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River Basin Planning

Principles, Procedures and Approaches for Strategic Basin Planning

Part of a series on strategic water management

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EXECUTIVE SUMMARY

Water provides the lifeblood of natural systems, societies and economies. People have lived near and on rivers, lakes, wetlands and deltas for many centuries. Rivers provide a multitude of services such as water supply, waste assimilation, fisheries, energy production, flood attenuation, spiritual, cultural and recreational benefits, and the habitat that supports a wide range of ecosystems.

It is precisely because water resources provide so many functions that planning for their use is so complex. The demands on rivers increasingly exceed their natural capabilities, resulting in over-abstraction, pollution, alien infestation, floodplain alteration and habitat destruction. These failures are usually the consequence of poor decision-making, inadequate management and inappropriate planning. Effective basin planning is the starting point for sustainable management of river basins.

The practice of basin planning has developed over time in response to the changing demands placed on river systems by societies, and the changing conditions of rivers. The first attempt to manage the hydrological cycle in a coherent way was undertaken in China about two millennia ago. The concept of the river basin as a unit of management became more widely established in the middle of the nineteenth century. It was the massive water resources infrastructure development that took place across the world between 1920 and 1970 that ushered in a phase of 'water resources development planning'. At the core of these initiatives was the view that river basin planning is primarily a technical activity that can be undertaken by engineers, with the objective of optimizing the benefits derived from infrastructure development and operation.

During the 1970s and 1980s it became evident that engineering solutions were no longer adequate to address the multifaceted problems of management, particularly the trade-offs between competing interests and values. The development of new approaches was influenced by a number of emerging trends in the water and environmental sectors:

- The exhaustion of options for technical, engineering solutions to problems. For example, it was no longer possible to construct new infrastructure to meet growing demand for water.
- The recognition of the importance of functioning aquatic ecosystems, and the rapid global decline in the health of freshwater ecosystems.
- The increasing costs associated with water supply and waste management.
- A desire for more decentralized management and greater stakeholder engagement.

These trends led to new approaches to water resources management and basin planning. These approaches were first articulated in the 1990s in the concept of integrated water resources management (IWRM). Many countries have since embarked on policy and law reforms, in most cases embracing the suite of approaches typically associated with IWRM, including basin planning. While enabling important progress, these reforms have highlighted some of the limitations of IWRM. These have included recognition of the approaches to planning in the context of limited information and imperfect institutions, the ongoing importance of infrastructure, the development of approaches to basin-scale environmental management, and decision-making in societies undergoing rapid economic and social change. In this context, more strategic approaches to basin planning and management are developing, building on the lessons from implementation in recent decades.

The characteristics of strategic basin planning

Water stands at the centre of the challenges around food security, economic development, energy generation and climate change. Under these conditions, basin plans need to recognize and be aligned with broader economic development and planning objectives. In this context, strategic basin planning can be defined as: a coherent multidisciplinary approach to managing basin water resources and their users in order to identify and satisfy social, economic and environmental priorities.

The aim of strategic basin planning is not just to meet straightforward, externally set objectives, but to choose from a series of possible water management objectives those that will best contribute to a range of competing economic, social and ecological goals. Further, achieving these goals typically involves the participation of a range of government bodies and stakeholders, beyond those directly involved with water management.

The following characterize this more strategic approach to basin planning:

- trade-offs between alternative economic, social and environmental objectives, and between existing and potential future demands
- a sophisticated approach to recognizing environmental water needs and the importance of aquatic ecosystem functioning in providing goods and services
- understanding basin interactions, including the range of hydrological, ecological, social and economic systems and activities at work within a basin
- robust scenario-based analysis to address uncertainty in future development and climate, by assessing alternative hydro-economic scenarios
- prioritization, to identify which of many demand are the key needs for economic development, social justice and environmental protection.

TEN GOLDEN RULES OF BASIN PLANNING

Basin planning approaches have developed across the world in response to shifting priorities, different crises and increasing complexity in water resources management. Despite this variety, a number of key issues have emerged as central to the challenge of basin planning.

Rule 1: Develop a comprehensive understanding of the entire system.

Rule 2: Plan and act, even without full knowledge.

Rule 3: Prioritize issues for current attention, and adopt a phased and iterative approach to the achievement of long-term goals.

Rule 4: Enable adaptation to changing circumstances.

Rule 5: Accept that basin planning is an inherently iterative and chaotic process.

Rule 6: Develop relevant and consistent thematic plans.

Rule 7: Address issues at the appropriate scale by nesting local plans under the basin plan.

Rule 8: Engage stakeholders with a view to strengthening institutional relationships.

Rule 9: Focus on implementation of the basin plan throughout.

Rule 10: Select the planning approach and methods to suit the basin needs.

Table 1: Attributes distinguishing technical and strategic basin planning

	Water resources development planning	Strategic basin planning
Extent of basin development	Basins with 'spare' water available for development and not facing significant environmental pressures	Complex or water-stressed basins requiring difficult trade-offs between economic, social and ecological objectives
Issues of concern	Responding to identified water resources pressures	Responding to broader basin stress and socio-economic pressures
Purpose of basin planning	Reconciliation of water availability or quality with existing development goals: 'water for the economy'	Water planning as an integral part of development planning: 'water in the economy'
Objective	Development	Protection and management
Focus of attention	Water focused: water resources infrastructure systems	Society focused: economic, social and environmental systems supported by the river
Environmental requirements	Threshold levels, in particular water quality	Maintenance of ecosystem goods and services
Key skills in the planning process	Water planner led, with a focus on engineering skills	Cooperation between development, water and environment planners
Analysis techniques	Technical optimization: ▪ WR infrastructure systems analysis ▪ economic cost–benefit analysis ▪ water quality assessment ▪ future water use projections	Economic and environmental scenarios: ▪ integrated WR systems analysis ▪ social/economic analysis of water ▪ strategic environmental assessment ▪ scenario planning

CONTENT AND STRUCTURE OF A BASIN PLAN

While the nature of basin plans differs from one situation to another, there are typically a number of similarities between the overall structures of basin plans. Figure 1 presents a very high-level structure of a basin plan and its links to the thematic plans that support and align with it.

FROM VISION TO STRATEGIC ACTION

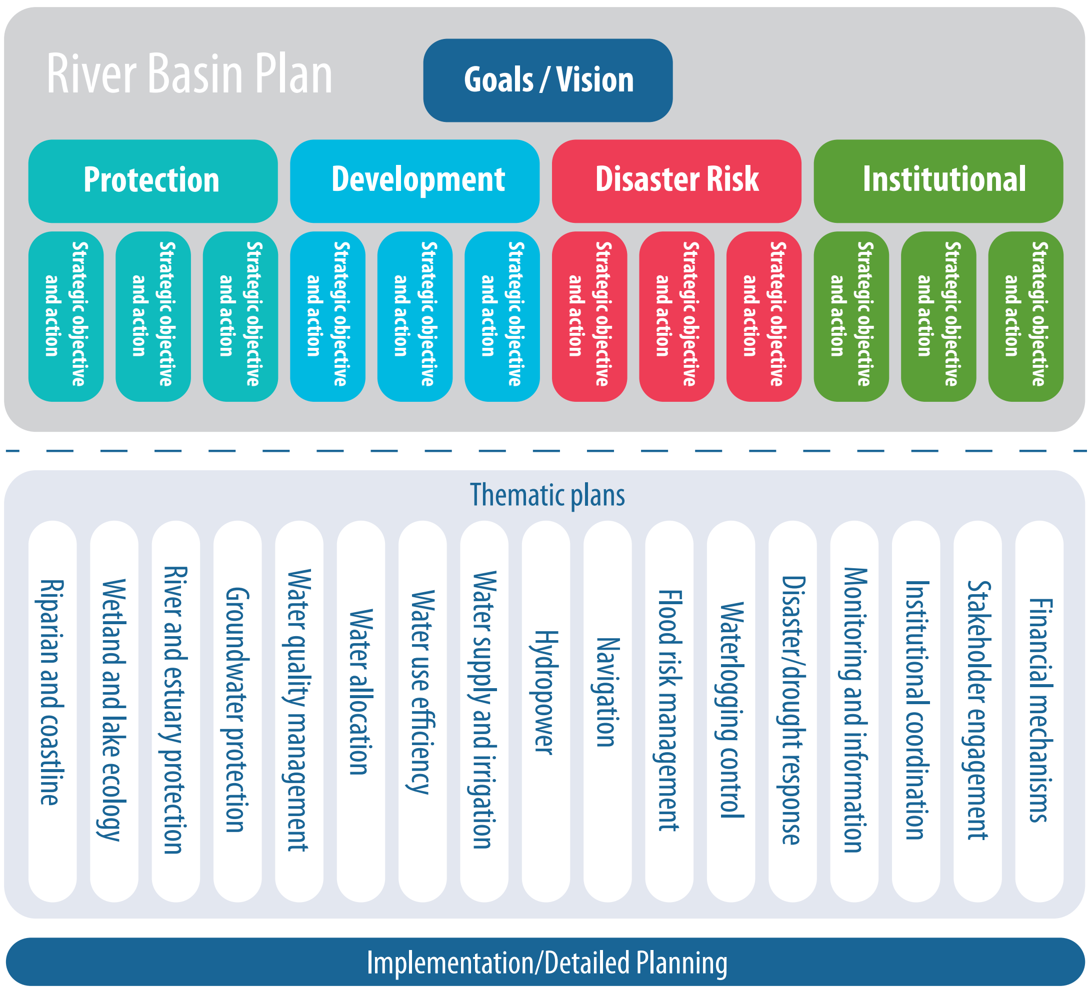
River basin planning typically involves a series of nested statements of intent which together form the means by which basin plans are developed and implemented. These relate to the basin vision and/or goal, more concrete objectives, and specific actions.

Vision statements are often aspirational rather than specific, providing a preliminary indication of political purpose before difficult decisions over trade-offs and investment need to be made. Basin visions tend to be developed around one or more of the following priorities (see Figure 1):

- **Protection:** environmental state of the water resources in providing goods and services
- **Development:** social and economic outcomes related to water use, land use or catchment areas
- **Disaster Risk:** human, property or ecological risks of flooding and other disasters
- **Institutional:** institutional intent for cooperation, collaboration and stewardship.

To be implemented, vision statements need to be translated into specific and measurable objectives and actions that are achievable with the available resources and given time frame. The basin plan performs this function.

Figure 1: Interface between the elements of the basin plan and supporting thematic plans



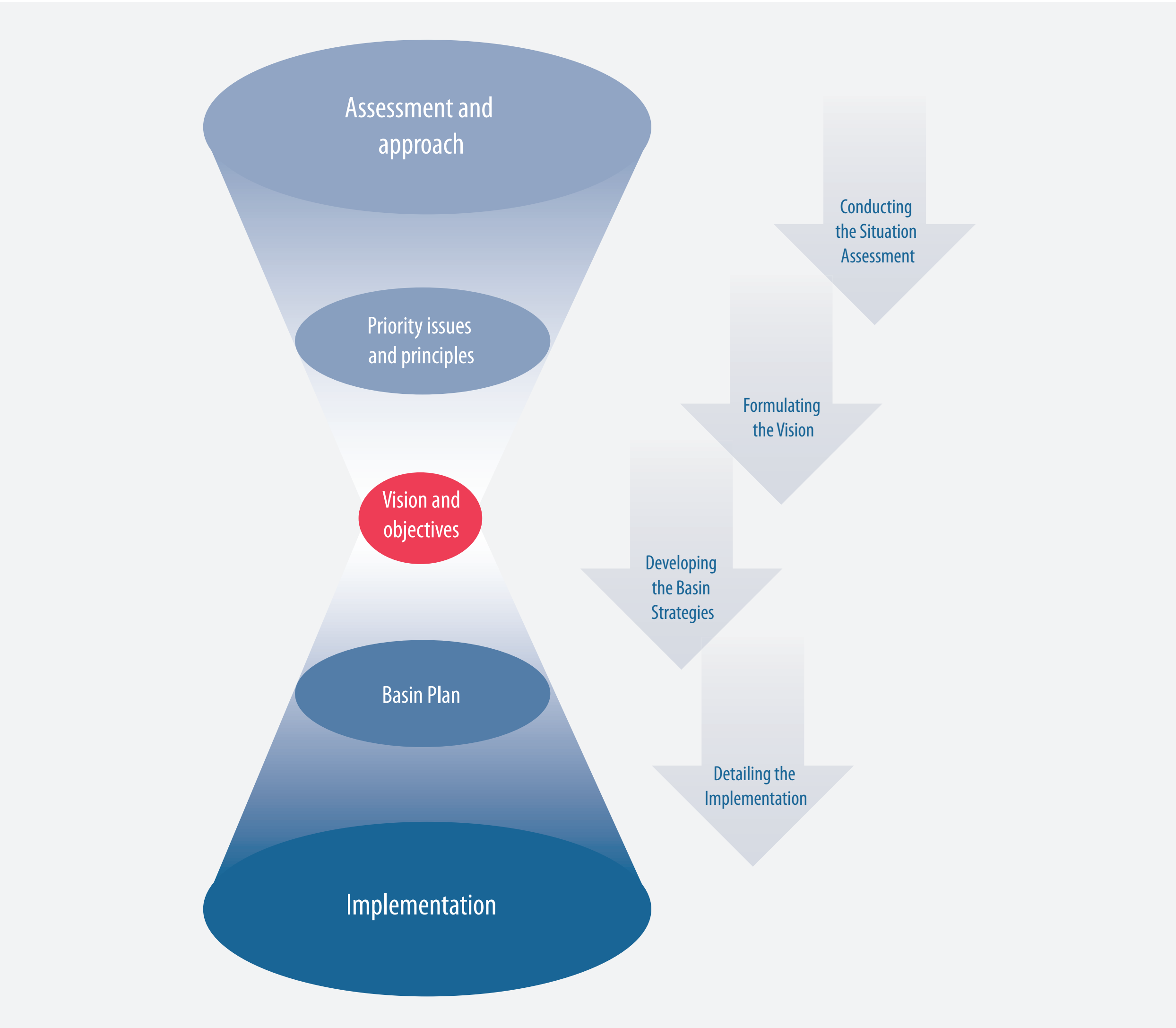
STAGES AND MILESTONES IN BASIN PLANNING

Basin planning typically considers a range of social, economic and environmental issues. However, the range of issues needs to be narrowed down to key priorities to allow for a high-level strategy to be developed. Based on these priorities and the strategy determined, detailed implementation planning is undertaken. This basin planning process can be represented in four key stages:

- **Conducting a situation assessment:** gaining an understanding of the current and future conditions in the basin, as well as identifying and prioritizing the key issues.
- **Formulating a vision and objectives:** that is, spelling out the desired state of the basin over the long term, together with goals (preliminary objectives) and principles to achieve this over time.
- **Developing basin strategies:** specifying a coherent suite of strategic objectives and outcomes related to protection, use, disaster management and institutional development, designed to achieve the vision.
- **Detailing the implementation:** defining actions that give effect to the basin strategies and should ultimately achieve the vision and objectives.

The basin planning process is therefore one of initially narrowing to the identification of a limited number of key issues, followed by broadening to detailed implementation planning. This is represented by the hourglass shape in Figure 2. Central to the process is the identification of strategic priorities and trade-offs. These priorities are determined by social preferences about the economy, society and the environment: these choices are the fulcrum about which the basin planning process turns.

Figure 2: The basin planning process



ENVIRONMENTAL MANAGEMENT IN STRATEGIC BASIN PLANNING

Historically, impacts on river environments have been localized, and responses could similarly be localized. More systemic threats to freshwater systems now require new approaches to basin environmental management, though. These approaches are characterized by the following:

- **Understanding system functioning, assets and services prior to decision-making.** This requires an understanding of functions performed by the river and how different activities within the basin affect those functions. Thus planning starts by considering the river and its services, rather than the pressures on it.
- **The incorporation of environmental goals in the basin vision and objectives.** Strategic environmental objectives can shape economic and development options. As such, environmental goals are part of the foundations of the basin planning process.
- **The emergence of basin ecological objectives.** Modern basin planning is increasingly developing ecologically based objectives, for example related to species and ecosystems, rather than more traditional 'environmental' objectives, such as water quality objectives.
- **The establishment of different objectives, priorities and levels of protection for different parts of a basin.** This recognizes the different characteristics or uses across the basin – with higher levels of protection required in some parts of the basin (e.g. key ecological zones, or sources of drinking water supply), while other areas are more heavily developed.
- **Sophisticated standards and plans for a range of environmental processes.** This can include rules and plans related to protecting environmental flow regimes, maintaining connectivity at the basin scale, and the management of wetlands and high conservation value species.

BARRIERS TO IMPLEMENTATION

Implementation is the greatest challenge in basin planning – something that is even more difficult in stressed basins – and there is always a great risk that the plan will become a paper plan that does not change management practice, actions or behaviour in the basin.

There can be technical barriers to implementation as a result of the design of the plan itself. This can occur where the plan is too ambitious or poorly focused, or where it is too complex and lacks alignment between different thematic areas. Problems can equally arise where actions and responsibilities for implementing the plan are not clearly defined. Finally, there can be problems when the plan is too inflexible to change and not robust to alternative futures.

There are also a number of critical contextual issues that may impede implementation. These include:

- **Lack of political commitment and awareness.** Inadequate leadership to drive implementation and allocate resources can mean that other stakeholders do not adopt the necessary changes.
- **Absence of stakeholder legitimacy and cooperation.** A lack of stakeholder support for the plan and its objectives and actions can be a major barrier. This is best addressed by an appropriately constructed stakeholder engagement process linked to the development of the plan. This includes engaging those stakeholders who are likely to remain unsupportive of the plan because of the potential implications for them.
- **Limited institutional mandate and capacity.** Key institutions need to have the power and capacity to give effect to the strategic actions of the plan. This can require policy and legislation to be in place, as well as institutional strengthening and capacity-building.
- **Poor information and communication.** Sound monitoring systems, communications strategies, formal communication and stakeholder engagement mechanisms facilitate improved information-sharing to support action.

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INTRODUCTION

This book is the result of a collaborative effort between the World Wide Fund for Nature (WWF) and the General Institute of Water Resources and Hydropower Planning and Design, Ministry of Water Resources, China (GIWP). GIWP has been tasked with coordinating the review and revision of a number of China's water policies, including China's master basin plans, the national water strategy, and the development of new inter-provincial water allocation plans. This book was originally conceived to provide support to these processes through the review and dissemination of modern approaches to water management challenges. The final product provides systematic analyses of the general process and methodologies for basin planning which the authors consider to have universal relevance.

The primary output from this collaboration has been three books, which together consider three fundamental water resources management issues: river basin planning, basin water allocation, and flood risk management. The books are:

- *River Basin Planning: Principles, Procedures and Approaches for Strategic River Basin Planning* (this book)
- *Basin Water Allocation Planning: Principles, Procedures and Approaches* (Speed et al., 2013)
- *Flood Risk Management: A Strategic Approach* (Sayers et al., 2013a).

The drafting of these books has been informed by a review of international experience in these fields. The results of this review form the basis of three additional books (Le Quesne and Schreiner, 2013; Quibell et al., 2013; Sayers et al., 2013b), which document a number of case studies on these three topics.

This book draws on the lessons from its companion volume, *River Basin Planning: International Experience and Lessons* (Le Quesne and Schreiner, 2013). That volume includes detailed case studies of the Murray-Darling (Australia), the Lerma Chapala (Mexico), the Rhine (Europe), the Danube (Europe), California (United States), South Africa and China. These cases in particular are referred to frequently in this book.

This document is designed to provide the reader with a general understanding of the process and frameworks of basin planning, to provide some guidance on the specific techniques and methodologies available to assist the basin planning process, and to describe how and when these techniques might be used. It is not intended, however, to provide guidance on the detailed technical tools and means of analysis that form part of the basin planning process, for example detailed hydrological, ecological or economic assessment methodologies. Instead, it is intended to provide an overview of the process, and the appropriate times and places at which these more specific techniques can be used.

References

This book frequently references the river basins that are the subject of the companion case study volume (Le Quesne and Schreiner, 2013). Le Quesne and Schreiner (2013) is often referred to as the reference source for material on those key cases, and further detailed references can be found in that volume. In addition, for the Chinese case studies, much of the material relies on contributions made by members of the GIWP team, based on documents that are not publicly available. In these instances, the source of the material is referenced as 'GIWP'.

Structure of this volume

This volume is divided into two sections. Part A provides an overview of the main approaches and techniques for basin planning. It starts with an overview of the historical evolution and development of basin planning, and highlights contemporary live issues in basin planning. It then provides an overview of the characteristics of modern basin planning, the contents of and process for developing basin plans, and issues around environmental planning.

Part B provides a more detailed description of some of the key techniques involved in basin planning. These include conducting a situation assessment, the process of developing a basin plan, addressing uncertainty, techniques for identifying objectives and balancing trade-offs, and developing thematic plans.

Scope

Basin planning is the process by which decisions are made over the competing uses and different demands for water resources and associated systems within a basin. Basin plans set objectives and the measures for developing, protecting and harnessing the resources of the basin in order to achieve these objectives and health and safety of the river itself. In its most developed form basin planning can bring together a range of different disciplines and themes, from hydrology and engineering to ecology and economics.

Basin planning has been undertaken over many years, for many different purposes and in different types of basins in many countries. Some of this planning has been very formal and organized; on other occasions it is more sporadic, less organized, or develops organically over time. As a result of this history, our understanding of the process, nature, methodologies and techniques for basin planning has developed.

While there are some common themes and principles that have emerged, there is no universally applicable template or roadmap for river basin planning. By nature, basin planning must reflect, consider and respond to the historical, physical, political, social, economic and institutional characteristics of the basin and country. It is this feature that complicates the development of generic guidelines for basin planning.

The main purpose of this document is to present an overview and synthesis of principles, procedures and techniques used in basin planning. The principles and procedures are drawn from the international experience detailed in the companion case study volume (Le Quesne and Schreiner, 2013).

One important note must be made at the outset concerning the particular focus of this volume. Some basin planning processes are comprehensive, seeking to address the broad range of interconnected issues and challenges in a basin. These processes lead to a plan that details actions to address a full range of issues in a river basin, including water quality, water resources development and use, hydropower planning, flood risk management and ecological protection. However, not all basin planning processes are comprehensive in this way: in other contexts, basin planning processes may focus on particular thematic issues, for example flood management or water quality. Because of the context of Chinese comprehensive basin planning process, the focus of this volume is on comprehensive or strategic basin plans. Nevertheless, many of the techniques and approaches set out here are also applicable in more narrowly focused planning exercises.

A cautionary note on terminology

As is emphasized throughout this book, detailed approaches to and techniques for managing water will always be shaped to a significant degree by local context, institutions, history and conditions. This means that there will always be important differences between the approaches and frameworks in different countries.

The implication is that there can be no single template or approach to basin planning. However, this variety also creates an important linguistic trap in attempts to compare approaches internationally or provide general guidance: the same concepts and words used in different contexts can mean very different things. Even the most basic concepts such as water rights and water resource management plans cover a broad array of very different approaches and concepts in different places. By way of further example, many countries produce a 'national water resources strategy' or 'national water resources plan'. However, the different legal, political and institutional systems in different contexts mean that the objectives and contents of these plans can be very different. At one extreme, in some unitary systems these plans set out a detailed national water allocation plan or infrastructure master plan; at the other extreme, they are simply expressions of strategic direction, without detailed administrative contents. Attempts to draw approaches from one context across to another without a clear understanding of these differences can lead to mistaken approaches.

We have attempted to use consistent terminology, and our understanding is set out in the glossary at the end of this section. Nevertheless, significant caution is required in the interpretation of the approaches set out here, and the application of any approaches to different contexts.

Existing guides

Various guidelines and handbooks have been developed over the past decade to support the planning and management of water resources in a more integrated manner. In 2005, CapNet developed a *Training Manual and Operational Guide for Integrated Water Resources Management Plans*, which while focused on the national level is applicable to the basin level. It presents a process, considerations and techniques for integrated water resources management (IWRM) planning. In 2009, UNESCO released the *IWRM Guidelines at River Basin Level* and the Global Water Partnership (GWP) and International Network of Basin Organizations (INBO) released *A Handbook for Integrated Water Resources Management in Basins*. The former focuses on the process of IWRM over time, providing guidance for different sectors and case study examples, while the latter focuses on the enabling institutional framework that promotes IWRM principles in basin management. A more comprehensive list of relevant guidelines and papers is provided in the bibliography at the end of this book.

Illustrative basin plans

Throughout this book selected published river basin plans have been used to illustrate key concepts. The richness and wisdom that have been captured in these plans have been gratefully drawn on for the purpose of this book, and any misconceptions or misinterpretations are entirely the fault of authors of this book. While a range of plans have been referred to, the most generally used plans and their references/links are:

Breede-Overberg Catchment Management Strategy (South Africa)
Breede-Overberg Catchment Management Agency. 2011. *Breede-Overberg Catchment Management Strategy. Worcester,* South Africa.
www.bocma.co.za

California Water Plan (United States)
State of California 2009. *California Water Plan Update 2009, Integrated Water Management*. Sacramento, CA., Department of Water Resources.
www.waterplan.water.ca.gov/cwpu2009/index.cfm#volume1

Danube (Europe)
International Commission for the Protection of the Danube River (ICPDR). 2009. *Vie Danube River Basin District Management Plan*. Vienna, Austria.
www.icpdr.org/participate/danube_river_basin_management_plan

Delaware (United States)
Delaware River Basin Commission. 2004. *Water Resources Plan for the Delaware River Basin*. Delaware, United States.
www.state.nj.us/drbc/basinplan.htm

Murray-Darling (Australia)
Murray-Darling Basin Authority (MDBA). 2010. *Guide to the Proposed Basin Plan*. Canberra, MDBA.
MDBA. 2011. *The Proposed Basin Plan*. Canberra, MDBA.
www.mdba.gov.au/draft-basin-plan

Rhine (Europe)
International Commission for the Protection of the Rhine (ICPR). 2009. *Internationally Coordinated Management Plan for the International River Basin District of the Rhine*. Koblenz, Germany.
www.iksr.org/index.php?id=240&L=3

Yellow River (China)
1987 Yellow River Water Allocation Scheme

GLOSSARY

River basin: Usable freshwater resources are found in rivers, lakes, wetlands and aquifers. River (or lake) basins refer to the hydrological area draining through a system of streams and rivers to the same outlet. This is typically an estuary or delta to the sea, but may also be an inland lake or wetland. Aquifer basins refer to a contiguous discrete body of underground water typically bounded by subterranean geological features; these do not necessarily coincide with river basins. Smaller basins and sub-basins are referred to as catchments in some countries. Importantly, basin boundaries seldom coincide with administrative boundaries, which pose challenges to alignment of planning and management activities.

Basin management: Basins are often recognized as the practical unit of water resources management, because this allows the upstream-downstream hydrological interactions to be considered in holistic solutions. This whole-basin approach also allows a systemic approach to ecological and infrastructure systems. However, basin management is complicated by inter-basin transfers, which fundamentally link two or more basins to form a larger system, while urban and agricultural water supply systems do not necessarily follow basin boundaries. This incongruence between basin boundaries and water management boundaries is a major challenge to basin management and planning.

Basin footprint: In addition to the physical linkages between different basins, there are often strong economic and social linkages associated with the flow of goods, services and people within and between functional and administrative regions (municipalities and provinces). The footprint of the basin may be seen as the geographic area that depends economically or socially on outputs from the basin, or provides inputs to the basin, either of which may be considered in basin planning processes.

Basin organization: A generic term used to refer to any institution that is directly involved in the management of river basins. They may range from large formal basin-scale agencies down to small informal catchment groups, and include transboundary commissions on international waters. The purpose and functions of basin organizations vary considerably, reflecting their legal mandate and the institutional arrangements within which they are established. Furthermore, basin organizations tend to evolve as political imperatives and water resources challenges shift over time. In some cases, a basin organization is responsible for multiple basins and may plan these together, while in other cases international or provincial boundaries force water management organizations to plan partial basins over which they have jurisdiction.

Strategic basin planning: This refers to planning that (i) seeks alignment between the basin plan and broader social and economic planning context, (ii) incorporates environmental requirements as part of the planning process, and (iii) requires harmonization between the competing water management elements within the plan. In this book, strategic basin planning is defined as a coherent multidisciplinary approach to managing basin water resources and their users in order to identify and satisfy social, economic and environmental priorities.

Vision, objectives, and strategies: These terms are used in this book to describe the hierarchy in a basin plan. The vision is typically a long-term, aspirational statement of what the basin might look like in the future. Achieving the vision is the ultimate goal of the basin plan, and defining a vision should identify the priorities for the basin. Objectives are used to refer to clearly defined, shorter-term targets for the basin. These provide more concrete, intermediate and (ideally) measurable goals on the path to achieving the vision. Strategies refer to the actions that will be taken to achieve the objectives. These (and other) terms are used in many different ways internationally, and hence in some instances it has been necessary to use these terms in other ways in this book. However wherever possible the terms are used as described above.

Thematic plans: These are plans that sit under a basin plan and focus on particular water-related issues. Examples include water allocation plans, water quality protection plans and flood management plans. Thematic plans are a mechanism for identifying and addressing specific priority issues at a level of detail that is not possible within the basin plan. They are the mechanism for expanding upon, and implementing, elements of the basin vision and objectives, as defined by the basin plan.

Scenario: A possible future situation, which is the result of a (hypothetical) combination of events, developments and conditions, which may be used to test the performance of the system and possible responses in an uncertain future. A distinction should be made between future or planning scenarios reflecting circumstances largely outside the control of the basin planning process (such as climate and population growth); and, response or development scenarios, reflecting these scenarios together with the suite of possible interventions that may be adopted in managing the basin.

List of acronyms

ADB	Asian Development Bank
ANAE	Australian National Aquatic Ecosystem
AusAID	Australian Agency for International Development
BDL	baseline diversion limit
BOCMA	Breede-Overberg Catchment Management Agency
CIPR	Commission Internationale pour la Protection du Rhin Contre la Pollution
CMA	catchment management agency
CMS	catchment management strategy
DBA	Danube Basin Assessment
DBRD	Danube River Basin District
DRBC	Delaware River Basin Commission
DSS	decision-support software
DWR	Department of Water Resources
EIA	environmental impact assessment
EHMP	Ecosystem Health Monitoring Program
FRM	flood risk management
GAP	Ganga Action Plan
GDP	gross domestic product
GEF	Global Environmental Facility
GIWP	General Institute of Water Resources and Hydropower Planning and Design, Ministry of Water Resources, China
GWP	Global Water Partnership
ICM	integrated catchment management
ICPDR	International Commission for the Protection of the Danube River
ICPR	International Commission for the Protection of the Rhine
IHP	International Hydrological Programme
INBO	International Network of Basin Organizations
IO	input–output
IRBM	integrated river basin management
IWMI	International Water Management Institute
IWRM	integrated water resources management
JPM	Joint Programme of Measures
MAF	million acre-feet
MAP	mean annual precipitation
MAR	mean annual run-off
MBDP	Mekong Basin Development Plan
MDBA	Murray-Darling Basin Authority
MRC	Mekong River Commission
NPV	net present value
NWA	National Water Act
NWC	National Water Commission
NWRS	National Water Resources Strategy
RAP	Rhine Action Program
RBMP	river basin management plan
RWQO	resource water quality objective
SAM	social accounting matrix
SAP	strategic action program
SARH	Agriculture and Hydraulic Resources Ministry (Mexico)
SCBA	strategic cost–benefit analysis
SDL	sustainable diversion limit
SEA	strategic environmental assessment
SWAN	State-wide Water Analysis Network (California)
TDA	transboundary diagnostic analysis
TE2100	Thames Estuary 2100
TVA	Tennessee Valley Authority
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
WFD	(European Union) Water Framework Directive
WHO	World Health Organization
WWAP	World Water Assessment Programme
WWF	World Wide Fund for Nature
ZRA	Zambezi River Authority

PART A

BACKGROUND AND OVERVIEW OF STRATEGIC BASIN PLANNING

Part A provides an overview of the historical evolution and a framework for strategic basin planning, built around ten core principles and the generic basin planning process. Considerations for the planning process, alignment with development planning, approach to strategic environmental planning and engagement with institutions are also presented as a context for the detailed procedures and techniques presented in Part B.

CHAPTER 1
ROLE, HISTORY AND EVOLUTION OF BASIN PLANNING

1.1 The role of basin planning in water management

Water resources provide the lifeblood of natural systems, societies and economies. People have lived near and on rivers, lakes, wetlands and deltas for many centuries. Most early civilizations emerged on the banks of some of the world's iconic rivers. Rivers provide a multitude of services such as water supply for farms and cities, waste disposal for factories and households, fisheries to provide food for communities, energy to drive economies, flood attenuation for downstream developments, cultural and recreational enjoyment for people, spiritual upliftment for believers and a habitat for many animals.

It is precisely because water resources provide so many functions that planning for their use is so complex. Unfortunately the demands on rivers increasingly exceed their natural capabilities, resulting in over-abstraction, pollution, alien infestation, floodplain alteration and habitat destruction. These failures are usually the consequence of poor decision-making, inadequate management and inappropriate planning.

The multiple uses of and demands on a river basin mean that an integrated approach to managing river basins is required. Reconciling and coordinating competing demands relies on appropriate planning mechanisms, and basin planning can now be seen as the starting point of sustainable management of river basins and the associated social and economic systems.

Basin planning is the process of identifying the way in which a river and its limited natural resources may be used to meet competing demands, while maintaining river health. It includes the allocation of scarce water resources between different users and purposes, choosing between environmental objectives and competing human needs, and choosing between competing flood risk management requirements.

Examples of single-purpose water allocation, flood control and navigation rules go back centuries. However, with increasing development and population pressures, the complexity of many of the world's river basins has increased and many have experienced serious crises related to floods, deteriorating water quality, acute water shortage or degraded ecological health. This has often led to the political requirement to manage rivers more effectively, in order to pre-empt crises and resolve conflicts. The practice of river basin planning has therefore increased in significance over the past few decades, with an emphasis on more integrated approaches to management.

While approaches to basin planning have evolved over time and are adapted to the local circumstances within a basin, basin planning is ultimately the process of:

- assessing and prioritizing issues of concern to be managed within a basin
- deciding on the way in which these priorities should be managed to achieve social objectives over time
- specifying the way in which different competing purposes (such as abstraction, hydropower, flood control and navigation) may develop or use the basin water resources.

Basin planning has historically has been prompted by the need to manage the challenges associated with one or more of the fundamental basin-scale water-related issues:

- Water allocation, reconciliation and utilization planning has tended to be the focus in more arid or seasonally variable basins where population and development has driven water demands.
- Water quality planning has been the focus in highly developed urban, industrial or mining dominated basins, as well as those with intensive irrigation.
- Flood risk management has tended to be the focus in higher rainfall basins, particularly where there is significant downstream development (people and property).

In some large and diverse basins all of these issues require significant consideration. However, in most basins, not all of these issues will be of equal concern.

1.2 A brief history of basin planning

The practice of basin planning has developed over time in response to the changing demands placed on river systems by societies, and the changing conditions of rivers. While the practice of basin planning has been under a process of continuous development, two major historic phases of basin planning can be identified: first, water resources development planning, then in recent times, more strategic approaches to basin planning. The latter have attempted to move beyond simply managing the construction and operation of infrastructure to a much broader set of objectives associated with the environmental, social and economic development of the basin.

WATER RESOURCES DEVELOPMENT PLANNING

The first attempt to manage the hydrological cycle in a coherent way was undertaken in China about two millennia ago, linked to the challenge of developing and managing flood, transport and irrigation infrastructure. However, despite increasing use of water resources in many parts of the world, the concept of the river basin as a unit of management only became more widely established in the middle of the nineteenth century. This occurred primarily in the context of flood control and navigation in the Eastern United States, and increasing industrialization, hydropower and irrigation development in Europe. The premise of these developments was the need to harness nature through infrastructure development, which could only be managed effectively through coordination along the entire river.

At this time, river basins were also being proposed as a natural administrative unit by certain modernist political interests in Europe and United States. This was based on the idea that the development of water resources could be planned and engineered as a catalyst for regional development. These radical administrative proposals understandably met opposition from existing interests in national and state bureaucracies, with the result that this utopian dream of hydrological administration was not implemented.

Nevertheless, these ideas, together with technological advances in construction at the beginning of the twentieth century, enabled the massive water resources infrastructure development that took place across the world between 1920 and 1970. This began in the more arid southern and south-western United States and southern Europe (such as Spain), focusing on dam-building for urban and irrigation supply and hydropower. These ideas had traction with emerging nationalist leaders in countries in the developing world such as Mexico, Brazil, South Africa and India, who built political capital on the development of large-scale infrastructure to harness 'wild rivers' in the interests of national progress and development. Jawaharlal Nehru, the first prime minister of independent India, famously described dams as the 'temples of modern India'.

Box 1: The role and evolution of the Tennessee Valley Authority

The unique social and economic pressures created by the Great Depression inspired a new era of innovation in development planning which allowed the US Congress the political leeway to establish the first basin-wide management entity in 1933, the Tennessee Valley Authority (TVA). Since the 1920s Congress had recognized that the development of water resources for flood control, improved transport, hydropower generation and the expansion of irrigation into the farmlands of the western United States would require coordinated water planning and management.

The TVA catalysed engineering and scientific knowledge into an approach that not only developed water resources directly through building dams and other infrastructure, but also supported higher and broader developmental ambitions such as education, poverty alleviation, farming improvements, health and sanitation, and small enterprise development. Although the TVA model was never again replicated in the United States, it provides the first example of leveraging river basin development beyond its historical water resource management focus and using it to support an integrated social and economic development policy program.

Many efforts to create similar valley authorities in other areas throughout the United States failed as the federal government became reluctant to create new governance institutions that would take decision-making authority away from the states and other already established federal entities.

Source: TVA (n.d.).

Box 2: The evolution of river basin planning in China

Since the founding of China, the Chinese government has placed water management in a strategic position. River basin planning in China has experienced the following three stages:

- From the 1950s to 1960s, the first round of river basin planning was carried out, with a focus on river regulation and management as well as disaster prevention and treatment. That laid a foundation for setting up the basic layout of major water projects in large river basins.
- In the 1980s, a second round of river basin planning was embarked on, with an emphasis on water resources development and utilization. Consideration of water resources protection and management was reinforced.
- At the beginning of the twenty-first century, a third round of river basin planning was conducted, based on the core philosophy of harmonious development between humans and nature. The emphasis was on maintaining river health and ensuring the sustainable development of water resources. In this round, more attention has been paid to solving major issues concerning water resources development, and the role of river basin planning in social management has been highlighted.

Modern basin planning in the Yangtze River, as in China more broadly, has evolved through a number of phases, based around the development of a series of master plans that have been produced for China's major river basins. The first of these planning phases was in the 1950s. In 1955, the Chinese State Council decided to undertake a comprehensive planning exercise for the Yangtze basin, establishing the Yangtze Basin Planning Office (the predecessor of the Changjiang (Yangtze River) Water Resources Commission), and compiling the first basin scale plan, *Key Points Report of the Comprehensive Utilization Plan for the Yangtze Basin*. In 1958, Premier Zhou Enlai led a process to examine and review the Yangtze River plan, and following this, plans for the Yangtze were approved by the Central Political Bureau through the *Opinion about Three Gorges Project and Yangtze River Plan*. This provided the basis for the pattern of future water infrastructure construction on the Yangtze.

Source: GIWP.

This era of infrastructure development was often associated with the establishment of river basin organizations to be responsible for the development and management of water resources, particularly infrastructure. The work of these organizations included the development of river basin (master) plans, with a focus on infrastructure development planning. At the same time, in the wetter parts of northern Europe and parts of the north-eastern United States, basin planning increasingly focused on pollution, flooding, navigation and hydropower. Germany, France and the Netherlands all developed basin-level organizations responsible for planning and in many case financing the extremely expensive infrastructure needed to deal with increasingly polluted rivers and flood control through highly populated urban areas.

Box 3: Rhine River basin planning

A decline in the salmon population in the late nineteenth century was the first driver of planning along the Rhine River. Much later, after the Second World War, increasing industrialization and urbanization resulted in serious water quality problems, resulted in a rapid deterioration of ecological health in the river and a collapse in the fish catch. As a result of this crisis, various agreements were put in place on the Rhine between 1950 and 1985, including the establishment of the International Commission for the Protection of the Rhine against Pollution (ICPR) in 1963.

Source: ICPR (2012).

At the core of all of these initiatives was the belief that river basin planning is primarily a technical activity undertaken by engineers, with the objective of optimizing the benefits derived from infrastructure development and operation in the basin. While both infrastructure development and water resources development planning continue to be important, recognition of the limitations of this approach has led to changes in the way basin planning is undertaken.

NEW APPROACHES TO BASIN PLANNING

The intensive water resources infrastructure development in the twentieth century resulted in significant negative social and environmental consequences in many parts of the world (World Commission on Dams, 2000). At the same time, many basins and aquifers around the world have become stressed as water has become insufficient to meet competing demands, the fitness of the water quality for use has declined and the modification of aquatic ecosystems has accelerated. Thus, as industrial, agricultural and urban demands for water have increased, the natural functioning and ability of these water resources to meet these economic, social and ecological needs has decreased. The challenges of reducing water use in over-allocated basins, decreasing waste loads from point and nonpoint sources in polluted rivers, and rehabilitating degraded river systems could not be resolved by the historical infrastructure-focused approaches to basin development.

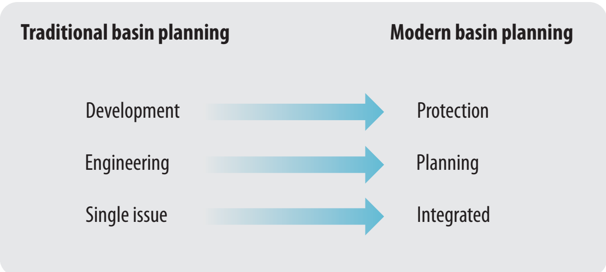
As a result, during the 1970s and 1980s the water development community began to question previously held assumptions about water resources planning and management. It became recognized that purely engineering solutions were no longer adequate to address the multifaceted and interconnected problems of basin management, in particular in conditions in which trade-offs between competing interests and values are required.

The development of new approaches to basin planning was influenced by a number of emerging trends in the water and environmental sectors:

- The recognition of the importance of functioning aquatic ecosystems, and the rapid global decline in the health of freshwater ecosystems. Freshwater ecosystems have been the biomes showing among the fastest rates in decline of any biomes on the planet.
- The exhaustion of engineering solutions. For example, in some cases demand for more water supplies could not be met through new reservoirs because of the absence of suitable sites or because all run-off in a catchment was already being utilized. In other cases, the construction of ever greater flood defences was no longer reducing risk.
- Steadily increasing costs of providing water services through engineering measures, such as increasing water treatment costs because of the pollution of water sources.
- The shift to decentralization and participatory governance of resources in many countries. This followed the recognition that there was a need for solutions that engaged with many individuals and groups through changes to development planning and natural resources management, and a stronger emphasis on demand management.

These trends led to new approaches to water resources management and basin planning that attempted to move beyond a narrow technical and engineering focus to address a wider range of issues and challenges. These new approaches are characterized by a focus on management at the basin scale, a recognition of the economic and developmental (including poverty reduction) significance of water resources, a focus on the environmental and social importance of water, the participation of a wide range of groups in decision-making, and the attempt to manage the use of water as well as augment supply.

Figure 3: Trends in the focus of basin planning



By the 1990s, the first coherent expression of these new trends was through the concept of integrated water resources management (IWRM). The concepts of IWRM were captured initially in the 1992 Dublin and Agenda 21 principles. Agenda 21 defined IWRM as 'based on the perception of water as an integral part of the ecosystem, a natural resource and a social and economic good, whose quantity and quality determine the nature of its utilization' (UNDESA, 1992). The Global Water Partnership (GWP) has defined IWRM as 'a process that promotes the coordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems.'[1]

Whatever the precise definition, these efforts were at their heart a response to deteriorating and collapsing ecosystems, together with the constraints on economic and social development associated with inefficient development and allocation of water. This philosophy was taken to its conclusion in the 2000 European Union Water Framework Directive (WFD) requirement for comprehensive basin management plans and the 2002 Johannesburg World Summit on Sustainable Development commitment by countries to develop IWRM plans at a national level.

Box 4: Comprehensive water reforms: examples from South Africa and Mexico

In the late 1990s South Africa revised its water resource policy (1997) and legislation (1998) to incorporate the principles of IWRM. This included the establishment of new institutions to manage water resources according to basin boundaries, the recognition of social and environmental needs as priorities for water management, and the development of nested national and basin-scale strategies for water resources management.

In Mexico, a new National Water Act was passed in 1992 and subsequently updated in 2004. This legislation introduced key aspects of IWRM. The act strengthened the National Water Commission (now referred to as 'Conagua'), better defined the roles of regional stakeholders, encouraged the participation of state and local water users and civil society, called for the formation of river basin councils (of which 25 out of 26 have now been established), and laid the foundation for a participatory planning process. The act established a system of water rights, under which around 450,000 entitlements have now been issued. Public policies related to water reform have also been oriented at the privatization of infrastructure development and operation, most notably the transfer of irrigation districts to farmers.

Sources: Republic of South Africa (1988), Le Quesne and Schreiner (2012).

Over this period, and particularly since 1990, a number of low and middle-income countries undertook thorough reforms of their water policy and legislation, and incorporated new basin-scale management and institutional arrangements into their legal frameworks. These reforms were often based on IWRM principles. China, Mexico, South Africa and Brazil were among the early countries that adapted their water law and policy to reflect the changing circumstances facing water resources management at the start of the 1990s, including a

1 IWRM is closely associated with the concept of integrated river basin management (IRBM), and the two concepts are often used interchangeably. IRBM places a particular emphasis on the management of water at the basin scale, while IWRM considers similar issues at a broader scale. As such, IRBM can be seen as a subset of the concept of IWRM.

legal requirement for basin-level planning. Since then, many other countries in Africa and Asia have embarked on policy and law reform processes, in most cases embracing the suite of approaches typically associated with IWRM, including basin planning.

The key social, economic and environmental challenges that led to the development of IWRM are as strong as ever, and IWRM remains a dominant concept in many international discussions. However, a number of countries that have attempted to develop reform processes based on IWRM principles have faced significant difficulties in doing so. As discussed below, a number of key issues with IWRM have emerged, and in response new approaches are beginning to develop, which apply a more strategic approach to basin planning.

1.3 Emerging challenges and live issues in basin planning

The evolution of basin planning over the last quarter of a century has therefore seen a profound shift in focus from a narrow, engineering-focused approach, to a more complex process incorporating environmental sustainability, demand management, institutional development and economic and social analysis and trade-offs.

Much of the development of these new approaches to basin planning has been implemented in the context of IWRM. However, the international experience with IWRM and its implementation has been mixed, and has led to a number of critiques. While the insights encapsulated in the early approaches to IWRM have clearly been important in a number of areas, there are now a number of issues emerging as central challenges for the development of basin planning as it seeks to move beyond the early IWRM concepts. Seven interrelated issues are identified here as being of particular significance. Taken together, these issues define the likely evolution of international approaches to basin planning in the years ahead.

There is no one blueprint for effective river basin planning, and the approach should be developed according to the specific basin challenges, priorities and conditions. This more pragmatic approach recognizes that while there are some common principles and approaches that can be adopted, river basin planning should build on and evolve out of existing historical and cultural experiences and approaches. In practice, the most appropriate approach to basin planning will respond to the local and national political, social and institutional context, the challenges faced by that basin, and the extent of development pressure and environmental stress within the basin.

A pragmatic approach needs to be adopted to institutional development. Much of the development of IWRM in both theory and practice was undertaken by practitioners rooted in the European context, where water management was conducted by a large number of well-resourced institutions, in basins with high levels of economic and infrastructure development and with effective legal and regulatory systems. This often led to the assumptions that basin planning required consideration of all interactions to reflect the interconnected nature of the system; a river basin organization was needed to coordinate this planning; the focus should be on demand-side management (rather than supply-side infrastructure); and that stakeholders must be engaged at all stages and levels of the process. As a consequence, the focus of river basin planning shifted strongly to the development of institutions and processes. However, while the development of management institutions is important in supporting improved basin planning, these institutions must be seen as an enabler of equitable, efficient and sustainable management of water resources, rather than as an end in themselves. In many cases, a tendency has emerged for planning to focus on the development of basin-scale institutions as the objective. As a consequence, the real objectives of basin planning initiatives may become lost. A more pragmatic interpretation of institutional development is now emerging, based on recognition of the need to simplify and focus management attention on key basin priorities, with basin plans developed in the context of the management resources, information and institutional capacity that are realistically available.

Strategic environmental planning is emerging as a critical area of focus. There is increasing acknowledgement of the need to progress beyond minimum-standards approaches to environmental and ecological planning, to techniques that seek to prioritize the key areas and processes in the river system that need to be protected and maintained. This is based on a greater recognition and better understanding of the reliance of human social and economic systems on the goods and services provided by natural and ecological water systems.

The issue of scale and scope has become increasingly fundamental. There is recognition that rather than a simplistic view of planning being undertaken at the basin scale, a more complex, multi-scale approach is required, with management undertaken at a series of scales including national, basin and sub-basin. This more complex, multi-scale approach has been driven by a number of tensions. These include tensions between basin boundaries and administrative boundaries. This means that governments conduct development planning according to administrative boundaries which do not align with basin planning boundaries. Basin planning exercises need to engage with a complex set of developmental, social, economic and environmental priorities across a range of issues. The social and economic 'footprint' of the basin also becomes an important consideration in a basin planning process, particularly where there are strong linkages between the basin and regional economic development activities located outside of the basin. At the same time, many basin planning processes attempt to address complex issues in heterogeneous basins. This complexity is increasingly being managed through the prioritization and nesting of thematic or geographic plans under the umbrella basin plan, rather than attempting grand comprehensive basin plans addressing all issues at a basin scale. While this challenge is complex between states in federal systems, it can become almost insurmountable on an international basis without strong cooperative arrangements.

Infrastructure development remains important in many contexts. The early application of IWRM was primarily undertaken in Europe, with the focus on managing water resources through environmental protection, allocation and demand management interventions, with water resources infrastructure development being viewed as no longer appropriate or desirable. The more recent interpretation of integrated basin planning in many developing countries recognizes the importance of infrastructure development in order to support economic and social development, while ensuring that this development does not result in unacceptable environmental and social consequences. This requires a shift from either a European approach focused on environmental restoration or the traditional infrastructure development approach, to a more nuanced approach that combines elements of both.

Both national and river basin water resources planning exercises need to engage actively with national, provincial and local development policies and strategies. This is required both to ensure that basin planning supports national, provincial and local development priorities, and that development planning is aligned with the opportunities and constraints related to water. The significance of this issue is highlighted by the private sector's increasing engagement with water policy, strategy and institutions. This follows the recognition by the private sector that inadequate water management and scarcity pose direct risks to their operations or supply chains. The ability of water planners to engage effectively with economic, development and planning ministries remains an international challenge.

The uncertainty and variability around climate change has emerged as a challenge to conventional river basin planning, leading to calls for adaptive management and scenario planning. This is particularly relevant for the longer-term (20+ year) aspects of basin planning. It becomes increasingly important to assess the degree of flexibility and robustness that current interventions may have under different futures, as well as the possible future options that an intervention may restrict. A major shift that water resource planners need to make is from deterministic or stochastic analysis of variability under assumptions of stationary hydrology based on historic data, to the assessment of uncertainty under nonstationary conditions. Uncertainties around changes to climate are exacerbated by rapid changes in energy, agriculture and industrial development. This is particularly the case in those parts of the world where climate predictions cannot even reliably indicate the direction of change in precipitation.

Together these issues highlight the interactions between water resources (and other natural resources) planning, economic development and environmental planning. In the past decade, this understanding has contributed towards the adoption of a more strategic approach to basin planning, where basin water resources planning engages directly with the opportunities (to catalyse) and challenges (to constrain) that this limited resource places on economic and social development. The rhetoric of moving 'outside of the water box' is becoming a reality in places as diverse as the Mekong, where basin water development is being planned in conjunction with economic development of the four downstream countries, and Zambia, where the national development plan is directly engaging the water sector as a catalyst or constraint on development. Interestingly, this represents a return to the vision of water development as a driver of social and economic development that underpinned the New Deal approach in places such as the Tennessee Valley.

1.4 The development of basin planning in selected countries

The evolutionary process in basin planning has occurred at different paces and in different contexts within different countries and regions. In most cases, the shifts in the approach to basin management and basin planning have been prompted by the onset of crisis, and the need to respond through new ways of planning and managing water resources. In each case, the crisis was one that was no longer amenable to traditional, engineering-based solutions:

- In South Africa, fundamental political transition, social equity and the need for water to drive the economy led to the 1998 South African Water Act, which established catchment agencies to conduct basin planning and sophisticated environmental water requirements.
- In China, development, flooding and environmental pressures led to the revised 2002 Water Law, the evolution

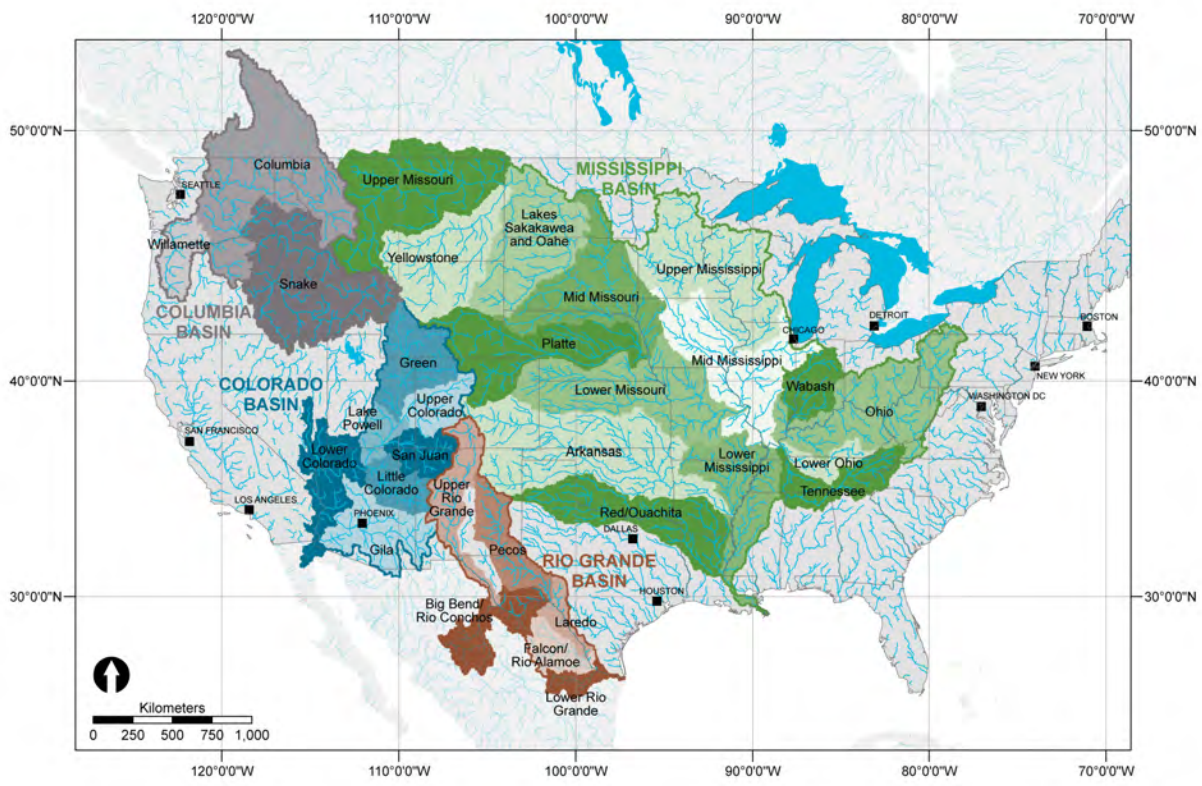
of the 'water saving society', implementing the 'most strict water resources management', and the development of third-generation basin master plans from 2008 built around principles of sustainability.

- In the Murray-Darling river basin (Australia), ecological collapse caused by over-abstraction, water scarcity and water quality deterioration, accompanied by threats to public and irrigated agriculture water supply, led to the revision and strengthening of water allocation and basin management approaches. This included the 1995 Basin Cap, the 2001 Integrated Catchment Management Strategy, the 2007 Water Law and the first whole-of basin plan.[2]
- In Mexico, increasing constraints to the availability of water for productive uses and associated ecological collapse led to the 1992 Mexican Water Act, which introduced a modern basin management approach.
- In northern Europe, crises were related to severe water quality degradation and extensive flooding events, leading to new basin-scale water quality and flood planning, for example in the Rhine valley. These processes led ultimately to the EU WFD.
- In the United States, the lack of basin-level management institutions has resulted in a focus on local watershed (catchment) management, coupled with state-level water agreements, known as compacts, to address various water allocation, water quality and environmental issues.

2 The first basin plan was in draft form at the time of writing.

These examples are considered in brief below, and in detail in the companion case-study volume (Le Quesne and Schreiner, 2012). They, as well as other examples, are drawn upon frequently throughout this book to illustrate different aspects of the basin planning process.

Figure 4: Map of the United States, showing the major river basins



Source: WWF (2013)

THE UNITED STATES

The history of water management in the United States has at various times been dominated by federal agencies, state-focused interests and river basin management authorities. A lack of political will caused by competing interests at both state and federal levels has undermined policy efforts to coordinate the management of water resources for social and economic development at a river basin level.

In the absence of basin-scale institutional arrangements the focus of water management in the United States in the twenty-first century has shifted to a local catchment level, with legally binding inter-state compacts taking the place of coherent planning at a basin scale.

Basin planning and the development of infrastructure in the United States

Cooperative water resource management in the United States dates back as far as the late eighteenth century, when the governments of Virginia and Maryland created a bi-state commission to investigate the navigational potential of the Potomac River. This desire to exploit the navigational potential of shared water bodies into a network of waterways in the Eastern and Central states spurred on a raft of canal construction projects by both private and state-funded entities in the early 1800s. Their cost, scale and complexity led to calls for a greater federal government role in their coordination, planning and regulation.

By the 1920s, growth in the western states began to be restricted by water supply constraints. This led to the establishment of legally binding interstate water compacts, which apportioned water flow to the states located along a river. States had an incentive to pursue these agreements as they facilitated long-term planning by apportioning water between states, as well as facilitating the construction of major storage infrastructure. The 1922 Colorado Compact was the first and most well known of these agreements.

In the 1930s, in response to the unemployment and economic upheaval of the Great Depression, the federal government led a series of intense, large-scale national water development projects. This period, which some consider the 'golden age' of water infrastructure development, saw the construction of the United States's four biggest multipurpose dams (Hoover, Shasta, Bonneville and Grand Coulee), and restored, albeit temporarily, the federal government's position as the main driver of water resource management.

The failure of federal coordination and greater state involvement

In 1943 in an attempt to create basin-wide agencies, the federal government established a Federal Interagency River Basins Committee to coordinate the activities of the various federal agencies working within a river basin. Despite this recognition that water resources should be managed as a single basin-wide unit, the committee was largely ineffectual as it did not have the statutory authority to approve water development schemes and its staffing was made up of members of its composite agencies. As a result whenever there was any conflict between the various agencies' plans (particularly between the Army Corps of Engineers and the Bureau of Reclamation) these entities bypassed the committee and went to straight to Congress. The committee was also heavily criticized for not allowing the states to become sufficiently involved in regional water resource planning, development and management.

Largely as a result of their failure to coordinate their activities, the 1960s saw the policy-making role of federal agencies reduced as water management moved away from federal dominance towards greater federal-state cooperation. Two basin planning arrangements emerged as a result of this shift: the interstate-interagency ('Title II') commissions and the inter-state compacts.

The Title II commissions addressed some of the shortcomings of the basin interagency committees. The commissions had a formal legislative basis in the Water Resources Planning Act (1965), and their membership had a mixture of both federal agency and state representatives. Unfortunately, the commissions were still largely dependent on the member agencies for resources and decision-making, and as result tended towards a 'soft' management style which tried to build consensus and unanimity. Inevitably, this meant that the commissions focused on uncontroversial functions such as information gathering and communication, rather than substantive basin planning decision-making.

There have been some exceptions. The Delaware River Basin Commission and the Susquehanna River Basin Commission are institutional arrangements that provide a more significant degree of autonomy and independence. These commissions have a wide range of responsibilities and are involved in water supply management, pollution abatement, flood control, river regulation, recreation and environmental protection. Given that both the river basin states and the federal government are signatories to the compacts that established them, the commissions are able to leverage both the political power of member state leaders for policy decisions and the resources of the federal government. This allows for a great deal of independence, which is supported by a technically competent staff complement.

However, in other basins, the absence of effective basin-scale management arrangements has meant governance of water resources in large US basins has become dominated by legal inter-state compacts, legally binding agreements over the division of water resources. Examples include the Snake River Compact (1949), the Yellowstone River Compact (1950), the Klamath River Compact (1957), the Delaware River Compact (1961) and the Great Lakes Compact (1968). While providing certainty over the division and management of water resources, these compacts offer little opportunity for flexibility or adaptation.

The river basin management void and the emergence of catchment management

In the 1970s the federal government retreated from regional river basin management towards a supportive, national legislative role which dealt with land management, pollution abatement, species protection and resource preservation issues. Examples include the Clean Water Act of 1977. This trend continued in the 1980s with the dismantling of the Title II Commissions and the re-emergence of state water compacts to deal with competing social, economic and environmental water interests.

This has created a void in water management at an interstate river basin level. While the federal government has been able to implement a national policy framework of water standards and quality that has largely addressed basin water quality management challenges, the actual management of water resources has become the responsibility of the individual states, with basin-level planning addressed through the inter-state compacts.

One of the consequences of the absence of cooperative water resource management at the basin scale has been serious environmental degradation and a constraint on economic and social development priorities. As a result of this, the small intra-state catchment has emerged as the focal point of water resource management in the United States in the twenty-first century. Thousands of 'watershed partnerships' have emerged in the past 15 years, made up of a broad composite of interests including federal, state and local government agencies, concerned citizens and landowners, and environmental interest groups. Given that these partnerships are dependent on a platform of consensus-building, they have been admirably effective in dealing with local environmental issues but have not been able to tackle more competitive (and hence more divisive) basin allocation issues.

