	246%
		Net economic value from purchased	NPV US$M	3,868	1136%	1,551	742%	462		653	245%	6,534	800%
1.3 Improve navigation	River transport	Navigable days by class	'000 boat-days	n/a		n/a		n/a		n/a		n/a	
		Net economic value	NPV US$M			64	35%					64	35%
1.4 Decrease damages by floods	Extent and duration of annual flooding by class	Average area flooded annually to max 1.0m depth	'000 ha	-8	-16%	-3	-6%	18	4%	146	15%	153	10%
		Average area flooded annually > 1.0m depth	'000 ha	-67	-19%	-78	-24%	-147	-8%	-162	-20%	-453	-14%
		Net economic value of flood damage	NPV US$M	124		124		47		65		360	
1.5 Maintain productivity of fishery sector	Capture fisheries and aquaculture production	Annual average capture fish availability	Mtonne / yr	-0.009	-3%	-0.035	-3%	-0.112	-14%	-0.031	-8%	-0.187	-7%
		Annual average aquaculture production	Mtonne / yr	0.126	161%	0.158	158%	0.116	91%	1.662	100%	2.063	105%
		Net economic value of capture fish	NPV US$M	139		119		-201		579		636	
2. Environmental protection													
2.1 Maintain water quality and acceptable flow conditions	Water quality	Total pollutant discharge	tonnes / yr	49,486	98%	86,552	79%	26,125	68%	37,646	22%	199,809	54%
		Water quality conditions	Severity										
	Flow characteristics	Average flow in March	m3/s	1,006	91%	1,133	78%	1,253	57%	1,026	33%	1,105	56%
		Average wet season peak daily flow	m3/s	-2,357	-15%	-2,080	-8%	-3,415	-7%	-846	-4%	-2,175	-8%
		Average flow volume entering Tonle Sap	MCM	n/a		n/a		-3,900	-12%	n/a		-3,900	-12%
	Protection of forests around Tonle Sap	Forest, marshes and grasslands flooded at Tonle Sap	'000 ha					-14	-1%			-14	-1%
		Net economic value	NPV US$M	-165				-4		-14		-183	
2.2 Maintain wetland productivity and	Productivity of wetland ecosystems	Are of wetlands (forest, marshes, wetland)	'000 ha	-6	-34%	-11	-18%	-30	-2%	-0	0%	-47	-3%
		Net economic value	NPV US$M	-18		-32		-125		-1		-176	
2.3 Manage salinity intrusion in the Mekong	Impact of salinity intrusion on land use	Area within delta within threshold level of salinity	'000 ha							-305	-16%	-305	-16%
		Net economic value	NPV US$M							25		25	
2.4 Minimize channel effects on bank erosion and deep pools	River bank erosion	Area at risk to erosion	Severity	Positive		Positive		Mildly positive		Neutral		Mildly positive	
		Net economic value	NPV US$M										
	Flow and sediment transport changes	Functioning deep pools	No.										
		Induced geomorphological changes	Severity	Negative		Mildly negative		Neutral		Neutral		Mildly negative	
2.5 Conservation of biodiversity	Impacts of flow management changes on endangered species	Status of river channel habitats	Severity	Negative		Mildly negative		Neutral		Neutral		Mildly negative	
		Flagship species	Survival	n/a		n/a		n/a		n/a		n/a	
		Unaffected environmental hot spots	Severity	Severely negative		Negative		Negative		Neutral		Negative	
		Biodiversity condition	Severity	Negative		Negative		Mildly negative		Mildly negative		Negative	
		Incremental net economic value of habitat areas	NPV US$M	-50		-40		-130				-220	
3. Social development													
3.1 Maintain livelihoods of vulnerable resource-users	Health, food and income security	No. of people affected	'000	699		201		212		452		1,564	
		Severity of impact on health, food and income security	Severity	Severely negative		Mildly negative		Negative		Mildly negative		Negative	
3.4 Increased employment generation in water related sectors	Incremental sustainable employment from water resource interventions	Incremental number of people engaged in:											
		Irrigated agriculture	'000	72	91%	119	53%	6	8%	14	41%	212	51%
		Reservoir fisheries (incremental to BS)	'000	28				1		3		32	
		Hydropower production	'000	168		7		20		29		224	
		Aquaculture (incremental to BS)	'000	55		77		57		164		352	
4 Equitable development													
4.1 Ensure that all four LMB countries benefit from the development of water and related resources	Aggregate benefits by country	Total net economic value	NPV US$M	11,688	444%	2,750	312%	1,446		3,712	188%	19,596	357%
		No. of people affected vulnerable to changes	'000	699		201		212		452		1,564	
		No. of jobs generated	'000	323	410%	203	89%	84	108%	210	602%	820	196%
		Overall environment impact	Severity	Negative		Negative		Mildly negative		Mildly negative		Negative	

Summary of scenario assessment

Incremental values relative to Definite Future Scenario

LMB 20-Year Plan Scenario without mainstream dams

Scenario run no. 5000

Specific development objective	Issue	Assessment criteria	Unit	Lao PDR		Thailand		Cambodia		Viet Nam		Total	
				Amount	Percent	Amount	Percent	Amount	Percent	Amount	Percent	Amount	Percent
1. Economic development													
1.1 Increase irrigated agricultural production	Irrigable area, production tonnage and value	Incremental area	'000 ha	283	170%	1,281	95%	183	67%	125	7%	1,872	54%
		Crop production	Mtonne / yr	3.354	385%	11.964	221%	3.324	174%	8.511	43%	27.153	97%
		Net economic value	NPV US$M	320	-1680%	874	-8528%	333	-314%	103	-1178%	1,631	-1132%
1.2 Increase hydropower production	Hydropower capacity, power generated and value	Installed capacity	MW	4,416	126%			480	48000%	299	13%	5,195	80%
		Power generated	GWh/yr	21,206	129%	14,028	115%	986	42%	2,753	20%	38,973	88%
		Net economic value from generation	NPV US$M	2,097	27%			420	56%	201	5%	2,719	21%
		Net economic value from purchased	NPV US$M	2,641	169%	700	66%	5	1%	46	5%	3,393	86%
1.3 Improve navigation	River transport	Navigable days by class	'000 boat-days	n/a		n/a		n/a		n/a		n/a	
		Net economic value	NPV US$M										
1.4 Decrease damages by floods	Extent and duration of annual flooding by class	Average area flooded annually to max 1.0m depth	'000 ha	-1	-3%	-0	-1%	10	2%	27	2%	35	2%
		Average area flooded annually > 1.0m depth	'000 ha	-9	-3%	-12	-5%	-33	-2%	-32	-5%	-86	-3%
		Net economic value of flood damage	NPV US$M	-55	-31%	-48	-28%	-4	-8%	5	8%	-102	-22%
1.5 Maintain productivity of fishery sector	Capture fisheries and aquaculture production	Annual average capture fish availability	Mtonne / yr	0.017	6%	-0.003	0%	-0.059	-8%	0.001	0%	-0.045	-2%
		Annual average aquaculture production	Mtonne / yr	0.054	36%	0.077	42%	0.076	45%	0.831	33%	1.037	35%
		Net economic value of capture fish	NPV US$M	166	-602%	133	-978%	31	-13%	31	6%	362	132%
2. Environmental protection													
2.1 Maintain water quality and acceptable flow conditions	Water quality	Total pollutant discharge	tonnes / yr	49,486	98%	86,552	79%	26,125	68%	37,646	22%	199,809	54%
		Water quality conditions	Severity										
	Flow characteristics	Average flow in March	m3/s	246	13%	214	9%	382	12%	200	5%	260	9%
		Average wet season peak daily flow	m3/s	-249	-2%	-611	-3%	-1,775	-4%	-366	-2%	-750	-3%
		Average flow volume entering Tonle Sap	MCM	n/a		n/a		-1,382	-5%	n/a		-1,382	-5%
	Protection of forests around Tonle Sap	Forest, marshes and grasslands flooded at Tonle Sap	'000 ha					-5	0%			-5	0%
		Net economic value	NPV US$M	-36	27%			3	-44%	3	-19%	-29	19%
2.2 Maintain wetland productivity and	Productivity of wetland ecosystems	Are of wetlands (forest, marshes, wetland)	'000 ha	-1	-8%	-2	-4%	-9	-1%	-0	0%	-12	-1%
		Net economic value	NPV US$M	9	-34%	16	-33%	28	-19%	-1	82%	53	-23%
2.3 Manage salinity intrusion in the Mekong	Impact of salinity intrusion on land use	Area within delta within threshold level of salinity	'000 ha							-33	-2%	-33	-2%
		Net economic value	NPV US$M							5	25%	5	25%
2.4 Minimize channel effects on bank erosion and deep pools	River bank erosion	Area at risk to erosion	Severity	Mildly positive		Mildly positive		Mildly positive		Neutral		Neutral	
		Net economic value	NPV US$M										
	Flow and sediment transport changes	Functioning deep pools	No.										
		Induced geomorphological changes	Severity	Mildly negative		Neutral		Neutral		Neutral		Mildly negative	
2.5 Conservation of biodiversity	Impacts of flow management changes on endangered species	Status of river channel habitats	Severity	Mildly negative		Neutral		Neutral		Neutral		Mildly negative	
		Flagship species	Survival	n/a		n/a		n/a		n/a		n/a	
		Unaffected environmental hot spots	Severity	Severely negative		Mildly negative		Negative		Neutral		Mildly negative	
		Biodiversity condition	Severity	Mildly negative		Mildly negative		Neutral		Neutral		Mildly negative	
		Incremental net economic value of habitat areas	NPV US$M	-50		-20	100%	-65	100%			-135	159%
3. Social development													
3.1 Maintain livelihoods of vulnerable resource-users	Health, food and income security	No. of people affected	'000	402	135%	155	337%	110	108%	10	2%	677	76%
		Severity of impact on health, food and income security	Severity	Mildly negative		Neutral		Mildly negative		Neutral		Mildly negative	
3.4 Increased employment generation in water related sectors	Incremental sustainable employment from water resource interventions	Incremental number of people engaged in:											
		Irrigated agriculture	'000	72	91%	119	53%	6	8%	14	41%	212	51%
		Reservoir fisheries (incremental to BS)	'000	16	129%					1	46%	17	112%
		Hydropower production	'000	116	223%	2	33%	5	32%	-3	-8%	120	116%
		Aquaculture (incremental to BS)	'000	26	94%	38	96%	37	188%			101	40%
4 Equitable development													
4.1 Ensure that all four LMB countries benefit from the development of water and related resources	Aggregate benefits by country	Total net economic value	NPV US$M	5,093	55%	1,655	84%	753	109%	395	7%	7,896	46%
		No. of people affected vulnerable to changes	'000	402	135%	155	337%	110	108%	10	2%	677	76%
		No. of jobs generated	'000	230	134%	159	59%	48	43%	13	6%	450	57%
		Overall environment impact	Severity	Mildly negative		Mildly negative		Neutral		Neutral		Mildly negative	

Summary of scenario assessment

Estimated total values

LMB 20-Year Plan Scenario with 6 mainstream dams in Northern Lao PDR

Scenario run no. 6100

Specific development objective	Issue	Assessment criteria	Unit	Lao PDR Amount	Lao PDR Percent	Thailand Amount	Thailand Percent	Cambodia Amount	Cambodia Percent	Viet Nam Amount	Viet Nam Percent	Total Amount	Total Percent
1. Economic development													
1.1 Increase irrigated agricultural production	Irrigable area, production tonnage and value	Incremental area	'000 ha	450		2,635		457		1,795		5,337	
		Crop production	Mtonne / yr	4.225		17.371		5.228		28.345		55.170	
		Net economic value	NPV US$M	300		864		225		95		1,484	
1.2 Increase hydropower production	Hydropower capacity, power generated and value	Installed capacity	MW	14,339		1,824		481		2,583		19,226	
		Power generated	GWh/yr	70,103		50,558		3,321		21,240		145,222	
		Net economic value from generation	NPV US$M	12,186		591		1,168		4,189		18,133	
		Net economic value from purchased	NPV US$M	7,784		2,976		462		958		12,180	
1.3 Improve navigation	River transport	Navigable days by class	'000 boat-days	n/a		n/a		n/a		n/a		n/a	
		Net economic value	NPV US$M			246						246	
1.4 Decrease damages by floods	Extent and duration of annual flooding by class	Average area flooded annually to max 1.0m depth	'000 ha	41		44		433		1,149		1,667	
		Average area flooded annually > 1.0m depth	'000 ha	290		244		1,614		637		2,785	
		Net economic value of flood damage	NPV US$M	124		124		47		65		360	
1.5 Maintain productivity of fishery sector	Capture fisheries and aquaculture production	Annual average capture fish availability	Mtonne / yr	0.306		0.984		0.652		0.342		2.285	
		Annual average aquaculture production	Mtonne / yr	0.204		0.259		0.243		3.326		4.031	
		Net economic value of capture fish	NPV US$M	154		89		-294		492		441	
2. Environmental protection													
2.1 Maintain water quality and acceptable flow conditions	Water quality	Total pollutant discharge	tonnes / yr	100,143		195,432		64,719		208,047		568,341	
		Water quality conditions	Severity										
	Flow characteristics	Average flow in March	m3/s	2,193		2,674		3,540		4,175		3,146	
		Average wet season peak daily flow	m3/s	13,713		23,590		43,405		20,466		25,293	
		Average flow volume entering Tonle Sap	MCM	n/a		n/a		28,339		n/a		28,339	
	Protection of forests around Tonle Sap	Forest, marshes and grasslands flooded at Tonle Sap	'000 ha					1,024				1,024	
		Net economic value	NPV US$M	-210				-4		-14		-228	
2.2 Maintain wetland productivity and	Productivity of wetland ecosystems	Are of wetlands (forest, marshes, wetland)	'000 ha	11		51		1,257		100		1,419	
		Net economic value	NPV US$M	-18		-34		-125		-1		-178	
2.3 Manage salinity intrusion in the Mekong	Impact of salinity intrusion on land use	Area within delta within threshold level of salinity	'000 ha							1,532		1,532	
		Net economic value	NPV US$M							23		23	
2.4 Minimize channel effects on bank erosion and deep pools	River bank erosion	Area at risk to erosion	Severity	Positive		Positive		Mildly negative		Neutral		Neutral	
		Net economic value	NPV US$M										
	Flow and sediment transport changes	Functioning deep pools	No.	15		11		3		5		34	
		Induced geomorphological changes	Severity	Mildly negative		Mildly negative		Neutral		Neutral		Mildly negative	
2.5 Conservation of biodiversity	Impacts of flow management changes on endangered species	Status of river channel habitats	Severity	Negative		Negative		Neutral		Mildly negative		Negative	
		Flagship species	Survival	Surviving		Extinct		Surviving		Surviving		Extinct	
		Unaffected environmental hot spots	Severity	Negative		Severely negative		Negative		Neutral		Negative	
		Biodiversity condition	Severity	Severely negative		Negative		Negative		Mildly negative		Negative	
		Incremental net economic value of habitat areas	NPV US$M	-50		-60		-130				-240	
3. Social development													
3.1 Maintain livelihoods of vulnerable resource-users	Health, food and income security	No. of people affected	'000	782		201		262		770		2,015	
		Severity of impact on health, food and income security	Severity	Severely negative		Mildly negative		Severely negative		Negative		Severely negative	
3.4 Increased employment generation in water related sectors	Incremental sustainable employment from water resource interventions	Incremental number of people engaged in:											
		Irrigated agriculture	'000	150		346		84		49		629	
		Reservoir fisheries (incremental to BS)	'000	36				1		3		40	
		Hydropower production	'000	318		20		20		29		387	
		Aquaculture (incremental to BS)	'000	55		77		57		164		352	
4 Equitable development													
4.1 Ensure that all four LMB countries benefit from the development of water and related resources	Aggregate benefits by country	Total net economic value	NPV US$M	20,270		4,795		1,351		5,807		32,223	
		No. of people affected vulnerable to changes	'000	782		201		262		770		2,015	
		No. of jobs generated	'000	559		442		161		245		1,408	
		Overall environment impact	Severity	Severely negative		Negative		Negative		Mildly negative		Negative	

Summary of scenario assessment

Incremental values relative to Baseline

LMB 20-Year Plan Scenario with 6 mainstream dams in Northern Lao PDR

Scenario run no. 6100

Specific development objective	Issue	Assessment criteria	Unit	Lao PDR		Thailand		Cambodia		Viet Nam		Total	
				Amount	Percent	Amount	Percent	Amount	Percent	Amount	Percent	Amount	Percent
1. Economic development													
1.1 Increase irrigated agricultural production	Irrigable area, production tonnage and value	Incremental area	'000 ha	245	120%	1,370	108%	183	67%	-201	-10%	1,597	43%
		Crop production	Mtonne / yr	3.354	385%	11.964	221%	3.324	174%	8.511	43%	27.153	97%
		Net economic value	NPV US$M	300		864		225		95		1,484	
1.2 Increase hydropower production	Hydropower capacity, power generated and value	Installed capacity	MW	13,718	2208%	1,579	645%	481		1,863	259%	17,641	1112%
		Power generated	GWh/yr	67,071	2212%	48,155	2004%	3,321		17,581	481%	136,129	1497%
		Net economic value from generation	NPV US$M	9,892	431%	100	20%	1,168		2,477	145%	13,638	303%
		Net economic value from purchased	NPV US$M	7,443	2186%	2,767	1323%	462		691	259%	11,364	1392%
1.3 Improve navigation	River transport	Navigable days by class	'000 boat-days	n/a		n/a		n/a		n/a		n/a	
		Net economic value	NPV US$M			64	35%					64	35%
1.4 Decrease damages by floods	Extent and duration of annual flooding by class	Average area flooded annually to max 1.0m depth	'000 ha	-8	-16%	-3	-6%	17	4%	146	15%	152	10%
		Average area flooded annually > 1.0m depth	'000 ha	-67	-19%	-78	-24%	-152	-9%	-162	-20%	-459	-14%
		Net economic value of flood damage	NPV US$M	124		124		47		65		360	
1.5 Maintain productivity of fishery sector	Capture fisheries and aquaculture production	Annual average capture fish availability	Mtonne / yr	-0.004	-1%	-0.044	-4%	-0.140	-18%	-0.057	-14%	-0.245	-10%
		Annual average aquaculture production	Mtonne / yr	0.126	161%	0.158	158%	0.116	91%	1.662	100%	2.063	105%
		Net economic value of capture fish	NPV US$M	154		89		-294		492		441	
2. Environmental protection													
2.1 Maintain water quality and acceptable flow conditions	Water quality	Total pollutant discharge	tonnes / yr	49,486	98%	86,552	79%	26,125	68%	37,646	22%	199,809	54%
		Water quality conditions	Severity										
	Flow characteristics	Average flow in March	m3/s	1,093	99%	1,221	84%	1,343	61%	1,104	36%	1,190	61%
		Average wet season peak daily flow	m3/s	-2,208	-14%	-1,911	-7%	-3,358	-7%	-844	-4%	-2,080	-8%
		Average flow volume entering Tonle Sap	MCM	n/a		n/a		-3,920	-12%	n/a		-3,920	-12%
	Protection of forests around Tonle Sap	Forest, marshes and grasslands flooded at Tonle Sap	'000 ha					-14	-1%			-14	-1%
		Net economic value	NPV US$M	-210				-4		-14		-228	
2.2 Maintain wetland productivity and	Productivity of wetland ecosystems	Are of wetlands (forest, marshes, wetland)	'000 ha	-6	-34%	-11	-18%	-31	-2%	-0	0%	-48	-3%
		Net economic value	NPV US$M	-18		-34		-125		-1		-178	
2.3 Manage salinity intrusion in the Mekong	Impact of salinity intrusion on land use	Area within delta within threshold level of salinity	'000 ha							-319	-17%	-319	-17%
		Net economic value	NPV US$M							23		23	
2.4 Minimize channel effects on bank erosion and deep pools	River bank erosion	Area at risk to erosion	Severity	Positive		Positive		Mildly negative		Neutral		Neutral	
		Net economic value	NPV US$M										
	Flow and sediment transport changes	Functioning deep pools	No.	-5	-25%	-6	-35%	-2	-40%			-13	-28%
		Induced geomorphological changes	Severity	Mildly negative		Mildly negative		Neutral		Neutral		Mildly negative	
2.5 Conservation of biodiversity	Impacts of flow management changes on endangered species	Status of river channel habitats	Severity	Negative		Negative		Neutral		Mildly negative		Negative	
		Flagship species	Survival	n/a		n/a		n/a		n/a		n/a	
		Unaffected environmental hot spots	Severity	Negative		Severely negative		Negative		Neutral		Negative	
		Biodiversity condition	Severity	Severely negative		Negative		Negative		Mildly negative		Negative	
		Incremental net economic value of habitat areas	NPV US$M	-50		-60		-130				-240	
3. Social development													
3.1 Maintain livelihoods of vulnerable resource-users	Health, food and income security	No. of people affected	'000	782		201		262		770		2,015	
		Severity of impact on health, food and income security	Severity	Severely negative		Mildly negative		Severely negative		Negative		Severely negative	
3.4 Increased employment generation in water related sectors	Incremental sustainable employment from water resource interventions	Incremental number of people engaged in:											
		Irrigated agriculture	'000	72	91%	119	53%	6	8%	14	41%	212	51%
		Reservoir fisheries (incremental to BS)	'000	36				1		3		40	
		Hydropower production	'000	318		20		20		29		387	
		Aquaculture (incremental to BS)	'000	55		77		57		164		352	
4 Equitable development													
4.1 Ensure that all four LMB countries benefit from the development of water and related resources	Aggregate benefits by country	Total net economic value	NPV US$M	17,636	670%	3,913	444%	1,351		3,828	193%	26,728	486%
		No. of people affected vulnerable to changes	'000	782		201		262		770		2,015	
		No. of jobs generated	'000	480	610%	216	95%	84	108%	210	602%	990	237%
		Overall environment impact	Severity	Severely negative		Negative		Negative		Mildly negative		Negative	

