Cooperation for Water, Energy, and Food Security in Transboundary Basins under Changing Climate

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Preface

Water, energy and food security are essential for the development of societies across the globe. Energy is a central element in our modern daily lives. The United Nations Universal Declaration of Human Rights recognises that, "Everyone has the right to a standard of living adequate for the health and well-being of himself and his family, including food." The United Nations has also explicitly recognised the human right to water.

About 40 per cent of the world's population lives in river basins that are shared by countries and cover almost half of the planet's land surface. They provide over 60 per cent of the global freshwater flow.

New approaches to transboundary cooperation in shared river basins can help to address the interconnections between water, energy and food. This nexus is useful because it allows for different perspectives. Climate change presents challenges and opportunities, but political will is necessary to put them into actions that deliver results.

There is a lot of global action but the experiences are very variable, and general lessons are sometimes difficult to apply. Transboundary cooperation would greatly benefit from agreements and institutions that adapt to changing environments and to the needs of a wide range of stakeholders.

I am pleased to present this publication which is based on the International Conference entitled: Cooperation for Water, Energy and Food Security in Transboundary Basins under Changing Climate, held in Ho Chi Minh City, Viet Nam from 2-3 April 2014. It is a synthesis of the views shared by experts and participants from 20 river and aquifer basin organisations around the world.

The International Conference—the third of its kind organised by the MRC—demonstrated that case studies provide a basis for what we can apply to our own situation. There is no one-size-fits-all or single recipe to tackle the existing and future challenges and we will continue learning. Pressures on water resources will grow and expectations will increase and these need to be managed. It is important to plan and a have constant dialogue with partners and stakeholders to make sure that we are building some flexibility.

The document highlights the role of river and aquifer basin organisations and the benefits of cooperation in managing transboundary basins. Through it we aim to deliver the key messages of the conference to a wider audience. We hope that it will be a good reference on the current global thinking around the interconnection

between water, energy and food security, and that it leads to new thinking and innovative solutions.

The Mekong River Commission would like to thank all the partners who have provided assistance over the years, as well as the authors of this publication and the conference participants for their valuable contribution to the event. I trust that this text will inspire new approaches to face the current and future challenges in transboundary water management based on mutual learning and shared ideas.

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Executive summary

The aim of this report is to present the main contributions from the participants of the Mekong River Commission's (MRC) international conference entitled: Cooperation for Water, Energy and Food Security in Transboundary Basins under Changing Climate, held in Ho Chi Minh City, Viet Nam from 2–3 April, 2014.

The MRC held the conference ahead of its 2nd Summit of Prime Ministers of the four Member Countries to share and learn from global experiences in transboundary water development and management. About 400 participants from 20 river and aquifer basin organisations in Asia, Africa, Europe and the Americas, together with government officials, policy-makers, development agencies, international and non-governmental organisations, the private sector and other stakeholders discussed the management of international watercourses, the role of river and aquifer basin organisations and discussed the benefits of cooperation in managing transboundary basins sustainably.

The conference focused on three key issues within the overall umbrella of water, energy and food security in transboundary basins:

- Sustainable development
- Climate change adaptation in a transboundary context
- Benefits of cooperation

The need for new approaches to transboundary cooperation in shared basins that will address the interconnections between water, energy and land resources is broadly recognised. The water, energy and food security nexus approach provides a useful policy framework to understand development opportunities and challenges and to involve multiple-sector stakeholders. This particular nexus is so important because of the dominant role of energy and food production on water use and management. However, focusing on these sectors does not belittle the role of water management for other uses such as health, transport, industry etc. and the vital role of ecosystem management.

The global Sustainable Development Goals (SDGs) are expected to provide an operational framework to implement development across sectors. There is strong support for dedicated goals on water, energy and food with a broad scope that reflects the realities of resource management.By adapting and coordinating national development plans appropriately, regional sustainability, affected by national developments, can be enhanced, without compromising the national objectives. This provides a strong argument for including transboundary cooperation in the SDGs. The interconnection between water, energy and food security requires integrated

planning, policy and management. The nexus approach provides a useful policy framework for development that involves multiple-sector stakeholders across boundaries. This is useful for analysing and diagnosing problems, although implementation of actions to address the issues does not require full institutional integration. Implementation will, and should, still take place through existing mechanisms and institutions, but bearing the nexus approach in mind. All stakeholders must understand the interdependencies among the three sectors and develop mechanisms to bring actors to the table at appropriate times. Basin organisations can bring them together, link the challenges in different sectors and identify benefits to be shared. Experience in many international river basins shows that benefit sharing is implemented in different ways according to circumstances. Typically, a central aim is to exploit opportunities to accelerate socio-economic development and to increase national revenue in a manner that one country alone could not achieve. Formalised transboundary cooperation not only allows for some of the joint benefits of development to be realised, but also for some of the negative ecosystem impacts to be mitigated. Understanding the issues and raising the political will is needed to shape developments and make corrections in the face of unexpected negative developments or unintended consequences.

Transboundary rivers, lakes and aquifers provide energy, transport, drinking water, and sediment transport for productive agriculture and delta stability. Development of these plays an important role in the economic prosperity of entire regions and millions of people, but it may also pose a risk to ecosystems and their services, upon which some of the more vulnerable communities often depend. Promoting sustainable development requires management of a wide range of factors and dialogue with stakeholders. Governments need to devise guiding frameworks including for the private sector to assess developments that consider cumulative environmental and social impacts, of which water quality, sediment transport, fish population and ecosystem health are important components.

The future climate is projected to amplify existing climate risks, suggesting that reducing vulnerability and exposure to present climate variability is a wise first step in climate change adaptation. Such low/no regret adaptation strategies help in the short-term as well as in preparing for the projected long-term changes. Adaptation is place and context specific, requiring knowledge and actions at local scale. Utilising the full range of storage options, including improved use of natural wetlands, canals, ponds and tanks and aquifer recharge, efficient under floods as well as dry conditions, may reduce the costs and negative impacts of the adaptation actions. Adaptive management is a key

approach to tackle the challenges of climate change in river deltas facing sea level rise to avoid overinvestment while doing what is necessary to meet development goals. While climate change adaptation actions may be local in scale at implementation, their consequences can be regional and should be safeguarded regionally through transboundary cooperation to share risks and maximise regional benefits. Increased variation across the basin puts more pressure on the transboundary cooperation in terms of sharing the burden and relief assistance. Transboundary basin organisations are well placed to support capacity improvements and development of methods required to provide the scientific basis as well as a negotiation platform to design and agree on climate change adaptation strategies.

Transboundary agreements and institutions need to adapt to changing environments. While many agreements include provision for cooperation on the broad range of aspects of integrated water resources management and across other sectors, some agreements were established to solve a few specific transboundary cooperation issues. Broad agreements provide a high degree of flexibility for cooperation that allows new management concepts to be introduced or a new understanding of relationships to be used as part of transboundary basin management without having to change or amend the treaty or agreement. Agreements with broader scope may be provide the best chance to benefit from these opportunities. For transboundary agreements to work effectively, a combination of political will, technical cooperation and an inclusive process involving all stakeholder groups is needed.

Understanding and interpreting information and uncertainty are huge challenges for both policy makers and scientists. One clear example is the information on which policy makers have to base their climate change adaptation planning. The uncertainty is being presented ever more clearly, which is good, but it also makes it difficult for policy makers and practitioners unless communication and interaction between scientists, policy makers and stakeholders are improved. An important element of successful transboundary management is evidence developed through involvement of the riparian parties and such technical collaboration can be a vehicle for moving development forward. The technical advances demonstrated in transboundary river basin management are significant and their policy relevance is very clear. This includes e.g. real-time flood management, flood modelling and visualisation, crop development, sediment management and delta management. There is an upward trend in openness, sharing of information, technical capacity and actions on the ground. Modern techniques such as geographic information systems, satellite information analysis and modelling are used to help overcome information shortfalls. The positive trend in technical advances

with clear policy relevance does not seem to be sufficiently reflected by increasing confidence of policymakers. Interaction between scientists and policymakers should be intensified and codified at different levels to have an effective science-policy dialogue with real impact.While decision makers need data, information and decision support systems, it must be remembered that action is needed even with a less than perfect evidence and information base. Science has an obligation to present information and analysis clearly, including uncertainties, and in doing so to present what we know, as well as what we don't know. However, there will always be a need to make decisions in the absence of 'complete' information. Waiting for perfect information before taking action could lead to inaction.

There is a clear message from the leadership of basin organisations around the world: reaching out to stakeholders and engaging with citizens is vital to the overall success of basin organisation operations, but is hard to achieve in a transboundary context, partly due to the asymmetries between a wide range of stakeholders in basin countries. Nevertheless, there are some excellent examples of community engagement and participatory models of water resources management. Not only are the stakeholders engaged in the development of solutions, they are also directly included in management of the water resources and used as a catalyst to get a dialogue going. These experiences reinforce the argument for meaningful participation of all stakeholders, including the private sector and civil society, from an early stage in the planning process, to contribute to sustainable basin development with benefits for all.

1. Background

Key national and regional socio-economic development agendas are related to water, energy and food security. With some 40% of the world's population living in transboundary river basins, and an even greater proportion when aquifers and surface water bodies shared between states and provinces within countries are included, many of these development issues have strong transboundary dimensions. The Mekong River Commission (MRC) held an international conference ahead of its 2nd Summit of Prime Ministers of the four MRC Member Countries, to share and learn from global experiences in transboundary water development and management. The topic of the conference and the Summit was: "Cooperation for water, energy and food security in transboundary basins under climate change".

1.1 Introduction

The international debate on water resources management – including its linkages to other sectors and issues – revolves around issues of high importance to the management of international basins. A key concern is achieving water, energy and food security in an integrated manner under a changing climate. Sustainable (green) growth that enables socio-economic growth of countries while also ensuring the long-term sustainability of their development paths is also a theme, as is the sharing of growth benefits with a wide range of stakeholders.

These topics are being widely addressed at the international level. The critical importance of water for development, livelihoods and maintenance of our ecosystems is recognised in international discussions on a potential dedicated Sustainable Development Goal (SDG) for water, along with how to stress the importance of water in other SDGs, which will be decided in 2015. The IPCC Fifth Assessment launched in March 2014, reconfirmed that the impacts of climate change and the actions required to adapt and build resilience to these impacts, are strongly related to water, and through water to food and energy security. A new global climate agreement will be discussed, and hopefully adopted, at the COP21 meeting in 2015.

These debates and their final outcome are of great importance to transboundary basin cooperation and the efforts of basin organisations and riparian states in managing water resources (Figure 1.1).

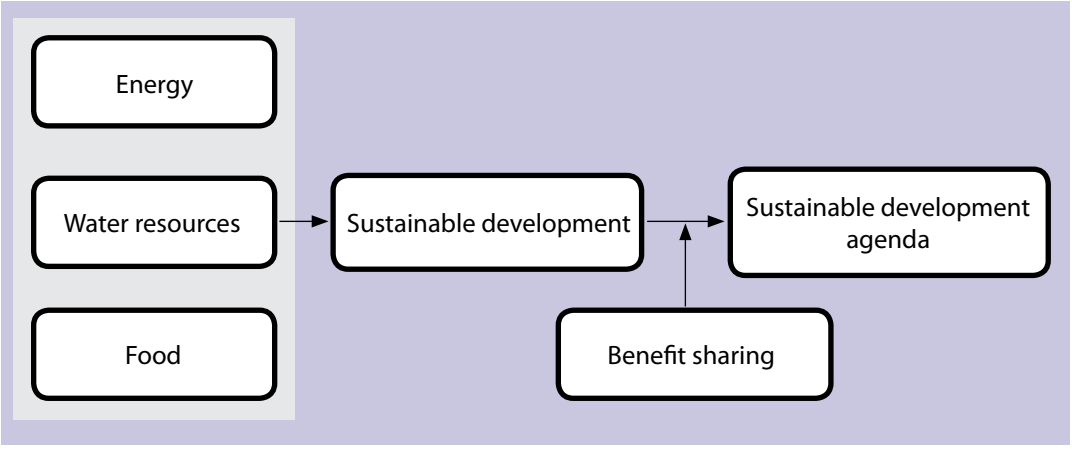

Figure 1.1: Recognising the interdependence between water, energy and food security and their integrated, transboundary management under a changing climate provides the basis for sustainable (green) growth, in turn a prerequisite for achieving sustainable development for riparian states with shared basins. Such sustainable development can, however, only be achieved if benefits from the use of water, energy and food resources are shared among the different stakeholders

Acknowledging the importance of these topics, the Mekong River Commission (MRC) has engaged an impressive number of other shared basins and the different actors involved in their management in an on-going dialogue about sustainable river basin and aquifer management and development that benefits entire basins and their populations. Following the 1st MRC Summit and the Pre-Summit International Conference "Transboundary Water Resources Management in a Changing World", held in Hua Hin, Thailand in 2010, and the MRC international conference "Mekong to Rio" held in Phuket, Thailand in 2012, the MRC organised a third international conference coinciding with its 2nd MRC Summit – the Pre-Summit International Conference entitled "Cooperation for Water, Energy and Food Security in Transboundary Basins under Changing Climate" held in Ho Chi Minh City, Viet Nam in 2014.

The large number of basins (21) and participants (400) from all continents, who participated in the third international conference in 2014, demonstrates the relevance of the conference topic and the need for transboundary basin stakeholders to reach beyond their local circumstances to look for new approaches and solutions to development issues. This conference


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also demonstrated that transboundary basin management discussions are moving fast away from a water centred approach towards an integrated approach with all water-related sectors. This is evident when comparing the report from the 'Mekong 2 Rio' conference held in 2012 (Bach et.al., 2012) and this report, which summarises the findings from the third international conference.

1.2 The water, energy and food security nexus from global to local scale

The need for new approaches to transboundary cooperation in shared basins to address issues such as the interconnections between water, energy and land resources is broadly recognised. Addressing water, energy and food security at the transboundary level could potentially generate closer strategic links between countries around regional solutions, eventually improving sustainability and regional and political and economic security (Bach et.al., 2012). Water, energy and food security, however, cannot be achieved in a business-as-usual scenario due to a lack of global resources. If we continue using resources at the current rate, by 2030 only about two-thirds of the water required for energy, food and other human needs will be available as an accessible, reliable, and environmentally sustainable supply (2030 WRG, 2009). New approaches require more than a search for new technologies, they also require a new way of thinking. In shared river basins, these challenges will be amplified unless transboundary cooperation is able to embrace new integrated approaches.

Providing sustainable energy is one of the keys to be successful in tackling the challenges of the future. But focusing on energy plans alone is not enough. Water and food security are equally important for sustainable development. A secure energy supply is not possible without water, effective water management is not conceivable without energy, while both water and energy are essential for food supply. Water is required to satisfy basic human needs, maintain ecosystems and for a wide range of societal uses. The two major water users are agriculture and energy. Above all, it is necessary to understand how these three issues of water, energy and food are related:

- Water is needed for irrigation: up to 90% of water is used for irrigation in arid countries. Water is also needed for energy generation (via hydropower and for cooling power plants).
- Energy is needed for the provision of water: a significant proportion of the domestic water supply costs are energy costs and about 30% of the world's available energy is used to supply food (FAO, 2014). Irrigation, water processing and distribution, collection and treatment of waste water all require energy.

- Land resources are essential for the water cycle, for agricultural production and for the production of biofuels.

These multiple needs often lead to overuse of water resources, pollution of surface water and groundwater, shortage of water resources for other uses and damage to important ecosystems. It should be realised in this context that water quantity and water quality are two sides of the same coin, since enough but heavily polluted water can result in water scarcity. Adding to these pressures, transboundary cooperation is critical to avoid focusing within national boundaries, handling water unilaterally and ignoring upstream and downstream needs and interlinkages.

Restructuring energy systems to achieve greater energy efficiency and a large share of renewables offers an excellent opportunity to reduce the energy sector's water footprint – both the amount of water it uses and the level of water pollution it causes. Disputes about expansion of hydropower or energy crop cultivation show, however, that even though these actions may fulfil energy, water and climate sustainability goals they represent potential areas of conflict and need to be carefully considered.

While substantial development progress has been made globally, there is still a lot to do (UN, 2014). About one billion people do not have enough to eat and similar numbers have no access to water and sanitation or modern forms of energy. The people who are hungry are often those without access to energy – energy they could use to increase their harvests, to pump water from the ground or to preserve their produce. Access to both water and energy is the key to enabling people to enjoy a dignified standard of living and to play an active role in social and economic processes. Water and energy are prerequisites for securing food supply, healthy ecosystems, economic development, economic growth and political stability. Three factors are making the situation even more difficult. First, the world population will soon (2025, UN estimate) reach eight billion; second, many parts of the world are becoming richer, which means the demand for resources is increasing; and third, climate change has a negative impact on water management and farming in many parts of the world. These global trends are the basis for the Sustainable Development Goals (SDGs), which ultimately need to be translated into local actions on the ground.

Undoubtedly, climate change impacts tend to increase pressures on water, energy and food security together with other global trends such as demographic growth, urbanisation and changing consumption patterns. Water resources are a central element of climate change impacts, for example impacts on food security. Water resources management will therefore be the key to adaptation to climate change. Extreme climatic events, such as droughts and floods, have revealed significant exposure and vulnerability of ecosystems and human systems and a lack

of preparedness to handle current climate variability (IPCC, 2014). Climate change is likely to result in increased variability and in increasing the frequency and magnitude of extreme events. The future climate is expected to amplify existing climate risks, suggesting that reducing vulnerability and exposure to present climate variability is a wise first step in climate change adaptation. Adaptation is place and context specific, requiring knowledge and actions at a local scale. While large uncertainties about the future climate exist, good relations among riparian states over shared water resources are important for understanding and handling the risks of climate change at the regional scale, which has an impact on the effectiveness of local actions (IPCC, 2014).

Considering water, energy and food systems as a nexus also means planning them in an integrated and transboundary way through suitable legal and institutional arrangements and frameworks, and with decision support instruments and incentives. It means avoiding negative impacts on other areas and striving for common solutions. The uncertainty of the global changes, including climate change, demands an increasing focus on adaptive management approaches, including so-called no-/low-regret actions, which are actions that benefit society, even if future scenarios do not eventuate. This raises high expectations of science and policy to deliver solutions, and of the effectiveness of the science/policy dialogue and involvement of stakeholders that support it.

1.3 The conference and this report

The conference took place in Ho Chi Minh City, 2-3 April, 2014 convened by the MRC, co-sponsored by 21 partners and hosted by the Government of Viet Nam. The central objective of the conference was to provide a platform to MRC Member Countries, Dialogue Partners, Development Partners, civil society representatives and partners from other basin management bodies, international organisations and academia to address and discuss recent challenges and potential solutions in river and aquifer basin management. A conference summary (see Annex 2) was prepared and presented at the end of the two-day event, and then submitted to the MRC Council. Upon consideration by the Council it was presented to the 2nd MRC Summit of Heads of States of Cambodia, Lao PDR, Thailand and Viet Nam held on 5th April 2014.

About 400 participants from 20 river and aquifer basin organisations in Asia, Africa, Europe and the Americas (see Annex 1 for a description of the participating basin organisations), together with government officials, policy makers, development agencies, international organisations, non-government organisations, the private sector and other stakeholders, shared experiences and discussed the management of international watercourses, the role of river and aquifer basin organisations and the benefits of cooperation in managing basins sustainably.

The report presents contributions from the participants, including managers of river and aquifer basins throughout the world, presenting experiences and knowledge from Asia's Aral Sea, Ganges, Indus and Mekong; Africa's Congo, Niger, Nile, North Western Sahara Aquifer, Orange-Senqu and Senegal; Europe's Danube, Genevese Aquifer, Sava, Severn and Vuoksi; the America's Columbia, Guarani, Parana (Itaipu Binacional), La Plata, São Francisco and Uruguay and from the Middle East, Jordan. The United Nations Economic Commission for Europe leading the work in the 'Convention on the Protection and Use of Transboundary Watercourses and International Lakes' and the African Network of Basin Organisations (ANBO) were also present.

The aim of this report is to make the conference findings available to all interested parties. The report is divided into two parts. Part 1 follows the three conference themes; advances in sustainable development (Chapter 2), climate change adaptation in a transboundary context (Chapter 3) and the benefits of transboundary cooperation (Chapter 4). The conference addressed many important topics, which underpin shared basin management. Of these, three were repeatedly mentioned throughout the conference and stood out as particularly relevant. Part 2 of the report highlights the discussions, examples and issues raised in these three areas; adaptive basin management (Chapter 5), science/policy dialogue (Chapter 6) and involvement of stakeholders (Chapter 7).The conference conclusions are elaborated in Chapter 8.