SOUTH AFRICA

South Africa rates very low in terms of water availability per capita, and receives low rainfall by international standards – around 60 per cent of the world average. Furthermore, it has one of the lowest ratios of mean annual precipitation (MAP) to mean annual run-off (MAR) in the world – only 9 per cent of rainfall enters rivers, compared with a global average of 31 per cent (DWAF, 1996). Rainfall is highly seasonal, and the situation is exacerbated by high interannual variability and frequent droughts. The result is water scarcity, with high levels of spatial and temporal variability in river levels, dam storage and groundwater levels.

Figure 5: Map of South Africa, showing water management areas

Source: South African National Water Resources Strategy (Sept 2004).

To cope with these climatic and physical challenges, South Africa has developed sophisticated and extensive surface water storage and transfer schemes, including inter-basin transfer schemes. Most catchments are linked to a degree that is unusual elsewhere in the world. However, continued development, industrialization and urbanization have increased the ecological and water quality challenges, while the emergence from apartheid has posed redistributive and supply challenges for water resources management. The story of basin planning is thus one of planning for highly interconnected systems, while managing increasing stress and complexity within basins and demand for transformation of access to water.

Infrastructure development

Water management from the 1900s until the 1980s was largely focused on the need to ensure food security, resulting in the development of irrigation schemes and storage to support the agricultural sector. During this period irrigated agriculture not only moulded water policy development, it was fundamental to the infrastructural, economic and social development of the country. In the water sector, this was essentially a period of unchecked infrastructure development, with little concern for social or environmental impacts and limited public participation. This infrastructure-focused planning phase reflected the dominant political and economic system at the time.

A gradual shift in focus from irrigation to urban-industrial supply took place over the half century to 2010. While irrigated agriculture provided the basis for water policy and infrastructure development in the early years of South Africa's economic development, from the middle of the twentieth century the industrial and mining sectors grew significantly, driven by the presence of minerals such as gold, coal and diamonds. However, this development has not been aligned with the availability of water: the largest industrial area, around Johannesburg, sits on the intersection of three catchments, and is poorly endowed with water.

Water planning in South Africa has subsequently become increasingly dominated by a disjuncture between water resource availability and regions of economic development, creating the need for a complex system of inter-basin transfers and dams to support the centres of industrial development, in particular for the economic heartland around Johannesburg and the Upper Vaal subsystem, in what today is known as Gauteng.

Integrated approaches

From the early 1970s through to the mid-1990s South Africa's perspectives on water resource management started to shift significantly. This was a period of improved scientific understanding of the increasing water quality challenges that the country was facing, as a result of discharges from large agricultural, industrial and mining developments. The 1970 Commission of Enquiry into Water Matters noted the lack of integrated planning and the potential impacts that this would have on water resources. However, it was only during the 1980s and onwards that South Africa started to comprehend the environmental impacts of limited regulation of agricultural and industrial development.

The 1990s saw fundamental changes in the water resources management paradigm for the region, reflecting the significant political changes around 1994 and the introduction of the first democratic government. Sweeping political change within South Africa created the opportunity to rewrite policy and legislation, based upon the latest thinking and understanding of how water resources should be sustainably managed. The development of the 1997 'white paper' policy statement on the management of the national water resource, and the promulgation of the 1998 National Water Act, set a trend for the entire region in terms of policy and legal frameworks for water resources management.

The 1998 Water Act requires the establishment of a National Water Resources Strategy (NWRS) by the Minister of Water. At the same time, a decentralized approach to water resources management was introduced, with the Act requiring the establishment of catchment management agencies (CMAs) that have the responsibility to develop and implement a catchment management strategy (CMS) that is consistent with the framework provided by the NWRS. Strategies are required to be developed in consultation with relevant stakeholders. In addition to these institutional changes, the Water Act introduced significant environmental and social aspects to water resources planning, notably the requirement to set aside water for basic human needs and environmental purposes prior to the allocation of water to economic uses.

The South African water resources planning framework is based on the international principles of IWRM. However, the complexity of integrated planning and the capacity needed to implement the results have outstripped the ability of the country to deliver. While the first NWRS was promulgated in 2004, only two CMAs had been established by 2011. Both agencies had developed their strategies by 2012, but were awaiting final legal gazettal of these strategies by the minister.

In the absence of these CMSs and in order to plan coherently for future water resources management challenges, the Department of Water Affairs has developed relatively technical (but fairly integrated) water resources strategies, named internal strategic perspectives, for all river basins in South Africa. While these were compiled without stakeholder consultation or much engagement with other government departments, they represent a first attempt to bring all available information about water resources together in one document.

CHINA

As a country that experiences frequent, severe flood and drought disasters, China has long attached great attention to water resources development and management. These natural challenges have been compounded in recent years by the huge pressure placed on water resources by China's massive population and rapid economic development. River basin master planning has provided the foundation for water resources management and development. Since 1949, and the founding of China, water management practices and river basin master plans have evolved over three major periods.

The first period was the 1950s and 1960s. Water management and river basin planning mainly focused on the rehabilitation of river systems, the construction of river embankments (such as levees), the drainage of watercourse to improve flood discharge, and reducing the risk and impact of flood and drought. At that time, the main objectives of water resources planning were river regulation and management, and disaster prevention and treatment. Water engineering construction significantly eased the pressure of frequent flood and drought disasters. Agricultural water supply was increased by 90 billion m^3 nationwide and the area of irrigated agriculture reached 26 million hectares. In this period, China completed the first set of comprehensive river basin master plans. The basic situation of the country's river systems was reviewed and the existing approach to water resources planning was reinforced. River basin plans for the seven major river basins were developed, as well as plans for important medium and small rivers.

The second planning phase was in the 1980s and 1990s. In this period, China was experiencing rapid social and economic development, rapid increases in water demand and an increasingly high water utilization ratio in many river systems, and water shortages and water pollution in some regions. Water management at this time mainly focused on water resources development, regulation and distribution, with a gradual shift from the development of water resources to water management. A series of regulations and policies were issued, including a new water law and regulations on river governance. In this period, the second round of river basin planning was embarked on for most river basins. The philosophy and methodology for planning progressed significantly, and as a result the river basin plans became more comprehensive and coordination between river basin planning and land management was strengthened. The content of river basin plans was enriched. Water resources protection was taken into consideration while water treatment and management remained significant. In this period, the first round of national water resources investigation and assessment was conducted and a series of plans were formulated. These included a water resources development plan, river basin master plans for the seven major river basins, plans for important tributaries of major river basins, and various thematic plans. Between them, these determined the overall development layout of the major river basins in China.

The third period of basin planning in China started at the beginning of the twenty-first century. China entered a period of rapid economic development and water resources construction. This increased both the role and the significance of river basin master plans. The Second National Water Resources Investigation and Assessment was conducted, and a series of strategic and thematic plans were developed, including the National Integrated Water Resources Plan, flood control plans for the seven major river basins, and the revision of the river basin plans for the seven major river basins. In addition, a number of thematic plans related to human well-being were formulated, such as the plan for securing urban and rural drinking water safety, the plan for reinforcing dangerous reservoirs and the plan for water-saving reform of irrigation districts. These plans have been progressively developed and implemented in accordance with the water resources planning framework set out in China's 2002 Water Law.

This latest phase of the river basin master planning has the following features. First, the planning approach has been innovative. Underpinned by the principle of harmonious development between humans and nature, the new round of river basin planning focuses on maintaining and improving river health, ensuring sustainable water resources development and fulfilling the concept of scientific development. Second, it is more concentrated on solving major issues in water resources management. In the context of global climate change, it is planned to establish four major systems for important river basins and regions:

- a comprehensive flood control and drought mitigation system
- an urban and rural water resources rational deployment and efficient utilization system
- a water environment protection and river ecology security system
- an improved water management and operation system.

It is hoped that these will address the outstanding problems related to weak water infrastructure, water shortages and the deterioration of the water environment, as well as the uneven development of water resources management between different regions.

Third, the role of the plan in social management has been highlighted and addressed. River basin master plans are seen not only as the basis of water resources development, but also as the basis for strengthening social management of water-related issues. Setting the 'bottom line' of water utilization in the river basin master plans means that all water-related activities can be regulated strictly in order to avoid the negative impact on river systems caused by rapid social and economic development. And through the influence of river basin master plans, the water-saving awareness of the general public can be strengthened, which will promote more efficient water use. This will lay a good basis for adjusting economic and industrial structures.

Fourth, mechanisms for coordinating different sectors and agencies have been established to address and balance the requirements from different development perspectives and to address conflicts between competing demands for water services. The involvement of experts and the broader public has also been encouraged during the planning process.

AUSTRALIA AND THE MURRAY-DARLING

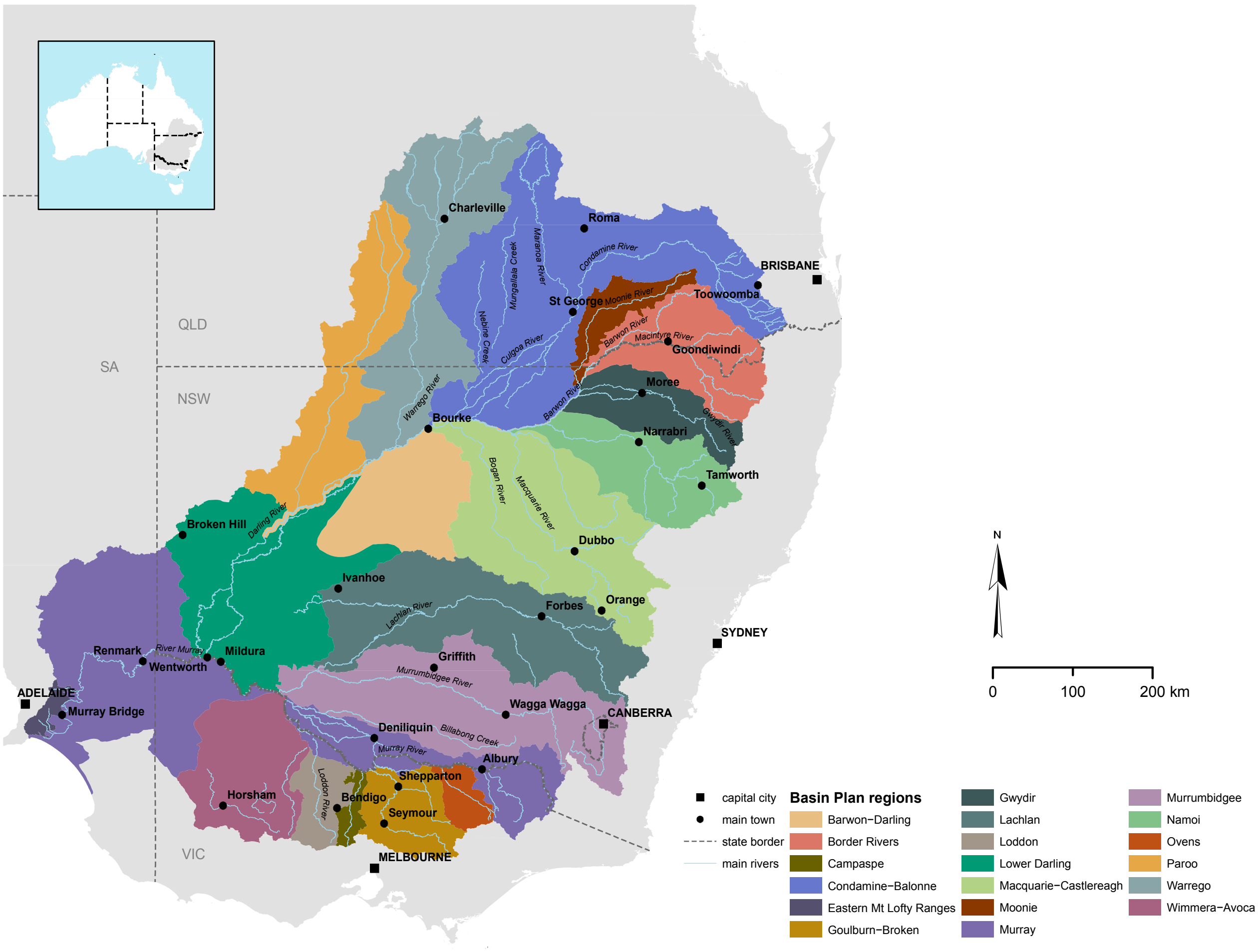
The history of water resources development in Australia's Murray-Darling basin can be considered in three phases: a development phase, a water resources management phase, and an adjustment phase. The development phase took place until about the 1970s. This phase was characterized by government-funded construction of large water storage infrastructure, water supply systems and inter-basin transfer schemes (such as the Snowy River scheme). These works were principally undertaken as a way of facilitating regional development. Much of the development in the Murray River was coordinated through the 1915 River Murray Agreement.

A basin commission was first established in 1917, to put the 1915 River Murray Waters Agreement into effect. The basin commission reported to a ministerial council, comprising representatives from the basin states and the federal government. The primary function of the commission was the regulation of the trunk stream of the Murray, to ensure the three lower states (and particularly the downstream state of South Australia) received their agreed shares. As such, the commission provided advice to the basin states and had responsibilities for implementation (including some operational functions), monitoring, and reporting, but did not perform a regulatory role.

The powers of the commission gradually increased over time, but remained limited to the same general areas. In 1982 the commission's role was extended to take account of water quality issues, primarily related to salinity. However, again these functions relate to monitoring and advising the basin states.

In the second phase of water resources planning, during the 1980s and 1990s, the focus shifted to water resources management. A major driver behind this shift was the new national competition policy, which required reforms across a range of sectors to promote economic efficiency and sustainability. These reforms required the removal of subsidies in the water sector and for water utility providers to adopt pricing to ensure their long-term commercial sustainability. Competition policy also drove the shift towards a market-based approach to water allocation.

Figure 6: Map of the Murray-Darling basin



Source: MDBA (2010).

Significant drivers at the time included deteriorating water quality and river health. There were growing problems related to salinity in the basin, and high nutrient loads associated with diffuse pollution. The latter was highlighted by a 1,000 km long algal bloom along the Murray-Darling in the early 1990s.

Increasing recognition of the pervasive water quality problems in the basin coincided with a heightened environmental awareness, both amongst politicians and within the broader community, and a realization that the over-allocation of water resources was reducing the reliability of existing supplies. Together these were seen as a threat to the long-term viability of regional communities. The management response was new price paths for water services, the introduction of caps on abstraction, an increased intensity of management, and the introduction of water trading.

These changes also precipitated a wholesale reform to the planning, institutional and entitlement systems. Australia's federal system meant that transboundary issues had to be dealt with by negotiation. In 1985, the River Murray Agreement was replaced by the Murray-Darling Basin Agreement. In the 1990s the agreement was amended to include 'the Cap', under which the states agreed to limit further abstractions, and as a result infrastructure development, to existing levels. In practical terms, a lack of further suitable sites for infrastructure has meant that infrastructure planning has not been a major issue in the Murray-Darling for some time. Similar agreements were made whereby states committed to maintain salt levels within the watercourse below agreed targets at key locations, as well as undertaking to address land degradation within the basin.

The 1990s also saw a commitment by the basin states to adopt the principles of integrated catchment management, through the Murray-Darling Basin Initiative. This has been via a number of high-level nonbinding commitments to different actions and targets. Notably, in 2001 the basin states and the federal government signed the Integrated Catchment Management in the Murray-Darling, 2001-2010 Policy Statement (ICM Policy Statement), which defined strategic goals for the catchment, and provided the framework for a number of issue-specific strategies, such as fish and salinity.

The third of the water sector's phases (the current one) can be regarded as an adjustment phase. This has been driven by recognition of the severity of the current situation in the Murray-Darling basin, which was exacerbated by the prolonged drought during the first decade of the twenty-first century. This led to national concerns over the ecological health of the basin and widespread calls for action. The combination of over-allocation and drought also meant that in many regions irrigators had little or no water allocated to them for a number of years.

In response, water resources policies have increasingly focused on protecting riverine ecosystems and providing secure, reliable water supplies. Amongst other measures, this has required reducing water use allocations and increasing the water available to the environment. This has been achieved through a combination of clawback under planning mechanisms, the purchase of water entitlements through market mechanisms and improving water use efficiency, especially in the irrigation sector. The federal government has committed A$12.9 billion over ten years towards these and related activities.

These activities will be underpinned by a basin plan. In 2008, the states agreed to transfer certain powers over the Murray-Darling basin to the federal government. This opened the way for the newly established Murray-Darling Basin Authority to start work on the first whole-of-basin strategic plan. The plan will be scientifically based, with a focus on protecting key ecological assets. The key elements of the plan will be:

- setting limits on abstraction of surface and groundwater
- an environmental watering plan, to define how environmental water will be managed
- a water quality and salinity plan, to manage water quality issues.

The basin plan was in draft form and undergoing public consultation at the time of writing. At the same time, infrastructure planning in the basin has shifted its focus from new storage to instead meet requirements to deliver environmental outcomes. This includes salt interception schemes constructed to meet water quality objectives.

MEXICO AND THE LERMA CHAPALA

Mexico has critical and urgent water-related problems. These include the over-exploitation and contamination of surface water and groundwater resources in the most populous and economically important regions of the country. The current situation is clearly not sustainable, and aggressive measures are required to avoid serious social, environmental and economic impacts. Although significant progress in basin planning activities has been made over the last two decades, there is still much work to be done. The 1917 Mexican Constitution establishes water as the inalienable property of the nation and gives the federal government responsibility for allocating water rights. Water management has historically been very centralized in Mexico. In 1926, the Federal Irrigation Act of Mexico was passed, and as a result, the National Irrigation Commission was created, which is considered to be the birth of water resources management in Mexico. This was followed in 1945 by the creation of the Ministry of Hydraulic Resources, which was the federal authority responsible for the development of irrigation infrastructure, the development and administration of irrigation districts, and river management and control, along with responsibility for municipal water and wastewater.

The new Ministry of Hydraulic Resources immediately began an ambitious dam construction programme in 1946, aimed at developing irrigation districts as the basic mechanism to give land to poor farmers, a goal of the 1910 Mexican Revolution. From 1947 to 1960, the Ministry of Hydraulic Resources created several river basin executive commissions, primarily to promote development of water infrastructure. The federal government administered these commissions, with very little participation in decision-making by water user associations and other state and local entities.

In 1977, the commissions were dismantled as a consequence of new public water policies oriented towards a reduction in government influence, particularly regarding irrigated agriculture. In 1976, the ministry was greatly reduced and became a part of the new federal Agriculture and Hydraulic Resources Ministry (SARH). The budget for water-related activities declined by some 67 per cent during the five years from 1983 to 1988.

Following new public policies oriented at reducing government influence in markets, the National Water Commission (Conagua) was created in 1989 as the sole federal water authority. It was placed inside the SARH, indicative of the continued focus on agriculture and supply side management, and had broad responsibilities for water rights, allocation, use, effluent discharge, monitoring, infrastructure and operations.

The 1992 National Water Act

In December 1992, a new National Water Act (NWA) was passed. It strengthened the National Water Commission (subsequently known as Conagua), better defined the roles of regional stakeholders, encouraged participation of state and local water users and civil society, and called for the formation of river basin councils.

However, environmental deterioration continued, as did the gap between supply and demand. Since then, twenty-five of the twenty-six planned river basin councils have been established, water planning readopted, and over 400,000 water rights titles issued. While efforts have been made to decentralize, they have not gone far. In reality, deconcentration is much more prevalent in the Mexico water sector than decentralization: in essence, there is no transfer of power down to a lower level of government, rather power remains at a federal level and activities are carried out through regional offices of federal institutions. While this may be a step towards decentralization, water is still primarily a federal activity. In spite of this, the river basin councils have played an important role in coordinating different levels of government institutions and negotiating with water users and social organizations.

Public policies related to water reform have also been oriented at the privatization of infrastructure development and operation. One of the most important water resources management issues in Mexico is related to the transfer of irrigation districts to farmers, which began in 1993 and as of 2010 was 98 per cent complete. As a result, about 3.5 million hectares have been transferred to farmers who are organized into one or more water user associations in each irrigation district.

Figure 7: Map of Mexico, showing hydrological administrative regions

Source: UNESCO (2013).

Over the last twenty years, Mexico has built capacity and made significant improvements in monitoring and assessment of surface and groundwater quantity and quality; operation of hydraulic infrastructure and dam safety; meteorological and hydrological forecasting; bottom-up and top-down approaches to water resources planning at the basin level; water rights administration and discharge control; establishment and strengthening of river basin councils and aquifer committees; and preparation of studies related to the integrated and sustainable management of water in areas with overexploited aquifers. Also, since 1990, an important programme for the construction of wastewater treatment infrastructure has been carried out by Conagua and state governments, and this programme has been heavily reinforced since 2007.

There have also been important developments in basin planning in some key basins. In the Lerma-Chapala, significant action was required to address water quality problems and water scarcity, including reductions in the quantity of water in Lake Chapala. A sophisticated basin allocation plan has been developed to attempt to address these pressures.

EUROPE, THE RHINE AND THE DANUBE

River basin planning in the relatively high rainfall and stable hydrological conditions of northern Europe has a long history. In the continent's major rivers, this has evolved from a focus on ensuring that rivers were navigable and the development of flood protection infrastructure, through the development of basin-scale efforts to restore water quality in the late twentieth century, and now on to a focus on the protection and restoration of the ecological functioning of these rivers. Two European rivers are used to illustrate the evolution of river basin planning in Europe, the Rhine and the Danube.

Basin planning and management in the Rhine River basin

The Rhine rises in Switzerland and Italy, and flows through France, Germany and the Netherlands into the North Sea. It is Europe's third largest river, with more than 58 million people living in the basin, and is one of the world's busiest waterways. The upper length of the Rhine provides a source of hydroelectric power. A number of canals link the river to other river systems, including the Danube.

Figure 8: Map of the Rhine River basin

Source: UNESCO (2013).

In 1815, the Central Commission for the Navigation of the Rhine was established, and during the nineteenth century extensive alterations were made to the river to improve navigability, and to enable agricultural development on alluvial areas along the river course. The result was the shortening of the river by 80 km, and the reduction of meanders. In the late nineteenth century, despite an international treaty between riparian states to protect salmon in the river, infrastructure development and navigation remained the highest priorities and the salmon population crashed.

With the increase in industrialization, particularly after the Second World War, and the increase in urbanization along the rivers, water quality deteriorated severely. The combination of physical alterations to the Rhine, for navigation, flood control and hydroelectricity production, and the high levels of pollution, resulted in a decrease in the fish catch in the river from more than 280,000 tons around 1870 to nothing in 1950. In 1971, during the low flow period, oxygen-consuming effluent and toxic discharges resulted in the disappearance of all aquatic life from stretches of the Rhine. This shocked both the public and politicians, and in 1972 the Rhine states decided to take action to reduce pollution in the river.

In response to this water quality crisis, between 1950 and 1985 various agreements were put in place, including the establishment of the International Commission for the Protection of the Rhine (ICPR) in 1950. One of the key drivers of the establishment of the commission was the loss of fish. At the end of the 1950s, the Netherlands, concerned with the impacts of water pollution, formulated water quality criteria for the Rhine. Joint monitoring programmes were put in place, and between 1970 and 1985 a range of joint measures reduced pollution in the river and saw oxygen levels increasing. This period focused mainly on end-of-pipe treatment solutions.

In 1976 a joint convention on the reduction of chemical pollution was finalized. As a result of the mistrust between the member states, it contained very detailed procedures. Under the convention, the parties agreed to eliminate, over a period of time, any emissions of 'black list' pollutants, and to reduce emissions of 'grey list' substances. However, implementation proved to be more difficult and time-consuming than expected, and by 1986 the ICPR had set emission standards for only twelve substances.

In 1986 a fire at the Sandoz plant near Basel in Switzerland resulted in between 10 and 30 tons of toxic substances being washed into the river by the water used to douse the fire. It resulted in the death of almost all aquatic life between Basel and the Loreley near Koblenz. This incident resulted in massive publicity, and a strong political response. Three ministerial-level conferences resulted in the Rhine Action Programme (RAP) of 1987, which set clear high-level goals to be achieved by 2000:

- to improve the state of the Rhine River to such an extent that fish such as salmon and sea trout return to the river
- to guarantee the production of drinking water from the Rhine for the future
- to reduce the pollution of river sediments so that sludge could be used for land filling or be dumped at sea.

These basin-scale strategic targets were to be achieved by national-level implementation. Importantly, industry also showed its commitment to reducing pollution. By 2000, almost all pollution reduction targets had been achieved. The programme did not only involve pollution reduction, it also included massive re-engineering to allow salmon the physical space to return to their spawning grounds. Salmon returned to the river in 1990 and began breeding in the river in 1992.

In 2000 the European Union introduced the WFD, which is binding on all Member States. The WFD obliges Member States to ensure that water bodies achieve 'good ecological status', placing ecological health firmly at the core of water policy. The WFD also attempted to bring together a variety of pieces of EU water legislation into a single framework. Member States are also required to coordinate measures at the international river basin level, moving cooperation driven largely by political commitment onto a legal footing.

In 2001 Rhine 2020, the Programme on the Sustainable Development of the Rhine, was adopted by the ministers in charge of the Rhine. It sets out the high-level objectives of the Rhine protection policy and the measures required for implementation over the next 20 years. The Rhine 2020 programme deals with ecological protection and restoration, water quality, groundwater protection and the Action Plan on Floods. In December 2009 the ICPR published the first Rhine River Basin Management Plan (Rhine RBMP) under the WFD. Rhine 2020 provides the political vision for the basin, while the Rhine RBMP provides the technical interpretation of the political vision.

The nature of planning and commitment by Member States has changed since the introduction of the WFD. Prior to the WFD, Member States were willing to commit to ambitious and nonbinding targets, such as restoring salmon to the river. The WFD is legally binding on all Member States, and failure to meet commitments under the directive can result in action being taken in the European Court of Justice, with sanctions imposed. Member states are therefore reluctant to commit to any targets unless they are very sure that sufficient funds have been committed to make achievement of the target possible. Member States are thus more cautious in their engagement than they used to be (van Wetering, pers. comm. 2010).

Basin planning in the Danube River

The Danube is Europe's second largest river after the Volga, flowing south-east from Germany in the west and eventually emptying into the Black Sea on the Romanian/Ukrainian coast. The basin is regarded as the most transboundary river system in the world, and includes the territories of nineteen countries.

The Danube River system has seen human impacts from as early as the eighteenth century, primarily as a result of its development as transport route into the heart of Europe. Changes in the river channel and banks to improve navigation and reduce flooding have considerably altered the river and it is now shorter than its natural length. Some 80 per cent of the original wetland systems have been lost, and many more are now disconnected from the main river. Throughout the nineteenth and early twentieth century growing populations and industrialization increased effluent discharges, leading to significant water quality problems. Today the system is modified from its natural condition for almost all of its length.

As on the Rhine, the first basin-scale management efforts on the Danube were focused around navigation. The European Commission of the Danube dated to the 1856 Treaty of Paris. It was made up of representatives from each of the riparian countries, and was responsible for administration of the Danube

River, with the primary goal of ensuring free navigation along the Danube for all European countries. In 1948, the Danube Commission was established, again focused on the provision of free navigation on the Danube. At the same time, the riparian states invested heavily in flood control structures.

The post-Second World War investment in industrial growth and the consequent increased effluent discharge to the river led to rapid deterioration of water quality in the entire Danube system. In the middle and lower reaches of the system, massive state investment by the Soviet Union, with little or no effluent management, led to significant impacts on surface and groundwater. In the middle reaches of the river, former Soviet Union countries like Hungary, the Czech Republic, Slovakia, Bulgaria and Croatia established relatively high rates of connection to a drinking water supply, but had very low rates of connection to an effective wastewater treatment plant. This led to significant pollution from nutrients as well as organic and hazardous substances.

The 1985 Bucharest Declaration, signed by the riparian states, focused on improvements to environmental quality. The development of major environmental action programmes for the river led to the signing of the Danube River Protection Convention, and the establishment in 1998 of International Commission for the Protection of the Danube River (ICPDR). The objectives of the ICPDR are identified as:

- safeguarding the Danube's water resources for future generations
- naturally balanced waters free from excess nutrients
- no more risk from toxic chemicals
- healthy and sustainable river systems
- damage-free floods.

Figure 9: Map of the Danube River basin

Source: ICPDR (2009a)

The EU Water Framework Directive

The promulgation of the EU WFD in 2000 had the single biggest impact on the development of basin planning in the Danube. It required the publication by December 2009 of RBMPs setting out how these objectives will be achieved. In the Danube, ICPDR has lead responsibility for the production of the plan. The Danube River Basin Management Plan includes both a vision and number of ambitious operational management objectives (see Chapter 3). The vision for the basin is a mixture of clearly defined ideals like 'zero emissions', 'do not cause any deterioration' and that all wetlands be 'reconnected and restored', and more qualitative visions like 'balanced management' and 'transparent' conduct. It remains a live issue whether the financial resources and political will exist to translate these objectives into reality, in the context of competing political pressures within the basin.

CHAPTER 2
STRATEGIC APPROACH TO BASIN PLANNING

2.1 The origins of strategic basin planning

Societies have been actively planning and developing rivers at the basin scale for the past century. Historically, these processes have had an engineering-based focus on the development of water infrastructure and systems. However, the ability of engineers to modify the natural environment significantly in the interests of economic and social development has had profound negative consequences on the associated water resources, ecosystems and communities that live downstream. At the same time, the intensive use of the water resources has led to many contexts in which continued social and economic development in stressed basins can no longer be supported by further infrastructure development. Basin planning processes therefore need to shift from identifying how to use more water, to a focus on the judicious management of the existing systems – in other words, to using water better.

These challenges have led to the development of new approaches to basin planning. The broad response of the water management community is reflected under the philosophy of IWRM. However, as discussed in Chapter 1, IWRM has faced serious challenges in implementation (Lenton and Muller, 2009). In order to avoid the preconceptions associated with IWRM, this book therefore uses the term *strategic basin planning* to refer to planning that seeks alignment between the basin plan and the broader social, environmental and economic planning context; incorporates environmental requirements as part of the planning process; and requires harmonization between the competing water management elements within the plan. We define strategic basin planning as *a coherent multidisciplinary approach to managing basin water resources and their users in order to identify and satisfy social, economic and environmental priorities***.** This chapter sets out the context and characteristics of strategic basin planning.

In describing the international experience with river basin planning, Chapter 1 highlighted the evolution of water resources management and basin planning. In general, a period of relatively uncoordinated planning evolved into an era of massive engineering-focused infrastructure planning during the twentieth century. This era in turn has evolved into multidisciplinary basin planning in the recent decades.

The requirements for planning within a specific basin typically evolve, therefore, through a number of phases. From a water quantity perspective, in the majority of basins water is initially available in an unconstrained way. As a consequence, water is typically utilized with little planning, although control and enforcement of individual users and uses may be implemented at a local level. As demand gets close to or exceeds the water available for supply, infrastructure is developed to increase water availability. This process of infrastructure development requires water resources system (infrastructure) planning. Often water is used at this stage without consideration of the requirements of freshwater ecosystems. At some stage, the limits of viable infrastructure construction are reached or exceeded, such that no further economically viable water resources can be made available from the construction of new infrastructure.

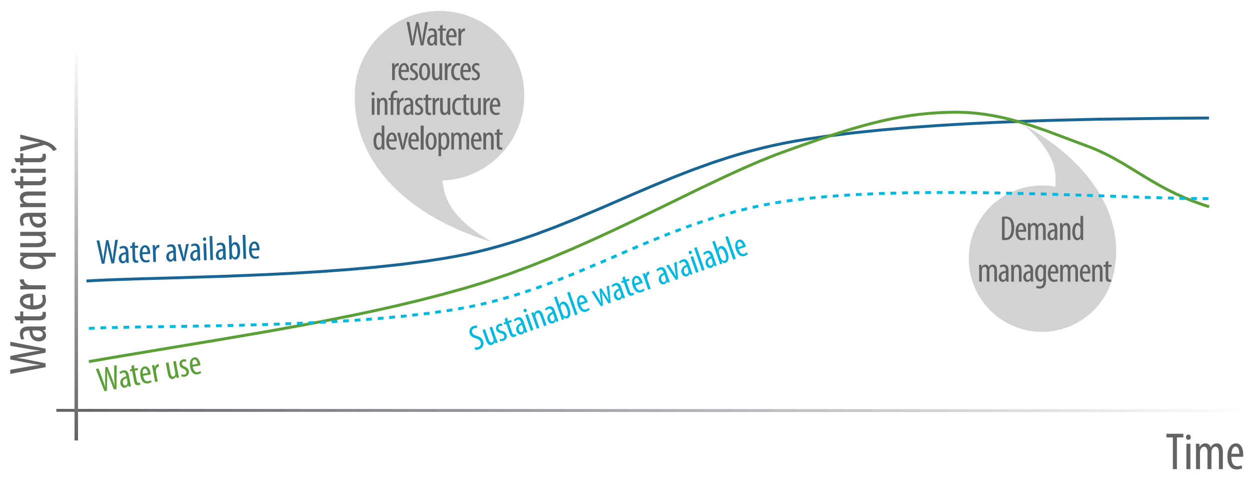
At this point, political, social, economic and ecological crises (often associated with drought) prompt action: new industries and domestic users are unable to access water. This can have a serious negative impact on development, and environmental degradation becomes socially unacceptable. As the crisis can no longer be resolved by the construction of new infrastructure, reforms are therefore required to the way in which water is managed and allocated, in particular to create opportunities for water to be reallocated from existing users to new users and environmental needs. Water quantity planning therefore ceases to be only about the construction of new infrastructure, and must now include a range of policies to manage the way in which water is used in the basin, and by whom. These processes, of management of the demand of water users and reallocation of water to balance environmental and human requirements, as well as reallocation between sectors, are typically complex and require the use of sophisticated management and planning interventions. The linkage between water and land management also becomes more important as activities in the upstream catchment areas have dramatic impacts on the receiving water resources. This requires new basin planning approaches based not only on engineering, but also on a new philosophy, coupled with a broader range of techniques. This process of development is illustrated in Figure 10.

Similar patterns of evolving approaches can be described for water quality and flood management. In the context of water quality, initially the river system is able to assimilate the pollutants discharged into it. As development and levels of pollutants increase, water quality deteriorates. At some point, levels go beyond an acceptable or tolerable range (defined by the needs of water users and ecosystems). At this stage, controls on point sources of pollution are implemented, requiring investment in treatment infrastructure at source. While this may have an important benefit, it is often not sufficient in the long term because of the additional impacts of diffuse sources of pollution. At the same time, as societies become more affluent, they often demand a better natural environment, characterized by improved river, lake and coastal water quality, as well as improvements in the broader landscape and overall river aesthetics. This can provide pressure to rehabilitate river systems and to address pollution through management of the broader catchment.

In the context of flood management, in initial stages of development there may be limited development in flood prone areas and thus little concern over the consequences and risks from flooding. As development progresses, land scarcity can result in development in the floodplain, resulting in more people being exposed to the risk of flooding, and flood (infrastructure) control structures are typically adopted to reduce risk. These are often constructed as a response to a particular flooding event. However, as basin population and development further increase and the costs and impacts of flood events rise, relying on infrastructure alone is insufficient. In addition, physical flood control infrastructure can make the situation worse, by increasing downstream flood risk, or providing a false sense of security to those living behind flood defences.

In response to these trends, a more complex response to the management of flood risk has been developed based on a portfolio of responses including controls on development planning, emergency planning and responses, and targeted construction and management of flood infrastructure. Again, this shift is often in response to the crisis associated with a major flood event.

Figure 10: Basin water quantity and reconciliation planning



THE HISTORIC PHASES OF BASIN PLANNING

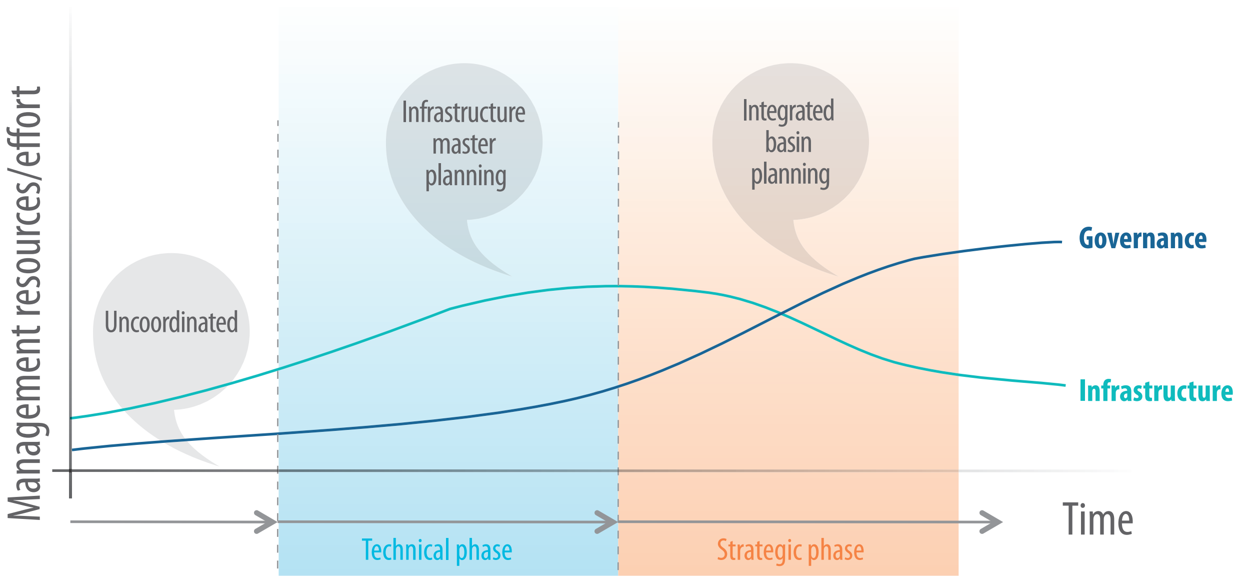
The commonality between these pathways is that they typically pass through three phases:

1. **Uncoordinated**: Early development, where ad hoc control and enforcement against minimum standards is at best applied, rather than coherent basin wide planning.
2. **Technical**: Infrastructure development and operational planning, where technical engineering solutions are the priority.
3. **Strategic**: Multidisciplinary planning, where economic, ecological and management solutions are applied.

Figure 11 highlights the evolving focus of management effort through these three phases. The first phase reflects the relatively undeveloped stage of basin development, with no requirement for substantive basin-scale coordinated management. The second phase focuses on infrastructure development and operation, at a period when there remains scope to manage challenges through engineering solutions. As the basin is developed and increasing stress arises, this infrastructure focus is replaced in the third phase by greater focus on legal, institutional, economic, social and ecological measures: engineering solutions need to be balanced by an increased focus on and investment in the governance-related management efforts required to address more complex basin-wide challenges with multifaceted solutions. This distinction into three groups is of course highly stylized, with considerable overlap between phases, and a distinctly different historical character to all basin development processes. Nevertheless, these three phases represent common development pathways in many river basins through time.

It is important to note that this does not mean that it is necessary to go through all three phases: where politically feasible, it may well be preferable to skip the second (technical) phase and move immediately to a more strategic approach, even where that phase may still involve significant infrastructure development.

Figure 11: The historic phases of basin planning



2.2 The characteristics of strategic basin planning

While each basin planning process is distinct and reflects basin priorities and context, there are two conceptually different approaches to water resources planning at a basin scale, reflecting different perspectives on its purpose: water resources development planning vs. strategic basin planning.

Box 5: Two differing approaches to basin planning in South Africa

The distinction between water resources development planning and strategic basin planning is illustrated by two different processes in the Western Cape. The first involved the Western Cape Reconciliation Strategy, which was a comprehensive traditional engineering analysis of options to balance water availability (supply) and requirements (demand) over forty years. Both water demand management and supply augmentation options were proposed, based on least financial cost, while meeting social and environmental requirements.

Water supply to Cape Town was the focus of the reconciliation study, based on estimated urban growth and associated domestic, commercial and industrial water requirements. In addition to the traditional development of reservoirs and diversions, nontraditional augmentation through salt water desalinization and waste water reuse was considered, as was intensive urban water demand management. However, for political and social reasons, the study did not explore more economically driven possibilities such as the water intensity of the urban growth pathways or reallocation of water from lower-value irrigation to higher-value urban use.

In going beyond a typical technical study, this study estimated the energy requirements of different options, considered the introduction of environmental flows (albeit delayed) in parts of the system, and assessed the impacts of climate change on the reconciliation.

In contrast, the Breede-Overberg Catchment Management Strategy focuses much more strongly on the linkage of water resources protection and utilization with the social and economic development drivers in the region. It covered a number of geographically linked catchments along the coast of the south-western Cape, which are primarily based on agriculture and tourism. An understanding of the importance of protecting flows and water quality was central to the strategy, as this is critical to the irrigation of export crops and maintenance of the estuaries upon which the coastal towns depend.

An important outcome of addressing the entire system was that while the reconciliation study estimated that there was wet-season winter water available for transfer to Cape Town, analysis of the entire ecological functioning of the Breede River system, in the context of stakeholder recognition of the necessity of estuary functioning, indicated that this water was largely needed for estuary maintenance. This resulted in reprioritization of augmentation options in the reconciliation study.

Sources: DWAF (2007*b*) and BOCMA (n.d.).

WATER RESOURCES DEVELOPMENT PLANNING

Historically, water resources planning has been focused on the development of water resources and associated infrastructure to meet the water requirements of economic and social development, identified separately from the basin planning process. For example, development plans may identify the need for an expansion in irrigation or industry in one part of the basin, or to provide flood protection for certain cities or regions. In such circumstances, the role of water resources planning is to develop a technical and engineering solution to meet those needs.

Water resource development planning therefore typically identifies infrastructure development and operating measures (including water use efficiency and waste disposal) that ensure the reconciliation of future water demand and supply, ensure that raw water quality meets required standards, provides for flood defence and meets navigational and other needs. The objective may be the minimization of financial costs, while ensuring that environmental, systems yield, water quality, flooding and navigational thresholds are met. Alternatively, the goal may be to maximize system yield from the existing infrastructure system under different constraints.

Where economic analysis is undertaken, this usually involves a focus on cost-benefit analysis of the possible options: there is little assessment of the relationship between water resources and the economic, ecological and social systems that depend on them. Where environmental requirements are incorporated into this planning approach, they are usually defined as threshold levels, in particular for water quality, which must be achieved. There is little analysis or consideration of the functioning of environmental systems within the basin.

The planning process usually seeks to resolve one or two identified core management concerns. Typical concerns that drive these processes are around water availability and balance (resource development, and the reconciliation of requirements and availability), water quality deterioration, or flood control (focus on infrastructure control measures). The nature of the challenge in the basin is such that technical or infrastructural measures are perceived to be appropriate to address the problem. The planning process is set out in the context of this particular concern, beginning with detailed investigations around those critical issues.

The advantage of water resources development planning is that it is procedurally relatively simple. It is usually undertaken by water resources planners and engineers, supported by social, environmental and economic practitioners, and relies heavily on water resources system models. It is particularly applicable to systems that do not have high risk of water stress, pollution or flooding, or basins that have water resources available for further development. The scale of attention may be at the basin level (although often parts of the basin are prioritized), or at the scheme-system level where inter-basin transfers connect multiple basins.

STRATEGIC BASIN PLANNING

Water is increasingly being recognized as a fundamental component of social and economic development, sometimes acting as a constraint, at others serving as a resource to catalyse or stimulate development. Water stands at the centre of challenges around food security, economic development, energy generation and climate change. As basins become more stressed, basin water planners need to make trade-offs that will have important economic and social impacts. Under these conditions, basin plans need to recognize and be aligned with broader economic development, environmental protection and planning objectives. As economic and social requirements for water shift with evolving economic development, so basin management objectives need to adapt. Equitable and efficient basin planning therefore needs to have a sophisticated understanding of development and conservation objectives so that these can be served by future water resources. When done comprehensively, it reflects a perspective of 'water in the economy', where basin planning not only aligns with economic and social development planning, but is also a key determinant of future development options.

Furthermore, there is increasing recognition that healthy and functioning aquatic ecosystems are fundamental to rivers, in terms of the goods and services that they provide, the cultural and other social activities they support, and their inherent biodiversity value. Experience shows that once seriously degraded, these systems become difficult and costly to return to healthy conditions. It is therefore critical for basin planning to incorporate an understanding of the ecological limits, thresholds and interconnections of the entire basin water resources.

In this context, strategic basin planning can be defined as a coherent multidisciplinary approach to managing the water resources, natural environment and human activities within a basin, in order to identify and satisfy social, economic and environmental priorities.

Strategic basin planning therefore differs from water resources development planning in recognizing that water is a key element of the broader society and economy. The aim of strategic basin planning is not just to meet straightforward, externally set objectives, but to guide rational choices between a series of possible water management objectives that will best contribute to a range of competing economic, social and ecological goals.

The following characterize this more strategic approach to basin planning:

- **Trade-offs between alternative economic, social and environmental objectives.** Where basins have become heavily developed, it is no longer possible to meet all demands for water. Basin planning therefore involves decisions on trade-offs between existing users, potential future demands and environmental requirements. These trade-offs are not simply technical issues, but involve broader societal, economic and biodiversity considerations and require engagement of decision-makers beyond the water sector. Similar trade-offs need to be addressed in the context of flood risk management, where standard approaches and levels of protection cannot be applied across the basin.

- **Sophisticated environmental requirements.** Basin planning recognizes the importance of aquatic ecosystem functioning in providing goods and services for social and economic development, as well as natural 'infrastructure' resilience to change. Strategic environmental planning considers issues such as flow regulation, protection of the catchment, flood attenuation, sediment-geomorphology maintenance and water quality assimilation services, as well the goods that the aquatic ecosystem provides, such as fisheries and tourism opportunities.

- **Understanding basin interactions.** There are a range of hydrological, ecological, social and economic systems and activities at work within a basin, all of which affect the water resources of the basin. A comprehensive understanding of the interactions and causal relationships between these systems and their elements is critical to effective basin planning. The scope of the supporting social and economic analyses may not be confined to the basin alone, but may consider the contribution of the basin to the wider regional economy.

- **Robust scenario-based analysis.** Basin planning typically addresses uncertainty in future development and climate, by assessing the challenges and opportunities associated with alternative hydro-economic scenarios. This allows for strategic prioritization and trade-offs leading to robust planning and decision-making for basin water resources management.

- **Prioritization.** Basin planning seeks to identify the key priorities within the basin, in terms of the needs for economic development, social justice and environmental protection. This prioritization is inherently a social and political decision which should be supported by multidisciplinary and multi-objective technical analysis.

- **High-level objective-setting at different time frames.** A strategic approach to basin planning requires the agreement of a common vision to which all aspects of the basin plan are designed to contribute, together with phased time-based objectives describing a preferred pathway towards that vision.

- **Reconciling and coordination of activities across all water sectors.** Basin planning recognizes not only requirements for water resources development and utilization, but other aspects of water management such as for water resources protection, demand management and promoting efficiency of water use, and flood risk management.

- **Multidisciplinary teams.** Basin planning brings water resources planners together with economic, environmental and developmental planners to jointly consider the role of water in the economy and society. It is supported by a stronger socio-economic and environmental understanding of the system, based on inputs from relevant multidisciplinary teams and analysis techniques.

Table 2 compares water resources development planning with strategic basin planning.

Strategic basin planning is therefore characterized by complexity. This complexity relates to the increasing number of pressures and demands on river basins, and the solutions that are required. Rather than being a process defined by a technical solution to one or two well-defined challenges, strategic basin planning seeks to respond to complex economic and environmental challenges through the development of solutions that typically require interventions by multiple parties. For example, basin planning may indicate that changes to development planning are required, either to reduce flood risk or to align development planning with water availability. This may require regional and local decision-makers to take action to implement the plan.

In addition to these elements of complexity, basin planning must also develop plans in a context of increasing uncertainty. This uncertainty relates both to rapid social and economic development, and to the uncertainties associated with climate change.

A central characteristic of strategic basin planning is therefore the ability to address inherent complexity, while at the same time being able to identify key priorities and set high-level political objectives for the basin. This represents both a core characteristic of and a significant challenge for strategic basin planning. Figure 12 illustrates the way strategic basin planning is able to achieve these characteristics. The hourglass image illustrates the way in which wide-ranging assessments of a number of complex issues become focused into decisions over a small number of high-level priorities and objectives; these are then translated into detailed implementation plans to address a wide range of issues. The details of the steps in this process are set out in the course of this book.

Table 2: Attributes distinguishing water resources development planning and strategic basin planning

	Water resources development planning	Strategic basin planning
Basin context	Basins with 'spare' water available for development and not facing significant environmental or flood risk pressures	Complex or water-stressed basins requiring difficult trade-offs between economic, social and ecological objectives
Purpose of basin planning	Reconciliation of water availability, quality or flood management with existing development goals: 'water for the economy'	Water planning as an integral part of development planning: 'water in the economy'
Focus of attention	Engineering focused: water infrastructure systems	Society focused: economic, social and environmental systems supported by the river
Environmental requirements	Threshold levels, in particular water quality	Maintenance of ecosystem goods and services
Economic requirements	Financial viability of proposed infrastructure development	Economic optimization and alignment with development planning
Key skills in the planning process	Water planner led, with a focus on engineering skills	Cooperation between development, water and environment planners
Analysis techniques	Technical optimization: water resources infrastructure systems analysis economic cost–benefit analysis water quality assessment future water use projections	Economic and environmental scenarios: integrated water resources systems analysis social/economic analysis of water strategic environmental assessment scenario planning

2.3 Ten golden rules of basin planning

Basin planning approaches have developed across the world in response to shifting priorities, different crises and increasing complexity in water resources management. These have developed in a range of countries and under a wide variety of hydrological, institutional and political conditions. Despite this variety, a number of key issues have emerged as central to the challenge of basin planning. The following ten golden rules have been distilled from the international lessons and experience with basin planning over the past century. These rules (or principles) are woven as a golden thread throughout this document, and are expanded upon in the various chapters that follow.

RULE 1: DEVELOP A COMPREHENSIVE UNDERSTANDING OF THE ENTIRE SYSTEM

The key interactions between the climate, landscape, hydrological, ecological, social, economic and institutional systems and elements in a basin need to be understood to inform effective basin planning. The development of this understanding through assessment should be prioritized. An initial screening assessment can be undertaken of the entire system, leading to more detailed and focused analysis of key aspects of the system required to develop the basin plan.

RULE 2: PLAN AND ACT, EVEN WITHOUT FULL KNOWLEDGE

Lack of information must not prevent decision-making; it will often be better to act on the basis of limited information and adapt to the consequences, than not to act at all, which can lead to worse outcomes. This requires a degree of pragmatism, maturity and leadership in decision-making, which must be supported by the best analysis possible in the available time and resources.

RULE 3: PRIORITIZE ISSUES FOR CURRENT ATTENTION, AND ADOPT A PHASED AND ITERATIVE APPROACH TO THE ACHIEVEMENT OF LONG-TERM GOALS

Some issues within basins will be of higher priority than others, and demand more immediate attention. In addition, it is typically not possible to address simultaneously all of the issues throughout a basin, and attempting to do so can lead to the most important issues not being identified or addressed. Basin planning is inherently a process of prioritization. This prioritization can take place on the basis of either key challenges, or priority catchments or parts of basins. Similarly, management measures may be prioritized according to technical, financial and institutional feasibilities. It may be important to recognize those issues that have a high current political profile, as well as those that can create momentum through immediate 'wins'.

The ability to prioritize action and to adapt can only be achieved if the cyclical nature of planning is recognized. This means that long-term goals for the basin are established, accompanied by a process of progressively moving towards these through a series of medium-term objectives and plans. On the one hand, a long-term perspective is required to ensure continuity over time, rather than responding to shifting short-term priorities. On the other hand, uncertainty and complexity prevent the development of detailed plans over a longer timeframe. Hence, the basin plan must include both long-term objectives and medium-term actions.

RULE 4: RECOGNIZE THAT BASIN PLANNING IS ITERATIVE AND OFTEN CHAOTIC

The ways in which basins are planned are rarely neat or orderly, despite the best intentions of water managers. Even within a planning exercise, political or financial challenges can often derail intended processes. In the longer term, basin planning may proceed in a series of episodic interventions in response to changing circumstances or new political imperatives.

RULE 5: ENABLE ADAPTATION TO CHANGING CIRCUMSTANCES

The demographic and economic situation associated with a basin is constantly shifting. This requires that basin planning must be adaptive, considering that the basin plan may not achieve its goals, that the conditions on which the basin plan was based might have changed, and the strategic objectives for the basin shift. Adaptation therefore requires a comprehensive monitoring, evaluation and review process, accompanied by a strategy and institutional arrangements that are inherently flexible. Climate change is likely to increase the importance of flexibility and adaptation.

RULE 6: DEVELOP RELEVANT AND CONSISTENT THEMATIC PLANS

Basin planning involves a range of water management fields, such as water allocation, water quality management, environmental rehabilitation, flood management and navigation. Each has its own planning approach and institutional considerations. Each of these therefore requires dedicated treatment in the form of thematic plans linked to the basin plan. These thematic plans provide coherence between administrative and catchment areas throughout the basin. However, the basin plan must provide an overarching strategic framework to ensure common objectives, management alignment and institutional cooperation around the interdependencies between these themes.

RULE 7: ADDRESS ISSUES AT THE APPROPRIATE SCALE BY NESTING LOCAL PLANS UNDER THE BASIN PLAN

In complex basins, it is critical to distinguish issues that must be addressed at the basin scale from those that should be addressed regionally, at a catchment scale or locally. If this is not done, identification of strategic priorities is impossible because basin planning is overwhelmed by local detail. At the same time, local implementation plans enable basin-level strategic objectives to be implemented flexibly according to local conditions. Geographic nesting of plans enables this flexibility, with the basin plan setting high-level objectives and priorities, and detailed plans developed at a catchment or administrative (for instance, provincial or municipal) level. Importantly, detailed thematic and implementation plans do not need to be developed everywhere for all issues, but can be focused on the highest priorities.

RULE 8: ENGAGE STAKEHOLDERS WITH A VIEW TO STRENGTHENING INSTITUTIONAL RELATIONSHIPS

Basin planning is only effective if it results in action, and this is typically dependent upon the cooperation of a number of institutions at different levels (from local to national), under the leadership of a lead water management institution. The leadership and actions of individuals within those organizations should also be seen as critical. Basin planning should therefore be seen as an opportunity to build trust and relationships between these bodies so that action to secure implementation can be achieved. The basin planning process should also recognize and try to incorporate the diverse perspectives of stakeholders at different scales that will have an influence on the implementation of the strategy. While this is critical for partners and stakeholders within the water sector, cooperation with potential partner institutions in other related sectors is equally important in creating the necessary linkages with other developmental and environmental planning processes.

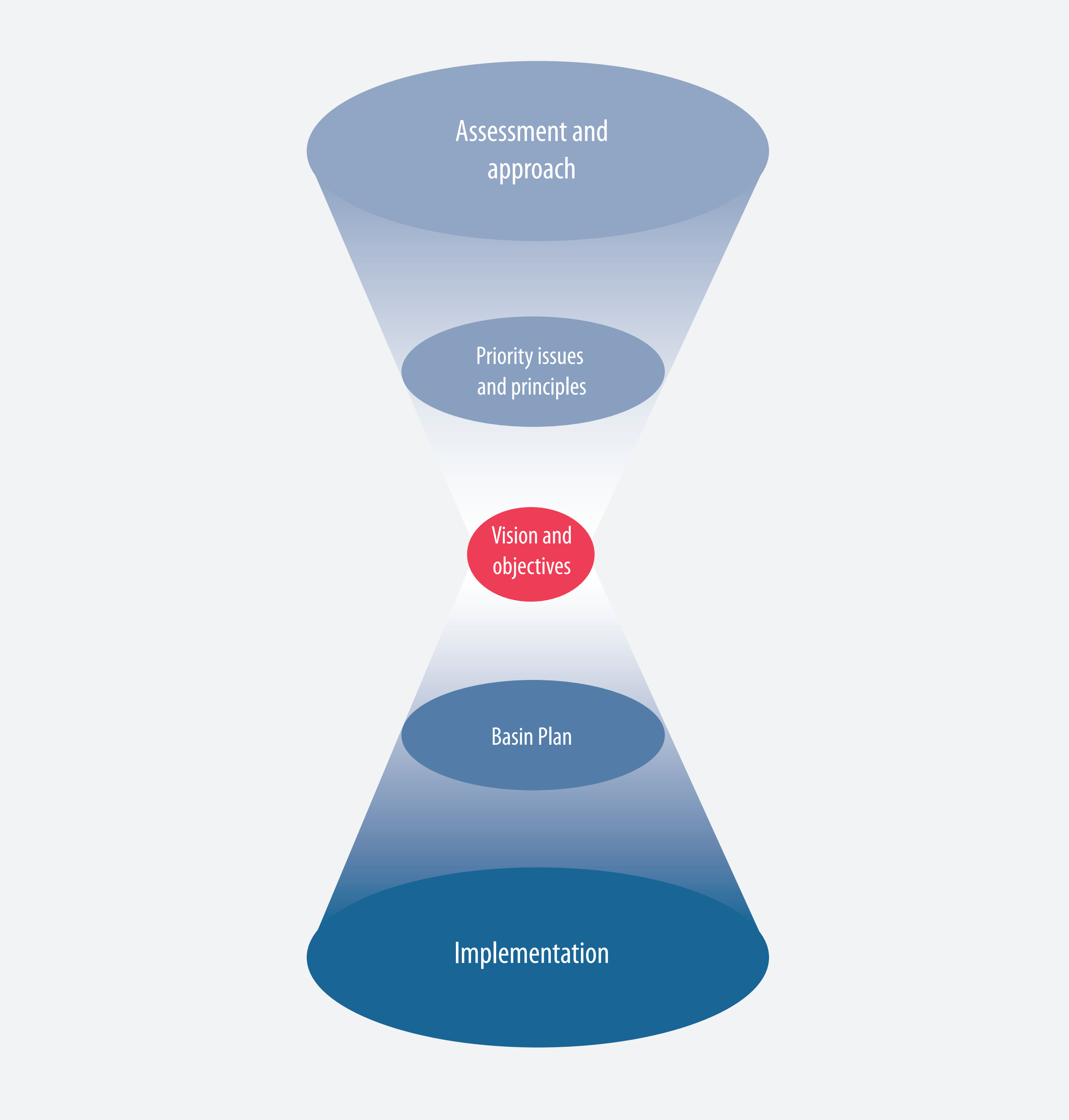
RULE 9: FOCUS ON IMPLEMENTATION OF THE BASIN PLAN THROUGHOUT

A basin plan that is not implemented is largely irrelevant. The development of the basin plan must consider the capacity and resources for implementation, particularly in terms of technical, financial and administrative capacities. If this is not done, the basin plan runs the risk of being a wish list that is not implemented. The actions, responsibilities, milestones and possibly even the resources necessary for implementation must be specified and agreed in the implementation plan, together with the relevant institutional, legal and decision-making mechanisms, responsibilities and powers that enable adoption.

RULE 10: SELECT THE PLANNING APPROACH AND METHODS TO SUIT THE BASIN NEEDS

There is no standard 'one size fits all' blueprint or protocol for basin planning; each basin has different history, conditions, challenges, stakeholders and information. Furthermore, understanding and information are gained through the basin planning process and through subsequent basin planning iterations that are not available at the outset. It is therefore a mistake to assume that the most appropriate techniques can be selected at the start. A credible and coherent process should therefore be designed that reflects local conditions, with flexibility to adapt to the evolving understanding and priorities of the basin.

Figure 12: The hourglass nature of the basin planning process



CHAPTER 3
PURPOSE AND GOALS OF BASIN PLANNING

3.1 Fundamental objectives of basin planning

The need for river basin planning arises due to the hydrological and ecological interconnectedness of river basins, and the multiple, and at times competing, services and functions that human societies derive from these systems. Because of the wide range of services provided by river basins, planning exercises typically need to address a broad range of issues. The following four broad groups of benefits are a valuable perspective through which to consider basin planning (Grey and Sadoff, 2005):

- environmental benefits to the 'river' – improved water quality, conserved biodiversity
- economic benefits from the 'river' – increased food, energy and manufacturing production
- reduced costs because of the 'river' – enhanced flood management
- benefits beyond the 'river' – catalysing wider cooperation and economic integration.

Basin planning is typically required to address all of these issues simultaneously, particularly for stressed river basins in the context of rapid economic growth. In doing so, basin planning exercises are typically underpinned by a number of fundamental principles:

- **Equity:** using water and enjoying the benefits of a river's services in a way that is fair and equitable amongst different groups. This can include equity between different administrative regions and between upstream and downstream areas. Considerations of social equity can also motivate basin planning that seeks to support opportunities for development in underdeveloped regions, as well as protecting and promoting the interests of socially marginalized groups.
- **Environmental protection:** managing water in a way that recognizes the need to maintain environmental functioning, as well as meeting the need for social and economic development. This must consider the direct development and use of the water resources, as well as the goods and services provided by these resources in to the future, ensuring that all of these can be provided into the future.
- **Efficiency in development:** managing water in a way that supports and promotes economic and social development, including national and strategic development priorities. As part of this, recognition is often given to the existing dependencies of communities and industries on water, and the opportunities for water conservation and demand management.
- **Balance:** basin planning needs to balance (trade off) competing needs and interests from the basin water resources (such as abstraction, discharge, flooding, navigation, power generation), and do so in a transparent way which provides security to water users.
- **Cooperation:** promoting alignment and joint action between institutions and groups with overlapping mandates and interests related to basin management.

These or similar principles are often applied in making a basin plan, or can be incorporated within the plan to guide future decision-making. The local circumstances may even require detailed unpacking of these into guiding principles to inform the implementation of the basin plan.

Box 6: Guiding principles and values: examples from Delaware and California

The *Water Resources Plan for the Delaware River Basin* (DRBC, 2004) is the first for the basin which seeks to present a coherent and unifying vision to manage water resources among several US states, each with many cities and other institutions playing a role in water resources management. To achieve this unifying vision and to set the groundwork for future plans, the Delaware basin plan has a strong institutional focus which emphasizes the importance of process in developing a cooperative and coordinated approach. The plan also emphasizes the links between state and federal law, as both must be satisfied. The importance of institutional cooperation is particularly relevant to this plan, and can be seen in the guiding principles below.