Summary of scenario assessment

Incremental values relative to Definite Future Scenario

LMB 20-Year Plan Scenario with 6 mainstream dams in Northern Lao PDR

Scenario run no. 6100

Specific development objective	Issue	Assessment criteria	Unit	Lao PDR		Thailand		Cambodia		Viet Nam		Total	
				Amount	Percent	Amount	Percent	Amount	Percent	Amount	Percent	Amount	Percent
1. Economic development													
1.1 Increase irrigated agricultural production	Irrigable area, production tonnage and value	Incremental area	'000 ha	283	170%	1,281	95%	183	67%	125	7%	1,872	54%
		Crop production	Mtonne / yr	3.354	385%	11.964	221%	3.324	174%	8.511	43%	27.153	97%
		Net economic value	NPV US$M	320	-1678%	874	-8528%	331	-313%	103	-1178%	1,628	-1130%
1.2 Increase hydropower production	Hydropower capacity, power generated and value	Installed capacity	MW	10,836	309%	1,079	145%	480	48000%	299	13%	12,694	194%
		Power generated	GWh/yr	53,700	327%	38,379	315%	986	42%	7,647	56%	100,712	226%
		Net economic value from generation	NPV US$M	4,500	59%			420	56%	368	10%	5,288	41%
		Net economic value from purchased	NPV US$M	6,217	397%	1,916	181%	5	1%	84	10%	8,222	208%
1.3 Improve navigation	River transport	Navigable days by class	'000 boat-days	n/a		n/a		n/a		n/a		n/a	
		Net economic value	NPV US$M										
1.4 Decrease damages by floods	Extent and duration of annual flooding by class	Average area flooded annually to max 1.0m depth	'000 ha	-2	-4%	-0	-1%	9	2%	27	2%	34	2%
		Average area flooded annually > 1.0m depth	'000 ha	-9	-3%	-12	-5%	-38	-2%	-33	-5%	-92	-3%
		Net economic value of flood damage	NPV US$M	-55	-31%	-48	-28%	-4	-8%	5	8%	-102	-22%
1.5 Maintain productivity of fishery sector	Capture fisheries and aquaculture production	Annual average capture fish availability	Mtonne / yr	0.022	8%	-0.013	-1%	-0.087	-12%	-0.025	-7%	-0.103	-4%
		Annual average aquaculture production	Mtonne / yr	0.054	36%	0.077	42%	0.076	45%	0.831	33%	1.037	35%
		Net economic value of capture fish	NPV US$M	182	-658%	102	-753%	-62	27%	-55	-10%	167	61%
2. Environmental protection													
2.1 Maintain water quality and acceptable flow conditions	Water quality	Total pollutant discharge	tonnes / yr	49,486	98%	86,552	79%	26,125	68%	37,646	22%	199,809	54%
		Water quality conditions	Severity										
	Flow characteristics	Average flow in March	m3/s	333	18%	302	13%	471	15%	278	7%	346	12%
		Average wet season peak daily flow	m3/s	-100	-1%	-443	-2%	-1,718	-4%	-364	-2%	-656	-3%
		Average flow volume entering Tonle Sap	MCM	n/a		n/a		-1,402	-5%	n/a		-1,402	-5%
	Protection of forests around Tonle Sap	Forest, marshes and grasslands flooded at Tonle Sap	'000 ha					-5	0%			-5	0%
		Net economic value	NPV US$M	-80	62%			3	-44%	3	-19%	-74	48%
2.2 Maintain wetland productivity and	Productivity of wetland ecosystems	Are of wetlands (forest, marshes, wetland)	'000 ha	-1	-8%	-2	-4%	-10	-1%	-0	0%	-13	-1%
		Net economic value	NPV US$M	8	-31%	14	-29%	28	-19%	-1	82%	50	-22%
2.3 Manage salinity intrusion in the Mekong	Impact of salinity intrusion on land use	Area within delta within threshold level of salinity	'000 ha							-47	-3%	-47	-3%
		Net economic value	NPV US$M							3	15%	3	15%
2.4 Minimize channel effects on bank erosion and deep pools	River bank erosion	Area at risk to erosion	Severity	Mildly positive		Mildly positive		Mildly negative		Neutral		Neutral	
		Net economic value	NPV US$M										
	Flow and sediment transport changes	Functioning deep pools	No.	-5	-25%	-6	-35%	-2	-40%			-13	-28%
		Induced geomorphological changes	Severity	Neutral		Neutral		Neutral		Neutral		Neutral	
2.5 Conservation of biodiversity	Impacts of flow management changes on endangered species	Status of river channel habitats	Severity	Mildly negative		Mildly negative		Neutral		Mildly negative		Mildly negative	
		Flagship species	Survival	n/a		n/a		n/a		n/a		n/a	
		Unaffected environmental hot spots	Severity	Negative		Negative		Negative		Neutral		Negative	
		Biodiversity condition	Severity	Negative		Mildly negative		Mildly negative		Neutral		Mildly negative	
		Incremental net economic value of habitat areas	NPV US$M	-50		-40	200%	-65	100%			-155	182%
3. Social development													
3.1 Maintain livelihoods of vulnerable resource-users	Health, food and income security	No. of people affected	'000	485	163%	155	337%	160	157%	328	74%	1,128	127%
		Severity of impact on health, food and income security	Severity	Mildly negative		Neutral		Negative		Mildly negative		Mildly negative	
3.4 Increased employment generation in water related sectors	Incremental sustainable employment from water resource interventions	Incremental number of people engaged in:											
		Irrigated agriculture	'000	72	91%	119	53%	6	8%	14	41%	212	51%
		Reservoir fisheries (incremental to BS)	'000	23	190%					1	46%	24	161%
		Hydropower production	'000	266	512%	14	279%	5	32%	-3	-8%	283	273%
		Aquaculture (incremental to BS)	'000	26	94%	38	96%	37	188%			101	40%
4 Equitable development													
4.1 Ensure that all four LMB countries benefit from the development of water and related resources	Aggregate benefits by country	Total net economic value	NPV US$M	11,041	120%	2,818	143%	657	95%	511	10%	15,028	87%
		No. of people affected vulnerable to changes	'000	485	163%	155	337%	160	157%	328	74%	1,128	127%
		No. of jobs generated	'000	388	226%	171	63%	48	43%	13	6%	620	79%
		Overall environment impact	Severity	Negative		Mildly negative		Mildly negative		Neutral		Mildly negative	

Summary of scenario assessment

Estimated total values

LMB 20-Year Plan Scenario with 9 mainstream dams, excl Thailand

Scenario run no. 6200

Specific development objective	Issue	Assessment criteria	Unit	Lao PDR		Thailand		Cambodia		Viet Nam		Total	
				Amount	Percent	Amount	Percent	Amount	Percent	Amount	Percent	Amount	Percent
1. Economic development													
1.1 Increase irrigated agricultural production	Irrigable area, production tonnage and value	Incremental area	'000 ha	450		2,635		457		1,795		5,337	
		Crop production	Mtonne / yr	4.225		17.371		5.228		28.345		55.170	
		Net economic value	NPV US$M	300		864		223		94		1,481	
1.2 Increase hydropower production	Hydropower capacity, power generated and value	Installed capacity	MW	15,385		745		4,761		2,583		23,473	
		Power generated	GWh/yr	70,664		51,691		23,061		35,058		180,474	
		Net economic value from generation	NPV US$M	13,118		591		1,315		4,659		19,682	
		Net economic value from purchased	NPV US$M	8,206		3,032		2,031		1,066		14,335	
1.3 Improve navigation	River transport	Navigable days by class	'000 boat-days	n/a		n/a		n/a		n/a		n/a	
		Net economic value	NPV US$M			246						246	
1.4 Decrease damages by floods	Extent and duration of annual flooding by class	Average area flooded annually to max 1.0m depth	'000 ha	41		44		433		1,149		1,667	
		Average area flooded annually > 1.0m depth	'000 ha	290		244		1,614		637		2,785	
		Net economic value of flood damage	NPV US$M	124		124		47		65		360	
1.5 Maintain productivity of fishery sector	Capture fisheries and aquaculture production	Annual average capture fish availability	Mtonne / yr	0.296		0.984		0.473		0.265		2.018	
		Annual average aquaculture production	Mtonne / yr	0.204		0.259		0.243		3.326		4.031	
		Net economic value of capture fish	NPV US$M	119		89		-893		234		-452	
2. Environmental protection													
2.1 Maintain water quality and acceptable flow conditions	Water quality	Total pollutant discharge	tonnes / yr	100,143		195,432		64,719		208,047		568,341	
		Water quality conditions	Severity										
	Flow characteristics	Average flow in March	m3/s	2,195		2,675		3,531		4,175		3,144	
		Average wet season peak daily flow	m3/s	13,540		23,417		43,307		20,466		25,182	
		Average flow volume entering Tonle Sap	MCM	n/a		n/a		28,340		n/a		28,340	
	Protection of forests around Tonle Sap	Forest, marshes and grasslands flooded at Tonle Sap	'000 ha					1,024				1,024	
		Net economic value	NPV US$M	-212				-122		-14		-349	
2.2 Maintain wetland productivity and	Productivity of wetland ecosystems	Are of wetlands (forest, marshes, wetland)	'000 ha	11		51		1,257		100		1,419	
		Net economic value	NPV US$M	-18		-34		-169		-4		-225	
2.3 Manage salinity intrusion in the Mekong	Impact of salinity intrusion on land use	Area within delta within threshold level of salinity	'000 ha							1,563		1,563	
		Net economic value	NPV US$M							21		21	
2.4 Minimize channel effects on bank erosion and deep pools	River bank erosion	Area at risk to erosion	Severity	Mildly negative		Mildly negative		Mildly negative		Neutral		Neutral	
		Net economic value	NPV US$M										
	Flow and sediment transport changes	Functioning deep pools	No.	12		13		3		5		33	
		Induced geomorphological changes	Severity	Negative		Negative		Mildly negative		Mildly negative		Negative	
2.5 Conservation of biodiversity	Impacts of flow management changes on endangered species	Status of river channel habitats	Severity	Negative		Negative		Mildly negative		Mildly negative		Negative	
		Flagship species	Survival	Extinct		Extinct		Surviving		Surviving		Extinct	
		Unaffected environmental hot spots	Severity	Severely negative		Severely negative		Severely negative		Neutral		Severely negative	
		Biodiversity condition	Severity	Severely negative		Severely negative		Severely negative		Mildly negative		Severely negative	
		Incremental net economic value of habitat areas	NPV US$M	-75		-60		-195				-330	
3. Social development													
3.1 Maintain livelihoods of vulnerable resource-users	Health, food and income security	No. of people affected	'000	907		515		1,212		1,725		4,359	
		Severity of impact on health, food and income security	Severity	Severely negative		Negative		Extremely negative		Negative		Severely negative	
3.4 Increased employment generation in water related sectors	Incremental sustainable employment from water resource interventions	Incremental number of people engaged in:											
		Irrigated agriculture	'000	150		346		84		49		629	
		Reservoir fisheries (incremental to BS)	'000	36				21		3		60	
		Hydropower production	'000	336		6		163		29		534	
		Aquaculture (incremental to BS)	'000	55		77		57		164		352	
4 Equitable development													
4.1 Ensure that all four LMB countries benefit from the development of water and related resources	Aggregate benefits by country	Total net economic value	NPV US$M	21,561		4,852		2,237		6,121		34,771	
		No. of people affected vulnerable to changes	'000	907		515		1,212		1,725		4,359	
		No. of jobs generated	'000	577		429		324		245		1,575	
		Overall environment impact	Severity	Severely negative		Severely negative		Severely negative		Mildly negative		Severely negative	

Summary of scenario assessment

Incremental values relative to Baseline

LMB 20-Year Plan Scenario with 9 mainstream dams, excl Thailand

Scenario run no. 6200

Specific development objective	Issue	Assessment criteria	Unit	Lao PDR		Thailand		Cambodia		Viet Nam		Total	
				Amount	Percent	Amount	Percent	Amount	Percent	Amount	Percent	Amount	Percent
1. Economic development													
1.1 Increase irrigated agricultural production	Irrigable area, production tonnage and value	Incremental area	'000 ha	245	120%	1,370	108%	183	67%	-201	-10%	1,597	43%
		Crop production	Mtonne / yr	3.354	385%	11.964	221%	3.324	174%	8.511	43%	27.153	97%
		Net economic value	NPV US$M	300		864		223		94		1,481	
1.2 Increase hydropower production	Hydropower capacity, power generated and value	Installed capacity	MW	14,764	2377%	500	204%	4,761		1,863	259%	21,888	1380%
		Power generated	GWh/yr	67,632	2231%	49,288	2051%	23,061		31,399	858%	171,381	1885%
		Net economic value from generation	NPV US$M	10,825	472%	100	20%	1,315		2,948	172%	15,187	338%
		Net economic value from purchased	NPV US$M	7,865	2310%	2,823	1350%	2,031		799	299%	13,519	1655%
1.3 Improve navigation	River transport	Navigable days by class	'000 boat-days	n/a		n/a		n/a		n/a		n/a	
		Net economic value	NPV US$M			64	35%					64	35%
1.4 Decrease damages by floods	Extent and duration of annual flooding by class	Average area flooded annually to max 1.0m depth	'000 ha	-8	-16%	-3	-6%	17	4%	146	15%	152	10%
		Average area flooded annually > 1.0m depth	'000 ha	-67	-19%	-78	-24%	-152	-9%	-162	-20%	-459	-14%
		Net economic value of flood damage	NPV US$M	124		124		47		65		360	
1.5 Maintain productivity of fishery sector	Capture fisheries and aquaculture production	Annual average capture fish availability	Mtonne / yr	-0.015	-5%	-0.044	-4%	-0.319	-40%	-0.134	-34%	-0.512	-20%
		Annual average aquaculture production	Mtonne / yr	0.126	161%	0.158	158%	0.116	91%	1.662	100%	2.063	105%
		Net economic value of capture fish	NPV US$M	119		89		-893		234		-452	
2. Environmental protection													
2.1 Maintain water quality and acceptable flow conditions	Water quality	Total pollutant discharge	tonnes / yr	49,486	98%	86,552	79%	26,125	68%	37,646	22%	199,809	54%
		Water quality conditions	Severity										
	Flow characteristics	Average flow in March	m3/s	1,095	100%	1,223	84%	1,333	61%	1,104	36%	1,189	61%
		Average wet season peak daily flow	m3/s	-2,381	-15%	-2,084	-8%	-3,456	-7%	-844	-4%	-2,191	-8%
		Average flow volume entering Tonle Sap	MCM	n/a		n/a		-3,918	-12%	n/a		-3,918	-12%
	Protection of forests around Tonle Sap	Forest, marshes and grasslands flooded at Tonle Sap	'000 ha					-14	-1%			-14	-1%
		Net economic value	NPV US$M	-212				-122		-14		-349	
2.2 Maintain wetland productivity and	Productivity of wetland ecosystems	Are of wetlands (forest, marshes, wetland)	'000 ha	-6	-34%	-11	-18%	-31	-2%	-0	0%	-48	-3%
		Net economic value	NPV US$M	-18		-34		-169		-4		-225	
2.3 Manage salinity intrusion in the Mekong	Impact of salinity intrusion on land use	Area within delta within threshold level of salinity	'000 ha							-288	-16%	-288	-16%
		Net economic value	NPV US$M							21		21	
2.4 Minimize channel effects on bank erosion and deep pools	River bank erosion	Area at risk to erosion	Severity	Mildly negative		Mildly negative		Mildly negative		Neutral		Mildly negative	
		Net economic value	NPV US$M										
	Flow and sediment transport changes	Functioning deep pools	No.	-8	-40%	-4	-24%	-2	-40%			-14	-30%
		Induced geomorphological changes	Severity	Negative		Negative		Mildly negative		Mildly negative		Negative	
2.5 Conservation of biodiversity	Impacts of flow management changes on endangered species	Status of river channel habitats	Severity	Negative		Negative		Mildly negative		Mildly negative		Negative	
		Flagship species	Survival	n/a		n/a		n/a		n/a		n/a	
		Unaffected environmental hot spots	Severity	Severely negative		Severely negative		Severely negative		Neutral		Severely negative	
		Biodiversity condition	Severity	Severely negative		Severely negative		Severely negative		Mildly negative		Severely negative	
		Incremental net economic value of habitat areas	NPV US$M	-75		-60		-195				-330	
3. Social development													
3.1 Maintain livelihoods of vulnerable resource-users	Health, food and income security	No. of people affected	'000	907		515		1,212		1,725		4,359	
		Severity of impact on health, food and income security	Severity	Severely negative		Negative		Extremely negative		Negative		Severely negative	
3.4 Increased employment generation in water related sectors	Incremental sustainable employment from water resource interventions	Incremental number of people engaged in:											
		Irrigated agriculture	'000	72	91%	119	53%	6	8%	14	41%	212	51%
		Reservoir fisheries (incremental to BS)	'000	36				21		3		60	
		Hydropower production	'000	336		6		163		29		534	
		Aquaculture (incremental to BS)	'000	55		77		57		164		352	
4 Equitable development													
4.1 Ensure that all four LMB countries benefit from the development of water and related resources	Aggregate benefits by country	Total net economic value	NPV US$M	18,927	719%	3,970	450%	2,237		4,143	209%	29,276	533%
		No. of people affected vulnerable to changes	'000	907		515		1,212		1,725		4,359	
		No. of jobs generated	'000	498	633%	202	89%	247	319%	210	602%	1,158	277%
		Overall environment impact	Severity	Severely negative		Severely negative		Severely negative		Mildly negative		Severely negative	

Summary of scenario assessment

Incremental values relative to Definite Future Scenario

LMB 20-Year Plan Scenario with 9 mainstream dams, excl Thailand

Scenario run no. 6200

Specific development objective	Issue	Assessment criteria	Unit	Lao PDR		Thailand		Cambodia		Viet Nam		Total	
				Amount	Percent	Amount	Percent	Amount	Percent	Amount	Percent	Amount	Percent
1. Economic development													
1.1 Increase irrigated agricultural production	Irrigable area, production tonnage and value	Incremental area	'000 ha	283	170%	1,281	95%	183	67%	125	7%	1,872	54%
		Crop production	Mtonne / yr	3.354	385%	11.964	221%	3.324	174%	8.511	43%	27.153	97%
		Net economic value	NPV US$M	320	-1678%	874	-8528%	329	-310%	103	-1177%	1,625	-1128%
1.2 Increase hydropower production	Hydropower capacity, power generated and value	Installed capacity	MW	11,882	339%			4,760	476000%	299	13%	16,941	259%
		Power generated	GWh/yr	54,261	331%	39,512	324%	20,726	888%	21,465	158%	135,964	305%
		Net economic value from generation	NPV US$M	5,432	71%			567	76%	839	22%	6,837	53%
		Net economic value from purchased	NPV US$M	6,638	424%	1,972	186%	1,574	345%	192	22%	10,377	262%
1.3 Improve navigation	River transport	Navigable days by class	'000 boat-days	n/a		n/a		n/a		n/a		n/a	
		Net economic value	NPV US$M										
1.4 Decrease damages by floods	Extent and duration of annual flooding by class	Average area flooded annually to max 1.0m depth	'000 ha	-2	-4%	-0	-1%	9	2%	27	2%	34	2%
		Average area flooded annually > 1.0m depth	'000 ha	-9	-3%	-12	-5%	-38	-2%	-33	-5%	-92	-3%
		Net economic value of flood damage	NPV US$M	-55	-31%	-48	-28%	-4	-8%	5	8%	-102	-22%
1.5 Maintain productivity of fishery sector	Capture fisheries and aquaculture production	Annual average capture fish availability	Mtonne / yr	0.011	4%	-0.013	-1%	-0.266	-36%	-0.102	-28%	-0.370	-15%
		Annual average aquaculture production	Mtonne / yr	0.054	36%	0.077	42%	0.076	45%	0.831	33%	1.037	35%
		Net economic value of capture fish	NPV US$M	146	-530%	102	-753%	-661	285%	-314	-57%	-726	-265%
2. Environmental protection													
2.1 Maintain water quality and acceptable flow conditions	Water quality	Total pollutant discharge	tonnes / yr	49,486	98%	86,552	79%	26,125	68%	37,646	22%	199,809	54%
		Water quality conditions	Severity										
	Flow characteristics	Average flow in March	m3/s	335	18%	303	13%	462	15%	278	7%	344	12%
		Average wet season peak daily flow	m3/s	-273	-2%	-615	-3%	-1,816	-4%	-364	-2%	-767	-3%
		Average flow volume entering Tonle Sap	MCM	n/a		n/a		-1,400	-5%	n/a		-1,400	-5%
	Protection of forests around Tonle Sap	Forest, marshes and grasslands flooded at Tonle Sap	'000 ha					-5	0%			-5	0%
		Net economic value	NPV US$M	-83	64%			-116	1840%	3	-19%	-195	127%
2.2 Maintain wetland productivity and	Productivity of wetland ecosystems	Are of wetlands (forest, marshes, wetland)	'000 ha	-1	-8%	-2	-4%	-10	-1%	-0	0%	-13	-1%
		Net economic value	NPV US$M	8	-31%	14	-29%	-15	10%	-4	587%	3	-1%
2.3 Manage salinity intrusion in the Mekong	Impact of salinity intrusion on land use	Area within delta within threshold level of salinity	'000 ha							-16	-1%	-16	-1%
		Net economic value	NPV US$M							1	5%	1	5%
2.4 Minimize channel effects on bank erosion and deep pools	River bank erosion	Area at risk to erosion	Severity	Negative		Negative		Mildly negative		Neutral		Negative	
		Net economic value	NPV US$M										
	Flow and sediment transport changes	Functioning deep pools	No.	-8	-40%	-4	-24%	-2	-40%			-14	-30%
		Induced geomorphological changes	Severity	Mildly negative		Mildly negative		Mildly negative		Mildly negative		Mildly negative	
2.5 Conservation of biodiversity	Impacts of flow management changes on endangered species	Status of river channel habitats	Severity	Mildly negative		Mildly negative		Mildly negative		Mildly negative		Mildly negative	
		Flagship species	Survival	n/a		n/a		n/a		n/a		n/a	
		Unaffected environmental hot spots	Severity	Severely negative		Negative		Severely negative		Neutral		Negative	
		Biodiversity condition	Severity	Negative		Negative		Negative		Neutral		Negative	
		Incremental net economic value of habitat areas	NPV US$M	-75		-40	200%	-130	200%			-245	288%
3. Social development													
3.1 Maintain livelihoods of vulnerable resource-users	Health, food and income security	No. of people affected	'000	610	205%	469	1020%	1,110	1088%	1,283	290%	3,472	391%
		Severity of impact on health, food and income security	Severity	Mildly negative		Mildly negative		Severely negative		Mildly negative		Negative	
3.4 Increased employment generation in water related sectors	Incremental sustainable employment from water resource interventions	Incremental number of people engaged in:											
		Irrigated agriculture	'000	72	91%	119	53%	6	8%	14	41%	212	51%
		Reservoir fisheries (incremental to BS)	'000	24	193%			20	3497%	1	46%	45	298%
		Hydropower production	'000	284	545%	1	21%	148	963%	-3	-8%	430	415%
		Aquaculture (incremental to BS)	'000	26	94%	38	96%	37	188%			101	40%
4 Equitable development													
4.1 Ensure that all four LMB countries benefit from the development of water and related resources	Aggregate benefits by country	Total net economic value	NPV US$M	12,332	134%	2,874	145%	1,543	223%	826	16%	17,576	102%
		No. of people affected vulnerable to changes	'000	610	205%	469	1020%	1,110	1088%	1,283	290%	3,472	391%
		No. of jobs generated	'000	406	237%	158	58%	211	187%	13	6%	788	100%
		Overall environment impact	Severity	Negative		Negative		Negative		Neutral		Negative	