In order to provide an easy reading throughout the report, mentioning the name of a river or aquifer, e.g. 'Senegal', refers to the basin even though this may also be a name of a country, city or geographic location/area. Whenever the other meaning of the name is used e.g. the country this will be made specific. To further illustrate certain findings and arguments and to strengthen the lessons to be learned, boxes describing basins or issues presented at the conference are included.

The authors, MRC and the sponsoring partners hope that this report will provide a resource and material for further discussion for decision makers and water resource managers as well as managers and practitioners in the fields of energy and agriculture. Annex 3 provides a list of presenters, panellists, chairpersons and facilitators. Other conference material is available on the MRC website: www.mrcmekong.org.


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3 April 2014, Ho Minh

Part 1

Addressing sustainable development and climate change impacts in a transboundary water basin context

Some 40% of the world's population live in river basins shared by several countries, and this proportion is even greater when aquifers and surface water bodies shared between states and provinces within countries are included. The water, energy, food security nexus approach provides a useful policy framework to understand development opportunities and challenges and to involve multiple-sector stakeholders. This nexus is so important because of the dominant role of energy and food on water use and management. However, the focus on these sectors does not discount the importance of water management for other societal sectors such as health, transport, industry etc. and the vital role of ecosystem management.

Wise water management is critical to climate change adaptation, not least in building resilience to sea-level rise, increased climate variability and extreme events. Water management that fails to sustainably address existing conditions, including current climate risks, increases the challenges and efforts needed to adapt to the projected changes in climate. It becomes even more important to manage resources sustainably when water is shared, in order to realise the full benefits of cooperation. Transboundary basin organisations play an important role in developing and managing shared water resources and the benefits to be derived from cooperation between upstream and downstream riparian countries.

This part of the report presents the experiences and ideas of the participants in the three conference tracks, which covered the following three topics: Sustainable development (Chapter 2); climate change adaptation (Chapter 3); benefits of transboundary cooperation (Chapter 4).

2. Sustainable development in transboundary river basins

While the principles of sustainable development were proposed more than a quarter of a century ago, it has proven extremely challenging to make them operationally relevant in an ever-changing and increasingly inter-connected world. Typically, sustainable development involves addressing trade-offs and conflicts between and within sectors at different geographical scales and political jurisdictions. A better understanding of the water, energy and food security nexus offers a pragmatic and timely framework to address some of these trade-offs, and to identify opportunities from a multi-sector approach. International cooperation is a prerequisite for achieving sustainable development in a transboundary context and cooperation is typically required at multiple levels, including local, national and regional. Given the complexity of addressing inter-sectoral and international issues, the potential for simplifying complex problem using the nexus framework makes this approach increasingly relevant.

Within a transboundary context, there are often significant asymmetries between countries that share a basin. These might include their level of development, dependence on the resource for livelihoods, and capacity to monitor and manage the system. These asymmetries pose an additional challenge for managing the basin as a whole.

2.1 Water, energy and food security nexus supporting sustainable development

It is envisioned that the global Sustainable Development Goals (SDGs) under negotiation will provide an operational framework to implement sustainable development across sectors. In the current Millennium Development Goals (MDGs), water is included with a focus on water supply and sanitation as a target under the environmental goal (MDG 7), which does not encompass the complexity of water management issues faced by practitioners around the world. For the post-2015 development agenda to reflect the reality on the ground, the scope needs to be broadened to also include water quality, waste water treatment, water related disasters and water governance, including catchment area based integrated water resources management and appropriate transboundary cooperation (Open Working Group on Sustainable Development Goals, 2014). When discussing water resources management, aquifers (in particular, transboundary aquifers) are often forgotten, even though they represent a valuable source of water and there is an inherent link between surface and groundwater.

Improvements in all of these areas are needed to reset the path towards more sustainable development and improve the livelihoods of the most vulnerable communities. While there has been some debate on whether to mould the SDGs within the water, energy and food security nexus framework, the consensus is that targets are more likely to be reached if they are designed from a broader sector perspective. Resources, initiative and efforts are typically channelled within specific sectors, and it is expected that outcomes would be stronger with sector-based goals. Consequently, there is a groundswell of support for dedicated goals on water,

energy and food. For this approach to succeed in delivering solutions, requires the sectors to work in an integrated way e.g. understanding the added value of water, energy and food security benefits.

The SDGs are focused at the national level, which makes it difficult to include transboundary aspects although their importance has been recognised in the global discussions on the SDGs (OWG, 2014). As many countries share waters with their neighbours, transboundary aspects such as water pollution, sediment transport and fish migration are often critical for achieving sustainable development at the national level. By "lifting the national boundaries" from the basin, additional opportunities at the regional level may surface, which are only feasible when countries cooperate. By adapting and coordinating national development plans appropriately, regional sustainability, impacted by national developments, can be enhanced, without compromising national objectives. This provides a strong argument for including transboundary cooperation in the SDGs.

Part of the solution for strengthening transboundary cooperation and realising these opportunities for more sustainable development lies in having an adequate understanding of the transboundary water systems. The number of transboundary studies at the basin scale is increasing, e.g. through the Transboundary Diagnostic Analyses (TDAs, developed and in many cases supported by UNDP/GEF) conducted in basins including the Danube, Guarani, Niger, Orange-Senqu, Patana, São Francisco and Senegal. TDAs are science-based analyses of transboundary water-related concerns and opportunities that exist in multi-country surface water, groundwater, and coastal/marine water systems. They identify priorities for joint action, root causes and scope for threats or opportunities and serve as the basis for reforms and investments included in action programmes. However, many analytical gaps remain. Global assessments, such as the Transboundary Waters Assessment Programme (TWAP), which is a global, baseline, comparative assessment of the world's transboundary water bodies contribute to filling these gaps (UNEP, 2014). Another example is the UNECE effort currently facilitating nexus assessments of transboundary river basins under the UNECE Convention on the Protection and Use of Transboundary Watercourses and International Lakes in the pan-European area as well as parts of Africa and Asia. This provides transboundary basins with an opportunity to improve the understanding of the basin and to promote sustainable development using multi-sector and transboundary dialogue through participatory workshops. Transboundary basin organisations can provide an effective framework for undertaking this type of inter-sectoral, transboundary collaboration (Box 1).

Box 1. Assessing the water–food–energy–ecosystems nexus under the UNECE Water Convention

The UNECE Convention on the Protection and Use of Transboundary Watercourses and International Lakes supports countries in areas such as cooperative transboundary monitoring, negotiating agreements and setting up joint bodies. Nexus assessment is part of the UNECE Water Convention's work programme for 2013–2015. The assessment, which involves stakeholders in a participatory approach hopes to provide the following benefits:

- improved knowledge base about linkages between sectors to support decision making at national, basin and transboundary levels
- joint identification of opportunities for benefits and solutions for capitalising on synergies, addressing trade-offs and reconciling different resource uses
- promotion of dialogue between sectors and countries at basin level involving stakeholders
- exchange of good practices
- capacity building.

The pilot case to develop the methodology was the Alazani/Ganikh (Georgia and Azerbaijan) basin. Some of the issues faced in the basin are: development pressures, deforestation, aging water infrastructure, small hydropower and pollution.

The methodology has been taken up by other transboundary basins such as the Sava, a sub-basin of the Danube in south-eastern Europe, which this year was selected to conduct the nexus assessment in the UNECE Water Convention context. The Framework Agreement on the Sava River Basin, the implementation of which is coordinated by the International Sava River Basin Commission, provides a basis for transboundary water cooperation in the Sava. The preparation of a River Basin Management Plan for the Sava makes nexus considerations very timely. The basin countries (Bosnia and Herzegovina, Croatia, Serbia, Slovenia and Montenegro) are experiencing promising economic development with a boom in hydropower development and growing tourism. At the same time there is a need to seek approaches that do not compromise sustainability and maintain a healthy environment. As a beginning to the nexus assessment process, a workshop was held where representatives of economic sectors presented their development plans and strategies. Looking at the plans from a nexus perspective revealed unexpected connections. While the need for irrigation and investments in the energy sector will grow, extreme weather events pose risks to infrastructure and there is a need for investment in land reclamation strategies. All these developments are linked and involve trade-offs. South-eastern Europe is among the areas predicted to be hardest hit by climate change in the future and in particular more water scarcity is expected. So, risk assessment of infrastructure investments and improvements in water use efficiency emerged as important considerations. The nexus assessment for the Sava is being developed in close cooperation with the national administrations involving also local stakeholders across sectors and across the basin during spring and summer 2014.

For many countries, an important aspect of sustainable development is moving towards a low carbon energy mix that considers climate change mitigation, and a low resource economy. While this may be efficient from the perspective of a climate mitigation policy perspective, it may not be the most suitable approach from a climate change adaptation point of view, or in a nexus context, as it potentially leads to policy disconnects. The nexus approach is again useful to consider potential implications of a move towards a low carbon economy on for example, agriculture, water resources and ecosystems. In the River Severn, shared between England and Wales, three potential low carbon projects (shale gas, nuclear energy, and tidal power) have very different implications within the nexus related to water quality, biodiversity and food security. An ongoing nexus-based study will generate an evidence based database of better practice (see also Box 2). One gap identified in the study is the lack of cumulative impact assessment for the range of proposed development projects.

An MRC-led basin-wide cumulative impact assessment of the basin countries' national plans (including hydropower and irrigation), with and without consideration of climate change impacts in the Mekong region, identified considerable transboundary nexus synergies and trade-offs between water, energy, food, environment and climate security issues (MRC, 2011). The assessment presented different future scenarios and allowed the countries to negotiate and agree on an IWRM-based Basin Development Strategy. One of the priorities of this strategy is to seek options for sharing the potential benefits and risks of development.

Box 2. Policy disconnect between climate, water, energy and food security in the Severn River Basin

The Severn River Basin is strategically important in the UK for its low carbon power generation potential (shale gas, nuclear power and tidal power) of about 10-20GW of electricity and about 7 years of shale gas. The basin supports five million people, including the major urban areas of Coventry, Cardiff and Bristol. It supplies water for two million households and 193,000 commercial operations.

Pressures on the basin include:

- population growth – forecast to increase by 24% by 2050;
- intensification of agriculture
- increased water demand from population and industry
- abstraction uncertainty
- climate change – flooding during the winter of 2013/2014 the wettest December/January period in the UK since records began
- political emphasis on energy security and climate change mitigation.

The low carbon opportunities all have considerable nexus implications and associated risks. The shale gas abstraction may use considerable amounts of water (potentially 180 mega litres per year permanently consumed), competing with agriculture, industry and household use. The nuclear power plant is planned to be located in the estuary where huge floods caused devastation in the winter of 2013–2014. Climate change is expected to result in more frequent flood events with the risk of impacts on the nuclear plant. The tidal barrage would close off Bristol harbour, affect the ecosystems of the whole estuary, including the fisheries, and create a lagoon system of unknown environmental conditions. The proposed energy policy is responsive to the need for a low carbon society, but has not sufficiently considered the links between water, energy and food security or even the possible impacts of climate change on the proposed actions. Additionally, each proposed low carbon project is being considered on its own merits and there is a lack of oversight assessing the potential cumulative impacts of these projects.

2.2 Ecosystem services for livelihood improvements and poverty eradication

Transboundary basin development provides both opportunities and threats to riparian populations. Many of the world's poorest and most vulnerable communities are critically dependent on the ecosystem services provided within these basins. Transboundary rivers, lakes and aquifers provide energy, transport, drinking water,

and sediment transport for productive agriculture and delta stability. Large deltas, such as the Ganges-Brahmaputra and the Mekong, support the livelihoods of millions of people. Their food and livelihood security is vulnerable to unnatural alterations in flow regime, the declining availability of water resources and sediment for agricultural productivity, increasing coastal instability and flood risk.

In improving access to energy, there is great potential to improve the operation and utilisation of existing hydropower plants, rather than automatically developing new ones, e.g. improve operation to increase output, improve operation and management with environmental (e.g. environmental flows) and social (e.g. programmes to address negative impacts of past relocation) considerations. This has been discussed in Viet Nam, where the energy mix is becoming more evenly distributed among the various sources with lower dependence on hydropower. This change may lead to other sustainability issues if the proportions of coal and natural gas thermal power are increasing. In the Orange-Senqu, the high exploration of the basin's hydropower potential, means that water conservation, water demand management and improved operation of existing installations (Figure 2.1) are now high priorities in order to balance demand and supply.

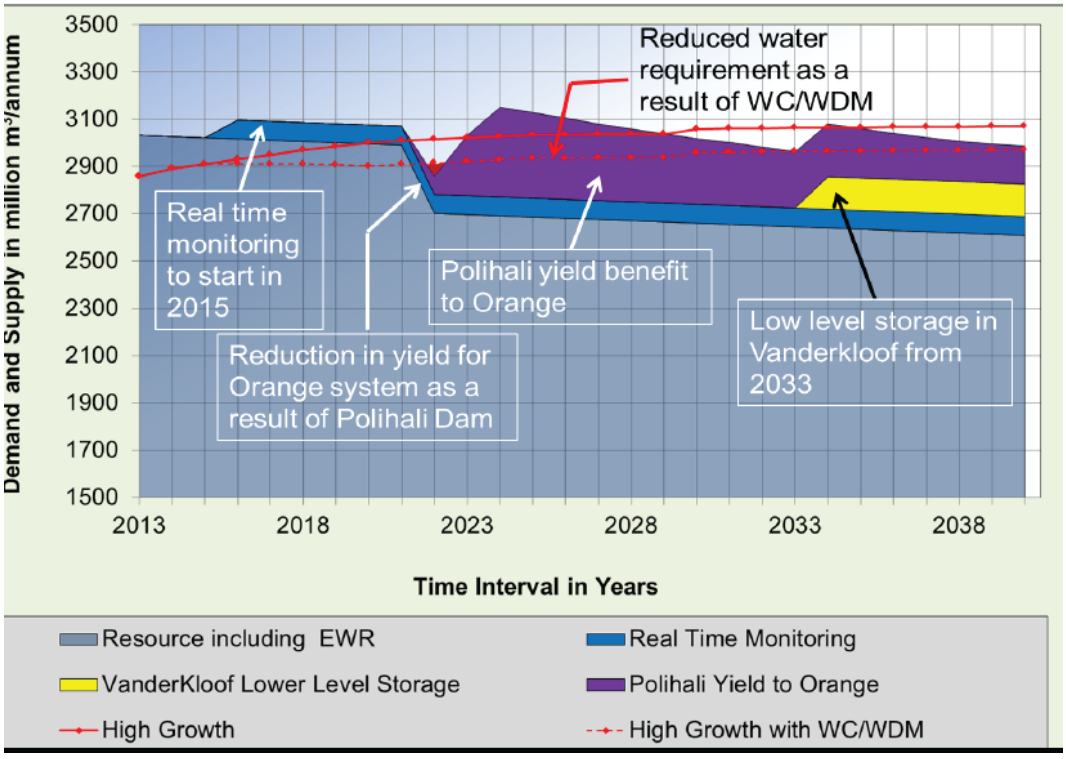

Figure 2.1: Illustration of water development scenarios to satisfy power production and other predicted water uses including ecosystems. Demand (red curves) in a high growth scenario with and without Water Conservation and Water Demand Management (WC/WDM) and supply (filled colours) following various dam developments and operational changes in the Orange-Senqu basin. The supply figures include reserves for Ecological Water Requirements (EWR). The predicted increase in water demand can be reduced by water conservation and water demand management.

Transboundary rivers provide important transport networks in both remote and more developed areas and river transport also has a role to play in poverty eradication. In large basins with remote areas, such as the Congo and La Plata river basins, river transport can be particularly important for development, providing access to goods and services such as education and health and ways to get agricultural and forest products to markets. Costs as well as impacts from inland water transport are much lower than for road transport of bulk commodities and goods. Analyses in the Congo River have shown that river transportation is 10 times cheaper than road transportation. Improvements in physical navigation, national capacities, and basin-wide regulatory frameworks and their monitoring help reinvigorate local, fragmented economic activities. This can improve food security and reduce energy consumption and emission of greenhouse gases, thus providing several nexus benefits. Improved navigation contributes to reducing transport costs of goods and people, i.e. improving the socio-economic situation in less developed areas. The safe transport of hazardous materials (such as petroleum) has positive impacts on both ecosystems and the communities that depend on them. Activities in the Mekong demonstrate how protection of environmental resources such as water quality, wetlands, fish and biodiversity and peoples' livelihood interests can improve sustainability of river transport. A range of vulnerability assessments of environment and livelihood to river transportation of dangerous good was used to develop guidelines for safe handling of the dangerous goods and establishment of emergency preparedness plans and procedures for river transportation.

In many parts of the world, transboundary groundwater resources provide irreplaceable benefits to local communities, particularly in arid areas, such as the North-West Sahara Aquifer System (NWSAS), which is shared between Tunisia, Algeria and Libya. Transboundary aquifers are an 'invisible' resource, which is too often overlooked and sometimes poorly understood, yet their key role in moving towards sustainable development seems obvious in many cases. Given relatively low recharge rates, withdrawals from aquifers are often classified as either 'sustainable' or 'unsustainable' (when withdrawals exceed recharge). In large aquifers with considerable reserves, such as the NWSAS, the recognition that current withdrawals are unsustainable can act as a driver for more efficient water use. In smaller aquifer systems, like the Genevese transboundary aquifer, shared between Switzerland and France, the situation can demand more urgent solutions, such as immediate limits on withdrawals. Experiences from highly developed areas such as the Genevese aquifer can support less developed basins to increase the societal benefits of their aquifer resources. Whether the aquifer is small in size (Genevese), or large but with relatively low lateral flow (Guarani;

shared between Argentina, Brazil, Paraguay and Uruguay), a key factor for successful management is addressing trade-offs, resolving conflicts and focusing collaboration at the local level (Box 3).

Sediment and sediment transport are critical for productive agriculture, fisheries and aquaculture, delta stabilisation and maintaining integrity of ecosystems. Studies on large deltas, such as the Nile, Mississippi and Mekong, show reduced sediment transport due to hydropower development, leading to increased coastal erosion around the delta. Findings from recent studies on the Mekong show (i) sand plays a critical role that has been underestimated in management plans and it is also a valuable resource for the construction sector; (ii) reduced sediment transport due to hydropower development and sand mining, leading to river bed incision and increased coastal erosion around the delta, (iii) surface nutrient delivery from the river to the delta plume already drastically reduced. Some of these findings were unexpected and demonstrate the high sensitivity to change of the Mekong ecosystem; thus more work is needed to understand the relative impact of existing or proposed developments on downstream sediment transport, including establishment of a detailed basin wide sediment budget. This, in turn, needs to be linked to impacts on livelihoods and ecosystems and other pressures such as climate change need to be considered. Studies on potential climate change impacts on sediment transport and hydropower efficiency have shown that increased precipitation and run-off would result in increased sediment yield and a faster reduction in storage capacity of the reservoirs. Land management, including terracing and various cropping techniques, may be possible adaptation options to reduce impacts on the reservoirs.

Box 3. Managing transboundary aquifers to improve livelihoods.

Overexploitation of transboundary aquifers is a common practice all over the world. The North-Western Sahara Aquifer System (NWSAS), shared by Algeria, Libya and Tunisia, is one of the major North African transboundary groundwater basins. Covering an area of more than 1 million km2 the aquifer has huge reserves, but significantly greater withdrawals than recharge has led to falling water levels, soil salinisation, large inputs of energy needed to extract water and rising prices of agricultural products. This puts the livelihoods of those dependent on the aquifer at risk, even though there are theoretically sufficient reserves to meet current demand. Similar issues are faced in many other transboundary aquifers, such as the Guarani aquifer, shared between Argentina, Brazil, Paraguay and Uruguay, and the network of transboundary aquifers in the Lower Mekong Basin. Experiences from the Genevese aquifer (30 sq km) shared between France and Switzerland, demonstrate how excessive withdrawals resulting in the groundwater level falling by more than 7m over 20 years can be reverted and the groundwater table stabilised through a groundwater management programme including artificial recharge and management instruments such as water rights and water pricing.

Elements of successful responses to the issues for transboundary aquifers include:

- A joint management programme or organisation with representatives from each member country, particularly from the local level, to foster cooperation and joint monitoring. This cooperation should lead to joint management plans, agreements and/or treaties. Examples include:
- the Sahara and Sahel Observatory (OSS), which provides a comprehensive consultation mechanism for all countries
- the Guarani Aquifer System Project, which stimulated debate on groundwater management within the four countries at national, regional and community levels. This led to the creation of the Guarani Aquifer Agreement of 2010, which was approved by all the transboundary countries
- the Mekong River Commission (MRC), which has included groundwater in its mandate.
- Management underpinned by strong technical knowledge of the physical aspects of the aquifer system, with mechanisms for sharing the information and feeding it into the decision making process
- A mixture of technical (e.g. water use efficiency) and 'soft' (e.g. diversify regional economic activity and promote non-agricultural job creation) responses.