1. Water is a precious and finite natural resource, it is essential to all life and vital to ecological, economic and social well-being.
2. The disparate distribution of water resources among watersheds poses a challenge to equitable allocation and use.
3. Prudent water management requires a commitment to ecological integrity and biologic diversity to ensure a healthy environment; to a dynamic economy; and to social equity for present and future generations.
4. The most effective way to eliminate pollution is to prevent its occurrence.
5. Integrated management is crucial for sound results. When making water resource management decisions:
   - Link water quality and water quantity with the management of other resources.
   - Recognize hydrological, ecological, social and institutional systems.
   - Recognize the importance of watershed and aquifer boundaries.
   - Avoid shifts in pollution from one medium to another and avoid creating a problem in a different location or environmental medium.
   - Push the boundaries of technologic possibility while balancing economic constraints.
6. Improved land management is essential for improving the condition of water resources.
   - Decision-making should be based on sound scientific principles and an understanding of the relationship between land and water resources.
   - Effective integrated management requires coordinated planning and action by all levels of government including federal, regional, state, and local levels.
   - Existing planning efforts can provide the foundation for improving land and water resources management.
7. Individually and collectively, we are responsible for the stewardship of our water resources through their judicious use and management.
   - An informed public is vital to an improved environmental future.
   - Public–private partnerships and enhanced cooperation are necessary for improved results.
   - Successful decision frameworks are those flexible enough to encourage and adapt to innovations and new knowledge.
8. Existing legal structures and laws provide the framework in which management decisions are made.
9. Decision-making should give due consideration to the policies and requirements in existing laws and the legal rights of persons and entities potentially affected by water management decisions.
10. Authority to make integrated management decisions shall be derived from existing law as applicable, and may entail modifying or enacting new laws.
11. Legal structures should be utilized that facilitate managing water resources within entire basins, watersheds and aquifers, rather than on the basis of political jurisdictional boundaries, while continuing to respect the sovereignty of states and their political subdivisions.
12. In water resources management, preferable actions are those that are structured to accommodate and be consistent with:
    - preservation and enhancement of ecological integrity
    - sustainability
    - feasibility
    - resilience to natural variability.

The California Water Plan and its Water Plan Update (State of California, 2009) is an example of a plan which seeks to manage water resources across several basins within a single state. Its emphasis is therefore on building institutional cooperation between departments and stakeholders representing multiple facets of water resources management within the state, while considering the highly variable nature of water across basins. The plan follows a previously completed strategy, and thus builds upon information and processes for cooperation already established. The values below represent this regional and cooperative focus.

- Use a broad, stakeholder-based, long-view perspective for water management.
- Promote management for sustainable resources on a watershed basis.
- Increase regional drought and flood preparedness.
- Increase regional self-sufficiency.
- Promote regional coordination and collaboration among local governments and agencies, public and private organizations, and Tribal governments and Tribal communities.
- Determine values for economic, environmental and social benefits, costs and trade-offs to base investment decisions on sustainability indicators.
- Incorporate future variability, uncertainties and risk in the decision-making process.
- Apply California's water rights laws, including the longstanding constitutional principles of reasonable use and public trust, as the foundation for public policy-making, planning, and management decisions on California water resources.
- Promote environmental justice – the fair treatment of people of all races, cultures, and incomes.
- Use science, best data, and local and indigenous peoples' knowledge in a transparent and documented process.

Sources: DRB (2004), State of California (2009).

3.2 Key decisions and trade-offs in the basin planning process

At the core of the strategic basin planning process are a number of high-level political decisions about priorities for the basin. As basins become increasingly stressed, it is no longer possible to meet all of the demands on a river and its resources: choices and trade-offs need to be made between different objectives.

Within the basin planning process, these trade-offs can take a number of different forms. In some basins, the planning exercise may focus on a particular issue; in more complex basins, a range of trade-offs may be under consideration at any one time.

Box 7: Reconciling trade-offs in Chinese basin planning

One of the approaches used to reconciling trade-offs in China's river basin planning is to assign different functions to different parts of the river basin, recognizing that some stretches of river should be maintained at high environmental standards, while in others there should be more of a focus on socio-economic development. The system is based on four types of river classification: development prohibited region, reserved region, rehabilitation region and development region. These are applied to each river section, based on the characteristics of rivers, current and future water resources use, environmental water needs, and socio-economic development scenarios.

Once the function of each river section has been established, the 'controlling index' is proposed: a set of numerical objectives for the basin, such as water quality and total water availability. This provides the basis on which management measures and river basin planning can be developed.

The function of 'development prohibited' regions is mainly to preserve the natural and eco-environmental function of the river. The function of 'reserved' regions is mainly to maintain the natural and eco-environmental service of the river, preserve the current utilization of the river, and prepare for sustainable development. The function of 'rehabilitation' regions is to solve the conflict between utilization and protection, and restore the natural and eco-environmental functions of the river. The function of the 'development' regions is to utilize the river's socio-economic potential, but nevertheless based on protection.

Source: GIWP.

ALLOCATION BETWEEN SECTORS OR REGIONS

In stressed or 'closed' river basins where no further water resources can be developed, key decisions need to be made over who will be allocated scarce water resources. Alternatively, the basin plan may set out mechanisms by which these decisions will be made, for example through trading between users. Depending on the context, basin planning may require trade-offs between sectors, often between the water needs of growing industrial sectors, with high economic value, and existing agricultural use, which may have a lower average economic value but have important social benefits and be associated with politically powerful communities. In larger basins that cross administrative regions, these tensions manifest as conflicts over water allocation between regions or states, as water is viewed as a constraint or catalyst to economic development.

HYDROPOWER VERSUS ABSTRACTION VERSUS FLOOD STORAGE

Among the most complex trade-offs are decisions over the operations of major infrastructure in the basin for the sake of different functions. Much of this relates to issues around water timing, and the operating rules that govern the release of water from dams. In the context of the reduction of flood risk, optimal management of the system typically requires that reservoirs be emptied ahead of the wet season, so as to create the maximum potential to store floodwaters. For hydropower, the priority will be to maintain high reservoir levels at all time, so as to maximize generating capacity. Within this overall pattern, daily releases would then be timed to coincide with peak power demands. Irrigation water users will favour limited releases of water from reservoirs outside the growing season, maximizing the water available for use when required for irrigation. Such a seasonal pattern of release is unlikely to be optimal for hydropower or flood storage. For multi-purpose reservoir facilities, it is therefore likely that these objectives will be in conflict, and decisions over trade-offs will need to be made in the design of system operating rules. These are further complicated when downstream abstraction and navigation requirements are considered. In basins with significant hydropower development, important trade-offs can exist between the needs of hydropower, and the needs of agricultural and industrial water users in the basin. At the most basic level, water abstracted for use upstream of hydropower facilities will reduce the resources available for electricity generation.

RECREATION VERSUS NAVIGATION

Recreation associated with storage reservoirs can be the basis of local economic development and improved quality of life. However, this requires the maintenance of these reservoirs at full capacity. For navigation, the priority is the continued maintenance of sufficient flows of water in navigable sections of the river to permit passage of transport ships. The inherent tension between the desire for stable reservoir levels and stable downstream flow levels is manifest in the definition of reservoir operating rules, which become more complicated by the abstraction requirements of other water users.

Box 8: Three Gorges Water Project in China: benefit trade-offs of different objectives

The operation of the Three Gorges water project is at the core of water resources regulation and management arrangements in the middle and lower Yangtze River. The operation of the dam seeks to achieve benefits in terms of flood control, hydropower generation, navigation and water recharge. Flood control is the most prominent priority for the operation of the dam. The Three Gorges dam can store flood water from the upper basin, so as to reduce the pressure of the middle and lower reaches. With a flood control storage capacity of 22.15 billion m^3, the Three Gorges dam can regulate and control large flood events. In order to both ensure the safety of the dam and enable floodwater storage, the water level of the Three Gorges reservoir should be kept at a certain low level during the flood season so as to ensure the maximum flood storage capacity. This is adapted based on the forecasting of precipitation in the upper basin. However, lowering the water level of the reservoir leads to a reduction in the benefits of hydropower generation, and the release schedule from the Three Gorges reservoir also impacts on irrigation in the middle and lower basin.

Source: GIWP.

WASTE DISCHARGE VERSUS DOWNSTREAM WATER QUALITY

Decisions over desired water quality levels represent an inherent trade-off between upstream and downstream water users and between the preferences of different sectors. Higher water quality standards imply higher treatment standards and investment costs on upstream water users. While increasing flows ultimately should not be regarded as the solution to water pollution problems, requirements to maintain water quality standards may require a reduction in available water for abstraction due to the need to maintain in-channel water to dilute pollutants.

RESPECT FOR THE NATURAL SYSTEM VERSUS CAPACITY TO CHANGE THE NATURAL SYSTEM

Typically, development of water resources fundamentally involves changing the nature of a river system. However, there are inherent limits on the extent to which the river system can be changed – in terms of damming of watercourses, abstraction of water, and modification of the river channel – without causing the system to collapse. Basin planning needs to be based on a full understanding of the characteristics of the river system, and through that understanding identify the scope for modification.

ENVIRONMENTAL FUNCTIONING VERSUS OTHER WATER USES

One of the most pervasive trade-offs in basin planning is between the need to maintain ecosystem functioning and the needs of other water users in the basin. This trade-off is manifest in many ways in basin planning. Decisions on providing environmental flows involve a clear trade-off with water for other users, where increased water use decreases the water available for the river. There are also trade-offs over the timing of releases from reservoirs, with conflict between the natural flood and dry seasons on the one hand, and the timing and the release requirements for hydropower, flood storage or navigation on the other. Similarly, the construction of water supply and flood infrastructure can have major, negative impacts for freshwater ecosystems. These tensions are not simply a question of balancing the needs of development and the needs of the environment, but can also often involve trade-offs between different social groups. For example, changes to water quality may not only affect the natural environment but may have significant negative economic impacts downstream, due for example to the impacts of low flows on estuarine regions or the costs associated with polluted water. Poor and socially marginalized groups are often those most dependent on the functioning of river ecosystems and services, and the loss of these services may lead to an inequitable distribution of benefits from a river. These groups are often also the least able to adapt to changing circumstances and thus made more vulnerable.

A key to successful strategic basin planning is the ability to identify those trade-offs that need to be made in the basin plan, and to undertake sufficient analysis so that the consequences of different options can be understood. This provides the basis on which informed political decisions can be made over basin objectives and priorities.

Box 9: Trade-offs in the Lower Kafue River

Water resources management in the lower part of the Kafue River basin in Zambia, one of the main tributaries to the Zambezi River, exemplifies a trade-off between managing flows to support environmental health, rural populations and hydropower. The river floods naturally every year, with the resulting flooding pattern supporting ecosystem health in the floodplain, including natural vegetation and wildlife. The rural populations in the lower part of the basin also rely heavily on changing water levels from flooding to support livelihoods through floodplain agriculture, livestock grazing, and to facilitate fish migration.

At the same time, the lower Kafue River is Zambia's largest source of electricity with a generation capacity of 900 megawatts. Water flows are controlled upstream of the lower Kafue floodplain at the Itezhi-Tezhi dam, with power generation occurring downstream of the floodplain. Operations at the Itezhi-Tezhi dam impact the timing and levels of flooding, and have implications for the environment and rural populations in the floodplain. In dry seasons, releases from the dam may result in lower flooding levels, which impacts agricultural productivity and ecological regeneration. In wet seasons, releases may result in higher than normal flooding levels and may cause infrastructure damage or harm to populations and livestock.

Further complicating the trade-offs between environment, social needs, and hydropower are disparate institutional capacities between these stakeholder groups. The area is very poor, with low institutional capacity for rural population and environmental concerns. With its importance in the Zambian economy, better institutional capacity exists for hydropower in terms of technical, financial and human resources.

Source: Schelle and Pittock (2005).

In some cases, decisions over these trade-offs may have been made either explicitly or implicitly before the basin plan is developed. This may be, for example, due to legislative or policy requirements to favour particular water users or to achieve certain environmental standards. On other occasions, the political stimulus for the initiation of a basin planning process, for example a serious environmental crisis, may imply that certain priorities should be recognized in the basin plan. For example, the 1987 Rhine plan was developed explicitly to address water quality and associated environmental declines in the basin, and the 2007 Australian Water Act and subsequent Murray-Darling basin planning process have been defined to redress over-allocation of water in the river. In each case, the political and legal context in which the basin plan is being produced has prejudged to a certain degree the way in which these trade-offs should be addressed. However, even in these cases where decisions over trade-offs have apparently been made prior to the detailed development of a basin plan, experience suggests that conflict over these tensions continues throughout the planning and decision-making process.

It is also useful to recognize that some tasks must by necessity be conducted at the basin level, such as water-sharing and flood management. Many other tasks can be conducted either at the basin level, the sub-basin level or the state administrative level, such as water supply, monitoring and enforcement. Identification of the appropriate level at which to plan these tasks can be an important aspect of conflict prevention and resolution. Furthermore, substantial professional expertise may be available within government agencies with mandates along administrative boundaries, and decentralization of some planning may tap into this capacity.

3.3 Basin visions as an indication of planning purpose

Many modern basin plans include a basin vision: a high-level statement of the goals and priorities that the basin plan is attempting to promote. Because the vision reflects and addresses the main concerns and aspirations within a given basin at a particular point in time, including the broader social, economic and environmental development concerns, these visions provide an insight into the purpose and objectives of basin planning. The basin vision may also give an indication of priorities in the context of the trade-offs and conflicts that will need to be addressed in the basin plan, for example by indicating economic priorities that need to be satisfied or environmental limits that need to be respected or restored.

A vision may range from a qualitative desired state, to a series of quasi-measurable statements. The former may be intentionally vague, allowing wide interpretation and therefore buy-in from stakeholders, prior to the difficult, detailed decisions about trade-offs. In situations where there is more commonality between stakeholders or greater understanding following previous basin planning processes, more focused statements may be possible. Vision statements tend to have a political dimension and should be aspirational and unifying in nature, rather than polarising. Some ambiguity is acceptable, because vision statements tend to provide a long-term structure to sequential basin plans, and must therefore be translated into medium term objectives during the strategy formulation process.

Even where visions may be diverse and even utopian, they can still provide practical, operational guidance. The vision formulation process serves a purpose in itself:

- by considering a desired future while disregarding various constraints and imminent problems to be solved
- by delineating a platform of shared values and preferences among various stakeholders with different perspectives
- by demonstrating that various perspectives can be pursued in parallel
- by raising awareness of the significance of basin planning.

While water resources priorities and their desired state are the core of most visions, national water management priorities must be considered. Furthermore many visions address catchment and land management issues that are beyond the mandate of water managers in general and the basin organisations in particular. The concept of cooperation and sector alignment may also be included in these visions. In some cases, for example in the case of the Mississippi, the vision may have a very long-term outlook.

There may also be reason to include multiple layers of vision within the basin plan, particularly where this is a new process and stakeholders wish to see all the dimensions of their agreements. It is important to recognise that the high level aspirational vision can include all aspects of concern, while by their nature focused vision statements (or goals) must prioritise a selected number of issues.

Box 10: Evolving vision statements in the Rhine over thirty years

Rhine 2020 – Program on the sustainable development of the Rhine (ICPR, 2001) provides a multi-country plan with a long history of facilitating improvement to the river. It is an umbrella plan within the context of European Union legislation that encourages cooperation between countries in the basin, while retaining individual countries as implementing agents. With its long history and the accumulation of information over time, the Rhine basin plan provides detailed technical information to inform targets and to determine actions that must be taken by individual countries. Although the evolution of basin planning in the Rhine has been driven by crisis and strong political leadership, over time it has become a well-defined process based on many years of experience, understanding of the basin, and building of trust between institutions.

When the first Rhine River basin plan was developed (1987), it had the following vision:

- to improve the state of the Rhine River to such an extent that fish such as salmon and sea trout return to the river
- to guarantee the production of drinking water from the Rhine for the future
- to reduce the pollution of river sediments so that sludge could be used for land filling or be dumped at sea.

This was expanded in the Rhine 2020 visioning process (2001), to include the following targets:

Ecosystem improvement

The former network of habitats typical for the Rhine (habitat patch connectivity) and the ecological patency of the Rhine from Lake Constance to the North Sea and the patency of tributaries figuring in the programme on migratory fish are to be restored.

Flood prevention and flood protection

- The risk of flood damage in the lowlands of the Rhine is to be reduced by 25 per cent (from 1995) by 2020.
- Extreme flood peaks downstream of the impounded part of the Upper Rhine (downstream of Baden-Baden) are to be reduced by up to 70 cm (from 1995).

Water quality

- Drinking water production will be possible using simple, nature-near treatment procedures.
- Water quality constituents must neither alone nor in interaction have negative impact on the biocoenosis of plants, animals and microorganisms.
- Fish in the Rhine, mussels and crustaceans are suitable for human consumption without any restriction whatsoever.
- Bathing in the Rhine is possible at suitable locations.
- It must be possible to dispose of dredged material without causing any harm.

Groundwater protection

- A good water quality must be restored.
- A balance of groundwater abstraction and groundwater recharge must be granted.

This vision still holds, with the objectives included in the basin plan focused on interpreting the legally imposed vision under the EU WFD of 'good water quality' in natural versus modified river reaches.

Sources: ICPR (2001, 2003).

Box 11: Principles of the Yangtze River basin plan

The current Yangtze River basin plan is intended to address the relationships between demand and supply, benefit generation and disaster mitigation, protection and development, and the requirements of different regions and different sectors, as well as the long term and the short term. The basic aim is to maintain a healthy Yangtze River and promote harmony between humans and water, based on the principle of improving development while protecting the river system.

The principles used in the Yangtze River basin plan are as follows:

- Human requirements and public welfare are the priority. Public benefits such as flood control, water supply safety and ecological safety are considered the priority.
- Coordinated development between water management and society. Water management should provide support and security for the overall coordinated and sustainable development of society and the economy. Socio-economic development planning should be consistent with the carrying capacity of water resources and the water environment.
- Improving development while protecting and fulfilling protection while developing. Correctly managing the relationship between development and eco-environmental protection.
- Comprehensive assessment and management. Coordinate flood control, water supply, irrigation, hydropower generation, navigation and water resources and water environment protection.
- Implement strict water use controls. Control the quantities of total water use and pollutants discharging into the river, and improve water use efficiency.
- Adjust measures to the local situation and combine short-term and long-term needs. Aiming at the prominent conflict of river basin development and protection, establish the planning objectives, tasks, priorities and implementation plans in the short-term and long term according to different priorities.
- Strengthen the joint operation of infrastructure. Strengthen the joint regulation and management of water storage and hydropower projects in the basin, to ensure the security of flood control, domestic water use, industrial water use and ecological water use.

Source: GIWP.

Box 12: Outcomes for the Murray-Darling Basin Plan

Basin planning for the Murray-Darling has a long history which includes a recent evolution in institutional roles. This evolution was driven by increasing stress in the basin, and the need to shift the focus from development to environmental protection and governance. While planning was traditionally done by individual states, in 2008 the states ceded authority over certain aspects of the management of the basin, including some water allocation planning decisions, to the national government. This also allowed for the creation of the Murray-Darling Basin Authority, which is responsible for developing an umbrella plan for the basin. As the first umbrella plan is developed under the Basin Authority, difficult decisions regarding abstraction limits, environmental requirements and water quality issues must be made. Additionally, the newly formed Basin Authority must navigate the boundaries of its own authority. Thus, the Murray-Darling Basin Plan will seek to fulfil a coordinated planning role, make key decisions, and has a very political focus.

The draft basin plan identifies a series of management objectives and outcomes to be achieved by the plan. The management objective and outcomes for the Basin Plan as a whole are:

(1) The management objective for the Basin Plan as a whole is to achieve a healthy working Murray-Darling Basin, including a healthy environment, strong communities and a productive economy, through the integrated and cost effective management of Basin water resources.

(2) The management outcomes that correspond to the objective in subsection (1) are that Basin water resources are used in a way that:

- (a) optimizes economic, social and environmental outcomes; and
- (b) gives effect to relevant international agreements; and
- (c) improves water security for all uses of basin water resources.

In addition to these whole-of-basin objectives, the draft plan specifies objectives and outcomes related to the environment, water quality and salinity, sustainable diversion limits, and water trading. (MDBA, 2011, ch. 5).

Source: MDBA (2011).

Box 13: Intergenerational Vision for the Mississippi Basin

The Mississippi River Commission and key stakeholders have developed a 200-year vision: *An Intergenerational Commitment* for the basin:

Our people ...

- Enjoy a quality of life unmatched in the world.
- Lead secure lives along any river or tributary in the basin.
- Enjoy fresh air and the surrounding fauna, flora, and forests while hunting, fishing, and recreating along any river or tributary in the basin.
- Travel easily, safely, and affordably to various destinations in the watershed.
- Drink from and use the abundant waters of any river, stream, or aquifer in the basin.
- Choose from an abundance of affordable basic goods and essential supplies that are grown, manufactured, and transported along the river to local and world markets.

This was based on an understanding of:

- Common desire:

  There is a need and desire for a shared vision for the Mississippi River Basin that encompasses the whole system in an integrated way; includes ecological, social, and economic factors; and leads to commonly accepted priorities (perhaps akin to the Millennium Ecosystem goals) to serve as meaningful, actionable touchstones for on-the-ground projects across the system. Secondly, there is a need for more effective institutional structure(s) to coordinate management of the river to turn the vision into reality.

- Common threat:

  Entrenched institutional arrangements have created what appear to many as unresponsive, unconnected silos. In the absence of a shared vision for ecosystem health and economic vitality across the whole basin, priorities are largely determined by default through the political process.

Source: Mississippi River Commission (2011).

Box 14: Desired future and outcomes for the California Water Plan

The California Water Plan takes a long-term perspective by using the year 2050 as its planning horizon. The desired future and outcomes reflect attention to climate, economic development, and management through institutional cooperation. The benefits and consequences of water decisions and access to state government resources are equitable across all communities.

Desired future for California water

California has healthy watersheds and integrated, reliable and secure water resources and management systems that:

- enhance public health, safety, and quality of life in all its communities
- sustain economic growth, business vitality, and agricultural productivity; and
- protect and restore California's unique biological diversity, ecological values, and cultural heritage.

Desired outcomes over the planning horizon 2050

1. California has water supplies that are adequate, reliable, secure, affordable, sustainable, and of suitable quality for beneficial uses to protect, preserve, and enhance watersheds, communities, and environmental and agricultural resources.
2. State government supports integrated water resources planning and management through leadership, oversight, and public funding.
3. Regional and interregional partnerships play a pivotal role in California water resources planning, water management for sustainable water use and resources, and increasing regional self-sufficiency.
4. Water resource and land use planners make informed and collaborative decisions and implement integrated actions to increase water supply reliability, use water more efficiently, protect water quality, improve flood protection, promote environmental stewardship, and ensure environmental justice in light of drivers of change and catastrophic events.
5. California is prepared for climate uncertainty by developing adaptation strategies and investing in a diverse set of actions that reduce the risk and consequences posed by climate change, that make the system more resilient to change, and that increase the sustainability of water and flood management systems and the ecosystems they depend on.
6. Integrated flood management, as a part of integrated water management, increases flood protection, improves preparedness and emergency response, enhances floodplain ecosystems, and promotes sustainable flood management systems.

Source: State of California (2009).

Box 15: Vision and Goals for the Breede-Overberg catchment management strategy

The catchment management strategy for the Breede-Overberg Water Management Area in South Africa is a legally required plan in which certain content is specified and certain processes, including stakeholder engagement, are required. It also represents the first such strategy for the area and is written by a newly formed Catchment Management Agency, shifting from a previously more centralized approach to managing water resources. As the first strategy of its kind for the area, its focus is on building institutional legitimacy, filling information gaps to support decision-making, and meeting legal requirements.

The strategy states, 'We understand that water will shape the growth and development of the Breede Valley and Overberg region, and that our future is linked to that of Cape Town, the Western Cape and the country as a whole. We also recognize that the way we respond to the challenges and opportunities of change in our natural and social environment, will determine how we live and work together.'

The Vision for the Breede-Overberg Water Management Area is captured by 'Quality water for all forever'.

Vision statements

- Protecting our rivers, groundwater, wetlands and estuaries in a healthy and functioning state for nature, people and the economy.
- Sharing our available water equitably and efficiently to maintain existing activities, support new development and ensure redress, while adapting to a changing climate and world.
- Cooperating to jointly nurture, take responsibility and comply, so that our water resources are well managed, under the leadership of a strong Breede-Overberg CMA.

Goals

- The majority of the estuaries and coastal wetland systems are protected in a slightly modified state.
- Riverine water quality is maintained at an acceptable level for the irrigation of fruit and vegetables.
- Adequate water of good quality is allocated to meet the social objectives of service delivery and equity.
- Economic returns of water used in productive and efficiency of domestic activities are continually improved.
- Compliance with water use authorization conditions is improved every year.
- Full implementation of the Breede-Overberg catchment management strategy by those responsible.

Source: BOCMA (2011).

Box 16: Vision statements for the Danube River Basin Plan

The Danube River Basin District Management Plan (ICPDR, 2009a) represents a multi-country basin plan which must address the diversity in capacities among countries in the basin in order to fulfil EU requirements. The basin plan follows the legal framework of the EU WFD and was formulated by the ICPDR, to which 14 countries are Contracting Parties. Individual countries maintain sovereignty and therefore play an important role in implementation, but uneven financial and other capacities among countries in the basin make it difficult for some countries to fulfil requirements. Therefore, financial assistance is provided to some EU countries, and the plan allows for commitments which are not financially resource-intensive for non-EU countries. The Danube plan is also built on significant information and a long history of planning, so specific requirements are well understood.

The vision statements contained in the basin plan for the Danube are deliberately ambitious with the intent to inspire the relevant authorities. They also represent a mixture of clearly defined ideals such as 'zero emissions' to more qualitative visions like 'balanced management'. Progression is provided for through a baseline, mid-term and vision scenario, and capacity assistance is given to help countries with less capacity work towards this vision.

- The organic pollution goal is zero emission of untreated wastewaters into the waters of the Danube River Basin District (DBRD).
- The nutrient pollution goal is the balanced management of nutrient emissions via point and diffuse sources in the entire DRBD so that neither the waters of the DRBD nor the Black Sea are threatened or impacted by eutrophication.
- The hazardous substances pollution goal is no risk or threat to human health and the aquatic ecosystem of the waters in the DRBD and Black Sea waters impacted by the Danube River discharge.
- The hydromorphological alterations goal is the balanced management of past, ongoing and future structural changes of the riverine environment, so that the aquatic ecosystem in the entire DRBD functions in a holistic way and is represented with all native species.
- Floodplains/wetlands in the entire DRBD are reconnected and restored.
- Hydrological alterations are managed in such a way that the aquatic ecosystem is not influenced in its natural development and distribution.
- Future infrastructure projects are conducted in a transparent way using best environmental practices and best available techniques in the entire DRBD – impacts on or deterioration of the good status and negative transboundary effects are fully prevented, mitigated or compensated.
- Emissions of polluting substances do not cause any deterioration of groundwater quality in the DRBD. Where groundwater is already polluted, restoration to good quality is the ambition.
- Water use is appropriately balanced and does not exceed the available groundwater resource in the DRBD, considering future impacts of climate change.

Source: ICPDR (2009*a*).

A vision may reflect a very long-term desired state, particularly in situations where water resources development and institutional arrangements shift gradually, and in some cases the vision may directly include broader non-water related imperatives.

There may also be reason to include multiple layers of vision within the basin plan, particularly where this is a new process and stakeholders wish to see all the dimensions of their agreements. It is important to recognize that the high-level aspirational vision can include all aspects of concern, while by their nature focused vision statements (or goals) must prioritize a selected number of issues.

Visions may be diverse and even utopian, but can still provide practical, operational guidance. The vision formulation process serves a purpose in itself:

- by considering a desired future while disregarding various constraints and imminent problems to be solved
- by delineating a platform of shared values and preferences among various stakeholders with different perspectives
- by demonstrating that various perspectives can be pursued in parallel
- by raising awareness of the significance of basin planning.

3.4 Dealing with change, uncertainty and complexity

Considerations of change and uncertainty have become increasingly central objectives of basin planning. This development has been driven by the emergence of global climate change and variability, and the rapid pace of social and economic development in many parts of the world. In each of these cases, significant future change is associated with high degrees of uncertainty.

The principles, procedures and approaches outlined in this volume are designed to address precisely these challenges. This volume does not consider specific mechanisms for addressing climate change as an isolated process from basin planning. Rather, mechanisms are set out that enable good water management in the broader context of rapid change and uncertainty. This section nevertheless highlights some of the key principles of basin planning that relate to change and uncertainty.

THE MULTIPLE DIMENSIONS OF CHANGE AND UNCERTAINTY

The impact on the hydrological cycle has been identified as one of the key consequences of global climate change and variability. Projected future changes include, for example, an increase in the frequency of floods and droughts; long-term changes to patterns of overall water resources availability; increased variability in water resource availability; increased temperatures driving increased risks of eutrophication; and changes to the seasonality of water, driven for example by shifts in precipitation from snow to rainfall. These changes have the potential to drive significant impacts, often negative, on both the social and economic activities dependent on water, and on freshwater ecosystems.

In addition to such climate-driven change, extraordinarily rapid social and economic change is taking place in many parts of the world, associated with profound changes in demand for, and impacts on, water resources. These social and economic changes will often be more significant than changes in the climate over the periods of relevance to many water planning decisions. Changes in both the climate and socio-economic development are characterized by high levels of uncertainty. This uncertainty consists of a number of factors:

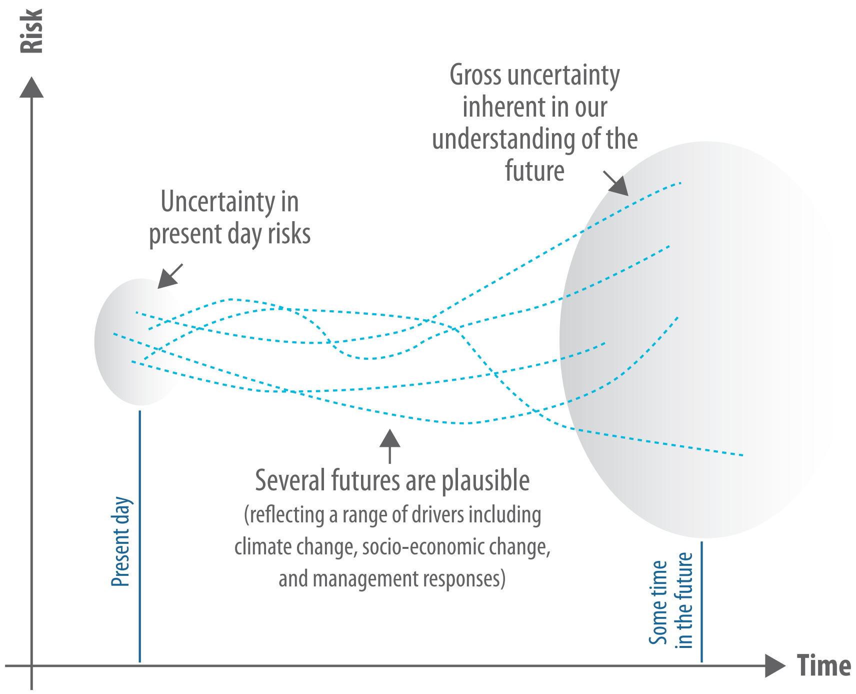
- **Changes in average water availability.** Climate change is likely to alter levels of precipitation, evaporation and runoff, and hence the volumes of water available for consumption. The nature and level of change will vary between regions, however, and is subject to considerable uncertainty.

- **Greater climatic variability.** Most climate predictions point to greater variability in climate, including more extreme events. Thus, even where long-term average runoff may remain the same, there may be an increase in the number of drought and flood periods. Alternatively, there may be an increase in variability in the timing of the annual wet season or other events.

- **Limited information.** Existing climate models do not currently predict changes in climate with sufficient confidence to allow water planners to make decisions with certainty, and may never do so. In some cases, future models do not even agree on whether there will be on average an increase or decrease in total precipitation and runoff for many regions (Le Quesne, Matthews and Von der Heyden, 2010). Models are increasingly unreliable at the smaller geographical and temporal scales which are of particular relevance for water resources managers, even in relatively large river basins such as the Yangtze in China and the Mississippi in North America. Increases in variability may occur, even while average variables remain constant, a further challenge for the use of existing models to support basin planning.

- **Profound uncertainty about the future.** The number of factors that are contributing to uncertainty over the future mean that even the development of ever more sophisticated modelling is unlikely to resolve future uncertainty. This is likely to be particularly the case when climate and development futures are considered together.

Figure 13: Increasing uncertainty over time. In addressing future changes, including climate change, basin planning needs to become a process that is fundamentally about managing uncertainty



Box 17: Uncertainty and change in the Yellow River basin

The Yellow River is the second largest river in China, and an important source of water for the north-western and northern parts of the country. It fulfils an important strategic position in the national economy and society. In the river basin, water resources per capita are 473m^3, about 23 per cent of the national average, and water resources per arable land are 220m^3, about 15 per cent of the national average. The Yellow River basin also needs to supply water for other river basins. In short, water conflict between water supply and demand is acute in the basin, and competition over water use is intense among different provinces within the basin.

In order to ensure sustainable utilization of water resources and maintain the eco-environmental system, water abstraction of each province along the Yellow River has been determined after deducting water needs for sediment transportation. In 1987, the Water Allocation Scheme for the Yellow River was approved. The scheme identified mean annual runoff of the Yellow River as 58 billion m^3, and this was used as the starting point for allocation. After deducting 21 billion m^3 for instream eco-environmental requirements, the remaining 37 billion m^3 was allocated to nine provinces along the Yellow River basin. The allocation scheme is one of the earliest allocation schemes for large river basins in China. With the formulation and implementation of an annual regulation plan, and effective monitoring and management of discharge water in control sections, the 1987 scheme has been implemented. This has had a significant impact on easing conflict over water use among different provinces, maintaining the order of water use and ensuring normal ecological functioning of the river.

Since the drawing up of the agreement, there have been substantial and unforeseen changes in the Yellow River. Annual water availability in the basin has declined significantly. The 58 billion m^3 of average annual runoff allocated by the scheme was based on flow data for the period from 1919 to 1975. In contrast, data for the period from 1956 to 2000 suggests annual runoff has reduced by around 10 per cent to 53 billion m^3. This is believed to be a result of changes in land use in the catchment, long-term declines in basin groundwater levels, and increased frequency of drought. At the same time, the pattern of economic development in the basin has been very different from that contemplated in 1987 as the basis for division of water among the basin provinces. Taken together, these changes mean that conditions in the basin are now very different from those on which the 1987 Water Allocation Scheme was based. The original 1987 agreement did not foresee a mechanism for making alterations to reflect these changes, and the question of whether the 1987 allocations should be revised is currently under negotiation.

Source: GIWP.

MANAGEMENT PRINCIPLES IN THE CONTEXT OF UNCERTAINTY AND CHANGE

The increasing recognition of these changes, and the uncertainty associated with them, has been one of the key factors behind the development of more strategic approaches to basin planning. Adapting water resources management to rapid socio-economic development and increasing climate variability requires approaches that are both robust to uncertainty and flexible enough to respond to changes as they occur. With this shift to a non-stationary and uncertain future, the underlying aims and associated techniques for basin planning are beginning to shift from a desire to identify an optimal outcome based on historical and current conditions within a basin, to the pursuit of robust outcomes that will be successful under a range of possible futures.

By way of example, flood risk strategies should be developed that can respond to a range of possible rates of increase in sea level over time. Water allocation systems should incorporate mechanisms that allow for water to be allocated equitably in the context of increased variability. Basin ecosystems should be maintained in a healthy condition so that they are well placed to withstand shocks and changes. Above all, a long-term set of objectives for the basin needs to be identified, with implementation plans adapted to meet these as change occurs.

In order to enable robust responses to an uncertain future, a number of high-level principles can be applied to basin planning decisions:

- **Make decisions that do not foreclose future options.** Some basin planning decisions remove the flexibility and ability to change at a later stage. This applies most obviously to decisions around physical infrastructure. It also applies in important ways to legal and institutional arrangements that may remove future flexibility, for example water allocation agreements that do not have the ability to be changed.
- **Develop the ability to respond to unforeseen events.** This includes the establishment of clear drought and flood planning contingency planning, including the ability to manage and respond to events that lie outside the historic record. Unforeseen events can also occur over longer-term time horizons, for example the development of new industrial, urban or agricultural centres in unforeseen locations, or long-term declines in runoff.
- **Monitor indicators so that we can observe change.** An effective and comprehensive system of monitoring is a crucial prerequisite to the adaptive management that is at the core of responding to change. Monitoring needs to cover a suitable suite of hydrological, water quality, ecological and economic variables, and importantly, should be accompanied by sufficient resources to analyse and assess data to identify long-term changes and trends.
- **Change plans as conditions change.** Basin plans and associated thematic plans need to be reviewed and updated in the context of changes. This requires a process and approach that is open to change.

THE IMPLICATIONS FOR BASIN PLANNING OBJECTIVES

These principles will have an impact across many of the decisions and objectives of basin planning. However, a number of the key implications are set out below, which can provide some guidance on the implications for some of the key aspects of basin planning.

- **A healthy and functioning environment.** Freshwater environments that are already degraded have limited assimilative capacity to withstand future shocks. For example, high levels of nutrient enrichment mean that water bodies are more vulnerable to eutrophication in the context of increased temperatures. Rivers that are already subject to excessive abstraction will be likely to suffer from very serious impacts from reduced runoff.
- **Flexible infrastructure.** Infrastructure decisions are amongst the longest-term of all basin planning decisions, with the least flexibility for change. Infrastructure should be constructed that will be adaptable to future changes. This has implications across infrastructure planning decisions. Importantly, there are significant advantages to the planning and operation of infrastructure at a basin scale, rather than as individual dams. This increases the ability of the system to respond flexibly to changing conditions. It may also suggest that some tributaries should be left free of infrastructure, to increase the overall environmental resilience of the river basin. Particular individual pieces of infrastructure should be constructed with engineering designs that permit flexibility, for example multiple releases at multiple levels of a reservoir, or the incorporation of space into flood defence infrastructure planning to allow for future development if required.
- **The ability to modify rules as conditions change.** Laws, policies and regulations should all be subject to change as conditions change. For example, this may relate to changes in development planning guidance or zonation as flood risk changes, or flexibility in water allocation agreements and plans in response to changes in run-off. Operating rules developed for any storage should allow flexibility in response to changing conditions. The ability to change will

apply not only to specific rules and agreements, but also at policy and regulatory levels as well.

- **Develop specific organizational capacity.** The ability to manage under uncertainty implies the development of new organizational capabilities. In particular, this suggests the monitoring and event response capacities of organizations may need to be increased. This implies a significant investment programme.

Box 18: The 1922 Colorado Compact: poorly equipped to address variability and change

The allocation of water between the basin states on the Colorado River is based primarily on the 1922 Colorado River Compact, supplemented by the 1944 Treaty between the United States and Mexico and the 1948 Upper Colorado River Compact. The 1922 Compact provides a very clear example on how a basin allocation agreement has not proved able to deal with changing hydrological and socio-economic conditions that were not anticipated at the time that the Compact was developed.

In essence, the 1922 Compact divides the US basin states into two groups: the upper basin states (Colorado, New Mexico, Utah and Wyoming) and the lower basin states (Arizona, California and Nevada). The Compact was based on the assessment that the annual average flow of the Colorado River was 16.4 million acre-feet (MAF). On this basis, 7.5 MAF per year was allocated to both the upper and lower basin states. The 1944 Treaty allocated a further 1.5 MAF per year to Mexico. The Mexican allocation is regarded as the highest priority allocation in the river. The 1922 Compact gives effect to the division of water by requiring the upper basin states to release 75 MAF to the lower basin states over ten years.

A number of problems have arisen. Most significantly, the assessment of annual average flows was based on thirty years of data that has, with hindsight, proved to cover a particularly wet period. Over a century of gauged records suggest an annual average of 14.8 MAF. Given that the 1922 Compact and the 1944 Treaty allocate 16 MAF, it is clear that the basin is over-allocated. The way in which the treaty allocates water means that this shortfall has not been shared equally between the basin states. Instead, Mexico and the lower basin states receive their allotted share, while the upper basin does not. Climate studies in the basin are nearly unanimous in predicting further declines in run-off (USBR, 2007), which will exacerbate this problem.

By way of contrast with this flawed approach, the 1948 Upper Colorado River Compact allocates water between the parties on the basis of percentages of available supplies, a mechanism that is robust to variability and change. Under a proportional approach, each state shares equally in any shortfalls.

In addition to the decline in water availability, the explosive growth of Las Vegas in Nevada was not anticipated in 1922. Nevada was allocated very low quantities of water in the original compacts. No provision was made in the Compact for flexibility in response to future development, and trading of water between states does not take place. These arrangements mean that there is increasing pressure on water availability for Las Vegas, with no mechanism available to respond to this.

Sources: Quibell et al. (2012), USBR (2007).

INCORPORATING UNCERTAINTY INTO THE BASIN PLANNING PROCESS

The existence of increasing variability, change and profound uncertainty implies significant changes in the processes and methodologies by which basin planning is undertaken. At its core, this involves a shift from a linear model of strategy development, based on certainty about future states of affairs and a single basin development pathway, to an adaptive model of strategy development that emphasizes risks, multiple future scenarios and options, and adaptive decision-making to achieve longer-term visions and objectives.

Table 3: Approaches to the decision-making process in the context of uncertainty

Stages of strategy development	Linear (certain) model of strategy development and decision-making	Adaptive (uncertain) model of strategy development and decision-making
Understanding the external and internal influences (Context)	Predictable future change – climate, demographics, development. Costs and benefits.	Unknown future change. Risks.
Deciding how to do it (Process)	Sequential process of planning, programming and implementation. Top-down strategy development. Deterministic planning.	Continuous alignment of plans, programmes and implementation activities with the changing world. Continuous reconciliation of the bottom-up initiatives and top-down strategies. Scenario-based assessment.
Deciding what to do (Content)	Predefined system of goals, objectives and desired outcomes. Defined set of activities and resource demands.	Emerging pattern of goals, objectives and desired outcomes, set in the context of a longer-term vision. Flexible configuration of resources and priorities.

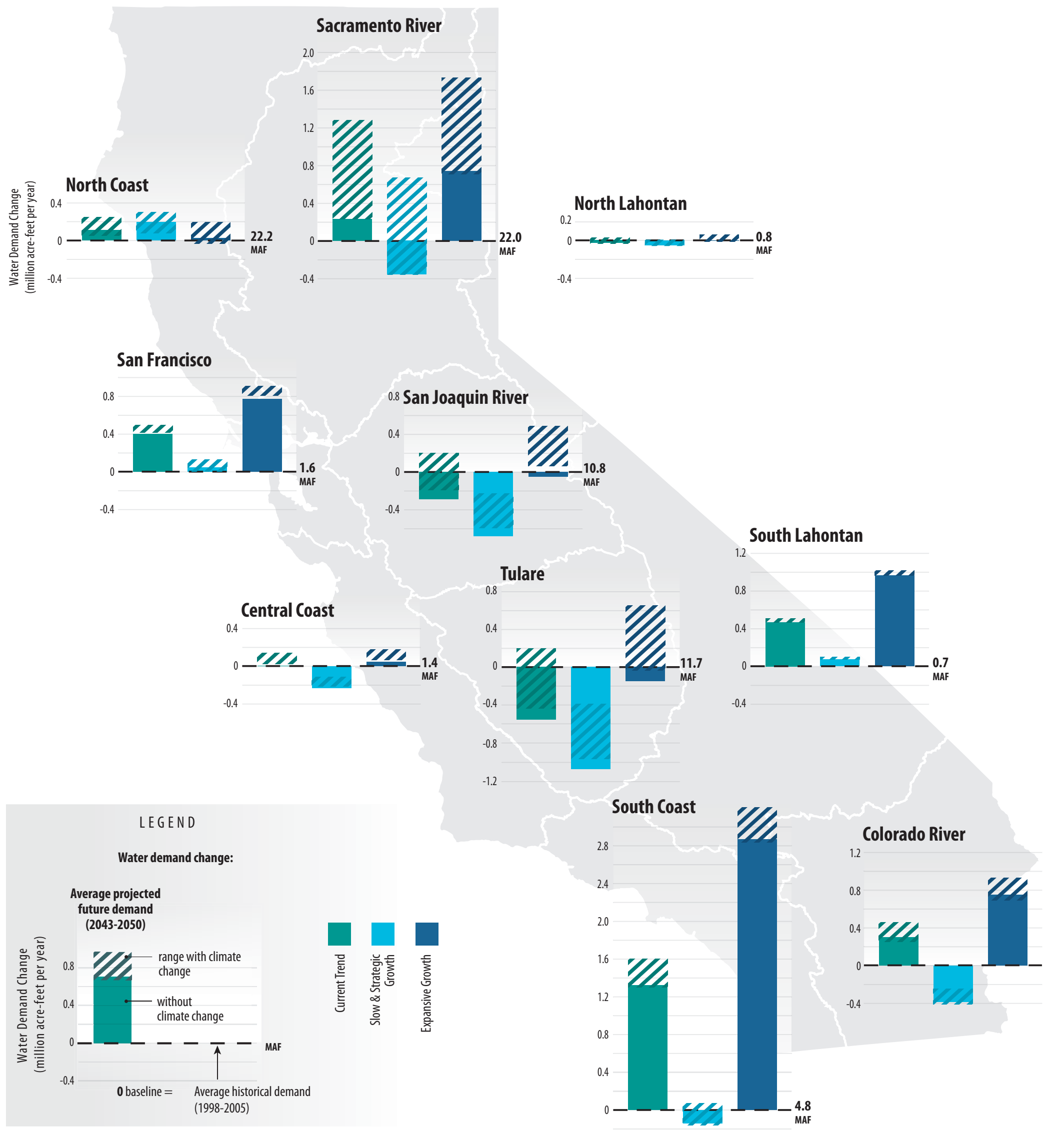
The basin planning process should permit revisions to be made, while at the same time allowing for long-term goals to be set. This can be achieved through the establishment of long-term goals for basin plans, with shorter cycles for review and implementation. This concept is at the core of the strategic basin planning approach.

A number of techniques are increasingly well developed that allow for planning to incorporate uncertainty and a range of possible futures. Central to this is the use of a range of scenarios for future conditions. These scenarios can combine a series of both possible development paths and climate futures. Risk assessment tools can supplement this as a mechanism for testing planned approaches against possible outcomes (World Bank, 2009*a*). Scenario planning is considered further in Section 10.5.

Box 19: Climate and development scenario planning in California

Water resources managers in California have recognized that water resources management strategies and plans must be dynamic and adaptive, and must incorporate considerations of uncertainty, risk and sustainability. The California Water Plan Update 2009 (State of California, 2009) used an approach encompassing multiple future scenarios and alternative response packages. The scenarios represented a range of plausible development and climate conditions for the future, while the response strategies combined different mixes of management strategies. The California plan does not try to take any one scenario and plan for that, but rather to use the three main scenarios to test what is necessary to manage water resources for each scenario, and within this, to identify if there are certain management responses that hold true for all scenarios.

Regional water demand scenarios projected under the California 2009 Water Plan Update



Source: State of California (2009).

CHAPTER 4
PLANNING FRAMEWORK FOR BASIN PLANNING

4.1 Overall framework for basin planning

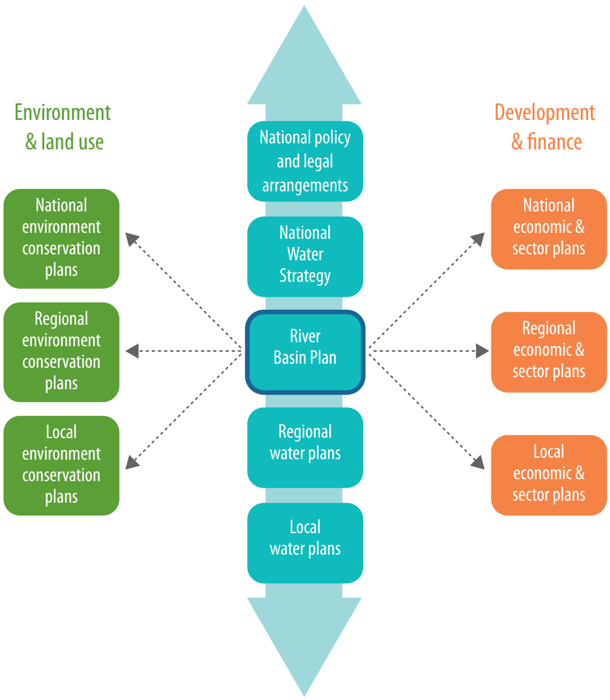
This chapter sets out the overall framework for basin planning: the relationship between basin planning and the many other planning exercises undertaken by government. Modern strategic basin plans need to address increasingly complex water challenges. Basin plans need to recognize and enable national water policies, and at the same time inform local and regional plans and policies. Furthermore, basin planning takes place in the context of a range of broader socio-economic and environmental planning processes.

Basin plans therefore need to consider both:

- Horizontal alignment, between the basin plan and plans from outside the water sector such as economic, spatial and environmental plans. These plans are likely to be at a range of scales, from national development and environmental laws and planning, through regional to local-scale plans. Typically, the geographical boundaries of the basin plan and these broader plans will not be aligned.
- Vertical alignment, between the basin plan and other national and local plans in the water sector.

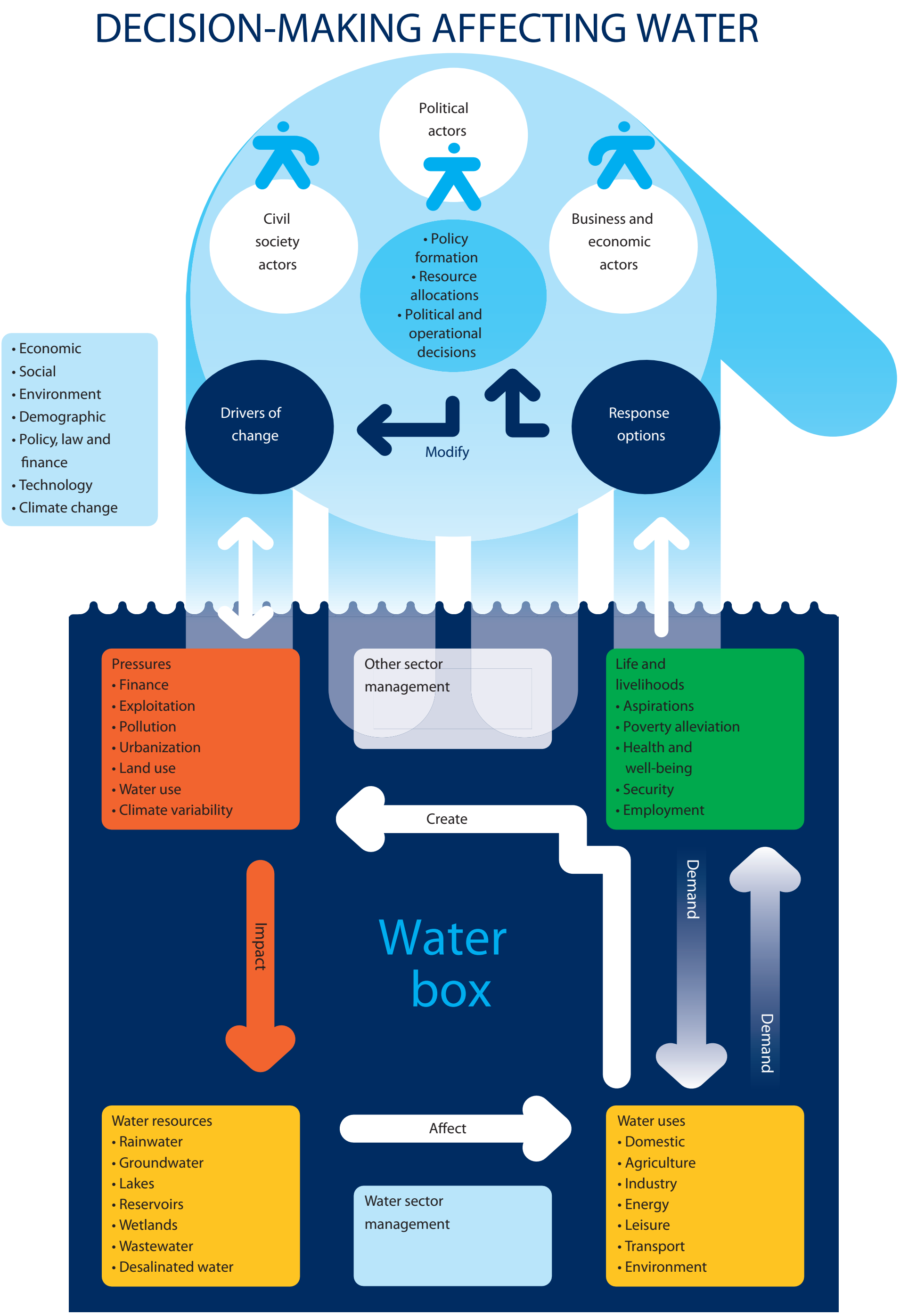
This concept of horizontal and vertical alignment is illustrated in Figure 14.

Figure 14: Framework for basin planning within its broader environment



There has been increasing recognition in recent years that decisions that affect water resources and how they are used are not made by water managers alone: there are a range of important socio-economic decisions which get made outside of the 'water box' that affect water (see Figure 15). It is critical that basin planners engage with those decision-makers and recognize the way different policies, processes and actions are likely to affect the water sector. This can include understanding how policies, the allocation of resources, and political and operational decisions might influence drivers of change and thus place greater pressures (pollution, exploitation and so on) on water resources and aquatic systems. At the same time, water managers need to be aware of the decisions and actions required from them to contribute to broader policy goals. A failure by water managers and basin planners to engage with the relevant (non-water) groups and processes can jeopardize the success of the basin plan, because of resource constraints or conflicting objectives and actions. It is necessary therefore for water managers to be engaged in broader socio-economic planning and policy development from the outset (WWAP, 2009).

Figure 15: The 'water box', showing issues, decisions, and actions directly within the scope of water managers, and the connection to influencing factors outside the water box



Source: WWAP (2009).

Box 20: Development planning as part of the Mekong Basin Plan

The Mekong Basin Development Plan (MBDP) represents a transboundary basin development plan based on the economic development of the water resources of the Mekong River. The process of developing the MBDP is being undertaken by the Mekong River Commission (MRC) on behalf of the four member countries of the MRC. The plan is strongly based on resource economics and financial analyses of investment costs and benefits. Developing the options and trade-offs inherent in the plan required extensive engagement with national developing planning committees. These committees provided the critical link between the basin development plan and the national development priorities and objectives, with the former guided by the latter. The committees also facilitated an iterative process, whereby issues emerging through the basin planning process could be fed back into national debates.

While the MBDP is not yet complete and has not yet been implemented, several notable successes have been achieved through the process. It is important to note that the successes are strongly linked to the collective net benefit achieved through the MBDP, with each country benefiting from the proposed development initiatives. Had significant national and international trade-offs emerged through the basin development planning process, it is possible that support would have been less forthcoming owing to the complexities around compensation. It is also important to note that in reality, the process of integration with the national development planning committees has been fraught, and that the iterative process has not always functioned successfully. This is in part because of individual, methodological and disciplinary differences between the stakeholders, and in part as a result of the constrained mandate of the MBDP. Despite the complexities of the realpolitik surrounding the MBDP, this process has demonstrated significant potential for river basins elsewhere in the world where international cooperation in basin planning and development will result in strong net benefits to, from, because of and beyond the river.

Source: WWF and World Bank (2010).

COMPREHENSIVE VERSUS THEMATIC BASIN PLANNING

In an increasing number of contexts internationally, river basin planning exercises are focused around the development of a comprehensive basin plan. Under these approaches, the river basin plan sets out a coherent overall strategy and objectives across the issues in the river basin. This is then translated into detailed regional, sectoral and thematic plans. Such a situation is set out in Figure 14.

Although becoming more common, such comprehensive basin planning approaches are not adopted in many water management contexts. In alternative approaches, basins are instead managed through a series of thematic or regional plans. This may be the case where there is no legislative or political requirement for the development of a comprehensive plan. Thematic rather than comprehensive planning processes may be appropriate where there are not the complex challenges that require the development of comprehensive plans, where there are many small basins in a territory, or transboundary rivers that preclude the development of comprehensive basin-wide plans. In other cases, 'river basin plans' may be developed that represent no more than a political aspiration, with important management decisions being undertaken through a parallel process of thematic planning.

Even in the absence of a comprehensive basin plan, many of the same principles and methods can apply. Even where water resources or infrastructure planning, for example, is undertaken in isolation from a broader basin planning exercise, these thematic planning exercises can still adopt many of the key principles underlying strategic basin planning, including alignment with current and future economic and development planning.

4.2 Diverse drivers for basin planning

Basin planning is undertaken for a wide range of different purposes, in response to different motivations. Every country and basin exists within a historical water resources and institutional context, which influence the rationale and nature of the basin planning process. Therefore basin plans are generally the outcome of a series of studies and negotiations, making each a unique snapshot of the basin status. For this reason, caution must be adopted in comparing basin plans with each other, or seeking to transpose the approach in one basin to other contexts.

There are a number of key differences between basin planning exercises undertaken around the world, shaping the purpose of the planning and the approaches that are adopted:

ISSUE OR OPPORTUNITY DRIVEN VERSUS LEGALLY DRIVEN

Some basin plans are produced in response to a legislative or policy requirement. For example, the South African Water Act requires the production of a catchment management strategy for each of the country's water management areas, and the EU WFD required the publication of river basin management plans across Europe by December 2009. In other cases, basin plans may be politically (or bureaucratically) motivated, in particular in response to a current or perceived future crisis. The basin planning exercises on the Rhine were examples of politically motivated basin plans that were instigated in response to water quality crises in the river. An increasing number of plans are responding to development opportunities in water-related sectors, such as hydropower responding to increasing energy process and carbon limits, or regional ecotourism development. In legislatively driven contexts, plans tend to provide a comprehensive framework to guide the activities of mandated water management institutions at different levels, with a strong focus on higher-level objectives and strategic actions for institutional cooperation, water management and monitoring. In issue-driven contexts, basin plans may be more focused on the particular crisis or issue that led to the instigation of the process, while opportunity-driven planning tends to create strong linkages with the sectors around which the opportunity may be developed.

FIRST EDITION PLANS VERSUS WELL-DEVELOPED PROCESSES

In many cases, first edition plans are able to identify priority issues, but often additional information or institutional relationships are necessary to specify clearly the solution. First-edition plans may therefore focus on actions for monitoring, assessment, cooperation and institutional development, with the expectation that future revisions of the plan will provide more concrete objectives and specific management actions. On the other hand, where there have been significant previous basin or (thematic) water management plans, there is likely to be adequate information and institutional clarity to set clear objectives and define detailed management actions. Even in the context of first edition plans, it is important to make some progress on key issues and 'quick wins' where sufficient information is available, to build credibility and prevent dissatisfaction with the process among key groups, before moving on to the harder issues.

CLEAR INSTITUTIONAL MANDATES VERSUS TRANSBOUNDARY COLLABORATIVE EFFORTS

The legal mandate of a basin plan can vary significantly, from basin plans produced within unitary political systems where an institution has the legal mandate to make binding decisions, through to plans drawn up between countries or states, where basin planning is based on collaborative agreement. In these latter cases, the basin plan itself may have little or no legal status, and be dependent on the goodwill of the participating parties. The plan may be developed to provide a framework for cooperation (and development), and be focused as much on institutional cooperation and economic development as on specific water resources management actions. In some cases, these basin plans may end up being 'paper plans', with little concrete implementation.

COMPLEX, STRESSED BASINS VERSUS BASINS WITH FEWER MULTI-PURPOSE TRADE-OFFS

The complexity and stress of the basin, and the degree to which difficult trade-offs need to be made between competing water requirements, has a profound impact on the nature of the basin plan and the associated planning process. Basin plans that require decisions to be made between competing purposes tend to require a coherent vision for the basin that reflects the priorities between the different purposes and development-environmental imperatives. This is common where water requirements for water allocation, hydropower, flood storage or environmental functioning cannot be met with the available water resources (even with further infrastructure development). On the other hand, basin plans that do not require significant trade-offs do not tend to have as greater focus on the basin vision, but rather are built around the strategic actions and outcomes related to particular issues. In such basins the challenge is typically in selecting and financing the most appropriate suite of management responses for the specific issues.

4.3 Vertical alignment within water sector planning

Coherent water planning that contributes to broader social, economic and environmental imperatives can seldom be achieved through a single document produced in isolation. Instead, water planning typically consists of a number of coherent plans on different issues and at a series of scales, located in a framework of national, basin and local water plans. In many situations, the basin plan is central to this framework, setting out key water management objectives at the river basin scale, and acting as a point of intersection for those regional plans and processes that impact on, and are impacted by, water management. However, it is important to note that there are many countries that do not produce basin plans at all, for example where water planning is split into separate thematic exercises (such as flood risk planning, water licence allocation mechanisms, water pollution standard-setting and permits) or where political boundaries in federal systems mean that no unified body exists which can undertake basin planning.

Where basin plans are produced, they should ideally sit within a tiered hierarchy of planning from the national to the local level.

- **National policy and legislative arrangements:** these provide the framework for all water planning, both substantive and procedural. This may include high-level principles and objectives, as well as detailed requirements, for example national water quality standards that must be achieved. Procedurally, national policy typically sets out the process and timing that must be followed in developing a basin plan.
- **National water strategy:** where a national water strategy is produced, this sets out the strategy to implement the national water policy, often in terms of specific goals and actions, and provides the basis on which basin plans are developed. National water strategies typically set out high-level policy objectives, provide for high-level strategic allocations, specify strategic infrastructure construction and operation, and address inter-basin transfer issues that cannot be addressed at the basin scale. This requires that the basin plan vision, objectives and actions are consistent with and give effect to the policies, strategic statements and standards that have been set at a national level.
- **River basin plan:** the basin plan should provide the high-level objectives and strategic actions for river basin management, including quantitative management objectives. It will deal with those issues that require attention at a basin scale, in particular issues around allocation of water, basin water quality objectives, high-level environmental targets, and the development and operation of major infrastructure in the basin.
- **Regional and local plans:** in larger river systems, regional water plans (provincial or local government) may implement key aspects of the basin strategy. Like the overall basin plan, these may include both strategic intentions and more detailed implementation arrangements. Because of their importance, at least the executive summary of these plans should also be seen as part of the overall basin plan.
- **Thematic and detailed plans:** these develop specific water resources strategies in more detail at a basin or sub-basin scale, and translate the strategic intent of the 'umbrella' basin plan into implementable water resources management activities. The thematic plans can include plans related to protection, development, disaster risk and institutional aspects of the basin plan. Where these exist prior to the basin plan development, aspects of these plans would usually be brought into the strategies within the basin plan.