Summary of scenario assessment

Estimated total values

LMB 20-Year Plan Scenario with 9 mainstream dams, excl Cambodia

Scenario run no. 6300

Specific development objective	Issue	Assessment criteria	Unit	Lao PDR Amount	Lao PDR Percent	Thailand Amount	Thailand Percent	Cambodia Amount	Cambodia Percent	Viet Nam Amount	Viet Nam Percent	Total Amount	Total Percent
1. Economic development													
1.1 Increase irrigated agricultural production	Irrigable area, production tonnage and value	Incremental area	'000 ha	450		2,635		457		1,795		5,337	
		Crop production	Mtonne / yr	4.225		17.371		5.228		28.345		55.170	
		Net economic value	NPV US$M	300		864		224		95		1,483	
1.2 Increase hydropower production	Hydropower capacity, power generated and value	Installed capacity	MW	15,385		3,696		481		2,583		22,144	
		Power generated	GWh/yr	84,416		56,746		3,321		21,240		165,723	
		Net economic value from generation	NPV US$M	14,585		964		1,168		4,189		20,906	
		Net economic value from purchased	NPV US$M	10,407		2,911		462		958		14,739	
1.3 Improve navigation	River transport	Navigable days by class	'000 boat-days	n/a		n/a		n/a		n/a		n/a	
		Net economic value	NPV US$M			246						246	
1.4 Decrease damages by floods	Extent and duration of annual flooding by class	Average area flooded annually to max 1.0m depth	'000 ha	41		44		433		1,149		1,667	
		Average area flooded annually > 1.0m depth	'000 ha	290		244		1,614		637		2,785	
		Net economic value of flood damage	NPV US$M	124		124		47		65		360	
1.5 Maintain productivity of fishery sector	Capture fisheries and aquaculture production	Annual average capture fish availability	Mtonne / yr	0.306		0.984		0.610		0.316		2.216	
		Annual average aquaculture production	Mtonne / yr	0.204		0.259		0.243		3.326		4.031	
		Net economic value of capture fish	NPV US$M	154		90		-437		406		212	
2. Environmental protection													
2.1 Maintain water quality and acceptable flow conditions	Water quality	Total pollutant discharge	tonnes / yr	100,143		195,432		64,719		208,047		568,341	
		Water quality conditions	Severity										
	Flow characteristics	Average flow in March	m3/s	2,194		2,675		3,535		4,175		3,145	
		Average wet season peak daily flow	m3/s	13,627		23,503		43,356		20,466		25,238	
		Average flow volume entering Tonle Sap	MCM	n/a		n/a		28,339		n/a		28,339	
	Protection of forests around Tonle Sap	Forest, marshes and grasslands flooded at Tonle Sap	'000 ha					1,024				1,024	
		Net economic value	NPV US$M	-236				-4		-14		-254	
2.2 Maintain wetland productivity and	Productivity of wetland ecosystems	Are of wetlands (forest, marshes, wetland)	'000 ha	11		51		1,257		100		1,419	
		Net economic value	NPV US$M	-18		-34		-125		-1		-178	
2.3 Manage salinity intrusion in the Mekong	Impact of salinity intrusion on land use	Area within delta within threshold level of salinity	'000 ha							1,563		1,563	
		Net economic value	NPV US$M							23		23	
2.4 Minimize channel effects on bank erosion and deep pools	River bank erosion	Area at risk to erosion	Severity	Mildly negative		Mildly negative		Neutral		Neutral		Neutral	
		Net economic value	NPV US$M										
	Flow and sediment transport changes	Functioning deep pools	No.	12		7		5		5		29	
		Induced geomorphological changes	Severity	Negative		Negative		Mildly negative		Mildly negative		Negative	
2.5 Conservation of biodiversity	Impacts of flow management changes on endangered species	Status of river channel habitats	Severity	Negative		Negative		Mildly negative		Mildly negative		Negative	
		Flagship species	Survival	Surviving		Extinct		Surviving		Surviving		Extinct	
		Unaffected environmental hot spots	Severity	Negative		Severely negative		Severely negative		Neutral		Negative	
		Biodiversity condition	Severity	Severely negative		Severely negative		Mildly negative		Mildly negative		Negative	
		Incremental net economic value of habitat areas	NPV US$M	-50		-60		-195				-305	
3. Social development													
3.1 Maintain livelihoods of vulnerable resource-users	Health, food and income security	No. of people affected	'000	782		516		352		1,088		2,738	
		Severity of impact on health, food and income security	Severity	Severely negative		Mildly negative		Severely negative		Negative		Severely negative	
3.4 Increased employment generation in water related sectors	Incremental sustainable employment from water resource interventions	Incremental number of people engaged in:											
		Irrigated agriculture	'000	150		346		84		49		629	
		Reservoir fisheries (incremental to BS)	'000	40				7		3		51	
		Hydropower production	'000	379		42		20		29		469	
		Aquaculture (incremental to BS)	'000	55		77		57		164		352	
4 Equitable development													
4.1 Ensure that all four LMB countries benefit from the development of water and related resources	Aggregate benefits by country	Total net economic value	NPV US$M	25,266		5,105		1,142		5,720		37,233	
		No. of people affected vulnerable to changes	'000	782		516		352		1,088		2,738	
		No. of jobs generated	'000	624		465		168		245		1,501	
		Overall environment impact	Severity	Severely negative		Severely negative		Negative		Mildly negative		Severely negative	

Summary of scenario assessment

Incremental values relative to Baseline

LMB 20-Year Plan Scenario with 9 mainstream dams, excl Cambodia

Scenario run no. 6300

Specific development objective	Issue	Assessment criteria	Unit	Lao PDR		Thailand		Cambodia		Viet Nam		Total	
				Amount	Percent	Amount	Percent	Amount	Percent	Amount	Percent	Amount	Percent
1. Economic development													
1.1 Increase irrigated agricultural production	Irrigable area, production tonnage and value	Incremental area	'000 ha	245	120%	1,370	108%	183	67%	-201	-10%	1,597	43%
		Crop production	Mtonne / yr	3.354	385%	11.964	221%	3.324	174%	8.511	43%	27.153	97%
		Net economic value	NPV US$M	300		864		224		95		1,483	
1.2 Increase hydropower production	Hydropower capacity, power generated and value	Installed capacity	MW	14,764	2377%	3,451	1410%	481		1,863	259%	20,559	1296%
		Power generated	GWh/yr	81,384	2684%	54,343	2262%	3,321		17,581	481%	156,630	1723%
		Net economic value from generation	NPV US$M	12,292	536%	473	96%	1,168		2,477	145%	16,410	365%
		Net economic value from purchased	NPV US$M	10,067	2957%	2,702	1292%	462		691	259%	13,922	1705%
1.3 Improve navigation	River transport	Navigable days by class	'000 boat-days	n/a		n/a		n/a		n/a		n/a	
		Net economic value	NPV US$M			64	35%					64	35%
1.4 Decrease damages by floods	Extent and duration of annual flooding by class	Average area flooded annually to max 1.0m depth	'000 ha	-8	-16%	-3	-6%	17	4%	146	15%	152	10%
		Average area flooded annually > 1.0m depth	'000 ha	-67	-19%	-78	-24%	-152	-9%	-162	-20%	-459	-14%
		Net economic value of flood damage	NPV US$M	124		124		47		65		360	
1.5 Maintain productivity of fishery sector	Capture fisheries and aquaculture production	Annual average capture fish availability	Mtonne / yr	-0.004	-1%	-0.044	-4%	-0.183	-23%	-0.083	-21%	-0.314	-12%
		Annual average aquaculture production	Mtonne / yr	0.126	161%	0.158	158%	0.116	91%	1.662	100%	2.063	105%
		Net economic value of capture fish	NPV US$M	154		90		-437		406		212	
2. Environmental protection													
2.1 Maintain water quality and acceptable flow conditions	Water quality	Total pollutant discharge	tonnes / yr	49,486	98%	86,552	79%	26,125	68%	37,646	22%	199,809	54%
		Water quality conditions	Severity										
	Flow characteristics	Average flow in March	m3/s	1,094	99%	1,222	84%	1,338	61%	1,104	36%	1,189	61%
		Average wet season peak daily flow	m3/s	-2,295	-14%	-1,998	-8%	-3,407	-7%	-844	-4%	-2,136	-8%
		Average flow volume entering Tonle Sap	MCM	n/a		n/a		-3,919	-12%	n/a		-3,919	-12%
	Protection of forests around Tonle Sap	Forest, marshes and grasslands flooded at Tonle Sap	'000 ha					-14	-1%			-14	-1%
		Net economic value	NPV US$M	-236				-4		-14		-254	
2.2 Maintain wetland productivity and	Productivity of wetland ecosystems	Are of wetlands (forest, marshes, wetland)	'000 ha	-6	-34%	-11	-18%	-31	-2%	-0	0%	-48	-3%
		Net economic value	NPV US$M	-18		-34		-125		-1		-178	
2.3 Manage salinity intrusion in the Mekong	Impact of salinity intrusion on land use	Area within delta within threshold level of salinity	'000 ha							-288	-16%	-288	-16%
		Net economic value	NPV US$M							23		23	
2.4 Minimize channel effects on bank erosion and deep pools	River bank erosion	Area at risk to erosion	Severity	Mildly negative		Mildly negative		Neutral		Neutral		Mildly negative	
		Net economic value	NPV US$M										
	Flow and sediment transport changes	Functioning deep pools	No.	-8	-40%	-10	-59%					-18	-38%
		Induced geomorphological changes	Severity	Negative		Negative		Mildly negative		Mildly negative		Negative	
2.5 Conservation of biodiversity	Impacts of flow management changes on endangered species	Status of river channel habitats	Severity	Negative		Negative		Mildly negative		Mildly negative		Negative	
		Flagship species	Survival	n/a		n/a		n/a		n/a		n/a	
		Unaffected environmental hot spots	Severity	Negative		Severely negative		Severely negative		Neutral		Negative	
		Biodiversity condition	Severity	Severely negative		Severely negative		Mildly negative		Mildly negative		Negative	
		Incremental net economic value of habitat areas	NPV US$M	-50		-60		-195				-305	
3. Social development													
3.1 Maintain livelihoods of vulnerable resource-users	Health, food and income security	No. of people affected	'000	782		516		352		1,088		2,738	
		Severity of impact on health, food and income security	Severity	Severely negative		Mildly negative		Severely negative		Negative		Severely negative	
3.4 Increased employment generation in water related sectors	Incremental sustainable employment from water resource interventions	Incremental number of people engaged in:											
		Irrigated agriculture	'000	72	91%	119	53%	6	8%	14	41%	212	51%
		Reservoir fisheries (incremental to BS)	'000	40				7		3		51	
		Hydropower production	'000	379		42		20		29		469	
		Aquaculture (incremental to BS)	'000	55		77		57		164		352	
4 Equitable development													
4.1 Ensure that all four LMB countries benefit from the development of water and related resources	Aggregate benefits by country	Total net economic value	NPV US$M	22,632	859%	4,223	479%	1,142		3,741	189%	31,738	578%
		No. of people affected vulnerable to changes	'000	782		516		352		1,088		2,738	
		No. of jobs generated	'000	545	693%	238	105%	90	117%	210	602%	1,084	259%
		Overall environment impact	Severity	Severely negative		Severely negative		Negative		Mildly negative		Severely negative	

Summary of scenario assessment

Incremental values relative to Definite Future Scenario

LMB 20-Year Plan Scenario wit
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Specific development objective	Issue	Assessment criteria	Unit	Lao PDR		Thailand		Cambodia		Viet Nam	
				Amount	Percent	Amount	Percent	Amount	Percent	Amount	Percent
1. Economic development											
1.1 Increase irrigated agricultural production	Irrigable area, production tonnage and value	Incremental area	'000 ha	283	170%	1,281	95%	183	67%	125	7%
		Crop production	Mtonne / yr	3.354	385%	11.964	221%	3.324	174%	8.511	43%
		Net economic value	NPV US$M	320	-1678%	874	-8528%	330	-312%	103	-1178%
1.2 Increase hydropower production	Hydropower capacity, power generated and value	Installed capacity	MW	11,882	339%	2,951	396%	480	48000%	299	13%
		Power generated	GWh/yr	68,013	415%	44,567	366%	986	42%	7,647	56%
		Net economic value from generation	NPV US$M	6,899	90%	373	63%	420	56%	368	10%
		Net economic value from purchased	NPV US$M	8,840	564%	1,851	175%	5	1%	84	10%
1.3 Improve navigation	River transport	Navigable days by class	'000 boat-days	n/a		n/a		n/a		n/a	
		Net economic value	NPV US$M								
1.4 Decrease damages by floods	Extent and duration of annual flooding by class	Average area flooded annually to max 1.0m depth	'000 ha	-2	-4%	-0	-1%	9	2%	27	2%
		Average area flooded annually > 1.0m depth	'000 ha	-9	-3%	-12	-5%	-38	-2%	-33	-5%
		Net economic value of flood damage	NPV US$M	-55	-31%	-48	-28%	-4	-8%	5	8%
1.5 Maintain productivity of fishery sector	Capture fisheries and aquaculture production	Annual average capture fish availability	Mtonne / yr	0.021	8%	-0.012	-1%	-0.129	-18%	-0.051	-14%
		Annual average aquaculture production	Mtonne / yr	0.054	36%	0.077	42%	0.076	45%	0.831	33%
		Net economic value of capture fish	NPV US$M	181	-656%	103	-759%	-205	88%	-142	-26%
2. Environmental protection											
2.1 Maintain water quality and acceptable flow conditions	Water quality	Total pollutant discharge	tonnes / yr	49,486	98%	86,552	79%	26,125	68%	37,646	22%
		Water quality conditions	Severity								
	Flow characteristics	Average flow in March	m3/s	334	18%	303	13%	466	15%	278	7%
		Average wet season peak daily flow	m3/s	-187	-1%	-529	-2%	-1,767	-4%	-364	-2%
		Average flow volume entering Tonle Sap	MCM	n/a		n/a		-1,401	-5%	n/a	
	Protection of forests around Tonle Sap	Forest, marshes and grasslands flooded at Tonle Sap	'000 ha					-5	0%		
		Net economic value	NPV US$M	-106	82%			3	-44%	3	-19%
2.2 Maintain wetland productivity and	Productivity of wetland ecosystems	Are of wetlands (forest, marshes, wetland)	'000 ha	-1	-8%	-2	-4%	-10	-1%	-0	0%
		Net economic value	NPV US$M	8	-31%	14	-29%	28	-19%	-1	82%
2.3 Manage salinity intrusion in the Mekong	Impact of salinity intrusion on land use	Area within delta within threshold level of salinity	'000 ha							-16	-1%
		Net economic value	NPV US$M							3	15%
2.4 Minimize channel effects on bank erosion and deep pools	River bank erosion	Area at risk to erosion	Severity	Negative		Negative		Neutral		Neutral	
		Net economic value	NPV US$M								
	Flow and sediment transport changes	Functioning deep pools	No.	-8	-40%	-10	-59%				
		Induced geomorphological changes	Severity	Mildly negative		Mildly negative		Mildly negative		Mildly negative	
2.5 Conservation of biodiversity	Impacts of flow management changes on endangered species	Status of river channel habitats	Severity	Mildly negative		Mildly negative		Mildly negative		Mildly negative	
		Flagship species	Survival	n/a		n/a		n/a		n/a	
		Unaffected environmental hot spots	Severity	Negative		Negative		Severely negative		Neutral	
		Biodiversity condition	Severity	Negative		Negative		Neutral		Neutral	
		Incremental net economic value of habitat areas	NPV US$M	-50		-40	200%	-130	200%		
3. Social development											
3.1 Maintain livelihoods of vulnerable resource-users	Health, food and income security	No. of people affected	'000	485	163%	470	1022%	250	245%	646	146%
		Severity of impact on health, food and income security	Severity	Mildly negative		Neutral		Negative		Mildly negative	
3.4 Increased employment generation in water related sectors	Incremental sustainable employment from water resource interventions	Incremental number of people engaged in:									
		Irrigated agriculture	'000	72	91%	119	53%	6	8%	14	41%
		Reservoir fisheries (incremental to BS)	'000	28	226%			6	1100%	1	46%
		Hydropower production	'000	327	628%	37	711%	5	32%	-3	-8%
		Aquaculture (incremental to BS)	'000	26	94%	38	96%	37	188%		
4 Equitable development											
4.1 Ensure that all four LMB countries benefit from the development of water and related resources	Aggregate benefits by country	Total net economic value	NPV US$M	16,037	174%	3,128	158%	449	65%	424	8%
		No. of people affected vulnerable to changes	'000	485	163%	470	1022%	250	245%	646	146%
		No. of jobs generated	'000	453	264%	194	71%	55	48%	13	6%
		Overall environment impact	Severity	Negative		Negative		Mildly negative		Neutral	

Summary of scenario assessment

Estimated total values

LMB Long-term Development Scenario

Scenario run no. 8000

Specific development objective	Issue	Assessment criteria	Unit	Lao PDR Amount	Lao PDR Percent	Thailand Amount	Thailand Percent	Cambodia Amount	Cambodia Percent	Viet Nam Amount	Viet Nam Percent	Total Amount	Total Percent
1. Economic development													
1.1 Increase irrigated agricultural production	Irrigable area, production tonnage and value	Incremental area	'000 ha	715		2,760		678		1,813		5,966	
		Crop production	Mtonne / yr	7.678		20.824		10.766		32.121		71.389	
		Net economic value	NPV US$M	772		1,344		1,539		386		4,041	
1.2 Increase hydropower production	Hydropower capacity, power generated and value	Installed capacity	MW	17,321		3,696		5,507		2,583		29,107	
		Power generated	GWh/yr	92,156		60,865		26,912		35,961		215,893	
		Net economic value from generation	NPV US$M	17,734		972		2,876		4,696		26,278	
		Net economic value from purchased	NPV US$M	10,533		3,109		2,190		1,066		16,898	
1.3 Improve navigation	River transport	Navigable days by class	'000 boat-days	n/a		n/a		n/a		n/a		n/a	
		Net economic value	NPV US$M			246						246	
1.4 Decrease damages by floods	Extent and duration of annual flooding by class	Average area flooded annually to max 1.0m depth	'000 ha	41		44		437		1,176		1,699	
		Average area flooded annually > 1.0m depth	'000 ha	290		247		1,578		598		2,712	
		Net economic value of flood damage	NPV US$M	141		140		54		73		408	
1.5 Maintain productivity of fishery sector	Capture fisheries and aquaculture production	Annual average capture fish availability	Mtonne / yr	0.318		0.980		0.551		0.264		2.112	
		Annual average aquaculture production	Mtonne / yr	0.306		0.388		0.365		4.989		6.047	
		Net economic value of capture fish	NPV US$M	275		193		-547		572		494	
2. Environmental protection													
2.1 Maintain water quality and acceptable flow conditions	Water quality	Total pollutant discharge	tonnes / yr	166,826		215,015		92,628		287,622		762,091	
		Water quality conditions	Severity										
	Flow characteristics	Average flow in March	m3/s	2,200		2,608		3,708		4,103		3,155	
		Average wet season peak daily flow	m3/s	13,597		23,574		41,698		20,160		24,757	
		Average flow volume entering Tonle Sap	MCM	n/a		n/a		26,937		n/a		26,937	
	Protection of forests around Tonle Sap	Forest, marshes and grasslands flooded at Tonle Sap	'000 ha					1,019				1,019	
		Net economic value	NPV US$M	-304				-413		-14		-731	
2.2 Maintain wetland productivity and	Productivity of wetland ecosystems	Are of wetlands (forest, marshes, wetland)	'000 ha	11		51		1,249		100		1,412	
		Net economic value	NPV US$M	-18		-32		-202		-8		-260	
2.3 Manage salinity intrusion in the Mekong	Impact of salinity intrusion on land use	Area within delta within threshold level of salinity	'000 ha							1,553		1,553	
		Net economic value	NPV US$M							22		22	
2.4 Minimize channel effects on bank erosion and deep pools	River bank erosion	Area at risk to erosion	Severity	Negative		Negative		Severely negative		Severely negative		Neutral	
		Net economic value	NPV US$M										
	Flow and sediment transport changes	Functioning deep pools	No.	12		7		3		5		27	
		Induced geomorphological changes	Severity	Severely negative		Severely negative		Extremely negative		Severely negative		Extremely negative	
2.5 Conservation of biodiversity	Impacts of flow management changes on endangered species	Status of river channel habitats	Severity	Severely negative		Severely negative		Extremely negative		Severely negative		Extremely negative	
		Flagship species	Survival	Extinct		Extinct		Extinct		Surviving		Extinct	
		Unaffected environmental hot spots	Severity	Catastrophic		Extremely negative		Extremely negative		Negative		Extremely negative	
		Biodiversity condition	Severity	Severely negative		Severely negative		Severely negative		Severely negative		Severely negative	
		Incremental net economic value of habitat areas	NPV US$M	-100		-80		-195		-60		-435	
3. Social development													
3.1 Maintain livelihoods of vulnerable resource-users	Health, food and income security	No. of people affected	'000	1,029		516		1,224		1,737		4,506	
		Severity of impact on health, food and income security	Severity	Severely negative		Severely negative		Extremely negative		Negative		Severely negative	
3.4 Increased employment generation in water related sectors	Incremental sustainable employment from water resource interventions	Incremental number of people engaged in:											
		Irrigated agriculture	'000	286		449		286		53		1,076	
		Reservoir fisheries (incremental to BS)	'000	52				71		3		126	
		Hydropower production	'000	360				149		18		527	
		Aquaculture (incremental to BS)	'000	82		115		85		246		528	
4 Equitable development													
4.1 Ensure that all four LMB countries benefit from the development of water and related resources	Aggregate benefits by country	Total net economic value	NPV US$M	29,035		5,892		5,302		6,733		46,963	
		No. of people affected vulnerable to changes	'000	1,029		516		1,224		1,737		4,506	
		No. of jobs generated	'000	781		564		591		321		2,257	
		Overall environment impact	Severity	Severely negative		Severely negative		Severely negative		Severely negative		Severely negative	

Summary of scenario assessment

Incremental values relative to Baseline

LMB Long-term Development Scenario

Scenario run no. 8000

Specific development objective	Issue	Assessment criteria	Unit	Lao PDR		Thailand		Cambodia		Viet Nam		Total	
				Amount	Percent	Amount	Percent	Amount	Percent	Amount	Percent	Amount	Percent
1. Economic development													
1.1 Increase irrigated agricultural production	Irrigable area, production tonnage and value	Incremental area	'000 ha	511	250%	1,494	118%	405	148%	-183	-9%	2,226	60%
		Crop production	Mtonne / yr	6.806	781%	15.418	285%	8.861	465%	12.287	62%	43.372	155%
		Net economic value	NPV US$M	772		1,344		1,539		386		4,041	
1.2 Increase hydropower production	Hydropower capacity, power generated and value	Installed capacity	MW	16,700	2688%	3,451	1410%	5,507		1,863	259%	27,521	1735%
		Power generated	GWh/yr	89,124	2940%	58,462	2433%	26,912		32,302	883%	206,800	2274%
		Net economic value from generation	NPV US$M	15,441	673%	481	98%	2,876		2,985	174%	21,783	485%
		Net economic value from purchased	NPV US$M	10,193	2994%	2,900	1386%	2,190		799	299%	16,082	1969%
1.3 Improve navigation	River transport	Navigable days by class	'000 boat-days	n/a		n/a		n/a		n/a		n/a	
		Net economic value	NPV US$M			64	35%					64	35%
1.4 Decrease damages by floods	Extent and duration of annual flooding by class	Average area flooded annually to max 1.0m depth	'000 ha	-8	-16%	-3	-6%	21	5%	174	17%	184	12%
		Average area flooded annually > 1.0m depth	'000 ha	-67	-19%	-75	-23%	-189	-11%	-201	-25%	-532	-16%
		Net economic value of flood damage	NPV US$M	141		140		54		73		408	
1.5 Maintain productivity of fishery sector	Capture fisheries and aquaculture production	Annual average capture fish availability	Mtonne / yr	0.007	2%	-0.048	-5%	-0.242	-31%	-0.136	-34%	-0.418	-17%
		Annual average aquaculture production	Mtonne / yr	0.228	292%	0.288	287%	0.237	187%	3.325	200%	4.078	207%
		Net economic value of capture fish	NPV US$M	275		193		-547		572		494	
2. Environmental protection													
2.1 Maintain water quality and acceptable flow conditions	Water quality	Total pollutant discharge	tonnes / yr	116,168	229%	106,135	97%	54,035	140%	117,220	69%	393,559	107%
		Water quality conditions	Severity										
	Flow characteristics	Average flow in March	m3/s	1,100	100%	1,155	80%	1,510	69%	1,031	34%	1,199	61%
		Average wet season peak daily flow	m3/s	-2,324	-15%	-1,927	-8%	-5,065	-11%	-1,150	-5%	-2,617	-10%
		Average flow volume entering Tonle Sap	MCM	n/a		n/a		-5,322	-16%	n/a		-5,322	-16%
	Protection of forests around Tonle Sap	Forest, marshes and grasslands flooded at Tonle Sap	'000 ha					-19	-2%			-19	-2%
		Net economic value	NPV US$M	-304				-413		-14		-731	
2.2 Maintain wetland productivity and	Productivity of wetland ecosystems	Are of wetlands (forest, marshes, wetland)	'000 ha	-6	-33%	-11	-17%	-39	-3%	-1	-1%	-55	-4%
		Net economic value	NPV US$M	-18		-32		-202		-8		-260	
2.3 Manage salinity intrusion in the Mekong	Impact of salinity intrusion on land use	Area within delta within threshold level of salinity	'000 ha							-299	-16%	-299	-16%
		Net economic value	NPV US$M							22		22	
2.4 Minimize channel effects on bank erosion and deep pools	River bank erosion	Area at risk to erosion	Severity	Negative		Negative		Severely negative		Severely negative		Severely negative	
		Net economic value	NPV US$M										
	Flow and sediment transport changes	Functioning deep pools	No.	-8	-40%	-10	-59%	-2	-40%			-20	-43%
		Induced geomorphological changes	Severity	Severely negative		Severely negative		Extremely negative		Severely negative		Extremely negative	
2.5 Conservation of biodiversity	Impacts of flow management changes on endangered species	Status of river channel habitats	Severity	Severely negative		Severely negative		Extremely negative		Severely negative		Extremely negative	
		Flagship species	Survival	n/a		n/a		n/a		n/a		n/a	
		Unaffected environmental hot spots	Severity	Catastrophic		Extremely negative		Extremely negative		Negative		Extremely negative	
		Biodiversity condition	Severity	Severely negative		Severely negative		Severely negative		Severely negative		Severely negative	
		Incremental net economic value of habitat areas	NPV US$M	-100		-80		-195		-60		-435	
3. Social development													
3.1 Maintain livelihoods of vulnerable resource-users	Health, food and income security	No. of people affected	'000	1,029		516		1,224		1,737		4,506	
		Severity of impact on health, food and income security	Severity	Severely negative		Severely negative		Extremely negative		Negative		Severely negative	
3.4 Increased employment generation in water related sectors	Incremental sustainable employment from water resource interventions	Incremental number of people engaged in:											
		Irrigated agriculture	'000	208	264%	223	98%	209	270%	19	53%	658	157%
		Reservoir fisheries (incremental to BS)	'000	52				71		3		126	
		Hydropower production	'000	360				149		18		527	
		Aquaculture (incremental to BS)	'000	82		115		85		246		528	
4 Equitable development													
4.1 Ensure that all four LMB countries benefit from the development of water and related resources	Aggregate benefits by country	Total net economic value	NPV US$M	26,401	1002%	5,010	568%	5,302		4,755	240%	41,468	755%
		No. of people affected vulnerable to changes	'000	1,029		516		1,224		1,737		4,506	
		No. of jobs generated	'000	702	892%	338	149%	514	663%	286	819%	1,839	440%
		Overall environment impact	Severity	Severely negative		Severely negative		Severely negative		Severely negative		Severely negative	