2.3 Environmental and social impacts of basin developments

Development of transboundary rivers, lakes and aquifers plays an important role in the economic prosperity of entire regions and millions of people, but it may also pose a risk to ecosystems and their services, upon which some of the more vulnerable communities often depend (Figure 2.2; Box 4). Basin development, for example for power generation, can affect natural flow regimes, fish and other aquatic species, and sediment transport. Many of the impacts are poorly understood and further research is needed. There is a call for improved impact assessments, which often require improved data, information and analysis to guide policy.

Promoting sustainable development requires management of a wide range of factors and dialogue with stakeholders. Governments need to devise guiding frameworks for the private sector to assess isolated and cumulative environmental and social impacts of which water quality, sediment transport, fish population and ecosystem health are important components (see also section 7.1). In order to assess sustainability, flexible and robust indicators and assessment tools, including tools that focus on vulnerable people as well as ecosystem services are needed. Studies in the Mekong region reveal an estimated total value of ecosystem services of US$9.3 billion (Moinuddin et.al., 2011), providing a strong argument for investing in natural capital (Figure 2.2). Assessments, such as a social impact monitoring and vulnerability assessment undertaken on the Mekong mainstream (MRC, 2014a), can provide baselines on which to benchmark the value of basin development. Such baseline assessments can help to identify the dependence on natural resources and whether these resources are used for income generation or food. They allow scenarios to be explored to identify solutions to mitigate negative impacts of basin development.

The many cases of impacts of water resources development on ecosystem services around the world, such as water pollution in the Ganges and Jordan rivers, sediment trapping affecting river productivity and deltas as mentioned above and loss of biodiversity due to e.g. pollution and habitat fragmentation show that precaution and mitigation actions are not always effective. But there are examples, such as the Itaipu hydropower scheme shared between Paraguay and Brazil, where considerable effort has been made to develop environmental and social programs within the basin to try to compensate for negative impacts of development.

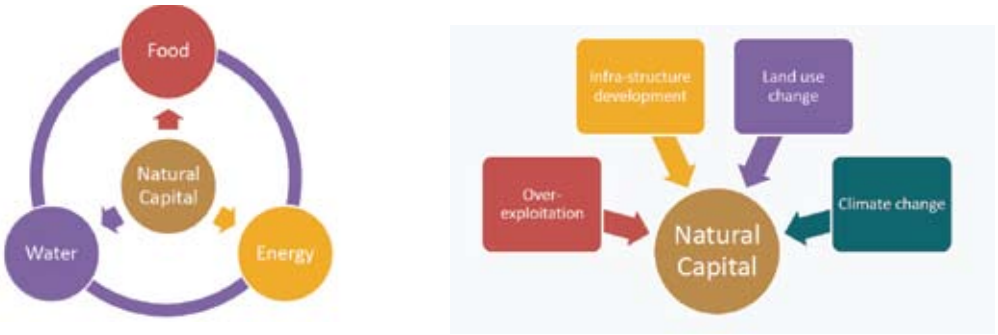

Figure 2.2 Natural capital is fundamental for economic growth and sustainability depends on the ability to manage increasing pressures.

Formalised transboundary cooperation allows not only for joint benefits of development to be realised but also for negative ecosystem impacts to be mitigated. For example, the agreement signed between Finland and the Soviet Union in 1964 provides a framework for regulation of hydropower of the transboundary Vuoksi River to maintain sufficient water levels in the upstream Lake Saimaa for the protection of the critically endangered Saimaa seal (Box 6, section 4.2). Similarly, the agreement between Canada and the US on the Columbia River was amended to include operational provision for the protection of fish species (salmon and trout) in both countries.

Both an understanding of the issues and political will are needed to shape developments and willingness to make corrections in the face of unexpected negative developments or unintended consequences.

Box 4. Fish in the water–energy–food security nexus in the Mekong

Fisheries in the Lower Mekong Basin are at the core of the water–energy–food security nexus. The Mekong fisheries are highly productive and bio-diverse, a key contributor to food and nutrition security in the Lower Mekong Basin (LMB), as well as providing employment and income. About 40% of fish species are long-distance transboundary migrants, which provide most of the catch. Carp and catfish contribute 85% of fish caught. Reduction in fish biodiversity, resulting from pressures such as dams blocking migration routes, can lead to alterations in aquatic food webs, and limited genetic diversity leads to fewer opportunities for growth and innovation in fish and fish related enterprises and thus, reduced nutrition security for mainly poor people in the LMB. Fish biodiversity is at risk, as is the contribution of fish to regional food and nutrition security. Mitigating some of these impacts requires e.g. dam construction to include upstream and downstream fish passages and other measures to increase environmental and social sustainability of hydropower. Otherwise, replacing lost proteins and micronutrients from reduced fish catches inevitably poses significant challenges. Any increase in the production of animal protein would have a high land footprint in terms of expanding pasture lands; even more so considering the current high import of animal feed stock into Thailand and Viet Nam. The nexus approach shows the need to reconcile competing demands for land and water to protect fishery habitats and maintain the highest inland capture fish production in the world.

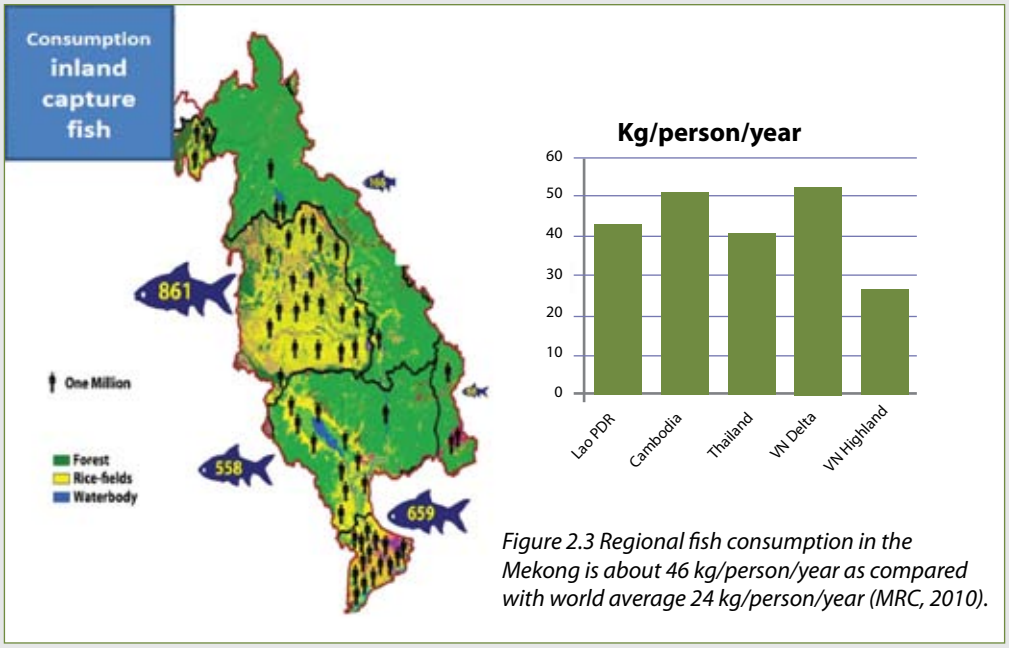

Figure 2.3 Regional fish consumption in the Mekong is about 46 kg/person/year as compared with world average 24 kg/person/year (MRC, 2010).

3. Climate change adaptation in a transboundary context

The expected changes in climate are long term even when compared with many societal changes and demographic trends. The short-term problems related to climate, such as extreme events and climate variability, are however, very much present. The longer-term changes in climate also include sea level rise and changes in temperature and precipitation affecting amongst others, hydrology, agriculture, ecosystems and human health. Improving the way society tackles the short-term issues, through various actions of river basin management will therefore in many cases also address at least part of the long-term challenges. Adaptation to a changing climate is the process of adjusting to new conditions, stresses and natural hazards that result from climate change. While the concrete adaptation actions need to be local and are context specific, the most efficient approaches to handle the larger shifts in climate and climate variability are much wider and at regional and global scale. These include development of shared climate change projections at global and regional scales, safeguarding of basin goals and objectives when climate change adaptation is planned and sharing of costs and benefits related to uneven distribution of impacts. Transboundary basin organisations can add value to the efforts of the riparian countries to find the right solutions.

3.1 Managing increased climate variability and climate extremes

Many large river basins already experience major climate variability within and between years as well as across basins, for natural reasons. This variability is reportedly becoming more pronounced. In the Senegal, for example, the difference in precipitation from north to south has been increasing over time, even before discussions about climate change began. The consequences of this climatic variability are yearly irregularities in flooding affecting agriculture, seawater intrusion affecting domestic and agricultural use of the land and degradation of natural resources, including ecosystems. Increased variation across the basin puts more pressure on transboundary cooperation in terms of sharing the burden and relief assistance. A common climate change adaptation measure is to try to reduce vulnerability to climate variability. These low/no regret adaptation strategies help in the short-term as well as in preparing for the projected long-term changes.

The most commonly experienced forms of climate variability are floods and droughts. In the longer term, increased variations in hot and cold weather may become a more predominantly experienced element of climate change, particularly related to health issues. The responses to floods and droughts are very often to provide water storage – not only dams, but also through environmental services rendered

by natural infrastructure such as wetlands, and improved land use planning in the flood plain. While dams can have negative impacts, as described above, dams operated with a climate perspective can also reduce the intensity of potential flood impacts and increase dry season water levels under drought, e.g. as claimed in the Upper Mekong River. The ability of dams to regulate flow is very commonly proposed as a climate change adaptation measure. The associated nexus benefits of storage dams providing energy through hydropower and water for agriculture and domestic use are highlighted in many basins on all continents. Utilising the full range of storage options, including improved use of natural wetlands, canals, ponds and tanks and aquifer recharge, which may be efficient under floods as well as dry conditions, may reduce the costs and negative impacts of the adaptation actions (Figure 3.1). Adaptation through local storage and land use regulations could be more efficient measures over the long run, but also more flexible considering the uncertainty of the range of projected change. An analysis of the water resources in the Orange-Senqu, where options for further development of dams are limited, revealed that demand management and operation optimisation, including joint operations of infrastructure, could significantly reduce the need for new infrastructures (Figure 2.1). Demand management has been part of the tool box in river basin management for a long time but the incentive to use it more consistently may be triggered by new conditions and trends such as climate change or the need to respond to increased variability.

Climate variability and the shifts in temperature and rainfall trends across basins due to climate change are severe challenges for countries and basin managers. There are great advantages of tackling these climate challenges at the regional level by cooperation within basins to share risk management, climate information systems (e.g. flood prediction), decision support systems (climate change impact predictions) and also to share benefits e.g. of climate opportunities.

The transition from current climate variability to more frequent extreme events is not well defined. Extreme events are intense rainfall, devastating floods and prolonged droughts. Warning systems and mitigation plans become more and more important with the expected increase in frequency and intensity of the extremes. Collaboration across state boundaries has obvious benefits and technology and communication systems based on real-time information using widespread mobile technologies are being developed, such as in the Mekong region for flood warning. Modelling techniques with weekly or daily prognoses broadcast on the MRC website have been known for years, but the focus of the new systems is real time information. Local communities, often in remote locations, are among the groups being targeted with the slogan: "information travels faster than the floods" (Box 5). Recent

extreme events in Europe have highlighted the difficulties involved in safeguarding assets and people's lives from severe floods and also shown the risk of damage to energy installations such as hydropower and nuclear power plants.

Deltas face multiple challenges as an expected consequence of climate change including sea level rise. Although different in character from the impacts mentioned above, sea level rise can exacerbate the impacts along shorelines and in river deltas. These include the impacts of floods related to a generally higher water level and therefore less capacity of the floodplains to accommodate the flood water and the impacts of salt water intrusion in rivers and aquifers during drought episodes. The range of actions to address the challenges of sea level rise includes e.g. infrastructure measures, floodplain restoration, coastal restoration, crop modifications, as well as institutional and capacity building measures. Adaptive management (see also section 5) is a key approach to tackle the challenges of climate change in river deltas facing sea level rise to avoid overinvestment while doing what is necessary to meet development goals.

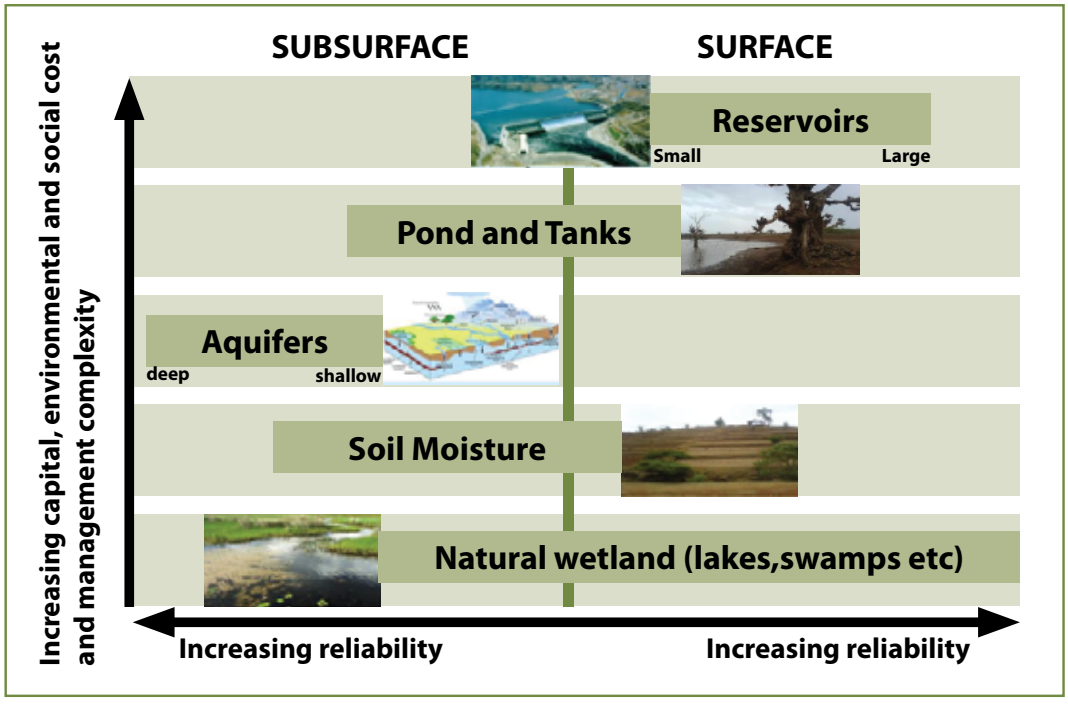

Figure 3.1. An adaptive approach – a water storage continuum (McCartney and Smakhtin, 2010).

3.2 Long-term commitment in climate change adaptation approaches

Climate change is a long-term change that requires long-term commitment in response. Many basin organisations have a long history, which augurs well for future cooperation in the context of climate change. The examples of long-term transboundary collaboration include many of the elements that are needed for climate change adaptation. River basin organisations such as the Danube, La Plata, Senegal and Orange-Senqu have climate change adaptation strategies that build on existing knowledge and ongoing collaboration systems. Managing variability is a key issue in these strategies and in some cases, such as the Intergovernmental Coordinating Committee of the La Plata River Basin Countries (CIC), 'variability' is mentioned specifically in the title of the adaptation strategy: "The Framework Program for the sustainable management of the La Plata Basin's water resources in relation with the effects of variability and climate change" highlighting the concern about short-term as well as long-term issues. Implementation is generally focused on using existing mechanisms to integrate climate change adaptation, such as flood warning and protection considerations. In the Vuoksi basin between Finland and Russia the existing agreements on high and low water level regulations are expected to be sufficient to handle the projected future changes including higher variability. However, forecasting and real-time warning become more important with climate change, increasing the probability for increasing variability and extreme events and it is planned that cooperation will be intensified as an important element in adapting to climate change. Another issue is the need to align planning horizons across a basin. This was raised as an issue of concern for the Orange-Senqu, in terms of being able to manage risks associated with uncertainties effectively, such as improving joint actions in response to the growing challenges caused by global changes.

Both technical and governance aspects of transboundary collaboration are important elements of climate change adaptation. The technical perspective includes sharing of data, information and capacity, e.g. monitoring, modelling and forecasting capacity and the governance aspects include sharing of experiences, improved and adaptive management approaches, regulation, capacity building and awareness raising. International experience, for example, the Dutch Delta (receiving fresh water from the transboundary rivers Rhine, Elbe and Meuse), the Danube basin and the transboundary water cooperation at the border between US and Mexico, highlight the benefits of adaptive management strategies based on innovative options that work with nature, no/low regret options, research and capacity building, and deferral of major and costly infrastructure projects to keep options open while ensuring a range of options are available before critical security thresholds are reached.

A range of these 'softer' approaches to climate change adaptation are often categorised as low or no-regret options, meaning they are beneficial to society even if future predictions do not materialise. Experience in the Dutch Delta, for example, shows that the uncertainty associated with the projected long-term impacts of climate change calls for much more flexible and adaptive approaches to avoid over-investment. Considering the costs associated with large infrastructure projects, more flexible, 'softer' options are also more attractive for developing countries unable to raise the capital needed for large investments. An adaptation strategy (such as the Danube's strategy) will often include a list of adaptation measures, where those evaluated as low/no-regret options are given priority. This is also the approach used in the Water, Climate Development Programme in Africa (WACDEP) being piloted in collaboration with GWP in five shared basins: the Lake Chad, Limpopo, Kagera and Volta basins and the North-West Sahara Aquifer System.

While adaptation actions may be local in scale at implementation, their consequences can be regional and should be safeguarded regionally through transboundary cooperation to share risks and maximise regional benefits.

3.3 Advances in capacity underpin solutions

Transboundary basin organisations are well placed to support capacity improvements and development of methods which will provide the scientific basis as well as a negotiation platform to design and agree on climate change adaptation strategies. The expected changes in climate have a regional scale and so projections of climate change and its impacts need to be made at this scale with downscaling to the local level if necessary and feasible. The selection of global climate change scenarios and downscaling them to the regional level is, however, still a major challenge faced by many regional basins.

The robustness and credibility of information to support decision making processes can be greatly enhanced by monitoring, modelling and operational systems, which become even more relevant and necessary with global changes. Managing variability requires improved collaboration, as mentioned above, but also more knowledge through scientific advances. In particular, addressing 'extreme' flood and drought events will require much analytical work, as well as cooperation and negotiation between countries, to develop acceptable and feasible adaptation strategies and plans at the basin and delta scales. The good news is that completed and on-going climate related studies are making progress to inform decision makers about policy options and best

solutions in all parts of the world, including transboundary basins such as the Mekong, La Plata, Orange-Senqu, Sava and Congo. Integration of climate change in flood and drought management involves access to a range of data, monitoring and modelling tools in order to cover in full the complex hydrology of large transboundary basins. In the La Plata basin, for example, climate change projection scenarios, downscaling and hydro-meteorological and hydro-climate services are provided at the regional level to support efforts dealing with water, energy and food security concerns. Modelling efforts would, however, be huge endeavours, should they cover all aspects at a level matching the local scale and the information needs of the local planning of adaptation action. Modern techniques can therefore be used to visualize results and can in some cases help overcome information shortfalls. This includes e.g. remote sensing, satellite data and GIS techniques (Figure 3.2).


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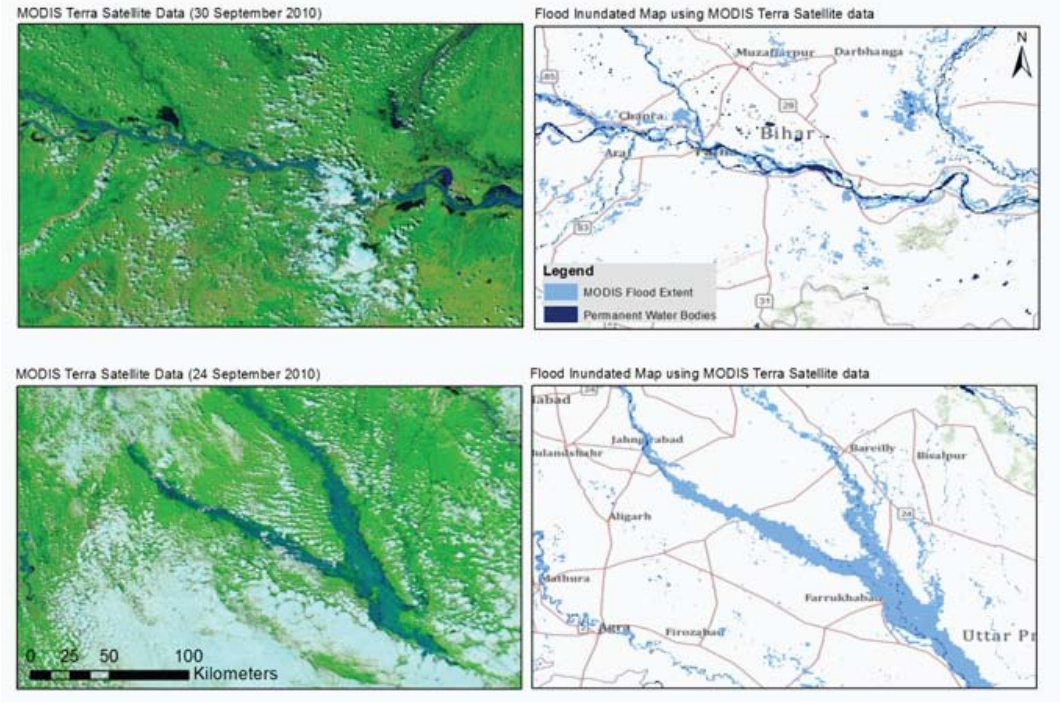


Figure 3.2 New approaches to quantifying the extent and risk of flood events – an example for the Ganges (Amarnath et al, 2012).