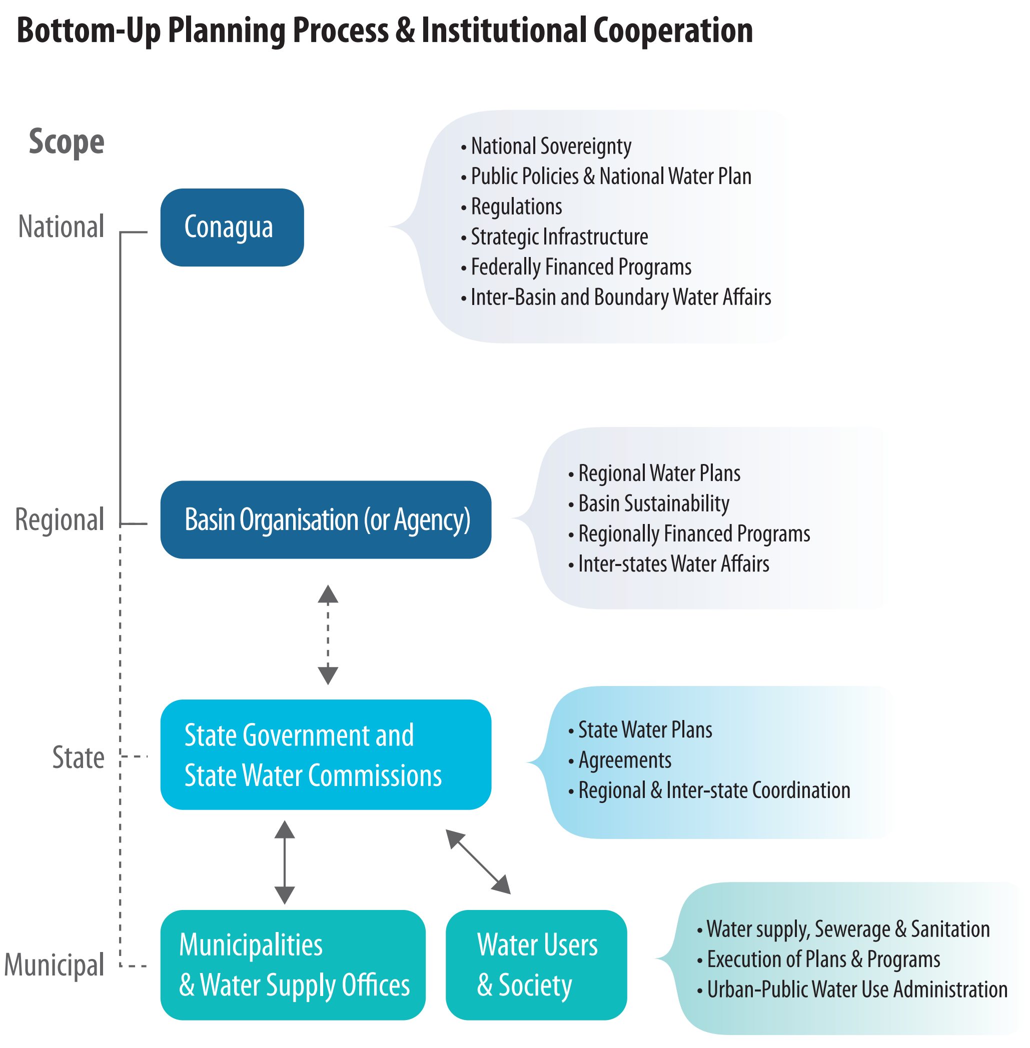
Not all of these different levels and types of plan exist in all contexts, and the relationship between plans is typically complicated by local hydrological, historical and political factors. In countries dominated by a single large river, for example the Indus in Pakistan and the Mekong in Cambodia and the Lao People's Democratic Republic, national planning and river basin planning are likely to be virtually synonymous. Equally, in countries with many small river systems such as the United Kingdom, water planning may be undertaken at a regional or national level, as it may be impractical and unnecessary to produce a separate basin plan for each individual catchment. Similarly, where there are significant inter-basin transfers of water, the boundaries between national planning and basin planning will necessarily become blurred. The reality is therefore typically more complex than a neat hierarchy of nested plans. This highlights the need for basin planning to focus on the broader strategic objectives, and to avoid being locked into a particular approach to structuring plans.

The economic and social aspects of strategic basin planning add a further complicating factor to the separation of management tiers between the national, basin and local level. Often, the economic implications of certain activities within a basin will extend beyond the boundaries of the basin itself. This may be most pronounced in the case of strategic industries which generate significant national foreign exchange earnings, or important regional or national energy generating facilities. There will be national interest in ensuring that these industries are supported, including sufficient allocation of water and the protection of strategic assets from unacceptable flood risk.

Box 21: Water planning levels in Mexico

Following the 1992 National Water Act, a tiered set of planning levels was introduced in Mexico.

According to the act, Conagua has the legal obligation to develop and carry out water resources planning. Financing for water resources management plans is given by the federal government mostly through Conagua, which introduces the process in the basin council, thus involving state governments, water users and other stakeholders in the process of preparation, development and approval of the plan. The act requires the participation of basin councils in water resources planning, so it is necessary that every plan be approved by consensus of the basin council. At the state level, there is a similar legal obligation according to the various state constitutions and the National Water Act.



Source: Le Quesne and Schreiner (2012).

NESTING WITHIN BASIN PLANS

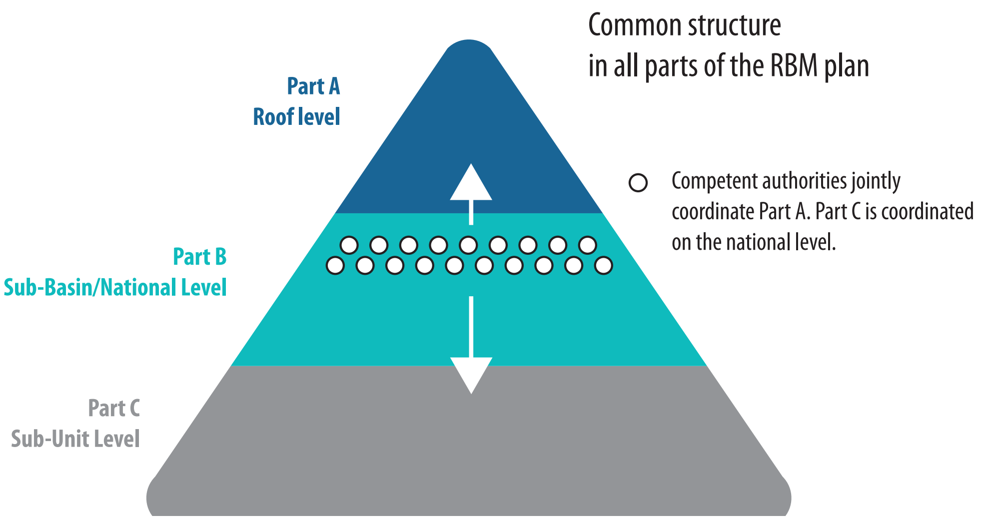
Basin planning should enable the development of a set of high-level objectives and actions for the basin that may be implemented through more detailed strategies or plans, developed on a thematic, sub-basin or regional basis. This is particularly important in large and complex basins, with multiple management issues across different catchments and administrative regions. The concept of nested plans is valuable in dealing with complexity and shared mandates, either at a thematic level (between allocation, water quality, flooding and so on) or at a geographic scale (between different catchments, provinces and so on).

In this context, basin plans may contain only overarching objectives and strategic actions. Thematic or regional plans may then be developed to provide the details of these overarching objectives. The basin plan tends to be coordinated by a national or basin-level organization, while nested plans may be developed in a more decentralized manner, with other mandated institutions such as line agencies or provinces taking the lead.

The nesting approach is distinct from those (comprehensive) planning approaches that attempt to develop a single plan that addresses all aspects of the basin plan in detail. Under a comprehensive approach, management attention is required down to the level of implementation detail across the basin. This approach can work in smaller basins, but becomes impractical or impossible in larger more complex basins. Modern basin planning can involve the development of analyses, scenarios and implementation plans running to thousands of pages and covering multiple jurisdictions and sectors. Nesting of plans makes it possible both to manage this complexity, and to engage external audiences and decision-makers around the key issues that are of relevance to them.

Box 22: Nesting in basin planning under the EU Water Framework Directive

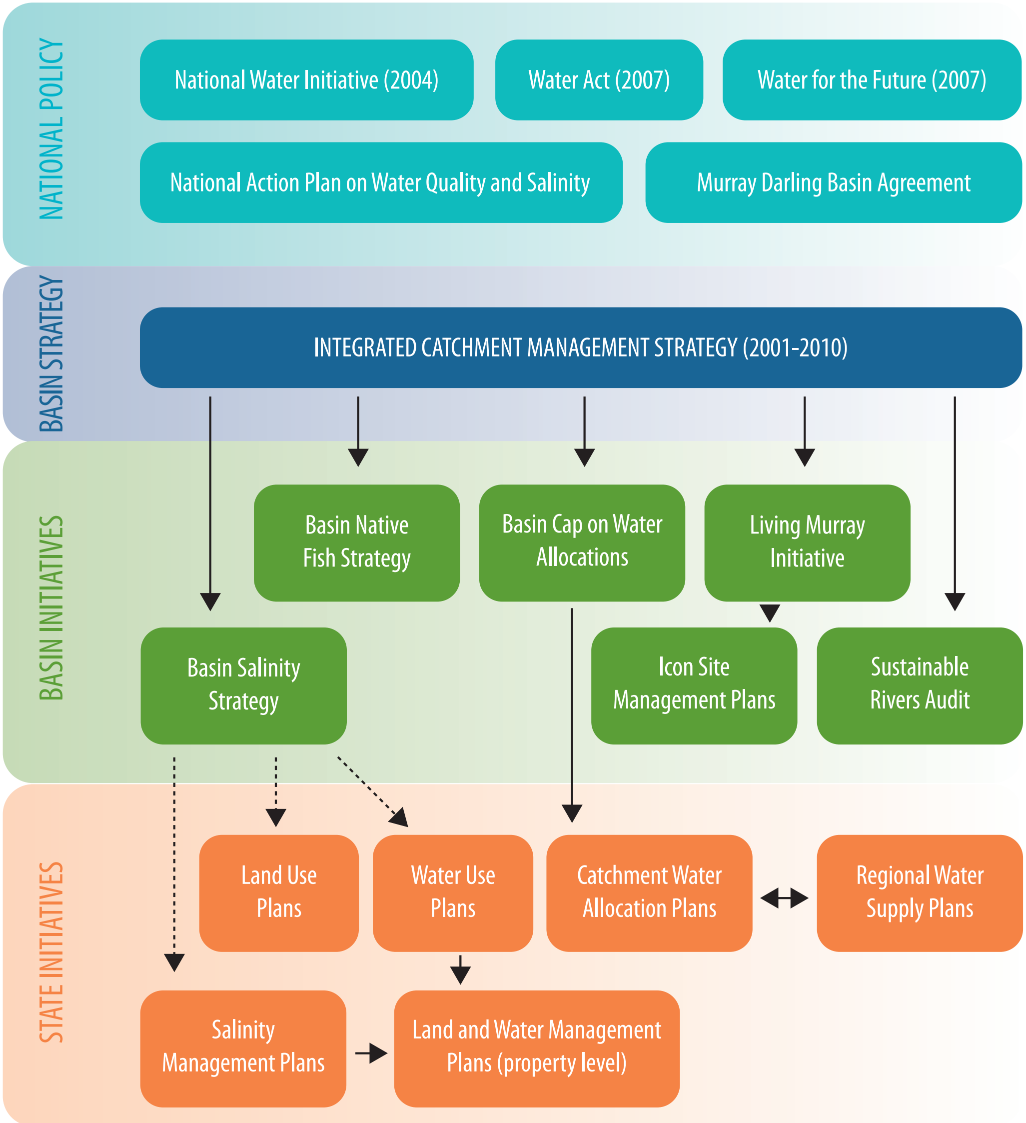
In transboundary basins the planning process outlined in the WFD is divided into three parts. Part A – or the roof level – is undertaken for each river basin by an implementing agent, Part B – the sub-basin or national level – is undertaken by 'competent authorities', while Part C – the sub-unit level – includes the detailed plans for groups of water bodies. The level of detail required by these plans increases towards the lower levels, with Part A summarizing the plans outlined in Part B, and Part B summarizing the plans in Part C. Part C is managed at a local level, coordinated with Part B at the national level. The process is intended to be driven primarily by the competent authorities at a national level, summarized upward to the roof level, and coordinated downward to the sub-unit level – but within the common framework of the WFD.



Source: ICPRD (2009*b*).

Box 23: Thematic and regional plans linked to the Murray-Darling IWRM Plan

Shown below are the various laws, policies, strategies, and plans that govern river basin management in the Murray-Darling basin. These show the situation prior to the ongoing implementation of the first whole-of-basin plan, which is in draft form at the time of writing. The new basin plan will replace the Integrated Catchment Management Strategy, and will give effect to a number of national laws, policies and initiatives. A range of local and thematic strategies and plans exist to implement the objectives set out in the basin strategy (current and future). These local and thematic strategies and plans will in some instances need to be adjusted to give effect to the binding targets that will be set by the new basin plan. For example, the basin plan will incorporate both a basin water quality and salinity management plan and an environmental watering plan. It will also set sustainable diversion limits for catchments across the basin: where necessary catchment water allocation plans will need to be amended to be consistent with these limits. A certification process exists under the Australian Water Act (2007), by which water allocation plans are assessed for consistency with the basin plan.



Source: Le Quesne and Schreiner (2012).

BASIN PLANNING IN FEDERAL AND UNITARY SYSTEMS

The role of, and relationship between, different levels of water planning depends to a very significant degree on the political system within which planning is taking place, as this influences the mandate and authority of the organizations that are responsible for producing the basin plan. This has significant implications for the role of basin planning within the overall water planning framework, and in some contexts it means that meaningful basin planning is not undertaken.

In countries with strongly federal political systems, in particular those in which legal mandates over water management are vested at a state or provincial rather than national level, there can be significant challenges to basin planning because of the lack of legal mandate that can be held by any inter-state organization or institution. This is the case in both India and the United States, where water is a 'state subject'. In these cases, not only may there not be a substantive national water strategy, there are political challenges to the production of comprehensive basin plans, as states are unwilling to hand over any meaningful power or authority to any inter-state institution.

In the context of this challenge, management of large basins in federal systems has taken a number of forms. In some countries with strong federalism, basin planning has been addressed through legally binding inter-state agreements or compacts. These approaches have been adopted, for example, in India, Pakistan, the United States and until recently Australia. These agreements result from a process of technical analysis and negotiation between the parties. The agreements typically define objectives to be achieved at the boundary (such as flow or quality levels) or define allocation between the parties. The common assumption is that the details of water resources management within each jurisdiction are not relevant to the agreement. These agreements may be indefinite or may be revised on an agreed timeframe. While these agreements or compacts imply some level of cooperation between the parties in their formulation, such approaches are a very narrow interpretation of basin planning (if they comprise it at all). In some cases, these agreements are actively used as a mechanism to avoid further basin planning or inter-state cooperation at a basin level (until the next negotiation), except in so far as monitoring of the narrow terms of the agreement is required.

Attempts to develop transboundary basin plans in international river basins face the same challenges to an even greater extent, as there are not even recognized legal structures to which the parties can appeal in the case of dispute. Indeed, many of the international customary law principles for transboundary basin management (such as the UN Water Courses Convention, Helsinki Rules and Berlin Rules) were at least partially derived from experience in federal basin management. Most transboundary basin plans take the form of inter-state agreements over boundary conditions or allocations. More substantive transboundary basin planning tends only to take place in the context of broader regional cooperation processes, for example the development of basin plans within the European Union. Transboundary basin management and planning efforts are strongly influenced by geopolitical relations between the riparian states.

Because national water management agencies can be given the mandate to develop basin plans that cross provincial boundaries, countries with unitary political systems do not have the same institutional and political challenges as federal countries. In those cases where the basin plan is to be drawn up by a basin management agency of some form, ultimate political authority to approve the basin plan typically resides at a national level. This is the case in China, South Africa and Mexico, where water management is led by national water ministries and agencies, with decentralized basin-scale management bodies responsible for developing basin plans.

Even in these cases, however, there can be major challenges as a result of provincial, regional and local government administrative boundaries. The differing mandates that provincial and regional institutions have on developmental and environmental planning can create complexities and political tensions in preparing a basin plan. In some unitary systems, sub-basin catchment areas tend to be more important than administrative boundaries in the basin planning process, while intersectoral interactions between agriculture, urban and industrial users are often the focus of allocation and water quality decisions.

Given the increasing challenges associated with basin management and the difficulties of addressing these within a federal political system, there has been a trend in recent years in a number of federal countries towards the transfer of mandates from provinces to more centralized political authorities with the authority to develop a comprehensive basin plan. This has been most clearly illustrated in the Murray-Darling system in Australia, where the main basin states vested powers to the national government to produce a binding basin plan through the 2007 Water Act. Similar trends have been evident in EU water policy, where successive European directives have imposed, first, common water quality standards across EU Member States and, with the introduction of the 2000 WFD, the requirement to produce plans at the (transboundary) basin scale. In India, the National River Ganga Basin Authority was established in 2009, with a mandate to produce an inter-state basin plan for the river, although without the substantive transfer of powers that have characterized the Australian or EU processes. At the time of writing, it remains to be seen how successful any of these attempts will prove in developing effective and binding basin plans in the context of federal or international political systems.

4.4 Horizontal alignment: water and development planning

As pressures on water resources increase, so water is becoming increasingly important across a range of development priorities. Water is being recognized by governments as an important catalyst of social development, a critical potential constraint on economic growth and a basic building block of environmental sustainability. Alignment between water planning and broader development planning is therefore crucial for effective basin planning.

Traditional water resources planning tends to treat this as a one-way process, in which water planners attempt to support or achieve the objectives of existing development and environmental plans. However, in an increasingly water-stressed environment, there are inherent trade-offs that must be made between different uses of water: it is typically no longer possible for water planners to meet all demands being made on the river. This has resulted in an important change in the nature of the alignment between water planning and development planning. Water planning now plays an important role in shaping development and environmental outcomes. Strategic basin planning therefore aspires to be a two-way process in which water planning is harmonized with other planning initiatives. This requires a dialogue between water planners and economic and environmental planners and policy-makers, particularly where there are parallel planning processes being carried out in these other sectors.

This change in emphasis has led to recognition that basin planning needs to actively engage with national, provincial and local development policies and strategies, to ensure that:

- basin planning supports the achievement of national, provincial and local development priorities
- the approaches and strategies that are adopted as part of the basin planning process reflect the broader political economy of the country and region
- national, provincial and municipal development planning (and associated resource allocation) aligns with the opportunities and constraints of water to support a country's development.

These objectives highlight the interrelated nature of water resources planning and socio-economic development and environmental planning. The need for water planning to engage with broader development planning processes has been identified as the need for water planning to move 'outside the water box' and engage with broader political decision-making.

In this context, the following planning processes have the most significant relationship to basin planning:

- Economic, social and infrastructure development planning, particularly for trade, industry, energy, agriculture, transport and water supply.
- Spatial development and land use planning (rural, urban and development nodes) at various levels ranging from national through provincial to district and local. This may be particularly important for flood risk management, where development and land use planning are key aspects of reducing flood risk. It will also be important to ensure that major development is not being planning in locations where water is unavailable.
- Environmental planning to ensure sustainability of natural resource use and protection of important biodiversity. This can include identification and alignment of important protected areas, as well as land use planning where this impacts on water quality and run-off, for example as a consequence of deforestation and land conversation.
- Financial planning, particularly in terms of the budget/resource allocation between sectors by the treasury or planning commissions to support development programmes.

In addition to alignment with government development planning, water planning is also increasingly required to consider the plans and priorities of the private sector. This follows the recognition by many major global corporations that inadequate water management poses direct risks to their operations or supply chains. Many large companies are becoming more efficient in their production, are driving efficiencies in supply chains, and are beginning to engage basin managers, local government and communities to minimize the risk associated with water at a local and catchment scale. This is likely to be particularly significant where there are major private or state-owned enterprises within a basin that are particularly dependent on significant water resources, for example in the mining or energy-generating sectors.

While achieving this two-way alignment between water and development planning is central to the strategic basin planning process, it poses significant challenges. First, it requires basin planning processes to develop a sophisticated understanding of development plans and their implications. This is particularly important for those sectors that have control over land use patterns and land utilization, as these have dramatic impacts on the hydrology and water quality of the receiving water resources.

Second, and perhaps more challenging, it requires economic and development planners to devote attention to the basin planning processes. These alignment challenges are compounded by the typical silo-based approach through which financial, infrastructural and human resources are allocated and business planning is conducted in each sector.

Third, governments typically conduct development planning according to administrative boundaries, such as provinces and municipalities. Rivers, however, seldom align with administrative boundaries; as a consequence, basin planning may require engagement with a complex set of development, social, economic and environmental priorities across a range of jurisdictions. This highlights the importance of institutional cooperation by water managers with other government departments, and institutions at a range of levels.

Box 24: Integrating water into development planning: the Zambian experience

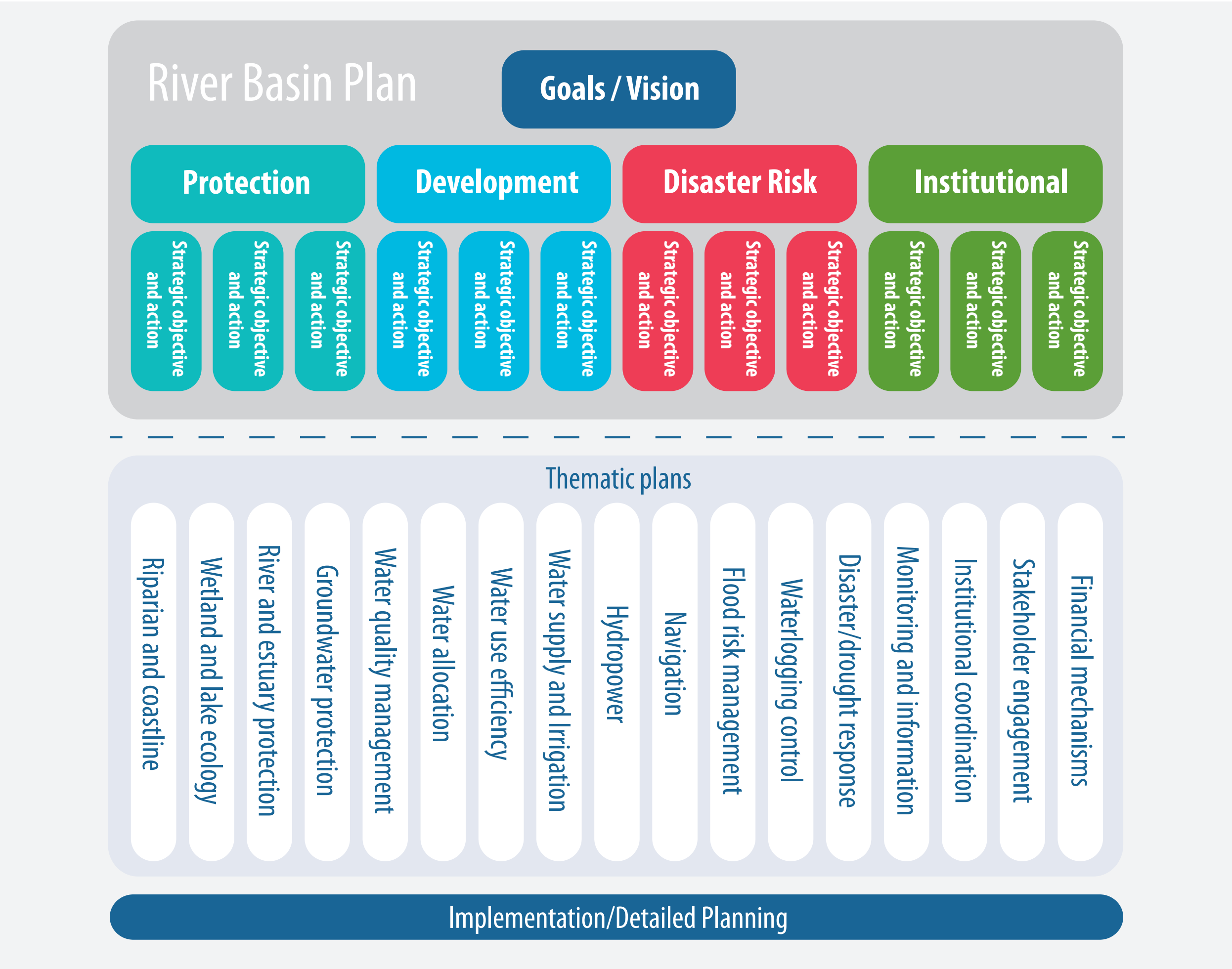
Zambia has made strong progress over the past fifteen years through the economic and administrative reforms that have underpinned strong economic growth. However, this growth, together a changing and variable climate and relatively limited water resources infrastructure, has resulted in increased competition for scarce water and the emergence of trade-offs in allocations, particularly between hydropower and agriculture. It therefore became clear that water was a critical factor of production in Zambia, and a potential constraint on continued growth and development in the Zambian economy. Against this backdrop, the Zambian IWRM plan was initiated as a truly cross-sectoral and interdisciplinary plan that was based on the role of water in the Zambian economy. The planning process established the Water Sector Advisory Group, with representation from the key economic and development planning and finance ministries in the government. The IWRM process led subsequently to the extensive involvement of the water sector in the development of the Fifth National Development Plan (2006–2010) and recently the Sixth National Development Plan (2011–2016). Climate change and adaptation issues have also been introduced into the National Development Plan, as a cross-cutting issue imposing significant risks on Zambian development through the water sector. The Zambian planning processes demonstrated the centrality of water to the Zambian economy, which is heavily dependent on hydropower, agriculture and mining, and highlighted the importance of a diverse process orchestrated by a champion (the Zambia Water Partnership in this case).

Source: SADC/ZRA (2008).

CHAPTER 5
CONTENT AND STRUCTURE OF A BASIN PLAN

This chapter sets out the overall structure and contents of a basin plan. While the nature of basin plans differs from one situation to another, depending on the context and purpose of the basin plan, there are typically a number of similarities between the overall structure of basin plans. Figure 16 presents a very high-level structure of a basin plan and its links to the thematic plans that support and align with it.

Figure 16: Interface between the elements of the basin plan and supporting thematic plans



In addition to the overarching goals and vision, basin plans (and their substrategies) tend to be built around the management of four broad areas: protection, development, disaster risk and institutional aspects. These may reflect or be unpacked into the separate thematic plans for the basin that jointly give effect to the basin plan.

It is also critical to understand that while the content of the final basin plan may seem coherent and structured, the process of developing that plan is likely to have been inherently chaotic and iterative. Therefore, while the basin plan document may seem to reflect a defined process, the structure and content of the plan should not be confused with the process.

5.1 Generic structure of a basin plan

Basin planning needs both to set high-level goals, and to provide the more detailed objectives and implementation plans that enable these goals to be turned into action. Water management in a basin is not typically set out in a single document, but instead through a series of strategies and plans. The basin plan provides the synthesis that sets out the overall objectives and ensures coherence across basin management. These different parts may be progressively developed over time and may be revised at different times, following the concept that basin planning is an ongoing, iterative and adaptive process.

Basin plans from different countries tend to have a number of core elements, even though these may be structured in different ways to reflect the varying hydrological, economic and institutional contexts. Figure 17 indicates the typical elements of a basin plan.

The key elements are:

- A basin description is usually included within a basin plan to provide information on the past, current and future situation (hydro-ecological, socio-economic and legal-institutional).
- The intent of the basin plan is provided by the basin vision, which encapsulates the vision statements, principles and goals outlining the desired future state for the basin to achieve broader social, economic and environmental priorities.
- The basin strategy outlines the way in the basin vision will be delivered through time-based objectives and strategic actions, and thus provides a synthesis of all the plans that have been or will be developed to manage the basin.
- These higher-level strategic objectives and actions are usually expanded upon in an implementation plan which provides a coherent set of priority actions, milestones, responsibilities and possibly resources to roll out the basin plan, together with an indication of the required institutional arrangements, financing possibilities, monitoring systems and review process to implement the plan.

Figure 17: Generic structure of a river basin plan

In this book, thematic plans – such as those dealing with issues like water allocation, water resources protection, flood risk management, and hydropower – are considered separate from the basin plan. Those plans do of course play a critical role in supporting the basin plan. Thematic plans and their relationship to the basin plan are discussed in detail in Chapter 13.

5.2 From vision to strategic action

Within management science, normative, strategic and operational planning are recognized as distinct planning levels, which translate values and aspirations into concrete action and responsibilities. These levels of management are typically present in river basin planning, resulting in a series of nested statements of intent which together are the means by which basin plans are developed and implemented.

- Visioning (normative planning): to develop a vision or desired state for the long-term future (typically between 20 and 100 years), together with guiding principles to which the plans and strategies must aspire, but that aligns with desired states in other sectors.
- Strategic planning: to develop a broad coherent medium-term set of priorities, objectives, strategic actions and the institutional arrangements (typically for five to ten years), that contribute towards achieving the vision under different possible future conditions and available capacity.
- Operational planning: to develop a short to medium-term (typically three to seven years) suite of plans that incrementally achieve the strategy, including short-term management targets, milestones, institutional responsibilities and resources. This may include:
    - Business planning: to identify the short-term (three to five year) plans, with programmes and budgets for each institution responsible for an aspect of the operational plans.
    - Programme planning: to identify the suite of projects (lasting two to five years) required to achieve a specific objective identified in the operational or business planning domain.
    - Project planning: to identify the tasks and activities required to implement a specific project (lasting from six months to seven years) required to achieve an outcome in the programme, business or operational planning domain.

These plans represent a nested process of basin planning that moves from long-term goals to immediate actions and resource allocations.

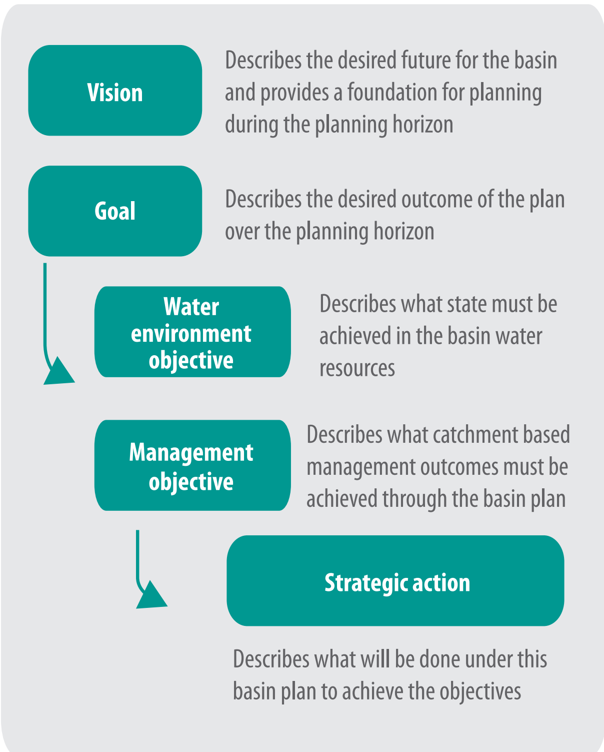
At a high level, basin visions tend to be developed around one or more of the following water resources management priorities:

- environmental state of the water resources in providing goods and services
- social and economic outcomes related to water use, land use or catchment areas
- human, property or ecological risks of flooding and other disasters
- institutional intent for cooperation, collaboration and stewardship.

To be implemented, these normative vision statements need to be translated into specific measurable strategic objectives and actions that are achievable with the available resources in a given time frame. This 'basin strategy' is the heart of the basin plan, and requires an iterative strategic planning process of assessment, evaluation and selection, described in the next chapter.

Figure 18 shows how the hierarchy of vision, objectives and actions form the core of the basin plan, together with the role they play in the basin plan.

Figure 18: Hierarchy of basin vision, goal, objectives and actions



While not all plans have all of these elements, they typically have a longer-term vision or goal, translated into some shorter-term objectives, which provides the basis for a number of strategic actions. There is often a blurring between the definition of goals and objectives, as well as between the definition of objectives and measures to achieve the vision. Furthermore, objectives and measures tend to vary between the different parts of the basin, reflecting the needs and ability to implement them, while the vision tends to refer to the entire basin.

5.3 Water environment and management objectives

While the vision and goals of a basin plan can be qualitative and aspirational, the objectives set out the specific – ideally quantitative – objectives that the basin plan will seek to achieve. These can broadly be divided into two groups of objectives: water environment objectives, which relate to the condition or state of the water resources, water environment or river; and, management objectives, which relate to activities by water users and activities that impact on water resources or the water environment.

WATER ENVIRONMENT OBJECTIVES

Water resources related objectives are based on the environmental function of the river system, and typically focus on ecological flow requirements, water quality, habitat, connectivity, biota (species), flood peak limits and/or navigability. Water quality, connectivity and habitat objectives are typically defined in terms of the requirements of ecosystem functioning and downstream users (fitness for use). In some cases, water quality objectives are specified as threshold concentration levels (usually based on water quality guidelines or standards). However, they are often more meaningfully defined as broad statements (or goals) that may be then be set as instream concentrations, translated into pollutant loading targets and specified as management objectives. Similarly flood risk management objectives may be defined in terms of acceptable risk or inundation, possibly set against a reference date or value. In some cases, the current understanding of the system is not adequate to define water resources targets, and in this case a broad qualitative objective may be defined, linked to an activity to develop criteria or targets.

Water environment objectives may also be defined as a measurable outcome, rather than a numerical target level or threshold. For example, the objective might be that a river be fit for swimming and other forms of human contact, without setting a specific water quality objective. It is important to recognize that there is a trade-off in the level of detail and specificity appropriate in setting objectives. While it is important for the objectives to be measurable, defining numerical objectives that are too specific or detailed complicates the basin plan and reduces the flexibility. It may be more appropriate for this level of detail to be incorporated in thematic plans (allocation, water quality and so on) developed under the auspices of the basin plan.

The vision statements (goals) and water environment objectives provide the greatest opportunity for planning alignment between the various thematic elements of the basin plan. It is therefore critical that the interrelationships between the objectives are considered, such as the impact of reduced flow on water quality or habitat.

Box 25: Water resources targets for Rhine Basin 2020

Through many basin planning cycles, much information has been gathered about the Rhine River, thus allowing for specific water resources targets to be set.

Water quality

- Water quality must be such that the production of drinking water is possible only using simple near nature treatment procedures.
- The water constituents or their interaction must not have any adverse effect on the biocoenosis of plants, animals or microorganisms.
- Fish caught in the Rhine, mussels and crayfish must be fit for human consumption.
- It must be possible to bathe in suitable places along the Rhine.
- It must be ensured that the disposal of dredged material does not have any adverse impact on the environment.

Flood risk

- In the lowlands of the Rhine risks of flood damage must be reduced by 25 per cent by 2020 (compared with 1995).
- Downstream the impounded section of the Upper Rhine (downstream of Baden-Baden) extreme flood peaks must be reduced by up to 70 cm (compared with 1995).

Source: ICPR (2001).

Box 26: Habitat objectives in the Delaware River basin plan

The Water Resources Plan for the Delaware River Basin outlines a process of moving from result area, sequencing down to goals, and finally forming objectives based on the current level of available information. This is illustrated by the example below which starts at a desired result for waterway management and then forms a set of goals to achieve that result, one of which is focused on ecosystem protection. Objectives, such as habitat conservation, are then identified to reach the goal.

> Desired result: Waterway corridors that function to minimize flood- induced loss of life, protect property and floodplain ecology, preserve natural stream channel stability, provide recreational access, and support healthy aquatic and riparian ecosystems.
>
> GOAL 2.3: Protect, conserve and restore healthy and biologically diverse riparian and aquatic ecosystems.
>
> Objective 2.3A: Implement conservation plans for populations, assemblages and communities of indigenous aquatic and terrestrial plants and animals.

The current information is too limited for the setting of quantified targets, but timeframes are specified to develop and implement these.

Source: DRBC (2004).

Box 27: Environmental flow objectives (as percentage MAR requirement) for the Breede River

In the Breede River, numerical estimates of instream flow requirements are calculated as a percentage of mean annual runoff (MAR). Figures for different river reaches are shown in the table below.

Node	River	Recommended ecological category	Natural mean annual runoff (Million m^3)	Reserve: Eflow (Million m^3)	Environmental flow as % MAR
	Mountain streams	B	-	-	45%–50%
Nviii1	Upper Breede	D	469	117	25%
	Central Breede tributaries	D	-	-	10%–20%
Nvii8	Central Breede	C/D	1082	415	38%
Ni2	Breede u/s ROE	C	1188	314	26%
Ni3	Riviersonderend	D	450	111	25%
Nv2	Breede d/s ROE	C	1817	480	26%
Nv13	Buffeljags	C	88	31	35%
Niii4	Breede u/s estuary	B/C	1842	671	36%
Niii5	Breede Estuary	B	1785	954	53%

Source: BOCMA (2011).

MANAGEMENT OBJECTIVES

While water environment objectives represent the targets implementing actions need to achieve, management objectives specify the thresholds or outcomes related to water use, waste discharge, land use, flood risk or infrastructure management that are needed to achieve the vision or water resource objectives.

Like vision statements or goals, management objectives are often descriptive (to prevent too much detail and complexity) and may imply outcomes to be achieved rather than thresholds that must be met.

Numerical management objectives may also be specified, usually differentiating objectives for different areas (or catchments) within the basin. The determination of these quantitative management objectives is usually done through a technical analysis relating instream water resource objectives to the catchment objectives.

Box 29: Vision and objectives for hazardous substances in the Danube River basin

The objectives for the Danube River Basin Plan include both water environment objectives ('reduction of the total amount of hazardous substances entering the Danube and its tributaries consistent with the achievement of good chemical status by 2015') and management objectives ('Implementation of Best Available Techniques and Best Environmental Practices including the further improvement of treatment efficiency, treatment level and/or substitution').

The ICPDR's vision for hazardous pollution is to ensure that human health and the aquatic ecosystem of the waters of the Danube River Basin and those of the Black Sea are not threatened by hazardous substances.

As a steps towards the vision, the implementation of the following management objectives is foreseen by 2015:

EU Member States, Accession Country and Non-EU MS:

- Elimination/reduction of the total amount of hazardous substances entering the Danube and its tributaries to levels consistent with the achievement of the good chemical status by 2015.
- Implementation of Best Available Techniques and Best Environmental Practices including the further improvement of treatment efficiency, treatment level and/or substitution.

In addition, for EU Member States

- Implementation of the Integrated Pollution Prevention Control Directive (96/61/EC), which also relates to the Dangerous Substances Directive 76/464/EEC.

Source: ICPDR (2009b).

Box 28: Salmon (biotic) objectives as Rhine Basin 2020

Objectives regarding salmon populations form part of the Rhine 2020 Program on the Sustainable Development of the Rhine. The vision puts forth specific, measurable objectives that are based on years of data gathering and careful monitoring:

- several thousands (7000 to 21,000) of salmon in the Rhine
- free upstream migration for salmon as far as Basel
- salmon stocking is self-sustaining
- wild salmon in the Rhine in 2020.

Source: ICPR (2012).

Box 30: Environmental water requirements and sustainable diversion limits in the Murray-Darling basin

The draft basin plan for the Murray-Darling basin proposes surface and groundwater diversion limits, known as sustainable diversion limits (SDLs), for catchments across the basin. These limits have been identified following detailed technical assessments, including environmental flow studies to assess the flows and flow regime required to sustain the basin's 'key environmental assets' and 'key ecosystem functions'. The range of SDLs, as currently proposed, will require significant reductions in abstraction required at a regional catchment level to provide the additional water required to meet environmental flows. Examples of these catchment- and aquifer-level water resources objectives are shown in the table below. This table shows the SDL for three different groundwater regions. The long-term SDL is shown in column 4. This is contrasted with existing levels of take – the baseline diversion limit (BDL) – which is shown in column 3. Where the long-term SDL is less than the BDL, this will require a reduction in water abstractions.

	Column 1	Column 2	Column 3	Column 4
Item	Groundwater SDL resource unit (code)	Groundwater covered by groundwater SDL resource unit	BDL for the SDL resource unit in gigalitres (GL) per year	Long-term average sustainable diversion limit for SDL resource unit in GL per year
89	Upper Condamine Basalts (GS68)	All groundwater in aquifers above the Great Artesian Basin	79.0	79.0
90	Upper Condamine alluvium (Central Condamine Alluvium) (GS67a)	All groundwater in aquifers above the Great Artesian Basin	81.4	46.0
91	Upper Condamine alluvium (Tributaries) (GS67b)	All groundwater in aquifers above the Great Artesian Basin	45.5	40.5

Source: MDBA (2011).

5.4 Strategic actions

Objectives by themselves do not provide for basin management, but require actions with assigned responsibility. The most important aspect of the basin plan is that there is a logical flow from the basin vision, through the objectives to the actions, and that this facilitates coherence between actions related to different thematic areas. As with all things in basin planning, this implies a great deal of iteration between setting preliminary objectives, testing them against possible actions and then revising them, if necessary.

Typically, the actions specified in a basin plan are defined at a relatively high strategic level, with detailed activities set out in thematic and regional plans. In some cases, this may be synthesized to a handful of broad strategic actions which together achieve the vision and objectives.

In other cases, quite specific actions may be defined with targets and milestones to achieve specific objectives. These may provide quantitative targets to be achieved, or may be more qualitative. In some cases, linkages to other related legislation or strategies may be explicit.

Measures and actions tend to include a range of technical, institutional and economic instruments that jointly contribute to achieving the objective. They may also be quite detailed, and in some cases have subactions to further clarify the action.

The definition of an action or measure to achieve one goal or objective may explicitly refer to another goal or objective to which it contributes, recognizing the inter-connected nature of water resources management functions. This is more desirable that duplicating the same action against different objectives. All of this information may be combined into an implementation plan for the basin plan.

Box 31: Vision, objectives and actions for the Yellow River

The problems of the Yellow River basin are unique and complicated, such as the relationship between water and sediment (with very high sediment loads), acute conflict between water supply and demand, and a fragile eco-environment. The vision for the Yellow River is to maintain a healthy Yellow River and seek the long-term safety of the Yellow River, so as to support sustainable social and economic development in the Yellow River basin.

This is to be achieved through the following objectives:

- Control and manage floods effectively and scientifically, and establish a flood control and sediment mitigation system in the lower Yellow River.
- Realize effective deployment and utilization of water resources, to meet the water demands for social and economic development.
- Improve the riparian ecosystem and ensure basic ecological water requirements, so as to realize the water quality objectives of the water functional zones.
- Consolidate water and soil conservation initiatives, and improve the monitoring network for water and soil conservation.
- Improve the institutional and operational mechanisms that coordinate river basin management and regional management.

In order to promote the sound development of river ecological health, the following measures have been established:

- Manage floods scientifically through joint operation of reservoir groups.
- Retain the sediment dynamics by using the deposition capacity of major reservoirs so as to reduce river deposition.
- Conduct rational allocation and optimal regulation of water resources, and adopt comprehensive treatment and management measures for water and soil conservation, such as the construction of silt-retention dam and primary farmland, plantation of vegetation, and small-sized water soil and conservation projects.
- Introduce water-saving measures, increase water supply capacity by seeking more water sources, carry out the most strict water resources management and improve water use efficiency.
- Reinforce the water functional zone management by controlling total pollutant inputs to the river, fulfilling measures for prevention and treatment of regional water pollution, and strengthening the treatment and management of water pollution.
- Improve institutional capacity, and establish and improve laws and regulations to strengthen the management capacity.

Source: GIWP.

Box 32: Target and measures for ecosystem improvement in the Rhine

The long history of basin planning for the Rhine allows for specific actions and targets to be set for the Rhine. The target (or objective) for ecosystem improvement is:

The former network of habitats typical of the Rhine (habitat connectivity) and the ecological patency (up- and downstream migration) of the Rhine from Lake Constance to the North Sea as well as the patency of the tributaries figuring in the Program on Migratory Fish must be restored.

Some of the measures identified to achieve this are:

- Reactivate at least 20 km^2 of inundation area along the Rhine by 2005 and 160 km^2 by 2020, preferably by relocating dikes, that is by permitting natural flooding and dynamic processes typical of the alluvial areas, such as erosion and filling-up by sedimentation.
- Enhance extensive agricultural use of the alluvial areas and draft development plans for a sustainable use of the alluvial areas, for example those defined according to the Habitats Directive and the Birds Directive.
- Restore the links of at least twenty-five oxbow-lakes and lateral water bodies with the Rhine River dynamics by 2005 and of 100 by 2020 and restore the formerly existing hydraulic and biological links between the river and its alluvial area in order to promote the development of biocoenosis adapted to these living conditions.
- Increase the structural diversity of at least 400 km of suitable river banks of the Rhine by 2005 and of 800 km by 2020, taking account of security aspects for both navigation and individuals.

Source: ICPR (2001).

Box 33: Objectives and related actions for water use efficiency in the California Water Plan

California's objective regarding water use efficiency is:

- Use water more efficiently with significantly greater water conservation, recycling and reuse to help meet future water demands and adapt to climate change.

An indication of the related actions illustrates the range of mechanisms:

- DWR will work cooperatively with the California Urban Water Conservation Council to establish a task force that will identify best management practices to assist the commercial, industrial and institutional sector in meeting the water conservation goal.
- ... and other agencies to implement strategies to increase regional water supply self-sufficiency and achieve a statewide 20 per cent reduction in per capita urban water use by 2020.
- Effective January 2009, all terms of water management loans and grants to urban water supplier administered by DWR, the State Boards and California Bay Delta Authority is conditioned on implementation of the water demand management measures described in Urban Water Management Plans.
- State government should authorize and fund new incentive-based programs to promote the widespread and mainstream adoption of substantial and aggressive water conservation, recycling and reuse, and related water use and reuse monitoring programs, by urban and agricultural water systems and their users.

Source: State of California (2009).

Box 34: Objectives, actions, outcomes and linkages for implementation in the Delaware basin plan

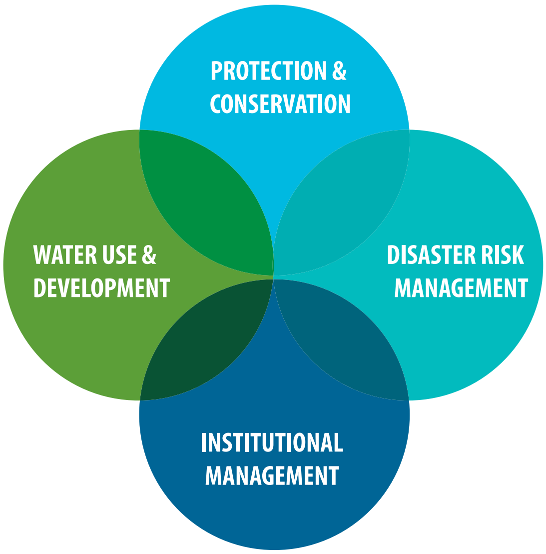
The Water Resources Plan for the Delaware River Basin shows how an objective contributes to reaching multiple goals, illustrating the linkages between various aspects of water resources management. Additionally, it sets out timelines for completing individual steps of the objective and defines the ultimate outcome desired. As the first plan of its kind for the basin, many objectives focus on gathering information required to make decisions.

Source: DRBC (2004).

5.5 Basin planning systems

The vision and objectives of a basin plan are typically very high level, cross-cutting outcomes. Implementation of these outcomes will require actions across a range of different areas which ultimately need to be set out in detailed thematic or regional implementation plans. In order to develop a link between the high-level objectives and the detailed thematic plans, most basin plans prioritize a limited number (typically between three and ten) of key issues around which to formulate the strategic objectives and actions. However, these can be grouped into distinct, but interconnected systems for basin planning, each with its own focus and logic (Figure 19).

Figure 19: Four strategic systems of basin planning



PROTECTION AND CONSERVATION SYSTEM

This area of planning is focused on the hydro-ecological system of the water resources and natural assets, particularly around the protection of the aquatic ecosystem health, water resource functioning in providing goods and services, fitness for use of quality for abstraction or instream activities. Specific plans and issues may include:

- environmental flow/regulation
- river coastline and riparian zone protection, utilization and rehabilitation
- water quality management
- wetland, lake and estuary protection
- fisheries management
- catchment protection and soil conservation.

WATER USE AND DEVELOPMENT SYSTEM

This area of planning is focused on the water resources infrastructure and water use systems, particularly around the abstraction, storage or regulation of the basin water resources for economic production or social development. Specific plans and issues may include:

- water allocation
- water use authorization, control and enforcement
- water conservation and demand management (efficiency)
- water resources supply infrastructure
- water resources demand management
- agricultural or urban supply and distribution schemes
- hydropower infrastructure
- navigation.

DISASTER RISK MANAGEMENT SYSTEM

This area of planning is focused on the impacts of extreme or unplanned events, particularly around the mitigation and management of public safety and property risks associated with flooding and unexpected disasters. Specific plans and issues may include:

- flood mapping
- flood risk management
- waterlogging and drainage control
- extreme drought event management
- pollution incidents.

INSTITUTIONAL MANAGEMENT SYSTEM

This includes the plans that provide the supporting cooperative arrangements and requirements for implementing the water management related strategies:

- institutional development and capacity building
- stakeholder engagement, awareness and communication
- information and monitoring
- economic instruments.

It is important to recognize that these four strategic systems span sectors and disciplines, with different legal, institutional and capacity implications. These systems are purely a means of strategically framing the many different elements of the basin plan, rather than being a detailed framework for implementation.

Not all of these systems may be adopted in all basin plans, depending on the nature of the specific challenges and priorities in the basin. However, where a system is not explicitly referenced, aspects of this system will be included on another grouping.

On the other hand, these systems may be further disaggregated in some basin plans, in order to highlight a particular issue which has arisen through the basin vision.

Box 35: The four planning systems in the Yangtze Basin Plan

The Yangtze Basin Plan is built around the four systems:

- The **flood control and disaster reduction** system includes flood control, drainage of waterlogging and harnessing the river channel of the middle and lower reaches of the main stream.
- The **comprehensive utilization** system of water resources includes water supply, irrigation, electricity generation, interbasin water transfers and shipping.
- The **protection** system of water resources and water ecological environment includes water resources protection, aquatic ecosystem protection and rehabilitation, water and soil conservation, and schistosomiasis prevention.
- The **comprehensive management** system includes improvement of laws and rules, enforcement and surveillance, strengthening water administration, and institutional arrangements between basin and regional administrations.

Source: GIWP.

Box 36: Three strategic areas of the Breede catchment management strategy

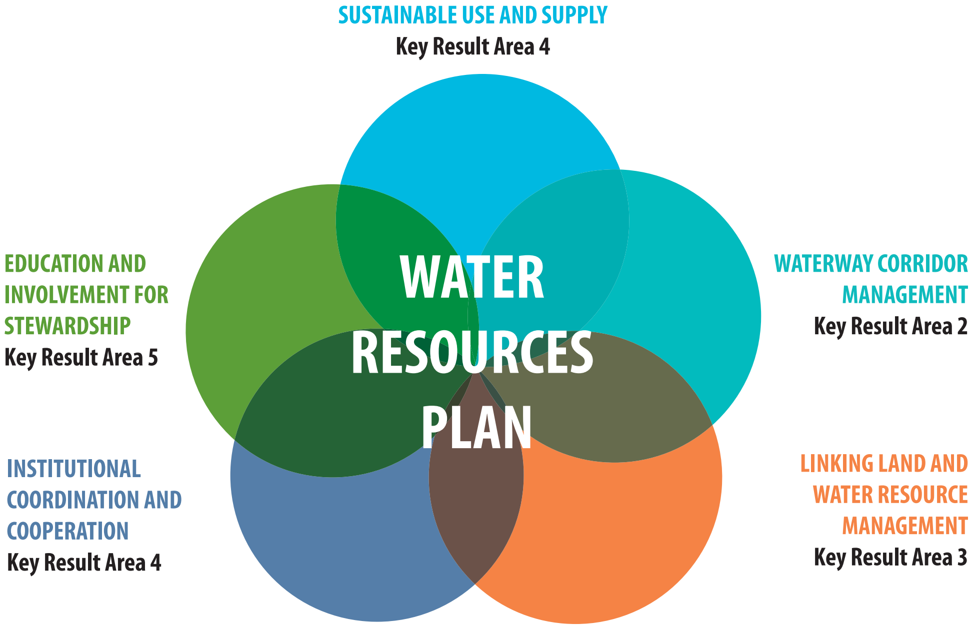
The three strategic areas for the Breede-Overberg catchment management strategy represent individual parts of an overarching vision for 'Quality water for all forever'. These three strategic areas reflect aspects of the four systems typically included in a basin plan. 'Protecting for people and nature' relates to protection and conservation, 'Sharing for equity and development' relates to water use and development, and 'Cooperating for compliance and resilience' most closely relates to institutional management. However, many overlaps and linkages exist between systems, with particularly institutional management and the relevant aspects of disaster management being present in all strategic areas.

These strategic areas serve as a bridge between a very broad vision, and more concrete measures, objectives and actions which will ultimately contribute towards achieving the vision.

Source: BOCMA (2011).

Box 37: Five result areas for the Delaware basin plan

As the first umbrella plan to coordinate between states and a large number of institutional stakeholders for the basin, the *Water Resources Plan for the Delaware River Basin* (DRBC, 2004) focuses on creating a framework for cooperation and presenting a unifying vision which was developed through the involvement of a wide range of stakeholders.



The document identifies five key result areas, each with a desired outcome statement and a set of goals and objectives essential to achieving the desired result. The key result areas emerged from a process of engaging a wide range of stakeholders to form a unifying vision to guide policy and action.

Although unique in some respects, the figure above illustrates the interrelated nature of the areas and emphasizes the importance of addressing each area to improve water resources management. Key Result Area 1 relates to water use and development, Key Result Areas 2 and 3 relate to protection and conservation, while Key Result Areas 4 and 5 are institutional management.

- **Supply** – Managing both the quantity and quality of the basin's waters for sustainable use.
- **Waterways** – Managing the system of waterway corridors to reduce flood losses, improve recreational experiences, and to protect, conserve and restore riparian and aquatic ecosystems.
- **Land management** – Integrating water resource management considerations into land use planning and growth management while recognizing the social and economic needs of communities.
- **Cooperation** – Strengthening partnerships for the management of water resources among all levels of government, the private sector, and individuals sharing an interest in sustainable water resources management.
- **Stewardship** – Providing opportunities to enhance appreciation and commitment to the protection, improvement and restoration of the basin's water resources.

Source: DRBC (2004).

CHAPTER 6
PROCESS OF DEVELOPING A BASIN PLAN

6.1 Basin planning as an ongoing iterative process

Basin planning is an inherently chaotic, iterative and adaptive process. This is largely because of the complexity, changing conditions, limited understanding and uneven management that are typical in most basins. While this means that the entire process cannot be mapped out in the beginning, a coherent procedure and method for iteratively screening information and focusing planning attention is required to guide the process.

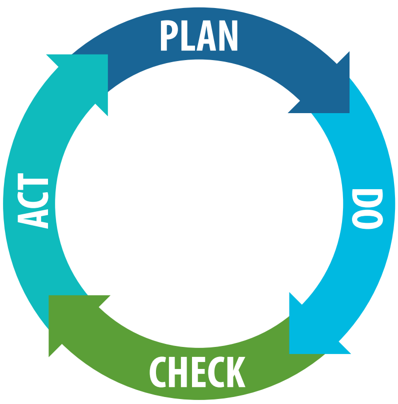
There is no single template or blueprint for basin planning, but rather some common procedural principles and lessons that have been learned over the past half-century. This chapter sets out the steps of a generic basin planning process against which techniques for basin planning can be outlined.

Effective management requires knowledge of the system to be managed and actions to be taken to achieve desirable outcomes. Planning represents the process of deciding on goals to be achieved and actions to be taken in getting there. The planning process typically poses four fundamental questions:

- Where are we now?
- Where do we want to be?
- How will we get there?
- How will we know that we are getting there?

There are a number of models outlining the planning process, but all have the same basic elements of planning (plan), implementing (do), monitoring (check) and reviewing (act). While this cycle was originally developed for business process quality improvement, the basic approach is just as applicable to river basin planning.

Figure 20: The planning process cycle



The final stage involves assessment of what to do next, based on what has been achieved. This may lead to a revision of the understanding of the problem, a modification of the activities to address the problem, or moving onto a new problem as the previous one has been addressed. This is the basis of the adaptive management process, in which planning is a continuous and ongoing part of the management cycle.

Traditional water resources planning focuses on hydrological, water quality and/or system analysis, followed by engineering feasibility studies. The planning process is well understood and can be captured in a project plan (for instance, a Gantt chart) detailing the activities and deliverables of the planning process.

Strategic basin planning however requires a process that is more flexible, in order to enable the process to reflect and adapt to the changes in understanding and priorities of the basin's environmental, water resources, socio-economic and institutional systems. The planning process tends to be iterative, explorative and outcome oriented, but is less well suited to traditional project planning approaches. This is important to reduce the risk that detailed analysis of all issues drains resources, obscures understanding and paralyzes decision-making.

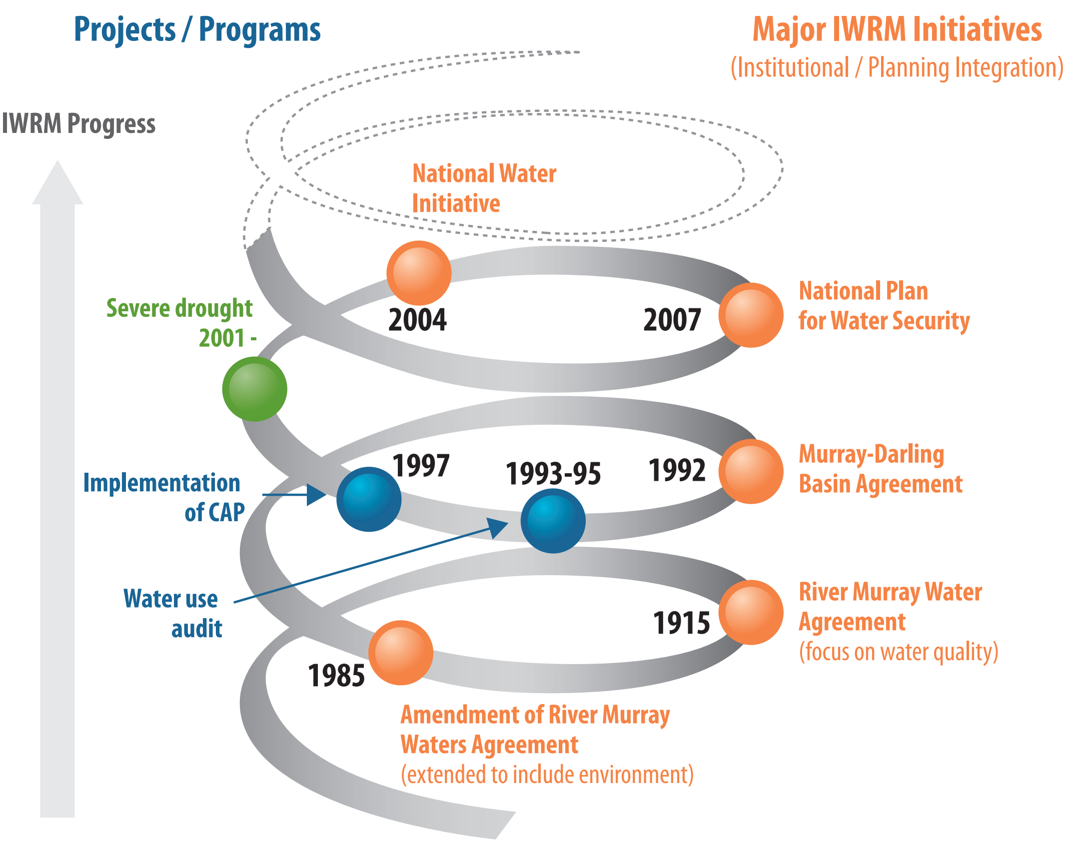
Effective basin planning processes are similar in nature to large complex information technology development processes, where the requirements of the final product are defined, but the process of getting to this is not necessarily well defined at the outset (in other words, 'what we want' is clear, but not 'how to do it'). The immediate activities may be defined, but the details of future activities are only clarified as the process unfolds, understanding improves and priorities are agreed.

The iterative nature of the planning process within a single iteration or edition of the basin plan is highlighted above. However, the longer iterative planning–implementation cycle from one basin plan edition to the next must also be recognized, as this allows priorities to shift as conditions change and issues are addressed.

Box 38: Long-term planning in the Murray-Darling basin

The evolution of basin planning processes over time was presented as a spiral in the 2010 UNESCO *IWRM Guidelines at River Basin Level*, with each turn representing an edition of the basin plan. The diagram below illustrates these concepts, using the evolution of planning and management in the Murray-Darling as an example.

Each new plan returns to many of the same issues as previous basin planning efforts, but does so with more understanding of the context and challenges around implementation. This diagram highlights that basin planning is, in most cases, an ongoing process of refinement and evolution.



Source: http://unesdoc.unesco.org/images/0018/001864/186418e.pdf

This demonstrates how basin planning matures in a basin as understanding is gained and institutional relationships are established. The early editions of the planning process may not be basin plans, but rather thematic plans that are incorporated into the basin planning process. The planning cycle expands from narrow sector master plans (for irrigation, flood protection or hydropower development) to broader basin planning over the course of time.

Box 39: Iteration of basin planning on the Rhine River

Basin planning for the Rhine River has developed into a comprehensive plan, but had origins as a series of plans focused on thematic issues.

Early basin planning for the Rhine was driven by thematic issues such as declining fish populations or pollution. Various agreements were put into place between 1950 and 1985 to address these concerns, including the establishment of the International Commission for the Protection of the Rhine (ICPR). The 1986 Sandoz disaster, which released many tons of toxic substances into the river, prompted the formation of the Rhine Action Programme, which set clear high-level goals to improve the state of the river for fish populations and drinking water, and to reduce pollution of river sediments. Major floods in the 1990s motivated an Action Plan on Floods.