Summary of scenario assessment

Incremental values relative to Definite Future Scenario

LMB Long-term Development Scenario

Scenario run no. 8000

Specific development objective	Issue	Assessment criteria	Unit	Lao PDR		Thailand		Cambodia		Viet Nam		Total	
				Amount	Percent	Amount	Percent	Amount	Percent	Amount	Percent	Amount	Percent
1. Economic development													
1.1 Increase irrigated agricultural production	Irrigable area, production tonnage and value	Incremental area	'000 ha	549	330%	1,405	104%	405	148%	143	9%	2,501	72%
		Crop production	Mtonne / yr	6.806	781%	15.418	285%	8.861	465%	12.287	62%	43.372	155%
		Net economic value	NPV US$M	792	-4155%	1,354	-13209%	1,645	-1552%	395	-4498%	4,185	-2905%
1.2 Increase hydropower production	Hydropower capacity, power generated and value	Installed capacity	MW	13,819	395%	2,951	396%	5,506	550600%	299	13%	22,575	346%
		Power generated	GWh/yr	75,753	462%	48,686	400%	24,577	1053%	22,367	165%	171,383	385%
		Net economic value from generation	NPV US$M	10,048	131%	381	65%	2,128	285%	875	23%	13,433	105%
		Net economic value from purchased	NPV US$M	8,966	572%	2,049	193%	1,733	379%	192	22%	12,940	327%
1.3 Improve navigation	River transport	Navigable days by class	'000 boat-days	n/a		n/a		n/a		n/a		n/a	
		Net economic value	NPV US$M										
1.4 Decrease damages by floods	Extent and duration of annual flooding by class	Average area flooded annually to max 1.0m depth	'000 ha	-1	-3%	-0	-1%	13	3%	55	5%	66	4%
		Average area flooded annually > 1.0m depth	'000 ha	-9	-3%	-9	-3%	-75	-5%	-72	-11%	-165	-6%
		Net economic value of flood damage	NPV US$M	-38	-21%	-32	-19%	3	6%	13	22%	-54	-12%
1.5 Maintain productivity of fishery sector	Capture fisheries and aquaculture production	Annual average capture fish availability	Mtonne / yr	0.033	11%	-0.016	-2%	-0.189	-26%	-0.103	-28%	-0.276	-12%
		Annual average aquaculture production	Mtonne / yr	0.156	104%	0.206	113%	0.197	118%	2.494	100%	3.053	102%
		Net economic value of capture fish	NPV US$M	303	-1096%	207	-1521%	-315	136%	25	4%	220	80%
2. Environmental protection													
2.1 Maintain water quality and acceptable flow conditions	Water quality	Total pollutant discharge	tonnes / yr	116,168	229%	106,135	97%	54,035	140%	117,220	69%	393,559	107%
		Water quality conditions	Severity										
	Flow characteristics	Average flow in March	m3/s	340	18%	236	10%	639	21%	205	5%	355	13%
		Average wet season peak daily flow	m3/s	-217	-2%	-458	-2%	-3,425	-8%	-670	-3%	-1,192	-5%
		Average flow volume entering Tonle Sap	MCM	n/a		n/a		-2,803	-9%	n/a		-2,803	-9%
	Protection of forests around Tonle Sap	Forest, marshes and grasslands flooded at Tonle Sap	'000 ha					-9	-1%			-9	-1%
		Net economic value	NPV US$M	-174	134%			-406	6449%	3	-19%	-577	376%
2.2 Maintain wetland productivity and	Productivity of wetland ecosystems	Are of wetlands (forest, marshes, wetland)	'000 ha	-1	-6%	-1	-3%	-18	-1%	-1	-1%	-20	-1%
		Net economic value	NPV US$M	9	-35%	15	-32%	-48	32%	-8	1237%	-32	14%
2.3 Manage salinity intrusion in the Mekong	Impact of salinity intrusion on land use	Area within delta within threshold level of salinity	'000 ha							-27	-2%	-27	-2%
		Net economic value	NPV US$M							2	10%	2	10%
2.4 Minimize channel effects on bank erosion and deep pools	River bank erosion	Area at risk to erosion	Severity	Severely negative		Severely negative		Severely negative		Severely negative		Severely negative	
		Net economic value	NPV US$M										
	Flow and sediment transport changes	Functioning deep pools	No.	-8	-40%	-10	-59%	-2	-40%			-20	-43%
		Induced geomorphological changes	Severity	Negative		Negative		Extremely negative		Severely negative		Severely negative	
2.5 Conservation of biodiversity	Impacts of flow management changes on endangered species	Status of river channel habitats	Severity	Negative		Negative		Extremely negative		Severely negative		Severely negative	
		Flagship species	Survival	n/a		n/a		n/a		n/a		n/a	
		Unaffected environmental hot spots	Severity	Catastrophic		Severely negative		Severely negative		Negative		Severely negative	
		Biodiversity condition	Severity	Negative		Negative		Negative		Negative		Negative	
		Incremental net economic value of habitat areas	NPV US$M	-100		-60	300%	-130	200%	-60		-350	412%
3. Social development													
3.1 Maintain livelihoods of vulnerable resource-users	Health, food and income security	No. of people affected	'000	732	246%	470	1022%	1,122	1100%	1,295	293%	3,619	408%
		Severity of impact on health, food and income security	Severity	Mildly negative		Negative		Severely negative		Mildly negative		Negative	
3.4 Increased employment generation in water related sectors	Incremental sustainable employment from water resource interventions	Incremental number of people engaged in:											
		Irrigated agriculture	'000	208	264%	223	98%	209	270%	19	53%	658	157%
		Reservoir fisheries (incremental to BS)	'000	40	320%			70	12065%	1	46%	111	729%
		Hydropower production	'000	308	592%	-5	-100%	134	873%	-13	-42%	424	409%
		Aquaculture (incremental to BS)	'000	54	190%	76	194%	65	331%	82	50%	277	110%
4 Equitable development													
4.1 Ensure that all four LMB countries benefit from the development of water and related resources	Aggregate benefits by country	Total net economic value	NPV US$M	19,806	215%	3,914	198%	4,609	665%	1,438	27%	29,768	173%
		No. of people affected vulnerable to changes	'000	732	246%	470	1022%	1,122	1100%	1,295	293%	3,619	408%
		No. of jobs generated	'000	609	356%	293	108%	478	423%	89	38%	1,469	187%
		Overall environment impact	Severity	Negative		Negative		Negative		Negative		Negative	

Summary of scenario assessment

Estimated total values

LMB Long-term Development Scenario
Climate change

Scenario run no. 8001

Specific development objective	Issue	Assessment criteria	Unit	Lao PDR Amount	Lao PDR Percent	Thailand Amount	Thailand Percent	Cambodia Amount	Cambodia Percent	Viet Nam Amount	Viet Nam Percent	Total Amount	Total Percent
1. Economic development													
1.1 Increase irrigated agricultural production	Irrigable area, production tonnage and value	Incremental area	'000 ha	715		2,760		678		1,813		5,966	
		Crop production	Mtonne / yr	7.678		20.824		10.766		32.121		71.389	
		Net economic value	NPV US$M	833		1,383		1,799		437		4,453	
1.2 Increase hydropower production	Hydropower capacity, power generated and value	Installed capacity	MW	17,321		3,696		5,507		2,583		29,107	
		Power generated	GWh/yr	92,156		60,865		26,912		35,961		215,893	
		Net economic value from generation	NPV US$M	17,734		972		2,876		4,696		26,278	
		Net economic value from purchased	NPV US$M	10,533		3,109		2,190		1,066		16,898	
1.3 Improve navigation	River transport	Navigable days by class	'000 boat-days	n/a		n/a		n/a		n/a		n/a	
		Net economic value	NPV US$M			246						246	
1.4 Decrease damages by floods	Extent and duration of annual flooding by class	Average area flooded annually to max 1.0m depth	'000 ha	52		55		433		713		1,253	
		Average area flooded annually > 1.0m depth	'000 ha	408		369		1,867		1,143		3,786	
		Net economic value of flood damage	NPV US$M	141		140		-244		-332		-296	
1.5 Maintain productivity of fishery sector	Capture fisheries and aquaculture production	Annual average capture fish availability	Mtonne / yr										
		Annual average aquaculture production	Mtonne / yr	0.306		0.388		0.365		4.989		6.047	
		Net economic value of capture fish	NPV US$M	275		193		-547		572		494	
2. Environmental protection													
2.1 Maintain water quality and acceptable flow conditions	Water quality	Total pollutant discharge	tonnes / yr	100,143		195,432		64,719		208,047		568,341	
		Water quality conditions	Severity										
	Flow characteristics	Average flow in March	m3/s	2,250		2,664		3,716		4,107		3,184	
		Average wet season peak daily flow	m3/s	13,738		26,083		48,886		21,154		27,465	
		Average flow volume entering Tonle Sap	MCM	n/a		n/a		29,781		n/a		29,781	
	Protection of forests around Tonle Sap	Forest, marshes and grasslands flooded at Tonle Sap	'000 ha					1,032				1,032	
		Net economic value	NPV US$M	-304				-413		-14		-731	
2.2 Maintain wetland productivity and	Productivity of wetland ecosystems	Are of wetlands (forest, marshes, wetland)	'000 ha	23		67		1,300		100		1,491	
		Net economic value	NPV US$M	21		14		5		-4		36	
2.3 Manage salinity intrusion in the Mekong	Impact of salinity intrusion on land use	Area within delta within threshold level of salinity	'000 ha							2,149		2,149	
		Net economic value	NPV US$M							-2		-2	
2.4 Minimize channel effects on bank erosion and deep pools	River bank erosion	Area at risk to erosion	Severity	Negative		Negative		Severely negative		Severely negative		Neutral	
		Net economic value	NPV US$M										
	Flow and sediment transport changes	Functioning deep pools	No.	12		7		3		5		27	
		Induced geomorphological changes	Severity	Severely negative		Severely negative		Extremely negative		Severely negative		Extremely negative	
2.5 Conservation of biodiversity	Impacts of flow management changes on endangered species	Status of river channel habitats	Severity	Severely negative		Severely negative		Extremely negative		Extremely negative		Extremely negative	
		Flagship species	Survival	Extinct		Extinct		Extinct		Surviving		Extinct	
		Unaffected environmental hot spots	Severity	Catastrophic		Extremely negative		Extremely negative		Catastrophic		Catastrophic	
		Biodiversity condition	Severity	Severely negative		Severely negative		Negative		Negative		Severely negative	
		Incremental net economic value of habitat areas	NPV US$M	-100		-80		-195		-150		-525	
3. Social development													
3.1 Maintain livelihoods of vulnerable resource-users	Health, food and income security	No. of people affected	'000	1,029		516		1,280		1,985		4,810	
		Severity of impact on health, food and income security	Severity	Severely negative		Severely negative		Extremely negative		Extremely negative		Extremely negative	
3.4 Increased employment generation in water related sectors	Incremental sustainable employment from water resource interventions	Incremental number of people engaged in:											
		Irrigated agriculture	'000	286		449		286		53		1,076	
		Reservoir fisheries (incremental to BS)	'000	52				71		3		126	
		Hydropower production	'000	360				149		18		527	
		Aquaculture (incremental to BS)	'000	82		115		85		246		528	
4 Equitable development													
4.1 Ensure that all four LMB countries benefit from the development of water and related resources	Aggregate benefits by country	Total net economic value	NPV US$M	29,134		5,978		5,470		6,270		46,852	
		No. of people affected vulnerable to changes	'000	1,029		516		1,280		1,985		4,810	
		No. of jobs generated	'000	781		564		591		321		2,257	
		Overall environment impact	Severity	Severely negative		Severely negative		Negative		Severely negative		Severely negative	

Summary of scenario assessment

Incremental values relative to Baseline

LMB Long-term Development Scenario
Climate change

Scenario run no. 8001

Specific development objective	Issue	Assessment criteria	Unit	Lao PDR		Thailand		Cambodia		Viet Nam		Total	
				Amount	Percent	Amount	Percent	Amount	Percent	Amount	Percent	Amount	Percent
1. Economic development													
1.1 Increase irrigated agricultural production	Irrigable area, production tonnage and value	Incremental area	'000 ha	511	250%	1,494	118%	405	148%	-183	-9%	2,226	60%
		Crop production	Mtonne / yr	6.806	781%	15.418	285%	8.861	465%	12.287	62%	43.372	155%
		Net economic value	NPV US$M	833		1,383		1,799		437		4,453	
1.2 Increase hydropower production	Hydropower capacity, power generated and value	Installed capacity	MW	16,700	2688%	3,451	1410%	5,507		1,863	259%	27,521	1735%
		Power generated	GWh/yr	89,124	2940%	58,462	2433%	26,912		32,302	883%	206,800	2274%
		Net economic value from generation	NPV US$M	15,441	673%	481	98%	2,876		2,985	174%	21,783	485%
		Net economic value from purchased	NPV US$M	10,193	2994%	2,900	1386%	2,190		799	299%	16,082	1969%
1.3 Improve navigation	River transport	Navigable days by class	'000 boat-days	n/a		n/a		n/a		n/a		n/a	
		Net economic value	NPV US$M			64	35%					64	35%
1.4 Decrease damages by floods	Extent and duration of annual flooding by class	Average area flooded annually to max 1.0m depth	'000 ha	4	7%	8	17%	17	4%	-290	-29%	-261	-17%
		Average area flooded annually > 1.0m depth	'000 ha	52	15%	47	15%	100	6%	343	43%	542	17%
		Net economic value of flood damage	NPV US$M	141		140		-244		-332		-296	
1.5 Maintain productivity of fishery sector	Capture fisheries and aquaculture production	Annual average capture fish availability	Mtonne / yr	-0.311	-100%	-1.027	-100%	-0.792	-100%	-0.400	-100%	-2.530	-100%
		Annual average aquaculture production	Mtonne / yr	0.228	292%	0.288	287%	0.237	187%	3.325	200%	4.078	207%
		Net economic value of capture fish	NPV US$M	275		193		-547		572		494	
2. Environmental protection													
2.1 Maintain water quality and acceptable flow conditions	Water quality	Total pollutant discharge	tonnes / yr	49,486	98%	86,552	79%	26,125	68%	37,646	22%	199,809	54%
		Water quality conditions	Severity										
	Flow characteristics	Average flow in March	m3/s	1,150	105%	1,212	83%	1,518	69%	1,035	34%	1,229	63%
		Average wet season peak daily flow	m3/s	-2,183	-14%	582	2%	2,123	5%	-156	-1%	91	0%
		Average flow volume entering Tonle Sap	MCM	n/a		n/a		-2,477	-8%	n/a		-2,477	-8%
	Protection of forests around Tonle Sap	Forest, marshes and grasslands flooded at Tonle Sap	'000 ha					-6	-1%			-6	-1%
		Net economic value	NPV US$M	-304				-413		-14		-731	
2.2 Maintain wetland productivity and	Productivity of wetland ecosystems	Are of wetlands (forest, marshes, wetland)	'000 ha	6	37%	6	9%	12	1%	-0	0%	24	2%
		Net economic value	NPV US$M	21		14		5		-4		36	
2.3 Manage salinity intrusion in the Mekong	Impact of salinity intrusion on land use	Area within delta within threshold level of salinity	'000 ha							297	16%	297	16%
		Net economic value	NPV US$M							-2		-2	
2.4 Minimize channel effects on bank erosion and deep pools	River bank erosion	Area at risk to erosion	Severity	Negative		Negative		Severely negative		Severely negative		Severely negative	
		Net economic value	NPV US$M										
	Flow and sediment transport changes	Functioning deep pools	No.	-8	-40%	-10	-59%	-2	-40%			-20	-43%
		Induced geomorphological changes	Severity	Severely negative		Severely negative		Extremely negative		Severely negative		Extremely negative	
2.5 Conservation of biodiversity	Impacts of flow management changes on endangered species	Status of river channel habitats	Severity	Severely negative		Severely negative		Extremely negative		Extremely negative		Extremely negative	
		Flagship species	Survival	n/a		n/a		n/a		n/a		n/a	
		Unaffected environmental hot spots	Severity	Catastrophic		Extremely negative		Extremely negative		Catastrophic		Catastrophic	
		Biodiversity condition	Severity	Severely negative		Severely negative		Negative		Negative		Severely negative	
		Incremental net economic value of habitat areas	NPV US$M	-100		-80		-195		-150		-525	
3. Social development													
3.1 Maintain livelihoods of vulnerable resource-users	Health, food and income security	No. of people affected	'000	1,029		516		1,280		1,985		4,810	
		Severity of impact on health, food and income security	Severity	Severely negative		Severely negative		Extremely negative		Extremely negative		Extremely negative	
3.4 Increased employment generation in water related sectors	Incremental sustainable employment from water resource interventions	Incremental number of people engaged in:											
		Irrigated agriculture	'000	208	264%	223	98%	209	270%	19	53%	658	157%
		Reservoir fisheries (incremental to BS)	'000	52				71		3		126	
		Hydropower production	'000	360				149		18		527	
		Aquaculture (incremental to BS)	'000	82		115		85		246		528	
4 Equitable development													
4.1 Ensure that all four LMB countries benefit from the development of water and related resources	Aggregate benefits by country	Total net economic value	NPV US$M	26,501	1006%	5,096	578%	5,470		4,292	217%	41,358	753%
		No. of people affected vulnerable to changes	'000	1,029		516		1,280		1,985		4,810	
		No. of jobs generated	'000	702	892%	338	149%	514	663%	286	819%	1,839	440%
		Overall environment impact	Severity	Severely negative		Severely negative		Negative		Severely negative		Severely negative	

Summary of scenario assessment

Incremental values relative to Definite Future Scenario

LMB Long-term Development Scenario
Climate change

Scenario run no. 8001

Specific development objective	Issue	Assessment criteria	Unit	Lao PDR		Thailand		Cambodia		Viet Nam		Total	
				Amount	Percent	Amount	Percent	Amount	Percent	Amount	Percent	Amount	Percent
1. Economic development													
1.1 Increase irrigated agricultural production	Irrigable area, production tonnage and value	Incremental area	'000 ha	549	330%	1,405	104%	405	148%	143	9%	2,501	72%
		Crop production	Mtonne / yr	6.806	781%	15.418	285%	8.861	465%	12.287	62%	43.372	155%
		Net economic value	NPV US$M	852	-4475%	1,394	-13599%	1,905	-1797%	446	-5087%	4,597	-3191%
1.2 Increase hydropower production	Hydropower capacity, power generated and value	Installed capacity	MW	13,819	395%	2,951	396%	5,506	550600%	299	13%	22,575	346%
		Power generated	GWh/yr	75,753	462%	48,686	400%	24,577	1053%	22,367	165%	171,383	385%
		Net economic value from generation	NPV US$M	10,048	131%	381	65%	2,128	285%	875	23%	13,433	105%
		Net economic value from purchased	NPV US$M	8,966	572%	2,049	193%	1,733	379%	192	22%	12,940	327%
1.3 Improve navigation	River transport	Navigable days by class	'000 boat-days	n/a		n/a		n/a		n/a		n/a	
		Net economic value	NPV US$M										
1.4 Decrease damages by floods	Extent and duration of annual flooding by class	Average area flooded annually to max 1.0m depth	'000 ha	10	23%	10	23%	9	2%	-408	-36%	-379	-23%
		Average area flooded annually > 1.0m depth	'000 ha	109	37%	113	44%	214	13%	472	71%	909	32%
		Net economic value of flood damage	NPV US$M	-38	-21%	-32	-19%	-295	-579%	-392	-654%	-758	-164%
1.5 Maintain productivity of fishery sector	Capture fisheries and aquaculture production	Annual average capture fish availability	Mtonne / yr	-0.285	-100%	-0.996	-100%	-0.739	-100%	-0.367	-100%	-2.387	-100%
		Annual average aquaculture production	Mtonne / yr	0.156	104%	0.206	113%	0.197	118%	2.494	100%	3.053	102%
		Net economic value of capture fish	NPV US$M	303	-1096%	207	-1521%	-315	136%	25	4%	220	80%
2. Environmental protection													
2.1 Maintain water quality and acceptable flow conditions	Water quality	Total pollutant discharge	tonnes / yr	49,486	98%	86,552	79%	26,125	68%	37,646	22%	199,809	54%
		Water quality conditions	Severity										
	Flow characteristics	Average flow in March	m3/s	390	21%	292	12%	647	21%	209	5%	384	14%
		Average wet season peak daily flow	m3/s	-75	-1%	2,050	9%	3,763	8%	324	2%	1,516	6%
		Average flow volume entering Tonle Sap	MCM	n/a		n/a		41	0%	n/a		41	0%
	Protection of forests around Tonle Sap	Forest, marshes and grasslands flooded at Tonle Sap	'000 ha					3	0%			3	0%
		Net economic value	NPV US$M	-174	134%			-406	6449%	3	-19%	-577	376%
2.2 Maintain wetland productivity and	Productivity of wetland ecosystems	Are of wetlands (forest, marshes, wetland)	'000 ha	11	91%	15	29%	33	3%	-0	0%	59	4%
		Net economic value	NPV US$M	48	-177%	61	-129%	158	-103%	-3	479%	264	-116%
2.3 Manage salinity intrusion in the Mekong	Impact of salinity intrusion on land use	Area within delta within threshold level of salinity	'000 ha							569	36%	569	36%
		Net economic value	NPV US$M							-22	-110%	-22	-110%
2.4 Minimize channel effects on bank erosion and deep pools	River bank erosion	Area at risk to erosion	Severity	Severely negative		Severely negative		Severely negative		Severely negative		Severely negative	
		Net economic value	NPV US$M										
	Flow and sediment transport changes	Functioning deep pools	No.	-8	-40%	-10	-59%	-2	-40%			-20	-43%
		Induced geomorphological changes	Severity	Negative		Negative		Extremely negative		Severely negative		Severely negative	
2.5 Conservation of biodiversity	Impacts of flow management changes on endangered species	Status of river channel habitats	Severity	Negative		Negative		Extremely negative		Extremely negative		Severely negative	
		Flagship species	Survival	n/a		n/a		n/a		n/a		n/a	
		Unaffected environmental hot spots	Severity	Catastrophic		Severely negative		Severely negative		Catastrophic		Extremely negative	
		Biodiversity condition	Severity	Negative		Negative		Mildly negative		Mildly negative		Negative	
		Incremental net economic value of habitat areas	NPV US$M	-100		-60	300%	-130	200%	-150		-440	518%
3. Social development													
3.1 Maintain livelihoods of vulnerable resource-users	Health, food and income security	No. of people affected	'000	732	246%	470	1022%	1,178	1155%	1,543	349%	3,923	442%
		Severity of impact on health, food and income security	Severity	Mildly negative		Negative		Severely negative		Severely negative		Severely negative	
3.4 Increased employment generation in water related sectors	Incremental sustainable employment from water resource interventions	Incremental number of people engaged in:											
		Irrigated agriculture	'000	208	264%	223	98%	209	270%	19	53%	658	157%
		Reservoir fisheries (incremental to BS)	'000	40	320%			70	12065%	1	46%	111	729%
		Hydropower production	'000	308	592%	-5	-100%	134	873%	-13	-42%	424	409%
		Aquaculture (incremental to BS)	'000	54	190%	76	194%	65	331%	82	50%	277	110%
4 Equitable development													
4.1 Ensure that all four LMB countries benefit from the development of water and related resources	Aggregate benefits by country	Total net economic value	NPV US$M	19,906	216%	4,000	202%	4,777	689%	975	18%	29,658	172%
		No. of people affected vulnerable to changes	'000	732	246%	470	1022%	1,178	1155%	1,543	349%	3,923	442%
		No. of jobs generated	'000	609	356%	293	108%	478	423%	89	38%	1,469	187%
		Overall environment impact	Severity	Negative		Negative		Mildly negative		Negative		Negative	