At the operational level, real-time flood monitoring and warning and improved communication technology can provide simple and low-cost solutions for emergency preparedness, local adaptation and disaster risk reduction connecting with remote areas. In a transboundary context this requires collaboration to agree on protocols that allow some harmonisation of technologies across borders in order to ensure sufficient reliability and credibility of the systems. Quality assurance, e.g. maintenance and regular systematic testing, is important and riparian ownership is necessary to make sure reliability is prioritised (Box 5).

Box 5. Operational climate change adaptation – flood protection and warning system

The Hindu Kush-Himalayas and the Mekong region are both vulnerable to recurring riverine and flash flood disasters, mainly from transboundary rivers and during the monsoon season. In the Hindu Kush Himalayan (HKH) region the 2010 floods in Pakistan killed 2000 people and affected more that 20 million and the recent flood disaster in Uttarakhand was reported to have killed more than 5000 people. Similarly, in the countries of the Lower Mekong region more than two million people are affected by floods on average annually, reducing agricultural production and resulting in large economic losses of US$61 million per year. The increased adverse impacts of floods in both regions calls for integrated approaches to flood risk management at a basin scale. New techniques and approaches are needed to make the information travel faster than the floods.

In response to these needs in both the regions Hydrological Cycle Observing System (HYCOS) programmes have been launched under the World Meteorological Organization (WMO)'s global framework of the WHYCOS programme to support disaster prevention and flood risk management thereby protecting lives and livelihoods from recurring flood disasters and promoting cooperation across national boundaries. In the HKH-HYCOS, real-time data from 38 hydro-meteorological stations from four countries are available in a flood information system. While in the Mekong HYCOS, 49 stations provide the flood situation in five countries. Both the HYCOS programmes are focused on state of the art technology for data collection, transmission and operation to support flood forecasting at the national level and data exchange and information dissemination in both the national and regional context. Quality assurance, harmonisation and interoperability are among the key challenges to make the systems work across national borders. A spirit of cooperation that is 'willing to give more than what is available to take' and to recognize the mutual benefits rather than requesting equal benefits were discovered as important aspects to improve the functioning of the state of the art technologies.

While the HKH-HYCOS has advanced in the areas of developing robust data collection and transmission systems, forming partnerships with telecom operators, the Mekong HYCOS leads the way in displaying project ownership through better maintenance of the sites as well as instruments.

Uncertainty is an inherent characteristic of climate change adaptation and, while science is used to inform policy makers about uncertainty, it is a huge challenge to convey this understanding to the policy and implementation level. Communication of the results of climate related studies, including the implications of uncertainty needs to be much more effective. It is important to recognise that we know a lot about the changing climate. Scientists need to qualify that information, describing what is known as well as focusing on uncertainties. An improved science-policy dialogue is essential to improve the understanding between policy needs and what science can offer.

Scenario modelling and calibration with data on the ground is being used as a method to test robustness of adaptation strategies, recognising the importance of learning from past mistakes e.g. in responding to extreme floods. Significant advances are being made in technical capacity and the studies and results appear very relevant to the policy challenges of climate change adaptation. Further analytical work will need to be based on a water, energy and food security nexus approach in order to identify the synergies and trade-offs and capture 'climate proof' and beneficial development opportunities.

4. Benefits of transboundary cooperation

The threat of reaching critical thresholds of water scarcity that could compromise human consumption, economic progress and environmental integrity is a powerful motivator for transboundary water cooperation, but there are many other issues, such as the need for economic development, disaster risk reduction, degrading water quality, threats to biodiversity and the need to increase resilience to climate change, which bring and keep transboundary organisations together. In its 2006 Human Development Report, the UNDP defines transboundary water cooperation as "the exchange of baskets of benefits that add to the aggregate welfare of both riparian countries" (UNDP, 2006). Regional benefit sharing is not about one country sharing the 'profits' it makes from using water with other countries. Rather, regional sharing of benefits is about increasing cooperation among basin countries with a view to increasing regional benefits and minimising costs for mutual gain of each country and mitigating transboundary impacts and risks from using the basin's water resources.

4.1 Agreements for transboundary cooperation

Although the status of transboundary water cooperation as reflected by the numerous treaties and agreements (about 250 in 113 basins; SIWI 213) in

river and aquifer basins throughout the world is encouraging, transboundary water management still requires difficult technical and political trade-offs. Building cooperation is a challenging, dynamic and continuous process. History shows that cooperation based on transboundary basin agreements can be longstanding and evolve continuously such as in the La Plata and the cooperation between U.S. and Mexico on transboundary rivers both more than 100 years old. Slow progress or deadlocks may occur, but there is a strong sense that turning back is not an option as for example, expressed for the Nile.

While many agreements include provision for cooperation on a broad range of issues related to integrated water resources management (IWRM) relevant for the basin, e.g. the Aral, Nile, Niger, Senegal, Orange-Senqu, Danube, Sava, La Plata and Mekong, some agreements were established to solve a few specific transboundary cooperation issues. Examples are power production and flood control in the Columbia Treaty, power production in the Itaipu and Salto-Grande, navigation in the Congo and flood and drought control in the Ganges. Some of the agreements with a narrow scope are being gradually expanded to adapt to changing realities and concepts. For example, the Congo agreement now addresses IWRM, even though navigation remains the key issue and the Itaipu Project promotes socio-economic development more broadly (e.g. agriculture, tourism) and embraces social and environmental responsibility.

The Ganges and Columbia Treaties are examples of transboundary collaboration, where the riparian countries in the further development and revision of existing agreements aim for a more comprehensive framework to negotiate and solve their common problems efficiently and equitably. These examples show that transboundary agreements and management bodies need to adapt to changing environments and often broaden their scope in line with a more comprehensive understanding of water resources management and sustainable development.

Transboundary cooperation agreements do not always include a transboundary river basin organisation such as for the basins mentioned above. Bilateral agreements covering several rivers exist between two countries such as between Finland and Russia sharing 18 watersheds and between Bangladesh and India, which established a Joint Rivers Commission as an umbrella organisation for the management of the more than 50 shared rivers between the two countries. Specific water treaties to address specific issues were established between Bangladesh and India e.g. the Ganges Water Treaty. The transboundary cooperation can also exist as practical agreements on hydrological information sharing, such as between China and some of its transboundary neighbours.

Although numerous transboundary cooperation agreements exist, their success can be restricted by a lack of detailed and

enforceable conflict resolution mechanisms. For example, in the Salto-Grande basin between Argentina and Uruguay, the dispute over construction of paper pulp factories on the Uruguayan side of the river was finally taken to the International Court of Justice for settlement. Better cooperation also means identifying clear but flexible collaboration mechanisms such as water allocations, water quality standards and information sharing, taking into account changing basin dynamics, hydrological and climatic events and societal values (SIWI, 2013).

For transboundary cooperation agreements to work effectively, a combination of political will, technical cooperation, effective dispute resolution mechanisms, and an inclusive process involving all stakeholder groups is needed. The Ganges Water Treaty between India and Bangladesh, which was only implemented after years of dispute and finally intervention from the UN, is an example of the need for building political will over time.

4.2 Governance and institutions

Equitable sharing of water resources is becoming an increasingly complex issue due to population and economic growth, development pressures and changing needs and values. Competition among different water uses and users has increased in almost all countries, as have the links connecting them, calling for more effective negotiation and allocation mechanisms (SIWI, 2013).

Some of the challenges, which water managers face in putting the concept of regional cooperation and benefit sharing into practice, are:

- Power asymmetry and disparity among riparian countries in socio-economic development
- Historical and cultural setting affecting the future options for cooperation
- Technical complexity and, lack of capacity
- Benefits often not evident to countries including difficulties of measuring hidden benefits such as regional stability and peace.
- Different priorities and strategies to utilise water resources

There are, however, examples of long-term cooperation developing well-functioning operational schemes that serve several purposes (e.g. flood protection, biodiversity conservation, hydropower generation) and provide different types of benefits to the parties (Box 6). Similar cooperation benefits are experienced by Canada and the U.S. through the Columbia River Treaty. While complexity and scale are very different when comparing these examples and the very big river basins such as the Nile, Ganges, La Plata and Mekong, the demonstrated very concrete and operational cooperation may also provide inspiration at other scales and complexity.

The second pan-European regional assessment on the conditions of transboundary waters and the effectiveness

of measures taken carried out by UNECE in 2011 highlighted as key issues, the frictions between sectors about water use in many basins, and a weak policy integration and coherence. Supporting the countries and transboundary basin organisations in using the nexus approach was initiated to address these problems (Box 1).

Box 6. Long-term cooperation provides multiple benefits to Russia and Finland

Finnish-Russian Transboundary Water Cooperation encompasses all transboundary inland water, covering 18 watersheds, of which most water flows from Finland to the Russian side. The agreement was established and signed in 1964. One of its main achievements has been the Lake Saimaa – River Vuoksi discharge rule, which took nearly 20 years to finalise. The catchment area is about 70,000 km2 of which three-quarters, including Lake Saimaa, is in Finland. The Vuoksi river flows from Finland to Russia. The total installed power in the river system's four hydropower plants is 440 MW. The discharge rule, which was implemented in 1991, allows for discharge from Lake Saimaa to be increased or reduced when the water level forecast is outside a 'normal zone'. The discharge rule allows the upstream country (Finland) to increase or decrease the downstream flows to e.g. protect against flooding or ensure a certain water level in Lake Saimaa to allow the endangered Saimaa seal to nest – requires a maximum water level during winter. The difference in electricity production between the natural flow and the altered flow is converted by the current electricity price to a compensation to be covered by Finland in certain cases. This allows Finland to protect its population and the environment while compensating the downstream partner (Russia) for the associated loss in revenue. The main aim is to minimise adverse consequences of floods and dry periods in the river system as a whole. The operational regulation is planned weekly by sharing forecasts and agreeing on the operation, while the compensation is settled per event.

The nexus approach is useful for analysing and diagnosing problems and analysing trends and options, whereas the implementation of actions to address the issues does not require full institutional integration. Implementation will, and should, still take place through existing mechanisms and institutions – but bearing the nexus approach in mind. It is important to ensure that all sectors understand nexus implications and develop mechanisms to bring actors to the table at appropriate times. In many cases these mechanisms already exist, for example basin organisations, which can provide a way of bringing sectoral representatives together. The approach has proved useful in achieving more sustainable outcomes in transboundary river basins, such as the Sava, which is undergoing significant development across a range of sectors, including hydropower, tourism, navigation and agriculture.

Transboundary basin organisations need to build and maintain robust operational and monitoring systems (governance and field level) to maintain a complementary function to individual state structures. While technical cooperation can provide a way to move transboundary cooperation forward, the technical track needs to be followed by a strengthened dialogue to bridge the differences at the political level to ensure this cooperation really does take place.

The international community has played a role in facilitating and supporting transboundary cooperation in many basins and it is a challenge for the basins to sustain the gains and keep the momentum in moving the cooperation between the riparian states forward. Exploring innovative partnerships and continuing to leverage funding for priority programmatic areas remains an ongoing effort.

4.3 Valuing and sharing benefits of cooperation

Over the past 10–15 years the focus has shifted from the volumetric allocation of water between states to the sharing of benefits derived from the use of water (Hensengerth et al., 2012; UN-Water, 2008). The advocates of the benefits sharing paradigm argue, that the shift from sharing water quantity to sharing the broader benefits would help riparian countries to consider transboundary water in the basin as a common and pooled resource (Sadoff and Grey, 2002). With this perspective, riparian countries should focus on optimising the generation of basin-wide benefits. Others argue that while the broader benefits of cooperation may exist, realisation requires specific agreements on often disputed property rights and enforcement mechanisms (Dombrowsky, 2009). Thus, the implementation of the benefit sharing concept is technically challenging and institutionally demanding. The availability of information about the benefits of cooperation is a key factor in influencing a country's decision to enter into cooperative management (Box 7).

Box 7. Quantification of benefits of transboundary cooperation.

In an attempt to quantify the benefits of transboundary cooperation, SIWI (2012) carried out work on benefit sharing in the Euphrates and Tigris basins. The study looked at the value of agriculture and hydropower, included information on wetlands and salinity and modelled water use efficiency (WUE). They developed a hydro-economic simulation model to model potential marginal benefits in monetary terms from using saved water gained through irrigated agriculture WUE improvements. The model is designed for stakeholders to be able to ask questions on the merits of cooperation and to explore cooperative policy options. A 'shadow value' approach was used to indicate the cost of using saved water for environmental flows. This value is used to compare the cost of acquiring saved water for environmental flows from other productive uses in the basin (hydropower and irrigated agriculture).Water use efficiency improvements in irrigated agriculture were modelled as the main driver for water saving in the 13 sub-basins. Simulations using the hydro-economic model illustrate that with saved water resulting from a 30% irrigated agriculture WUE improvement in all sub basins the value of the marginal benefits could range from $US200 million to $US1.45 billion, depending on the scenarios. The potential productive uses of saved water are significant and could be jointly managed across the sub basins for a range of productive uses including hydropower, irrigated agriculture, salinity management, wetlands and sea coast ecosystem goods and services.

A review of case studies of benefit sharing in eight international river basins shows that commonly, transboundary benefit sharing is founded on the principle of a win-win outcome, underpinned by an appropriate legal framework (MRC, 2014b). Benefit sharing agreements can include all transboundary basin countries or can be a sub-set, often just two countries. Issues are often encountered in agreements on benefit sharing when:

- Social and environmental costs are not included at the beginning – leading to unforeseen costs to one or other country, e.g in the Senegal Basin where discussions about how to bring these costs into the equation are ongoing
- National-to-local benefit sharing mechanisms are weak – leading to less satisfactory outcomes than intended
- Agreements are inflexible to deal with changing circumstances (such as energy market price fluctuations) – leading to tensions between countries.

The review showed two common features for success:

(i) A mutual benefit in the developments taken up – e.g. the La Plata Basin, where bilateral projects, such as the Salto-Grande between Argentina and Uruguay, are based on equal equity and benefits; and the Columbia River, where central investments are made by upper riparian countries against an agreed payment process from lower basin countries. By contrast, the Ganges water treaty has no economic incentives to bind the parties together, making it a fragile agreement that relies on political goodwill and neighbourliness.

(ii) A legal framework fit for purpose – A wide range of agreements have been used to underpin benefit sharing arrangements. La Plata has an overall treaty binding all the riparian countries together in a manner similar to the Mekong Agreement. The agreement also has scope for bilateral agreements for specific benefit sharing, such as the Salto Grande between Argentina and Uruguay.

Experience in many international river basins shows that benefit sharing is implemented in different ways according to circumstances. Typically, a central aim is to exploit opportunities to accelerate socio-economic development and to increase national revenue in a manner that one country alone could not achieve. This generally involves creation of major new infrastructure to develop and manage a shared water resource more effectively (see also Box 8). Joint ownership of infrastructure is often taken up with joint investment and predetermined sharing of costs based on expected benefits, e.g. flood control, water supply, energy, navigation, irrigation.

Box 8. Benefit sharing in the Senegal River Basin

In the Senegal river basin, shared between the countries of Senegal, Mauritania, Mali and Guinea, the Organization for the Development of the Senegal River (OMVS) is a basin organisation created in 1972 between Mali, Mauritania and Senegal. Guinea joined in 2006. Its objective is to promote economic development through irrigation, hydropower production, navigation, potable water supply and environment protection. According to a 1978 convention, the OMVS structures are jointly owned by the member countries, meaning that the countries party to the convention have rights to collective use of these works. With this notion of common ownership, national sovereignty is ceded for the greater good of shared interests and solidarity.

Through the agreement two large dams have been constructed: the multi-purpose Manantali Dam in Mali, with a storage capacity of 11.5 billion m3 and an irrigation potential of 225,000 ha and the Diama dam on the Mauritania-Senegal border, which provides fresh water year round for agriculture, livestock and domestic use. The two dams have been implemented under joint ownership in equal share. Investment and operating costs are shared in proportion to a pre-determined estimate of benefits accruing to each country in irrigation, hydropower and navigation. Negotiation of these proportions was not easy and reflected a degree of mistrust between the countries over what would be fair. At the outset, environmental and social costs/impacts were excluded, although discussions on bringing these into the equation have started and are ongoing.

The expected benefits for each country of the dams (built in the 80s) have yet to be fully realised. Environmental and social challenges have arisen as a result of changes in the basin ecosystem due to the dams. Nevertheless, through cooperation the countries have realised benefits, which they would not individually have been able to achieve.

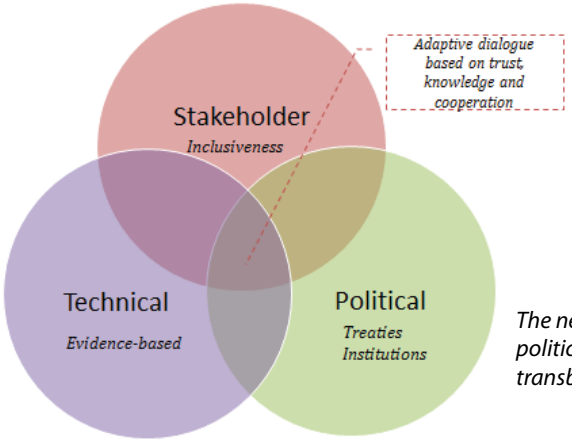
Part 2

Key features of successful transboundary basin management

This part of the report captures some of the cross-cutting issues addressed at the conference. It includes discussion of the political framework and will, scientific evidence and technical capacity and stakeholder involvement. These are all important management basics, regardless of the issues and context of the individual transboundary basin and the conceptual framework in which it is studied and managed (Figure I).

The compilation and sharing of knowledge and data is the basis for regional collaboration. Technical cooperation, such as diagnostic studies, hydrological and water quality monitoring and modelling can be an effective way to start and gradually build a wider framework of cooperation. Stakeholders can see benefits from these collaborations, thus motivating further steps and triggering political will. Formal/ institutionalised cooperation frameworks (even interim/transitional forms) that look at opportunities as well as challenges to sustainable development and management of shared waters, make transboundary cooperation in complex basins possible.

Basin institutions are not static. They change and evolve to accommodate changing contexts and to meet emerging challenges, reflecting that transboundary water resources management is an iterative and participatory process. Transboundary cooperation can contribute to peace and security between countries. The extent to which this occurs depends on the will for inclusive cooperation. Long-standing cooperation does not guarantee that cooperation will continue if stakeholder participation and consultation are not part of the cooperation framework as illustrated below.



The nexus between technical capacity, political will and stakeholder involvement for transboundary river basin management.

5. Policy development embracing adaptive management

Accessing sufficient water, energy and food is a daily struggle for many of the poorest people throughout the world. Resource depletion and environmental degradation can lead to local competition for resources, migration, violence, terrorism, and the emergence of ungovernable spaces, with the potential for international repercussions (Andrews-Speed et al., 2012). Similarly, substantial risks for economic and social development can only be overcome if interaction and interdependencies among these areas in developing policies and strategies are consistently incorporated (World Economic Forum, 2011). Climate change risks increase the pressure on society as well as the uncertainties of the future.

The increasing pace of change and the uncertainty calls for more flexibility and the ability to adapt to changing circumstances in policy development. Iterative and pragmatic approaches are needed within an adaptive management framework.

5.1 Transboundary agreements and institutions supporting flexibility

Taking account of variability is not new in transboundary river basin cooperation. Variability has historically been part of international treaties – even as far back as 1863 in the Meuse River treaty between the Netherlands and Belgium. Many treaties include monitoring and conflict resolution provisions, which are essential for adaptation to changing conditions. A lack of flexible mechanisms to incorporate variable and changing conditions can lead to conflict, such as occurred during multiple years of drought in US/Mexico; and during low flow conditions in the Ganges, due to mistrust over the Farakka agreement that was intended to guarantee water from India to Bangladesh in the dry periods (Box 11).