Finally, the Rhine 2020 Program on the Sustainable Development of the Rhine (ICPR, 2001) was adopted in 2001. It covers many issues, including ecological protection and restoration, water quality, groundwater protection and flooding. It also complies with the EU WFD to coordinate measures and motivate for cooperation. The first *Rhine River Basin Management Plan* was then published in 2009 (ICPR, 2009).

Source: Le Quesne and Schreiner (2012).

6.2 Stages and milestones in basin planning

Basin planning balances a number of competing imperatives. A process is therefore required that allows for the analysis of scenarios across a range of social, economic and environmental issues. However, these complex issues need to be narrowed down into a series of key priorities for the basin, against which a high-level strategy can be developed. This strategy consists of coherent objectives and actions, which are ultimately detailed in a series of implementation plans and activities.

The process initially narrows from broad screening, through comprehensive analysis, to prioritization and objective-setting, and then broadens again through strategic action down to detailed implementation planning. This basin planning process can be represented in four key stages:

- **Conducting the situation assessment** to gain an understanding of the current and future conditions in the basin, as well as identify and prioritize the key issues.
- **Formulating the vision and goals** to provide the long-term aspirational desired state for the basin together with goals (preliminary objectives) and principles to achieve this over time.
- **Developing the basin strategies** to specify a coherent suite of strategic objectives, outcomes and actions related to protection, use, disaster and institutions in the basin, designed to achieve the vision.
- **Detailing the implementation** to define actions that give effect to the basin strategies and ultimately achieve the vision and objectives.

Central to the process is the identification of strategic priorities and trade-offs in the river basin. These priorities are determined by social preferences about the economy, society and the environment, so these choices are the fulcrum on which the basin planning process rests. Basin planning is therefore an iterative process of screening options and issues to allow for prioritization. This process is supported by the identification, analysis and selection of feasible options to achieve defined goals.

Figure 21: Key milestones (outcomes) in strategic basin planning against the hourglass

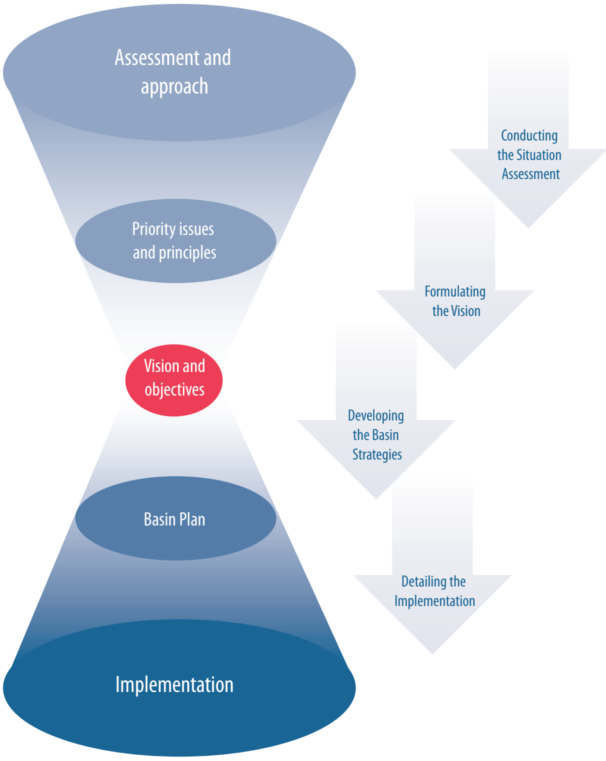


Figure 21 shows these stages in the development of the basin plan, together with the key milestones (outcomes) during the process. The hourglass shape illustrates the way in which the process moves from the consideration of a wide range of detailed issues, into a narrow focus on a limited number of key high-level objectives, and then broadens out again into detailed implementation planning.

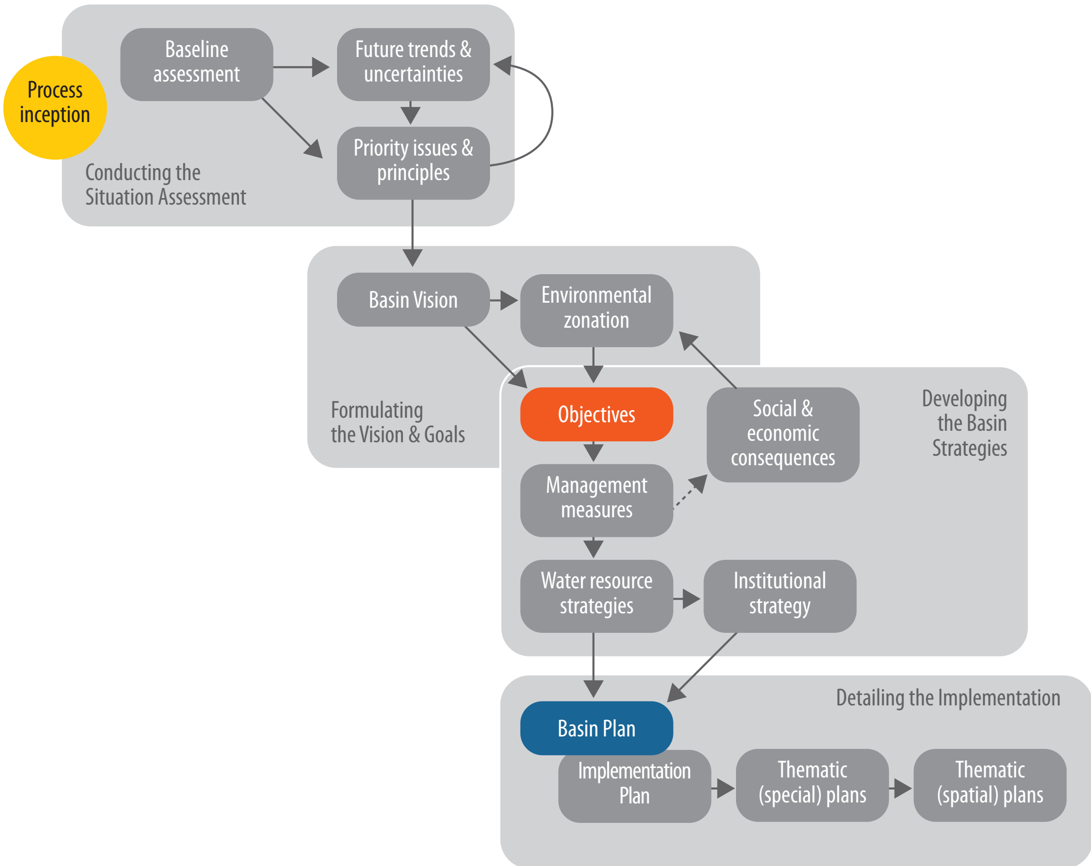
It is also important to recognize that the highly iterative nature of the basin planning process implies that these stages tend to overlap. Therefore, the outcomes that are nominally linked to a particular stage may be revisited during the entire process as further information and understanding is gained.

Each of the four stages has a different purpose, and consequently has distinct approaches, methods and assumptions. Much of the remainder of this document details the rationale, procedures and techniques that may be used to move through these stages, from the perspective of the planners that must drive the basin planning process.

PROCESS ROADMAP FOR BASIN PLANNING

The four stages may be unpacked into the more detailed roadmap of the basin planning process outlined in Figure 25. While this represents a comprehensive process, not all of these steps and associated outcomes are followed in all basin plans.

Figure 25: A roadmap to the basin planning process



CONDUCTING THE SITUATION ASSESSMENT

- Process inception and design, which includes delineation of the basin.
- Baseline assessment of the current situation and historical evolution.
- Future development and trends provides forecasts or scenarios of development pathways.
- Priority issues and principles indicates the key challenges and concerns for planning.

FORMULATING THE VISION AND GOALS

- Basin vision for the long-term desired state of the basin.
- Environmental zonation providing the desired state in river reach or catchment that reflects a balance between social, economic and ecological imperatives.
- Water resources objectives as time-based targets associated with the state of the river that lead towards the achievement of the vision over time.
- Social and economic consequences indicating the implications of achieving the objectives.

DEVELOPING THE BASIN STRATEGIES

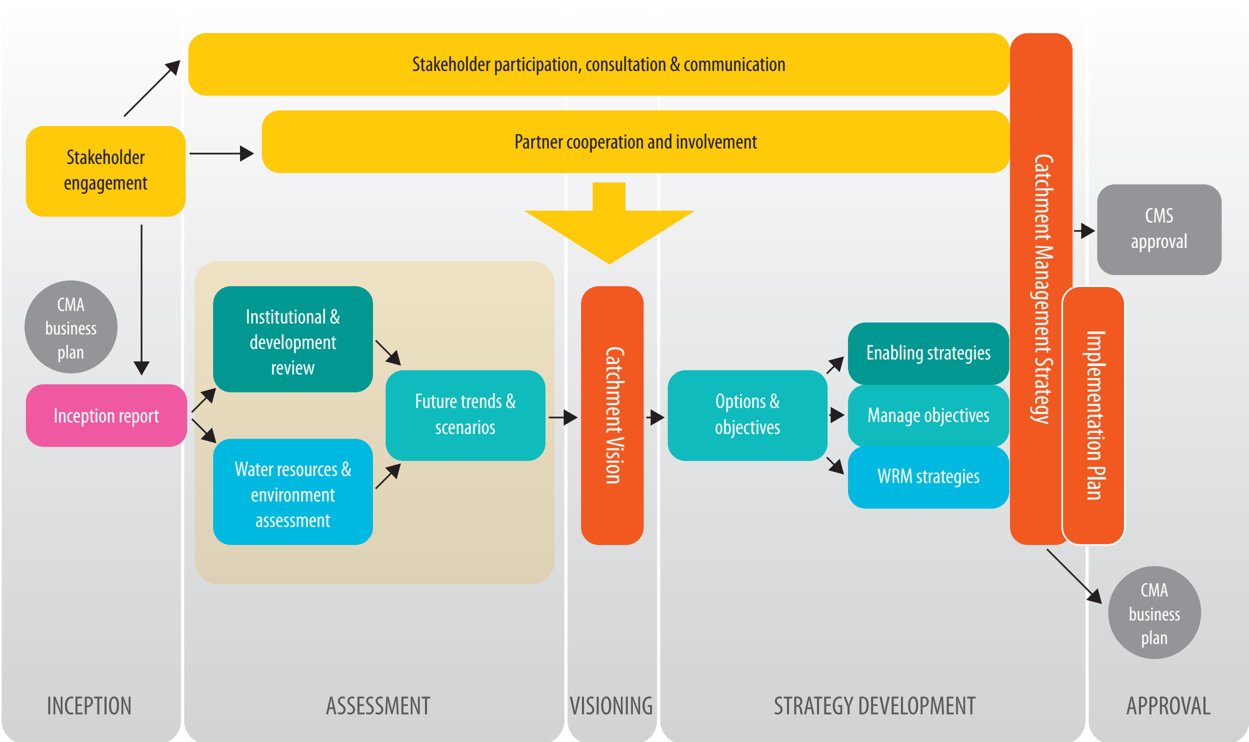
- Management objectives as time-based targets to achieve the vision and water resources objectives.
- Management measures (options) that provide high-level interventions that jointly will achieve the vision and objectives.
- Water resource strategies that define strategic objectives, actions and milestones to achieve the basin objectives for the priority water resources concerns in the basin.
- Institutional system strategies that enable administration, cooperation, financing and information management to support the water resources strategies.

DETAILING THE IMPLEMENTATION

- Implementation plan outlining the activities, milestones, responsibilities and resources to achieve the basin strategies.
- Thematic plans detailing the interventions around a specific water resources issue.
- Regional plans detailing the interventions within a defined subarea of the basin.

Box 40: Planning process for the Breede-Overberg catchment management strategy

The 'roadmap' to the basin planning process for the Breede-Overberg CMS followed five stages, from inception to approval and implementation, supported by partner cooperation and stakeholder engagement.



Source: BOCMA (2011).

6.3 Cooperation and engagement as part of basin planning

No department or authority is likely to be able to implement a basin plan alone or impose its will on other institutions or independent bodies. Cooperation is therefore the most appropriate approach, and should be institutionally built through the basin planning process.

As already noted, strategic basin planning requires alignment with other planning processes. To do so effectively, basin planning requires close cooperation between a range of organizations, institutions and groups. This achieves four main purposes:

- **Obtaining a diversity of perspectives** on the nature and causes of problems, as well as the possibilities and opportunities for solutions. Many groups have important information, and engaging external stakeholders (outside the water sector) provides an important way of incorporating diversity into the process and thus making it more robust.
- **Fostering alignment** with the planning activities and objectives of other institutions. This assists in the understanding and incorporation of these imperatives into the basin planning process and the ongoing cooperation of these institutions in basin management.
- **Generating ownership and understanding** amongst a wide range of stakeholders of the concerns and solutions that are addressed by the plan. This in turn can greatly improve the effectiveness of implementation.
- **Disseminating knowledge** that has been developed through the basin planning process to other sectors' decision-makers, particularly where the sector is not being generally monitored or evaluated.

Achieving this requires cooperation with partner institutions and engagement of broader stakeholder groups.

INSTITUTIONAL COOPERATION

It is critical to build on existing institutions wherever possible, and avoid unnecessary transfers of authority from one body to another. Requirements for shifts of institutional mandates and responsibilities can take a long time, and eventually cause the failure of well-intended reforms.

A variety of different approaches to engagement with other government institutions is possible. It is important to clarify the type of engagement that is most appropriate at different stages, distinguishing between:

- **Review (incorporation):** where the basin planning process needs to incorporate aspects of another sector's plan, that is either already completed or requires relatively little input from basin water resources planning; this is appropriate where the inter-relationship between the planning processes must be considered but are relatively independent.
- **Consultation (alignment):** where planners recognize there is a need to exchange views and information before acting, while accepting that the two processes remain independent; this is appropriate where planning decisions have an impact on each other and should be aligned as far as possible, but do not require harmonization as mandates are distinct.
- **Coordination (harmonization):** where the basin plan (and its implementation) requires harmonization between two planning process; this is appropriate where there are close interfaces or overlapping mandates which require coherence and consistency in application.
- **Cooperation (integration):** where the basin plan must be integrated in content and process with another process, leading to some degree of joint decision making; this is appropriate where effective and/or efficient implementation requires common action and/or response.

Box 41: Institutional alignment in the Murray-Darling basin

Water resources management is primarily a state function in Australia, bringing a number of challenges for management in transboundary basins, most notably in the Murray-Darling basin. Responsibilities for water resources management are split across a range of institutions at the local, state and federal levels. Significantly, as the state governments are not subject to direction from the federal government, decisions on policy and management strategies must often be reached by agreement. The major reforms in Australia's water sector since about the early 1990s have depended on different institutions agreeing on the reforms, then coordinating actions for their implementation. The alignment of institutional objectives and actions has been critical for gaining support for major policy reforms (such as the 2004 National Water Initiative and the 2008 referral by states to the federal government of certain powers over management of the Murray-Darling), as well as for ensuring organizations are working towards a common purpose (for instance, that on-ground activities of local catchment management authorities align with broader basin objectives).

Central to this reform process has been the establishment (at various times) of a number of working groups involving senior officers from different government agencies and from different jurisdictions. This has included the involvement of the central agencies in each of the states (Premiers, Treasury), which has generally elevated the debate above the technical difficulties of implementation and ensured that funding was available to implement the reforms. The establishment of officer-level working groups across the basin helped improve relationships between senior bureaucrats within the water agencies. Given the history of suspicion, noncompliance, and conflict, building relationships at that level was critical to developing the trust necessary for the states to support the referral of powers to the federal government.

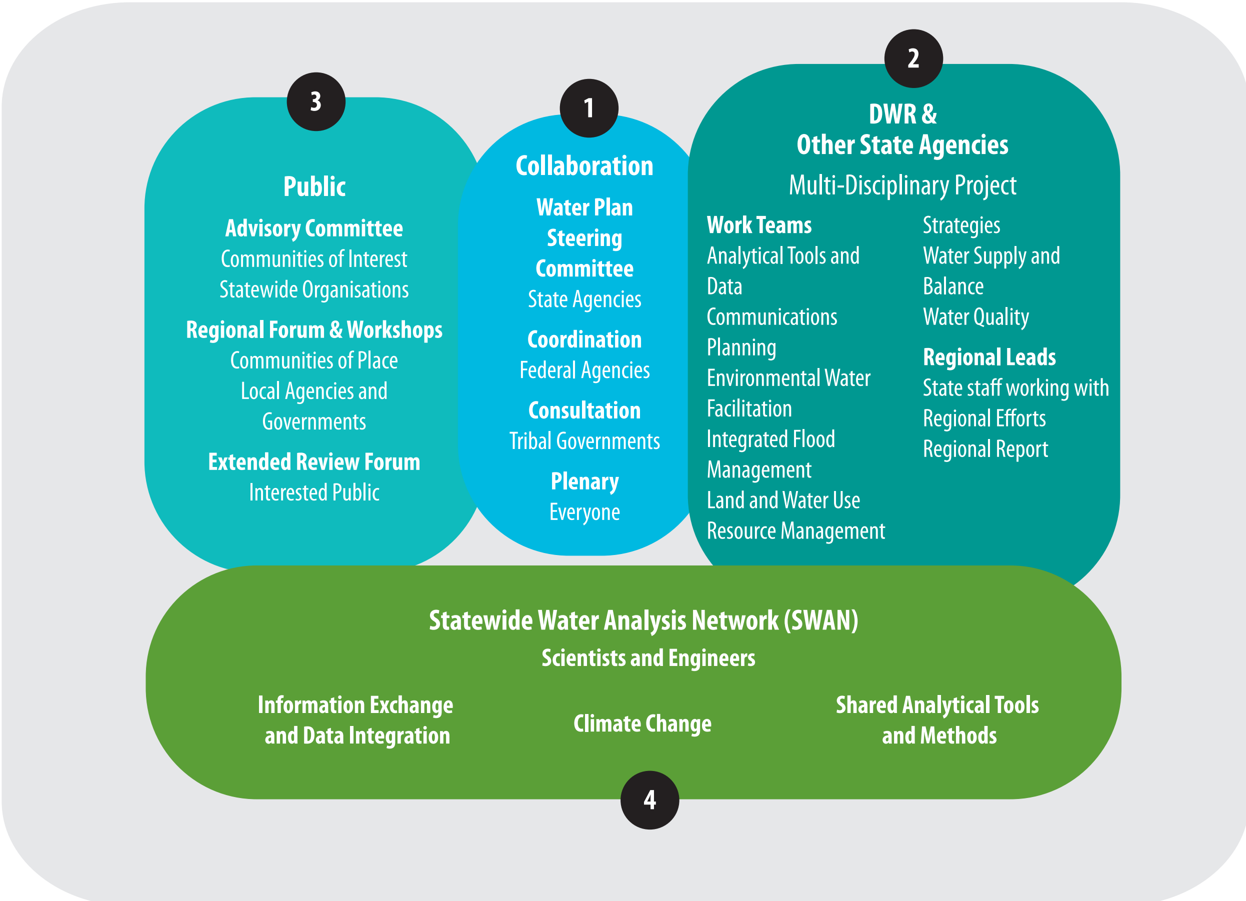
Source: Le Quesne and Schreiner (2012).

Box 42: Engagement process for the California Water Plan 2009

The California Water Plan process includes institutional cooperation and participation from many stakeholders, along with the required exchange of information to support collaboration. A Steering Committee made up of representatives of twenty-one state agencies was designed to guide the process. The central circle is the point of collaboration between the Department of Water Resources (DWR), other state agencies, coordination with federal agencies, and consultation with the public and technical experts.

The Steering Committee works closely with a public Advisory Committee, and the updating of the California Water Plan is done in a consultative manner that involves input from stakeholders and the general public. The public Advisory Committee focuses on state-wide policy issues, while other work groups deal with technical and coordination issues. The Advisory Committee includes representatives from many groups representing interests such as business, citizen organizations, energy and water consumer advocates, environment and public trust, environmental justice, local government and land use planning, production agriculture and recreation.

The Steering Committee also works with the State-wide Water Analysis Network (SWAN), and regional planning initiatives. It is the role of the Steering Committee to make sure that the Water Plan is based on sound science, the best information, and that it encompasses state, federal, tribal and regional issues and processes. The Steering Committee identifies the most important other government plans from which to access data, data sources, analysis and scenarios to compare with those developed in the water planning process.



Source: State of California (2009).

These represent increasing levels of engagement, with the appropriate level being related to how important it is that the partner acts in a manner that supports the basin plan.

Clarification of roles and responsibilities is critical to an effective planning process that is integrated with other sectors. In this it is important that the 'lead voice' in the basin planning process acts as facilitator and coordinator, rather than dictating actions. The institutional and bureaucratic mechanisms that are necessary to support this role need to be understood and developed.

In thinking about mechanisms to promote alignment, harmonization or integration, it is important to reiterate that planning is cyclical and requires bureaucratic mechanisms to be in place during both planning and implementation. Institutional-bureaucratic mechanisms that have proved useful in fostering some degree of alignment and/or cooperation include:

- **Enabling framework:** legislation and policy requirements may assist cooperation or alignment between organizations, but are not generally sufficient to achieve this except where penalties are incurred.
- **Governance and representation:** representation of political or bureaucratic leadership on governance structures.
- **Institutional structures:** regular joint meetings at a formal or informal level between officials of each institution.
- **Organizational design:** internal organizational structuring and systems to foster engagement with other institutions, including assessable job titles and functions.
- **Delegation and contracting:** inter-agency delegation of functions promotes cooperation, potentially beyond the contracted function.
- **Financial arrangements:** inter-agency financing promotes interaction and accountability.
- **Capacity building and support:** of another institution.
- **Engagement in planning processes:** representative attendance of each other's planning processes and meetings.
- **Consultation and comment:** on planning documentation ensures areas of potential nonalignment are raised.
- **Information sharing and exchange:** providing relevant information builds trust and potentially ensures action by another agency if the information is presented to help identify possible issues.

It is important to recognize that cooperation is built on experience and trust, that this typically begins with personal interactions and that the critical dimension is to institutionalize and operationalize these fledgling opportunities into long-term engagement (particularly where cooperation or coordination is required).

NONGOVERNMENTAL STAKEHOLDER ENGAGEMENT

Complex highly developed basins tend to have diverse water users and interest groups at a range of spatial scales and focused on various basin issues. Increasingly, major business, private sector and civil society organizations are becoming involved in basin and water resources planning exercises. Typically these organizations are in addition to the governmental institutions that need to cooperate, and they may all have some level of influence on the implementation of the basin plan. Properly designed, this stakeholder engagement can complement the institutional cooperation discussed above.

Particular complementarities may be found between the public and the private sector, with the potential benefits of an active collaboration and capacity-sharing, although it is important to be mindful of the possible negative consequences related to perceptions of other stakeholders around institutional capture.

With the focus still being on obtaining diversity, generating ownership and fostering cooperation, in stakeholder engagement it can be useful to distinguish between:

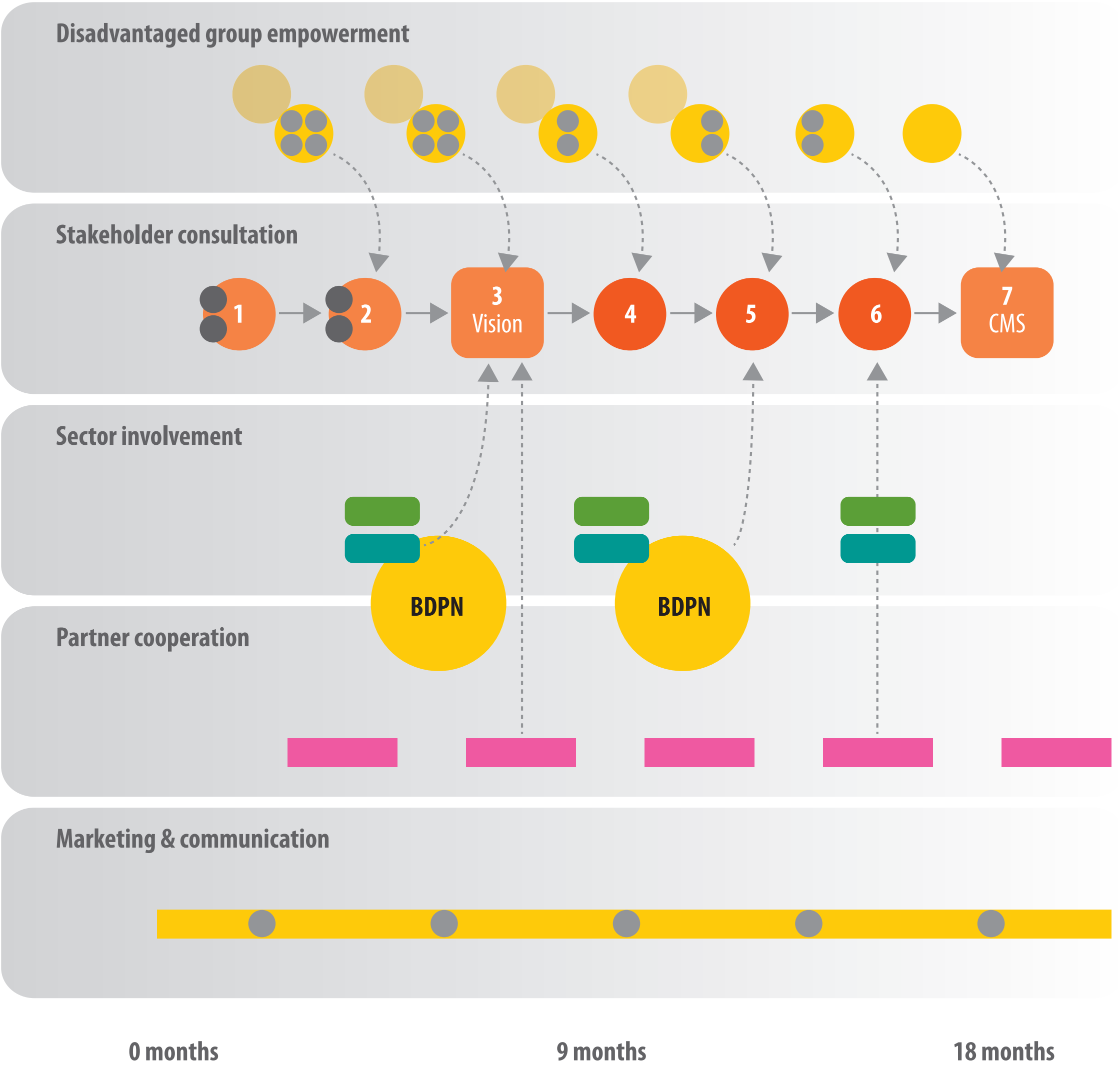
- **informing stakeholders,** through the provision of information to assist them in understanding the problems, opportunities and response
- **consulting stakeholders** to consider perspectives and feedback around issues, priorities, objectives and solutions before decisions are made
- **involving stakeholders** in making decisions throughout the process in order to ensure that their concerns and interests are incorporated
- **collaborating with stakeholders** for joint decision-making leading to joint action, including the development of objectives and the identification of preferred solutions.

Stakeholder engagement must recognize the differences between these levels, acknowledging that each has a role in the basin planning process for different stakeholder groups. A balance needs to be maintained between informing many groups and people, and involving only those that are most relevant. When done effectively, stakeholder engagement becomes the basis for strengthening the institutional and bureaucratic arrangements on which implementation will depend, because stakeholder resources and cooperation may be mobilized through the development of local stakeholder structures (such as committees and forums).

Box 43: Stakeholder engagement during the Breede-Overberg catchment management strategy

The Breede-Overberg catchment management strategy was required to be developed in a participative manner to obtain local knowledge and insights, as well as to create a sense of ownership for the strategy as it would eventually require the coordinated efforts of various stakeholders for implementation. The stakeholder engagement process involved five streams:

- A main stream of stakeholder engagement was done through initial consultations with a broad group of stakeholders for mobilisation and identification of the key issues, and through smaller consultations with a Reference Group that was nominated by a larger group of stakeholders as the process became more technical.
- A support stream focusing on disadvantaged group empowerment, which assisted primarily disadvantaged groups to prepare for meetings by explaining technical concepts, meeting objectives, and stakeholder roles and responsibilities.
- Specific engagement with key sector groups, such as agricultural and environmental groups, which have significant interest in water resources management issues.
- Specific engagement with key partners such as provincial and local government to ensure alignment of plans and cooperation.
- Ongoing communications, including newsletters and website updates, to provide a foundational stream of work to ensure that stakeholders were generally aware of the strategy's development process and key findings.



Source: BOCMA (2011).

6.4 Basin planning review and adaptation

The concept of adaptive management is gaining currency for water management, because it recognizes that the basin plan may require modification over time because of the:

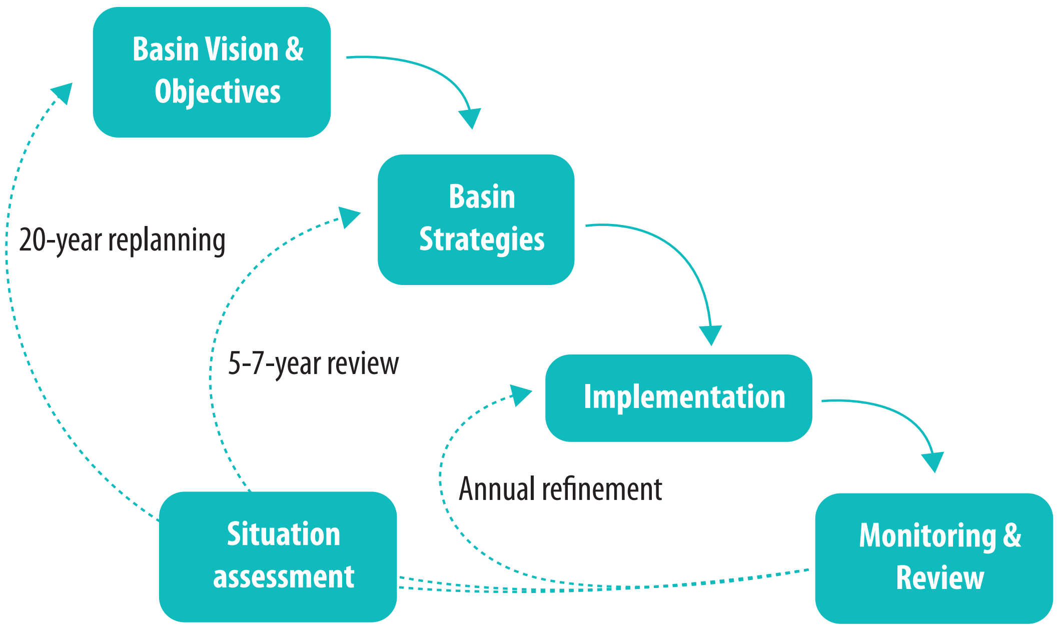
- complexity of the basin, implying that it will seldom be possible to get complete information, understanding, knowledge and solutions during the planning process
- uncertainty of the future, implying that it is not possible to accurately predict development and climate pathways during the basin planning process.

Adaptive management systems are usually developed around good monitoring and information systems, with flexibility provided in the way in which objectives and actions are defined and achieved. Combining this adaptive management philosophy with the stages of planning results in a series of review and feedback loops. The iterative nature of the entire basin planning processes is illustrated in Figure 22.

- **Annual refinement.** In dynamic situations, it is appropriate to conduct annual refinement of the implementation plans, focusing on actions, resources and responsibilities to achieve the agreed strategic outcomes and objectives (of the thematic and area-based plans).
- **Five to seven year review.** Most planning processes have a five to seven year review, during which the achievements of the plan are evaluated and a new or revised basin strategy is developed (possibly including revised short to medium-term management objectives). This involves a review not of the long-term vision, but rather of the priorities and progress towards achieving it.
- **Twenty-year revision.** In order to maintain continuity and stability in implementation, a review and revision of the longer-term objectives and basin vision statements should not occur less than every twenty years, unless major changes in the basin invalidate the original assumptions and a fundamentally new planning process is initiated.

In South Africa, the National Water Act requires catchment management strategies to be reviewed every five years. In Australia, the Murray-Darling basin plan must be reviewed every ten years, as must the state water allocation plans in the basin. In the Lerma-Chapala basin the 'Coordination Agreement for the Recovery and Sustainability of the Lerma-Chapala Basin' (CEA Jalisco, 2004) must be reviewed every two years to evaluate the actions that have been committed to and the results that have been obtained. The annexes to the agreement are reviewed whenever it is felt necessary by the signatories or is specified in the annexes themselves. The European river basin plans must be reviewed every six years according to the EU WFD.

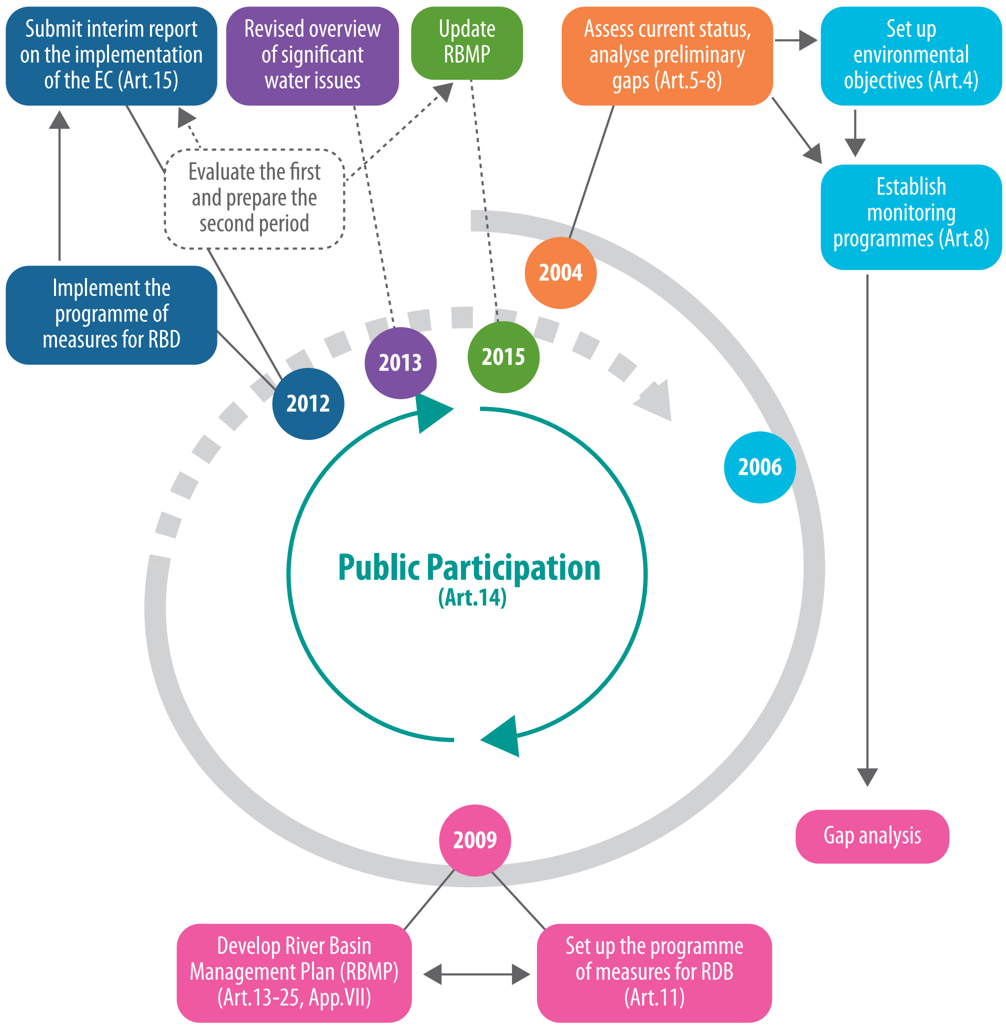
Figure 22: The generic process of basin planning, iteration and adaptation



Box 44: Reporting and review of the under the EU Water Framework Directive

The EU WFD sets out a timeline for developing targets and for implementation, both of which require intermediate steps of reporting and review. For example, by 2004 a pressures and impacts study had to be completed for all water bodies, by 2006 monitoring programmes as required by the WFD had to be operational, by 2009 the River Basin Plan had to be finalized, and by 2015 all water bodies must have a 'good status'.

A second planning cycle is then scheduled for 2015 to 2021 which requires the review of the first basin plan, and already a third review and planning cycle is scheduled from 2021 to 2027.

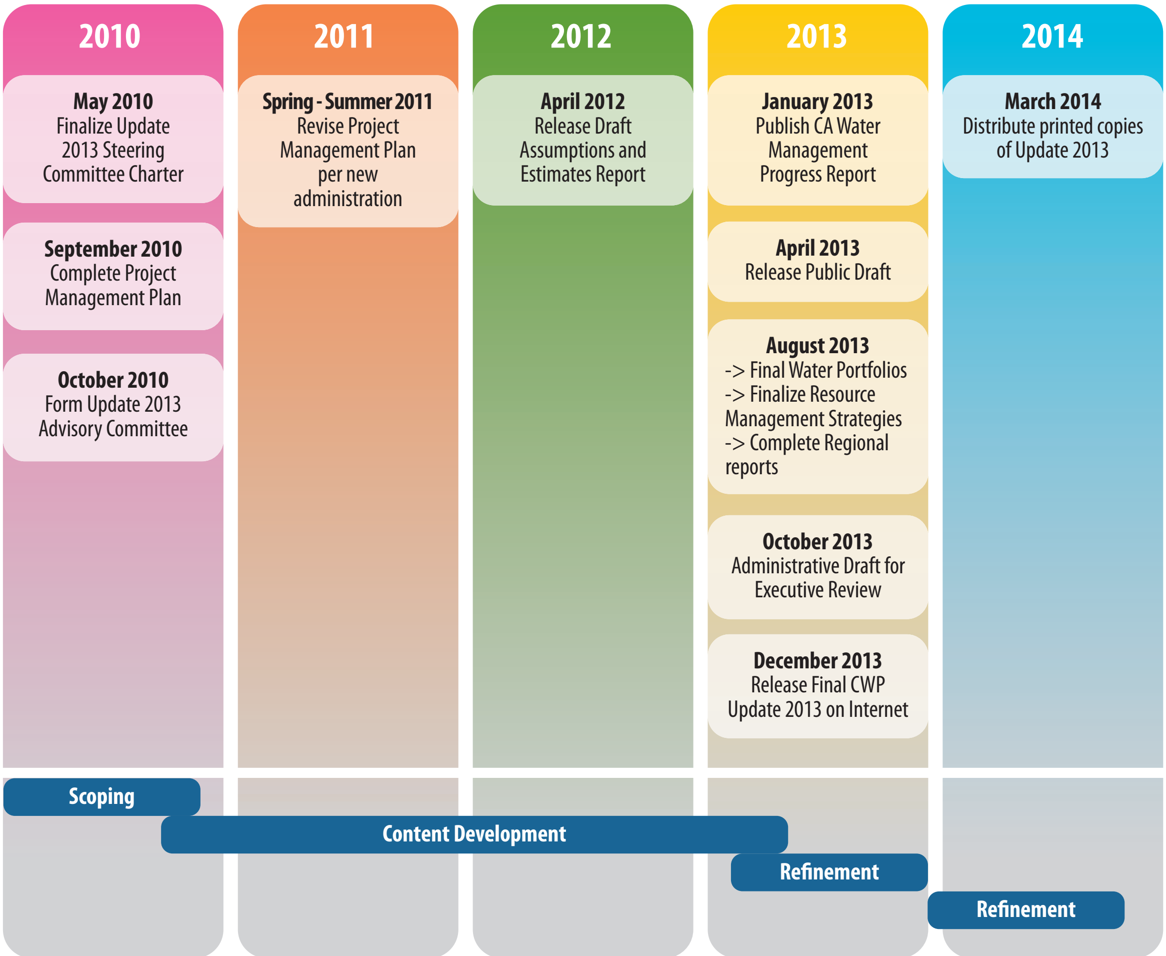


Source: ICPR (2012*b*).

Box 45: Review of the California Water Plan 2013

The California Water Plan must be updated every five years, with the next version due in 2013. The review process required the preparation of water portfolios, future scenarios, regional report, resource management strategies and an implementation plan. The Steering Committee and dedicated employees of the California Department of Water Resources are central to the updating process, and facilitate consultation with stakeholders and the public as well as with technical and scientific experts.

In the 2013 update, the DWR hopes to bring other agencies responsible for various aspects of water resources management more closely into the process so that the plan deals with their functions and responsibilities as well, such as environmental flows, water rights and water quality. It is also expected that the 2013 update will focus more on recommendations for resource management strategies with increased specificity and regional emphasis, and will provide updated reference and technical guides.



Source: State of California (2012).

CHAPTER 7
STRATEGIC ENVIRONMENTAL BASIN PLANNING

Increasing global pressure on freshwater resources has led to the rapid development of environmental sustainability as an underpinning principle for basin planning. In many cases, it has been an environmental crisis that has triggered the adoption of more comprehensive and integrated approaches to basin planning. Strategic environmental planning has now become a cornerstone of the basin planning process.

Decisions made in the basin planning process can have a range of critical impacts on freshwater ecosystems and services. Key elements of the planning process, and their potential environmental impacts, include:

- **Abstraction and water use planning.** The location, extent and timing of abstraction, water use and water diversions will impact on the volume and timing of water flows in rivers, lakes, wetlands and estuaries. The hydrological regime of river basins is increasingly being recognized as critical to environmental health and associated functions.
- **Infrastructure development planning.** The construction and operation of freshwater infrastructure, in particular dams, has substantive and pervasive impacts on freshwater systems. These include impacts on both the quantity and timing of freshwater flows and connectivity within freshwater ecosystems, in particular the ability of species to migrate. Storage dams can also have impacts on downstream water quality.
- **Development planning.** Basin plans may support patterns of development planning in the river corridor and linked systems, impacting on freshwater ecosystems.
- **Water quality planning.** Reduced water quality from urban, industrial and agricultural sources impacts on aquatic ecosystems, the uses to which water resources can be put, and treatment costs, for example to make water fit for irrigation or industrial users.
- **Biodiversity protection planning.** This process should identify priority species, habitats and ecosystems, and determine the measures to be put in place for their protection.

There is no single approach or process for incorporating environmental priorities into basin planning. Rather there are several allied approaches that have been used in different parts of the world, depending on the characteristics and environmental challenges in the basin, available budget, information and institutional capacity, and the severity of the pressure on the environment.

Many of the strategic approaches to environmental planning in river basins build on the techniques that have been developed over recent years for strategic environmental assessment (SEA) in the water sector. SEAs have been undertaken for both proposed new policies, to develop environmental action plans, and to support particular programs of investment (Hirji and Davis, 2009).

7.1 Freshwater ecosystems and ecosystem services

Freshwater ecosystems provide a range of goods and services that underpin economic development. Maintaining freshwater ecosystems can be viewed as maintaining natural infrastructure, equivalent to constructing and maintaining the built infrastructure that provides technological services for society. Unfortunately the role that healthy freshwater systems play, both in terms of ecosystem services and in acting as the resource base upon which a range of freshwater services are based, is often recognized only when these systems have been degraded or lost.

A number of different approaches have been used for characterizing ecosystem services, with an increasing number building on the approach adopted by the Millennium Ecosystem Assessment. This divided ecosystem services into provisioning services, regulating services and cultural services. The provisioning services associated with freshwater include, in particular, food in the form of fisheries. The regulating services of freshwater ecosystems are particularly important, and are being increasingly recognized as freshwater systems degrade and these services are no longer provided.

Table 4: Key regulating services of freshwater systems

Flow regulation and patterns	Storage and release of flood peaks in wetlands; recharge of groundwater
Sediment transport	Maintenance of river channel, wetland and estuary form and function; provision of sediment to near-shore environments; replenishment of wetland and floodplain sediment
Flows to marine systems	Maintenance of coastal, delta and mangrove ecosystems; prevention of saline intrusion in coastal and estuarine regions
Waste assimilation	Retention and removal of pollutants and excess nutrients; filtering and absorption of pollutants

Many of these regulating services are dependent on different elements of the flow regime and can be affected in different ways by modifications to that regime. For example, waste assimilative capacity is typically affected by changes to low flows in a river system, while the ability of freshwater systems to maintain sediment transport or groundwater recharge may be more dependent on flood or pulse events.

Freshwater systems also provide important regulating services to estuarine, deltaic and near-shore environments. Maintenance of key elements of the flow of freshwater is often important to the maintenance of ecosystems such as mangroves and estuarine fisheries, which in turn provide very significant development benefits. For example, the role of healthy mangrove forests in reducing flood risk is being recognized increasingly.

In addition to loss of regulating services, the pollution of freshwater systems can impose very significant treatment costs, reduce the availability of water for human use, lead to sickness and disease, and result in the degradation of ecosystems. Globally, water pollution is increasing (UN WWAP, 2009). Much of this is driven by increasing intensity of human activities including agriculture, mining, atmospheric emissions and the disposal of industrial and human waste, undermining the quality of rivers, lakes and aquifers around the world. Nutrients, persistent organic matter, microbial pathogens, oil, sediments and heavy metals are just a few of the resultant contaminants which alter the physical, chemical and biological composition of water.

The pollution of freshwater systems has far-reaching impacts on ecosystem and human health, as well as socio-economic development. The economic costs can be significant. The most widespread and significant water quality problem globally is high concentrations of nutrients leading to eutrophication and harmful algal blooms (UN WWAP, 2009). Water quality degradation can have devastating implications for human health and well-being; 3 million people each year die from waterborne diseases in developing countries, and microbial pollution is the greatest single cause of human death and illness globally (UNEP, 2007b). Pollution can also impose very significant treatment costs and reduce the availability of water that is safe for human use.

The decline in the health of freshwater ecosystems around much of the planet, and the associated reduction in ecosystems services, has been widely recorded. Global datasets that provide a comprehensive record of the health and status of freshwater ecosystems are unavailable. However, global surveys have identified freshwater ecosystems as suffering from greater alteration and degradation than any other ecosystem on the planet:

- In 2005, the Millennium Ecosystem Assessment concluded: 'Inland water habitats and species are in worse condition than those of forest, grassland or coastal systems .... It is well established that for many ecosystem services, the capacity of inland water systems to produce these services is in decline and is as bad or worse than that of other systems.... The species biodiversity of inland water is among the most threatened of all ecosystems, and in many parts of the world is in continuing and accelerating decline' (Millennium Assessment, 2005).
- In 2010, WWF updated its global Living Planet Index (WWF, 2010a), a statistical review that charts the status of populations of species across the world. The freshwater index tracks changes in 2750 populations of species of fish, birds, reptiles, amphibians and mammals found in freshwater ecosystems. The index for tropical freshwater systems has declined by 70 per cent between 1970 and 2007, the largest fall in any biome on the planet.
- In 2010, the Convention on Biological Diversity published its Global Biodiversity Outlook 3. This concluded: 'Rivers and their floodplains, lakes and wetlands have undergone more dramatic changes than any other type of ecosystem.' (Secretariat of the Convention on Biological Diversity, 2010).

The drivers of these declines are multiple, reflecting the range of uses to which freshwater systems are put, and include abstraction of water for irrigation, industrial and household use; the input of nutrients and other pollutants into freshwater systems; the damming of rivers for hydropower, storage and flood control purposes; and the modification and drainage of freshwater habitats and wetlands.

There are many examples from around the world that illustrate vividly the costs of basin-scale environmental degradation. In each of these cases, environmental problems have arisen as a result of pervasive activities across large parts of basins. The extent of these problems has often lead to significant rethinking of basin planning processes in order to develop the necessary solutions, leading in some cases to profound changes to basin planning approaches.

THE INDUS: THE ENVIRONMENTAL AND HUMAN CONSEQUENCES OF ALTERED FLOW REGIMES

When modification of flows leads to the failure of regulating services, the impacts can be significant. In Pakistan, flows of both freshwater and sediment to the Indus River delta have been very significantly affected over recent decades by upstream irrigation and water infrastructure development. The consequences of these reduced freshwater and sediment flows have been rapid declines in the environment quality of the delta, including saline intrusion into deltaic land and aquifers, and impacts on delta fisheries and mangroves (World Bank, 2005). As this area is home to a very large community, the human and environmental consequences of the loss of these services have been profound. There remain ongoing disputes between the main provinces in Pakistan – Sindh and Punjab – over the way in which environmental flows should be recognized in the terms of the 1991 Indus Water Accord, and these problems remain unresolved.

THE MURRAY-DARLING BASIN: NEGLECT OF ENVIRONMENTAL REQUIREMENTS AFFECTING ECOSYSTEM FUNCTIONING

Decades of river regulation, increasing flow diversion and over-abstraction have significantly altered the Murray-Darling basin and its rivers. Deterioration of river ecosystems, water quality issues (in particular acute salinity) and reduced reliability of supply have emerged as enduring challenges. The costs – financial, environmental and social – have been high. Salinity problems have been driven in large part by agricultural practices: natural dryland salinity has been exacerbated by human activities such as agricultural irrigation, clearing of native vegetation and river regulation, causing groundwater tables to rise, and mobilizing salts stored in subsoils, with significant impacts on ecosystem health. Salinity can also damage human infrastructure, and make water unsuitable for agricultural, industrial and domestic uses. Reduced flows have exacerbated water quality problems, caused stratification in weir pools and increased blue-green algal blooms, with toxins adversely impacting human health, livestock and aquatic life.

In 1991 the New South Wales Government declared a state of emergency when the world's largest blue-green algal bloom developed along 1000 km of the Darling River. The mean annual flow at the Murray Mouth has been reduced by 61 per cent from natural levels, and from 2002 until late 2010 there were no significant flows at all. An audit of the health of the basin, completed in 2007, found that twenty-one of the twenty-three subcatchments were in poor or very poor condition. The environmental crisis in the basin has been a major driving force behind reforms in the basin over the past decades, including the introduction of a cap on further increases in water withdrawals in the 1990s, a range of policies and strategies to improve the ecological health of the catchment, and since 2008, the preparation of the first whole-of-basin plan.

THE RHINE RIVER: WATER QUALITY AND THE ENVIRONMENTAL COST OF DEVELOPMENT

Industrialization and urbanization following the end of the Second World War led to the rapid deterioration of water quality in the Rhine. Municipal, industrial and agricultural wastewater was discharged into the river, causing heavy contamination with pesticides, hydrocarbons, heavy metals and organic chlorine compounds. The Rhine earned a reputation as the sewer of Europe. Development objectives were pursued at the sacrifice of riverine ecosystem health, until the degradation was so acute that the river could no longer meet all the uses assigned to it. By the end of the 1960s, pollution by organic substances had lowered oxygen levels so severely that almost all aquatic life had disappeared (Wieriks and Schulte-Wülwer-Leidig, 1997). Environmental degradation undermined the use of the river as a source of drinking water, and for fishing and tourism. In 1986 a chemical spill from the Sandez plant near Basel, Switzerland led to 200 km of the Rhine being deemed ecologically dead. This accident demonstrated the extreme vulnerability of the river and prompted swift political action on pollution control. As a result of the coordinated efforts of all nine riparian countries and the passage of significant pieces of domestic and European water quality legislation, the water quality of the Rhine has since improved significantly. However, the ecology of the river system has been altered permanently.

CHINA: RISING ECONOMIC AND HEALTH COSTS OF WATER QUALITY DEGRADATION

Water quality is one of the most critical environmental problems facing China as a result of the rapid economic growth of recent decades. Water resources are grossly polluted with agricultural fertilizers, industrial waste and sewage. It is estimated that more than 70 per cent of the country's rivers and lakes and 90 per cent of groundwater resources under cities are polluted (Hong, 2006). Half of the rivers and more than three-quarters of the lakes and reservoirs are unfit for drinking water consumption after treatment (MEP, 2009). Yet, severe water shortages and competition for resources mean users are often forced to use contaminated water. The World Health Organization estimates that almost 100,000 people die annually from water quality related causes (WHO, n.d.). In rural areas, mortality caused by diseases associated with water pollution (such as stomach, liver and bladder cancers) is considerably higher than world averages (World Bank, 2009*b*).

7.2 The characteristics of environmental management in strategic basin planning

While environmental impacts have long been a concern of basin planning, the way in which environmental issues have been incorporated into basin planning processes has undergone a significant evolution as environmental challenges have changed. This evolution mirrors the broader developments in basin planning approaches.

Historically, impacts on river environments were localized, and responses could similarly be localized. As pressure on river systems increased, so there was an increasing need to focus on larger, basin-scale concerns. In the nineteenth and twentieth centuries, the focus of much of this concern was around water quality impacts from increasing urbanization and industrialization. The first significant piece of water quality legislation in the United Kingdom was the River Pollution Prevention Act, passed in 1876, with a particular focus on the control of sewage pollution. Economic growth in the twentieth century led to increasing impacts on river water quality. In the second half of the twentieth century these concerns led, for example, to the passage of comprehensive pieces of water quality legislation such as the Federal Water Pollution Control Amendments (1972) and the Clean Water Act (1977) in the United States, and the Urban Waste Water Treatment Directive (1991) in the European Union.

Box 46: From quality standards to ecological health: the development of European water and environment legislation

The European Union has been very active in passing a series of pieces of water quality legislation. These illustrate the trends in the development of approaches to the management of environmental water quality. The first wave of legislation between 1975 and 1980 focused primarily on quality standards for particular types of water bodies. These included the Surface Water Directive (1975), Dangerous Substances Directive (1976), Bathing Water Directive (1976), Fish Waters Directive (1978), Shellfish Waters Directive (1979), Groundwater Directive (1980) and Drinking Water Directive (1980).

In 1988 a review of existing legislation led to a second wave of legislation which focused on emissions standards, addressing key sources of pollution from wastewater, industries and agriculture. The 1991 Nitrates Directive was passed to protect water quality by preventing nitrates from agricultural sources polluting ground and surface waters, requiring states to implement programmes for monitoring and reducing nitrate pollution of their water bodies. The 1991 Urban Wastewater Treatment Directive was created to reduce water pollution by domestic sewage and industrial wastewater, setting standards for collection, treatment and discharge. The 1996 Directive for Integrated Pollution and Prevention Control addressed pollution from large industrial installations.

From the mid-1990s there was increasing recognition of the need to move beyond the growing list of separate directives to a more coherent approach to water environmental management in the European Union. The Water Framework Directive (2000) was created to replace multiple fragmented water policies with a single framework piece of legislation. In addition, the WFD replaced specific water quality standards with ecological health as its objective, requiring all EU waters to achieve 'good ecological status'. The directive also set out a comprehensive process for the production of river basin plans, which are intended by the directive to set out the measures for the achievement of 'good' status.

At the same time, the rapid pace of development led to increasing concern in the second half of the twentieth century about the negative environmental impacts from large infrastructure construction. This concern focused initially on upstream impacts from dams, in particular inundated areas and displaced communities; however, increasing recognition has developed of the impacts of dams and infrastructure on downstream ecosystems. In many countries, this led to greater requirements for environmental impact assessment prior to the construction of major infrastructure. These concerns culminated in the World Commission on Dams (1997–2000), which sought to address many of these issues.

These types of approaches to water environmental management are typical of the era of water resources development management. Water environmental management at that time generally displayed the following characteristics:

- **Focused on impact mitigation.** Environmental management activities were designed to minimize the negative impacts of identified human development activities. This typically led to conditions on developers or water users in the basin to mitigate the impact of ongoing activities, for example requirements for treatment of waste and effluent.

- **Based on single pressures.** The focus of environmental management activities was on a series of individual pressures or sectors, rather than the desired outcome in terms of overall environmental health. In this context, environmental objectives typically consisted of certain standards to be achieved, such as water quality standards.
- **Developed after the production of a basin or water resources management plan.** Environmental concerns were typically considered following the production of a draft basin plan. They proposed mitigating measures, or at best acted as an overall constraint within which basin planning was to be undertaken.

In response to growing, systemic threats to freshwater systems, new approaches to basin environmental management are beginning to emerge across the world as part of the shift towards strategic basin planning. While many of these approaches are still relatively new, there are a number of emerging of environmental management undertaken in the context of strategic basin planning:

- understanding system functioning, assets and services prior to decision-making
- the incorporation of environmental goals in the basin vision and objectives
- the emergence of basin ecological objectives
- the establishment of different objectives and priorities for different parts of river basins
- sophisticated standards and plans for a range of environmental processes.

Table 5: Environmental management in water resources development planning and strategic basin planning

	Water resources development planning	Strategic basin planning
Goals	The achievement of thresholds for particular pressures, for example water quality standards	Ecological and environmental health incorporated in the basin vision and objectives
Uniformity	Uniform standards and objectives across river basins	Variable objectives for different parts of the river basin, with priority areas identified
Management objectives	Simple threshold standards	Complex objectives defining flow regimes, environmental functioning and management
Timing in planning process	Undertaken subsequent to major decisions, for example infrastructure and allocation planning decisions	Undertaken prior to, and contributing to, the identification of basin objectives and actions. Updated regularly to ensure continued relevance.
Assessment	Monitoring of basic environmental parameters such as fisheries, water quality	Detailed understanding of environmental systems, functions and services

UNDERSTANDING SYSTEM FUNCTIONING, ASSETS AND SERVICES PRIOR TO DECISION-MAKING

Strategic environmental planning starts from an analysis of the key environmental systems, assets and services of the basin, and the requirements for their maintenance. These include functions such as groundwater recharge, waste assimilation and sediment movement, as well as key biological assets such as fisheries and wetlands. This requires an understanding of system functioning and how different activities within the basin – abstractions, flows, wastewater discharge and so on – affect those functions. As such, the starting point of the planning process is the river and its services, rather than the pressure. This requires that a comprehensive environmental assessment is undertaken at the outset. Environmental planning is therefore undertaken prior to, or 'upstream' of, basin planning, with the objective of informing the basin vision and objectives. Rather than looking to develop subsequent mitigation measures, environmental planning fundamentally affects the objectives and options for the basin.

THE INCORPORATION OF ENVIRONMENTAL GOALS IN THE BASIN VISION AND OBJECTIVES

Environmental objectives are often recognized in the high-level vision, goals and objectives in basin planning. Environmental objectives are present in different forms in all of the vision, goal and objective statements in Chapter 3. Indeed, responding to environmental crises and meeting environmental targets has often been a driver of the development of new or revised basin strategies, and therefore central to the overall purpose of basin planning exercises.

Strategic environmental objectives are not only present in high-level strategies, but can also form the basis around which economic and development options in the basin are shaped. As such, environmental objectives can be part of the foundations of the basin planning process. There are attractive synergies between proactive environmental management and social and economic development. For example, a healthy and well-managed river basin may be attractive to investors, or reduce risks to production from water quality or quantity uncertainty.

THE EMERGENCE OF BASIN ECOLOGICAL OBJECTIVES

Modern basin planning is increasingly developing ecologically based objectives. This focus on species and ecosystems represents an evolution from more traditional water environment objectives which were based around more straightforward physico-chemical objectives, for example water quality objectives.

The achievement of basin-level ecological and environmental health outcomes typically requires coordinated action across many of the systems in the basin plan. As a result, environmental and ecological objectives are typically identified at the basin vision and objective levels, with objectives and implementation plans to achieve this incorporated in the basin strategies and implementation plans.

Examples of ecological objectives include the objectives for the return of salmon populations to the Rhine in successive basin plans, and ecosystem-based objectives in the 2010 *Guide to the Proposed Murray-Darling Basin Plan* (MDBA, 2010). At a broader legislative scale, the EU WFD places the achievement of good ecological status as the core objective of European water policy.

THE ESTABLISHMENT OF DIFFERENT OBJECTIVES AND PRIORITIES FOR DIFFERENT PARTS OF RIVER BASINS

Environmental management in the context of water resources development planning tended to focus on the achievement of identified, uniform thresholds of environmental quality. In contrast, more strategic approaches may identify different levels of environmental protection as being required across different parts of the basin. This recognizes that different parts of the basin may have different characteristics or uses. For example, some parts of the basin may be of particular ecological importance, or be important sources of drinking water and so require protection. In other parts of the basin there may be hard-working 'workhorse' rivers, where environmental standards may need to be lower. Prioritization exercises such as this are central to the trade-offs and broader prioritization that is at the heart of strategic basin planning.

A prioritization process that seeks to identify these different parts of the basin can also identify those services that it may be most important to preserve to meet national or local needs for the basin, and critical thresholds which should not be crossed, for example prevention of saline intrusion to estuarine areas, or particular migratory needs of important species.

The concept of identifying different priorities for different parts of river basins is relatively new, and a variety of approaches are being adopted to achieve this in different parts of the world. At a legislative level, the US Wild and Scenic Rivers Act (1968) allowed for the recognition and special protection of selected rivers in the country, and the EU Habitats Directive (1992) has resulted in special protected status being given to a number of rivers or tributaries in Europe. Within basin planning methodologies, the South African classification system and the Chinese functional zonation system both provide a more systematic mechanism for identifying different objectives for different parts of river basins (see Chapter 11 for more details).

SOPHISTICATED STANDARDS AND PLANS FOR A RANGE OF ENVIRONMENTAL PROCESSES

As environmental objectives have become more central to basin planning, the extent and sophistication of environmental objectives and plans within the basin planning process has increased. As part of this, increasingly sophisticated environmental objectives are identified as part of the overall basin level objectives. Most importantly, this can include sophisticated environmental flow regimes, but can also include plans for connectivity at the basin scale. Basin plans are typically accompanied by a range of thematic plans detailing implementation of key environmental aspects of the basin planning process, including wetland plans, water quality plans, and plans for the management and conservation of particular high-conservation-value species.

Box 47: Environmental flows: new challenges in basin-scale environmental management

As economic growth has led to increased water stress in recent decades, the maintenance and restoration of environmental flows has emerged as a key issue in environmental water management. The maintenance of environmental flows poses new challenges for basin planning: environmental flows are intimately bound up with core water resources and infrastructure planning in basins, and require action to be taken at a basin scale. This contrasts with longer-standing issues around water quality, which typically require remedial measures in industrial and agricultural activities outside the core concerns of water resources planners, and can be addressed locally or at a tributary level.

Most countries in the world now have high-level recognition of environmental flows in water resources strategies, policies and plans, including recognition in many US state water laws, the EU WFD, the Indus Water Accord, the establishment of the Ganga Basin Authority, and new water acts across Africa, Asia, Latin America and Australia. At the same time, in most countries there has been limited progress in implementing these high-level political aspirations. This illustrates that implementation is one of the key challenges in successful environmental basin planning.