Summary of scenario assessment

Estimated total values

LMB Very High Development Scenario

Scenario run no. 9000

Specific development objective	Issue	Assessment criteria	Unit	Lao PDR Amount	Lao PDR Percent	Thailand Amount	Thailand Percent	Cambodia Amount	Cambodia Percent	Viet Nam Amount	Viet Nam Percent	Total Amount	Total Percent
1. Economic development													
1.1 Increase irrigated agricultural production	Irrigable area, production tonnage and value	Incremental area	'000 ha	1,896		2,994		1,667		1,848		8,406	
		Crop production	Mtonne / yr	23.694		26.521		34.830		36.279		121.324	
		Net economic value	NPV US$M	3,180		2,582		9,293		800		15,855	
1.2 Increase hydropower production	Hydropower capacity, power generated and value	Installed capacity	MW	17,816		3,696		5,590		2,583		29,684	
		Power generated	GWh/yr	94,487		60,865		27,411		36,065		218,828	
		Net economic value from generation	NPV US$M	18,443		972		3,091		4,701		27,207	
		Net economic value from purchased	NPV US$M	10,562		3,109		2,155		1,067		16,893	
1.3 Improve navigation	River transport	Navigable days by class	'000 boat-days	n/a		n/a		n/a		n/a		n/a	
		Net economic value	NPV US$M			246						246	
1.4 Decrease damages by floods	Extent and duration of annual flooding by class	Average area flooded annually to max 1.0m depth	'000 ha	40		44		441		1,188		1,713	
		Average area flooded annually > 1.0m depth	'000 ha	287		244		1,540		583		2,654	
		Net economic value of flood damage	NPV US$M	149		149		57		77		432	
1.5 Maintain productivity of fishery sector	Capture fisheries and aquaculture production	Annual average capture fish availability	Mtonne / yr	0.332		0.979		0.559		0.264		2.133	
		Annual average aquaculture production	Mtonne / yr	0.408		0.518		0.486		6.652		8.063	
		Net economic value of capture fish	NPV US$M	406		309		-433		913		1,194	
2. Environmental protection													
2.1 Maintain water quality and acceptable flow conditions	Water quality	Total pollutant discharge	tonnes / yr	239,049		244,031		122,632		333,101		938,813	
		Water quality conditions	Severity										
	Flow characteristics	Average flow in March	m3/s	2,093		2,277		2,942		3,386		2,675	
		Average wet season peak daily flow	m3/s	13,410		23,341		41,241		20,039		24,508	
		Average flow volume entering Tonle Sap	MCM	n/a		n/a		27,008		n/a		27,008	
	Protection of forests around Tonle Sap	Forest, marshes and grasslands flooded at Tonle Sap	'000 ha					1,009				1,009	
		Net economic value	NPV US$M	-354				-454		-14		-822	
2.2 Maintain wetland productivity and	Productivity of wetland ecosystems	Are of wetlands (forest, marshes, wetland)	'000 ha	11		51		1,240		100		1,401	
		Net economic value	NPV US$M	-18		-34		-249		-9		-310	
2.3 Manage salinity intrusion in the Mekong	Impact of salinity intrusion on land use	Area within delta within threshold level of salinity	'000 ha							1,631		1,631	
		Net economic value	NPV US$M							16		16	
2.4 Minimize channel effects on bank erosion and deep pools	River bank erosion	Area at risk to erosion	Severity	Negative		Negative		Severely negative		Severely negative		Neutral	
		Net economic value	NPV US$M										
	Flow and sediment transport changes	Functioning deep pools	No.	12		7		3		5		27	
		Induced geomorphological changes	Severity	Severely negative		Severely negative		Extremely negative		Severely negative		Extremely negative	
2.5 Conservation of biodiversity	Impacts of flow management changes on endangered species	Status of river channel habitats	Severity	Severely negative		Severely negative		Extremely negative		Severely negative		Extremely negative	
		Flagship species	Survival	Extinct		Extinct		Extinct		Surviving		Extinct	
		Unaffected environmental hot spots	Severity	Catastrophic		Catastrophic		Catastrophic		Catastrophic		Catastrophic	
		Biodiversity condition	Severity	Severely negative		Severely negative		Extremely negative		Severely negative		Extremely negative	
		Incremental net economic value of habitat areas	NPV US$M	-125		-100		-325		-150		-700	
3. Social development													
3.1 Maintain livelihoods of vulnerable resource-users	Health, food and income security	No. of people affected	'000	1,106		516		1,231		1,741		4,594	
		Severity of impact on health, food and income security	Severity	Severely negative		Severely negative		Extremely negative		Negative		Severely negative	
3.4 Increased employment generation in water related sectors	Incremental sustainable employment from water resource interventions	Incremental number of people engaged in:											
		Irrigated agriculture	'000	586		460		828		79		1,953	
		Reservoir fisheries (incremental to BS)	'000	61				78		3		141	
		Hydropower production	'000	384				171		18		573	
		Aquaculture (incremental to BS)	'000	109		153		114		328		704	
4 Equitable development													
4.1 Ensure that all four LMB countries benefit from the development of water and related resources	Aggregate benefits by country	Total net economic value	NPV US$M	32,241		7,233		13,135		7,401		60,011	
		No. of people affected vulnerable to changes	'000	1,106		516		1,231		1,741		4,594	
		No. of jobs generated	'000	1,139		614		1,190		428		3,371	
		Overall environment impact	Severity	Severely negative		Severely negative		Extremely negative		Severely negative		Extremely negative	

Summary of scenario assessment

Incremental values relative to Baseline

LMB Very High Development Scenario

Scenario run no. 9000

Specific development objective	Issue	Assessment criteria	Unit	Lao PDR		Thailand		Cambodia		Viet Nam		Total	
				Amount	Percent	Amount	Percent	Amount	Percent	Amount	Percent	Amount	Percent
1. Economic development													
1.1 Increase irrigated agricultural production	Irrigable area, production tonnage and value	Incremental area	'000 ha	1,692	829%	1,728	137%	1,394	510%	-148	-7%	4,666	125%
		Crop production	Mtonne / yr	22.823	2620%	21.115	391%	32.925	1729%	16.444	83%	93.307	333%
		Net economic value	NPV US$M	3,180		2,582		9,293		800		15,855	
1.2 Increase hydropower production	Hydropower capacity, power generated and value	Installed capacity	MW	17,194	2768%	3,451	1410%	5,590		1,863	259%	28,098	1772%
		Power generated	GWh/yr	91,455	3017%	58,462	2433%	27,411		32,406	886%	209,735	2307%
		Net economic value from generation	NPV US$M	16,149	704%	481	98%	3,091		2,990	175%	22,711	505%
		Net economic value from purchased	NPV US$M	10,221	3002%	2,900	1386%	2,155		800	299%	16,076	1969%
1.3 Improve navigation	River transport	Navigable days by class	'000 boat-days	n/a		n/a		n/a		n/a		n/a	
		Net economic value	NPV US$M			64	35%					64	35%
1.4 Decrease damages by floods	Extent and duration of annual flooding by class	Average area flooded annually to max 1.0m depth	'000 ha	-8	-17%	-3	-6%	25	6%	185	18%	198	13%
		Average area flooded annually > 1.0m depth	'000 ha	-69	-19%	-78	-24%	-227	-13%	-216	-27%	-590	-18%
		Net economic value of flood damage	NPV US$M	149		149		57		77		432	
1.5 Maintain productivity of fishery sector	Capture fisheries and aquaculture production	Annual average capture fish availability	Mtonne / yr	0.021	7%	-0.048	-5%	-0.234	-30%	-0.136	-34%	-0.397	-16%
		Annual average aquaculture production	Mtonne / yr	0.330	422%	0.417	416%	0.359	282%	4.988	300%	6.094	310%
		Net economic value of capture fish	NPV US$M	406		309		-433		913		1,194	
2. Environmental protection													
2.1 Maintain water quality and acceptable flow conditions	Water quality	Total pollutant discharge	tonnes / yr	188,392	372%	135,151	124%	84,039	218%	162,699	95%	570,281	155%
		Water quality conditions	Severity										
	Flow characteristics	Average flow in March	m3/s	993	90%	825	57%	745	34%	315	10%	719	37%
		Average wet season peak daily flow	m3/s	-2,511	-16%	-2,160	-8%	-5,521	-12%	-1,271	-6%	-2,866	-10%
		Average flow volume entering Tonle Sap	MCM	n/a		n/a		-5,250	-16%	n/a		-5,250	-16%
	Protection of forests around Tonle Sap	Forest, marshes and grasslands flooded at Tonle Sap	'000 ha					-29	-3%			-29	-3%
		Net economic value	NPV US$M	-354				-454		-14		-822	
2.2 Maintain wetland productivity and	Productivity of wetland ecosystems	Are of wetlands (forest, marshes, wetland)	'000 ha	-6	-34%	-11	-18%	-48	-4%	-1	-1%	-66	-4%
		Net economic value	NPV US$M	-18		-34		-249		-9		-310	
2.3 Manage salinity intrusion in the Mekong	Impact of salinity intrusion on land use	Area within delta within threshold level of salinity	'000 ha							-221	-12%	-221	-12%
		Net economic value	NPV US$M							16		16	
2.4 Minimize channel effects on bank erosion and deep pools	River bank erosion	Area at risk to erosion	Severity	Negative		Negative		Severely negative		Severely negative		Severely negative	
		Net economic value	NPV US$M										
	Flow and sediment transport changes	Functioning deep pools	No.	-8	-40%	-10	-59%	-2	-40%			-20	-43%
		Induced geomorphological changes	Severity	Severely negative		Severely negative		Extremely negative		Severely negative		Extremely negative	
2.5 Conservation of biodiversity	Impacts of flow management changes on endangered species	Status of river channel habitats	Severity	Severely negative		Severely negative		Extremely negative		Severely negative		Extremely negative	
		Flagship species	Survival	n/a		n/a		n/a		n/a		n/a	
		Unaffected environmental hot spots	Severity	Catastrophic		Catastrophic		Catastrophic		Catastrophic		Catastrophic	
		Biodiversity condition	Severity	Severely negative		Severely negative		Extremely negative		Severely negative		Extremely negative	
		Incremental net economic value of habitat areas	NPV US$M	-125		-100		-325		-150		-700	
3. Social development													
3.1 Maintain livelihoods of vulnerable resource-users	Health, food and income security	No. of people affected	'000	1,106		516		1,231		1,741		4,594	
		Severity of impact on health, food and income security	Severity	Severely negative		Severely negative		Extremely negative		Negative		Severely negative	
3.4 Increased employment generation in water related sectors	Incremental sustainable employment from water resource interventions	Incremental number of people engaged in:											
		Irrigated agriculture	'000	507	644%	234	103%	750	968%	44	126%	1,535	367%
		Reservoir fisheries (incremental to BS)	'000	61				78		3		141	
		Hydropower production	'000	384				171		18		573	
		Aquaculture (incremental to BS)	'000	109		153		114		328		704	
4 Equitable development													
4.1 Ensure that all four LMB countries benefit from the development of water and related resources	Aggregate benefits by country	Total net economic value	NPV US$M	29,608	1124%	6,351	720%	13,135		5,423	274%	54,517	992%
		No. of people affected vulnerable to changes	'000	1,106		516		1,231		1,741		4,594	
		No. of jobs generated	'000	1,061	1347%	387	171%	1,113	1436%	393	1127%	2,954	707%
		Overall environment impact	Severity	Severely negative		Severely negative		Extremely negative		Severely negative		Extremely negative	

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Appendix D Comparison of scenario outcomes by country

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Summary of scenario assessment

Incremental values relative to Baseline

Lao PDR

Specific development objective	Issue	Assessment criteria	Unit	2000 2015-UMD		3000 2015-DF		4000 2030-20Y		4001 2030-20Y+CC		5000 2030-20Y-w/o MD		6100 2030-20Y-w/o LMD		6200 2030-20Y-w/o TMD		6300 2030-20Y-w/o CMD		8000 2060-LTD		8001 2060-LTD+CC		9000 2060–VHD	
1. Economic development																									
1.1 Increase irrigated agricultural production	Irrigable area, production tonnage and value	Incremental area	'000 ha			-38	-18%	245	120%	245	120%	245	120%	245	120%	245	120%	245	120%	511	250%	511	250%	1,692	829%
		Crop production	Mtonne / yr					3.354	385%	3.354	385%	3.354	385%	3.354	385%	3.354	385%	3.354	385%	6.806	781%	6.806	781%	22.823	2620%
		Net economic value	NPV US$M			-19		300		327		301		300		300		300		772		833		3,180	
1.2 Increase hydropower production	Hydropower capacity, power generated and value	Installed capacity	MW			2,881	464%	14,764	2377%	14,764	2377%	7,298	1175%	13,718	2208%	14,764	2377%	14,764	2377%	16,700	2688%	16,700	2688%	17,194	2768%
		Power generated	GWh/yr			13,371	441%	81,384	2684%	81,384	2684%	34,577	1140%	67,071	2212%	67,632	2231%	81,384	2684%	89,124	2940%	89,124	2940%	91,455	3017%
		Net economic value from generation	NPV US$M			5,393	235%	12,292	536%	12,292	536%	7,490	327%	9,892	431%	10,825	472%	12,292	536%	15,441	673%	15,441	673%	16,149	704%
		Net economic value from purchased	NPV US$M			1,227	360%	10,066	2957%	10,066	2957%	3,868	1136%	7,443	2186%	7,865	2310%	10,067	2957%	10,193	2994%	10,193	2994%	10,221	3002%
1.3 Improve navigation	River transport	Navigable days by class	'000 boat-days	n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a	
		Net economic value	NPV US$M																						
1.4 Decrease damages by floods	Extent and duration of annual flooding by class	Average area flooded annually to max 1.0m depth	'000 ha	n/a	n/a	-6	-13%	-8	-16%	0	0%	-8	-16%	-8	-16%	-8	-16%	-8	-16%	-8	-16%	4	7%	-8	-17%
		Average area flooded annually > 1.0m depth	'000 ha	n/a	n/a	-57	-16%	-67	-19%	-6	-2%	-67	-19%	-67	-19%	-67	-19%	-67	-19%	-67	-19%	52	15%	-69	-19%
		Net economic value of flood damage	NPV US$M			179		130		130		124		124		124		124		141		141		149	
1.5 Maintain productivity of fishery sector	Capture fisheries and aquaculture production	Annual average capture fish availability	Mtonne / yr	-0.009	-3%	-0.026	-8%	-0.012	-4%	-0.311	-100%	-0.009	-3%	-0.004	-1%	-0.015	-5%	-0.004	-1%	0.007	2%	-0.311	-100%	0.021	7%
		Annual average aquaculture production	Mtonne / yr	0.072	92%	0.072	92%	0.126	161%	0.126	161%	0.126	161%	0.126	161%	0.126	161%	0.126	161%	0.228	292%	0.228	292%	0.330	422%
		Net economic value of capture fish	NPV US$M			-28		129		129		139		154		119		154		275		275		406	
2. Environmental protection																									
2.1 Maintain water quality and acceptable flow conditions	Water quality	Total pollutant discharge	tonnes / yr					49,486	98%	49,486	98%	49,486	98%	49,486	98%	49,486	98%	49,486	98%	116,168	229%	49,486	98%	188,392	372%
		Water quality conditions	Severity																						
	Flow characteristics	Average flow in March	m3/s	774	70%	760	69%	1,118	102%	1,165	106%	1,006	91%	1,093	99%	1,095	100%	1,094	99%	1,100	100%	1,150	105%	993	90%
		Average wet season peak daily flow	m3/s	-2,090	-13%	-2,108	-13%	-2,381	-15%	-2,230	-14%	-2,357	-15%	-2,208	-14%	-2,381	-15%	-2,295	-14%	-2,324	-15%	-2,183	-14%	-2,511	-16%
		Average flow volume entering Tonle Sap	MCM	n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a	
	Protection of forests around Tonle Sap	Forest, marshes and grasslands flooded at Tonle Sap	'000 ha																						
		Net economic value	NPV US$M			-130		-236		-236		-165		-210		-212		-236		-304		-304		-354	
2.2 Maintain wetland productivity and	Productivity of wetland ecosystems	Are of wetlands (forest, marshes, wetland)	'000 ha			-5	-29%	-6	-34%	-1	-4%	-6	-34%	-6	-34%	-6	-34%	-6	-34%	-6	-33%	6	37%	-6	-34%
		Net economic value	NPV US$M			-27		-18		-3		-18		-18		-18		-18		-18		21		-18	
2.3 Manage salinity intrusion in the Mekong	Impact of salinity intrusion on land use	Area within delta within threshold level of salinity	'000 ha																						
		Net economic value	NPV US$M																						
2.4 Minimize channel effects on bank erosion and deep pools	River bank erosion	Area at risk to erosion	Severity	Mildly positive		Mildly positive		Mildly negative		Negative		Positive		Positive		Mildly negative		Mildly negative		Negative		Negative		Negative	
		Net economic value	NPV US$M																						
	Flow and sediment transport changes	Functioning deep pools	No.					-8	-40%	-8	-40%			-5	-25%	-8	-40%	-8	-40%	-8	-40%	-8	-40%	-8	-40%
		Induced geomorphological changes	Severity	Neutral		Mildly negative		Negative		Negative		Negative		Mildly negative		Negative		Negative		Severely negative		Severely negative		Severely negative	
2.5 Conservation of biodiversity	Impacts of flow management changes on endangered species	Status of river channel habitats	Severity	Neutral		Mildly negative		Negative		Negative		Negative		Negative		Negative		Negative		Severely negative		Severely negative		Severely negative	
		Flagship species	Survival	n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a	
		Unaffected environmental hot spots	Severity	Neutral		Neutral		Extremely negative		Catastrophic		Severely negative		Negative		Severely negative		Negative		Catastrophic		Catastrophic		Catastrophic	
		Biodiversity condition	Severity	Neutral		Mildly negative		Severely negative		Severely negative		Negative		Severely negative		Severely negative		Severely negative		Severely negative		Severely negative		Severely negative	
		Incremental net economic value of habitat areas	NPV US$M					-75		-100		-50		-50		-75		-50		-100		-100		-125	
3. Social development																									
3.1 Maintain livelihoods of vulnerable resource-users	Health, food and income security	No. of people affected	'000			297		907		907		699		782		907		782		1,029		1,029		1,106	
		Severity of impact on health, food and income security	Severity	Mildly negative		Negative		Severely negative		Severely negative		Severely negative		Severely negative		Severely negative		Severely negative		Severely negative		Severely negative		Severely negative	
3.4 Increased employment generation in water related sectors	Incremental sustainable employment from water resource interventions	Incremental number of people engaged in:																							
		Irrigated agriculture	'000					72	91%	72	91%	72	91%	72	91%	72	91%	72	91%	208	264%	208	264%	507	644%
		Reservoir fisheries (incremental to BS)	'000			12		40		40		28		36		36		40		52		52		61	
		Hydropower production	'000			52		382		382		168		318		336		379		360		360		384	
		Aquaculture (incremental to BS)	'000			28		55		55		55		55		55		55		82		82		109	
4 Equitable development																									
4.1 Ensure that all four LMB countries benefit from the development of water and related resources	Aggregate benefits by country	Total net economic value	NPV US$M			6,595	250%	22,588	858%	22,605	858%	11,688	444%	17,636	670%	18,927	719%	22,632	859%	26,401	1002%	26,501	1006%	29,608	1124%
		No. of people affected vulnerable to changes	'000			297		907		907		699		782		907		782		1,029		1,029		1,106	
		No. of jobs generated	'000			93	118%	549	698%	549	698%	323	410%	480	610%	498	633%	545	693%	702	892%	702	892%	1,061	1347%
		Overall environment impact	Severity			Mildly negative		Severely negative		Severely negative		Negative		Severely negative		Severely negative		Severely negative		Severely negative		Severely negative		Severely negative	