Climate change adds a new dimension by increasing variability, extremes of weather and rising sea level. Some of the mechanisms used to ensure flexibility and address variability in transboundary agreements include:

- Flexible allocation, e.g. percentage allocation rather than absolute volumes
- Multi-faceted adaptation – e.g. increasing storage potential using existing storage opportunities more efficiently; including natural, local storage (wetlands, ponds etc.) and linking management of surface and groundwater systems
- Formalised communication – data exchange, notifications, political consultations – e.g. on drought and flooding
- Broadening scope of cooperation – e.g. covering nexus considerations and trade-offs integrating the nexus sectors using existing mechanisms (Drieschcova et.al, 2008).

Transboundary basin agreements can suffer from a lack of flexibility because of a narrow scope where the focus is on only one or two issues, e.g. the Columbia, Ganges and Congo. Some agreements have been gradually extended to improve water resources management as the need arose – in itself an adaptive management response. One example is the collaboration over the Columbia River between Canada and the US, which has faced challenges to integrate non-power requirements, like environmental flows and salmon fishery issues, within the rather narrow treaty covering only flood control and power production on both sides of the border. Supplementary operational agreements have been made to the benefit of both parties. Canada desired adjustments in reservoir releases for whitefish spawning in winter and trout spawning in spring and the US desired additional water from Canada to augment river flows for salmon. Canada exchanged power to the US in compensation for lost power production.

Broad agreements, such as the Framework Agreement on the Sava River Basin on the other hand, which covers most sectors and the main issues of river basin management (Figure 5.1), provide a high degree of flexibility for cooperation. This allows new management concepts to be introduced or a new understanding of relationships to be used as part of transboundary river basin management without having to change or amend the treaty or agreement. The water, energy and food security nexus is an example of a new understanding or concept being introduced. Its relevance and potential for identification of solutions and win-win situations have been widely demonstrated for many transboundary river basins (see examples in Part 1). Implementation through existing mechanisms and institutions as mentioned earlier (section 4.2) can support flexibility and adaptive management. In many cases these mechanisms already exist, for example basin organisations can provide an opportunity to bring sectoral representatives together. Those with a broader scope may be in the best position to benefit from these opportunities.

Transboundary aquifer agreements can seem narrow in scope as they concentrate on water abstraction and recharge, but the users can represent several sectors, including the environment. The potential of these agreements to increase flexibility of management options is high, particularly when management of surface and groundwater systems is linked or at least supports each other. An example is the Northwestern Sahara Aquifer System (NWSAS) shared by Algeria, Libya and Tunisia (Box 3). Consultation between the three countries led to recommendations for sustainable management of the aquifer system. The farming sector is the major water consumer in the region and the energy costs of water extraction and water prices are high, implying that prices of agricultural products rise when groundwater levels fall e.g. due to over-abstraction. Collaboration on the

NWSAS initiated activities to improve sustainability at the farm level by adapting cultivation types to fit with the climate and improving water use efficiency This has led to improved water management and increased agricultural productivity and reduced prices, thus demonstrating a scope that is broader than traditional aquifer management.

Active / Field of work	E	F	N	H	A	T	C
River Basin Management Olan (EU WFD)	+	+	+	+	+		+
Water and Climate Adaptation Plan		+	+	+	+		+
Integated Information System (INSPIRE Dir.)	+	+	+	+	+		
Navigation	+		+	+		+	
Tourism	+	+	+	+		+	

E - Environ protection
F - Flood management
A - Agriculture
N - Navigation
H - Hydropower
T - Tourism
C - Climate change

Figure 5.1. The broad scope of the International Sava River Basin Commission illustrated by a matrix of inter-sectoral coordination.

Within some transboundary basins, arrangements exist between a sub-set of countries e.g. bilateral projects or agreements. These can provide a flexible mechanism to facilitate overall transboundary cooperation and provide tangible outputs that would otherwise be difficult to achieve. Such arrangements may be operational agreements on infrastructure projects, such as in the La Plata basin or they may be various kinds of technical cooperation, which demonstrate the added value of the transboundary activities and motivate further cooperation, creating trust and triggering political will, such as experienced in the case of the Nile.

The La Plata hosts a number of bi-national infrastructure agreements. The 'umbrella' organisation (the Intergovernmental Coordinating Committee) promotes sustainable development and cooperation across all countries adding value to the 'mix' of binational agreements e.g. the collaboration on responses to climate change variability and change (Box 9).

In the Mekong, a number of bilateral management projects involve two countries in projects concerning various issues related to IWRM (Figure 5.2). These bilateral projects have elements such as fisheries management, water management and establishment of river basin committees implemented at sub-national level to support collaboration between local authorities on both sides of a border. Ideally, these projects would facilitate policy development and water resources management from local to national and transboundary levels. Ensuring this connection between management levels is a huge challenge, but nevertheless considered the answer to many of the problems encountered in watershed management (Bach et al., 2011).

The Genevese transboundary aquifer arrangement is a different type of example of long-term, successful local collaboration across national borders between the Canton of Geneva and the prefecture of Haute Savoie in France. A key success factor to the collaboration of more than 30 years has been addressing a problem relating to international water resources at the local level (Canton of Geneva and Department of Haute-Savoie) by a technically capable committee rather than at a national level. Transboundary co-management at the local level has reversed the trend of deterioration of the resource and re-established the groundwater level.

The cooperation between a sub-set of basin countries and transboundary local-scale collaboration are examples that add to the toolbox of adaptive and flexible management mechanisms. While the bilateral cooperation through agreements and projects may be operational in delivering tangible results it is complementary and the basin should remain the basic unit for overall planning and management.

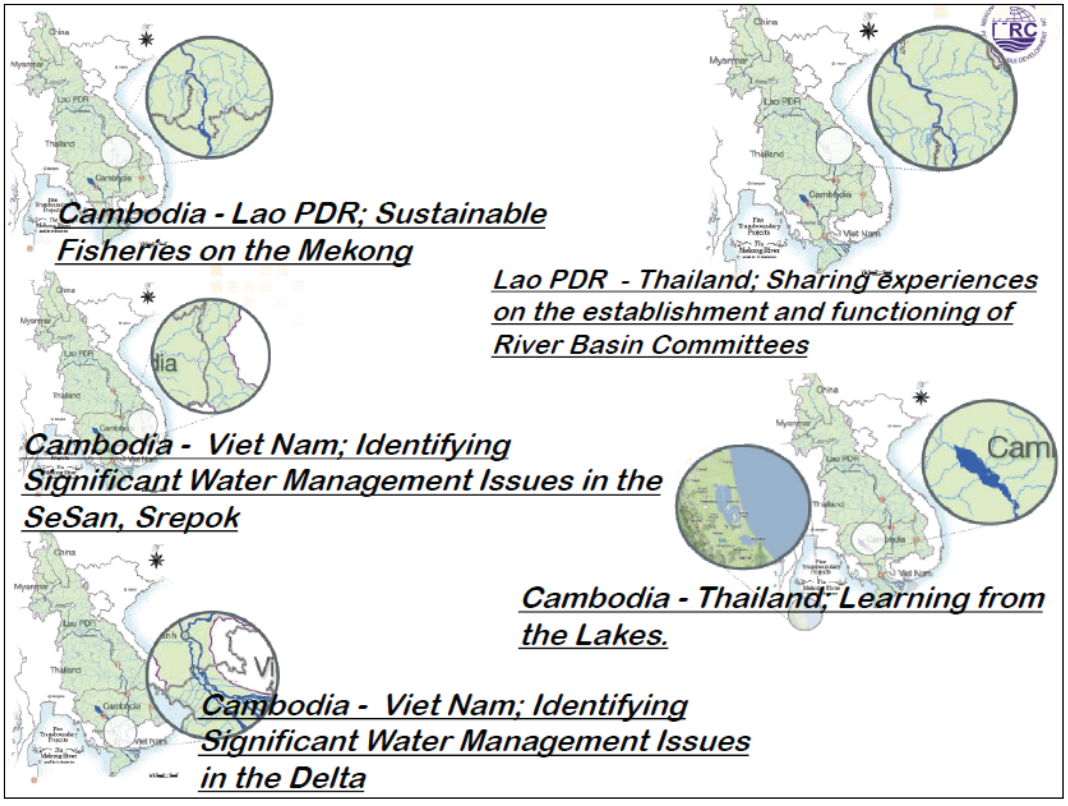


Figure 5.2 Bilateral IWRM projects in the Lower Mekong Basin.

Box 9. La Plata Basin cooperation

The La Plata Basin drains about one-fifth of South America (3.1 million km2) and its boundaries cover five countries: Argentina, Bolivia, Brazil, Paraguay and Uruguay. Critical transboundary issues include extreme hydrological events connected with climate change, water quality degradation, sedimentation, biodiversity, non-sustainable use of fish resources, and non-sustainable use of aquifers.

Three large transboundary dams – Itaipu, Yacyretá and Salto Grande – are operated through bilateral agreements. As well, the Guarani transboundary aquifer is part of the collaboration through the 2010 Guarani Aquifer Agreement.

The La Plata Basin treaty was endorsed in 1969 by the governments of the five countries. It consolidates the Intergovernmental Coordinating Committee of the La Plata Basin Countries (CIC).

A framework programme for sustainable management of the basin's water resources has been established to strengthen transboundary cooperation and coordination. One of its objectives is to strengthen cooperation between countries to ensure integrated and sustainable management of shared water resources within the context of climate variability and change. Components of the plan include strengthening basin-wide cooperation capacity for integrated hydro-climate management, which involves harmonising institutional and legal frameworks. The programme also includes components of IWRM and hydro-climatic models and scenarios for adaptation. A strategic action plan will be completed by 2015.

5.2 Adaptive approaches in transboundary river basin management

Analyses using the nexus approach, and including other important factors such as climate change, ecosystem services, drought and flood control, are useful tools to identify policy disconnects. This is clearly demonstrated in the case of the Severn River Basin between England and Wales, where proposed climate mitigation policies for the energy sector were found to exert a heavy toll on food and water security and environmental services of the basin (Box 2). Using a nexus approach would have enabled a better coherence of the various sector policies.

Global trends, including climate change,

have a much greater influence on basins than in the past. At the same time, these trends are fluctuating and uncertain, as demonstrated by the recent Global Financial Crisis and the continued debate over climate change. Management, therefore, has to incorporate uncertainties in their risk analysis and managers must act, even though the knowledge they act upon is associated with uncertainty, unless inaction is deliberately considered the best policy option. One way to handle this is to work in parsimonious iterations, using step-wise and cyclic approaches, regularly checking the need for revision and updating of strategies, plans etc. This approach was used when the Danube developed a climate change adaptation strategy in 2012. Another reaction to uncertainties is to try to reduce risks. Aligning the planning horizons of states sharing a transboundary river was found critical in the Orange-Senqu to underpin the value of joint actions at basin level. Selecting development options with regional benefits such as national projects that create opportunities elsewhere reduces transboundary impacts and risks.

As well as flexibility in agreements (as elaborated in section 5.1), adaptive arrangements require more information exchange, greater dialogue and defined procedures. External as well as internal conditions must be allowed to shape the collaboration over time otherwise it becomes irrelevant. Making this happen, however, is not easy. For example, the Senegal Basin organisation, OMVS, has since 1972 had an objective that covers economic development involving multiple sectors, but from the start with limited consideration of the associated impacts on social and environmental conditions (Box 8). This has challenged the value of the cooperation even though it had delivered according to the initially defined expectations.

Delta managers face specific challenges with the delta integrating the sum of all the changes in the basin upstream as well as the specific issues related to the interactions between fresh water and the sea (e.g. salinity intrusion, tidal variations, sea level rise etc). Considering the range of uncertainties, a new and adaptive approach to management is required (Box 10).

One essential step to enhance adaptive capacity is to develop strong science-policy dialogues involving science, policy and civil society in an iterative process that results in consolidated, evidence-based solutions. Ingredients of effective transboundary science-policy dialogues include:

- Public participation in decision making by full range of stakeholders
- Robust communities of practice that link policy makers, managers, scientists and social scientists from both or multiple sides of border
- Strong transboundary institutions
- Recognition of interconnectedness and inseparability of the issues involved, e.g. the nexus issues
- Trust - needed for genuine transnational cooperation
- Access to comparable data and reliable information flows

Box 10. Adaptive management – learning from the past and keeping options open

Almost 60% of the Netherlands is subject to flooding, making protection against floods a major priority for the country. Measurements show that sea level is rising and subsidence is occurring. More extreme weather with more wet periods is expected. In response to these threats the Dutch government introduced the Delta Programme, which is a long-term program for water safety and supply for the delta, which receives fresh water from the rivers Rhine, Elbe and Meuse. The goals of the program are to keep the country safe, with a plan to 2100 and a guaranteed supply of fresh water.

The Delta Programme is a national programme in which the Dutch government, provinces, municipalities and water authorities work together in collaboration with civil society organisations, the business community and knowledge institutions under the direction of the government commissioner for the Delta Programme (the Delta Commissioner). A Delta Act became law in 2012 and a Delta Fund of €1 billion/year to guarantee long term financial stability.

The approach aims to be prepared in advance to avoid a disaster occurring rather than having to respond to one. It is an example of adaptive management that examines and learns from past experiences, avoiding major, costly infrastructure investments that would lock future options and actions. In this way the Delta Programme keeps its options open, allowing for appropriate timely actions in response to climate change impacts and other drivers of change.

6. Science-policy dialogue

Transboundary collaboration should be based on scientific evidence that supports the development of strategies and plans. Similarly, when plans are implemented, their impacts, positive or negative, need to be monitored. This requires data and information about the shared river or aquifer system. Using the nexus approach also needs to be based on scientific evidence of trade-offs and gains.

These days, technical advances in support of water resources management and climate change adaptation are often delivered with a better understanding of the uncertainties of our knowledge, particularly regarding future developments and their impacts on natural resources. The interactions between human activity and environment are very complex. Our knowledge about these interactions is improving and analyses about transboundary river basin management issues are becoming more relevant for policy development, but there is still a gap between the scientific knowledge generated and how it is conveyed in a useful way to help policy makers and inform the general public.

6.1 Policy relevant technical advances

The technical advances demonstrated in transboundary river basin management are significant and their policy relevance is very clear. This includes e.g. real-time flood management, flood modelling and visualisation, crop development, sediment management and delta management. There is an upward trend in openness, sharing of information, technical capacity and actions on the ground. Modern techniques, such as geographic information systems, satellite information analysis and modelling are used to help overcome information shortfalls. There are, however, still important gaps in knowledge on topics such as water quality, sediment transportation, fish population and habitats and ecosystem health.

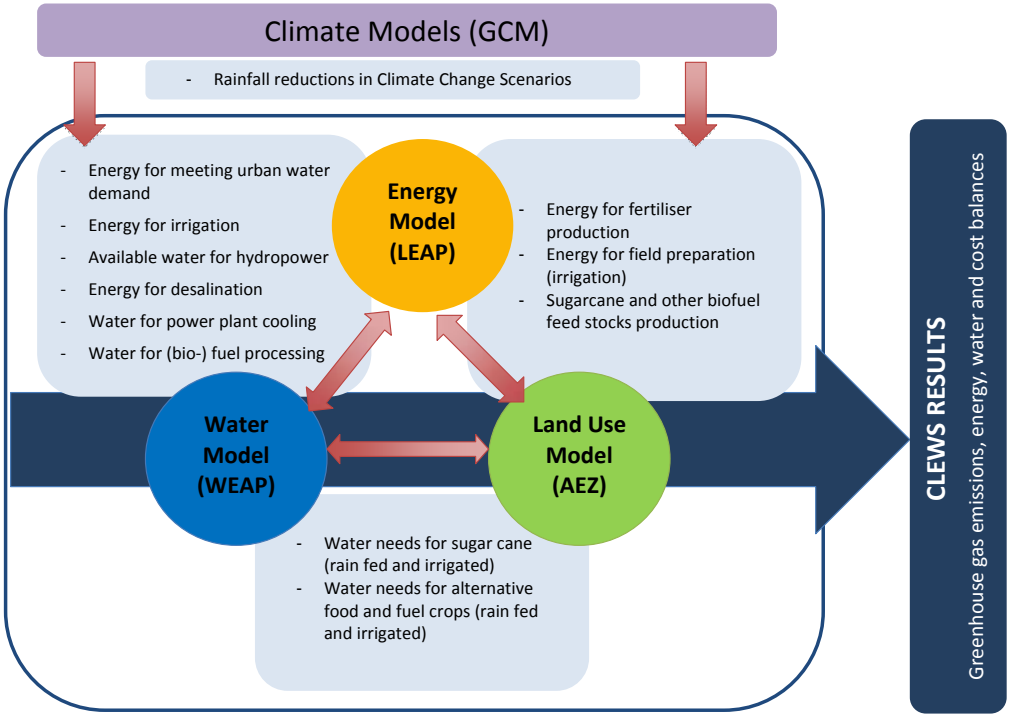
An important element in successful transboundary management is evidence developed through involvement of the riparian parties. There are many examples where the knowledge base and a strong analytical capacity are considered an important part of the basin collaboration, such as the Nile, Mekong and Orange-Senqu river basins. This is even more evident in transboundary aquifer management and collaboration, where the necessary understanding of aquifer structure, extent, recharge and other key characteristics and resulting nexus issues requires in-depth knowledge, technical capacity and communication. A strong scientific evidence base was instrumental in creating results in the Jordan river as it demonstrated clearly the root causes of the problems as well as the possibilities of making change. Over 95% of the river water was diverted, resulting in devastation of the Jordan river system and loss of cultural heritage and tourism revenue. A rehabilitation plan was designed by stakeholders including NGOs, based on scenarios analysed by credible

scientists, and with strong support from civic and religious leaders, progress is being made in rehabilitating the river system.

The management challenges of increasing variability and fast paced development trigger accelerated development of science and knowledge. The demand for data generation, sharing and analysis increases in order to inform policy making and improve impact assessments. Climate variability and change is a driver in knowledge generation due to the high uncertainty and potentially large consequences. The Finnish-Russian cooperation over the River Vuoksi is an example of planned improvement and introduction of forecasting tools on hydrology and meteorology, real-time control, flood risk management tools and transboundary early warning systems. Knowledge gaps on fisheries and restoration needs are studied through common research projects. In the Mekong, information needs to analyse possible hydropower developments are high and a range of long-term studies on sediment transport, ecologically sensitive areas, environmental and socio-economic baselines including water quality, fish and biodiversity are being implemented. As well, an MRC study has mapped the social dependency on the natural resources along the mainstream Mekong. Modelling, particularly for the Mekong Delta, has commenced. How this wealth of information will be used and what impact it will have on decision making and transboundary collaboration in the future will be interesting to see.

A nexus approach requires tools that are broad in scope to cover the relevant sectoral issues as well as the associated impacts. Studies have shown that existing sectoral decision support tools can be linked to produce useful conclusions and recommendations that integrate multiple sectors to assess and quantify nexus trade-offs (Figure 6.1). Another example is the IWRM Toolbox covering transboundary as well as nexus issues and case studies (GWP, 2014).

While decision makers need data, information and decision support systems, it must be remembered that action is needed even with a less than perfect evidence and information base. Science has an obligation to present information clearly, including uncertainties, and in doing so to present what we know, as well as what we don't know. However, there will always be a need to make decisions in the absence of 'complete' information. Waiting for perfect information could lead to inaction.



Schematic of CLEWS Approach

Figure 6.1 Modelling systems used to assess multiple sectors and trade-offs with a nexus approach (Stockholm Environment Institute).

6.2 Improving the policy-science dialogue

While technical understanding and capacity can create trust and confidence and thereby be instrumental in creating action, there is a limit to how much and how far it can push collaboration. The pace of cooperation is determined by political will, which should remain the main vehicle to implement technical cooperation.

Bridging the gap between science and policy makers will be an eternal quest, but one which is critical for more efficient management and collaboration. The positive trend in technical advances with clear policy relevance does not seem to be

sufficiently reflected by confidence of policy makers. Interaction between scientists and policy makers should be intensified to create an effective science-policy dialogue with real impact.

Stakeholder involvement in creating the evidence base can support the science-policy dialogue. Participatory scenario development is one of the methods used in a transboundary context e.g. in the Ganges (Box 11) and the Jordan rivers. In the Jordan River, civil society and local communities were engaged in common fact finding and scenario development, which created not only political will, but also conditions and incentives at the local level for behavioural changes, adding impetus to the progress of the river restoration.

Communication of the complexities of a large river basin to policy makers and civil society is a real challenge and lack of such communication leads to the risk of failure in decision making. In this context, the uncertainty of information and how the knowledge about uncertainties can be used in decision making is even more challenging. There is a need to work more on developing participatory science-policy dialogues to make knowledge generation even more relevant and to have an even better interaction between knowledge production and knowledge use. Iterative processes are needed as opposed to the more commonly used linear schemes (Figure 6.2).