Source: Le Quesne 2010.

7.3 Content and purpose of basin environmental planning

The overall purpose of basin environmental planning is to achieve the desired quality in the freshwater environment of the river basin, through either protection of the existing environmental quality, or restoration of degraded environments. Basin environmental planning is often viewed in terms of one or more of three related overarching objectives:

- **Maintenance of key river basin functions and processes.** Certain of the functions and processes of river systems are of particular importance, including the key regulating functions such as flow patterns, groundwater recharge, sediment transport and the maintenance of channel form, waste assimilation, and maintenance of estuarine, delta and coastal functions. River basin planning needs to identify both these key processes, and the measures required to ensure their maintenance.

- **Protection of water quality, for both human purposes and environmental needs.** Different water users in the basin require the maintenance of water quality to certain standards to prevent high treatment costs or, in some cases, reductions in the water available for use. Water quality standards are also required to safeguard ecosystems and protect human health. Protection of water quality requires an identification of the impacts associated with reduced water quality, the desired water quality standards, and the measures required across a range of sectors to achieve these.

- **Protection of key basin ecosystems and species.** Particular ecological assets within the basin will be identified as requiring protection. This can include high conservation value areas of the basin, and important species from a social or conservation perspective. Basin plans can also seek to conserve representative examples of the different ecosystems in the basin, to ensure that no species or ecosystems are lost. As with the other purposes of basin planning, this requires both an understanding of the ecosystems and species in the basin, and the identification of goals and implementation measures.

Because of their implications for many of the water users in the basin, environmental objectives are likely to be at the core of the basin planning process. Much of the purpose of basin environmental planning focuses on trade-offs between environmental objectives and other social and economic objectives. It is therefore important both that environmental objectives are consistent with the other objectives in the basin plan, and that the steps necessary to achieve the objectives and their implications are understood, in particular by decision-makers who may be outside the water sector.

A HIERARCHY OF ENVIRONMENTAL VISIONS AND OBJECTIVES

Chapter 5 set out the hierarchy of objectives that form the core of the basin plan, from high-level visions and goals, through management objectives to key strategic actions. The same hierarchy applies to the environmental components of basin planning, and environmental aspects feature prominently in many of the examples in Chapter 5.

Many modern basin plans include environmental aspirations as part of the overall basin vision statement. As with visions more broadly in basin planning, environmental visions tend to set out an overall philosophy or approach, and may identify priority issues of concern. Often, however, these vision statements can be aspirational rather than specific, and not provide a clear set of objectives that can be implemented. These vision statements can provide a preliminary indication of political purpose around which stakeholders can agree, before difficult decisions over trade-offs and investment need to be made. As such, while they may not provide a clear direction to the basin plan, environmental vision statements can play an important part in the process of agreeing a basin plan, indicating that maintenance and protection of the basin environment is an important consideration in the development of the basin plan.

Box 48: Environmental components of basin visions and mission statements

The draft Murray-Darling Basin Plan (MDBA, 2011) management objective is 'to achieve a healthy working Murray-Darling Basin, including a healthy environment, strong communities and a productive economy, through the integrated and cost effective management of basin water resources'.

The California Water Plan (State of California, 2009) values and philosophies are to 'Promote management for sustainable resources on a watershed basis.'

The *Rhine 2020 Vision* (ICPR, 2001) states that 'The former network of habitats typical for the Rhine (habitat patch connectivity) and the ecological patency of the Rhine from Lake Constance to the North Sea and the patency of tributaries figuring in the programme on migratory fish are to be restored.'

The vision from the 2010 Yangtze Basin Master Plan is 'Maintaining a healthy Yangtze River, promoting harmony between people and water.'

The vision of the *Breede-Overberg Catchment Management Strategy* (CMS), South Africa is 'Protecting our rivers, groundwater, wetlands and estuaries in a healthy and functioning state for nature, people and the economy' (BOCMA, 2011).

While basin visions can set out a broad political direction, recognizing the importance of freshwater environments, these visions need to be converted into more specific objectives and actions. Water environmental objectives are often described not in terms of specific water quality, volume or protection parameters, but the desired environmental purpose or outcome. This is often one or more of the overarching objectives identified above: maintenance of key system functions, particular water quality objectives, or conservation of particular ecological systems or species.

The specification of environmental objectives in terms of purpose or function rather than particular parameters is an important development of strategic basin planning. It permits stakeholders and political decision-makers to understand the purpose of environmental measures, and the reasons that the costs and trade-offs associated with those measures are required.

It can permit the development of multiple actions to achieve a particular objective, which is likely to be particularly important in the many contexts where ecological health depends on a range of parameters such as habitat, water quality, connectivity and flow regime. Importantly, it can allow for the revision of more detailed actions and implementation plans if these higher-level objectives are not being met.

Box 49: Examples of environmental components of basin objectives

In each of these cases, environmental objectives are expressed in terms of the purpose or function of an environmental service. This not only allows for measures and objectives to be revised if they are not meeting this objectives, it also engenders political support for the goals.

Goals of the Breede-Overberg CMS

- Riverine water quality is maintained at an acceptable level for the irrigation of fruit and vegetables.
- Adequate water of good quality is allocated to meet the social objectives of service delivery and equity.

Water resources targets for Rhine 2020 Vision

- Water quality must be such that the production of drinking water is possible only using simple near nature treatment procedures.
- The water constituents or their interaction must not have any adverse effect on the biocoenosis of plants, animals or microorganisms.
- Fish caught in the Rhine, mussels and crayfish must be fit for human consumption.
- It must be possible to bathe in suitable places along the Rhine.

Actions identified under the Yellow River 2020 Master Plan

- Establish a sediment deposition mitigation system in the lower Yellow River.
- The water quality of important water function zones will reach level 3 or better.
- Eco-environmental needs of important section in the main stream will be ensured. The deterioration of water ecosystem will be controlled.
- The monitoring and management system of water and soil conservation and prevention will be perfected. New water and soil erosion caused by human activities will be controlled.

KEY ENVIRONMENTAL STRATEGIES

In order to achieve the specified environmental objectives, a key component of basin plans will be a number of core environmental strategies. While the focus will vary with the particular challenges and pressures, basin plans are likely to require the following related strategies:

- **Environmental flows.** Details of the environmental flow requirements for the river, including both overall quantities and the timing of environmental water needs. The strategy will probably also need to identify more detailed objectives that the environmental flows strategy is designed to achieve, for example maintenance of channel form, prevention of saline intrusion, or support to migration of particular species.
- **Basin prioritization, zonation or protected areas.** Where different areas of the basin are to be afforded different levels of protection or purpose, this needs to be set out in the basin strategy. Recognition of different levels of environmental objectives for different parts of the basin is emerging as a key component of basin planning, allowing for the protection of parts of the basin that are particularly important for the maintenance of key processes or protection of high value or representative ecosystems.
- **Species, habitat and ecosystem conservation.** The strategy should identify priority species, habitats and ecosystems, and the measures that will be put in place to ensure their protection. Measures can include limits on activities within critical areas and protections for specific species (such as fishing bans), as well restoration and rehabilitation.
- **Infrastructure development.** Meeting basin environmental objectives will typically have implications for the construction and operation of existing and future infrastructure in the basin. This can include designation of certain parts of the basin as 'no go' areas for infrastructure, designations on total cumulative infrastructure construction in the basin, and details of operating rules for key infrastructure in the basin.
- **Water quality.** The water quality strategy needs to specify both specific water quality targets for relevant water quality parameters (such as dissolved oxygen, nutrients, heavy metals), and actions to be delivered and the sectors responsible for delivering and financing these.
- **Catchment protection.** Strategies can relate to maintaining vegetation cover and reducing erosion, soil degradation and livestock in important parts of the catchment, particularly within the river corridor or upstream of drinking water sources.
- **Cultural and social development.** Rivers are central to a range of cultural and social activities. In many places, they also support significant tourism. Strategies can be required to protect the particular values associated with direct human uses of the river. These can relate to maintaining aesthetics, access, water quality (for instance, to support swimming), and supporting cultural and other recreational activities.

The environmental flows, prioritization and infrastructure strategies for the basin will have profound implications for a range of other strategies, including basin water allocation and use strategies and infrastructure development strategies. These need, therefore, to be developed with an understanding of their implications for other strategies in the basin.

IMPLEMENTATION PLANS

Achieving the environmental objectives of the basin plan requires both specific plans for the environmental sector, and the development of environmental elements of broader basin planning processes. Key stand-alone implementation plans are likely to include water quality, fisheries and wetland management planning. In the context of environmental flows and infrastructure development, there will be a need for strong environmental aspects to overall basin water allocation and infrastructure planning.

Box 50: Environmental planning and the South African Water Act

The South African Water Act (1998) represents one of the most ambitious attempts to include environmental requirements within a comprehensive modern basin planning approach to water management. The Act is based on the principle that 'the protection of the quality of water resources is necessary to ensure the sustainability of the nation's water resources in the interests of all water users'. The Act introduced a number of key environmental requirements, including the establishment of environmental water needs as a prior right, or reserve, before economic uses of water, and the need for 'resource quality objectives' to be set, allowing for different levels of environmental objectives for different parts of river basins as a means to allow for the balancing of development and environmental objectives. The primary mechanism for implementation of the Act is envisaged as the development of a series of catchment management strategies across newly established, catchment-based water management areas across the country.

Progress in implementation of the requirements of the Act has proceeded more slowly than had been hoped, in particular due to challenges of institutional capacity. A key live issue within the country is the extent to which the implementation of the environmental requirements has become too complex and technical, with difficulties integrating environmental and water resource planning within overall basin management.

Source: Republic of South Africa (1988).

7.4 The process of environmental basin planning and alignment with development priorities

Basin environmental planning can vary in complexity and scope. For example, it may be a simple process that focuses on a single issue such as infrastructure location. Alternatively, it can be a comprehensive process that considers a greater complement of possible requirements, seeking to establish environmental priorities across large river basins. As with all other aspects of basin planning, it is important that the process is tailored to the challenges in the basin and the availability of institutional capacity. Unnecessarily complicated processes for small basins in areas with low institutional capacity can result in environmental requirements that are too complicated for incorporation within the basin planning process.

While the environmental component of strategic basin planning is an important programme of work in its own right, it should not become separated from the main process of basin planning. Environmental analysis and requirements are at the core of basin planning. The main elements of environmental planning are the same as the broader basin planning process: understanding the current situation and future scenarios in sufficient detail; identifying priorities; setting clear, high-level objectives for the basin; and translating these into actions through implementation plans.

Figure 23 highlights the key environmental planning elements that occur during the basin planning process, distinguishing between the four main stages outlined in the basin planning framework:

- **Situation assessment.** As part of the situation assessment for the basin, a series of analyses need to be undertaken of the present status of the environmental resources, together with assessments of key requirements for maintenance of the system. Central to this will be the development of a strong understanding of the nature of the interactions within the system, and the key functions and services provided by the basin. This is likely to include environmental flow assessment, and an assessment of the connectivity requirements of the main species in the basin. There is also a need to understand the relationships between environmental and development futures, in particular those contexts where social and economic objectives depend on environmental health, for example industrial or agricultural water quality requirements, groundwater recharge and fisheries.
- **Development of basin vision and objectives.** On the basis of the situation assessment, the strategic environmental priorities for the basin need to be identified, in terms of pressures to be addressed such as pollution, or key functions or areas of the basin that are of particular importance. Environmental objectives typically form a component part of the high-level vision and objectives that are set out for the basin. These can be in the form of achievable aquatic environmental water resource objectives, such as a water quality standard or an environmental flow regime. Where zonation of the basin into different areas of protection is undertaken (for example,

in China and South Africa), this can be done while basin objectives are identified. Assessing and understanding the trade-offs and interrelationships between high-level environmental and development objectives is central to the strategic basin planning process.

- **Basin strategy.** Environmental objectives need to be reflected in the key basin strategies. This will often involve the development of more quantitative targets than at the vision and objectives level. The basin strategy is supported by environmental thematic plans, designed to address key environmental issues such as water quality, soil and water conservation, river corridor protection, and environmental flow regulation.
- **Implementation.** As with all other aspects of the basin plan, the environmental objectives need to be translated into detailed implementation plans. For some objectives, this will requires close integration with the major basin actions and thematic plans such as water allocation and infrastructure development. For other objectives, there may need to be specific plans developed, such as urban wastewater treatment plans or fisheries plans.

At the core of the strategic basin planning process is the reconciliation of future development scenarios with decisions about environmental objectives for the basin. This will typically involve high-level political decisions about development priorities, significant programmes of investment, and trade-offs between competing objectives. Strategic environmental assessment and planning can provide a framework by which basin planning addresses these challenges, as well as providing a framework for decision-making over broader economic priorities for the basin.

While aligning environmental and developmental objectives is central to strategic basin planning, achieving this represents a significant challenge. This typically requires an iterative process of assessing the relationships between development and environmental priorities, identifying key issues, and deciding on trade-offs. The use of scenarios can play an important role in this process, allowing for the implications of alternative approaches and management options to be tested.

Figure 24 sets out a stylized process through which development and environmental objectives can be identified, trade-offs assessed, and management objectives agreed. This can be understood in terms of a number of steps. First, as part of the situation assessment, development and environmental priorities can be identified. Second, possible future scenarios for the basin can be identified, and the implications and consequences of these assessed. Where the consequences are deemed to be unacceptable, alternative scenarios can be developed and tested. These scenarios may be environmental scenarios, against which development and economic implications are tested; development scenarios, against which environmental consequences can be tested; or combined environmental and development scenarios. Finally, on the basis of these scenarios, decisions about the future management of the basin can be made, and set out as management objectives for the basin.

The iterative process envisaged in Figure 24 may be undertaken formally as part of the basin planning process, with detailed economic and environmental analysis supporting the development of a range of alternative basin development scenarios. Alternatively, and frequently, this is a process that happens in an unplanned manner, as decision-makers develop and test alternative objectives for the management of the basin.

The process of understanding development and environment priorities, and using these as the basis for developing future scenarios for the basin, can also become a key mechanism for engaging a range of decision-makers and stakeholders in decisions around future of the basin. This approach can allow for the implications of different decisions to be set out clearly, including key trade-offs between development scenarios. The establishment of environmental objectives and trade-offs through a scenario-based process is one of the key techniques at the heart of strategic basin planning.

Figure 23: Process of environmental basin planning

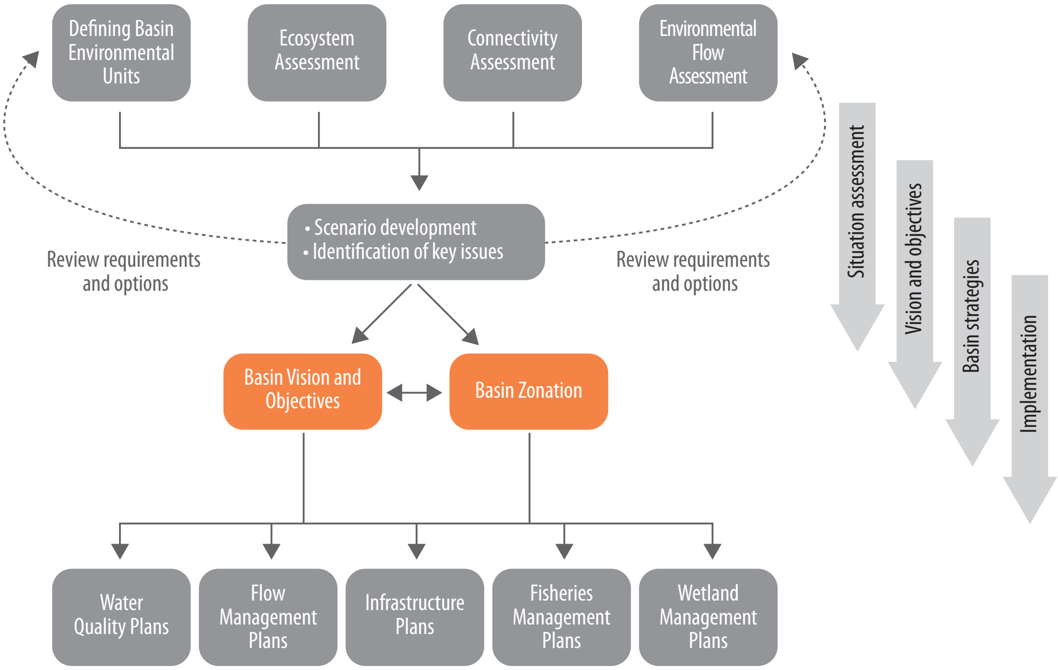
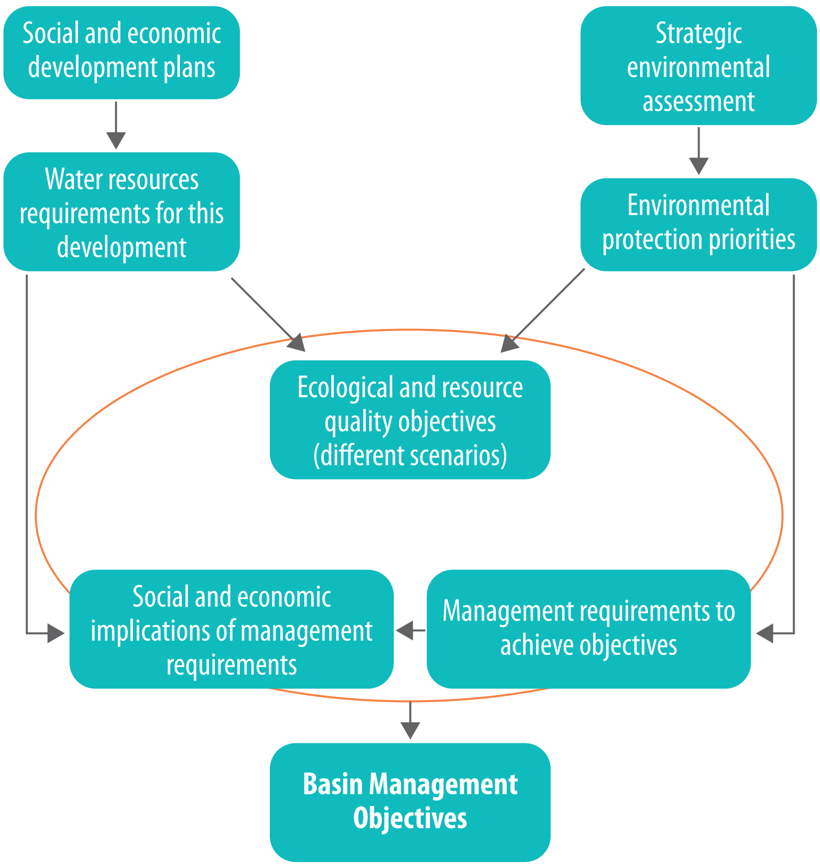


Figure 24: The iterative assessment of environmental and development objectives

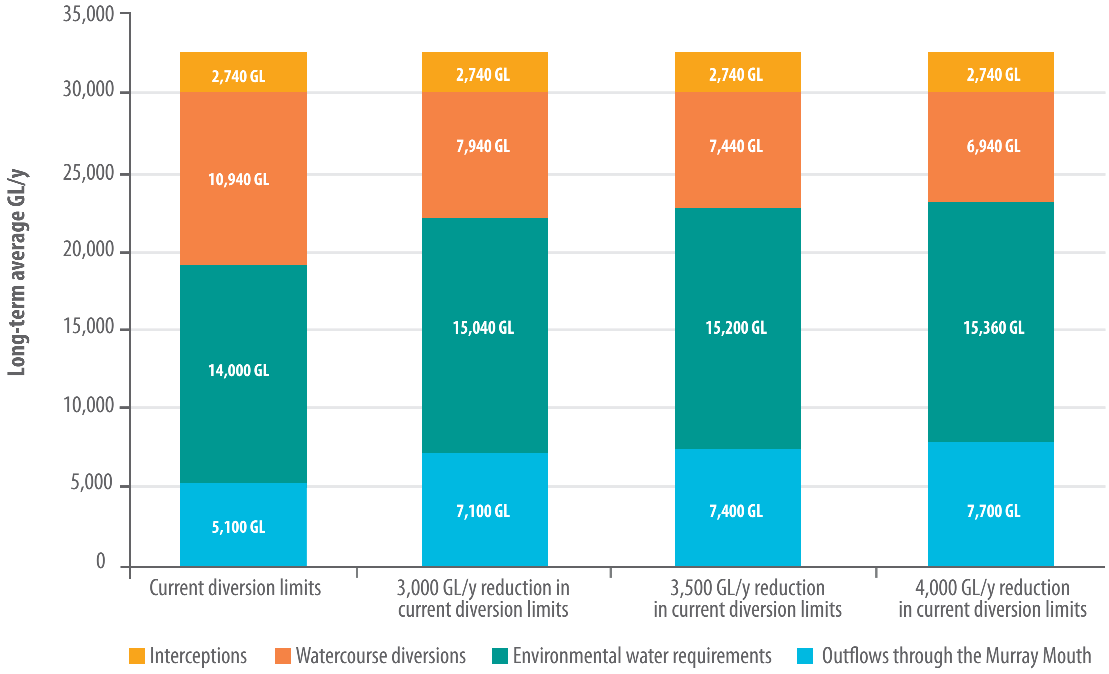


Box 51: A scenario-based approach to reconciling environment and development objectives in the Murray-Darling basin

Over-abstraction and drought in the Murray-Darling system have led to significant long-term impacts on basin and estuarine ecosystems. Australia's 2007 Water Law established and mandated the Murray-Darling Basin Authority (MDBA) to produce a basin plan for the river that optimized social, economic and environmental outcomes. The basin plan is therefore explicitly required to reconcile competing environmental and economic objectives (although how these different interests should be balanced remains a source of major contention).

In preparing the draft basin plan, the MDBA has considered a range of scenarios as the mechanism for assessing the implications of different options related to reducing water abstractions and returning water to the environment. A sophisticated assessment was first undertaken to determine the reductions in abstractions from the basin required to maintain key environmental assets and ecosystem functions. On the basis of this work, the Authority then considered in more detail three water allocation scenarios, involving reductions in abstraction of 3000 (22 per cent), 3500 (26 per cent), and 4000 (29 per cent) gigalitres per year. The socio-economic implications of these reductions for different communities, regions and economic sectors in the basin were then assessed.

An important lesson from international practice is that this iterative process of assessing scenarios and revising objectives can take place over periods of time, and in both formal and informal ways. Such trade-offs are fundamentally political. This is the case in the Murray system. Following the publication of the *Guide to the proposed Basin Plan* in October 2010 (MDBA, 2010), protests within the basin over the proposed reductions in abstraction have resulted in the commissioning of further socio-economic studies by the government, which will be used to inform decisions about trade-offs in the draft and ultimately the final plan.



Source: MDBA (2010).

CHAPTER 8
ENABLING ENVIRONMENT AND IMPLEMENTATION

Developing and implementing a strategic basin plan is a challenging process, whether this is initiated by legal statute or basin concerns. Changing the way that basins are managed is typically a long-term process, and the development of the basin plan will generally go through a series of iterations. The basin planning process has a greater chance of remaining coherent and actionable through these iterations where there is a supportive policy and legal context, a clear institutional home and an effective implementation monitoring system for the basin plan. It is therefore important to consider this broader legal and institutional context and understand the possible barriers to successful implementation.

In understanding the legal and institutional arrangements within which a basin plan is developed and implemented, it is worth revisiting the context of basin planning presented in Chapter 3:

- The differing origins of basin plans, from those that are politically motivated to those driven by legislative requirements.
- The range of different cross-border arrangements, from institutions with clear mandates to manage rivers across provincial or national boundaries, to situations requiring negotiated co-operation arrangements.

This can be seen as a two-dimensional space against which each basin planning process may be plotted at a given time period. It is critical to recognize though that the context of a specific basin may evolve over time, with an associated shift in the legal and institutional arrangements for that basin planning process. As illustration:

- The Delaware Basin Plan (DBRC, 2004) resulted from a politically motivated cooperative process between states, facilitated by a mandated basin commission.
- Murray-Darling basin planning began as a politically motivated cooperative process between states to address existing water problems, but has evolved to being a legally driven requirement of a specifically created legally mandated basin organization.
- The Rhine basin planning began as a politically motivated cooperative process between countries, which now has specific legal content and process requirements at the European level. It is to be cooperatively implemented, facilitated by a recognized basin organization.
- South African policy and legislation enables the establishment and provides the mandate for basin organizations which are legally required to develop basin plans with nationally specified content.
- On the other extreme, the Zambezi basin plan appears to be an (externally) politically motivated plan developed cooperatively as a project within a regional legal framework, but in the absence of a clearly mandated basin organization.

It is important to recognize that basin plans are strongly influenced by the legal and institutional arrangements and capacity within which they are developed and implemented, but conversely these legal-institutional arrangements themselves are informed by and evolve in response to the needs of and lessons learned during the basin planning processes.

8.1 Policy and legislation

While political support is necessary for effective initiation, decision-making and resource allocation for development and implementation of a basin plan, it should ideally be supported by policies and legislation that provide guidance and certainty to decision-makers and stakeholders about government's intent for the basin plan and the mechanisms for its implementation. In particular, the policy-legal framework should:

- clarify the overarching purpose, principles and outcomes of basin planning, including the nature and content of the plan and its legal character
- define the process for developing, approving and reviewing a basin plan, which enables local flexibility, while ensuring concrete milestones and outcomes
- designate and empower the institution(s) responsible for developing and implementing basin plans, including the roles of other levels and agents of government
- require formal mechanisms for stakeholder engagement, the airing of grievances and dispute resolution
- establish the mechanisms and instruments that are required to implement basin management according to the basin plan.

Box 52: The enabling legal framework for basin planning in South Africa

The National Water Act (NWA) in South Africa provides the legal framework for the establishment of catchment management agencies (CMAs) and the development of catchment strategies, and sets out clear legal requirements in terms of content and process for the developing the strategy. This leads to a strategy which is prescribed in terms of addressing specific points of content and process, but which has flexibility to incorporate additional content and process as appropriate.

Section 80 of the NWA requires the CMA to:

a. Investigate, and advise interested persons on the protection, use, development, conservation, management and control of the water resources.
b. Develop a catchment management strategy.
c. Coordinate the related activities of water users, and of water management institutions.
d. Promote the coordination of the implementation of its catchment management strategy with implementation of applicable development plans.
e. Promote community participation in its functions.

The development of a CMA is thus a cornerstone of the catchment management agency's responsibility. In terms of content, the NWA requires the catchment strategy to not conflict with the National Water Resource Strategy, to take into account national and regional plans, to include a water allocation plan, and to set principles for allocating water. In terms of process, the NWA requires, for example, that the catchment management agency seek cooperation and agreement from various stakeholders.

Source: Republic of South Africa (1988).

In the absence of "a clear national or regional policy and legal framework, the basin plan itself must clarify these aspects following agreement by the mandated stakeholders within the basin. This is particularly important for basins that cross state boundaries, whether this is within a federally decentralized country with water management mandated at a state or provincial level, or between countries.

Box 53: Institutional arrangements as part of the Delaware basin plan

The *Water Resources Plan for the Delaware River Basin* (DRBC, 2004) was created voluntarily by the relevant US basin states to provide a unified framework for addressing water resource issues, as opposed to being required by a national law. As it is a plan applicable across state boundaries, the relevant legal framework includes legislation of each basin state and national legislation.

Following a long history of divided management, a sense of shared ownership of the Delaware River emerged and resulted in the formation of the Delaware River Basin Commission (DRBC) in 1961. The DRBC is comprised of federal government and states joined as equal operating partners for coordinated water resources management. Although the DRBC was formed much earlier, it was not until 1999 that the basin states resolved to develop a comprehensive basin plan.

The formation of the Delaware basin plan was initiated by basin states in an agreement to cooperate, and was not required by law. Despite this, the basin plan must still comply with both state and federal legal requirements, and is therefore highly fragmented to comply with applicable legislation.

Source: DRBC (2004).

The legal framework also dictates the process of approval or endorsement of the plan. Legally required processes typically require formal political approval at a national or state level, while mandated institutions require approval by the organization's accounting authority (its board or executive). Given the importance of stakeholder support to the implementation of basin plans, most legally required basin plans also require a period for obtaining and considering stakeholder comments on the basin plan before formal approval. Politically motivated cooperative processes have more complex approval processes, which typically require political endorsement and even ratification of the plan by the parties (states or countries).

8.2 Institutional arrangements and capacity

Effective strategic basin-wide planning is difficult without a single mandated lead institution to drive the process. This does not imply that this institution must necessarily have the all of the decision-making and implementation powers and functions, but rather that it is recognized to have the authority to convene and facilitate the cooperative planning process at a basin scale. Where a river basin organization exists, this is the natural institutional home for basin planning. In the absence of a basin organization, an institution with a jurisdiction across the basin or a formally established joint committee that is recognized by the parties may serve this purpose.

Box 54: Establishment and empowering of the Murray-Darling Basin Authority

Institutional responsibilities for management of the Murray-Darling basin have evolved significantly over the past century. A basin commission was first established in 1917 to give effect to the 1915 Murray Waters Agreement, although the commission's powers were mostly limited to coordination and monitoring. Over time, the commission's powers have slowly been expanded in response to growing challenges – for example, the commission was given certain responsibilities in respect of water quality in 1982 in response to growing salinity issues. Fundamentally though, the commission (in its various forms) could be characterized as an organization whose function remained one of coordination and monitoring, and significantly, it had multiple masters – the Australian state, territory and federal governments.

Despite significant efforts at improving management arrangements in the basin, river health across the basin continued to decline during the 1990s and 2000s, and water security was threatened, as a result of a combination of over-allocation and extended drought. These and other factors led ultimately to the recognition in certain quarters that the existing management arrangements – which involved the state governments having primary responsibility for water resources management in the basin – were unsustainable. The combination of local politics and the states acting in their own self-interest were limiting the capacity of the existing institutional arrangements to produce the whole-of-basin outcomes required.

This led to a federal government 'takeover' of management of the basin's water resources. This was implemented by the relevant by the relevant state governments agreeing to refer certain powers over the basin to the federal government. This paved the way for the establishment under federal law of the Murray-Darling Basin Authority (MDBA), which replaced the former commission. While the new authority is required to consult with state governments, it is directly answerable to the federal water minister alone. The Water Law 2007 also created a far more powerful mandate for the authority than its predecessor. The authority is charged with preparing the first whole-of-basin plan, which will including binding limits on water abstraction for each of subcatchments across the basin, as well establishing a basin water quality and salinity management plan.

Sources: Connell (2007), Le Quesne and Schreiner (2012).

Increasing complexity and uncertainty within basins has led to more sophisticated and multidisciplinary basin planning. This in turn demands greater institutional capacity from the managers and practitioners responsible for the development and implementation of the basin plan. Global experience highlights the fundamental importance of matching the basin plan with the institutional capacity available to implement it. Where this is not done, the basin plan remains as a paper 'wish list' on the shelf and is not converted to action on the ground.

There are two aspects to this conundrum. The first is to develop the strategic actions and designate the responsibilities within the basin plan, considering the likely available capacity and resources for implementation. These should not be interpreted as the existing capacity and resources, but rather those that can realistically be built over the timeframe of the plan. Thus the second aspect is to establish institutional strengthening as a cornerstone of the plan. This strengthening may be at the basin scale, focusing on the capacity of the mandated basin institution, and/or may have a decentralized focus, particularly where sub-basin institutions will be required to implement many of the actions required by the plan.

Box 55: National strengthening as part of the Danube basin plan

The *Danube River Basin District Management Plan* (ICPDR, 2009a) applies to states which differ in individual capacity, and differ in their ability to receive EU assistance as a result of membership or non-membership of the European Union. In recognition of this diversity, the basin plan acknowledges potential difficulties for certain states to obtain financing or sustain pollution abatement in the short term. The managing body, the International Commission for the Protection of the Danube River (ICPDR), is funded by basin countries in relation to their ability to contribute, meaning that poorer countries contribute less.

Importantly, however, the Danube basin plan also facilitates the institutional strengthening of basin states. For example, EU financing for interventions to achieve pollution abatement and to stop degradation is available to EU Member States. Additionally, states which are not part of the European Union may receive assistance in accessing funds from external sources such as the World Bank to build institutional capacity and finance initiatives.

Source: ICPDR (2012).

In doing this, it is important to consider the multifaceted nature of institutional capacity, which includes at least the following seven dimensions:

- **Policy and legal capacity:** the enabling framework for basin planning, including the appropriate mandates and management instruments for implementation of the basin plan, as well as the legal standing (approval) of the basin plan itself.
- **Planning and managerial capacity:** the ability of those driving the process to facilitate the basin planning process strategically in typically complex institutional environments and to translate the outcomes into implementable activities by numerous organizations and individuals.
- **Human and infrastructural capacity:** the technically skilled people and associated information, communication and logistical infrastructure necessary to acquire (monitor), evaluate (assess) and synthesize diverse water, environmental, social, economic and institutional information in order to make recommendations and implement actions for basin management.
- **Organizational and procedural capacity:** the structures and systems required to support the implementation of the basin plan, through direct regulatory control, economic incentives, participatory cooperation and institutional collaboration.
- **Financial capacity:** the financial resources required to develop the basin plan and to implement the actions outlined at the necessary levels and by the responsible parties, which

includes the ability to secure and manage these funds effectively (see further below).

- **Network capacity:** the linkage into peer groups and associations that assist in sharing experience with other basin planners and through this to strengthen the other dimensions of institutional capacity for basin planning.
- **Stakeholder support:** the legitimacy of lead institutions and the perceived credibility of the basin plan by various stakeholders that will be responsible for acting for its implementation, whether these are public, private sector or civil society role-players, without whose support the transaction cost of implementing the basin plan increases dramatically.

8.3 Financing implementation

Implementation of basin plans can be costly and the sustainable funding of the relevant actions is not always easy to achieve, particularly where there are challenges in terms of revenue generation from water users or insufficient funds from the national or state budget. In addition, there may be questions about the value of the benefits derived from the implementation, relative to the costs. Ensuring effective and sustainable funding for implementation should be a central consideration in the planning process. Indeed, enabling financial resources can be the key step to achieving real results in a basin.

Basin plans may incorporate, or be supported by, separate financial plans, detailing the proposed approach to funding actions under the plan. It can be relevant to consider:

- **The financial cost of different activities.** This can include costs associated with construction of infrastructure, operation and maintenance, river rehabilitation and restoration activities, implementing regulatory systems, and monitoring and compliance.
- **Potential sources of funding.** Actions may be directly funded by governments, including through development assistance in the case of developing countries. It is increasing common for governments to look recover basin planning and management costs from those that derive benefit from the river system, such as through water user fees or polluter fees.
- **The appropriate mechanisms and institutions for collecting and directing funding.** Ideally, those organizations with responsibility for developing and implementing strategies under a plan should have some level of control over their funding arrangements.

Box 56 describes some approaches and issues related to funding drawn from international experience.

Box 56: Funding basin plan implementation

The Murray-Darling Basin Agreement (MDBA, 2011) includes detailed provisions on how the Ministerial Council will determine the financial contributions to be made by the signatories to the agreement in respect of investigations, construction and administration costs, as well as maintenance costs for shared infrastructure in the basin. The agreement also prescribes how funds will be administered. Separate from the basin agreement, federal funding programmes, such as the National Action Plan on Water Quality and Salinity, have been aligned with basin initiatives – such as the basin salinity management strategy – to ensure funding and actions are linked.

In Mexico, financing for water resources management plans is provided by the federal government, mostly through Conagua. Approaches to financing have included increasing water income through water rights fees, and transferring infrastructure to farmers (and thus transferring responsibility for maintenance costs). One of the key objectives under the National Water Plan is to 'improve the technical, administrative and financial aspects of the sector'. This requirement is mirrored at the basin level. For example, the 2004 Coordination Agreement for the Lerma-Chapala Basin (CEA Jalisco, 2004) includes four strategies, one of which is 'sustainability and administration of water'. Actions under the strategy include reviewing tariffs and promoting legislative reforms to establish financial mechanisms linked to rights and obligations, to support the recovery and sustainability of the basin.

In South Africa, institutional capacity, together with a lack of sufficient financial resources to support planning and implementation, has been a major limiting factor to implementation of basin plans. For example, BOCMA is dependent on an allocation of funds from the federal water department, since the collection of water management charges has not been delegated to the CMA. This has raised several concerns regarding the financial sustainability of CMAs largely because of lack of certainty in terms of how much funding it will receive, and when. The CMA is thus dependent on national processes (such as those related to tariff reform) for its financial viability, and such processes may not be sufficiently responsive to needs and opportunities on the ground.

In the Danube, the EU WFD specifies that the financing of the Joint Programme of Measures (JPM) is a national responsibility. The plan however indicates that the necessary financial resources for implementing and sustaining pollution abatement might in the short term exceed the capabilities of some of the member states of the ICPDR, and EU financial support is available for the poorer EU Member States. Financing the interventions in the non-EU states remains a problem, and in these cases the ICPDR may facilitate access to international financing bodies like the World Bank. Commitment to management interventions for the non-EU states may consequently be incentivized by the promise of financial support to comply with the JPM.

In China, national water policy requires the establishment of a compensation mechanism for sharing the costs and benefits arising from harnessing, exploiting and protecting activities across a basin. Financing will primarily be from government investment, supplemented by public investment. Amongst other measures, the Chinese government has spent significant energy developing mechanisms for 'ecological compensation', to share the costs and benefits associated with managing a basin. Such arrangements can provide, for example, incentive payments to provinces that achieve particular water quality targets, at the same time as requiring that payments be made by the downstream provinces that benefit from the improved water quality.

8.4 Monitoring and reporting

The ultimate purpose of a basin plan is to enable coherent and strategic management of the basin water resources to support associated social, economic and ecological systems. While every endeavour is usually made to develop an implementable and effective basin plan, the specified actions might not be implemented adequately, their implementation might not contribute to the desired outcomes, or the environment might change unexpectedly. Therefore monitoring, together with evaluation and reporting on the results, is a critical aspect of the implementation of the basin plan.

Broad monitoring may relate to water resources, environmental, social, economic or institutional information, and plays a number of roles in basin plan implementation:

- **Operational monitoring:** of the current conditions in the basin assists in making operational decisions and implementing strategic actions by water managers, stakeholders and other role-players, typically on a daily, weekly or monthly timeframe.
- **Compliance monitoring:** of actions and activities by water users or those with an impact on the water resources, as well as those responsible for implementing strategic actions under the basin plan, typically on a monthly to annual timescale.
- **Strategic monitoring:** of the state of the basin over time to provide ongoing understanding of the system or fill information gaps to support longer-term planning, refinement or revision of the basin plan, typically on a multiyear timescale.

From the perspective of the basin plan implementation, monitoring has three related areas of focus:

- implementation of the specified actions within the agreed timeframes (on an annual basis)
- achievement of the defined objectives of the plan, resulting from the actions specified in the plan (on a one to five-year basis)
- contribution to broader social, economic and ecological imperatives related to the vision (within the timeframe of the plan – typically five to twenty years).

Box 57: Monitoring and reporting system associated the Rhine basin plan

The *Rhine 2020 Program on the Sustainable Development of the Rhine* (ICPR, 2001) views success control, or assessments and monitoring, as an essential part of the programme. Assessments are carried out according to the EU WFD, and monitoring programmes have been established in basin countries. In addition to national reports on monitoring programmes required by the WFD, countries in the Rhine basin have also drafted a joint summary report on the coordination of monitoring programmes.

The plan also required the design of new assessment and monitoring instruments which relate to specific objectives. For example, the programme states:

- A new instrument must be developed with a view to controlling progress in the field of creating the habitat connectivity. It must be combined with the requirements of the Habitat and the Birds Directive.
- The effectiveness of measures aimed at reducing flood damage risks must become calculable. Calculation models are under development. Maps illustrating flood-prone areas and areas at risk of flooding in the lowlands of the Rhine highlight the damage risks and their targeted reduction.

Source: ICPR (2001).

The first and second areas of focus are typically included in the monitoring system, but the third area is generally more difficult to assess. Indicators must be developed to reflect actions, objectives or imperatives, according to the implementation priorities of the plan. In developing a monitoring system for a basin plan, the following should be considered:

- purpose of the monitoring system
- costs and benefits of monitoring
- responsibilities for monitoring
- quality assurance and information management
- accuracy and frequency of monitoring.

Finally, evaluation and reporting on the implementation of the plan, as well as the state of water resources and associated social, economic and ecological conditions, closes the planning cycle. The concept of an annual basin planning scorecard has been adopted in some catchments, focusing on the achievement of actions and the objectives. These reports can build confidence in the basin plan by cooperating partners and engaged stakeholders, by providing a measure of transparency and accountability. Alternatively, state of the basin reports can provide reporting on the outcomes of basin plan implementation and water management. Reporting requirements need to be tailored to suit the situation, based on the audience, the type and depth of information required, and the best method(s) for communication.

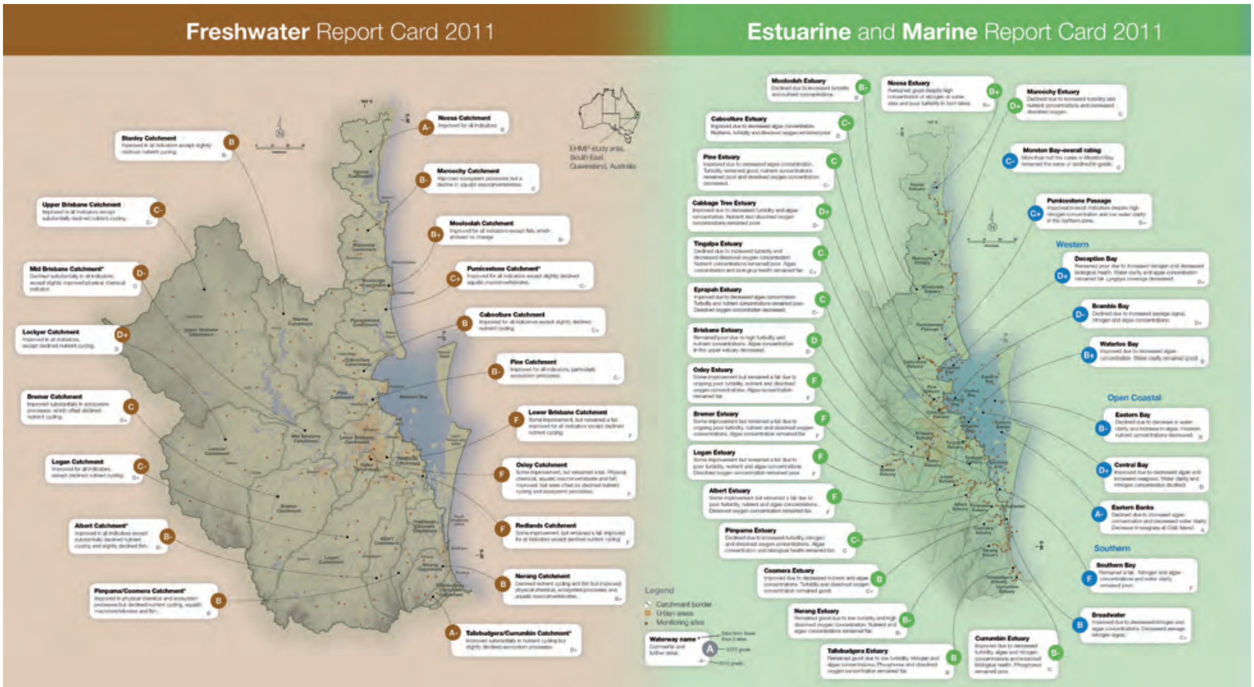
Box 58: South-East Queensland Ecosystem Health Monitoring Program

South-East Queensland's Ecosystem Health Monitoring Program (EHMP) provides an assessment of the condition of the region's rivers and estuaries, as well as Moreton Bay. The region includes Brisbane and the Gold Coast, and is located on Australia's east coast. The *South East Queensland Healthy Waterways Strategy* (2007–2012) identifies a number of actions designed to maintain and improve the health of the region's waterways. The strategy builds on earlier documents, which defined a vision for the region, as well as a series of 'values' to be protected and maintained, developed through stakeholder consultation. The EHMP is a critical tool in implementing the strategy.

The EHMP has been designed to guide management strategies and to assess their effectiveness. The assessment is based on five indicator groups: fish, aquatic macroinvertebrates, physical/chemical, nutrient cycling, and ecosystem processes, with sampling undertaken twice per year at 135 freshwater sites. A further 254 estuarine and marine sites are monitored monthly. Objectives for different indicator values were set based on the requirements to protect the predefined values.

Scores for each indicator are standardized to produce a score from 0 to 1 (with 1 being derived from a reference condition). These scores can then be aggregated and reported for different sites, indicator groups and catchments. Catchments are graded from A (excellent) to F (fail). The assessment is undertaken annually by an independent scientific panel and the results released publicly via a 'river health report card'. The report cards show clearly whether catchment health has improved or declined over the previous twelve months, and attract significant media attention.

The EHMP has been important in building community support for management interventions, as well as guiding those interventions. The programme identified the sources of high nutrient loads in Moreton Bay, which led to an investment in new wastewater treatment facilities. Similarly, studies identified that 10 per cent of the catchment was contributing 65 per cent of the sediment load entering Moreton Bay. This has allowed targeted action to reduce land degradation in those parts of the catchment.



Source: Bunn et al. (2010).

8.5 Barriers to implementation

While the development of a basin plan may be intellectually and procedurally complex, the far greater challenge is in the implementation. This is made even more difficult in stressed basins where tough trade-offs have been made in the planning process (with some perceived losers), indicating that some groups or institutions will have to change their activities or behaviour in order to adopt the strategic actions. The greatest threat is that the basin plan becomes a paper plan that does not change management practice, actions or behaviour in the basin.

The first group of barriers to implementation of a basin plan are in the design of the plan itself. Ways of avoiding most of these are discussed throughout this book, and are the focus of the ten golden rules in Chapter 2. In particular, implementation is challenged when the basin plan:

- is too ambitious or poorly focused, by failing to prioritize issues and attempting to address too many issues
- is too complex or incoherent, in lacking alignment between actions and objectives within the different thematic areas
- rollout is not adequately detailed, with actions are not being clearly defined in terms of activities and responsibilities

- is too inflexible to change, with actions being too prescriptive and not robust to alternative futures, and the monitoring system not enabling adaptation.

A number of quite critical contextual issues can also impede implementation. It is important to recognize that these are seldom technical or even financial, but rather have their origin in the political, institutional and social domains. These can be captured under the following broad categories:

- **Political commitment and awareness:** inadequate leadership to drive implementation and allocate resources means that other role-players may not adopt the necessary changes. Where tough decisions and institutional change are required, support from political leaders is required, which in turn is dependent on their awareness of the issues or perceived magnitude of the concerns being addressed in the basin plan. In short, the shared pain being felt by not addressing the problem (or the perceived benefit of implementing the basin plan) needs to outweigh the individual costs of adopting the strategic actions. This leadership is particularly important where there are trade-offs and may be polarization between and among environmental interests and powerful vested interests. This is best facilitated by targeted messaging for political leaders focused on their actual concerns.
- **Stakeholder legitimacy and cooperation:** individuals not making the effort to change or adapt their functions and activities in order to implement the basin plan. The implementation of a basin plan can seldom be entirely regulated or decreed, because it typically requires the concerted action of thousands of officials and enterprise managers. For this to occur the basin plan and the required actions must be clearly motivated and understood, but these groups also need to have a sense of ownership to foster the need to change, supported by simple mechanisms to incentivize improved cooperation. This is best facilitated by an appropriately constructed stakeholder engagement process linked to the development of the plan.
- **Institutional mandate and capacity:** the inability of key institutions to create and enable the mechanisms that are required to give effect to the strategic actions of the basin plan. The institutions required to drive the implementation of the plan at a basin, regional or local level need to have relevant legal powers, responsibilities and resources to create and/or implement the mechanisms that enable compliance, adoption or cooperation by other groups and bodies. This requires a supportive enabling environment defined by policy, legislation or strategically through the basin plan itself, as well as institutional strengthening and capacity building, with a focus on the apex basin organization that is the designated custodian of the basin plan. In the absence of a mandate, the basin organization will need to strengthen its position through cooperative arrangements with mandated bodies.
- **Management information and communication:** insufficient information to make decisions restricts the operational implementation and adaptation of the plan. Implementation of the actions from a basin plan requires appropriate information to be made available on a timely basis to those making the decisions, as does the refinement or adaptation of actions to respond to changing conditions against a commonly understood baseline. This ranges from acquisition and management of the monitoring of conditions in the basin, through communication of plans and actions between different institutions, to dissemination of information to create awareness in diverse stakeholders. Sound monitoring systems, communications strategies, formal communication and stakeholder engagement mechanisms facilitate improved information sharing to support action.

It is critical that these types of barriers are recognized and addressed during the development of the basin plan, to prevent their becoming insurmountable during implementation. As has been outlined throughout this part of the book, implementation may be supported by:

- understanding the institutional landscape associated with delineated activities
- identifying implementing bodies 'up front', and getting these bodies onboard, for the sake of ownership and support to implementation
- selecting a portfolio of uncontroversial and clearly useful 'fast-track' or 'green lane' initiatives that can start immediately in order to generate momentum
- initiating targeted social marketing, broad promotion and awareness-building.

Box 59: Failure of implementation: the Ganga Action Plan

In response to serious declines in water quality in the River Ganga as result of industrial and sewage pollution, the Government of India launched the Ganga Action Plan (GAP) in 1985. The GAP was a highly ambitious plan to improve water quality through investment in treatment capacity. The Government of India established new institutions to manage and implement the plan, including the Central Ganga Authority in February 1985 (renamed the National River Conservation Authority in September 1995), under the chairmanship of the prime minister. The government also established the Ganga Project Directorate in June 1985 as a wing of the Department of Environment, to execute the projects under the guidance and supervision of the Central Ganga Authority. Despite this high-level political support, the GAP is widely acknowledged as having failed to achieve its objectives. By 2000, only 39 per cent of the intended treatment capacity was reported to have been installed, and, even then, many of these plants were either totally or partially inoperative. Between 1993 and 1999 water quality in the river actually deteriorated. Following the failed implementation of the GAP, subsequent efforts have been launched, including the establishment in 2009 of a new National River Ganga Basin Authority, chaired again by the prime minister.

Source: Government of India (2000).

PART B

TECHNIQUES FOR BASIN PLANNING

Part B presents a synthesis of the most relevant procedures and methods that have been used to support basin planning in each of the stages. The intent is to provide an indication of the purpose of the technique, an overview of the evolution, approach and assumptions behind the various methods that may be adopted for the technique, and a procedural framework for applying different methods. Detailed methodological and technical descriptions are not provided, but case descriptions illustrate the techniques and references to other sources are provided where relevant.

CHAPTER 9
BASELINE SITUATION ASSESSMENT

The principles, approach and process that are adopted in the planning of a basin need to reflect the nature of the basin, its historical evolution and the motivation for the current planning initiative. Where this is not done, considerable time and effort may be wasted.

The situation assessment provides the opportunity to narrow the focus of the strategy and develop an understanding of the key management concerns. It should begin with a comprehensive screening of issues, followed by a synthesis of understanding, and conclude with a prioritization of concerns to be addressed by the basin plan. During this process, both the historical evolution of the basin to its current state and the future development trends need to be considered.

Detailed analysis and understanding should continue throughout the planning process, in response to emerging priorities. This implies that the information in the situation assessment is continually being updated and is only complete at the end of the planning process, not when the visioning starts. Alternatively, the situation assessment may be viewed as continuing in parallel to the other stages in the strategic basin planning process.

Figure 26: Procedure for basin planning project inception and situation assessment

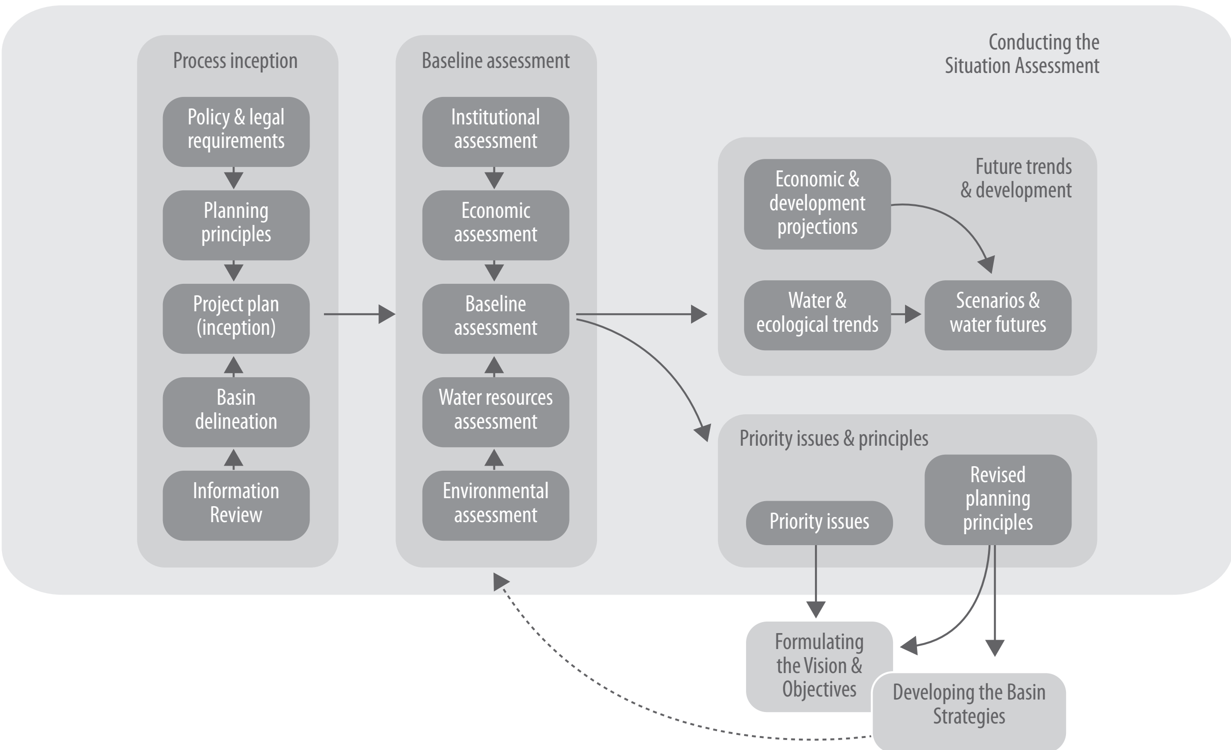


Figure 26 attempts to capture the procedure for situation assessment in strategic basin planning. The activities are outlined in the detailed discussion below. For simplicity of presentation, a linear process is indicated, with the implication that all information from previous activities is carried through subsequent activities. In practice there is significant iteration between the baseline assessment, future development and issue prioritization.

SCOPE OF THE SITUATION ASSESSMENT

The role of the basin situation assessment is fourfold.

- First, it aims to understand the nature and status of the river basin, the hydrological cycle, and interactions between the river hydrological cycle, the landscape, river ecosystems and human activities.
- Its second role is to understand the past and current water resources, environmental, social, economic and institutional baseline conditions in the basin.
- Third, it aims to project future development and water related possibilities around which to plan
- Fourth, to identify and prioritize issues that will guide the further development of the basin plan. This also indicates the scope of the assessment (summarized in Figure 26).

The procedures and techniques adopted for this situation assessment relate directly to the goal of the basin-planning process. At a minimum, situation assessments to support technical basin planning processes tend to focus on the water resources assessment, whether this is hydrological, water use and systems analysis oriented, or water quality management oriented. Comprehensive situation assessments to support more strategic basin planning processes tend to have a broader emphasis on water resources, environmental, social-economic and institutional assessments.

Figure 26 indicates a clear distinction between the assessment of current state in the baseline assessment and the projection of trends and scenarios, in order to highlight the different techniques associated with each activity. In practice, this is not as well defined, with the thematic assessments providing some information about trends and projections that are then incorporated and synthesized into the future developments and scenarios task.

Box 60: Conducting a situation assessment in the Danube River basin

In 2004 the ICPDR completed the Danube Basin Assessment (DBA) which summarized the overall condition of the river using the approaches outlined in the WFD, and was compiled from reports provided by all the Member States except Moldova. It was the first characterization of the surface and ground waters of the Danube River Basin District (DRBD) as a whole. It identified the water bodies at risk, possibly at risk and not at risk with respect to the failure to reach the 'good status' required by the WFD.

The DBA identified four significant water management issues: organic pollution, nutrient pollution, hazardous substances and hydromorphological alterations. Groundwater was dealt with as a separate issue. The DBA then identified the main risks underlying these issues, which were linked primarily to poor or absent urban and industrial wastewater treatment, or poor agricultural practices. In a few cases risks associated with the over-abstraction of groundwater were noted.

The assessment was supported by the results of a Joint Danube Survey undertaken in 2001 which included a detailed survey of all aspects of water resource quality, as well as analyses for substances not routinely analysed by the competent authorities. This process was also used to share information on sampling and analysis procedures, ultimately helping to improve the overall quality of data collection.

A separate analysis of accidental pollution risks was also undertaken, largely stimulated by an accidental spill of cyanide in the Tisza River in February 2000. This process assessed the risk of accidental pollution from sites throughout the basin based on volumes of waste material, the nature of the waste and risk of polluting the river.

According to the requirements of the EU WFD, the DBA also included an economic analysis, although this did not include a rigorous assessment of the economic viability and sustainability of pollution control measures across the basin.

An important outcome of the DBA was the signing of the Danube Declaration in December 2004, which committed all the ICPDR Member States to addressing the issues raised in the situation assessment.

Source: Le Quesne and Schreiner (2013).

It is important to recognize that the assessments conducted to support the development of the basin plan are not necessarily reflected in the basin plan catchment description, which is usually published with the plan. The latter range from a chapter on the water resources status, socio-economic conditions and institutional arrangements in the basin, through to detailed descriptions of issues included in the strategic actions presented in the latter parts of the basin plan documentation. The most important observation is that every plan conducts and presents the situation assessment in a different way, but that there are some common features.

The following sections present techniques to support the environmental, socio-economic, institutional-policy and future development elements of the situation assessment, with only a brief review of the water resources assessment (as this is typically well described in other texts).

9.1 Scoping, design and basin delineation

DEVELOPING A PROJECT PLAN

There are four main elements in the project plan which should be addressed before actually beginning the basin planning process. This may be viewed as an inception phase for the planning process:

- **Clarify the motivation or purpose of basin planning.** This should interpret the implications of a legally, politically or organically motivated planning process (including lead mandate and planning responsibilities), position the plan within the broader social-economic development and resources protection-conservation context, select the broad approach (technical or economic) that will be adopted, and formulate key principles that will guide the planning process.
- **Scope the key challenges and opportunities for basin planning.** A preliminary understanding of the basin information availability, the critical water resources management challenges, the developmental imperatives and the institutional arrangements is critical to designing an effective basin planning process and focusing the situation assessment phase. This is entirely based on secondary information and discussions with selected key water managers and specialists that have insight into the basin.
- **Outline the basin planning process.** The process specifies the phases and tasks required to deliver a basin plan in the required or proposed timeframe (typically from one to four years to develop a basin strategy/plan from inception). This will often include a stakeholder analysis of the important partner institutions and stakeholder groups that have interests in and may influence the implementation of the basin plan, and usually results in an institutional and/or stakeholder engagement plan to support the development of the basin planning process.
- **Establish the basin planning management arrangements.** Managing basin planning is a complex process, and requires management arrangements that balance technical guidance with political relevance. Where a basin organization exists, this tends to be the lead, but it might need to ensure that key planning departments or provincial/local government are also part of the process. An important distinction must be made between the arrangements for operational project management and strategic-political guidance.

These elements are achieved through the following activities:

- **Policy and legal requirements** include issues of institutional mandate and management arrangements.
- **An information review** comprehensively scopes the available information and thereby identifies potential challenges, gaps and inconsistencies.
- **Basin delineation** sets out the basin management zones against which information will be assessed and presented, and ultimately the plan will be developed (see technique below).
- **Planning principles** for the basin planning process, which reflect the legal, policy and strategy intent of basin planning in this country and region.
- **A project plan** which captures all of the inception information to guide the management of the basin planning process.

A facilitator with understanding of the basin planning and multidisciplinary processes is typically necessary to guide the basin plan inception (or project formulation). This is particularly relevant in basins in which there are shared mandates, sensitivities or mistrust between key stakeholders. The development of this project plan can take anywhere from two months to a year in more institutionally complex basins.

PLANNING PRINCIPLES

There are two distinct types of planning principles relevant for the basin plan, namely:

- **Procedural principles,** guiding the way in which the basin planning process should be conducted, which need to reflect the institutional, political and historical management context in the basin.
- **Substantive principles,** guiding the strategic development of the basin plan itself, which need to reflect planning priorities and development imperatives of the core stakeholders.

Box 61: Procedural principles

These are adapted from the Global Environment Facility's (GEF's) transboundary diagnostic analysis (TDA)/strategic action programme (SAP) guidelines:

- Full stakeholder participation in developing the objectives and strategic options for the development of the basin plan.
- Transparency in information sharing and decision-making, with information in the public domain and made available by the river basin organizations.
- Joint fact-finding between the basin organization, other institutions and stakeholders builds credibility and trust between groups.
- Integrated management recognizes the interrelated nature of hydrological, ecological, social and economic systems, in line with the national water policy and legislation.
- Adaptive management requires flexibility in approaches to respond to unforeseen circumstances or inadequate management decisions.
- Causal understanding of the underlying economic and social drivers, and the balance between equity, sustainability and efficiency is clearly motivated by the need for integrated and adaptive management.
- Subsidiarity to implement management at the lowest appropriate level, particularly through other institutions, where these have appropriate mandate and capacity.
- Intersectoral (and intrasectoral) focus, recognizing the relationships (in terms of impact and influence) of other sectors with water resource management.
- Stepwise consensus building to reach a broad consensus, beginning with small wins and areas of agreement at each step in the process.
- Pragmatism in selecting implementable options, considering capacity and resource availability in the short and medium term.
- Clear accountability by the basin organization, government and stakeholders for implementing agreed elements of the strategy.
- Joint commitment to the strategy and its elements by key stakeholders, including formal endorsement where resources are required.
- Institutionalizing the process by linking to existing structures, developing water sector participatory bodies and empowering stakeholders.