Summary of scenario assessment

Incremental values relative to Definite Future Scenario

Lao PDR

Specific development objective	Issue	Assessment criteria	Unit	2000 2015-UMD	3000 2015-DF	4000 2030-20Y		4001 2030-20Y+CC		5000 2030-20Y-w/o MD		6100 2030-20Y-w/o LMD		6200 2030-20Y-w/o TMD		6300 2030-20Y-w/o CMD		8000 2060-LTD		8001 2060-LTD+CC		9000 2060–VHD	
1. Economic development																							
1.1 Increase irrigated agricultural production	Irrigable area, production tonnage and value	Incremental area	'000 ha			283	170%	283	170%	283	170%	283	170%	283	170%	283	170%	549	330%	549	330%	1,729	1039%
		Crop production	Mtonne / yr			3	385%	3	385%	3	385%	3	385%	3	385%	3	385%	7	781%	7	781%	23	2620%
		Net economic value	NPV US$M			320	-1678%	346	-1816%	320	-1680%	320	-1678%	320	-1678%	320	-1678%	792	-4155%	852	-4475%	3,199	-16793%
1.2 Increase hydropower production	Hydropower capacity, power generated and value	Installed capacity	MW			11,882	339%	11,882	339%	4,416	126%	10,836	309%	11,882	339%	11,882	339%	13,819	395%	13,819	395%	14,313	409%
		Power generated	GWh/yr			68,013	415%	68,013	415%	21,206	129%	53,700	327%	54,261	331%	68,013	415%	75,753	462%	75,753	462%	78,084	476%
		Net economic value from generation	NPV US$M			6,899	90%	6,899	90%	2,097	27%	4,500	59%	5,432	71%	6,899	90%	10,048	131%	10,048	131%	10,757	140%
		Net economic value from purchased	NPV US$M			8,840	564%	8,840	564%	2,641	169%	6,217	397%	6,638	424%	8,840	564%	8,966	572%	8,966	572%	8,994	574%
1.3 Improve navigation	River transport	Navigable days by class	'000 boat-days			n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a	
		Net economic value	NPV US$M																				
1.4 Decrease damages by floods	Extent and duration of annual flooding by class	Average area flooded annually to max 1.0m depth	'000 ha			-2	-4%	6	15%	-1	-3%	-2	-4%	-2	-4%	-2	-4%	-1	-3%	10	23%	-2	-5%
		Average area flooded annually > 1.0m depth	'000 ha			-10	-3%	52	17%	-9	-3%	-9	-3%	-9	-3%	-9	-3%	-9	-3%	109	37%	-12	-4%
		Net economic value of flood damage	NPV US$M			-49	-27%	-49	-27%	-55	-31%	-55	-31%	-55	-31%	-55	-31%	-38	-21%	-38	-21%	-30	-17%
1.5 Maintain productivity of fishery sector	Capture fisheries and aquaculture production	Annual average capture fish availability	Mtonne / yr			0	5%	-0	-100%	0	6%	0	8%	0	4%	0	8%	0	11%	-0	-100%	0	16%
		Annual average aquaculture production	Mtonne / yr			0	36%	0	36%	0	36%	0	36%	0	36%	0	36%	0	104%	0	104%	0	172%
		Net economic value of capture fish	NPV US$M			156	-565%	156	-565%	166	-602%	182	-658%	146	-530%	181	-656%	303	-1096%	303	-1096%	433	-1567%
2. Environmental protection																							
2.1 Maintain water quality and acceptable flow conditions	Water quality	Total pollutant discharge	tonnes / yr			49,486	98%	49,486	98%	49,486	98%	49,486	98%	49,486	98%	49,486	98%	116,168	229%	49,486	98%	188,392	372%
		Water quality conditions	Severity																				
	Flow characteristics	Average flow in March	m3/s			358	19%	405	22%	246	13%	333	18%	335	18%	334	18%	340	18%	390	21%	233	13%
		Average wet season peak daily flow	m3/s			-273	-2%	-122	-1%	-249	-2%	-100	-1%	-273	-2%	-187	-1%	-217	-2%	-75	-1%	-403	-3%
		Average flow volume entering Tonle Sap	MCM			n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a	
	Protection of forests around Tonle Sap	Forest, marshes and grasslands flooded at Tonle Sap	'000 ha																				
		Net economic value	NPV US$M			-106	82%	-106	82%	-36	27%	-80	62%	-83	64%	-106	82%	-174	134%	-174	134%	-224	173%
2.2 Maintain wetland productivity and	Productivity of wetland ecosystems	Are of wetlands (forest, marshes, wetland)	'000 ha			-1	-8%	4	35%	-1	-8%	-1	-8%	-1	-8%	-1	-8%	-1	-6%	11	91%	-1	-8%
		Net economic value	NPV US$M			8	-31%	24	-88%	9	-34%	8	-31%	8	-31%	8	-31%	9	-35%	48	-177%	9	-32%
2.3 Manage salinity intrusion in the Mekong	Impact of salinity intrusion on land use	Area within delta within threshold level of salinity	'000 ha																				
		Net economic value	NPV US$M																				
2.4 Minimize channel effects on bank erosion and deep pools	River bank erosion	Area at risk to erosion	Severity			Negative		Severely negative		Mildly positive		Mildly positive		Negative		Negative		Severely negative		Severely negative		Severely negative	
		Net economic value	NPV US$M																				
	Flow and sediment transport changes	Functioning deep pools	No.			-8	-40%	-8	-40%			-5	-25%	-8	-40%	-8	-40%	-8	-40%	-8	-40%	-8	-40%
		Induced geomorphological changes	Severity			Mildly negative		Mildly negative		Mildly negative		Neutral		Mildly negative		Mildly negative		Negative		Negative		Negative	
2.5 Conservation of biodiversity	Impacts of flow management changes on endangered species	Status of river channel habitats	Severity			Mildly negative		Mildly negative		Mildly negative		Mildly negative		Mildly negative		Mildly negative		Negative		Negative		Negative	
		Flagship species	Survival			n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a	
		Unaffected environmental hot spots	Severity			Extremely negative		Catastrophic		Severely negative		Negative		Severely negative		Negative		Catastrophic		Catastrophic		Catastrophic	
		Biodiversity condition	Severity			Negative		Negative		Mildly negative		Negative		Negative		Negative		Negative		Negative		Negative	
		Incremental net economic value of habitat areas	NPV US$M			-75		-100		-50		-50		-75		-50		-100		-100		-125	
3. Social development																							
3.1 Maintain livelihoods of vulnerable resource-users	Health, food and income security	No. of people affected	'000			610	205%	610	205%	402	135%	485	163%	610	205%	485	163%	732	246%	732	246%	809	272%
		Severity of impact on health, food and income security	Severity			Mildly negative		Mildly negative		Mildly negative		Mildly negative		Mildly negative		Mildly negative		Mildly negative		Mildly negative		Mildly negative	
3.4 Increased employment generation in water related sectors	Incremental sustainable employment from water resource interventions	Incremental number of people engaged in:																					
		Irrigated agriculture	'000			72	91%	72	91%	72	91%	72	91%	72	91%	72	91%	208	264%	208	264%	507	644%
		Reservoir fisheries (incremental to BS)	'000			28	226%	28	226%	16	129%	23	190%	24	193%	28	226%	40	320%	40	320%	48	390%
		Hydropower production	'000			330	635%	330	635%	116	223%	266	512%	284	545%	327	628%	308	592%	308	592%	332	638%
		Aquaculture (incremental to BS)	'000			26	94%	26	94%	26	94%	26	94%	26	94%	26	94%	54	190%	54	190%	81	287%
4 Equitable development																							
4.1 Ensure that all four LMB countries benefit from the development of water and related resources	Aggregate benefits by country	Total net economic value	NPV US$M			15,993	173%	16,010	173%	5,093	55%	11,041	120%	12,332	134%	16,037	174%	19,806	215%	19,906	216%	23,013	249%
		No. of people affected vulnerable to changes	'000			610	205%	610	205%	402	135%	485	163%	610	205%	485	163%	732	246%	732	246%	809	272%
		No. of jobs generated	'000			456	266%	456	266%	230	134%	388	226%	406	237%	453	264%	609	356%	609	356%	968	565%
		Overall environment impact	Severity			Negative		Negative		Mildly negative		Negative		Negative		Negative		Negative		Negative		Negative	

Summary of scenario assessment

Incremental values relative to Baseline

Thailand

Specific development objective	Issue	Assessment criteria	Unit	2000 2015-UMD		3000 2015-DF		4000 2030-20Y		4001 2030-20Y+CC		5000 2030-20Y-w/o MD		6100 2030-20Y-w/o LMD		6200 2030-20Y-w/o TMD		6300 2030-20Y-w/o CMD		8000 2060-LTD		8001 2060-LTD+CC		9000 2060–VHD	
1. Economic development																									
1.1 Increase irrigated agricultural production	Irrigable area, production tonnage and value	Incremental area	'000 ha			89	7%	1,370	108%	1,370	108%	1,370	108%	1,370	108%	1,370	108%	1,370	108%	1,494	118%	1,494	118%	1,728	137%
		Crop production	Mtonne / yr					11.964	221%	11.964	221%	11.964	221%	11.964	221%	11.964	221%	11.964	221%	15.418	285%	15.418	285%	21.115	391%
		Net economic value	NPV US$M			-10		864		878		864		864		864		864		1,344		1,383		2,582	
1.2 Increase hydropower production	Hydropower capacity, power generated and value	Installed capacity	MW			500	204%	3,451	1410%	3,451	1410%	500	204%	1,579	645%	500	204%	3,451	1410%	3,451	1410%	3,451	1410%	3,451	1410%
		Power generated	GWh/yr			9,776	407%	58,291	2426%	58,291	2426%	23,804	991%	48,155	2004%	49,288	2051%	54,343	2262%	58,462	2433%	58,462	2433%	58,462	2433%
		Net economic value from generation	NPV US$M			100	20%	473	96%	473	96%	100	20%	100	20%	100	20%	473	96%	481	98%	481	98%	481	98%
		Net economic value from purchased	NPV US$M			851	407%	2,899	1386%	2,899	1386%	1,551	742%	2,767	1323%	2,823	1350%	2,702	1292%	2,900	1386%	2,900	1386%	2,900	1386%
1.3 Improve navigation	River transport	Navigable days by class	'000 boat-days	n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a	
		Net economic value	NPV US$M	-0	0%	64	35%	64	35%	64	35%	64	35%	64	35%	64	35%	64	35%	64	35%	64	35%	64	35%
1.4 Decrease damages by floods	Extent and duration of annual flooding by class	Average area flooded annually to max 1.0m depth	'000 ha	n/a	n/a	-2	-5%	-3	-6%	-2	-3%	-3	-6%	-3	-6%	-3	-6%	-3	-6%	-3	-6%	8	17%	-3	-6%
		Average area flooded annually > 1.0m depth	'000 ha	n/a	n/a	-66	-21%	-78	-24%	-25	-8%	-78	-24%	-78	-24%	-78	-24%	-78	-24%	-75	-23%	47	15%	-78	-24%
		Net economic value of flood damage	NPV US$M			172		130		130		124		124		124		124		140		140		149	
1.5 Maintain productivity of fishery sector	Capture fisheries and aquaculture production	Annual average capture fish availability	Mtonne / yr			-0.031	-3%	-0.048	-5%	-1.027	-100%	-0.035	-3%	-0.044	-4%	-0.044	-4%	-0.044	-4%	-0.048	-5%	-1.027	-100%	-0.048	-5%
		Annual average aquaculture production	Mtonne / yr	0.082	81%	0.082	81%	0.158	158%	0.158	158%	0.158	158%	0.158	158%	0.158	158%	0.158	158%	0.288	287%	0.288	287%	0.417	416%
		Net economic value of capture fish	NPV US$M			-14		74		74		119		89		89		90		193		193		309	
2. Environmental protection																									
2.1 Maintain water quality and acceptable flow conditions	Water quality	Total pollutant discharge	tonnes / yr					86,552	79%	86,552	79%	86,552	79%	86,552	79%	86,552	79%	86,552	79%	106,135	97%	86,552	79%	135,151	124%
		Water quality conditions	Severity																						
	Flow characteristics	Average flow in March	m3/s	778	54%	920	63%	1,246	86%	1,306	90%	1,133	78%	1,221	84%	1,223	84%	1,222	84%	1,155	80%	1,212	83%	825	57%
		Average wet season peak daily flow	m3/s	-1,621	-6%	-1,469	-6%	-2,084	-8%	418	2%	-2,080	-8%	-1,911	-7%	-2,084	-8%	-1,998	-8%	-1,927	-8%	582	2%	-2,160	-8%
		Average flow volume entering Tonle Sap	MCM	n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a	
	Protection of forests around Tonle Sap	Forest, marshes and grasslands flooded at Tonle Sap	'000 ha																						
		Net economic value	NPV US$M																						
2.2 Maintain wetland productivity and	Productivity of wetland ecosystems	Are of wetlands (forest, marshes, wetland)	'000 ha			-9	-15%	-11	-18%	-4	-6%	-11	-18%	-11	-18%	-11	-18%	-11	-18%	-11	-17%	6	9%	-11	-18%
		Net economic value	NPV US$M			-47		-34		-13		-32		-34		-34		-34		-32		14		-34	
2.3 Manage salinity intrusion in the Mekong	Impact of salinity intrusion on land use	Area within delta within threshold level of salinity	'000 ha																						
		Net economic value	NPV US$M																						
2.4 Minimize channel effects on bank erosion and deep pools	River bank erosion	Area at risk to erosion	Severity	Mildly positive		Mildly positive		Mildly negative		Negative		Positive		Positive		Mildly negative		Mildly negative		Negative		Negative		Negative	
		Net economic value	NPV US$M																						
	Flow and sediment transport changes	Functioning deep pools	No.					-10	-59%	-10	-59%			-6	-35%	-4	-24%	-10	-59%	-10	-59%	-10	-59%	-10	-59%
		Induced geomorphological changes	Severity	Neutral		Mildly negative		Negative		Negative		Mildly negative		Mildly negative		Negative		Negative		Severely negative		Severely negative		Severely negative	
2.5 Conservation of biodiversity	Impacts of flow management changes on endangered species	Status of river channel habitats	Severity	Neutral		Mildly negative		Negative		Negative		Mildly negative		Negative		Negative		Negative		Severely negative		Severely negative		Severely negative	
		Flagship species	Survival	n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a	
		Unaffected environmental hot spots	Severity	Neutral		Negative		Severely negative		Extremely negative		Negative		Severely negative		Severely negative		Severely negative		Extremely negative		Extremely negative		Catastrophic	
		Biodiversity condition	Severity	Neutral		Mildly negative		Severely negative		Severely negative		Negative		Negative		Severely negative		Severely negative		Severely negative		Severely negative		Severely negative	
		Incremental net economic value of habitat areas	NPV US$M			-20		-60		-60		-40		-60		-60		-60		-80		-80		-100	
3. Social development																									
3.1 Maintain livelihoods of vulnerable resource-users	Health, food and income security	No. of people affected	'000	46		46		516		516		201		201		515		516		516		516		516	
		Severity of impact on health, food and income security	Severity	Mildly negative		Mildly negative		Severely negative		Severely negative		Mildly negative		Mildly negative		Negative		Mildly negative		Severely negative		Severely negative		Severely negative	
3.4 Increased employment generation in water related sectors	Incremental sustainable employment from water resource interventions	Incremental number of people engaged in:																							
		Irrigated agriculture	'000					119	53%	119	53%	119	53%	119	53%	119	53%	119	53%	223	98%	223	98%	234	103%
		Reservoir fisheries (incremental to BS)	'000																						
		Hydropower production	'000			5		38		38		7		20		6		42							
		Aquaculture (incremental to BS)	'000			39		77		77		77		77		77		77		115		115		153	
4 Equitable development																									
4.1 Ensure that all four LMB countries benefit from the development of water and related resources	Aggregate benefits by country	Total net economic value	NPV US$M	-0	0%	1,095	124%	4,410	500%	4,445	504%	2,750	312%	3,913	444%	3,970	450%	4,223	479%	5,010	568%	5,096	578%	6,351	720%
		No. of people affected vulnerable to changes	'000	46		46		516		516		201		201		515		516		516		516		516	
		No. of jobs generated	'000			44	20%	234	103%	234	103%	203	89%	216	95%	202	89%	238	105%	338	149%	338	149%	387	171%
		Overall environment impact	Severity			Mildly negative		Severely negative		Severely negative		Negative		Negative		Severely negative		Severely negative		Severely negative		Severely negative		Severely negative	

Summary of scenario assessment

Incremental values relative to Definite Future Scenario

Thailand

Specific development objective	Issue	Assessment criteria	Unit	2000 2015-UMD	3000 2015-DF	4000 2030-20Y		4001 2030-20Y+CC		5000 2030-20Y-w/o MD		6100 2030-20Y-w/o LMD		6200 2030-20Y-w/o TMD		6300 2030-20Y-w/o CMD		8000 2060-LTD		8001 2060-LTD+CC		9000 2060–VHD	
1. Economic development																							
1.1 Increase irrigated agricultural production	Irrigable area, production tonnage and value	Incremental area	'000 ha			1,281	95%	1,281	95%	1,281	95%	1,281	95%	1,281	95%	1,281	95%	1,405	104%	1,405	104%	1,639	121%
		Crop production	Mtonne / yr			12	221%	12	221%	12	221%	12	221%	12	221%	12	221%	15	285%	15	285%	21	391%
		Net economic value	NPV US$M			874	-8528%	889	-8672%	874	-8528%	874	-8528%	874	-8528%	874	-8528%	1,354	-13209%	1,394	-13599%	2,592	-25294%
1.2 Increase hydropower production	Hydropower capacity, power generated and value	Installed capacity	MW			2,951	396%	2,951	396%			1,079	145%			2,951	396%	2,951	396%	2,951	396%	2,951	396%
		Power generated	GWh/yr			48,515	398%	48,515	398%	14,028	115%	38,379	315%	39,512	324%	44,567	366%	48,686	400%	48,686	400%	48,686	400%
		Net economic value from generation	NPV US$M			373	63%	373	63%							373	63%	381	65%	381	65%	381	65%
		Net economic value from purchased	NPV US$M			2,048	193%	2,048	193%	700	66%	1,916	181%	1,972	186%	1,851	175%	2,049	193%	2,049	193%	2,049	193%
1.3 Improve navigation	River transport	Navigable days by class	'000 boat-days			n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a	
		Net economic value	NPV US$M																			-0	0%
1.4 Decrease damages by floods	Extent and duration of annual flooding by class	Average area flooded annually to max 1.0m depth	'000 ha			-0	-1%	1	2%	-0	-1%	-0	-1%	-0	-1%	-0	-1%	-0	-1%	10	23%	-0	-1%
		Average area flooded annually > 1.0m depth	'000 ha			-12	-5%	41	16%	-12	-5%	-12	-5%	-12	-5%	-12	-5%	-9	-3%	113	44%	-12	-5%
		Net economic value of flood damage	NPV US$M			-42	-24%	-42	-24%	-48	-28%	-48	-28%	-48	-28%	-48	-28%	-32	-19%	-32	-19%	-23	-13%
1.5 Maintain productivity of fishery sector	Capture fisheries and aquaculture production	Annual average capture fish availability	Mtonne / yr			-0	-2%	-1	-100%	-0	0%	-0	-1%	-0	-1%	-0	-1%	-0	-2%	-1	-100%	-0	-2%
		Annual average aquaculture production	Mtonne / yr			0	42%	0	42%	0	42%	0	42%	0	42%	0	42%	0	113%	0	113%	0	184%
		Net economic value of capture fish	NPV US$M			87	-640%	87	-640%	133	-978%	102	-753%	102	-753%	103	-759%	207	-1521%	207	-1521%	322	-2370%
2. Environmental protection																							
2.1 Maintain water quality and acceptable flow conditions	Water quality	Total pollutant discharge	tonnes / yr			86,552	79%	86,552	79%	86,552	79%	86,552	79%	86,552	79%	86,552	79%	106,135	97%	86,552	79%	135,151	124%
		Water quality conditions	Severity																				
	Flow characteristics	Average flow in March	m3/s			326	14%	387	16%	214	9%	302	13%	303	13%	303	13%	236	10%	292	12%	-95	-4%
		Average wet season peak daily flow	m3/s			-615	-3%	1,887	8%	-611	-3%	-443	-2%	-615	-3%	-529	-2%	-458	-2%	2,050	9%	-691	-3%
		Average flow volume entering Tonle Sap	MCM			n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a	
	Protection of forests around Tonle Sap	Forest, marshes and grasslands flooded at Tonle Sap	'000 ha																				
		Net economic value	NPV US$M																				
2.2 Maintain wetland productivity and	Productivity of wetland ecosystems	Are of wetlands (forest, marshes, wetland)	'000 ha			-2	-4%	5	10%	-2	-4%	-2	-4%	-2	-4%	-2	-4%	-1	-3%	15	29%	-2	-3%
		Net economic value	NPV US$M			14	-29%	35	-73%	16	-33%	14	-29%	14	-29%	14	-29%	15	-32%	61	-129%	14	-29%
2.3 Manage salinity intrusion in the Mekong	Impact of salinity intrusion on land use	Area within delta within threshold level of salinity	'000 ha																				
		Net economic value	NPV US$M																				
2.4 Minimize channel effects on bank erosion and deep pools	River bank erosion	Area at risk to erosion	Severity			Negative		Severely negative		Mildly positive		Mildly positive		Negative		Negative		Severely negative		Severely negative		Severely negative	
		Net economic value	NPV US$M																				
	Flow and sediment transport changes	Functioning deep pools	No.			-10	-59%	-10	-59%			-6	-35%	-4	-24%	-10	-59%	-10	-59%	-10	-59%	-10	-59%
		Induced geomorphological changes	Severity			Mildly negative		Mildly negative		Neutral		Neutral		Mildly negative		Mildly negative		Negative		Negative		Negative	
2.5 Conservation of biodiversity	Impacts of flow management changes on endangered species	Status of river channel habitats	Severity			Mildly negative		Mildly negative		Neutral		Mildly negative		Mildly negative		Mildly negative		Negative		Negative		Negative	
		Flagship species	Survival			n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a	
		Unaffected environmental hot spots	Severity			Negative		Negative		Mildly negative		Negative		Negative		Negative		Severely negative		Severely negative		Extremely negative	
		Biodiversity condition	Severity			Negative		Negative		Mildly negative		Mildly negative		Negative		Negative		Negative		Negative		Negative	
		Incremental net economic value of habitat areas	NPV US$M			-40	200%	-40	200%	-20	100%	-40	200%	-40	200%	-40	200%	-60	300%	-60	300%	-80	400%
3. Social development																							
3.1 Maintain livelihoods of vulnerable resource-users	Health, food and income security	No. of people affected	'000			470	1022%	470	1022%	155	337%	155	337%	469	1020%	470	1022%	470	1022%	470	1022%	470	1022%
		Severity of impact on health, food and income security	Severity			Negative		Negative		Neutral		Neutral		Mildly negative		Neutral		Negative		Negative		Negative	
3.4 Increased employment generation in water related sectors	Incremental sustainable employment from water resource interventions	Incremental number of people engaged in:																					
		Irrigated agriculture	'000			119	53%	119	53%	119	53%	119	53%	119	53%	119	53%	223	98%	223	98%	234	103%
		Reservoir fisheries (incremental to BS)	'000																				
		Hydropower production	'000			33	636%	33	636%	2	33%	14	279%	1	21%	37	711%	-5	-100%	-5	-100%	-5	-100%
		Aquaculture (incremental to BS)	'000			38	96%	38	96%	38	96%	38	96%	38	96%	38	96%	76	194%	76	194%	114	292%
4 Equitable development																							
4.1 Ensure that all four LMB countries benefit from the development of water and related resources	Aggregate benefits by country	Total net economic value	NPV US$M			3,315	168%	3,350	169%	1,655	84%	2,818	143%	2,874	145%	3,128	158%	3,914	198%	4,000	202%	5,256	266%
		No. of people affected vulnerable to changes	'000			470	1022%	470	1022%	155	337%	155	337%	469	1020%	470	1022%	470	1022%	470	1022%	470	1022%
		No. of jobs generated	'000			190	70%	190	70%	159	59%	171	63%	158	58%	194	71%	293	108%	293	108%	343	126%
		Overall environment impact	Severity			Negative		Negative		Mildly negative		Mildly negative		Negative		Negative		Negative		Negative		Negative	