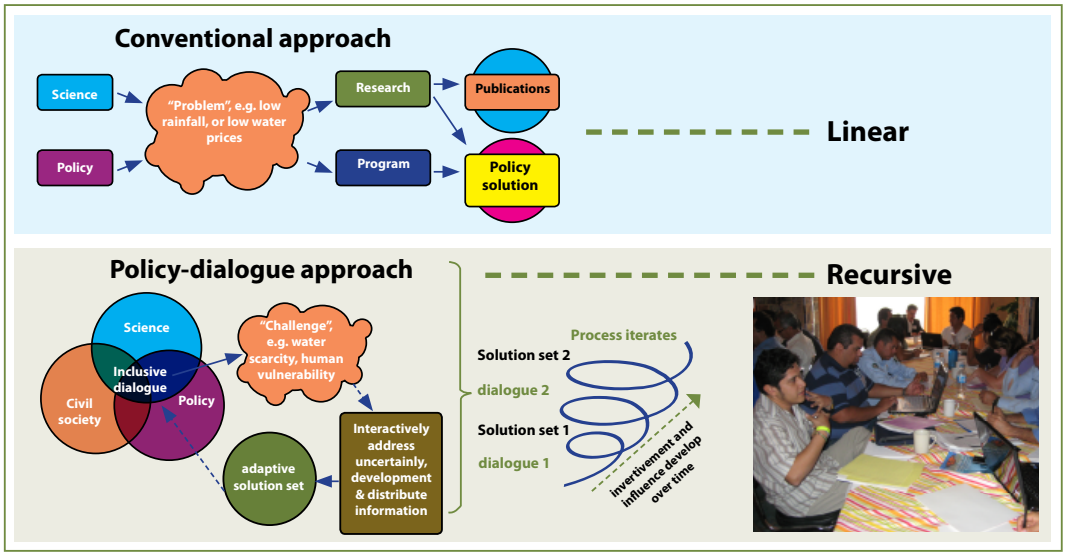


Figure 6.2. Participatory knowledge production and development of policy solutions through a science-policy dialogue is iterative as opposed to the more linear conventional approaches.

Box 11. Ganges Water Treaty between Bangladesh and India involving stakeholders in science development for improved cooperation and management

The Ganges Water Treaty between India and Bangladesh was signed in 1996 and covers the sharing of dry season flows at the Farakka Barrage. However, the treaty does not cover the flood period, provides no minimum share of water for Bangladesh; does not cover water quality issues; includes no provision for arbitration; and no specific allocation as environmental flow for sustaining the health of the river ecosystem.

The governments of Bangladesh and India signed a Framework agreement on cooperation for development in 2011. This agreement provides scope for basin management of common rivers for mutual benefit and jointly developing and financing projects in the power sector and water resources management, harnessing advantages of sub-regional cooperation.

The South Asia Water Initiative of the World Bank supports the cooperation under the Ganges Treaty to improve shared understanding, management and development, to increase economic growth and improve resilience to climate variability and change.

The pressures facing the Ganges Basin include population growth and urbanisation, which will increase demand for water supply, energy and food. Competition for water between sectors will increase and require allocation of water away from irrigation. Analyses of the current situation revealed that new dams could help meet growing water demand, but have limited ability to mitigate flooding.

In order to unlock the potential of the Ganges Basin, the analysis also found that the following needs to be developed:

- sound evidence on the costs and benefits of alternative development options
- broad stakeholder engagement with open access to data and evidence
- cooperative basin-wide planning and national/state inter-sectoral water management

The evidence base is under development including hydrological and allocation modelling, benefit assessments and trade-off modelling. This will be further developed with better quantification of water use by river reach and sector, strengthening of the economic modelling and including environmental assessments covering values and services into the analytical framework. Stakeholder engagement is being planned at the technical and political level. A participatory modelling approach will be developed exploring a wider range of management options and solution to build shared understanding and support regional cooperation.

7. Getting stakeholders involved

Experience has shown that sustainable development needs all stakeholders to be engaged at various levels. This poses significant challenges in a transboundary context. Roles and responsibilities of government and the private sector can often be clarified and strengthened, and lessons can be learnt from excellent examples of harnessing community power for better water resources management. Improved civil society participatory processes are needed to move away from government-centred outlooks to multi-stakeholder schemes.

7.1 Interactions with the private sector

Often the private sector is one of the main drivers of water resources development, including agricultural and hydropower developments, as well as in water services such as water supply and wastewater treatment. To ensure this development is as sustainable as possible requires a combination of public sector guidance and regulation, and for a clear business case to be developed for sustainable development. Developing the necessary capacity at government level to ensure appropriate use of guidelines and tools and a transparent evaluation process is a prerequisite for the impact assessments to contribute to a sustainable development.

Water and wastewater utilities are developing climate friendly water infrastructures such as wastewater treatment plants with reduced greenhouse gas emissions while at the same time delivering nexus benefits. These include reducing operational costs (lower water prices), less dependency on fluctuations of energy prices by reducing energy consumption and more efficient use of water resources, which mean more water available for other sectors. While regulations have been improving to guide private sector investments to mitigate adverse social and environmental impacts, it is becoming apparent that there is a need to better understand the cumulative impacts of multiple investments. This is a good example of where nexus thinking supports practical management options. The field of 'Cumulative Impact Assessments' (CIAs) (Box 12) is evolving as a tool to help developers or project sponsors (a) recognise that their developments may contribute to cumulative impacts on valued environmental and social components on which other existing or future developments may also have detrimental effects, and (b) avoid and/or minimise these impacts to the greatest extent possible. Furthermore, their developments may be at risk because of an increase in cumulative effects on ecosystem services that they may depend on. As developers increasingly appreciate these risks, they are asking governments for more guidance and information on how to address

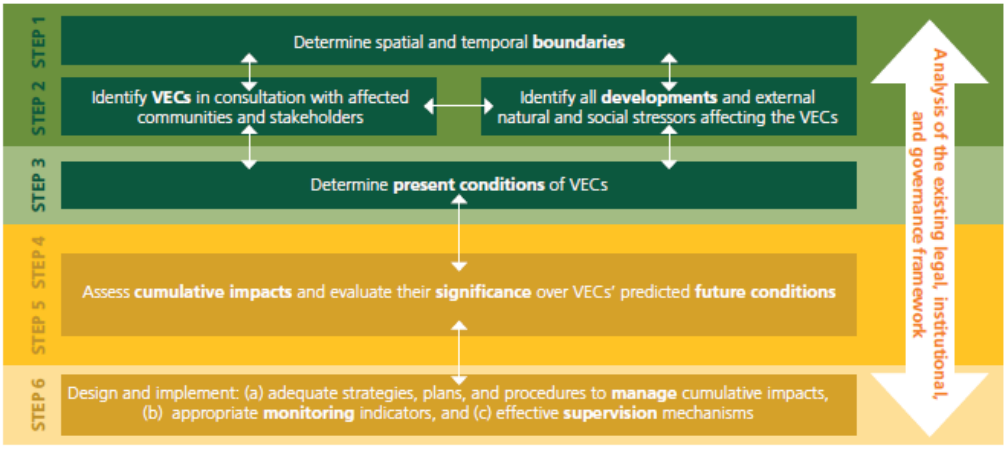
cumulative impacts. And though developers realise their responsibility for undertaking individual CIAs, the ultimate responsibility for the overarching CIA framework lies with government and, particularly within a transboundary context, regional planners.

The private sector calls for more information and education on the concepts that are being discussed, such as the nexus, in order to be able to position themselves for future developments and to prepare the necessary risk analyses for their current activities. Climate change is a factor that increases risk and concerns the private sector as much as the rest of the society. The private sector needs to understand the implication of policy developments including the risks of policy disconnects such as the example presented for the Severn River Basin (Box 2).

Box 12. Cumulative impact assessments of development investments

The International Finance Corporation (IFC), the private sector arm of the World Bank Group, has developed a 'Good Practice Handbook on Cumulative Impact Assessment and Management: Guidance for the Private Sector in Emerging Markets' (IFC 2013). The six steps of a 'rapid' CIA are shown below. This assessment may either be undertaken as part of an environmental and social impact assessment (ESIA) or as a separate process.

FIGURE 1. RCIA: SIX-STEP APPROACH



While this method has been trialled in a number of cases at the local level, more effort is needed to begin to implement it at the transboundary level.

While the private sector is often acknowledged as a key player by public authorities and development practitioners, and collaboration is on the rise, a more robust discussion is needed on how to engage the private sector in long-term planning for good governance and sustainable development. The incentive for the private sector to engage in this process is to avoid environmental and social risks that could turn into commercial risks.

7.2 Raising awareness and engaging riparian populations

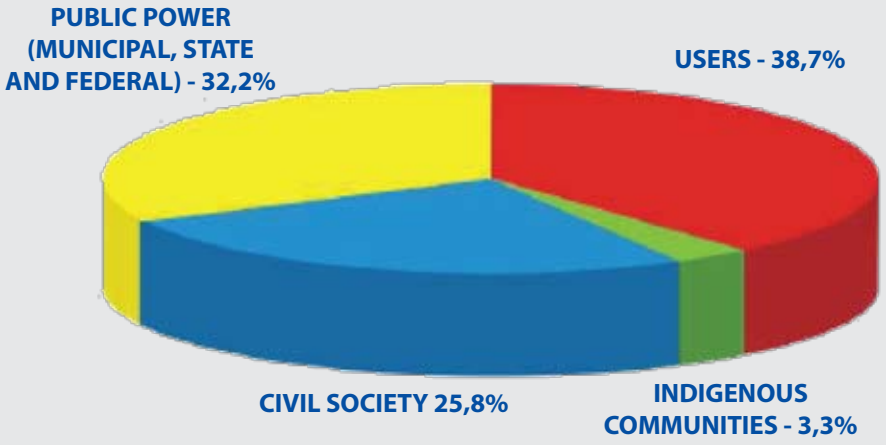
There is a clear message from the leadership of basin organisations around the world: engaging with all stakeholders and citizens is vital to the overall success of basin organisation operations, but is hard to achieve in a transboundary context, partly due to the asymmetries between a wide range of stakeholders in basin countries. Long-term successful collaborations can be challenged, such as the collaboration between Argentina and Uruguay on their shared reach of the Uruguay river in the La Plata basin, which is being disputed by stakeholders opposed to some industrial developments. Uruguay authorised construction of two paper pulp factories on the opposite side of the river to a city in Argentina, which led to a strong social mobilisation that led to diplomatic disputes between the two countries, and outrage from Argentinian residents reacting to the pollution threat. A local mobilisation kept an international bridge blocked for three years and the dispute affected a range of other sectors such as tourism, commerce and transportation. The collaboration was threatened and the dispute went into a resolution path when taken to the International Court of Justice.

Nevertheless, there are some excellent examples of community engagement and participatory models of water resources management where stakeholders are engaged not just in the development of solutions, but also directly in the management of the water resources, such as in the São Francisco basin (Box 13).

In areas of conflict, dialogue between nation states over water resources may stall or be hostile. In the Jordan River basin, Friends of the Earth Middle East (FoEME), have achieved remarkable results by using civil society as the catalyst for creating political will. Using a grassroots community model, FoEME facilitated the establishment of 28 'Good Water Neighbour' communities in the basin, partnering with municipalities, schools and community centres. The empowerment of local constituents pushing for political engagement, along with science-driven information and scenario testing, has led to concrete agreements and actions at the national level within the riparian countries.

Box 13. Stakeholder engagement in transboundary basin management

The São Francisco river in Brazil is an example of an intra-state transboundary river basin. With an area of 645,000 km2, and 13 million people, it spans six states, one federal district, and 504 municipalities on its 2,700 km journey to the Atlantic Ocean. Nexus challenges are clear here, with water being used for hydropower, irrigation, domestic supply, navigation, artisanal fishing, aquaculture, and tourism, with high biodiversity in a number of different biomes. This multitude of uses is driven by a huge diversity of stakeholders, including large and small cities, farmers, and traditional communities. The São Francisco Basin Committee has adopted a strong participatory model of water resources management to balance these nexus challenges involving such a wide variety of stakeholders. Civil society and indigenous communities have a formal role to play in the management of the shared water resources, and this is reflected in the composition of the basin committee (Figure 7.1).



Importantly, the committee collects about $US9 million per year, primarily from the large water users, including irrigators, industry, and water supply companies. This provides a sustainable funding source to develop and manage the basin in a sustainable manner.

Figure 7.1 – Composition of the São Francisco Basin Committee

As mentioned several times in this report, technical collaboration can be a vehicle for moving development forward and this should also engage a large set of stakeholders for sustainable development. The Ganges River basin is a complex interplay of economic, environmental and social dimensions within the nexus, yet there is no mechanism for basin-level planning and benefit sharing. An open-access water and economic modelling system is being developed to facilitate evidence-based, basin-wide planning. However, there are significant challenges in data sharing and accessibility, as well as technical capacity within the basin. A participatory modelling process engaging stakeholders and building shared understanding and supporting regional cooperation is planned to move the work forward (Box 11).

Parallels can be drawn with experiences from the Nile, where transboundary cooperation at the technical level has developed steadily, even when dialogue at the political level may have slowed down.

Another example of including civil society in the basin planning process is in the Danube, where different stakeholder groups, represented by organisations, have a formal status as 'observers' in the RBO. In this way they can contribute to, and influence, the planning process, though they do not have voting rights, as the representatives of the member states do.

These experiences reiterate the argument for meaningful participation of all stakeholders, including the private sector and civil society, from an early stage in the planning process, to contribute to sustainable basin development with benefits for all, including at the political level.

8. Conclusion

The water, energy, food security nexus approach provides a useful transboundary policy framework to understand development opportunities and challenges and to involve multiple-sector stakeholders. The nexus approach is useful for analysing and diagnosing problems, although the implementation of actions to address the issues does not require full institutional integration. Focusing on these sectors does not belittle the role of water management for other uses such as health, transport, industry etc. and the vital role of ecosystem management.

There is a groundswell of support for dedicated Sustainable Development Goals (SDGs) on water, energy and food with a broad scope reflecting the resource management realities on the ground. including transboundary cooperation reflected in the SDGs.

Promoting sustainable development requires management of a wide range of factors and dialogue with stakeholders. Governments need to devise guiding principles and operational frameworks and tools including for the private sector to assess developments that consider cumulative environmental and social impacts. Understanding the issues and raising the political will is needed to shape developments and make corrections in the face of unexpected negative developments or unintended consequences.

The future climate is projected to amplify existing climate risks, suggesting that reducing vulnerability and exposure to present climate variability is a wise first step in climate change adaptation. While climate change adaptation actions may be local in scale at implementation, their consequences can be regional and should be safeguarded regionally through transboundary cooperation to share risks, minimise costs and maximise regional benefits. Transboundary basin organisations are well placed to support capacity improvements and development of methods required to provide the scientific basis as well as a negotiation platform to design and agree on climate change adaptation strategies.

Understanding and interpreting information and uncertainty are huge challenges for both policy makers and scientists. The technical advances demonstrated in transboundary river basin management are significant and their policy relevance is very clear. There is an upward trend in openness, sharing of information, technical capacity and actions on the ground.

The positive trend in technical advances with clear policy relevance does not seem to be sufficiently reflected by confidence of policy makers. Interaction between scientists and policy makers should be intensified to have an effective science-policy dialogue with real impact. It must be remembered that action is needed even with a less than perfect evidence

and information base. Waiting for perfect information before taking action could lead to inaction.

Transboundary agreements and institutions need to adapt to changing environments while maintaining a long-term commitment. Broad agreements provide a high degree of flexibility for cooperation, that allows new management concepts to be introduced or a new understanding of relationships may have the best chance to benefit from these opportunities.

Implementation will, and should, still take place through existing mechanisms and institutions – but bearing the nexus approach in mind linking the challenges in different sectors and identify benefits to be shared. Transboundary basin organisations can have added value as institutions with potential to facilitate sectoral coordination at transboundary level. For transboundary agreements to work effectively, a combination of political will, technical cooperation and an inclusive process involving all stakeholder groups is needed.

There is a clear message from the leadership of basin organisations around the world: engaging with all stakeholders and with citizens more generally is vital to the overall success of basin organisation operations. The experiences reinforce the argument for inclusion and meaningful participation of all stakeholders, including the private sector and civil society, from an early stage in the planning process, to contribute to sustainable basin development with benefits for all, including at the political level.

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Annex I:
River basins represented at the Conference

Aral Sea Basin

The Aral Sea Basin has a total area of 1.8 million km2 and is inhabited by over 46 million people. It is right at the heart of the Eurasian continent, extending over the following seven countries: Afghanistan, Iran, Kazakhstan, the Kyrgyz Republic, Tajikistan, Turkmenistan and Uzbekistan. It is fed by two major rivers, the Amu Darya in the south, and the Syr Darya in the north. Oases are a significant feature of the region. Even if they only cover a small part of the overall basin area, they have been at the centre of human activity since ancient times because of their more favourable living conditions.

Before 1960, the Aral Sea was the world's fourth largest lake but it has been progressively drying up, and today is considered one of the major anthropogenic environmental degradations worldwide. The Aral Sea now consists of three sections: the Small Sea or Northern Sea in Kazakhstan, the Central Sea, and the Western Sea, which is the deepest, mostly in Uzbekistan. The Sea has lost three-quarters of its volume and half of its surface area, salinity has tripled, and more than 50 lakes have disappeared. Fishing and fish industries were abandoned leaving many unemployed. The environmental disaster was mainly due to huge irrigation expansion for intensive cotton monoculture that also brought inputs as fertilisers and pesticides, and massive resettlements.

In 1992, after the demise of the USSR, the five newly independent countries (Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan) signed interstate agreements on water sharing, use, conservation, financing and management and established the Interstate Commission on Water Coordination (ICWC), appointing relevant deputy ministers for water as its members. The International Fund for Saving the Aral Sea (IFAS) is another interstate organisation established among the same five states in order to fund and credit joint regional environmental and research programmes and projects aimed at improving the environmental situation and solving the socio-economic problems of the Basin. In 2002, the Central Asian countries and the Caucasus formed the CACENA Regional Water Partnership under the Global Water Partnership (GWP), as a platform between state departments, local, regional and professional organisations, scientific and research institutes as well as the private sector and NGOs to promote the IWRM concept in the region and national and transboundary water policy dialogues.

Columbia River Basin

The Columbia River Basin is more than 1900 km long and covers an area of more than 660,000 km2. About 15% of the basin is in

Canada and the remainder in the United States (US). It is shared by the Canadian Province of British Columbia and six US states, the most prominent of which are Washington and Oregon. With more than 100 tributaries, the Columbia River Basin is a water-rich basin that provides many opportunities to riparian states and people. The salmon industry and sustainable hydropower development are the river's primary revenue sources, and are guiding the Columbia towards its prosperous future. Many dams have been built to capture that potential, turning the Columbia River into a highly regulated basin. River transportation is important and navigability has been improved over the past centuries through considerable hydromorphological alterations, causing a number of environmental problems for the basin. In 1961, Canada and the US signed the Columbia River Treaty, which focuses on hydroelectricity and flood control and establishes national authorities responsible for its implementation.

The International Joint Commission (IJC) was created much earlier, in 1909, by the Boundary Water Treaty signed by both countries. It is responsible for assisting the governments of Canada and the US to find solutions to problems that relate to all their shared waters, including the Columbia River. This comprises the coordination of water resources development plans, the exchange of information on hydropower generation and flood control activities, the establishment and operation of a hydrometeorological system, the investigation of water quality and other issues that concern the use of the river resources.

Congo River Basin

With 4,700 km of flowing waters the Congo River is the second longest river in the African continent, after the Nile, and the fifth longest in the world. It is shared by 13 riparian states: Angola, Burundi, Cameroon, Central African Republic, Congo, Democratic Republic of Congo, Gabon, Malawi, Rwanda, Sudan, Tanzania, Uganda and Zambia. The basin has a total surface of 3.822.000 km2. Water resources management issues in the Congo River Basin focus on water quality, invasive species and navigation.

The International Commission of the Congo-Oubangui-Sangha Basin (CICOS – Commission Internationale du Bassin Congo-Oubangui-Sangha) was established in 1999 through the Agreement Establishing a Uniform River Regime and Establishing the CICOS, and is based in Kinshasa, in the Democratic Republic of Congo. As of today, CICOS has five member states: Cameroon, the Central African Republic, Congo, the Democratic Republic of Congo, and Gabon. Angola has observer status. The Commission's goal is to improve regional coordination of river basin management. While the organisation originally focused exclusively on navigation, its mandate expanded in 2007, and now also includes non-navigational issues. Within this

mandate, it now covers water quantity and quality, invasive species and regulations on the river flow regime to ensure navigability.