Source: Bloxham et al., 2005

BASIN DELINEATION (DEFINING MANAGEMENT AREAS)

The definition of the river basin boundary is usually specified before the planning process is initiated, and typically reflects the surface hydrology boundary of the basin (although groundwater aquifers may be considered). Small coastal catchments may be combined within a single plan, because urban areas often stretch over a number of these smaller catchments.

Often the river basin is too large and complex to analyse and manage as a single unit. The basin should be subdivided into sub-basin 'management areas', in order to:

- manage the diversity and complexity of issues and information at the basin scale, by breaking the basin up into coherent and relatively homogeneous parts
- facilitate the effective planning and implementation of basin-level water resources management, supported by local planning that reflects local possibilities and concerns
- reflect institutional mandates in different parts of the basin, to enable decentralization of the planning process.

Management areas are primarily defined along hydrological boundaries often distinguishing major tributaries, but considering many of the following factors:

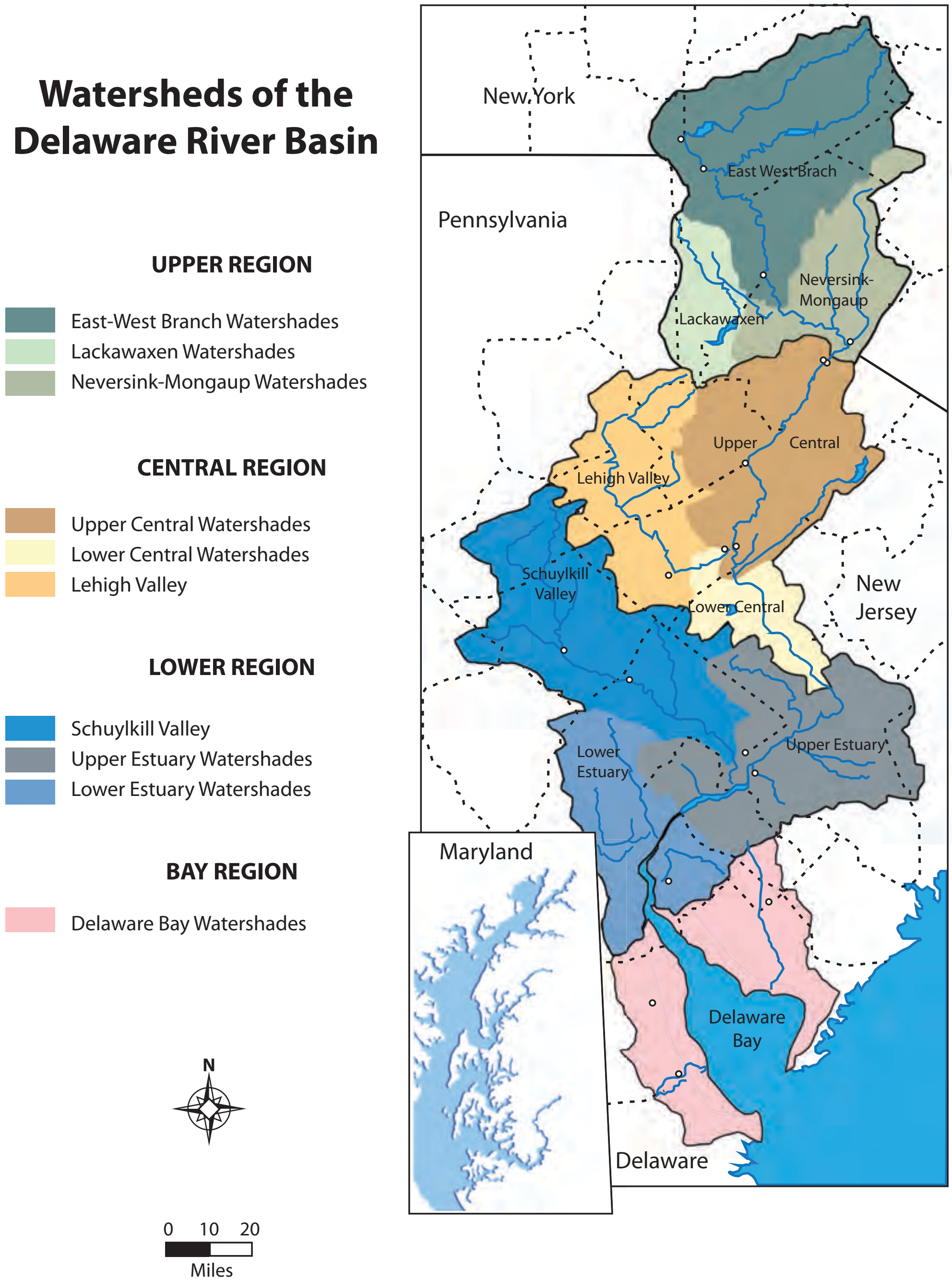
- water use patterns
- groundwater aquifers
- ecosystem functioning
- catchment biophysical conditions
- water infrastructure connectivity
- social and economic characteristics
- institutional arrangements and capacity
- administrative boundaries related to water mandates.

The aim is to define a pragmatic number (typically between five and twenty) of sub-basin areas with relatively similar conditions, issues and management arrangements. Further disaggregation may be done for the purposes of hydrological or ecological analysis, but these will be represented as units within the higher level management areas.

A single basin plan may also be developed for a cluster (number) of small coastal rivers in a water resources management zone, in which case multiple rivers with similar characteristics may be defined as a single management area.

Box 62: Catchments used for the Delaware basin plan

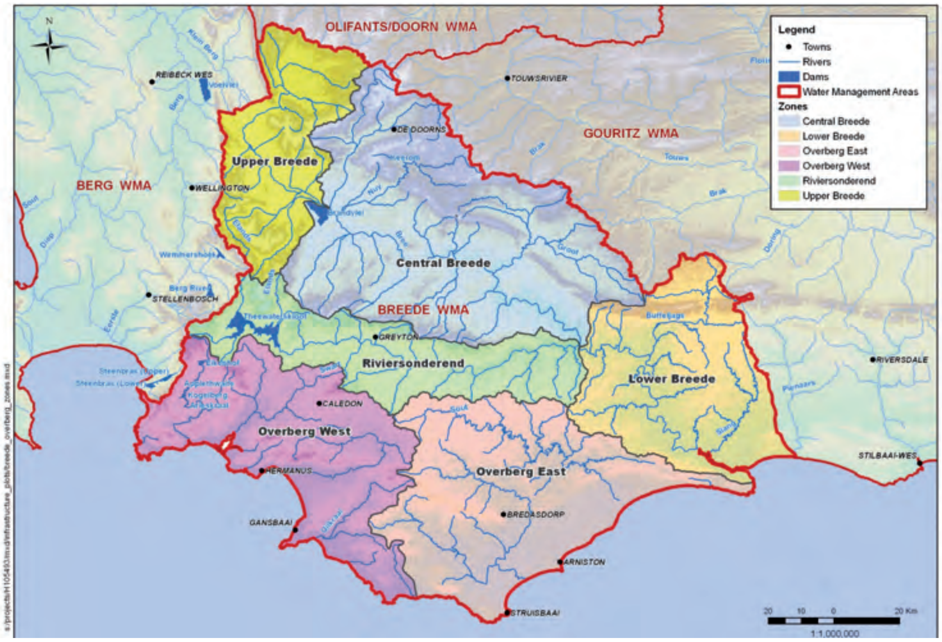
The Delaware River basin is subdivided into seven main stem catchments and three tributary catchments, upon which the basin analysis and planning was focused. These partly reflect state boundaries, but in some parts of the basin these boundaries follow the river course.



Source: DRBC (2004).

Box 63: Management zones for the Breede-Overberg catchment management strategy

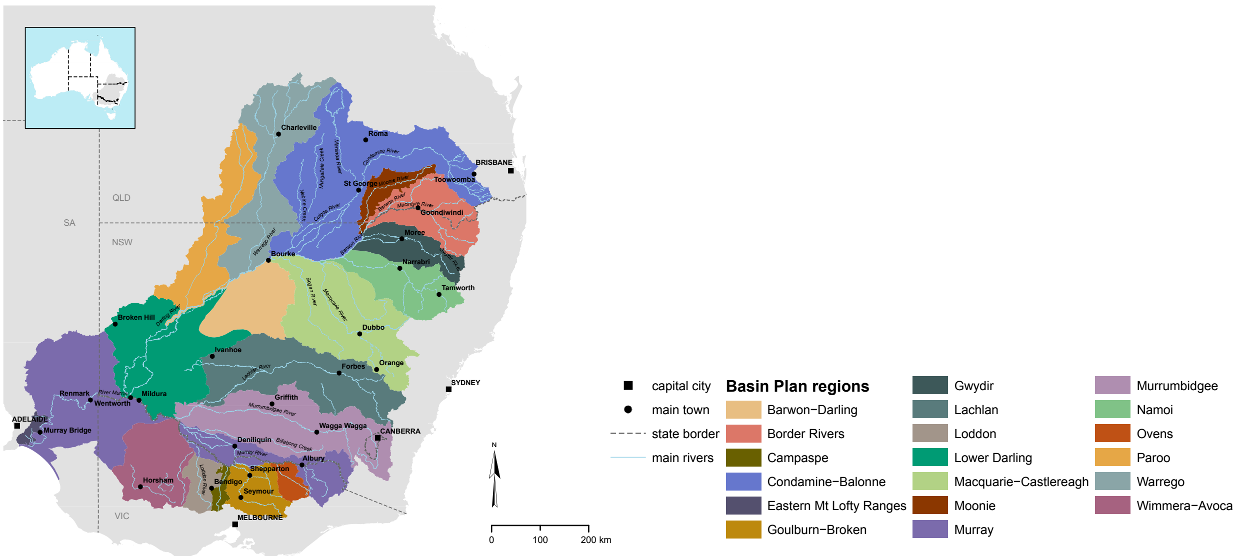
The Breede-Overberg water management area was separated into six management zones reflecting catchment boundaries, but also considering the physical interconnections and institutional responsibilities for managing local supply schemes. The Breede River was divided into three zones on the main stem and one large tributary, while the nine small coastal rivers were combined into two zones according to socio-economic and local government linkages.



Source: BOCMA (2011).

Where administrative boundaries with a mandate over water resources subdivide the basin, hydrological boundaries are usually maintained, but these may be further subdivided for the purposes of managing allocations.

Box 64: Basin plan regions for the Murray-Darling Basin plan

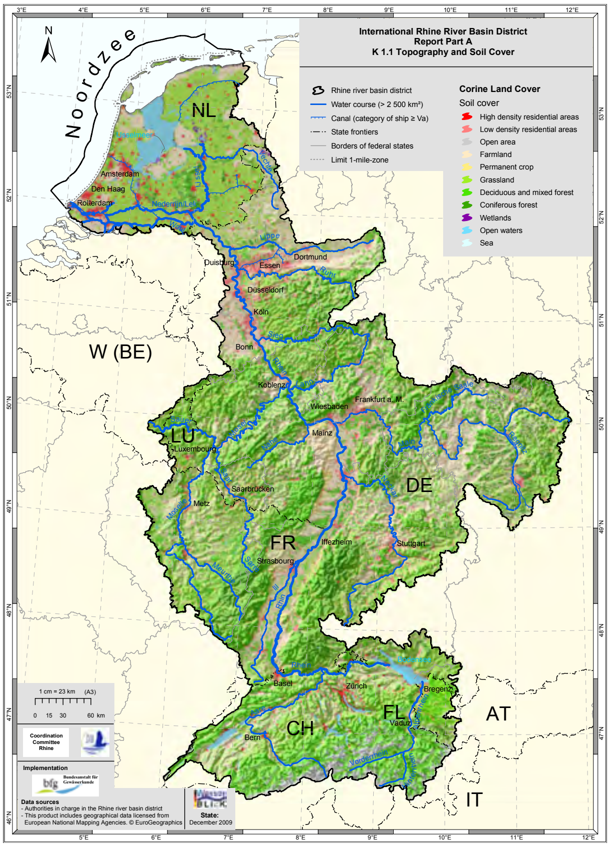


The Murray-Darling basin was subdivided into eighteen basin plan regions based on hydrological characteristics. However these were further divided to account for state boundaries for the purposes of sustainable diversion limits (that is, water allocation).

Source: MDBA (2010).

Where there is a water quality or flood focus, however, catchment boundaries are not necessarily subdivided along administrative boundaries.

Box 65: Sub-basins in the Rhine basin management plan



The Rhine River basin is divided into nine sub-basins based on physical characteristics, with six on the main stem and three covering tributaries. This is appropriate because the focus is on water quality, so the management of discharge to these transboundary sub-basins is addressed through institutional cooperation mechanisms.

Source: ICPR (2009).

9.2 Water resources assessment

Approaches to this aspect of the basin plan are well established and are traditionally well covered in most water resources planning processes through a 'water resources situation assessment' or a 'basin monograph'. This component is therefore not discussed in detail in this section, apart from the following brief comments.

The water resources assessment component typically consists of various thematic studies around existing or emerging issues for the basin. These studies use a range of disciplinary relevant simulation and/or optimization analysis techniques, the nature of which is relatively standard for most basin planning processes. Data limitations pose the greatest challenge to these studies. The common elements of a water resources assessment include:

- water demand (and water use) requirements (including water use efficiency)
- hydrological analysis (historical and current day)
- water balance (comparing annual or seasonal availability and requirements)
- system analysis (based on infrastructure operation at a specified assurance of supply)
- water quality assessment (point and nonpoint sources impact on instream quality)
- flood risk assessment.

Other potential studies in some basins include:

- hydropower analysis (linked to energy strategy)
- navigation requirements (linked to transport strategy).

The process of analysis typically goes through a number of stages, with a comprehensive broad screening (shallow) assessment of all issues, leading to more detailed (deeper) thematically and geographically analysis of specific issues of concern.

The historical and present-day situation is the focus of these assessments, but projections of possible trends and future impacts are often included in the analysis process, to inform the scenario-building process. It is important to recognize that the reconciliation of water availability and demand is often built on uncertainty (even without climate change possibilities), because inadequate historical water resources monitoring might restrict the understanding of water availability, and inadequate monitoring of actual water use and restrictions to availability might disguise the demand. The analysis however needs to drive towards confidence in the estimates, rather than reflecting uncertainty alone.

A final, but critically important, dimension of the water resources assessment relates to monitoring and information systems, which provide the basis for adaptive management and review. The adequacy of these systems must be assessed against the information management needs of the basin.

9.3 Environmental assessment

The environmental assessment is a core part of the situation assessment, and one that is becoming increasingly important to basin planning exercises globally. Traditionally, the environmental assessment component of a basin plan was based on approaches to environmental impact assessment (EIA). The EIA family of techniques involve the assessment of the consequences of draft basin strategies and plan, undertaken ***after*** the substantive decisions around basin planning have been made. EIA approaches are therefore significantly limited in the extent to which they can contribute to the key decisions over basin management, and at the most can usually only identify mitigation measures. As basins have come under increasing environmental pressure, in many cases these mitigation measures are no longer sufficient to safeguard key environmental functions and conditions in the basin. Under strategic basin planning approaches, however, EIA is undertaken ***before*** key decisions over the future management and development of the basin are undertaken. Environmental issues therefore play an important role in shaping the overall approach and strategy for the basin.

Many of the environmental assessment techniques available for use in strategic basin planning are based on approaches that have emerged through the development of strategic environmental assessment (SEA), including SEAs in the context of water resources planning and policies (Hirji and Davis, 2009). SEA constitutes a wide range of techniques; rather than being a single approach, it represents a family of approaches. Many of the objectives of SEA in the water sector are similar to the motivations for the development of strategic basin planning more broadly, including the desire to understand environmental functioning and impacts at the whole basin scale, an attempt to integrate environmental and water resources planning and priorities, and the incorporation of a broader range of stakeholders in the planning exercise. Some of the more developed SEA approaches, such as the GEF's transboundary diagnostic analysis (TDA), are effectively strategic basin planning exercises in their own right. While SEAs can be undertaken as stand-alone exercises that seek to meet many of the objectives of strategic basin planning, the same techniques can form components of broader strategic basin planning exercises.

The environmental assessment needs to reflect the key characteristics of the overall basin situation assessment, including both a thorough assessment of the baseline situation in the basin, and the identification of key priorities to be addressed in the basin plan. While baseline assessments of some form are relatively well established, the development of tools and approaches to allow for prioritization of environmental issues and management strategies is emerging as a key component of strategic basin planning.

BASELINE ASSESSMENT

The first step in the environmental assessment is a review of the existing environmental conditions in the basin. This can be broadly divided into three areas:

- environmental zonation
- aquatic ecosystem and functioning:
  - morphology and sediment
  - water quality
  - fisheries
  - ecological assets and species
  - wetlands
- human impacts and dependencies on aquatic ecosystems:
  - pressures and impacts on ecosystems and water quality
  - economic and social values, including direct use, non-use values, fisheries, spiritual and cultural values and so on.

While baseline assessments are conceptually straightforward, they present a number of practical challenges. First, there is often poor or nonexistent data for many variables. This may require creative use of available data, for example records of fisheries catches. Where important data gaps are identified, this can provide guidance to the establishment of more comprehensive monitoring programmes that need to be established in the implementation of the basin plan. There may also need to be a recognition that decisions will often need to be made on the basis of weak data.

Second, prioritization of key issues emerging from the baseline assessment is important. The baseline assessment is likely to collect a very large volume of data, and there is a danger that it will become impossible for priorities for action to be identified.

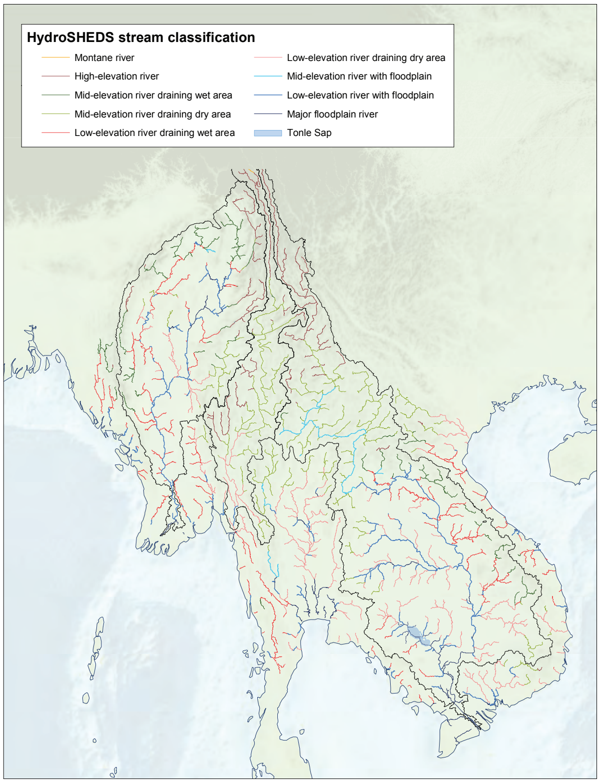
As part of the baseline assessment, division of the river basin into environmental zones can be undertaken. No study can address every kilometre of river, or every person living within a basin. Thus, representative areas are used to represent whole study areas. These areas should be reasonably homogeneous in ecological character and/or function. The biophysical environmental delineation aims to identify stretches of river that differ from each other but are internally ecologically similar. This is different from the management area delineation described above, which is based on range of other factors and tends to be at a coarser scale.

Box 66: Environmental units in the Mekong

WWF coordinated a delineation of environmental units for the Greater Mekong Subregion, based on hydrogeomorphic characteristics, and including system type, elevation, geology, vegetation, hydrology and stream network characteristics.

Each type class was subdivided into different elevation zones, and each of these unique combinations was then further subdivided according to geology, vegetation, etc. A preliminary delineation was then adjusted at a workshop of regional experts.

The resulting assessment indicated the distribution of the main different habitat types in the river basin.



Source: WWF (2010*b*).

Once identified, one or more representative sites can be chosen in each environmental unit, which become the focus of data-collection activities, and the results from each will be extrapolated over the entire unit. These units determine the focus, design, effort and scope of the subsequent environmental assessment and management tasks, but must also be aligned to the broader basin planning activities. Therefore, the definition of environmental units must also consider the basin management delineation.

In recent years, a more comprehensive approach to the assessment and monitoring of river health has developed in many locations. For example, the monitoring and assessment of ecological data has become increasingly important in situation assessments. Whereas earlier environmental components of basin planning exercises tended to focus on a more limited suite of water quality data, there is an increasing focus on ecological indicators. In the United Kingdom for example, implementation of the WFD has resulted in the development of a more comprehensive suite of ecological indicators than the pre-existing general quality assessment indicators. The consequence of this greater collection of ecological data has been to reveal a far wider range of pressures on freshwater ecosystems that had previously been evident.

In a similar way, a number of more evolved approaches to comprehensive 'river health' assessments have been undertaken. A 'healthy' river is generally considered one that has maintained its ecosystem integrity, and thus the capacity to maintain its structure and function, as well as to support biota and dependent communities, including human communities. River health assessments, often undertaken as part of routine, ongoing monitoring programmes, measure the condition of a waterway using a series of predefined indicators and reference values. Indicators commonly used include physical and chemical parameters (such dissolved oxygen, pH, conductivity), biota (for example the number, richness or diversity of fish, macroinvertebrate or algal populations, as well as riparian vegetation), hydrology (often with reference to changes to the natural flow pattern) and physical form (measures relating to the structure and form of the river channel).

Ideally, indicators are selected that are suitable to local conditions, to reflect the local, natural environment, the key assets or priorities in the catchment, and known pressures. Importantly, indicators need to respond predictably to disturbances in the catchment (such as changes in land use, or pollution), which allows them to be used to measure changes in overall river condition.

Reference values for each indicator are set based on what values would be expected from a river in good condition, often based on measures taken from undisturbed 'reference' sites. Reference values can also be set an 'acceptable' condition (which maybe something less than a pristine site). This is most common for water quality parameters, with values set based on levels that are suitable for the intended use of water from the river: drinking water supplies, irrigation and so on.

River health assessments can provide valuable information on both the health of a waterway

and changes in its health. Importantly, these programmes are designed to be diagnostic. Ideally they will be able to assess the cause of a decline in river health. The assessment may be able to identify whether it is point or diffuse pollution that is the cause of water quality problems; whether it is human or livestock waste that is contributing to high nutrient loads; or which parts of a catchment are contributing most of a river's sediment load.

These types of assessment are designed to provide both information on the current state of a river, estuary or catchment, and to guide management actions including prioritization of restoration activities. They are also valuable in assessing the effectiveness of management actions.

A comprehensive river health assessment programme can serve not only to inform the objectives of the basin plan, but to play an important ongoing role in monitoring the success of actions under the plan in meeting the stated objectives, and allowing for communication of progress in an accessible way with stakeholders.

ENVIRONMENTAL PRIORITIZATION AND PLANNING TECHNIQUES

The situation assessment phase of basin planning needs not only to establish existing environmental conditions in the river basin, but in addition to identify the priority issues for future planning in the basin. These priorities play an important role in informing the assessment of trade-offs with other basin planning goals and identifying the vision, objectives, and strategic actions for the basin plan.

Basin-scale environmental planning exercises typically seek to meet two overall objectives (Nel et al. 2009):

- **Representation,** which seeks to adequately conserve the full variety of biodiversity features in the river basin. This requires the protection or restoration of a representative sample of main habitat types and species within a river basin, as well as protection of sites of particular importance.
- **Persistence,** which requires maintenance of the natural processes in the river basin that underpin key functions of the river basin, and maintain ecosystems and biodiversity in the river basin.

The environmental basin planning techniques identified below each contribute to these overall objectives. The appropriate planning techniques will depend on the particular context and challenges in the river basin. Three related assessment techniques are discussed here: environmental zonation and prioritization, environmental flow assessment, and connectivity and infrastructure assessments. In complex basins facing multiple pressures it is likely that there will be a role for each of these, with the results of each assessment informing the others.

Environmental priority zonation

The purpose of environmental priority zonation techniques is to identify the areas of the basin that are of particular importance for protection and conservation, and should be afforded particular recognition or protection in the development of the river basin plan. Criteria for the selection of priority freshwater ecosystems vary but include:

- protection of an intact example of each of the main habitat types found within the basin
- presence of globally, nationally or regionally significant concentrations of species (particularly endemic or endangered species)
- globally, nationally or regionally significant areas where most naturally occurring species exist in natural patterns of distribution and abundance
- formally protected areas (such as RAMSAR sites and national parks)
- rare, threatened or endangered ecosystems that are not formally protected
- areas fundamental to meeting the needs of local communities (for example, for food, health, drinking water)
- areas fundamental to the regional or national economy (such as fisheries)
- areas that provide ecosystem services in critical situations (such as flood attenuation, nursery areas, maintenance of dry-season base flows)

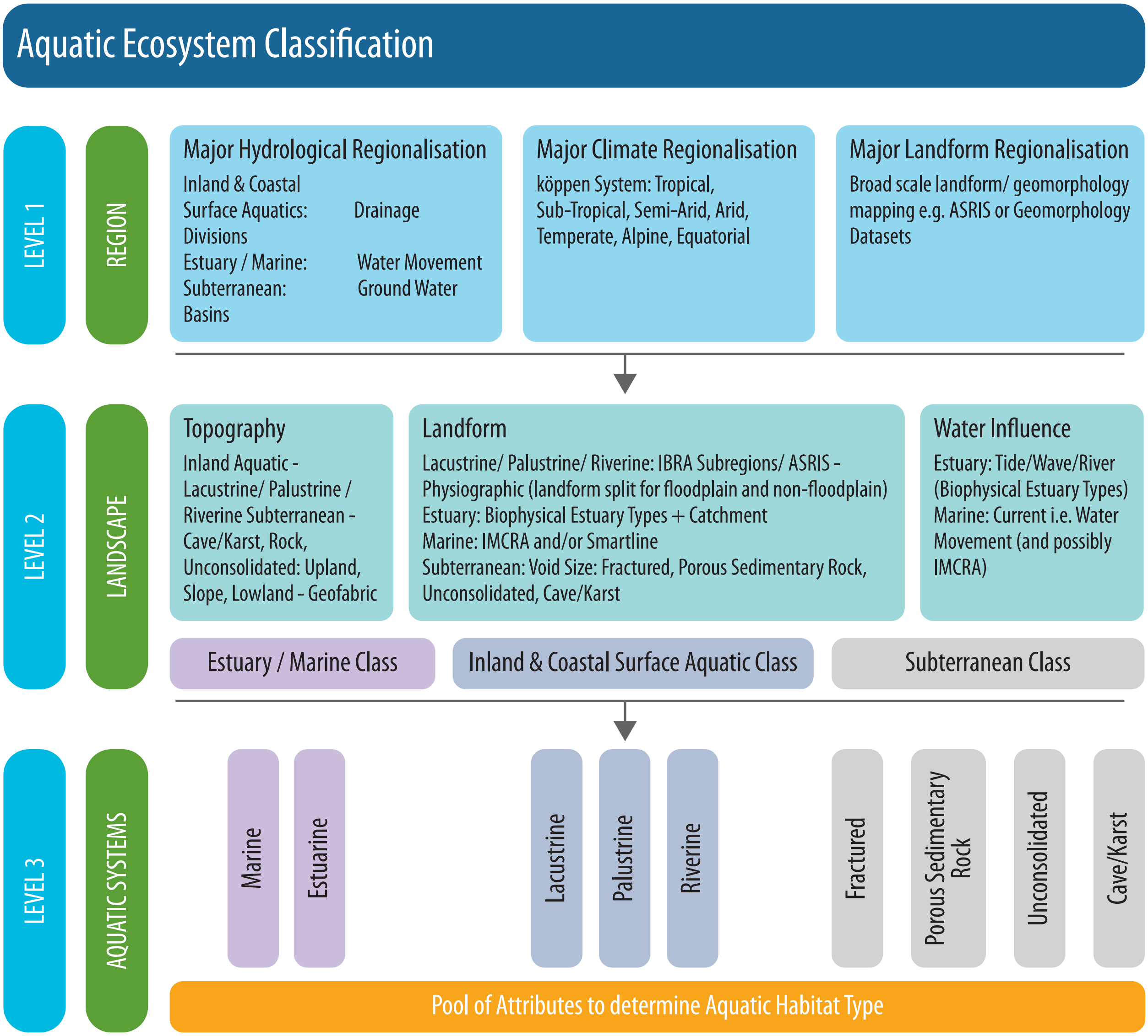
These assessments seek to identify the most important areas, processes and functions in the basin that need to be conserved and protected in the river basin plan. They provide, among other things, maps of the distribution of freshwater ecosystems that should be conserved to meet agreed biodiversity targets and/or protect critical ecosystem services, such as flood attenuation. Environmental priority zonation exercises therefore build on the environmental zonation exercises undertaken as part of the baseline assessment.

Under some basin planning approaches, one of the objectives of basin plans can be the establishment of a comprehensive system of basin environmental zonation, with different levels of protection afforded to different parts of the basin. Comprehensive approaches such as this are under development in South Africa and China, and are discussed in more detail in Chapter 12.

There are numerous different approaches that have been used to assess the biodiversity value for different basins around the world. Typically, they use decision-support software (DSS) to undertake assessments that are spatial, GIS-based, and make use of criteria that include representation of selected groups of species, although substitutes for species richness, such as river types/zones, habitat integrity and extent of anthropogenic threats, have also been used.

Box 67: The Australian National Aquatic Ecosystem classification system

The Australian National Aquatic Ecosystem (ANAE) classification system was designed for use in the assessment of the distribution and extent of different aquatic habits and their relationships to the distribution of biota. This aids in the identification of areas of high conservation significance (see the table below).



An important feature of this scheme is that it identifies habitat or hydrosystem types that are linked to aspects of hydrology. For example, palustrine wetlands require overbank flow for inundation. Knowing that such hydrosystems exist in a catchment clearly identifies the need for flooding to be incorporated in environmental flow planning if such habitats are to be protected. The ANAE has been used to identify and map hydrosystem diversity and distribution in Australia, most recently in the identification of high conservation value aquatic ecosystems of northern Australia.

Source: Auricht (2010).

Environmental flow assessment

The timing and volume of the flow of water through river basins plays a vital role in supporting the functioning of freshwater systems and their biodiversity. Environmental flow assessments aim to develop an understanding of the role of the flow regime in maintaining the functioning of the freshwater environment. The outputs of environmental flow assessments are often central to the overall basin planning process: they influence the volume of water that is available for use and the timing of flows of water through the system, with important implications for both hydropower and flood control infrastructure.

While environmental flows are a relatively new science, there are now a very wide number of different methods that have been used to undertake environmental flow assessments in a range of contexts across the world. The methodologies range from rudimentary approaches that can provide a preliminary view in a short period of time, through to very complex processes that can provide detailed information with higher levels of certainty. The choice of the appropriate environmental flow assessment technique will depend on the conditions in the basin. For example, in relatively underdeveloped basins with limited infrastructure and relatively infrequent water stress, a comparatively quick assessment may be appropriate. In river basins with key environmental functions and important infrastructure development, more complex and sophisticated flow assessment methods are likely to be appropriate.

Environmental flow assessment can be prescriptive (they state how much water is needed for ecosystem maintenance) or scenario-based (they describe what would happen to the ecosystem if different flows were allocated for river maintenance). Some also include consideration of the livelihoods of people that use the systems for subsistence.

For a more detailed discussion of environmental flow assessment, see the accompanying volume to this one on basin allocation planning (Speed et al., 2012).

Connectivity and infrastructure planning

The impacts of infrastructure on freshwater ecosystems can be profound, including inundation of habitats, changes to flow and sediment regimes, water quality impacts in downstream reaches, and interruption of migration and connectivity in the river system. The maintenance of freshwater ecosystem quality and functioning can imply constraints on the construction and operation of infrastructure within the river basin plan. A number of these aspects will be covered by the more general environmental prioritization exercises: environmental priority zonation implies the identification of areas of the river basin in which infrastructure construction should be prohibited, or limited and undertaken with caution; environmental flow requirements will have important implications for the location, design and operating rules of any basin infrastructure.

In addition to these broader basin environmental issues, a particular environmental implication from infrastructure construction is on connectivity in the river basin. Where infrastructure is an important feature of the basin planning process, a basin connectivity assessment can form an important part of the environmental assessment.

Connectivity is widely acknowledged as a fundamental property of all ecosystems (Kondolf et al., 2006). In river systems, it refers to the water-mediated fluxes of material, energy and organisms within and between the channels, floodplains, alluvial aquifers and other parts of the ecosystem, and operates in longitudinal, lateral and vertical dimensions, and over time (Ward, 1989, cited in Kondolf et al., 2006). These connections support and drive ecosystem structure and function, affecting processes such as flow patterns, life-cycle strategies and food supply. Levees, channelization, incision, dams, barrages, weirs or flow reductions all impact on these links, with a concomitant impact on ecosystem functioning, integrity and biodiversity. In many places, the most significant connectivity issues from a basin planning perspective are likely to be upstream and downstream connectivity, often of vital importance in supporting fisheries migration.

Protection of ecosystems in a basin, or parts thereof, thus requires that these vital connections are maintained, and that limits are set on the sorts of infrastructure or channel manipulations that are acceptable there.

The connectivity assessment identifies the primary lateral and longitudinal linkages that support the freshwater ecosystems identified in the conservation assessment task. These include:

- the lateral and longitudinal movement of animals and plants, such fish migration routes, drift of seeds and larvae, and access to refuge areas
- the movement of sediment through the system
- in some cases, the lateral and longitudinal linkages that moderate the flow regime, such as floodplains that attenuate floods, and groundwater links that supply baseflows.

Box 68: Connectivity assessment for the Danube River

In development of the Danube River basin management plan for the Water Framework Directive (ICPDR, 2009b), the barriers to connectivity, in particular for sturgeon migration, were identified as one of the key environmental issues. ICPDR, the body responsible for producing the Basin management plan, commissioned an exercise to identify priority sites for restoration of connectivity in the basin. The assessment identified priority sites based on a weighting that combined the amount of migratory habitat opened up, the distance from the river mouth, whether an obstacle was the first upstream, and the protected status of any reconnected habitat. A map indicating priority areas for intervention was published as part of the *Danube River Basin District Management Plan* in 2009. Although this part of the plan does not legally bind countries to plan measures strictly based on this methodology, it has nevertheless become an important decision support tool for the future management of the basin.

Source: ICPDR (2009b), Annex 18: Draft ecological prioritisation of measures to restore river and habitat continuity in the DRBD.

9.4 Institutional and economic assessments

Institutional and socio-economic analysis is becoming increasingly important in the situation assessment, because these provide an understanding of the linkages of water into the broader development and economic realms.

SOCIAL AND ECONOMIC ASSESSMENT

Typically, the baseline situation assessment describes the social and economic conditions in a basin and develops an understanding of possible future growth in key water-using sectors. Similar analyses are used to assess the potential social and financial implications of different management options (as part of the strategy formulation process). As with the environmental assessment, the social and economic assessment therefore broadly divides into basic descriptive material relating to socio-economic characteristics in the basin, and more analytic attempts to understand priorities and trends in the basin.

In terms of the baseline economic and social assessments, the following information is typically collected at a regional, basin or zone scale:

- structure of the economy, including geographic differences in the basin
- economic growth and sectoral distinctions
- employment characteristics

- income distribution and inequality
- human development (indices)
- health and education status
- access to services.

In addition to this baseline data, a number of more sophisticated analyses can be undertaken to attempt to understand the social and economic priorities associated with water use in the basin:

Economic value of water

A range of economic methodologies are available that attempt to understand the relative economic value of water to different locations and sectors of the economy. These assessments can show huge disparities between the economic value added and employment generated from water used in different parts of the economy. As a characteristic example of one of many studies that have been undertaken internationally, a 2007 assessment in the Hai River in northern China estimated the economic value of water in industries such as mining, energy, manufacturing and construction at 19 yuan/m^3, compared with 4.2 yuan/m^3 in agriculture (GIWP, 2007). In addition to comparing the different values of offstream consumptive uses of water, economic valuation exercises can attempt to assess the value derived from other instream uses of water, in particular hydropower, but also navigation.

Understanding the relative economic value of water in different sectors can yield important information to contribute to basin planning. However, there are a number of drawbacks to relying on this information as a stand-alone in making planning decisions. First, decisions are in fact rarely made on the basis purely of economic value-added. Even leaving aside political influence, basin plans are likely to wish to take into account a broader series of socio-economic issues, for example employment, equity, foreign exchange earnings, food security, strategic importance, or support to marginalized economic groups. These are not accounted for in economic valuation exercises. Second, these analyses do not consider future development scenarios and imperatives. As a consequence, economic valuation studies and cost–benefit analyses are rarely used as the principle tool for basin planning, as opposed to playing an important contributory role.

Future economic development scenarios

Central to the process of strategic basin planning is the need to develop an understanding of future economic growth scenarios, and the implications of these for water demand. This can include a detailed analytic assessment of gross domestic product (GDP) growth projections, assessments of sectoral growth, and an understanding of the implications of these for water demand in different parts of the basin. In addition to this more quantitative analysis of future water demand trends, there is a need for basin plans to understand the future economic, development and planning strategies in the basin, and the implications of these for water use. Developing this understanding of economic and planning priorities in the basin is likely to require engagement between basin planners and economic and planning decision-makers in the basin throughout the development of the basin plan.

Social impact and dependency assessments

As basin plans seek to make trade-offs between existing and potential future users of water, there is an increasing need to move beyond simply analysing the marginal economic value-added of water, and understand the broader socio-economic context of water use. Understanding these effects through assessments of the socio-economic impacts of proposed basin plans can reduce negative socio-economic impacts and maximize benefits. The concept of dependency is often used as an important part of these assessments. This concept tries to understand the extent to which alternatives to existing water using activities are available to sectors and regions. The concept can enable the identification of those groups that will suffer the most significant adverse impacts from reductions in water allocations.

External costs associated with water quality

Assessment can be made of the external economic costs associated with water quality in the basin, in particular costs such as treatment costs associated with poor water quality. This can assist in developing investment programmes to address these water quality declines, and provide important motivation to decision-makers to approve such programmes.

A more extended discussion of some of the economic assessment methods associated with water resources and allocation planning is contained in the parallel book to this on basin allocation planning (Speed et al., 2012).

Box 69: Estimating economic information in the Netherlands

In the Netherlands, three economic analyses have been conducted since the introduction of the EU WFD. These were conducted across the whole country. The first analysis, completed in 2005, provided a high-level estimate of the potential costs of implementing the WFD in the Netherlands but was limited by the lack of detail of what measures were actually going to be undertaken.

A strategic cost-benefit analysis (SCBA) was then completed in 2006. The SCBA started from the assumption that the WFD objectives would be met by 2015. The analysis was based on data gathered from the eight river basin districts and at national level, and looked at the costs and benefits of different measures and different intensities of implementation. There were considerable limitations to this assessment, since the scenarios provided by the regional authorities were different in nature in the different basins, and the information on costs was often unclear and ambivalent. As a result, some information had to be interpolated or estimated.

Source: Batterink (2006).

The emerging techniques around water footprint at a basin scale provide a possibly promising avenue to link water utilization with the economy it serves. The water footprint of a basin is defined as the total amount of water that is used to produce the goods and services in the area. Once the water footprint has been developed, this enables the use of water and the flow of embedded water in and out of the catchment to be described, and this can then be linked to the social and economic use/value of water resources.

The greatest challenge of all these types of analysis relates to the lack of information at the scale of analysis required. Few countries outside of Western Europe and North America have reliable economic and demographic data at a local scale, particularly where demographic change (growth and migration) and economic development (growth and sectoral shifts) are very dynamic. This is further complicated by the boundary differences between social and economic data reported at an administrative scale.

Finally, it is worth noting that despite conducting these social and economic assessments, many planning processes still use technical and financial analyses and political considerations as the basis of decision-making. However, if the analysis sets out the social and economic implications for the basin, the strategic planning discussion can be influenced to consider developmental aspects.

INSTITUTIONAL, LEGAL AND GOVERNANCE ASSESSMENT

A strategic basin plan is likely to have a profound impact on the institutional environment within and related to the river basin. It is therefore essential to have a full understanding of the historical, current and emerging institutional context. This implies that the institutional assessment needs to identify and understand the key stakeholders in the water sector and other sectors, their mandates and relationships with the mandated basin water management organization, their policy and planning initiatives that need to be considered by the basin plan, their financial arrangements and their relevant capacity. This implies:

- assessment of the roles, functions and capacities of the different organizations in the basin
- understanding the plans of other sectors: it is important to be clear how this is different from an assessment of future socio-economic scenarios.

The institutional assessment considers the critical aspects related to implementation: legal mandates, policy intent, governance arrangements, and financing and organizational capacity. This guides the identification of stakeholders that must be engaged on key emerging issues, and also highlights particular bottlenecks that may be faced in the acceptance of the plan and its eventual adoption.

A critical aspect of this review relates to potential misalignments between the policy and development planning intent of different government sectors. This enables the identification of gaps and inconsistencies between policies and plans, as well as potential inconsistencies in plans for the water available in the basin.

This leads to the institutional mapping of the roles and relationships of government departments, agencies and levels of government, together with their interactions with private sector and nongovernmental organizations around water-related and developmental issues. Typical elements of the institutional mapping include:

- **Water management institutions:** Understanding the roles and relationships between institutions and structures (both legally established and informally functioning) that are involved in water management. This ranges from the national department of water and national agencies or authorities, through basin-level organizations and provincial departments, down to entities involved in the local operation of irrigation schemes, urban and domestic water supply systems, and local water resources management.

- **Provincial and local government:** Understanding the roles and relationships of the water sector with provincial and local government mandates related to spatial, social and economic development, as well as environmental management and conservation. This should include an assessment of the pragmatism and relevance of plans and initiatives at different levels, because often paper plans are not meaningful or the relevant institutions do not have adequate capacity to implement them. Therefore, this assessment should develop a clear picture of the water-related requirements, impacts, management challenges and opportunities for the basin plan development, and will usually require direct engagement with provincial and local government.

- **Other institutions:** A number of other institutions have an influence on the water resource management arena which needs to be captured in this institutional review. Among them are other national departments and their agencies and in some instances programmes. The potential intentions of the private sector should be considered, particularly linked to agri-business, as should be the engagement and intentions of active nongovernmental and community-based organizations.

9.5 Identifying issues and refining planning principles

As highlighted above, basin planning in complex situations cannot address all issues in all places. It is necessary to identify the key water resources issues and carry out some level of prioritization, both for the situation assessment and for the further development of the plan. In the final stage of the situation assessment these issues should be identified. This stage forms the bridge between situation assessment and the development of a basin strategy. Identification and prioritization of issues is typically done through a combination of the following:

- political priorities/negotiation dictated by political leaders emerging in response to events within the basin or country
- expert perspectives of knowledgeable managers and practitioners, gained through a Delphi-type process
- technical/economic analysis and screening of issues by a small project team during the baseline assessment
- the engagement of local stakeholders through consultation sessions and technical review and synthesis of their inputs.

The identification and prioritization of water-resources-related issues is usually an iterative process, with priorities emerging during the situation assessment baseline and future scenario analyses. During this process, understanding improves around these issues, particularly as they relate to specific problems and zones in the basin. In some cases, causal relationships are explored to describe the base and intermediate causes of an issue. Important considerations in assessing the priority of an issue include:

- the current social, economic or ecological severity of impact associated with the issue
- the future expected severity of the issue under changing circumstances
- the uncertainty associated with current understanding or future implications
- the feasibility and degree to which basin planning can address the issue.

These priority issues are used in three distinct ways in the basin strategy process:

- to refine the substantive principles on which the remainder of the process will be based, in order to reflect the specific nature of the basin planning challenges and opportunities
- to guide the focus for the basin visioning and objective-setting process
- to indicate the thematic areas of focus (systems) that must be developed as part of the basin planning process, which will eventually be rolled out into thematic plans.

CHAPTER 10
ENGAGING TRENDS AND UNCERTAINTY

10.1 Purpose of the future assessment

Basin planning clearly needs to consider the current water management issues highlighted by the baseline assessment, but at the same time must identify emerging issues and potential threats. This future assessment is particularly important for strategic basin planning that takes a long-term perspective, within a dynamic and uncertain climate and development environment.

There are two distinct ways of approaching this future assessment, reflecting different views of the future. The first assumes that the future can largely be predicted (within bounds) and that the management response can be optimized, possibly even considering different trajectories with their estimated probabilities of occurrence. The second recognizes that the future is highly uncertain and that management responses need to be robust to various alternative pathways (with no indication of probability of occurrence) within the domain of possible futures. Traditional water resource planning has been largely based on the former. However, the latter is being increasingly explored in response to the acknowledgement that development and climate changes imply that the future is fundamentally uncertain.

Strategic basin planning is therefore evolving to reflect a paradigm of uncertainty about the future, rather than trying to anticipate and plan for one or more probable futures. This need to develop robust solutions that can accommodate multiple futures is driven by two key uncertainties:

- **Rapid social, demographic and economic change** has been observed in several basins (particularly in developing countries). This can lead to water requirements or use patterns that are different from those that were present or anticipated at the time of planning. These unanticipated changes lead to challenges when the basin plan is too rigid in its design. For example, the Yellow River shifted rapidly from a primarily agrarian economy to an industrial economy towards the end of the twentieth century and the beginning of the twenty-first century. This led to very different development and water use patterns than were anticipated at the time of the water allocation agreement in 1987.
- **Climate change** may cause variation in rainfall and temperature that affects water resource availability, increases the frequency and severity of floods and droughts, and disrupts the ecosystems that maintain water quality. The degree of change in a specific area and the timeframe over which change will occur is difficult to predict, resulting in significant uncertainty.

There are also two distinct ways in which to assess the degree to which water and its management impact on the broader social and economic development drivers of change. Traditional water resource management assumes that the development future is independent of the water future, and therefore basin planning needs to respond to these exogenous drivers of water requirements. Alternatively, as water resources become stressed, water resources availability and management have a greater influence on economic and social development pathways, and the role of water as a catalyst or constraint to development is being considered through feedback to the understanding of future water requirements for strategic basin planning.

There is increasing recognition that strategic basin planning requires one to gaze into a future filled with uncertainties, while being aware of the context of water in the broader political economy. The way in which water resources are protected, developed and used has a profound influence on broader public and private-sector risks and opportunities, and therefore has significant consequences for economic activity, social development and political stability.

Understanding and evaluating these uncertainties and their impacts on future development, hydrological and water demand patterns, is a fundamental part of the situation assessment phase of strategic basin planning. Various techniques have been adopted or proposed to assess these changes and uncertainties, some of which are described below in three groupings:

- the impact of future development on water resources (and vice versa)
- the impact of climate variability and change on water resources and vulnerability
- the impact of development and climate uncertainty on robust decision-making.

The ultimate purpose of understanding the future is to inform decisions as part of the basin planning process. Therefore the approaches that are used to assess the future situation also typically support decision-making that considers or optimizes selected objectives and actions against that future. However, even though it is an artificial distinction, this chapter focuses on the understanding of future conditions, while Chapter 12 explores the approaches and techniques for making decisions and balancing trade-offs (many of which are extensions of the techniques discussed below).

Before unpacking the different approaches, it is useful to outline the three basic elements of any basin planning analysis, each of which may be affected in different ways by future changes.

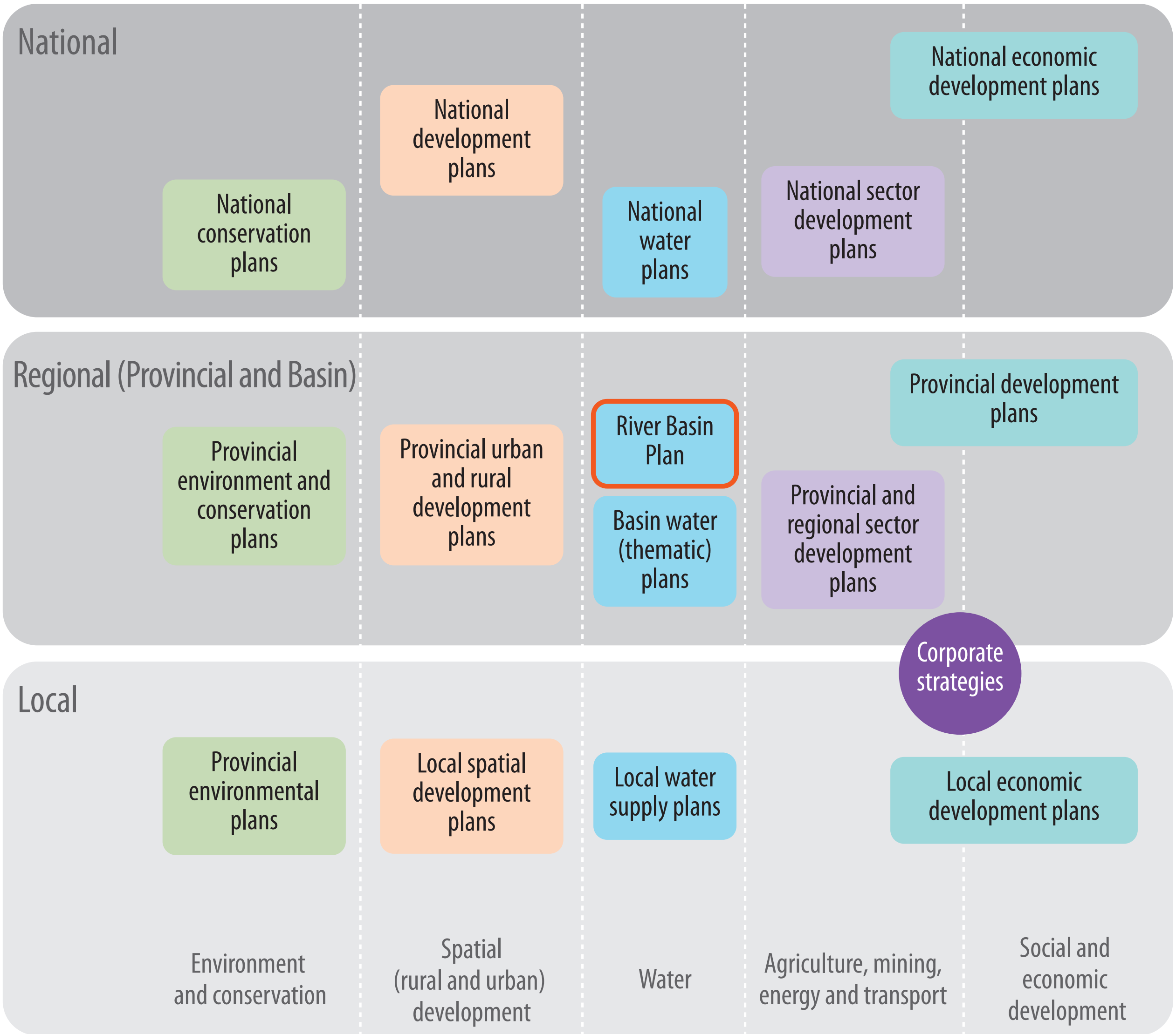
- First, the catchment land use patterns, climatic variability and hydrological processes drive the flow, water quality and flood response of rivers, wetlands, lakes and estuaries. Socio-economic development and climate changes affect the quantity and quality of infiltration, runoff and discharge of water to surface and ground water. Assessment of these future impacts may be done through a range of heuristic, deterministic or stochastic methods to produce 'synthetic' future estimates of hydrology and water quality, against current-day or naturalized conditions.
- Second, the hydraulic characteristics and configuration of the surface water, aquatic environment and reservoir system determine the quantity, quality and timing of water flowing through the basin. Changing climate, hydrological and water quality inputs and/or instream infrastructure development and habitat modification may change the characteristics and thus the response of the system. Techniques to assess these responses depend on the issue being addressed, and vary from large system analysis for water allocation and hydropower generation, through water quality modelling to hydraulic routing for flood risk and navigation.
- Third, the system requirements in terms of ecosystem functioning, water supply, water quality or flooding determine the demands on the water resources, as well as providing the link back to the social, economic and ecological imperatives for development. These requirements shift with changing development patterns and climate variability in the basin, from the obvious increases in water demand with increased production, through increasing flood risk with land use change, to less obvious changes, such as in crop evapotranspiration as temperature and carbon dioxide levels shift.

All three of these elements clearly interact, and only by combining them can a complete picture of future changes in the basin be assessed. However, it must also be recognized that no one model or technique can answer all of the possible issues. Rather, purpose-specific thematic analysis techniques and models tend to be developed around the priority issues. The aim of basin planning is to ensure that the assumptions and principles underlying these different techniques are consistent and that the interactions between them are considered.

10.2 Synthesizing development futures

A crucial, but often underestimated, stage in strategic basin planning involves the interpretation and synthesis of future perspectives of other economic, social, environmental and sector development plans (or processes), at the national, regional and local scales (Figure 27). This should indicate the developmental and environmental imperatives, priorities and initiatives related to the basin, from which developmental-environmental visions or outcomes can be derived. These plans may also specify the water-resource-related requirements to support their implementation, which highlights the need to engage existing national, basin and local water plans in terms of their developmental and environmental imperatives and initiatives.

Figure 27: Tapestry of environmental and developmental plans at different scales to be considered for the basin planning



While these are mainly public-sector plans, in some basins individual companies or groups of companies have corporate strategies with significant implications for the basin development. This is most relevant for large mining, petrochemical, energy, manufacturing and agricultural companies, whose activities have major impacts on land use activities, water requirements or waste discharge in the basin.

However, it is important to recognize that these plans are seldom coherent or aligned, either horizontally between sectors or even vertically between levels. They often provide only high-level statements of intent, and may not even be internally consistent. In many situations, private-sector development strategies (and actions) deviate from publicly espoused plans, and companies manipulate the inconsistencies between levels and sectors to further their own interests. Development plans often do not engage with or even consider water resources opportunities and constraints, but rather take water availability and waste discharge as a given. Therefore the interpretation and synthesis of the future perspectives of other plans can be a complex task, which requires a great deal of subjectivity in deriving a coherent picture of the future (or possible alternative futures).

The assessment of future perspectives in other planning processes should frame the assessment of water-related development futures (in the following tasks) and will inform the formulation of the basin vision or goals. However, as importantly, the potential gaps and inconsistencies between these plans and in relation to the water resources should be highlighted and be used to inform engagement between the basin planning process and the mandated institutions responsible for these other plans, with the intention to facilitate greater alignment of these plans.

Box 70: Alignment with development planning for the Breede-Overberg CMS

Encouraging economic growth and improving social livelihoods are at the centre of the Breede-Overberg area's development future, and therefore are central to the CMS. The role of water in supporting development is especially critical in the Breede-Overberg area because the economy and population are inextricably linked to agriculture, and the water resources available are limited.

The strategy aligned itself with broader development planning by engaging with and incorporating the principles of development-focused policies into the catchment strategy. This included provincial-level development documents such as the *Provincial Growth and Development Strategy, the Provincial Economic Review and Outlook*, and the *Spatial Development Framework*. The catchment strategy also aligned itself with local economic and social development initiatives, such as the *Local Government Integrated Development Plan and the Water Services Development Plan*. The catchment strategy identifies linkages between water resources management and the development issues and challenges, and incorporates these linkages into its vision and its basis for strategic actions.

For example, the vision for 'Sharing our available water equitably and efficiently to maintain existing activities, support new development and ensure redress, while adapting to a changing climate and world' reflects the development needs to encourage economic growth and to redress historical social inequities. This vision is supported by a strategic action to authorize water allocation according to principles which incorporate these development priorities, including:

- Reallocate water to Reserve and (HDI) farmers through various innovative regulatory, economic and technical mechanisms, following improved understanding of the water use and hydrology of the system.
- Authorise new agricultural irrigation with greater than 50 per cent HDI component, while considering applications with greater than 30 per cent HDI, requiring strict water use efficiency.
- Promote commercial agricultural development through improvement of efficiency, sharing in joint ventures and equity schemes with HDIs and transfer of validated lawful water use entitlements.

Source: BOCMA (2011).

10.3 Assessing the impacts of future development

The projection of future hydrological conditions and water requirements has always been a fundamental part of water resources planning, but these techniques have become increasingly sophisticated as the interrelationships between water and economy have become more complex. The focus of these future projections is usually on, first, the water requirements (driven by changing economic and demographic development patterns), and second, the hydrology (driven by changing land use patterns and more recently climate variability). Possible impacts of technology change should also be considered (such as crop species with lower water requirements or desalination options), but are typically less well captured in these assessments. This section outlines at a high level the range of techniques that are typically used to predict or bound future changes to hydrology and water requirements for basin planning.

Changes in hydraulic characteristics of river systems tend to be specific to flood routing, water quality management and reservoir system operation, and in response to instream modification or infrastructure development. These are typically within the scope of the basin plan, and their evaluation is therefore related to the evaluation of strategic actions addressed in the next two chapters.

When projecting into the future, scenarios are often used to represent different possible futures (usually represented as scenarios of the future), reflecting the uncertainty in the drivers of these futures. At this point in the discussion, it is important to distinguish conceptually between planning scenarios that are independent of water management responses (driven by exogenous factors such as economic growth) and development scenarios that reflect a management response (driven by endogenous factors such as demand management interventions). Both types of scenarios are used (often in combination) in water resources planning, but in this chapter the discussion revolves around the former (the latter is addressed in the following two chapters).

PROJECTION OF WATER AND LAND USE TRENDS

Projection of future water resources scenarios from historical trends represents a traditional and simple method of forming scenarios that only minimally incorporates uncertainty. Trend projection may incorporate regression techniques to assess the dependent water resources variable/s (typically sector or area-based water demands/patterns), from one or more exogenous variables reflecting demographics or economic growth. Early studies only projected the water demand trends, but this has been replaced by projections of trends in economic and demographic growth (possibly distinguishing rural-agricultural from urban-industrial growth). Uncertainty in these projections is usually reflected by the definition of bounds, in terms of a high, medium and low growth scenario defining water use projections. In some cases, the implications of demand management assumptions are also included as additional scenarios.

The projection of hydrological (and water quality) inputs to the system is done similarly by projecting future changes in land use, economic development and demographics, and modelling their implications for surface runoff, aquifer recharge, water quality contamination and flood peaks. While various scenarios may be developed for different development pathways, the differences between them tend to be relatively insignificant at a basin scale, particularly when compared with changing water requirements, so a single hydrological future is usually adopted. However land use and economic changes do have a more significant impact on flood routing and waste discharge (particularly at a catchment scale), and thus may receive attention where this is an issue.

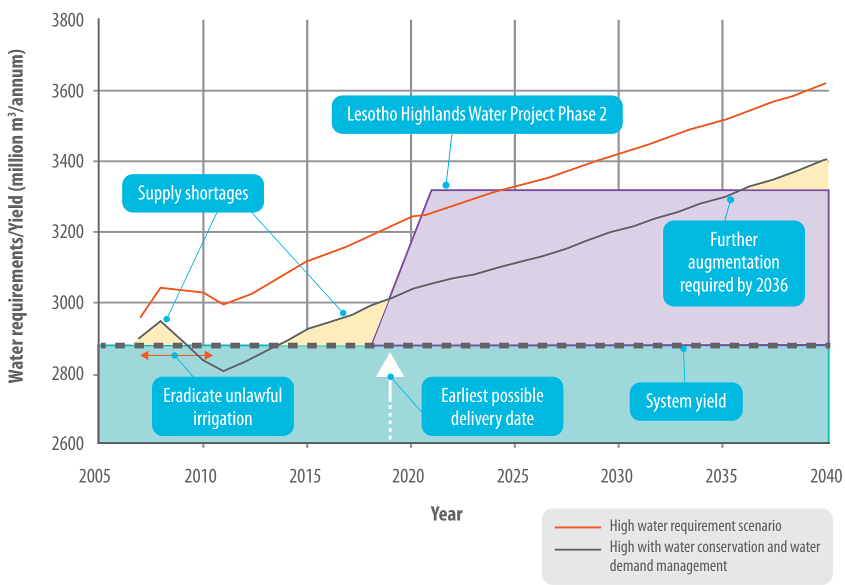
Traditionally, future hydrological assessment has assumed a stationary climate (stable rainfall and temperature regimes), with the changes being the result of direct anthropogenic activities, but more recently climate variability has been included. (Assessing the impacts of climate uncertainty is addressed in more detail in the next section.)

All of the above assessments require some degree of analytical modelling upon which to base these future projections. While a range of techniques and models have been used, these generally fall into one of two categories:

- **Deterministic techniques** imply that the causal relationships driving variability into the future are adequately understood and that planning involves the identification of the most effective way of getting to the goal. Deterministic modelling is typically used to simulate the future system conditions associated with assumptions about future hydrology and development (water requirements).
- **Stochastic techniques** accept (typically stationary) random variability in the system and attempt to find the most appropriate way of getting to the goal, considering a probabilistic interpretation of this variability. Stochastic modelling is typically used to represent future system conditions through representation of statistical relationships with hydrology or development.

A third category of physical models (in which three-dimensional replicas are constructed) tends to be used to assess the hydraulic impacts of changes, rather than to assess future system hydrological or water requirement impacts.

Box 71: Demand projections in the Vaal River system



The Vaal River system trend analysis performed by the Department of Water Affairs in South Africa shows a high water demand scenario, indicated by the red line. This scenario is based on high population growth resulting from successful implementation of HIV/AIDS interventions and in-migration due to economic growth, increases in water required to produce and meet energy needs throughout the country, and also includes an initial decrease in demand from terminating illegal irrigation. A base scenario projected from current trends, and a low scenario estimated from lower population and economic growth were also quantified.

The high demand scenario is used for planning to ensure that sufficient supply measures are in place to meet these requirements. The projection with water conservation and demand management measures are also shown by the black line, and include reductions in future urban, industrial, mining, and power demands achieved through efficiency improvements and loss management. Source: DWAF (2010).

FUTURE ECONOMIC PROJECTIONS

Slightly more complex projections are based on projecting water requirements using simple macroeconomic models to assess the implications of possible future growth in key sectors that affect water demand (and possibly runoff). In these types of studies, similar analyses are used to assess the potential social and financial implications of different management options (as part of the strategy formulation process).

This assessment and modelling is quite closely linked to the assessment of future development pathways outlined in the previous section (10.2). The challenge is to identify and select the key social, economic, institutional and infrastructure development drivers in other sectors that will have an impact on water requirements and hydrology.

Taken to its conclusion techniques exist to evaluate the potential future social and economic implications of water resources availability and utilization. Economic modelling approaches include:

- macroeconomic modelling of the primary and secondary impacts of water use in economic production and consumption, such as adapted social accounting matrices and input–output analysis
- microeconomic modelling related to the valuation primary and multiplier impacts of water used in different sectors, from which aggregate understanding of economic implications may be identified.