Summary of scenario assessment

Incremental values relative to Baseline

Cambodia

Specific development objective	Issue	Assessment criteria	Unit	2000 2015-UMD		3000 2015-DF		4000 2030-20Y		4001 2030-20Y+CC		5000 2030-20Y-w/o MD		6100 2030-20Y-w/o LMD		6200 2030-20Y-w/o TMD		6300 2030-20Y-w/o CMD		8000 2060-LTD		8001 2060-LTD+CC		9000 2060–VHD	
1. Economic development																									
1.1 Increase irrigated agricultural production	Irrigable area, production tonnage and value	Incremental area	'000 ha					183	67%	183	67%	183	67%	183	67%	183	67%	183	67%	405	148%	405	148%	1,394	510%
		Crop production	Mtonne / yr					3.324	174%	3.324	174%	3.324	174%	3.324	174%	3.324	174%	3.324	174%	8.861	465%	8.861	465%	32.925	1729%
		Net economic value	NPV US$M			-106		223		600		227		225		223		224		1,539		1,799		9,293	
1.2 Increase hydropower production	Hydropower capacity, power generated and value	Installed capacity	MW			1		4,761		4,761		481		481		4,761		481		5,507		5,507		5,590	
		Power generated	GWh/yr			2,335		23,061		23,061		3,321		3,321		23,061		3,321		26,912		26,912		27,411	
		Net economic value from generation	NPV US$M			748		1,315		1,315		1,168		1,168		1,315		1,168		2,876		2,876		3,091	
		Net economic value from purchased	NPV US$M			457		2,031		2,031		462		462		2,031		462		2,190		2,190		2,155	
1.3 Improve navigation	River transport	Navigable days by class	'000 boat-days	n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a	
		Net economic value	NPV US$M																						
1.4 Decrease damages by floods	Extent and duration of annual flooding by class	Average area flooded annually to max 1.0m depth	'000 ha	n/a	n/a	8	2%	16	4%	1	0%	18	4%	17	4%	17	4%	17	4%	21	5%	17	4%	25	6%
		Average area flooded annually > 1.0m depth	'000 ha	n/a	n/a	-114	-6%	-158	-9%	285	16%	-147	-8%	-152	-9%	-152	-9%	-152	-9%	-189	-11%	100	6%	-227	-13%
		Net economic value of flood damage	NPV US$M			51		50		-226		47		47		47		47		54		-244		57	
1.5 Maintain productivity of fishery sector	Capture fisheries and aquaculture production	Annual average capture fish availability	Mtonne / yr			-0.053	-7%	-0.320	-40%	-0.792	-100%	-0.112	-14%	-0.140	-18%	-0.319	-40%	-0.183	-23%	-0.242	-31%	-0.792	-100%	-0.234	-30%
		Annual average aquaculture production	Mtonne / yr	0.040	32%	0.040	32%	0.116	91%	0.116	91%	0.116	91%	0.116	91%	0.116	91%	0.116	91%	0.237	187%	0.237	187%	0.359	282%
		Net economic value of capture fish	NPV US$M			-232		-895		-895		-201		-294		-893		-437		-547		-547		-433	
2. Environmental protection																									
2.1 Maintain water quality and acceptable flow conditions	Water quality	Total pollutant discharge	tonnes / yr					15,764	41%	26,125	68%	26,125	68%	26,125	68%	26,125	68%	26,125	68%	54,035	140%	26,125	68%	84,039	218%
		Water quality conditions	Severity																						
	Flow characteristics	Average flow in March	m3/s	780	35%	871	40%	1,348	61%	1,380	63%	1,253	57%	1,343	61%	1,333	61%	1,338	61%	1,510	69%	1,518	69%	745	34%
		Average wet season peak daily flow	m3/s	-1,091	-2%	-1,640	-4%	-3,456	-7%	3,752	8%	-3,415	-7%	-3,358	-7%	-3,456	-7%	-3,407	-7%	-5,065	-11%	2,123	5%	-5,521	-12%
		Average flow volume entering Tonle Sap	MCM	-2,113	-7%	-2,518	-8%	-4,265	-13%	-1,596	-5%	-3,900	-12%	-3,920	-12%	-3,918	-12%	-3,919	-12%	-5,322	-16%	-2,477	-8%	-5,250	-16%
	Protection of forests around Tonle Sap	Forest, marshes and grasslands flooded at Tonle Sap	'000 ha			-9	-1%	-14	-1%	15	1%	-14	-1%	-14	-1%	-14	-1%	-14	-1%	-19	-2%	-6	-1%	-29	-3%
		Net economic value	NPV US$M			-6		-122		-122		-4		-4		-122		-4		-413		-413		-454	
2.2 Maintain wetland productivity and	Productivity of wetland ecosystems	Are of wetlands (forest, marshes, wetland)	'000 ha			-21	-2%	-31	-2%	40	3%	-30	-2%	-31	-2%	-31	-2%	-31	-2%	-39	-3%	12	1%	-48	-4%
		Net economic value	NPV US$M			-153		-169		120		-125		-125		-169		-125		-202		5		-249	
2.3 Manage salinity intrusion in the Mekong	Impact of salinity intrusion on land use	Area within delta within threshold level of salinity	'000 ha																						
		Net economic value	NPV US$M																						
2.4 Minimize channel effects on bank erosion and deep pools	River bank erosion	Area at risk to erosion	Severity	Mildly positive		Mildly positive		Mildly negative		Negative		Positive		Positive		Mildly negative		Mildly negative		Negative		Negative		Negative	
		Net economic value	NPV US$M																						
	Flow and sediment transport changes	Functioning deep pools	No.					-2	-40%	-2	-40%			-2	-40%	-2	-40%			-2	-40%	-2	-40%	-2	-40%
		Induced geomorphological changes	Severity	Neutral		Neutral		Mildly negative		Mildly negative		Neutral		Neutral		Mildly negative		Mildly negative		Extremely negative		Extremely negative		Extremely negative	
2.5 Conservation of biodiversity	Impacts of flow management changes on endangered species	Status of river channel habitats	Severity	Neutral		Neutral		Mildly negative		Mildly negative		Neutral		Neutral		Mildly negative		Mildly negative		Extremely negative		Extremely negative		Extremely negative	
		Flagship species	Survival	n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a	
		Unaffected environmental hot spots	Severity	Neutral		Mildly negative		Extremely negative		Extremely negative		Negative		Negative		Severely negative		Severely negative		Extremely negative		Extremely negative		Catastrophic	
		Biodiversity condition	Severity	Neutral		Mildly negative		Severely negative		Negative		Mildly negative		Negative		Severely negative		Mildly negative		Severely negative		Negative		Extremely negative	
		Incremental net economic value of habitat areas	NPV US$M			-65		-195		-195		-130		-130		-195		-195		-195		-195		-325	
3. Social development																									
3.1 Maintain livelihoods of vulnerable resource-users	Health, food and income security	No. of people affected	'000	90		102		1,212		1,212		212		262		1,212		352		1,224		1,280		1,231	
		Severity of impact on health, food and income security	Severity	Mildly negative		Mildly negative		Extremely negative		Extremely negative		Negative		Severely negative		Extremely negative		Severely negative		Extremely negative		Extremely negative		Extremely negative	
3.4 Increased employment generation in water related sectors	Incremental sustainable employment from water resource interventions	Incremental number of people engaged in:																							
		Irrigated agriculture	'000					6	8%	6	8%	6	8%	6	8%	6	8%	6	8%	209	270%	209	270%	750	968%
		Reservoir fisheries (incremental to BS)	'000			1		21		28		1		1		21		7		71		71		78	
		Hydropower production	'000			15		163		163		20		20		163		20		149		149		171	
		Aquaculture (incremental to BS)	'000			20		57		57		57		57		57		57		85		85		114	
4 Equitable development																									
4.1 Ensure that all four LMB countries benefit from the development of water and related resources	Aggregate benefits by country	Total net economic value	NPV US$M			693		2,237		2,627		1,446		1,351		2,237		1,142		5,302		5,470		13,135	
		No. of people affected vulnerable to changes	'000	90		102		1,212		1,212		212		262		1,212		352		1,224		1,280		1,231	
		No. of jobs generated	'000			36	46%	247	319%	254	328%	84	108%	84	108%	247	319%	90	117%	514	663%	514	663%	1,113	1436%
		Overall environment impact	Severity			Mildly negative		Severely negative		Negative		Mildly negative		Negative		Severely negative		Negative		Severely negative		Negative		Extremely negative	

Summary of scenario assessment

Incremental values relative to Definite Future Scenario

Cambodia

Specific development objective	Issue	Assessment criteria	Unit	2000 2015-UMD	3000 2015-DF	4000 2030-20Y		4001 2030-20Y+CC		5000 2030-20Y-w/o MD		6100 2030-20Y-w/o LMD		6200 2030-20Y-w/o TMD		6300 2030-20Y-w/o CMD		8000 2060-LTD		8001 2060-LTD+CC		9000 2060–VHD	
1. Economic development																							
1.1 Increase irrigated agricultural production	Irrigable area, production tonnage and value	Incremental area	'000 ha			183	67%	183	67%	183	67%	183	67%	183	67%	183	67%	405	148%	405	148%	1,394	510%
		Crop production	Mtonne / yr			3	174%	3	174%	3	174%	3	174%	3	174%	3	174%	9	465%	9	465%	33	1729%
		Net economic value	NPV US$M			329	-310%	706	-666%	333	-314%	331	-313%	329	-310%	330	-312%	1,645	-1552%	1,905	-1797%	9,399	-8867%
1.2 Increase hydropower production	Hydropower capacity, power generated and value	Installed capacity	MW			4,760	476000%	4,760	476000%	480	48000%	480	48000%	4,760	476000%	480	48000%	5,506	550600%	5,506	550600%	5,589	558900%
		Power generated	GWh/yr			20,726	888%	20,726	888%	986	42%	986	42%	20,726	888%	986	42%	24,577	1053%	24,577	1053%	25,077	1074%
		Net economic value from generation	NPV US$M			567	76%	567	76%	420	56%	420	56%	567	76%	420	56%	2,128	285%	2,128	285%	2,343	313%
		Net economic value from purchased	NPV US$M			1,574	345%	1,574	345%	5	1%	5	1%	1,574	345%	5	1%	1,733	379%	1,733	379%	1,698	372%
1.3 Improve navigation	River transport	Navigable days by class	'000 boat-days			n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a	
		Net economic value	NPV US$M																				
1.4 Decrease damages by floods	Extent and duration of annual flooding by class	Average area flooded annually to max 1.0m depth	'000 ha			8	2%	-7	-2%	10	2%	9	2%	9	2%	9	2%	13	3%	9	2%	16	4%
		Average area flooded annually > 1.0m depth	'000 ha			-44	-3%	399	24%	-33	-2%	-38	-2%	-38	-2%	-38	-2%	-75	-5%	214	13%	-113	-7%
		Net economic value of flood damage	NPV US$M			-1	-2%	-277	-543%	-4	-8%	-4	-8%	-4	-8%	-4	-8%	3	6%	-295	-579%	6	12%
1.5 Maintain productivity of fishery sector	Capture fisheries and aquaculture production	Annual average capture fish availability	Mtonne / yr			-0	-36%	-1	-100%	-0	-8%	-0	-12%	-0	-36%	-0	-18%	-0	-26%	-1	-100%	-0	-24%
		Annual average aquaculture production	Mtonne / yr			0	45%	0	45%	0	45%	0	45%	0	45%	0	45%	0	118%	0	118%	0	190%
		Net economic value of capture fish	NPV US$M			-663	286%	-663	286%	31	-13%	-62	27%	-661	285%	-205	88%	-315	136%	-315	136%	-201	87%
2. Environmental protection																							
2.1 Maintain water quality and acceptable flow conditions	Water quality	Total pollutant discharge	tonnes / yr			15,764	41%	26,125	68%	26,125	68%	26,125	68%	26,125	68%	26,125	68%	54,035	140%	26,125	68%	84,039	218%
		Water quality conditions	Severity																				
	Flow characteristics	Average flow in March	m3/s			477	16%	508	17%	382	12%	471	15%	462	15%	466	15%	639	21%	647	21%	-127	-4%
		Average wet season peak daily flow	m3/s			-1,816	-4%	5,393	12%	-1,775	-4%	-1,718	-4%	-1,816	-4%	-1,767	-4%	-3,425	-8%	3,763	8%	-3,881	-9%
		Average flow volume entering Tonle Sap	MCM			-1,747	-6%	922	3%	-1,382	-5%	-1,402	-5%	-1,400	-5%	-1,401	-5%	-2,803	-9%	41	0%	-2,732	-9%
	Protection of forests around Tonle Sap	Forest, marshes and grasslands flooded at Tonle Sap	'000 ha			-5	0%	24	2%	-5	0%	-5	0%	-5	0%	-5	0%	-9	-1%	3	0%	-20	-2%
		Net economic value	NPV US$M			-116	1840%	-116	1840%	3	-44%	3	-44%	-116	1840%	3	-44%	-406	6449%	-406	6449%	-448	7108%
2.2 Maintain wetland productivity and	Productivity of wetland ecosystems	Are of wetlands (forest, marshes, wetland)	'000 ha			-10	-1%	61	5%	-9	-1%	-10	-1%	-10	-1%	-10	-1%	-18	-1%	33	3%	-27	-2%
		Net economic value	NPV US$M			-15	10%	273	-178%	28	-19%	28	-19%	-15	10%	28	-19%	-48	32%	158	-103%	-96	63%
2.3 Manage salinity intrusion in the Mekong	Impact of salinity intrusion on land use	Area within delta within threshold level of salinity	'000 ha																				
		Net economic value	NPV US$M																				
2.4 Minimize channel effects on bank erosion and deep pools	River bank erosion	Area at risk to erosion	Severity			Mildly negative		Negative		Mildly positive		Mildly negative		Mildly negative		Neutral		Severely negative		Severely negative		Severely negative	
		Net economic value	NPV US$M																				
	Flow and sediment transport changes	Functioning deep pools	No.			-2	-40%	-2	-40%			-2	-40%	-2	-40%			-2	-40%	-2	-40%	-2	-40%
		Induced geomorphological changes	Severity			Mildly negative		Mildly negative		Neutral		Neutral		Mildly negative		Mildly negative		Extremely negative		Extremely negative		Extremely negative	
2.5 Conservation of biodiversity	Impacts of flow management changes on endangered species	Status of river channel habitats	Severity			Mildly negative		Mildly negative		Neutral		Neutral		Mildly negative		Mildly negative		Extremely negative		Extremely negative		Extremely negative	
		Flagship species	Survival			n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a	
		Unaffected environmental hot spots	Severity			Severely negative		Severely negative		Negative		Negative		Severely negative		Severely negative		Severely negative		Severely negative		Catastrophic	
		Biodiversity condition	Severity			Negative		Mildly negative		Neutral		Mildly negative		Negative		Neutral		Negative		Mildly negative		Severely negative	
		Incremental net economic value of habitat areas	NPV US$M			-130	200%	-130	200%	-65	100%	-65	100%	-130	200%	-130	200%	-130	200%	-130	200%	-260	400%
3. Social development																							
3.1 Maintain livelihoods of vulnerable resource-users	Health, food and income security	No. of people affected	'000			1,110	1088%	1,110	1088%	110	108%	160	157%	1,110	1088%	250	245%	1,122	1100%	1,178	1155%	1,129	1107%
		Severity of impact on health, food and income security	Severity			Severely negative		Severely negative		Mildly negative		Negative		Severely negative		Negative		Severely negative		Severely negative		Severely negative	
3.4 Increased employment generation in water related sectors	Incremental sustainable employment from water resource interventions	Incremental number of people engaged in:																					
		Irrigated agriculture	'000			6	8%	6	8%	6	8%	6	8%	6	8%	6	8%	209	270%	209	270%	750	968%
		Reservoir fisheries (incremental to BS)	'000			20	3497%	27	4703%					20	3497%	6	1100%	70	12065%	70	12065%	77	13289%
		Hydropower production	'000			148	963%	148	963%	5	32%	5	32%	148	963%	5	32%	134	873%	134	873%	156	1018%
		Aquaculture (incremental to BS)	'000			37	188%	37	188%	37	188%	37	188%	37	188%	37	188%	65	331%	65	331%	94	475%
4 Equitable development																							
4.1 Ensure that all four LMB countries benefit from the development of water and related resources	Aggregate benefits by country	Total net economic value	NPV US$M			1,544	223%	1,934	279%	753	109%	657	95%	1,543	223%	449	65%	4,609	665%	4,777	689%	12,442	1795%
		No. of people affected vulnerable to changes	'000			1,110	1088%	1,110	1088%	110	108%	160	157%	1,110	1088%	250	245%	1,122	1100%	1,178	1155%	1,129	1107%
		No. of jobs generated	'000			211	187%	218	193%	48	43%	48	43%	211	187%	55	48%	478	423%	478	423%	1,077	952%
		Overall environment impact	Severity			Negative		Mildly negative		Neutral		Mildly negative		Negative		Mildly negative		Negative		Mildly negative		Severely negative	

Summary of scenario assessment

Incremental values relative to Baseline

Viet Nam

Specific development objective	Issue	Assessment criteria	Unit	2000 2015-UMD		3000 2015-DF		4000 2030-20Y		4001 2030-20Y+CC		5000 2030-20Y-w/o MD		6100 2030-20Y-w/o LMD		6200 2030-20Y-w/o TMD		6300 2030-20Y-w/o CMD		8000 2060-LTD		8001 2060-LTD+CC		9000 2060–VHD	
1. Economic development																									
1.1 Increase irrigated agricultural production	Irrigable area, production tonnage and value	Incremental area	'000 ha			-326	-16%	-201	-10%	-201	-10%	-201	-10%	-201	-10%	-201	-10%	-201	-10%	-183	-9%	-183	-9%	-148	-7%
		Crop production	Mtonne / yr					8.511	43%	8.511	43%	8.511	43%	8.511	43%	8.511	43%	8.511	43%	12.287	62%	12.287	62%	16.444	83%
		Net economic value	NPV US$M			-9		94		132		95		95		94		95		386		437		800	
1.2 Increase hydropower production	Hydropower capacity, power generated and value	Installed capacity	MW			1,564	217%	1,863	259%	1,863	259%	1,863	259%	1,863	259%	1,863	259%	1,863	259%	1,863	259%	1,863	259%	1,863	259%
		Power generated	GWh/yr			9,935	272%	31,399	858%	31,399	858%	12,688	347%	17,581	481%	31,399	858%	17,581	481%	32,302	883%	32,302	883%	32,406	886%
		Net economic value from generation	NPV US$M			2,109	123%	2,948	172%	2,948	172%	2,310	135%	2,477	145%	2,948	172%	2,477	145%	2,985	174%	2,985	174%	2,990	175%
		Net economic value from purchased	NPV US$M			607	227%	799	299%	799	299%	653	245%	691	259%	799	299%	691	259%	799	299%	799	299%	800	299%
1.3 Improve navigation	River transport	Navigable days by class	'000 boat-days	n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a	
		Net economic value	NPV US$M																						
1.4 Decrease damages by floods	Extent and duration of annual flooding by class	Average area flooded annually to max 1.0m depth	'000 ha	n/a	n/a	119	12%	146	15%	-178	-18%	146	15%	146	15%	146	15%	146	15%	174	17%	-290	-29%	185	18%
		Average area flooded annually > 1.0m depth	'000 ha	n/a	n/a	-129	-16%	-162	-20%	230	29%	-162	-20%	-162	-20%	-162	-20%	-162	-20%	-201	-25%	343	43%	-216	-27%
		Net economic value of flood damage	NPV US$M			60		67		-307		65		65		65		65		73		-332		77	
1.5 Maintain productivity of fishery sector	Capture fisheries and aquaculture production	Annual average capture fish availability	Mtonne / yr	-0.034	-9%	-0.032	-8%	-0.135	-34%	-0.400	-100%	-0.031	-8%	-0.057	-14%	-0.134	-34%	-0.083	-21%	-0.136	-34%	-0.400	-100%	-0.136	-34%
		Annual average aquaculture production	Mtonne / yr	0.831	50%	0.831	50%	1.662	100%	1.662	100%	1.662	100%	1.662	100%	1.662	100%	1.662	100%	3.325	200%	3.325	200%	4.988	300%
		Net economic value of capture fish	NPV US$M			548		234		234		579		492		234		406		572		572		913	
2. Environmental protection																									
2.1 Maintain water quality and acceptable flow conditions	Water quality	Total pollutant discharge	tonnes / yr					37,646	22%	37,646	22%	37,646	22%	37,646	22%	37,646	22%	37,646	22%	117,220	69%	37,646	22%	162,699	95%
		Water quality conditions	Severity																						
	Flow characteristics	Average flow in March	m3/s	659	21%	826	27%	1,107	36%	1,006	33%	1,026	33%	1,104	36%	1,104	36%	1,104	36%	1,031	34%	1,035	34%	315	10%
		Average wet season peak daily flow	m3/s	-348	-2%	-480	-2%	-855	-4%	219	1%	-846	-4%	-844	-4%	-844	-4%	-844	-4%	-1,150	-5%	-156	-1%	-1,271	-6%
		Average flow volume entering Tonle Sap	MCM	n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a	
	Protection of forests around Tonle Sap	Forest, marshes and grasslands flooded at Tonle Sap	'000 ha																						
		Net economic value	NPV US$M			-17		-14		-14		-14		-14		-14		-14		-14		-14		-14	
2.2 Maintain wetland productivity and	Productivity of wetland ecosystems	Are of wetlands (forest, marshes, wetland)	'000 ha			-0	0%	-0	0%	-0	0%	-0	0%	-0	0%	-0	0%	-0	0%	-1	-1%	-0	0%	-1	-1%
		Net economic value	NPV US$M			-1		-4		-3		-1		-1		-4		-1		-8		-4		-9	
2.3 Manage salinity intrusion in the Mekong	Impact of salinity intrusion on land use	Area within delta within threshold level of salinity	'000 ha	-240	-13%	-272	-15%	-309	-17%	23	1%	-305	-16%	-319	-17%	-288	-16%	-288	-16%	-299	-16%	297		-221	-12%
		Net economic value	NPV US$M			20		27		-2		25		23		21		23		22		-2		16	
2.4 Minimize channel effects on bank erosion and deep pools	River bank erosion	Area at risk to erosion	Severity	Mildly positive		Mildly positive		Mildly negative		Negative		Positive		Positive		Mildly negative		Mildly negative		Negative		Negative		Negative	
		Net economic value	NPV US$M																						
	Flow and sediment transport changes	Functioning deep pools	No.																						
		Induced geomorphological changes	Severity	Neutral		Neutral		Neutral		Mildly negative		Neutral		Neutral		Mildly negative		Mildly negative		Severely negative		Severely negative		Severely negative	
2.5 Conservation of biodiversity	Impacts of flow management changes on endangered species	Status of river channel habitats	Severity	Neutral		Neutral		Mildly negative		Negative		Neutral		Mildly negative		Mildly negative		Mildly negative		Severely negative		Extremely negative		Severely negative	
		Flagship species	Survival	n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a	
		Unaffected environmental hot spots	Severity	Neutral		Neutral		Neutral		Negative		Neutral		Neutral		Neutral		Neutral		Negative		Catastrophic		Catastrophic	
		Biodiversity condition	Severity	Neutral		Mildly negative		Mildly negative		Mildly negative		Mildly negative		Mildly negative		Mildly negative		Mildly negative		Severely negative		Negative		Severely negative	
		Incremental net economic value of habitat areas	NPV US$M							-60										-60		-150		-150	
3. Social development																									
3.1 Maintain livelihoods of vulnerable resource-users	Health, food and income security	No. of people affected	'000	390		442		1,725		1,725		452		770		1,725		1,088		1,737		1,985		1,741	
		Severity of impact on health, food and income security	Severity	Mildly negative		Mildly negative		Negative		Negative		Mildly negative		Negative		Negative		Negative		Negative		Extremely negative		Negative	
3.4 Increased employment generation in water related sectors	Incremental sustainable employment from water resource interventions	Incremental number of people engaged in:																							
		Irrigated agriculture	'000					14	41%	14	41%	14	41%	14	41%	14	41%	14	41%	19	53%	19	53%	44	126%
		Reservoir fisheries (incremental to BS)	'000			2		3		4		3		3		3		3		3		3		3	
		Hydropower production	'000			31		29		29		29		29		29		29		18		18		18	
		Aquaculture (incremental to BS)	'000			164		164		164		164		164		164		164		246		246		328	
4 Equitable development																									
4.1 Ensure that all four LMB countries benefit from the development of water and related resources	Aggregate benefits by country	Total net economic value	NPV US$M			3,317	168%	4,151	210%	3,726	188%	3,712	188%	3,828	193%	4,143	209%	3,741	189%	4,755	240%	4,292	217%	5,423	274%
		No. of people affected vulnerable to changes	'000	390		442		1,725		1,725		452		770		1,725		1,088		1,737		1,985		1,741	
		No. of jobs generated	'000			197	565%	210	602%	211	604%	210	602%	210	602%	210	602%	210	602%	286	819%	286	819%	393	1127%
		Overall environment impact	Severity			Mildly negative		Mildly negative		Negative		Mildly negative		Mildly negative		Mildly negative		Mildly negative		Severely negative		Severely negative		Severely negative	