Danube River Basin

Stretching from Central to Eastern Europe, the Danube River Basin is the most international river basin in the world, as it is shared by 19 countries: Albania, Austria, Bosnia-Herzegovina, Bulgaria, Croatia, Czech Republic, Germany, Hungary, Italy, Macedonia, Moldova, Montenegro, Poland, Romania, Serbia, Slovakia, Slovenia, Switzerland, and the Ukraine. More than 80 million people live in the basin. After a 2,800 km-long journey through a vast and ecologically rich delta, the river empties into the Black Sea.

The Danube Basin has a surface of 800,000 km2, occupying 10% of Continental Europe. Since the 16th century, riparian communities have altered the river flow for navigation, flood defence and hydropower generation. Water pollution is a major challenge and hydromorphological alterations have led to the disconnection of wetlands and floodplains as well as to changes in hydrological flow. Furthermore, floods pose a great threat to people and economies in the basin. In order to cooperatively manage the Danube River Basin, signatories of the 1994 Danube River Protection Convention established the International Commission for the Protection of the Danube River (ICPDR) in 1998, based in Vienna, Austria.

The ICPDR has the following 14 member countries in addition to the European Union: Austria, Bosnia-Herzegovina, Bulgaria, Croatia, Czech Republic, Germany, Hungary, Moldova, Montenegro, Romania, Serbia, Slovakia, Slovenia, and the Ukraine. The ICPDR aims to promote and coordinate sustainable water management for the benefit of all people of the Danube River Basin by implementing the Danube Convention and the European Water Framework Directive. Its work focuses, in particular, on improving water quality and the overall ecological state of the basin. For instance, measures to reduce pollution have been identified jointly and required programmes have been implemented. In order to prevent harm to the river basin through accidental spills, a Danube Accident Emergency Warning System (AEWS) was established. To improve flood resilience, an Action Programme on Sustainable Flood Protection has been adopted. Moreover, the ICPDR prepares a Danube River Basin Management Plan that includes a Joint Programme of Measures to improve water quality. The next Management Plan will be available in 2015. The ICPDR consists of a Meeting of the Contracting Parties to the Convention and a Secretariat. Its work is supported by and implemented through Expert Groups, each of them focusing on specific river management topics, namely pressures and measures (including pollution), monitoring and assessment, information management and GIS, river basin management, and public participation. The ICPDR collaborates closely

with different stakeholders, including civil society, the scientific community and the private sector.

Ganges River Basin

The Bhagirathi, the traditional sources of this river, rises from the Gangotri glacier in the Himalaya, India at an elevation of 7010 m. It is joined by the Alakananda at Deva Prayag and thereafter the river is known as the Ganga/Ganges. The Ganges River Basin has a surface of about 1.08 million km2 and covers areas of Bangladesh, China, India and Nepal. The Ganges River, joins the Brahmaputra and Meghna (Barak) in Bangladesh before continuing to the Bay of Bengal. The basin is one of the key basins in South Asia. Agriculture dominates water use patterns in the river basin, although the river also serves other uses such as navigation, fisheries, hydropower generation and tourism. High population growth and density particularly in India and Bangladesh are constantly increasing the riparian population's dependency and pressure on the river's resources. It is estimated that at least 650 million people live in the Ganges River Basin. The Ganges is one of the world's most polluted rivers and suffers from many other environmental problems. Most of the agreements signed in the basin are bilateral.

The India-Bangladesh Joint River Commission was established in 1972 between the two countries and is responsible for the management of all 54 shared rivers, including the Ganges and the Brahmaputra. It has the task to foster cooperation by ensuring joint efforts in the areas of flow monitoring, flood control, flood warning, mutual information on national projects and coordinated research. It consists of commissioners from both member countries. Within India, the Ganges-Brahmaputra is managed by the National Ganga River Basin Authority (NGRBA), which was established in 2009 and is led by the Prime Minister. The NGRBA's objective works towards the effective reduction of pollution in the river and the conservation of the river and its basin through integrated and comprehensive planning and management. The Government of Bangladesh established the Joint Rivers Commission Bangladesh (JRCB) to address the issues relating to the sharing and managing of the water of all transboundary rivers and liaise with India and other co-riparian countries.

Genevese Transboundary Aquifer

The Genevese Aquifer extends over 19 kilometres underneath the southern extremity of Lake Geneva and the Rhône River, across the border between France and Switzerland. The width of the aquifer varies between 1 and 3.5 kilometres. Uncontrolled over-pumping in the 1960s and 1970s led to groundwater levels falling drastically and to the complete drying up of some of the wells. France and Switzerland entered negotiations to solve this common problem and a first agreement between the two

countries was reached in 1978, replaced in 2007 by the Convention on the Protection, Utilization, Recharge and Monitoring of the Franco-Swiss Genevese Aquifer. The Convention was signed between three French communities and Switzerland (the Republic and Canton of Geneva).

The Genevese Aquifer Management Commission has three Swiss and three French members, and is co-headed by a member with deliberative powers designated by each delegation. The Commission proposes an annual aquifer utilisation programme that takes into account the needs of various users, establishes measures to protect the waters in the aquifer or to remedy possible causes of pollution, and gives its technical opinion on the construction of new extraction works on the aquifer and on the modification of existing equipment. It monitors all waterworks in the aquifer, which have to include devices to record the volume of water extracted from the aquifer and variations in its water-level. The services of the Secretariat of the Commission are assumed by the Aquifer Service for the Geneva State and by the Community of the Annemassienne Region for the French Party.

Guarani Aquifer System (part of the Paraná-La Plata River Basin)

The Guarani Aquifer System (GAS) is the largest groundwater resource in the world, with 45,000 km3 of water and a surface area of 1.1 million km2. It is located in the vast Paraná-La Plata River Basin and is shared by Argentina, Brazil, Paraguay and Uruguay. Growing demand for water in the four countries brought concerns over pollution and future over-exploitation of the Guarani Aquifer and led the four countries to start negotiating a common framework of action. Thus, in August 2010, the four states signed the Agreement on the Guarani Aquifer, which is the first shared-management agreement for a transboundary aquifer in Latin America. The Agreement was based on some of the findings of the Environmental Protection and Sustainable Development of the Guarani Aquifer System Project (also known as the Guarani Aquifer System Project). The project ran from 2003 to 2009 and was significant in raising awareness on the GAS's characteristics and in promoting debate on groundwater management within the four countries at national, provincial, and community levels.

The Agreement on the Guarani Aquifer aims at promoting the management, monitoring and sustainable utilisation of the water resources of the GAS, as well as fostering the sharing of technical and scientific information. It also represents a continuation of this region's history of cooperation at various fora such as the Intergovernmental Committee for the La Plata River Basin and the MERCOSUR trade mechanism.

Itaipu Binacional (in the Paraná-La Plata Basin)

The Itaipu Dam is one of the central hydraulic structures on the Paraná River, in the border between Brazil and Paraguay. The dam is one of the world's largest hydropower facilities with a capacity of more than 10,000 MW, generated on the basis of 20 turbines. The construction of the Itaipu Dam solved an old diplomatic standoff whereby the two countries claimed possession over the land in the Seven Falls area, today covered by the power plant's lake. In 1973 the Itaipu Treaty on the use of the Paraná River for hydroelectric purposes was signed between Brazil and Paraguay. A Tripartite Agreement with Argentina had to be signed in 1979, following a tense dispute in the region due to Argentinean claims that the power plant would damage their rights and interests over the waters of the Paraná River.

In 1974 the Itaipu Binacional Company was created to manage the construction of the power plant and then operate it. Initiated in the 1970s and inaugurated in 1982, the project was jointly developed between Brazil and Paraguay. Itaipu Binacional presents itself as the world's largest generator of renewable clean energy. Its mission is to provide quality electricity through socially and environmentally responsible practices, and to foster a sustainable economy, tourism industry and technological development. Today it provides approximately 17% of the energy consumed in Brazil and 75% of consumption in Paraguay.

Jordan River Basin

The Jordan River Basin has a total area of about 18,500 km2 that expands over Israel, Jordan, Lebanon, Syria, and Palestine (West Bank). The Jordan River is 250 km long and flows into the Dead Sea. Despite its relatively short length, many riparian populations depend on it. The quality of water in the Jordan River has severely deteriorated in recent decades, especially in the lower section, where 96% of its historic flow has been diverted. The main environmental problems are associated with the drop in water levels, increased salinisation, untreated sewage and agricultural flows. The decline of the Dead Sea threatens the stability of the overall basin ecosystem. Since the early 20th Century numerous attempts to foster cooperation between basin riparians have been hampered by the regional political conflict. Some bilateral agreements encourage cooperation over water between Israel and Jordan, Israel and Palestine, and Jordan and Syria, but political tensions have so far been standing in the way of any multilateral basin-wide agreement on water. Only the 1955 Johnston Plan was envisaged to apply to the whole basin, but it was never signed or ratified. The main issues addressed in bilateral agreements have been water allocations and transfers and hydropower development and bilateral

water commissions have been set up. There have been recent cross-border initiatives to devise a basin-wide strategy involving all riparian states, notably a Master Plan for the Lower Jordan, developed by FoEME with partner organisations.

Mekong River Basin

The Mekong is the tenth largest river in the world. Its basin drains a total land area of 795,000 km2 from the eastern watershed of the Tibetan Plateau to the Mekong Delta. The Mekong River flows approximately 4900 km through three provinces of China, continuing into Myanmar, Lao PDR, Thailand, Cambodia and Viet Nam before emptying into the South China Sea. Upstream flow contributes only a small portion of the total annual flow of the Mekong River. Most of the total flow volume is delivered to the Mekong from tributaries in the Lower Mekong Basin. However, the importance of upstream flow should not be underestimated as dry season snow melt from China contributes to over 24% of the total flow. The flood season in the Mekong River Basin lasts from June to November and accounts for 80 to 90% of the total annual flow. The annual flood season is especially important in the Lower Mekong Basin where it has shaped the environment and its inhabitants.

Many of the Mekong's key ecosystems have developed as a result of seasonal flow fluctuations. The area's extensive wetland habitats would not exist without the annual flood. Likewise, the life-cycles of many Mekong fish species depend on it. Fish migrate to deep pools in the mainstream to seek refuge during the dry season; later, during the flood season, they migrate back to spawning and nutrient-rich feeding grounds on floodplains. At present, only 10% of the estimated hydro-electrical potential in the Lower Mekong Basin is developed. The issue of hydropower development in the basin is very controversial with many dams proposed on the Mekong mainstream and many more planned or under construction on its tributaries.

The Mekong River Commission (MRC) was founded in its current form with the signing of the 1995 Mekong Agreement, which established the rules and procedures of the organisation. It has its origin in the Mekong Committee, and the Interim Mekong Committee, which were in force between 1957 and 1995. The role of the MRC is to ensure the sustainable use and management of water and related resources of the Lower Mekong Basin. The MRC is governed by its four Member Countries: Cambodia, Lao PDR, Thailand and Viet Nam through the Joint Committee and MRC Council. Technical and administrative support is provided by the MRC Secretariat. The upstream Mekong countries, China and Myanmar, became Dialogue Partners with the MRC in 1996. The MRC Secretariat has one office in Vientiane, Laos, and another one in Phnom Penh, Cambodia.

Niger River Basin

The source of the Niger River is only 240 km inland from the Atlantic Ocean. However, taking one of the most unusual routes of any major river, the Niger follows a boomerang-shaped route and flows over 4,200 km across Western Africa, until it meets the Ocean. It is the third longest river in Africa, behind the Nile and the Congo. Its basin covers more than 2 million km2 and is shared by nine countries: Benin, Burkina Faso, Cameroon, Chad, Côte d'Ivoire, Guinea, Mali, Niger and Nigeria, covering more than 7% of the African continent. It is an important lifeline for the riparian populations, an estimated 150 million people, and states, especially against the region's poverty challenge. Water resources management is closely linked to socio-economic development and poverty alleviation.

The river's resources provide important opportunities for agriculture, fisheries, food supply and navigation. At the same time, the basin is threatened by various environmental problems, most notably land degradation and erosion, deforestation, water pollution from agriculture and households, biodiversity loss and the intrusion of invasive species. These issues hamper water resources development opportunities for riparian states.

The Niger Basin Authority (NBA) was established by the nine countries in 1980 under the Niger Basin Convention, and relies on a long history of cooperation, dating back to 1964 with the establishment of the Niger Basin Commission. It is based in Niamey, Niger. Its goal is to promote cooperation between member states and ensure integrated development of the river basin. Its focus is thus largely on socio-economic development and its work covers a large number of sectors, including agriculture, energy, fisheries, forestry, transport, industry and communications. In order to achieve its goal, the NBA is mandated to undertake a number of activities, including data gathering, standardisation and dissemination, the design of joint plans for infrastructure development and transport, the establishment of norms and activities for preventing and reducing environmental threats, especially in the field of water pollution, and the promotion of joint programmes and projects on agriculture, forestry and fisheries.

Nile River Basin

Running through 10% of the African continent for 6,700 km, the Nile is the world's longest river. It brings together a considerable number of riparian states: Burundi, Central African Republic, Democratic Republic of Congo, Egypt, Eritrea, Ethiopia, Kenya, Rwanda, South Sudan, Sudan, Tanzania, and Uganda. Riparian states and populations are highly dependent on often very scarce water resources, making sustainable water

resources- management a key focus for the basin. Egypt is highly dependent on the Nile's water resources and has so far benefited from a very favourable water allocation regime that was established in 1959 with Sudan. With increasing socio-economic development in upstream states, water demands and abstraction in these regions have increased, igniting disputes on water allocation.

Established in 1999, the Nile Basin Initiative (NBI) has now the following 10 members: Burundi, Democratic Republic of Congo, Egypt, Ethiopia, Kenya, Rwanda, South Sudan, Sudan, Tanzania and Uganda. Eritrea participates as an observer. The NBI is a transitional and informal mechanism that should evolve into a full-fledged RBO, once the Cooperative Framework Agreement is finalised and agreed upon by all the riparian states. This multilateral legal and institutional framework has only been signed by seven riparian states as yet. Egypt and Sudan, two of the key players in regional water management, have still not formally joined the cooperation. The NBI has the goal to achieve sustainable socio-economic development through the equitable utilisation of and benefit from the common Nile Basin water resources. In order to achieve this goal, a number of activities are undertaken, focusing on capacity building; water resources management activities such as regional policy development and basin-wide planning; data and information management; and the provision of technical support to member states for strengthening national water policies.
The NBI is governed by the Nile Council of Ministers (Nile-COM), and is assisted by the Nile Technical Advisory Committee (Nile-TAC) and its Secretariat, based in Entebbe, Uganda. In addition, specific programme management bodies have been established, which include the Eastern Nile Subsidiary Action Programme (ENSAP) and the Nile Equatorial Lakes Subsidiary Action Program (NELSAP).

North West Saharan Aquifer

The North West Sahara Aquifer system (NWSAS) is the most important water resource in the desert and semi-desert area of North Western Sahara. It covers an area of over 1 million km2 between Algeria, Libya, and Tunisia. This large, multilayered hydro-geological system has important water reserves (~30,000 km3) which are, however, mostly non-renewable and not fully exploitable. Its exploitable water reserves have been calculated at 1,280 km3. Being located in one of the driest regions on the planet, these resources are still of great importance to the socio-economic development of its riparian countries. However, water withdrawal has been increasing, resulting in aquifer pressure loss, salinisation, soil degradation, natural oases disappearance, and natural discharge depletion. While no formal treaty has been signed, the riparian states reached an agreement to establish a Consultation Mechanism for the NWSAS within the

framework on the NWSAS Project, managed by the Sahara and Sahel Observatory (OSS – Observatoire du Sahara et du Sahel). The OSS is an international, intergovernmental organisation operating in Africa's Sahara-Sahel region. It was founded in 1992 in Paris and moved its headquarters to Tunis, Tunisia, in 2000. It includes 22 African member countries, non-regional member countries, four sub-regional organisations representing West Africa, East Africa, and North Africa, and a non-governmental organisation. The NWSA Project began in 1999 and is now in its third phase. It started with promoting studies to improve the knowledge on the aquifer, its potential and risks at stake, mainly from a hydrological and hydro-geological standpoint. The current phase focuses on the utilisation of water resources (mainly agricultural) and more generally on the social, economic and environmental aspects related to irrigation in the basin. The NWSA Project advances transboundary cooperation amongst riparian states through the above-mentioned Consultation Mechanism.

Orange-Senqu River Basin

The Orange-Senqu River is 2,500 km long and its basin extends over four countries: Botswana, Lesotho, Namibia, and South Africa, covering an area of 1,000,000 km^2. The geography of the Orange-Senqu River basin is highly variable, from the highlands of Lesotho, through the semi-arid and arid landscapes of South Africa's Karoo and Richtersveld, to the deserts of southern Namibia. The basin is the most developed transboundary river basin in the South African Development Community (SADC) region, including industrially developed parts of Southern Africa and featuring 27 storage dams. The management of water resources in the basin is thus required to address many interrelated issues, such as water quality, supply and pollution control. The Orange-Senqu River Commission (ORASECOM) was established by the Governments of Botswana, Lesotho, Namibia and South Africa through the "Agreement for the Establishment of the Orange-Senqu Commission", in 2000. Its overarching goal is the promotion of an equitable and sustainable development of the resources of the Orange-Senqu River. It provides a forum for consultation and coordination between the riparian states to foster integrated water resources management and development within the basin. ORASECOM has a Council consisting on three representatives from the respective government agencies responsible for water affairs, a Secretariat and a Technical Task Teams. The Secretariat is based in the city of Centurion, in South Africa.

Paraná-La Plata River Basin

The Paraná-La Plata River is more than 4,500 km long and is shared by five countries: Argentina, Bolivia, Brazil, Paraguay and Uruguay. The basin has an area of approximately 3,000,000 km2 making it the fifth largest basin in the world and

the second largest in South America. The Paraná-La Plata Basin encompasses the world's most extensive wetland (Pantanal), and one of the largest aquifers, the Guarani. The basin supports regional inland navigation, and delivers water supply and hydropower generation to millions that rely on it. Intensive use of the basin and its resources has led to a number of river basin management challenges, namely water quality problems, as well as issues related to navigation and the environment.

In 1969, the five riparian countries signed the La Plata Basin Treaty creating the Intergovernmental Coordination Committee (CIC – Comité Intergubernamental Coordinador) responsible for developing activities of common interest in the Basin. After the 1969 treaty, other agreements were signed by two or three countries, and different commissions were established amongst the signatories. Many of the agreements focus on the development of hydropower projects in shared waters. Amongst the cooperation mechanisms created are the Administrative Commission of the River Uruguay (CARU –Comisión Administradora del Río Uruguay), between Argentina and Uruguay, the Joint Technical Commission of Salto Grande (CTM – Comisión Técnica Mixta), established also by Argentina and Uruguay; the Trilateral Commission for the Development of the Riverbed of the Pilcomayo, bringing together Argentina, Bolivia and Paraguay; and the Itaipu Binacional, between Brazil and Paraguay. The Paraná-La Plata Basin is thus characterised by a high density of institutionalised cooperation, indicating the riparian states' strong commitment to the cooperative management of their shared resources, at least on a more direct bilateral approach. The CIC is located in Buenos Aires, Argentina.

Rhine River Basin

The Rhine River is the most important commercial river in Europe and its most densely navigated shipping route. It originates in the Swiss Alps and flows through 1,300 km until it discharges in the North Sea. Its basin is shared by nine countries: Austria, Belgium, France, Germany, Italy, Liechtenstein, Luxembourg, the Netherlands and Switzerland. Out of these nine countries, the following four share 92% of the total area of the Rhine River Basin: France, Germany, the Netherlands and Switzerland. The waters of the Rhine River are used for navigation (880 km of the total length is navigable), power generation, as a source for drinking water and for recreation purposes.

Commercial fisheries are negligible but the once abundant salmon has been a flagship of reintroduction programmes. The Netherlands, situated at the Rhine delta and on the North Sea, is particularly prone to flooding due to its location and to having much of its territory below sea level. The Rhine Delta is also very vulnerable to salt intrusion from the North Sea. The first regulations to manage the Rhine were

issued in the mid-15th century and since then different agreements on specific issues have ensued (free shipping, protection of the salmon, salt, etc.). Two major accidents in the Rhine Basin accelerated the cooperation amongst riparian countries. Firstly, the 1986 fire at Sandoz, a chemical production plant in Switzerland. Massive quantities of highly toxic pesticides were thrown into the river and caused the death of aquatic life downstream. In 1995-96 severe floods occurred in Germany and in the Netherlands, causing extensive damage. As a consequence, the Bern Treaty and the Chemical Convention were agreed upon a few years after the accidents only to be replaced in 1999 by the Convention on the Protection of the Rhine, which was signed by five riparian countries (France, Germany, Luxembourg, the Netherlands and Switzerland) and the European Union. The International Commission for the Protection of the Rhine (ICPR), dating back to 1950, was also amended according to the new Rhine Convention. Austria, Italy, Liechtenstein and the Belgian region of Wallonia have observer status within the ICPR. Until the late 1980s, the major environmental concern in the Rhine Basin was point source pollution, mainly wastewater discharges by industries, agriculture, traffic, and households. Today almost all the population of the basin is connected to wastewater treatment plants and the biggest industrial plants have their own treatment plants. Therefore, the main tasks of the ICPR are the now the improvement of the overall chemical and ecological state of the river, flood prevention and protection and support of the coordinated implementation of the European Water Framework Directive and the Floods Directive. The international secretariat of the ICPR is located in Koblenz, Germany.

São Francisco River Basin

With its 2,700 km, the São Francisco River is the longest river running entirely in Brazilian territory, and the fourth longest in South America. Its journey begins in southern Minas Gerais state and flows north-eastward, crossing another four Brazilian states, until it reaches the Atlantic Ocean. The São Francisco Basin extends over 639.219 km2, includes six states, the Federal State and 504 municipalities (accounting for 9% of total national municipalities). River vessels can travel its middle course, but are prevented from reaching the sea by a series of rapids and falls.

The river is used for irrigation, and the falls and several dams are used to generate hydroelectric power for a wide area of north-eastern Brazil. Even if there is abundance of water in the basin, there is high variability of rainfall, limited groundwater, and recurrent droughts in the extended basin. A plan to divert water from the São Francisco River to the four north-eastern states of Pernambuco, Ceará, Paraíba and Rio Grande do Norte is an idea that dates back to the 19th century and it was finally launched by the Federal

Government in 2004. The transposition plan will operate via two main canals that will feed into a network of rivers and reservoirs, and aims at improving water security in the basin. At the basin level, the São Francisco River Basin Committee (CBHSF - Comité da Bacia Hidrográfica do Rio São Francisco) is the basin organisation in charge of managing its water resources.

Sava River Basin

The Sava River flows for about 940 km, from its source in western Slovenian mountains to its mouth to the Danube in Belgrade. It is the Danube's third longest tributary and the largest by discharge. The Sava River runs through four countries, Bosnia and Herzegovina, Croatia, Serbia and Slovenia, and connects three capitals of these four countries: Ljubljana in Slovenia, Zagreb in Croatia, and Belgrade in Serbia. The fourth capital, Sarajevo, in Bosnia and Herzegovina, also belongs to the Sava River Basin. The basin expands over an area of 97,713 km2, and adds Montenegro to the four mentioned countries.

The Sava River features outstanding biological and landscape diversity. It hosts the largest complex of alluvial wetlands in the Danube Basin (Posavina - Central Sava Basin) and large lowland forest complexes. Concerning the navigation capacity, the Sava River is, nowadays, navigable for large vessels up to Slavonski Brod (377 km) and for small vessels up to Sisak (583 km). After the dissolution of the Socialist Federal Republic of Yugoslavia in the early 1990s, the Sava River, which was the biggest national river, became an international river. The four riparian countries of the Sava River started cooperating within the framework of the "the Sava River Basin Initiative" that led in 2002 to the conclusion of the Framework Agreement on the Sava River Basin (FASRB), whereby the International Sava River Basin Commission (ISRBC) was established. Its permanent Secretariat is based in Zagreb, Croatia, and started to work in 2006. The mission of the ISRBC is the establishment of an international regime of navigation, the implementation of sustainable water management policies and undertaking of measures to prevent or limit hazards.

Senegal River Basin

The Senegal River, the second largest river in Western Africa after the Niger, travels 1,800 km from Guinea, crossing Mali, Mauritania and Senegal on its way to the Atlantic Ocean. Its basin covers an area of 289,000 km2. The river is a key resource for all three countries. Large herds of cattle, camels, goats and sheep migrate across these borders and herders rely on this water source to sustain them. The basin receives only an average of 660mm of rainfall per year, therefore the Senegal River is the key to agriculture in the region. After agriculture, fishing is the largest economic activity in the region. Other river based economic activities include sugar cane production, rice farming and, to a lesser

extent, mining. The Senegal River Basin is severely affected by drought. Erosion, saltwater intrusion, drop in groundwater, vegetation loss amongst other impacts were felt in the entire region resulting in the exodus of large numbers of inhabitants from the rural areas to the cities. Impacts of expansion of irrigation and increase in the incidence of numerous waterborne diseases are other important concerns in the region. Unlike other international water bodies, cooperation over this basin did not originate in a conflict over use of the Senegal River resources. The catalyst for cooperation was the drought-induced vulnerability of the populations of the basin riparian states.

The Organisation for the Development of the Senegal River (OMVS - Organisation pour la Mise en Valeur du Fleuve Sénégal) was created in 1972 by Mali, Mauritania and Senegal. Guinea joined in 2006. Its clear goal was the promotion of economic growth and development, through the exploitation of the river's resources, and two dams were later constructed. In 2002 a Water Charter was signed by the countries and environmental concerns such as efficient allocation of water amongst different sectors, annual artificial flooding and minimal environmental flows became part of OMVS's mission. In 2009, the River Basin Committee including a broad range of water users was formed and a Strategic Plan for Water Development and Management was adopted. The OMVS is based in Dakar, Senegal.

Severn River Basin

The Severn River is the longest river in Great Britain and the border between England and Wales cuts through the basin district. It is 350 km long and its basin covers an area of 21,590 km2. The Severn River source is located in the mountains of mid-Wales and from here it flows into the Severn Estuary, which feeds into the Bristol Channel. A special feature of the Severn estuary is its high tidal range of 14.5m, the second highest in the world, after Burntcoat Head in the Bay of Fundy, Eastern Canada. The River Severn is a major source of water, mainly abstractions for public water supply and to a lesser extent for industry and agriculture. The Severn is also valued for its navigational and recreational uses. During periods of dry weather the river is regulated by reservoir releases to maintain flows at an acceptable level. In very dry years additional releases to the river can be made from the Shropshire Groundwater Scheme. The river basin has several major urban centres, including Bristol, Cardiff and Coventry, but it has still an overall rural character, particularly within the Welsh side.

The current key environmental challenges are diffuse pollution from agriculture, point source pollution from industry sewage works, physical modification of water bodies, diffuse pollution from urban sources and floods. The Severn Estuary and its surrounding area enjoy a very high level of protection under European

wildlife law and have important inter-tidal and sub-tidal habitats and migratory fish species. The two institutions involved in the management of water resources of the River Severn are the Environment Agency under DEFRA (UK Governmental Department for Environment, Food and Rural Affairs) and the recently created Natural Resources Wales.

The Uruguay River - Salto Grande (in the Paraná– La Plata River Basin)

The Uruguay River is 1,800 km long and flows through Argentina, Brazil and Uruguay. It is part of the vast Paraná – La Plata basin, being one of the main tributaries of that system. The stretch of the Uruguay River that is shared by Argentina and Uruguay is regulated by two agreements and managed by a specific commission. The first is the Agreement on the Utilization of the Rapids of the Uruguay River in the Salto Grande area, signed by both countries in 1946, which established a Joint Technical Commission of Salto Grande (CTM – Comisión Técnica Mixta). The CTM was mandated to carry out the Salto Grande hydraulic project. It first promoted studies and projects, and then constructed and now operates the Salto Grande Dam. The dam is located a few kilometres upstream from the Argentinean city of Concordia and the Uruguayan city of Salto. Currently, the Salto Grande Dam covers 60% of Uruguay's energy demand and 10% of Argentina's market. Later, in 1975, the two countries signed the Uruguay Treaty and established the Administrative Commission of the River Uruguay (CARU – Comisión Administradora del Río Uruguay), in charge of managing the whole of the Uruguay River shared by Argentina and Uruguay (not including the upstream country, Brazil). It is based on a previous treaty on boundaries, again signed by the two countries in 1961, and is also a result of the 1969 La Plata River Basin Treaty, the umbrella framework for several bilateral agreements between the riparian states.

Lake Victoria

Lake Victoria is located in central Africa along the Equator and its 3,500 km-long shoreline borders the countries of Kenya, Tanzania and Uganda. With a surface area of 68,800 km2, which also includes Burundi and Rwanda, it is the world's second largest body of fresh water in size, after Lake Superior. Lake Victoria is relatively shallow, reaching a maximum depth of about 80m, and an average depth of about 40m. Lake Victoria has extraordinary fish resources that are both consumed by riparian populations (around 30 million people) and exported. The main environmental threats are declining water levels due to persistent drought; water abstraction for power generation, unsustainable fishing practices, increasing water pollution, eutrophication and the resurgence of invasive species, mainly the water hyacinth.

In 2003, a Protocol for the Sustainable Development of the Lake Victoria Basin was signed and the Lake Victoria Basin

Commission (LVBC) was established. As with other main agreements governing the Lake Victoria Basin, the Protocol and the LVBC fall under the institutional umbrella of the East African Community (EAC), a regional intergovernmental organisation. The LVBC is a specialised institution of the EAC that developed from a previous Lake Victoria Development Programme (LVDP). The LVBC objectives are the promotion of equitable economic growth and poverty eradication, sustainable management of natural resources, and safety of navigation. The LVBC is located in Kisumu, in Kenya.

Vuoksi River Basin

The Vuoksi is a transboundary river that flows 150 km from Lake Saimaa in south-eastern Finland to Lake Ladoga in north-western Russia. The Vuoksi River Basin extends between these two lakes and covers an area of 4,100 km2. The abundance of surface water resources means that meeting water demand is usually not a concern in the Vuoksi River Basin. Nevertheless, during severe droughts, low water levels can affect fish farms, water transport, industrial and household water supply and recreational activities.

The Joint Finnish-Russian Commission on the Utilization of Frontier Waters was created in 1964 and started operating two years later. It encompasses most of the water resources of the eastern frontier (about 1000 km) with the exception of sea areas. The two countries share 20 watercourses and 448 lakes, rivers, ponds and streams. The largest river basins along the common border are those of the Vuoksi and Paatsjoki. With three working groups, the Commission monitors activities that could affect transboundary waters and assesses the compensation required in the event of damage caused by either one of the countries. One of the most significant results of the cooperation is the 1991 Discharge Rule between Lake Saimaa and the Vuoksi River, aiming at preventing and diminishing damage caused by floods or low water levels. The Discharge Rule established a permanent flow of information between the two countries and allows for a rapid and flexible change of discharge volumes, in case there is a flood threat.

Annex II:
Message.

International conference on:
'Cooperation for Water, Energy, and Food Security in Transboundary Basins under Changing Climate
Ho Chi Minh City, Viet Nam, 2-3 April 2014

CONFERENCE SUMMARY

BACKGROUND AND RATIONALE

In the year 2015, stock-taking of the Millennium Development Goals (MDG) is on the international agenda, along with the adoption of a new set of Sustainable Development Goal (SDG) to succeed them, setting the stage for the post-2015 development agenda. Recognising the critical importance of water for development, livelihoods and maintenance of our ecosystems, a potential dedicated SDG on water is being discussed internationally, along with how to stress the importance of water in other SDGs. The year 2015 is also the year of the COP 21 in Paris at which a new global climate agreement is on the agenda. As reconfirmed by the IPCC Fifth Assessment launched in March 2014, the impacts of climate change and the actions required to adapt and build resilience to these impacts, are strongly related to water, and through water to food and energy security. Both of these agendas have strong transboundary dimensions.

Acknowledging this, the Mekong River Commission (MRC) and other shared basins of the world came together to address these issues. The purpose was to inform the international community, and transboundary basins around the world, in their efforts to shape the future global agenda, as well as to inform the Mekong Region leaders meeting at the 2nd MRC Summit on 5th April 2014. Following similar initiatives before the 1st MRC Summit, the Pre-Summit International Conference held in 2010, and the MRC international conference "Mekong to Rio" held in 2012, the MRC organised a third international conference conjoint with its 2nd MRC Summit – the Pre-Summit International Conference entitled "Cooperation for Energy, Food and Water Security in trans-boundary Basins under changing climate".

This conference gathered about 300 participants, including chief and senior representatives from some 20 transboundary river basin organisations in Asia, Africa, Europe and the Americas[1], leading representatives of some 20 international and regional organisations, most of which supported the Conference as Sponsoring Partners[2], and a wide range of stakeholders from the Mekong region and beyond.

GENERAL MESSAGES

Some 40% of the world's population live in river basins shared by several countries, and

these are even more when also counting shared aquifers and water shared between sovereign entities (states, provinces) within countries. Transboundary basin organisations play an important role in developing and managing shared water resources and the benefits to be derived from cooperation between upstream and downstream riparian countries.

Wise water management is critical to climate change adaptation, not least in building resilience to sea-level rise and increased variability and extreme events, and is key to food and energy production. This underscores the importance of an integrated view on water, energy and food security. This becomes even more important when water is shared in order to realize the full benefits of cooperation.

SPECIFIC MESSAGES

In addressing the overall topic, the Conference focused on three key issues:

Climate change adaptation in a transboundary context

- Progress should be acknowledged. The trend is upwards, not downwards, in openness, sharing of information, technical capacity and actions on the ground. Action should continue focusing on no/low regret options, while at the same time deepening the technical capacity and cooperation addressing trade-offs; otherwise asking for perfection may lead to inaction.
- There is sense of realism and long-term commitment in climate change adaptation approaches. There is no such thing as a quick fix. Scientific advances in support of adaptation show clear policy orientation on e.g. flood management, crop development and delta management. Interaction with policymakers should be intensified to have an effective science-policy dialogue with real impact.
- The focus of the discussions and the actions is sharpened when concentrating on climate variability,

[1] The transboundary basins (shared river basins and aquifers) represented were Aral Sea, Columbia, Congo, Danube, Ganges, Guarani, Geneva Aquifer, Indus, Itaipu Binacional, Jordan, La Plata, Mekong, Niger, Nile, North Western Sahara Aquifer, Orange-Senque, Sao Francisco, Sava, Senegal, Severn, Vuoksi

[2] The Conference was convened in collaboration with the following sponsoring partners: African Network of Basin Organisations (ANBO), Asian Development Bank (ADB), Australian National University (ANU), Conservation International, (CI), Danish International Development Agency (Danida), German Agency for International Cooperation (GIZ), Global Water Partnership (GWP), International Union for Conservation of Nature (IUCN), International Water Management Institute (IWMI), International Finance Corporation (IFC) of the World Bank Group, International Water Association (IWA), World Wide Fund for Nature (WWF), Stockholm International Water Institute (SIWI), Stockholm Environment Institute (SEI), International Center for Integrated Mountain Development (ICIMOD), United Nations Economic Commission for Europe (UNECE), United Nations Environment Programme (UNEP), UNESCO-IHE, University of Arizona, University of West England, U.S. Army Corps of Engineers (USACE), World Bank WB), World Water Council (WWC)

but there are still gaps in important areas such as water quality, sediment transportation, fish population and ecosystem impacts.

Sustainable development

- The nexus approach provides a very useful policy framework to understand development opportunities and challenges, and to involve multiple-sector stakeholders. However, the implementation of actions to address the issues will and should still take place through existing mechanisms and institutions, bearing the nexus approach in mind.
- While the nexus approach is important for the development of targets and goals in the post-2015 agenda, these targets are more likely to be reached through a dedicated goal on water. There is a risk that assuming that 'water is everywhere' leads to 'water being nowhere'. This goal must clearly reflect transboundary surface and groundwater challenges.
- Guidance is needed for the private sector to assess cumulative impacts of multiple developments to mitigate impacts on e.g. sediment transport, fisheries and livelihoods.

Benefits of cooperation

- Appropriate use of a nexus perspective in transboundary basins helps transform challenges in water management into opportunities and create the will to connect.
- In order to collectively benefit from the opportunities, transboundary agreements and institutions develop and need to adapt to changing environments. For these to work effectively, a combination of political will, technical cooperation and an inclusive process is required. Stakeholder's interests, both individuals and sovereign states, need to be balanced.
- The multi-stakeholder processes and institutions are key to turning social and environmental challenges into benefits to be shared between riparian communities and countries.

IN CONCLUSION

This outcome will inform the MRC Summit leaders in their deliberations on the future of the Mekong region and the MRC. It is also intended that the outcome will be useful the transboundary basin management agenda to receive attention among the participants and negotiators addressing the SDGs and the climate agreement at COP 21 in 2015.

In order to further disseminate and promote the outcome of this conference a Publication will be launched at the World Water Week in Stockholm in September 2014. The international Sponsoring Partner organizations will convey the outcome of the conference to relevant stakeholders world-wide.

Ho Chi Minh City, 3rd April 2014

Annex III:
Speakers, panellists and facilitators

Luiz Amore, Foreign Affairs Chief Adviser, National Water Agency (ANA), Brazil

Nico Bakker, MRC Flood Management and Mitigation Programme

Eric Kemp Benedict, Asia Centre Director, Stockholm Environment Institute (SEI)

Teffera Beyene, Executive Director, Nile Basin Initiative

Jeremy Bird, CEO, International Water Management Institute

Peter Koefoed Bjørnsen, Director, UNEP-DHI Center for Water and Environment

Gao Bo, Ministry of Water Resources of China

Benedito Braga, President World Water Council

Gidon Bromberg, Friends of the Earth Middle East (FoEME)

Torkil Jønch Clausen, Conference Facilitator

Gabriel De los Cobos, Hydrogeologist, Geology, Soil and Waste Department (GESDEC)- State of Geneva

Anivaldo de Miranda Pinto, President, São Francisco Basin Committee

John Dore, Australia Department of Foreign Affairs and Trade

David Dumaresq, Emeritus Fellow, Fenner School of Environment and Society, Australian National University

Rashid El Futaisi, Coordinator of Consultation Mechanism, Sahara And Sahel Observatory

Jorge Habib Hanna El Khouri, Itaipu Binacional

Tracy Farrell, Conservation International

Nelton Miguel Friedrich, Itaipu Binacional

Abdou Guero, Technical director, Niger Basin Authority

Hans Guttman, CEO, Mekong River Commission Secretariat

Minna Hanski, Ministerial Advisor, Finland

Enda Hayes, Senior researcher, International Water Security Network, University of the West of England

Suthy Heng, Mekong River Commission Information and Knowledge Management Programme

Fritz Holzwarth, formerly Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety, Germany

Sajjad Hossain, Member Joint Rivers Commission, Bangladesh

Huong Thuy Phan Nguyen, Mekong River Commission Secretariat – Climate Change Adaptation Initiative

Kurt Mørck Jensen, Session Facilitator, Danish Ministry of Foreign Affairs

Ma Jianhua, Changjiang Water Resources Commission, China

Innocent Kabenga, Project Manager, African Network of Basin Organisations

Vijay Khadgi, International Center for Integrated Mountain Development (ICIMOD)

Kyungmee Kim, Stockholm International Water Institute

Anoulak Kittikhoun, Mekong River Commission Secretariat

Lois Koehnken, World Wildlife Fund (WWF)

Kabine Komara, High Commissioner of the Senegal River Basin Development Authority (OMVS)

Dejan Komatina, Secretary, International Sava Basin River Commission

Tom Kompier, First Secretary Water Sector, Embassy of the Kingdom of the Netherlands to Viet Nam

Henrik Larsen, Mekong River Commission Secretariat - Environment Programme

Kate Lazarus, International Finance Corporation, World Bank Group

Le Duc Trung, Director General, Viet Nam National Mekong Committee, Member of the MRC Joint Committee for Viet Nam

Annukka Lipponen, United Nations Economic Commission for Europe (UNECE)
Philipp Magiera, GIZ

Matthew McCartney, International Water Management Institute

Varmar Mahendra Singh, Deputy Commissioner, Joint River Commission, Ministry of Water Resources, Government of India

Shreedhar Maskey UNESCO-IHE Institute for Water Education

Al Mahdi Megrbi, General Water Authority, Libya

Abel Mejia, Session Facilitator, senior consultant on water projects

H.E Te Navuth, Secretary General, Cambodia National Mekong Committee

Nguyen Thi Thu Linh; Viet Nam National Mekong Committee, Ministry of Natural Resources and Environment of Viet Nam

Nguyen Van Duyen, Mekong River Commission Secretariat

H.E. Nguyen Thai Lai, Deputy Minister of Natural Resources and Environment of Viet Nam, Alternate Member of the MRC Council for Viet Nam

Monemany Nhoybouakong, Secretary General of Lao National Mekong Committee

John Nielsen, Danish Ambassador to Viet Nam

Kim Wium Olesen, DHI
Ganesh Pangare, International Water Association

Daovong Phonekeo, Director General, Department of Energy Policy and Planning, Ministry of Energy and Mines, Lao PDR

Voradeth Phonekeo Mekong River Commission - Initiative on Sustainable Hydropower

Victor Pochat, Senior Advisor, former National Water Director of Argentina

Sumit Pokhrel, Greater Mekong Subregion, Core Environment Programme

David Ponganis, US Army Corps of Engineers (USACE)

Jerry Priscoli, US Army Corps of Engineers

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