Summary of scenario assessment

Incremental values relative to Definite Future Scenario

Viet Nam

Specific development objective	Issue	Assessment criteria	Unit	2000 2015-UMD	3000 2015-DF	4000 2030-20Y		4001 2030-20Y+CC		5000 2030-20Y-w/o MD		6100 2030-20Y-w/o LMD		6200 2030-20Y-w/o TMD		6300 2030-20Y-w/o CMD		8000 2060-LTD		8001 2060-LTD+CC		9000 2060–VHD	
1. Economic development																							
1.1 Increase irrigated agricultural production	Irrigable area, production tonnage and value	Incremental area	'000 ha			125	7%	125	7%	125	7%	125	7%	125	7%	125	7%	143	9%	143	9%	178	11%
		Crop production	Mtonne / yr			9	43%	9	43%	9	43%	9	43%	9	43%	9	43%	12	62%	12	62%	16	83%
		Net economic value	NPV US$M			103	-1177%	141	-1605%	103	-1178%	103	-1178%	103	-1177%	103	-1178%	395	-4498%	446	-5087%	809	-9223%
1.2 Increase hydropower production	Hydropower capacity, power generated and value	Installed capacity	MW			299	13%	299	13%	299	13%	299	13%	299	13%	299	13%	299	13%	299	13%	299	13%
		Power generated	GWh/yr			21,465	158%	21,465	158%	2,753	20%	7,647	56%	21,465	158%	7,647	56%	22,367	165%	22,367	165%	22,471	165%
		Net economic value from generation	NPV US$M			839	22%	839	22%	201	5%	368	10%	839	22%	368	10%	875	23%	875	23%	881	23%
		Net economic value from purchased	NPV US$M			192	22%	192	22%	46	5%	84	10%	192	22%	84	10%	192	22%	192	22%	193	22%
1.3 Improve navigation	River transport	Navigable days by class	'000 boat-days			n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a	
		Net economic value	NPV US$M																				
1.4 Decrease damages by floods	Extent and duration of annual flooding by class	Average area flooded annually to max 1.0m depth	'000 ha			27	2%	-297	-26%	27	2%	27	2%	27	2%	27	2%	55	5%	-408	-36%	66	6%
		Average area flooded annually > 1.0m depth	'000 ha			-33	-5%	359	54%	-32	-5%	-33	-5%	-33	-5%	-33	-5%	-72	-11%	472	71%	-87	-13%
		Net economic value of flood damage	NPV US$M			7	12%	-367	-612%	5	8%	5	8%	5	8%	5	8%	13	22%	-392	-654%	17	28%
1.5 Maintain productivity of fishery sector	Capture fisheries and aquaculture production	Annual average capture fish availability	Mtonne / yr			-0	-28%	-0	-100%	0	0%	-0	-7%	-0	-28%	-0	-14%	-0	-28%	-0	-100%	-0	-28%
		Annual average aquaculture production	Mtonne / yr			1	33%	1	33%	1	33%	1	33%	1	33%	1	33%	2	100%	2	100%	4	167%
		Net economic value of capture fish	NPV US$M			-314	-57%	-314	-57%	31	6%	-55	-10%	-314	-57%	-142	-26%	25	4%	25	4%	365	67%
2. Environmental protection																							
2.1 Maintain water quality and acceptable flow conditions	Water quality	Total pollutant discharge	tonnes / yr			37,646	22%	37,646	22%	37,646	22%	37,646	22%	37,646	22%	37,646	22%	117,220	69%	37,646	22%	162,699	95%
		Water quality conditions	Severity																				
	Flow characteristics	Average flow in March	m3/s			281	7%	179	5%	200	5%	278	7%	278	7%	278	7%	205	5%	209	5%	-512	-13%
		Average wet season peak daily flow	m3/s			-374	-2%	699	3%	-366	-2%	-364	-2%	-364	-2%	-364	-2%	-670	-3%	324	2%	-791	-4%
		Average flow volume entering Tonle Sap	MCM			n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a	
	Protection of forests around Tonle Sap	Forest, marshes and grasslands flooded at Tonle Sap	'000 ha																				
		Net economic value	NPV US$M			3	-19%	3	-19%	3	-19%	3	-19%	3	-19%	3	-19%	3	-19%	3	-19%	3	-19%
2.2 Maintain wetland productivity and	Productivity of wetland ecosystems	Are of wetlands (forest, marshes, wetland)	'000 ha			-0	0%	0	0%	-0	0%	-0	0%	-0	0%	-0	0%	-1	-1%	-0	0%	-1	-1%
		Net economic value	NPV US$M			-4	587%	-3	416%	-1	82%	-1	82%	-4	587%	-1	82%	-8	1237%	-3	479%	-8	1327%
2.3 Manage salinity intrusion in the Mekong	Impact of salinity intrusion on land use	Area within delta within threshold level of salinity	'000 ha			-37	-2%	295	19%	-33	-2%	-47	-3%	-16	-1%	-16	-1%	-27	-2%	569	36%	51	3%
		Net economic value	NPV US$M			7	35%	-22	-110%	5	25%	3	15%	1	5%	3	15%	2	10%	-22	-110%	-4	-20%
2.4 Minimize channel effects on bank erosion and deep pools	River bank erosion	Area at risk to erosion	Severity			Neutral		Mildly negative		Neutral		Neutral		Neutral		Neutral		Severely negative		Severely negative		Severely negative	
		Net economic value	NPV US$M																				
	Flow and sediment transport changes	Functioning deep pools	No.																				
		Induced geomorphological changes	Severity			Neutral		Mildly negative		Neutral		Neutral		Mildly negative		Mildly negative		Severely negative		Severely negative		Severely negative	
2.5 Conservation of biodiversity	Impacts of flow management changes on endangered species	Status of river channel habitats	Severity			Mildly negative		Negative		Neutral		Mildly negative		Mildly negative		Mildly negative		Severely negative		Extremely negative		Severely negative	
		Flagship species	Survival			n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a	
		Unaffected environmental hot spots	Severity			Neutral		Negative		Neutral		Neutral		Neutral		Neutral		Negative		Catastrophic		Catastrophic	
		Biodiversity condition	Severity			Neutral		Neutral		Neutral		Neutral		Neutral		Neutral		Negative		Mildly negative		Negative	
		Incremental net economic value of habitat areas	NPV US$M					-60										-60		-150		-150	
3. Social development																							
3.1 Maintain livelihoods of vulnerable resource-users	Health, food and income security	No. of people affected	'000			1,283	290%	1,283	290%	10	2%	328	74%	1,283	290%	646	146%	1,295	293%	1,543	349%	1,299	294%
		Severity of impact on health, food and income security	Severity			Mildly negative		Mildly negative		Neutral		Mildly negative		Mildly negative		Mildly negative		Mildly negative		Severely negative		Mildly negative	
3.4 Increased employment generation in water related sectors	Incremental sustainable employment from water resource interventions	Incremental number of people engaged in:																					
		Irrigated agriculture	'000			14	41%	14	41%	14	41%	14	41%	14	41%	14	41%	19	53%	19	53%	44	126%
		Reservoir fisheries (incremental to BS)	'000			1	46%	2	74%	1	46%	1	46%	1	46%	1	46%	1	46%	1	46%	1	46%
		Hydropower production	'000			-3	-8%	-3	-8%	-3	-8%	-3	-8%	-3	-8%	-3	-8%	-13	-42%	-13	-42%	-13	-42%
		Aquaculture (incremental to BS)	'000															82	50%	82	50%	164	100%
4 Equitable development																							
4.1 Ensure that all four LMB countries benefit from the development of water and related resources	Aggregate benefits by country	Total net economic value	NPV US$M			834	16%	409	8%	395	7%	511	10%	826	16%	424	8%	1,438	27%	975	18%	2,106	40%
		No. of people affected vulnerable to changes	'000			1,283	290%	1,283	290%	10	2%	328	74%	1,283	290%	646	146%	1,295	293%	1,543	349%	1,299	294%
		No. of jobs generated	'000			13	6%	13	6%	13	6%	13	6%	13	6%	13	6%	89	38%	89	38%	196	84%
		Overall environment impact	Severity			Neutral		Mildly negative		Neutral		Neutral		Neutral		Neutral		Negative		Negative		Negative	

Summary of scenario assessment

Incremental values relative to Baseline

Lower Mekong Basin

Specific development objective	Issue	Assessment criteria	Unit	2000 2015-UMD		3000 2015-DF		4000 2030-20Y		4001 2030-20Y+CC		5000 2030-20Y-w/o MD		6100 2030-20Y-w/o LMD		6200 2030-20Y-w/o TMD		6300 2030-20Y-w/o CMD		8000 2060-LTD		8001 2060-LTD+CC		9000 2060–VHD	
1. Economic development																									
1.1 Increase irrigated agricultural production	Irrigable area, production tonnage and value	Incremental area	'000 ha			-275	-7%	1,597	43%	1,597	43%	1,597	43%	1,597	43%	1,597	43%	1,597	43%	2,226	60%	2,226	60%	4,666	125%
		Crop production	Mtonne / yr					27.153	97%	27.153	97%	27.153	97%	27.153	97%	27.153	97%	27.153	97%	43.372	155%	43.372	155%	93.307	333%
		Net economic value	NPV US$M			-144		1,481		1,938		1,487		1,484		1,481		1,483		4,041		4,453		15,855	
1.2 Increase hydropower production	Hydropower capacity, power generated and value	Installed capacity	MW			4,946	312%	24,839	1566%	24,839	1566%	10,142	639%	17,641	1112%	21,888	1380%	20,559	1296%	27,521	1735%	27,521	1735%	28,098	1772%
		Power generated	GWh/yr			35,417	389%	194,136	2135%	194,136	2135%	74,389	818%	136,129	1497%	171,381	1885%	156,630	1723%	206,800	2274%	206,800	2274%	209,735	2307%
		Net economic value from generation	NPV US$M			8,350	186%	17,028	379%	17,028	379%	11,069	246%	13,638	303%	15,187	338%	16,410	365%	21,783	485%	21,783	485%	22,711	505%
		Net economic value from purchased	NPV US$M			3,142	385%	15,796	1934%	15,796	1934%	6,534	800%	11,364	1392%	13,519	1655%	13,922	1705%	16,082	1969%	16,082	1969%	16,076	1969%
1.3 Improve navigation	River transport	Navigable days by class	'000 boat-days	n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a	
		Net economic value	NPV US$M	-0	0%	64	35%	64	35%	64	35%	64	35%	64	35%	64	35%	64	35%	64	35%	64	35%	64	35%
1.4 Decrease damages by floods	Extent and duration of annual flooding by class	Average area flooded annually to max 1.0m depth	'000 ha			118	8%	151	10%	-179	-12%	153	10%	152	10%	152	10%	152	10%	184	12%	-261	-17%	198	13%
		Average area flooded annually > 1.0m depth	'000 ha			-367	-11%	-465	-14%	485	15%	-453	-14%	-459	-14%	-459	-14%	-459	-14%	-532	-16%	542	17%	-590	-18%
		Net economic value of flood damage	NPV US$M			462		377		-273		360		360		360		360		408		-296		432	
1.5 Maintain productivity of fishery sector	Capture fisheries and aquaculture production	Annual average capture fish availability	Mtonne / yr	-0.044	-2%	-0.142	-6%	-0.515	-20%	-2.530	-100%	-0.187	-7%	-0.245	-10%	-0.512	-20%	-0.314	-12%	-0.418	-17%	-2.530	-100%	-0.397	-16%
		Annual average aquaculture production	Mtonne / yr	1.025	52%	1.025	52%	2.063	105%	2.063	105%	2.063	105%	2.063	105%	2.063	105%	2.063	105%	4.078	207%	4.078	207%	6.094	310%
		Net economic value of capture fish	NPV US$M			274		-459		-459		636		441		-452		212		494		494		1,194	
2. Environmental protection																									
2.1 Maintain water quality and acceptable flow conditions	Water quality	Total pollutant discharge	tonnes / yr					189,447	51%	199,809	54%	199,809	54%	199,809	54%	199,809	54%	199,809	54%	393,559	107%	199,809	54%	570,281	155%
		Water quality conditions	Severity																						
	Flow characteristics	Average flow in March	m3/s	748	38%	844	43%	1,205	62%	1,214	62%	1,105	56%	1,190	61%	1,189	61%	1,189	61%	1,199	61%	1,229	63%	719	37%
		Average wet season peak daily flow	m3/s	-1,288	-5%	-1,424	-5%	-2,194	-8%	540	2%	-2,175	-8%	-2,080	-8%	-2,191	-8%	-2,136	-8%	-2,617	-10%	91	0%	-2,866	-10%
		Average flow volume entering Tonle Sap	MCM	-2,113	-7%	-2,518	-8%	-4,265	-13%	-1,596	-5%	-3,900	-12%	-3,920	-12%	-3,918	-12%	-3,919	-12%	-5,322	-16%	-2,477	-8%	-5,250	-16%
	Protection of forests around Tonle Sap	Forest, marshes and grasslands flooded at Tonle Sap	'000 ha			-9	-1%	-14	-1%	15	1%	-14	-1%	-14	-1%	-14	-1%	-14	-1%	-19	-2%	-6	-1%	-29	-3%
		Net economic value	NPV US$M			-153		-372		-372		-183		-228		-349		-254		-731		-731		-822	
2.2 Maintain wetland productivity and	Productivity of wetland ecosystems	Are of wetlands (forest, marshes, wetland)	'000 ha			-35	-2%	-48	-3%	35	2%	-47	-3%	-48	-3%	-48	-3%	-48	-3%	-55	-4%	24	2%	-66	-4%
		Net economic value	NPV US$M			-228		-225		101		-176		-178		-225		-178		-260		36		-310	
2.3 Manage salinity intrusion in the Mekong	Impact of salinity intrusion on land use	Area within delta within threshold level of salinity	'000 ha	-240	-13%	-272	-15%	-309	-17%	23	1%	-305	-16%	-319	-17%	-288	-16%	-288	-16%	-299	-16%	297	16%	-221	-12%
		Net economic value	NPV US$M			20		27		-2		25		23		21		23		22		-2		16	
2.4 Minimize channel effects on bank erosion and deep pools	River bank erosion	Area at risk to erosion	Severity	Mildly positive		Mildly positive		Mildly negative		Negative		Positive		Positive		Mildly negative		Mildly negative		Negative		Negative		Negative	
		Net economic value	NPV US$M																						
	Flow and sediment transport changes	Functioning deep pools	No.					-20	-43%	-20	-43%			-13	-28%	-14	-30%	-18	-38%	-20	-43%	-20	-43%	-20	-43%
		Induced geomorphological changes	Severity	Neutral		Mildly negative		Negative		Negative		Mildly negative		Mildly negative		Negative		Negative		Extremely negative		Extremely negative		Extremely negative	
2.5 Conservation of biodiversity	Impacts of flow management changes on endangered species	Status of river channel habitats	Severity	Neutral		Mildly negative		Negative		Negative		Mildly negative		Negative		Negative		Negative		Extremely negative		Extremely negative		Extremely negative	
		Flagship species	Survival	n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a	
		Unaffected environmental hot spots	Severity	Neutral		Mildly negative		Severely negative		Extremely negative		Negative		Negative		Severely negative		Negative		Extremely negative		Catastrophic		Catastrophic	
		Biodiversity condition	Severity	Neutral		Mildly negative		Severely negative		Severely negative		Negative		Negative		Severely negative		Negative		Severely negative		Severely negative		Extremely negative	
		Incremental net economic value of habitat areas	NPV US$M			-85		-330		-415		-220		-240		-330		-305		-435		-525		-700	
3. Social development																									
3.1 Maintain livelihoods of vulnerable resource-users	Health, food and income security	No. of people affected	'000	527		887		4,360		4,360		1,564		2,015		4,359		2,738		4,506		4,810		4,594	
		Severity of impact on health, food and income security	Severity	Mildly negative		Negative		Severely negative		Severely negative		Negative		Severely negative		Severely negative		Severely negative		Severely negative		Extremely negative		Severely negative	
3.4 Increased employment generation in water related sectors	Incremental sustainable employment from water resource interventions	Incremental number of people engaged in:																							
		Irrigated agriculture	'000					212	51%	212	51%	212	51%	212	51%	212	51%	212	51%	658	157%	658	157%	1,535	367%
		Reservoir fisheries (incremental to BS)	'000			15		64		72		32		40		60		51		126		126		141	
		Hydropower production	'000			104		612		612		224		387		534		469		527		527		573	
		Aquaculture (incremental to BS)	'000			251		352		352		352		352		352		352		528		528		704	
4 Equitable development																									
4.1 Ensure that all four LMB countries benefit from the development of water and related resources	Aggregate benefits by country	Total net economic value	NPV US$M	-0	0%	11,700	213%	33,386	608%	33,403	608%	19,596	357%	26,728	486%	29,276	533%	31,738	578%	41,468	755%	41,358	753%	54,517	992%
		No. of people affected vulnerable to changes	'000	527		887		4,360		4,360		1,564		2,015		4,359		2,738		4,506		4,810		4,594	
		No. of jobs generated	'000			370	89%	1,240	297%	1,248	299%	820	196%	990	237%	1,158	277%	1,084	259%	1,839	440%	1,839	440%	2,954	707%
		Overall environment impact	Severity			Mildly negative		Severely negative		Severely negative		Negative		Negative		Severely negative		Severely negative		Severely negative		Severely negative		Extremely negative	

Summary of scenario assessment

Incremental values relative to Definite Future Scenario

Lower Mekong Basin

Specific development objective	Issue	Assessment criteria	Unit	2000 2015-UMD	3000 2015-DF	4000 2030-20Y		4001 2030-20Y+CC		5000 2030-20Y-w/o MD		6100 2030-20Y-w/o LMD		6200 2030-20Y-w/o TMD		6300 2030-20Y-w/o CMD		8000 2060-LTD		8001 2060-LTD+CC		9000 2060–VHD	
1. Economic development																							
1.1 Increase irrigated agricultural production	Irrigable area, production tonnage and value	Incremental area	'000 ha			1,872	54%	1,872	54%	1,872	54%	1,872	54%	1,872	54%	1,872	54%	2,501	72%	2,501	72%	4,941	143%
		Crop production	Mtonne / yr			27	97%	27	97%	27	97%	27	97%	27	97%	27	97%	43	155%	43	155%	93	333%
		Net economic value	NPV US$M			1,625	-1128%	2,082	-1445%	1,631	-1132%	1,628	-1130%	1,625	-1128%	1,627	-1129%	4,185	-2905%	4,597	-3191%	15,999	-11105%
1.2 Increase hydropower production	Hydropower capacity, power generated and value	Installed capacity	MW			19,892	305%	19,892	305%	5,195	80%	12,694	194%	16,941	259%	15,612	239%	22,575	346%	22,575	346%	23,152	354%
		Power generated	GWh/yr			158,719	357%	158,719	357%	38,973	88%	100,712	226%	135,964	305%	121,213	272%	171,383	385%	171,383	385%	174,318	392%
		Net economic value from generation	NPV US$M			8,678	68%	8,678	68%	2,719	21%	5,288	41%	6,837	53%	8,061	63%	13,433	105%	13,433	105%	14,362	112%
		Net economic value from purchased	NPV US$M			12,654	320%	12,654	320%	3,393	86%	8,222	208%	10,377	262%	10,781	272%	12,940	327%	12,940	327%	12,934	327%
1.3 Improve navigation	River transport	Navigable days by class	'000 boat-days			n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a	
		Net economic value	NPV US$M																			-0	0%
1.4 Decrease damages by floods	Extent and duration of annual flooding by class	Average area flooded annually to max 1.0m depth	'000 ha			33	2%	-297	-18%	35	2%	34	2%	34	2%	34	2%	66	4%	-379	-23%	80	5%
		Average area flooded annually > 1.0m depth	'000 ha			-98	-3%	851	30%	-86	-3%	-92	-3%	-92	-3%	-92	-3%	-165	-6%	909	32%	-223	-8%
		Net economic value of flood damage	NPV US$M			-85	-18%	-735	-159%	-102	-22%	-102	-22%	-102	-22%	-102	-22%	-54	-12%	-758	-164%	-30	-6%
1.5 Maintain productivity of fishery sector	Capture fisheries and aquaculture production	Annual average capture fish availability	Mtonne / yr			-0	-16%	-2	-100%	-0	-2%	-0	-4%	-0	-15%	-0	-7%	-0	-12%	-2	-100%	-0	-11%
		Annual average aquaculture production	Mtonne / yr			1	35%	1	35%	1	35%	1	35%	1	35%	1	35%	3	102%	3	102%	5	169%
		Net economic value of capture fish	NPV US$M			-734	-268%	-734	-268%	362	132%	167	61%	-726	-265%	-62	-23%	220	80%	220	80%	920	336%
2. Environmental protection																							
2.1 Maintain water quality and acceptable flow conditions	Water quality	Total pollutant discharge	tonnes / yr			189,447	51%	199,809	54%	199,809	54%	199,809	54%	199,809	54%	199,809	54%	393,559	107%	199,809	54%	570,281	155%
		Water quality conditions	Severity																				
	Flow characteristics	Average flow in March	m3/s			361	13%	370	13%	260	9%	346	12%	344	12%	345	12%	355	13%	384	14%	-125	-4%
		Average wet season peak daily flow	m3/s			-770	-3%	1,964	8%	-750	-3%	-656	-3%	-767	-3%	-712	-3%	-1,192	-5%	1,516	6%	-1,441	-6%
		Average flow volume entering Tonle Sap	MCM			-1,747	-6%	922	3%	-1,382	-5%	-1,402	-5%	-1,400	-5%	-1,401	-5%	-2,803	-9%	41	0%	-2,732	-9%
	Protection of forests around Tonle Sap	Forest, marshes and grasslands flooded at Tonle Sap	'000 ha			-5	0%	24	2%	-5	0%	-5	0%	-5	0%	-5	0%	-9	-1%	3	0%	-20	-2%
		Net economic value	NPV US$M			-219	143%	-219	143%	-29	19%	-74	48%	-195	127%	-100	65%	-577	376%	-577	376%	-669	436%
2.2 Maintain wetland productivity and	Productivity of wetland ecosystems	Are of wetlands (forest, marshes, wetland)	'000 ha			-13	-1%	70	5%	-12	-1%	-13	-1%	-13	-1%	-13	-1%	-20	-1%	59	4%	-30	-2%
		Net economic value	NPV US$M			3	-1%	329	-144%	53	-23%	50	-22%	3	-1%	50	-22%	-32	14%	264	-116%	-81	36%
2.3 Manage salinity intrusion in the Mekong	Impact of salinity intrusion on land use	Area within delta within threshold level of salinity	'000 ha			-37	-2%	295	19%	-33	-2%	-47	-3%	-16	-1%	-16	-1%	-27	-2%	569	36%	51	3%
		Net economic value	NPV US$M			7	35%	-22	-110%	5	25%	3	15%	1	5%	3	15%	2	10%	-22	-110%	-4	-20%
2.4 Minimize channel effects on bank erosion and deep pools	River bank erosion	Area at risk to erosion	Severity			Negative		Severely negative		Neutral		Neutral		Negative		Mildly negative		Severely negative		Severely negative		Severely negative	
		Net economic value	NPV US$M																				
	Flow and sediment transport changes	Functioning deep pools	No.			-20	-43%	-20	-43%			-13	-28%	-14	-30%	-18	-38%	-20	-43%	-20	-43%	-20	-43%
		Induced geomorphological changes	Severity			Mildly negative		Mildly negative		Mildly negative		Neutral		Mildly negative		Mildly negative		Severely negative		Severely negative		Severely negative	
2.5 Conservation of biodiversity	Impacts of flow management changes on endangered species	Status of river channel habitats	Severity			Mildly negative		Negative		Mildly negative		Mildly negative		Mildly negative		Mildly negative		Severely negative		Severely negative		Severely negative	
		Flagship species	Survival			n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a	
		Unaffected environmental hot spots	Severity			Negative		Severely negative		Mildly negative		Negative		Negative		Negative		Severely negative		Extremely negative		Catastrophic	
		Biodiversity condition	Severity			Negative		Negative		Mildly negative		Mildly negative		Mildly negative		Mildly negative		Negative		Mildly negative		Severely negative	
		Incremental net economic value of habitat areas	NPV US$M			-245	288%	-330	388%	-135	159%	-155	182%	-245	288%	-220	259%	-350	412%	-440	518%	-615	724%
3. Social development																							
3.1 Maintain livelihoods of vulnerable resource-users	Health, food and income security	No. of people affected	'000			3,473	392%	3,473	392%	677	76%	1,128	127%	3,472	391%	1,851	209%	3,619	408%	3,923	442%	3,707	418%
		Severity of impact on health, food and income security	Severity			Negative		Negative		Mildly negative		Mildly negative		Negative		Mildly negative		Negative		Severely negative		Negative	
3.4 Increased employment generation in water related sectors	Incremental sustainable employment from water resource interventions	Incremental number of people engaged in:																					
		Irrigated agriculture	'000			212	51%	212	51%	212	51%	212	51%	212	51%	212	51%	658	157%	658	157%	1,535	367%
		Reservoir fisheries (incremental to BS)	'000			49	325%	57	375%	17	112%	24	161%	45	298%	35	233%	111	729%	111	729%	126	833%
		Hydropower production	'000			508	490%	508	490%	120	116%	283	273%	430	415%	366	353%	424	409%	424	409%	470	453%
		Aquaculture (incremental to BS)	'000			101	40%	101	40%	101	40%	101	40%	101	40%	101	40%	277	110%	277	110%	453	181%
4 Equitable development																							
4.1 Ensure that all four LMB countries benefit from the development of water and related resources	Aggregate benefits by country	Total net economic value	NPV US$M			21,685	126%	21,703	126%	7,896	46%	15,028	87%	17,576	102%	20,038	117%	29,768	173%	29,658	172%	42,816	249%
		No. of people affected vulnerable to changes	'000			3,473	392%	3,473	392%	677	76%	1,128	127%	3,472	391%	1,851	209%	3,619	408%	3,923	442%	3,707	418%
		No. of jobs generated	'000			870	111%	878	111%	450	57%	620	79%	788	100%	714	91%	1,469	187%	1,469	187%	2,584	328%
		Overall environment impact	Severity			Negative		Negative		Mildly negative		Mildly negative		Negative		Negative		Negative		Negative		Severely negative	

End

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