To assist basin planning, these need to be linked to a broader assessment of the implications of water use through economic and social development, which goes back to the implications for water requirements and hydrology. Assessing these feedback processes is complex and has not yet been well developed in basin planning experience.

10.4 Assessing climate variability, change and vulnerability

Recently, climate change impacts (or scenarios) are reflected as projections on water availability, typically using downscaled estimates of future rainfall and temperature time series with deterministic hydrological models.

A vulnerability assessment is a systematic review to identify the susceptibility of a water system to potential threats, and to identify actions to reduce the risk of serious consequences if the threats materialize. Vulnerability assessments are a risk-focused way to address uncertainty.

The term *vulnerability* in water resources management refers to the weaknesses and flaws of a water resources system that may undermine the system's functionality in the face of socio-economic and environmental change. A system's vulnerability is determined by:

- **exposure:** the water resources system's exposure to stressors
- **sensitivity:** the degree to which a system is sensitive to external stressors, without considering adaptive capacity
- **adaptive capacity:** the adaptive capacity of the ecosystem and society to cope with the threats to functionality.

The *Methodologies Guidelines for Vulnerability Assessment of Freshwater Resources to Environmental Change* from the United Nations Environment Programme (UNEP, 2007*a*) provides one approach to performing a vulnerability assessment. First, a comprehensive understanding of the existing water resources situation must be gained. Second, trends of future scenarios regarding water resources should be developed. Both the current situation and trends should describe total available water resources, resource development and use, ecological health, and management capacity including policies and operational procedures.

Once the current state and trends are understood, the third step is to perform an analysis to identify key issues or vulnerabilities. Key issues should account for the ability of the water resources base to support socio-economic development, and should address variability that may affect the stability of the resources base. A vulnerability score may be developed by expressing vulnerability as a function of:

- resources stress
- development pressures
- ecological insecurity
- management challenges.

Fourth, for each key issue or vulnerability, the following steps are taken to understand the nature of the vulnerability and to determine a response. Expert consultation is often used as the method of analysis.

1. Determine driving forces creating the vulnerability, including social, economic and environmental changes.
2. Estimate pressures, meaning the major pressures resulting from the driving forces that impact on the water resources.
3. Understand changes to the current state and trends that will occur from the pressures.
4. Analyse the impacts of changes in the current state, including environmental, social, and economic impacts.
5. Define and formulate responses to cope with system vulnerabilities.

Ultimately, a vulnerability assessment will lead to a prioritized list of water resources actions that should be taken to protect against and minimize the consequences of threats.

Box 72: Vulnerability assessment sample for the Yellow River basin

The table below presents two key issues from a vulnerability assessment of the Yellow River basin in China as portrayed in Huang and Cai (2009). For each key issue, the social, economic, or environmental driver is identified, along with the resulting pressure and change in state of water resources. In this case, the scarcity of water resources is driven by population growth, from which the pressures are urbanization and economic development which puts further stress on the state of water resources. The impacts of additional stress are poverty and environmental degradation, representing social, economic and environmental impacts. Water policy has been identified as a central response.

The two issues identified here represent examples of base-level water resources issues and variability issues. The scarcity of water resources is a base issue, related to the overall population growth. In contrast, the instability of water resources is a variability issue driven by climate change.
Source: Huang and Cai (2009).

ISSUES	DRIVERS	PRESSURES	STATE	IMPACTS	RESPONSES
SCARCE WATER RESOURCES	Population expansion	Urbanization: economic development	Population expansion	Poverty and environmental degradation	Water use policy
INSTABILITY OF WATER RESOURCES	Climate change	Land use	Climate change	Land use	Environmental protection program

10.5 Scenario planning and robust assessment

Over the first decade of the twenty-first century, the concept of uncertainty in future projections for water resource planning has evolved from a focus on variability around defined future pathways, to more fundamental uncertainty about the nature and direction of the future pathways themselves. This has arisen from the experience of rapidly and dramatically changing social and economic conditions in increasingly stressed basins, and the recognition of impacts of changing climate on hydrology, water requirements, environmental processes and other economic and social sector development.

Increased uncertainty is beginning to introduce a planning shift from optimizing for more or less likely projected future conditions with similar underlying assumptions, to identifying management approaches that are robust against a range of dramatically different future scenarios with an unknown likelihood of occurring.

The adoption of the 'no regrets' or 'low regrets' approach to evaluating possible future interventions reflects this emerging philosophy, which inherently attempts to identify interventions that are suitable to a range of possible future situations (in other words, they are robust). While this may be done as an additional screen to the previous processes, some degree of scenario development or even scenario planning is necessary to assess the possibility that an intervention will not be appropriate under a given future.

SCENARIO PLANNING

Scenario planning is a means of assessing the consequences of multiple equally plausible futures, and thus represents a technique that moves away from exogenous trend analysis and towards planning for uncertainty. It provides a technique to engage potentially complex developmental and climate futures in a basin and their interactions with management strategies. Scenario planning is built on thorough analysis of future possibilities, combined with the knowledge and insight of individuals who know and understand the basin.

Scenario planning begins with the identification of future uncertainties (at various scales) that will affect the social-economic development, environment and water resources in the basin. An assessment of the level of uncertainty against the level of impact on water resources allows the identification of highly uncertain and high-impact issues, around which different futures may be formulated. Typically these futures are captured in three to four plausible scenarios reflecting different futures (with no indication of their different likelihood of occurring), together with a narrative on the pathway and key drivers from the current state to that future.

These scenarios provide the landscape against which the planner can identify the key levers that should be the focus of planning interventions, and evaluate the degree to which possible interventions are resilient to future change. Alternatively they may provide a landscape within which water-related development can take place without exceeding agreed boundaries. For example four scenarios were identified for the Lower Mekong basin: low and high irrigation development, and low and high (hydropower-related) storage capacity development (MRC, 2005).

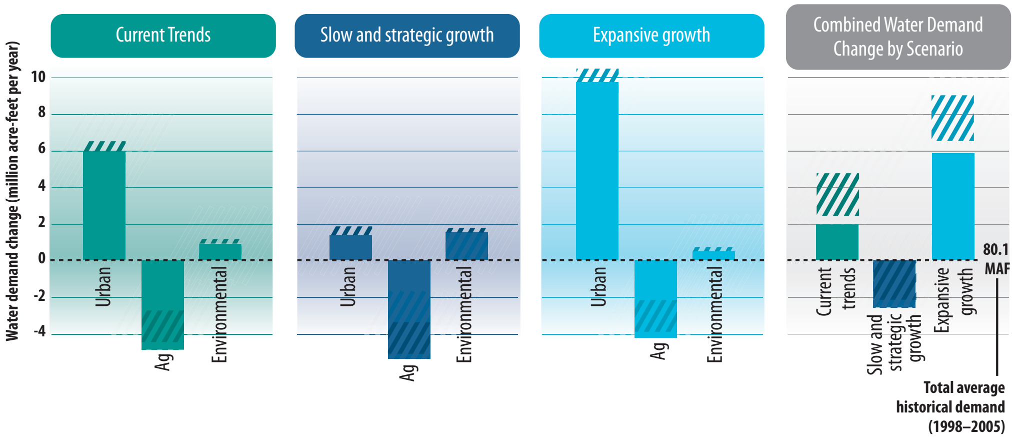
Box 73: Scenarios for the California Water Plan

Three plausible future water demand scenarios were developed for the *California Water Plan* for 2050, to represent:

- current growth projections
- lower population and less resource-intensive growth
- expansive population and more resource-intensive growth.

The total annual change in demand in each scenario, shown in the right-most figure below, is based on changes calculated from each of the key demand drivers (urban, agricultural and environmental demands). Variability as a result of climate change is incorporated by overlaying the potential impact of climate change on each of the key demand drivers, as indicated by the hatched areas on each bar.

Rather than planning for a single future, the range in demand changes between scenarios emphasizes the need for decision-makers and planners to use a range of considerations and management levers given the uncertain future, and provides information to understand how management actions may perform in several plausible future scenarios.



Source: State of California (2009).

CHAPTER 11
DEVELOPING THE BASIN PLAN

11.1 Approach to developing the basin plan

The primary aim of basin planning is to provide a coherent strategy to address the priority water resources concerns in the basin, concerns which typically relate to objectives of conservation and sustainable development. This requires the alignment, harmonization or integration of many management themes and disciplines in order to create a holistic and coherent basin plan. There are two conceptually distinct ways of doing this, each of which reflects a different approach and assumptions for the basin planning process:

- **The development of a strategic vision**, based on the priority issues and future scenarios identified for the basin during the situation assessment process. This may distinguish between different parts of the basin according to local conditions. The strategic objectives and actions are developed against this coherent vision. This allows disciplinary (thematic) differences and local (area) constraints to be considered, but continually comes back to the unifying vision, thereby facilitating proactive harmonization at the basin level.

  This represents a process of visioning with spatial and thematic disaggregation.

- **The development of thematically based actions and associated objectives** for the priority issues identified during the situation assessment, considering future development scenarios. The development of a coherent set of strategic actions, targets (objectives) and outcomes (goals) for the basin then becomes a project management function (aligning the distinct thematic processes), with more reactive synthesis and agglomeration of the emerging and in some cases prior existing plans into the basin strategic objectives towards the end of the process.

  This represents a process of alignment with spatial and thematic aggregation.

In practice, while any given basin planning process may have elements of both approaches, it will be inherently grounded in one or other of the two philosophies outlined above. On the one hand, visioning-based processes typically do not start with a blank slate, but instead must incorporate and align with previous basin or catchment thematic objectives and plans. On the other hand, the process of alignment often requires a perspective on subcatchment or basin visioning to balance potentially competing needs.

Both of these basin planning approaches should be contrasted with parallel thematic planning processes that may be done at a basin scale, but only entail superficial or ad hoc alignment. This is quite common in more traditional planning environments, where flood planning, navigation planning, hydropower planning, irrigation planning and urban water supply planning are done separately by different ministries. The outcome is that these plans are often in conflict in terms of their understanding, aims and requirements on water management.

While all of these approaches may be applicable in some circumstances, proactive strategic visioning and alignment approaches tend to be more effective, and have emerged as the common practice in the planning of basins that have greater complexity, involve trade-offs between competing uses of the basin water resources, and require alignment with broader economic and social development imperatives.

A GENERIC STRATEGIC PROCESS FOR DEVELOPING THE BASIN PLAN

Once the relatively linear process of conducting the situation assessment has provided an adequate understanding and prioritization of the issues and principles, the more iterative and chaotic process of developing a basin plan must begin. The process description below attempts to frame the multitude of ways in which this is done for strategic basin planning. In practice, basin planning processes have many of these elements, but few involve all aspects.

It is important to recognize that most basin planning processes begin with a relatively clear high-level project plan, and end with a relatively coherent structured basin plan, both of which imply a logical planning sequence. However, it should also be acknowledged that the process in between may not look much like either of these, because it is only through meandering, exploring dead-ends and tracking back on previously covered ground that the necessary level of common understanding between key stakeholders and the required alignment of objectives and actions is possible.

The common feature of strategic basin planning processes is an attempt to combine the priority water resources issues (considering their current and future states), with broader social, economic and ecological imperatives. They typically distinguish a longer-term aspirational intent (vision) from short-term measurable targets (objectives) that describe the start of a pathway to this aspiration. Each basin planning process tackles this in a different way. Some define a clear unifying vision from which the strategy flows, while others formulate goals or statements of intent, and the remainder develop a coherent suite of objectives.

They all share a commonality in the definition of objectives that reflect the imperatives to manage the basin, and the interpretation of these objectives into actions that consider technical feasibility, financial viability and institutional capacity of implementation. This is the reason that objectives sit at the narrow point of the hourglass of the basin planning process presented in Chapter 6. From a conceptual perspective, strategic basin planning may be separated into two interrelated, but distinct phases:

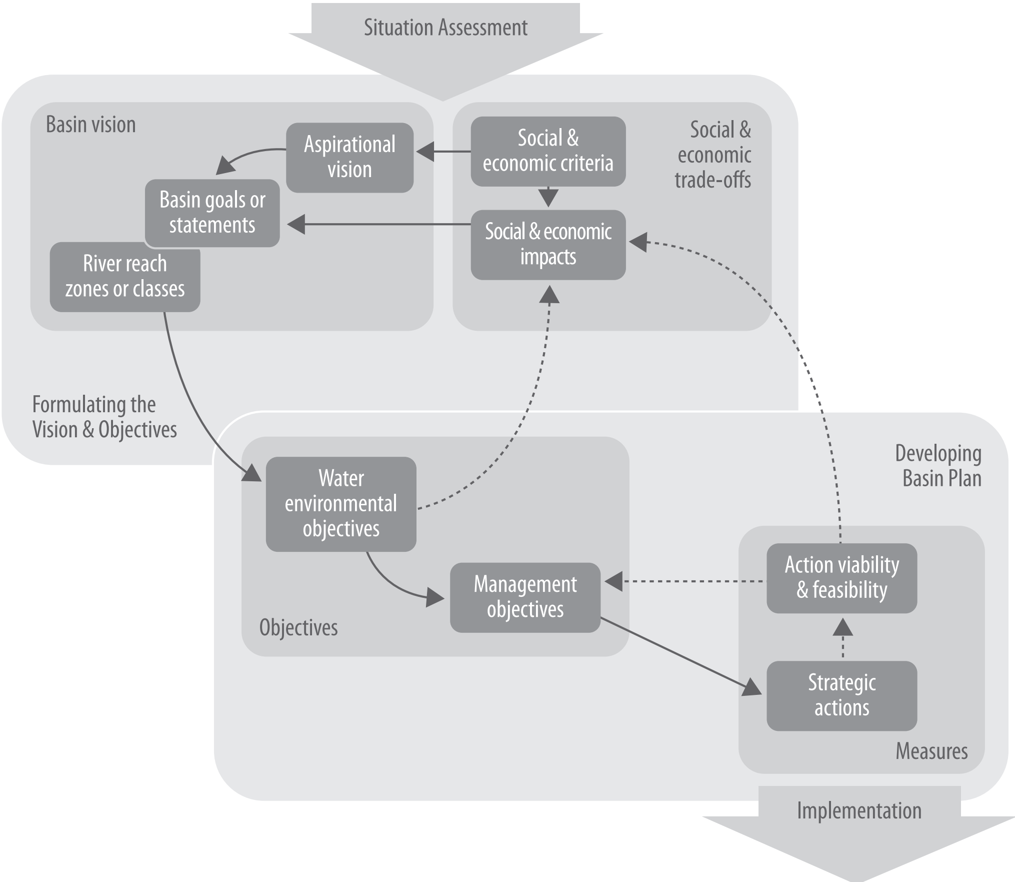
The first involves determining *what* is to be achieved, or more specifically the setting of strategic objectives that contribute to meeting the basin imperatives in a coherent and time-bound manner. This may involve some of the following steps:

- development of an aspirational vision according to developmental and environmental imperatives in the basin articulated in basin level social and economic principles/ criteria
- definition of qualitative statements (goals or outcomes), reflecting the priority issues and defined planning principles
- functional zonation (or classification) of river reaches or catchments (and their inter-connectivity) balancing levels of protection and development
- translation of these visions, goals or zones into measurable water environmental objectives to be achieved during and/ or beyond the timeframe of the basin plan
- assessment of the broader social and economic (developmental) impacts of setting these water environmental objectives, with possible iterative refinement of the goals or zonation.

The second relates to *how* this is to be achieved, or more specifically the development of strategic actions that jointly enable the relevant strategic objectives to be attained over the period of the basin plan. This typically involves the following steps:

- translation of the (vision and) water environmental objectives into tangible management objectives related to catchment development and/or water use
- identification of technically feasible strategic actions that will jointly contribute to the achievement of the management objectives and water environmental objectives
- evaluation of the social, institutional and financial viabilities of these strategic actions and the sustainability of their implementation in achieving the specified objectives
- assessment of the broader social and economic consequences (and trade-offs) of the suite of defined objectives and associated strategic actions.

Figure 28: Procedure for formulating the basin vision, objectives and actions



The specific evaluation and broader assessment outlined in the last two steps may lead respectively to modification of the management objectives and strategic actions, or revision of the basin goals and water environmental objectives. This potential iterative refinement of the basin goals, objectives and actions may continue until an acceptable balance is achieved between the desired state defined by the objectives and the implementation requirements of the associated strategic actions. The process outlined above is captured in diagrammatic form in Figure 28.

11.2 Formulating coherent and aligned objectives

The setting of basin-level (water environmental or management) objectives represents a common critical point in the development of a strategic basin plan. However, there are multiple pathways that can lead to this point, each of which is suited to a different context and approach to basin planning. Three distinct pathways are described below, which while not necessarily exhaustive, do reflect the broad range of possible approaches to strategic basin planning.

In understanding the applicability of each of these pathways, it is important to highlight two key aspects that distinguish the context of different basin planning processes.

The first relates to the level of a common understanding of the basin and its critical issues, which is usually dependent on whether there have been previous basin planning iterations. Where there is a common understanding, it is relatively easier to move towards objectives through processes that require stakeholders to first find common ground.

The second relates to the nature of the trade-offs required by the basin planning process, which depends on the character of the basin and its critical issues. In more stressed basins with diverse and competing priorities, the trade-offs may be between fundamentally different purposes or thematic areas (such as between allocation, hydropower and flooding), which requires a common perspective on the future desired state and priorities for the basin. Where the priorities are clear and focused on one or two purposes, the trade-offs tend to focus on how to achieve the future state and whether it is desirable.

The analyses required to support the setting of objectives that achieve this balance of trade-offs between different priorities are discussed in Chapter 12. These range from the technical and economic models that indicate the water resources, environmental, social and economic implications of adopting different objectives, through to the decision support systems that assist in planning to achieve multiple criteria with noncommensurate objectives.

A word of caution is required at this point, because the description implies that there is a natural progression from 'good knowledge' and 'good tools' to a 'good plan'. However, planning is far more complicated, and often a scientific approach alone is not adequate to make sound decisions. There is no scientific way to choose between a solution with moderate costs and benefits and an alternative with higher costs and benefits, although many tools are available for illustrating the implications of the choice, or even to simulate a choice on the basis of various criteria. Deciding on basin priorities is inherently a political decision, and is typically the outcome of an iterative and even chaotic process involving some degree of negotiation between political leaders, bureaucrats and/or stakeholders.

BASIN VISIONING

A basin vision (and principles) typically provides a somewhat generic and qualitative statement of long-term intent, because the aim is to develop something that all stakeholders can support on the level of principles. The advantage of this is that the specific implications of the vision for individual water users are not initially clarified, so stakeholders focus on a desired state for the basin rather than for themselves. It is in translating this into objectives that the process becomes more quantitative and focused (with the implications on individuals becoming clearer), but in the visioning pathway, this happens within the context of a collective vision and principles.

The vision will be continually interrogated and refined during the basin planning process, and more detailed vision statements, goals and objectives may emerge as improved understanding and greater common ground is found. It is therefore a mistake to interpret the vision presented in a completed basin plan as the vision that was developed at the start of the process, and conversely to judge a vision that is developed early in a basin planning process as being too vague.

The process of developing a vision tends to be a combination of centralized political positioning, institutionalized bureaucratic negotiation and decentralized stakeholder consultation, with the balance between these forces being dependent on both the planning context and the specific situation in the basin. In practice, this is inherently a political process that needs to be managed carefully by the facilitator of the basin planning process. Technical and economic analyses are largely used to support the development of objectives and the evaluation of management options to achieve this vision.

The visioning process requires a skilled facilitator who is perceived by all stakeholders to be technically competent (understands the issues), politically astute (sensitive to the process) and independent (not aligned to an interest). This typically implies someone who is external to the basin management organization responsible for the basin plan.

Basin visioning is particularly valuable in processes where there is significant complexity in the basin, with potentially difficult trade-offs between different environmental and development perspectives for the basin. It is particularly applicable where a number of diverse stakeholders with limited common understanding of the basin must come together to develop the basin plan. As such it is relevant where previous basin planning process have tended to be technical and infrastructural and not strategic in nature.

CATCHMENT ZONATION OR CLASSIFICATION

The newly emerging approach to catchment (or reach) zonation represents a decentralized 'pseudo-visioning' process within relatively homogeneous catchment areas or river reaches, while considering the interconnections between subcatchments within a basin. The approach is based on defining a desired management objective for each basin zone, which specifies the balance between utilization of the water for social and economic development and water environmental protection for the goods and services it provides. This balance is then translated into water environmental objectives specified in each zone, which consider the social and economic consequences for the zone, the basin and even wider region.

Catchment zonation inherently mainstreams consideration of the water environment as a key focus of decision making, within the broader context of social and economic development. It recognizes that different parts of the same river basin may have varying protection status, with some sensitive areas requiring high levels of ecological functioning and others being heavily utilized and impacted for social and economic development purposes.

Catchment zonation is particularly useful in diverse and heterogeneous basins in which local catchment areas of the same basin may have different imperatives for environmental protection or socio-economic development, implying distinctly different desired states throughout the basin. The process of catchment zonation is described in more detail as one of the methods for balancing trade-offs between competing uses in Chapter 12. Basin zonation depends on technical and economic analyses at a zone level, both to facilitate the decision-making about the management class and to enable the consideration of upstream-downstream connectivity between zones.

GOAL ALIGNMENT

A suite of basin management goals or outcomes (qualitative and/or quantitative statements of intent) may be developed, without first formulating a unifying and aspirational basin vision. These are typically thematically based, are derived from basin principles and the key management issues, and entail some degree of alignment and coherence. In some cases these goals are defined as thematic visions for the basin, the distinction being that they do not indicate the balance between different themes. The basin planning process thus revolves around the iterative setting of goals and objectives, and evaluation of the strategic actions required to achieve these.

Basin goals or outcomes typically provide a clearer set of aims from which to develop basin objectives, but require a sound understanding of the basin functioning and issues. Ensuring alignment between the goals may be a challenge, as may the indication of clear priorities between goals in order to guide the process of making trade-offs between competing interests. Thus it is important that the number of goals be limited to the key priorities (between four and seven goals) and that these reflect the implicit understanding of the desired state for the basin.

Developing basin goals or outcomes may be more appropriate in a basin that has undergone previous basin planning processes, and in which there is some common understanding of the basin processes, the critical issues and an implicit strategic direction. Thus goals may be developed against this understanding, without first going through the visioning process, particularly where there is limited conflict between different thematic areas.

The main trade-offs may be between the objectives that reflect the goals within a theme (such as water quality), or between the strategic actions required to achieve these objectives. The approach to this is outlined in the next section, on developing actions to achieve objectives. Alignment of objectives between themes is more a matter of checking consistency than managing trade-offs. The technical and economic analysis must focus on the consistency and/or trade-offs in the development of objectives, while considering the goals as multiple criteria to be balanced against each other.

Box 74: Formulation of outcomes for the Murray-Darling Basin Plan

The process of developing the outcomes for the Murray-Darling Basin Plan identified the following as priorities:

- water-dependent ecosystems in the basin would be more able to withstand short and long-term changes in watering regimes resulting from a more variable and changing climate
- the use of basin water resources would not be adversely affected by water quality, including salinity levels
- there would be improved clarity in water management arrangements in the basin, providing improved certainty of access to the available resource
- basin entitlement holders and communities would be better adapted to reduced available water.

Source: MDBA (2010).

RECOGNITION OF PRIOR PROCESSES AND CONTEXT

In many basin planning processes, goals or objectives may be set prior to the basin planning process, through national strategies, previous thematic plans or by political dictate. The basin plan needs to be built around these prior goals or objectives, possibly refining these where necessary. In this case, the basin planning process is akin to the goal alignment processes outlined above.

While it has been implied throughout this book, it is important to reiterate that the nature of the objectives and associated strategic actions developed for a basin plan will reflect the context and stage of development of the basin planning process. As illustration:

- Basin plans that are responding to a clear water resources problem that has been identified through previous planning iterations will define clear objectives and actions that respond directly and materially to the problem.
- First-edition basin plans may focus on investigation and information-gathering, with institutional cooperation objectives and actions to build common understanding to enable more material interventions in future planning processes.
- Legally required basin plans will respond to the legal content requirements of the plan, and may have strong cooperation-based objectives and actions to build the legitimacy of the mandated institution.
- Basin plans in the context of decentralized mandates (transboundary) will tend to focus on the clarification of institutional mandates and strengthening of capacity and relationships, while addressing a few basin-level issues which are transboundary in character.

11.3 Developing achievable objectives and implementable actions

The initial set of objectives that are developed following one of these processes will necessarily be preliminary, because before they can be adopted their relevance must be tested against the viability of the actions required to achieve them. While the previous visioning-objective setting stage is inherently political and procedural, this evaluation stage is more technical and analytical.

FORMULATING MANAGEMENT OBJECTIVES

Water environmental objectives may need to be translated into management objectives, against which actions can be identified. To illustrate this point, a couple of examples are useful:

- The water environmental objective might indicate the environmental flow requirement for the river and possibly the water available for allocation to the various users. However, in order to make decisions about allocation, water use management objectives are required, such as the possible surplus water available or additional supply required for new allocation, the required reduction in existing allocations for overallocated systems, or the politically necessary allocation to specific groups.
- The water environmental objective might indicate the target concentration or range for a given water quality variable, and possibly even the total permissible constituent load to the system under different flow regimes. Water quality management decisions require estimates of the reduction in load discharged into different catchments, or alternatively the possible additional loading capacity available, which could be established as management objectives.

Alternatively, there might be management objectives that must be implemented by law, but which require evaluation of the consequence for the water environmental objectives. These are typically related to measures such as waste discharge/effluent standards, water use efficiency benchmarks, or flood protection zones.

This process requires technical basin or catchment hydrological-system, water quality or flood routing analysis (modelling) to establish the relationships between the water environmental and management objectives.

IDENTIFYING AND SCREENING THE VIABILITY OF MANAGEMENT ACTIONS

The basin objectives will only the achieved through coordinated, coherent and appropriate management actions. Thus the achievability of an objective must first be assessed against the possible actions (options) that might be implemented to jointly contribute to its attainment, and second, the viability and sustainability of these actions need to be evaluated from technical, financial, social, environmental and institutional perspectives.

For strategic basin planning, a combination of biophysical, infrastructural, social, economic and/or institutional measures or interventions is typically required to achieve a specified water environmental and/or management objective. For the basin plan, it is adequate to describe these at a conceptual feasibility (rather than design) level, but with enough detail that the management impacts can be assessed and the viability evaluated.

The options screening process entails the evaluation and ranking of the identified measures of interventions against relevant technical, financial, social, ecological and management criteria, both during the period of the basin plan (indicating viability) and in the long term (indicating implementation sustainability, where relevant). The suite of most viable (and sustainable) options that jointly contribute to the achievement of the objectives is then selected as strategic actions, making realistic assumptions about the resources available for their implementation. Where the viable options are not adequate to achieve an objective in the timeframe of the basin plan, the objective needs to be refined until it is achievable, by relaxing its level or postponing its timing.

The process of formulating the objectives and strategic actions must balance the resource requirements of the actions with the desirability of the objectives. This iterative process is reflected in the following steps, through which there is convergence to an appropriate and workable solution:

1. First, drawing on an expert group to identify the possible management options, supported by input from various informed stakeholders.
2. Assessing the contribution of each option to achieving the agreed preliminary objectives, and proposing refinement of the objectives, if necessary.
3. Evaluating and ranking the options against clear technical, financial, social, ecological, economic and institutional criteria.
4. Evaluating the level of robustness to alternative futures reflected by the uncertainty-based scenarios, including refinement of the options where necessary.

5. Consulting relevant stakeholders to solicit diverse perspectives and preferences.
6. Selecting the suite of most viable (and sustainable) options, with proposed refinement of the objectives, if necessary.
7. Assessing the economic, social and ecological implications of the refined objectives, and refining the suite of actions where these outweigh the additional resources required to implement the necessary actions.

A wide range of analysis techniques and tools may be used to support this process, illustrations of which are presented in Chapter 12. Some of these are specific to technical disciplines, others are more broadly social and economic in nature, and the remainder are derived from decision-making management theory.

SYNTHESIZING STRATEGIC ACTIONS AND OBJECTIVES

By its nature, the preceding analysis is focused on the thematic areas. However, it is typical to find overlaps between actions that are required to meet different thematic objectives. So for example:

- rehabilitation of wetland functioning and lake systems connectivity may contribute to water quality, water allocation and flood management objectives
- water use efficiency measures may contribute to allocation objectives by reducing demand, while contributing to water quality objectives by reducing waste discharge
- clearing of alien vegetation from the riparian zone may contribute to both water availability and ecological functioning
- salinity reduction measures contribute to water quality objectives, while potentially freeing up water from dilution requirements for allocation to other users.

It is quite plausible that actions selected to meet an objective in one thematic area will prove not to be consistent with the actions or objectives in another thematic area. The impact of this should be limited, if the process of objective setting is comprehensive, coherent and robust. However, where this occurs, these inconsistencies need to be resolved through further iteration of the objective-setting and action selection process.

The synthesis of the thematically based objectives and actions involves rationalization of any duplicate actions, resolution of any inconsistencies and highlighting of the interactions. Particular attention is required to the development of the enabling institutional and financial strategies as part of the 'management system', because actions in this area typically support a number of the more technical actions. Synthesis of the actions and objectives into a coherent basin plan therefore requires the following steps:

1. Compare and resolve redundancy and inconsistency between proposed actions.
2. Refine objectives if necessary, to create an achievable set of objectives.
3. Develop a suite of coherent objectives and associated strategic actions for the basin plan.
4. Formulate enabling actions that create the mechanisms to implement the basin plan.
5. Review the vision in light of any changes to the objectives.

DEVELOPING THE IMPLEMENTATION PLAN

The basin plan provides the coherent framework for water resources management within the basin, but typically needs associated thematic plans, catchment-regional plans and institutional-business plans to provide detail. The objectives, principles and priorities for these plans should be outlined in the strategic actions, as should key interventions or investigations that must be put into action.

Rollout of the basin plan requires more detail about the activities, milestones, responsibilities and possibly resources required to implement each action. This implementation plan is often presented in a tabular format, with cross-referencing to the contribution that the action makes to other objectives.

The implementation plan may also define the institutional and financial arrangements required to support the implementation of the basin plan, including the roles of different institutions and stakeholder groups in giving effect to the plan. Finally, the monitoring system and review process should also be defined.

11.4 Structure of the basin plan

Figure 29: Structure of a river basin plan

Box 75: Structure of the Delaware basin plan

The structure of the Delaware plan as a first-evolution plan was:

1. Introduction: a challenge and vision
2. The basin plan: purpose, structure and use
3. Guiding principles
4. Key result area 1: Sustainable use and supply
5. Key result area 2: Waterway corridor management
6. Key result area 3: Linking land and water resource management
7. Key result area 4: Institutional coordination and cooperation
8. Key result area 5: Education and involvement for stewardship
9. Matrix of goals and objectives
10. Moving from plan to action

Source: DRBC (2004).

Box 76: Structure of the Danube basin plan

The structure of the Danube plan as water quality/flood focused plan was:

1. Introduction and background
2. Significant pressures identified in the Danube River Basin District
3. Protected areas in the DRBD
4. Monitoring networks and ecological / chemical status
5. Environmental objectives and exemptions
6. Economic analysis of water uses
7. Joint Programme of Measures (JPM)
    - Surface waters: rivers
    - Surface waters: lakes, transitional waters and coastal waters
    - Groundwater
    - Financing the JPM
    - Key conclusions
8. Flood risk management and climate change
9. Public information and consultation

Source: ICPDR (2009a).

The way in which the final basin plan is documented and structured varies considerably, depending on the purpose and approach adopted in the basin planning process. It is important to recognize that the structure of the basin plan document does not represent the actual basin planning process (even though it often follows this logic). The basin plan is usually captured in a single summary document (which can be supported by a suite of thematic or geographic reports: see Figure 16). The summary document should include:

- a basin description, presenting the key aspects of the situation assessment
- a basin vision, outlining the imperative for the basin plan and the desired state for the basin captured by the vision, principles and goals
- the basin strategy, specifying the objectives and strategic actions within a thematically clustered system
- the implementation plan, detailing the activities, responsibilities, resources and monitoring systems required to give effect to the plan.

These elements provide the general content of the basin plan itself, but the combination and ordering may differ, with many plans distributing the basin description into the basin strategies.

Box 77: Structure of the Breede-Overberg Catchment Management Strategy

The structure of the Breede-Overberg Plan as an institutionally linked plan was:

1. Introduction
2. The imperative to act
3. The vision of the Breede-Overberg
4. Strategic area 1: Protecting people and nature
5. Strategic area 2: Sharing for equity and development
6. Strategic area 3: Cooperating for compliance and resilience
7. Implementation plan

Source: BOCMA (2011).

Box 78: Structure of the Yangtze River basin plan

1. Introduction
2. Overview of the river basin
3. Projection of social and economic development and demand analysis in the river basin
4. Overall river basin plan
5. Plan of the river basin system:
    - plan of the flood control and disaster mitigation system
    - plan of the water resources integrated utilization system
    - plan of the water resources and water eco-environmental protection system
    - plan of river basin integrated management systems
6. Plan of main stream regulation, development and protection
7. Plan of major tributaries and lakes regulation, development and protection
8. Impact evaluation on the environment
9. Suggestions on the implementation of the plan and analysis of the implementation effect
10. Suggestions on the follow-up work

Source: GIWP.

Box 79: Structure of the Zambezi River basin plan

The structure of the Zambezi plan as a transboundary IWRM/development plan was:

1. Introduction
2. Summary of existing situation
3. Challenges and issues
4. Main strategies
    - Integrated and coordinated water resources development
    - Environmental management and sustainable development
    - Adaptation to climate variability and climate change
    - Basin-wide cooperation and integration
5. Implementation plan
6. Follow up steps

Source: SADC/ZRA (2008).

CHAPTER 12
BALANCING OBJECTIVES AND MANAGING TRADE-OFFS

At its core, strategic basin planning involves the setting of achievable objectives that balance competing requirements and interests for the basin water resources. In complex, multipurpose or highly stressed basins this typically required some degree of trade-off between different social, economic and environmental imperatives or goals.

While this is an inherently political process, which may involve engagement with diverse stakeholders, a number of decision-making approaches and techniques have been used to assist in finding an acceptable, optimal and/or robust solution, based on technical and economic information or perceptions.

Some approaches to basin planning build the trade-off discussion around the desired state of the aquatic environment and its implications for social and economic development and utilization of the basin water resources.

At the other end of the spectrum, technical, financial, economic and institutional trade-offs need to be made between the costs and benefits of different options to achieve the specified objectives.

The complexity of river basin planning can mean that the implications of a solution are not well understood or the imperatives that drive its selection cannot be agreed. In this case, stepwise adoption of objectives and actions may be more appropriate, with major decisions being delayed until they are absolutely necessary.

This chapter explores a range of commonly used approaches to support these various trade-off decision processes which are a fundamental part of basin planning.

12.1 Approaches for managing trade-offs

There are four broad families of methods that may be used to support decisions around trade-offs between competing objectives:

- hierarchy/priority approaches
- strategic scenario assessment
- multicriteria decision support
- optimization.

There are two basic challenges for all of these approaches:

- **Defining the problem:** to first translate broad interests and imperatives into clearly defined goals or criteria that can guide the decision. These may be combined into a single commensurate measure (such as monetary value) or may accept that the evaluation criteria are distinct, conflicting and non-commensurate.
- **Solving the problem:** finding the suite of objectives and so on that 'best' achieve these goals or criteria. This requires some way of identifying and evaluating possible alternatives.

While the following techniques are used to inform the decision-making or making recommendations, the final decision tends to be a negotiation between representatives of parties or interests.

HIERARCHY-BASED APPROACHES

This approach implies that some level of priority can be attached to the competing imperatives or objectives, with some a priori being deemed to be politically, strategically or economically more important. The way this typically manifests is with decisions required to achieve identified imperatives in one or more sectors taking precedence over other sectors. As illustration, energy (hydropower) generation, urban water supply or flood risk management may be the dominant purpose in a basin, with these requirements being met at the expense of water availability or quality requirements for other purposes.

No other technical or economic rationale is required to motivate the priority requirements, although thematically based assessment may be needed to define the requirement itself. Under this approach, lower-priority requirements or purposes would only be met to the degree possible and provided they do not encroach on the priority requirements.

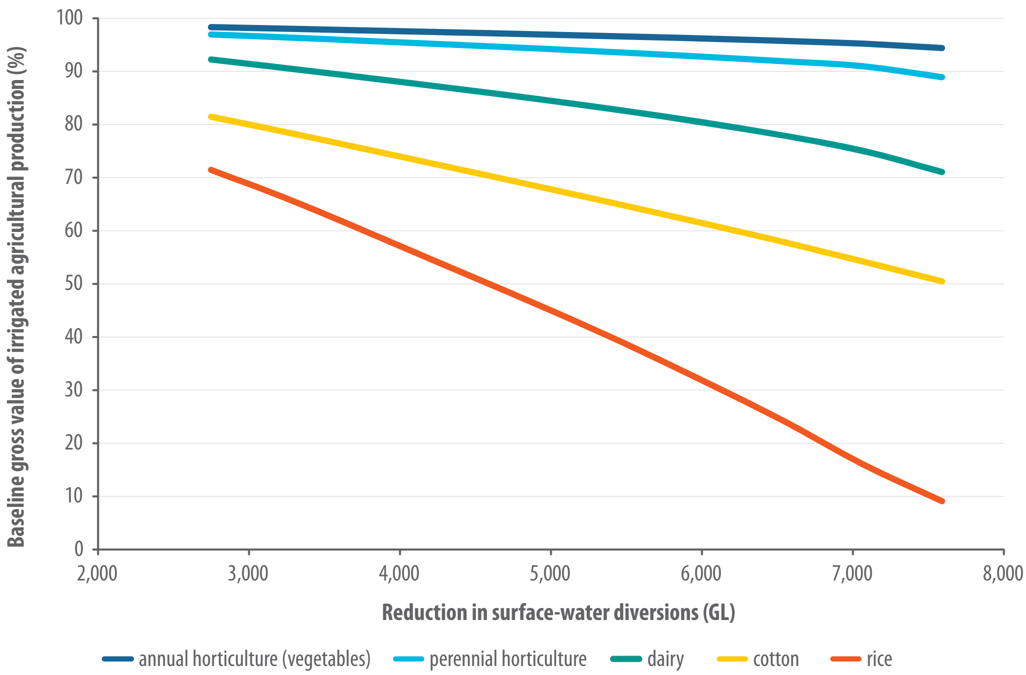
The specification of the hierarchy may be dictated by political representatives, be formulated through expert opinion (such as in a Delphi process), or agreed through consultation stakeholder representatives. In each of these cases, this is a heuristic approach, seldom supported by detailed economic analysis of the consequences of the prioritization in a particular basin.

Box 80: Socio-economic evaluation of environmental flow allocation in the Murray-Darling

Over-abstraction and drought in the Murray-Darling system have led to significant long-term impacts on basin and estuarine ecosystems. Australia's 2007 Water Law mandated the MDBA to produce a basin plan for the river that optimized social, economic and environmental outcomes. The basin plan was therefore explicitly required to reconcile competing environmental and economic objectives.

The basin plan uses scenarios as the mechanism for making these trade-offs. A sophisticated assessment was first undertaken of the reductions in abstractions from the basin that were necessary to restore functioning environmental systems. On the basis of this, three scenarios were identified, with reductions in abstraction of 3000 GL/y (22 per cent), 3500 GL/y (26 per cent), and 4000 GL/y (29 per cent). The socio-economic implications of these reductions for different communities, regions and economic sectors in the basin were then assessed. In view of the assessment of these findings, the 2010 draft basin plan recommended that scenario 1, a reduction of 3000 GL/y, be adopted. It was assessed that the socio-economic implications of the other two scenarios were unacceptable. The assessment of scenarios also identified necessary mitigation measures.

An important lesson from international practice is that this iterative process of assessing scenarios and revising objectives can take place over periods of time, and in both formal and informal ways. Such trade-offs are fundamentally political. This is the case in the Murray system: following the publication of the *Basin Plan* in October 2010, protests within the basin over the proposed reductions in abstraction have resulted in the commissioning of further socio-economic studies by the government. In effect, the iterative process of developing and testing scenarios is therefore now continuing outside the original planned scope of the basin planning process.



Sources: MDBA (2010, 2011).

STRATEGIC SCENARIO ASSESSMENT

As basins become more stressed and decisions become politically more complex, economic (and social) impact models are often used to assess the economic implications of different scenarios for water resources protection, utilization and development. These scenarios are typically generated around the definition of key water environmental objectives and implications for the use of water resources, following expert input from technical specialists in the relevant disciplines and themes.

The economic evaluation models are usually based on the models that are applied (and calibrated) during the situation assessment. Typical economic techniques include resource economic analysis, multiplier analysis, production value approach and input–output (IO) approach, and social accounting matrices (SAMs). They usually reflect economic impact in terms of the changes to the economy as represented by gross product and employment (by sector and/or region). These economic analyses tend to be piggy-backed onto water resources system planning models that provide an indication of the environmental condition, infrastructure development and water use by different sectors, associated with each option. The difficulty with these approaches is that they are expensive and information-intensive to develop, and their validity decreases as conditions deviate from the current state.

This type of options assessment may be the basis of a single-criterion decision-making process, such as determining the option that provides the greatest contribution to economic development. It represents an extension of the more traditional supply-financing assessment for water resources planning studies. Alternatively, socio-economic models may be used to develop a range of indicators of the implications of each option, such as growth and employment, which provide base information for the multicriteria decision-making approaches described below.

Ultimately the selection of the preferred scenario involves comparison of the implications (from the assessment) of each identified scenario, possibly refined according to the understanding gained through the assessment.

MULTICRITERIA DECISION SUPPORT

Diverse interest groups and stakeholders in basin planning processes seldom share the same perspective about the importance of specific economic, social or environmental imperatives or criteria. Thus trade-offs between water environmental objectives to be achieved by the basin plan must consider more than one criterion that cannot be compared (because it cannot be translated into monetary terms). Under these circumstances, different options (or scenarios) may be generated through expert input, followed by an evaluation of their consequences for identified criteria related to aquatic environmental health, economic development, energy generation, flood risk mitigation and so on.

Various decision support tools have been proposed to assist selection of the preferred option considering different criteria. This represents an entire field of study, which is not summarized here. Suffice it to say that at a high level, these techniques are based on:

1. Weighting the different criteria to identify a weighted score that can be compared for each option (scenario).
2. Inferring relative priorities of the criteria to enable the reduction of options that are inferior to others.
3. Identifying thresholds for the criteria to enable the reduction of options by excluding those that do not achieve the minimum requirements, or providing a user-friendly protocol to assist stakeholders with explicitly defined (or implicitly assumed) interests or priority around these criteria to move towards consensus.

OPTIMIZATION AND GOAL PROGRAMMING

Optimization techniques require the development of the problem statement as an objective function (or goals), together with relationships and constraints that govern the functioning of a system. These techniques generate globally optimal solutions that maximize or minimize the objective function (or meet the required goals). They can also be used to generate locally optimal solutions that meet goals (or thresholds on criteria).

The difficulty with using these methods to support decision-making in complex basins is the challenge of including the necessary complexity (including relationships and nonlinearity) around trade-offs and of defining relevant quantitative objective functions (or goals) that reflect imperatives. As has been indicated above, these tools provide useful methods of screening solutions to find a range of noninferior possibilities that can be considered, taking account of the qualitative understanding of imperatives, relationships and constraints that senior decision-makers generally have.

12.2 Robust decision-making under uncertainty

There is a range of causes of uncertainty in basin planning, ranging from inadequate knowledge of the relationships between elements of the system, through natural variability in hydrological, social and economic systems, to limited ability to forecast future changes in the climate and development drivers of these systems. Various methods have been proposed to engage and deal with this uncertainty.

UNCERTAINTY ANALYSIS

Uncertainty analysis is based on the representation of key model parameters or relationships in a probabilistic manner, and evaluating the implications of this uncertainty on the conclusions of the analysis. While it provides a broad indication of the implications of uncertainty in an assessment, the assumption is that the probability distribution of this uncertainty is known, which is unlikely in practice.

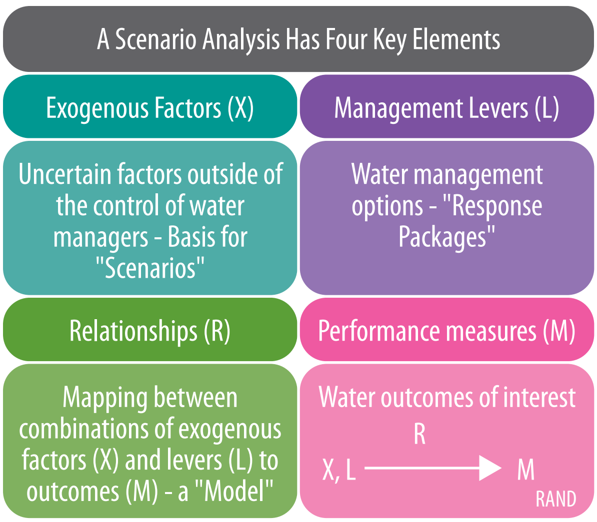
SENSITIVITY ANALYSIS

Sensitivity analysis aims to describe how the outcome of the above analyses may change with a change in the conditions, constraints or assumptions of the models. This allows the decision-maker to identify which issues have the greatest impact on the outcome and thereby to prioritize attention to understanding and managing these issues.

SCENARIO PLANNING

Scenario planning begins with the identification of future uncertainties (at various scales) that will affect the social-economic development, environment and water resources in the basin. Following an assessment of the level of uncertainty against the level of impact on water resources it is possible to identify highly uncertain and high-impact issues, around which different futures may be formulated. Typically these futures are captured in three to four plausible scenarios reflecting different futures (with no indication of the different likelihood of their occurring), together with a narrative on the pathway and key drivers from the current state to that future.

Figure 31: Elements of scenario planning used by the California Water Plan 2009



These drivers and pathways can then be used to identify the important management levers that will influence the outcome, with the intention of making it more benign for water management. The basin strategy development would focus on these levers and could be assessed against these scenarios, in order to evaluate its robustness under different possible future developments.

Box 81: Using scenarios to guide basin planning in the Breede-Overberg

Various scenario planning processes have been conducted in the fifteen years since 1997 in South Africa, and it is against this backdrop and an analysis of uncertainties that three narratives/perspectives (scenarios) of the future for the Breede-Overberg were described. The three scenarios are:

- **All in it together:** This reflects a cooperative future, supported by sustained development, growth and institutional strengthening. This provides the most favourable environment for balanced and effective water resources protection, development, sharing and efficient use.
- **Race to the bottom:** While maintaining some growth, this is characterized by ongoing inequality and limited cooperation. Inadequate institutional capacity results in limited regulation of water use or waste discharge, which is exacerbated by the limited cooperation.
- **Things fall apart:** This is characterized by social disintegration and stagnant economic growth, together with limited institutional capacity and ineffective policy. Limited growth and investment implies little significant increase in water requirements from agricultural or urban users, although the existing use may become less efficient.

The first scenario clearly suits the new paradigm of water management in the Breede-Overberg, but the question is what the other two scenarios imply for the CMS and the Breede-Overberg CMA. The second scenario would require a stronger regulatory authority to address gross violations, but would require a greater prioritization of attention to the really critical water resources management issues. The third scenario would require empowerment and support to water users and institutions that may not have adequate resources to act appropriately.

In summary, the three scenarios require a slightly different while complementary focus for the Breede-Overberg CMS led by a strong CMA. These are participatory-cooperative management as a priority for the first, control-regulatory management as a priority for the second and empowering-supportive management as a priority for the third. Together these reflect the spirit of the new paradigm and provide the pillars for a robust strategy and a resilient institution that must be maintained under any future conditions. Obviously this needs to be supported by adequate information about national and global shifts and emerging challenges in the area.

Source: BOCMA (2011).

12.3 Environmental zonation and classification

A more comprehensive approach to integrating development and environmental planning at the basin or regional scale is now being developed in a number of countries around the world, in particular in China and South Africa. These zonation or classification approaches seek to identify explicit environmental objectives for each different subunit of the river basin, with a series of objectives across a number of parameters required to be met to satisfy the overall objective. These environmental objectives have implications in terms of basin development and investment. As such, environmental zonation is not just about environmental future of the basin, but also about development objectives.

In an important development from more traditional approaches to environmental management, these approaches allow for the recognition of different objectives in different parts of the river basin. This recognizes that certain parts of a river basin are likely to be 'hard-working' sections of river that support intensive economic and social development, while other parts of the river have high importance in terms of ecosystems or the maintenance of river functions. This innovation is an important step forward in moving from technical planning approaches to more sophisticated strategic processes that can focus on identifying and meeting both development and environmental priorities.

Zonation and classification exercises can be undertaken in more or less formalized ways. In a less formalized context, different overall visions, objectives and priorities can be set out for the different parts of the basin. In a more formalized approach, specific environmental and management objectives can be set out for each specified zone of the basin.

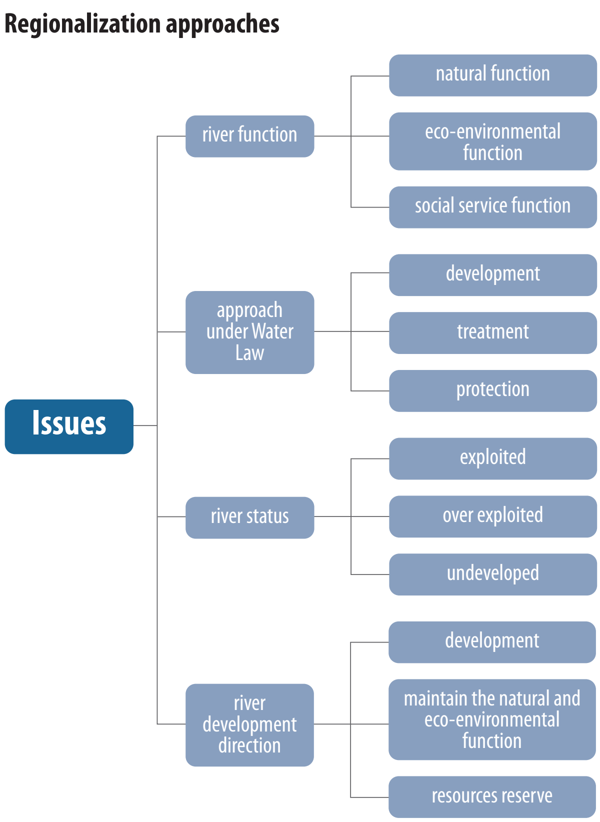
Zonation or classification processes typically pass through a number of steps. The basin or region needs to be divided into appropriate zones. A number of scenarios can then be created with different objectives for each zone. The potential classes or categories for these objectives will usually be set by national legislation or policy, and range from high-protection pristine zones to heavily utilized river reaches. Through the basin planning process, these different scenarios can be tested and compared, with the ultimate zonation system forming part of the final basin strategy. The output of the zonation process is not simply a set of environmental classifications and associated environmental strategies. Importantly, zonation also implies a set of objectives and constraints on development in the basin, including water quality, environmental flows and infrastructure. Classification exercises of this nature therefore provide an overall shape to the planning of all aspects of the basin, and the resolution of trade-offs between competing basin objectives.

Where such systems are used, the choice of a particular suite of zonation or classification objectives provides the backbone for the strategic objectives of the basin plan. It provides a clear and quantitative set of environmental objectives for different sections of the basin, and in so doing guides future development and investment options. Such zonation or classification schemes can therefore provide a comprehensive and formal mechanism for developing and testing alternative scenarios for the basin plan.

CASE STUDY: CHINA'S FUNCTIONAL ZONATION SYSTEM

China has recently developed a functional zonation system for use as part of the river basin planning process. This is based on the basic characteristics of rivers, the current and potential future use of water resources, the water needs for environmental protection and socio-economic development. This basin is divided into river sections, and each of these is assigned one of four types of function: development prohibited region, reserved region, rehabilitation region and development region (Figures 32 and 33).

Figure 32: China's functional zonation system

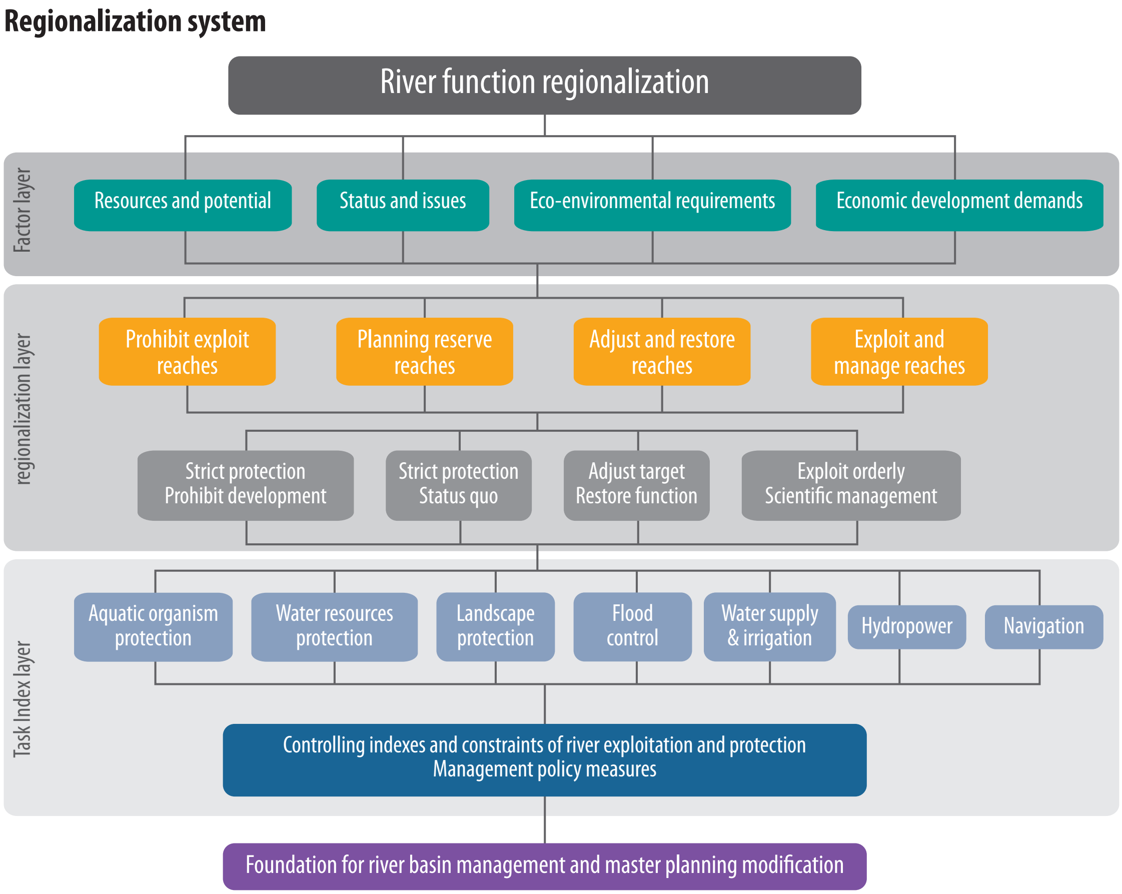


Source: GIWP.

After the function of each river section is established, the relationship between river sections of different functions and different sectors can be coordinated, and then the controlling index and conditions are established, providing the basis for the implementation of IRBM, developing management measures and formulating a RBMP.

- The function of **development-prohibited regions** is mainly to preserve the natural and eco-environmental functions of the river basin. In these zones, development activities are strictly prohibited except for activities with the purpose of protecting the environment or water resources, and appropriate small-scale development that meets the basic survival demands of local residents.
- The function of **reserved regions** is mainly maintaining the natural and eco-environmental services of the river, preserving the current socio-economic development and preparing for sustainable development. In these zones, new development projects require a strict approval process, and large-scale development activities are prohibited. Development activities of a high need go through a special approval process.
- The function of the **rehabilitation region** is to solve the conflict between utilization and protection, and restore the natural and eco-environmental function of the river. Aiming at issues concerning utilization and protection, it is intended to readjust the relationship between development and protection in these zones.
- The function of the **development region** is to make use of the river's services, but maintain a basis of protection. According to the carrying capacity of water resources and the water environment, the major objectives and tasks for development are determined. For regions of important ecological protection significance and with special natural or cultural scenic significance, development should be within certain limitations, based on the principle of scientific management and moderate development.

Figure 33: The approach to regionalization adopted by the Chinese planning process



CASE STUDY: THE SOUTH AFRICAN CLASSIFICATION SYSTEM

The South African Water Resource Classification System represents one of the most comprehensive attempts to date to develop a full classification system as part of the basin planning process. There is a particular focus on environmental flows in the South African classification context, as this represents a key environmental pressure and point of dispute in the basin planning process. Underpinning the system is the identification of six different categories of environmental status, ranging from Class A (pristine) to Classes E and F (heavily degraded). Under the system, these form the basis of a classification system, based on three different classes (see Table 6).

Table 6: Requirements for ecological condition for the three management classes in the South African system

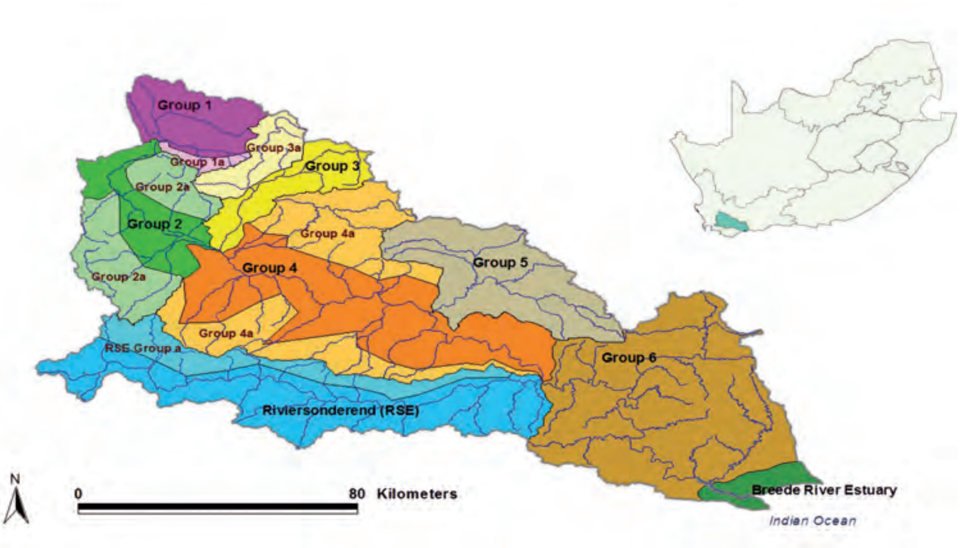
Management class	Description	Configuration guidelines
Class 1: Minimally used	The configuration of water resources results in an overall water resource condition that is minimally altered from its pre-development condition.	At least 60 per cent of the freshwater ecosystems in a sub-basin are in an A or B category.
Class 2: Moderately used	The configuration of water resources results in an overall water resource condition that is moderately altered from its pre-development condition.	At least 40 per cent of the freshwater ecosystems in a sub-basin are in an A or B category.
Class 3: Heavily used	The configuration of water resources results in an overall water resource condition that is significantly altered from its pre-development condition.	No requirement for A or B categories

In the development of catchment management plans under the South African National Water Act, the classification system is used as the basis for arriving at decisions over trade-offs between environmental priorities and use of water for agriculture, industry and domestic purposes. Under the process, the current ecological status of the catchment is assessed, and a number of scenarios are developed for the future condition of the river.

On the basis of these scenarios, the implications in terms of the environmental water requirements for the river and the resulting availability of water for additional purposes are set out. A number of models can be used to develop an understanding of the implications of the different scenarios, including a water resource model to determine water yield, a water quality model to assess water quality implications (fitness for use) for all users, environmental flow requirements to maintain different ecological conditions, and an economic model to assess the economic and social implications. This set of scenarios, together with the assessment of their implications, is then presented to stakeholders as the basis for discussion and negotiation through the basin planning process.

The example below is from the Breede CMA in the south-west of South Africa, in which the classification system made an important contribution to the development of the broader CMS. In this case, the process identified that ecological status across the catchment was declining. A number of different scenarios for the desired future ecological condition in the catchment were identified, and these were used to formulate priorities and objectives for the basin plan, including the need to prevent any further deterioration in ecological status in the basin, the need to maintain the general good-quality mountain streams in Class I status, and the importance of maintaining and restoring the estuary due to its regional and national social, environmental and economic importance. The functioning of the estuary depends upon the pattern of freshwater flows and floods from the catchment, and this objective therefore has important implications for management of the basin as a whole.

Figure 34: The Breede River basin, showing broadly similar ecological areas



Source: BOCMA (2011).

Table 7: The estimated overall ecological condition (projected to 2020) of rivers in the Breede basin under three scenarios

Management area	Group	1999	2009	Scenario 1	Scenario 2	Scenario 3
Ceres Area	BrGr1	D	D	D	D	D
	BrGr1a	C	B	C	B	B
Upper Breede	BrGr2	C	D	C	D	C
	BrGr2a	B	B	C	B	B
Hex	BrGr3	D	D	D	D	D
	BrGr3a	C	C	C	C	C
Central Breede and Koo	BrGr4	C	D	D	D	C
	BrGr4a	B	B	C	B	B
Montagu	BrGr5	C	E	E	D	C
Tradouw/ Buffeljags	BrGr6	C	C	C	C	B
Riviersonderend	RSE	C	D	D	D	C
	RSEa	B	B	C	B	B
Estuary	BrRest	B	B	C	B	B

12.4 Comparing and selecting management actions

COST–BENEFIT DECISIONS

Traditional decision-making in water resources involves a cost–benefit analysis to compare specific interventions. This analysis was originally economic in nature, comparing all quantifiable benefits from an intervention with the costs of implementing that same intervention, expressing the costs and benefits in a common monetary unit. Where the benefits exceed the cost, an annual rate of return can be determined and used to compare the return of several options.

Cost–benefit analysis has evolved to include non commensurate costs in the analysis, including institutional and social impact assessments, and now many complex considerations are accounted for in such an analysis. Costs and benefits are disaggregated to identify who among government, donors and private interests will be affected, and so to inform those who may be most appropriate to support the intervention. Health benefits, environmental impacts and preferences are also considered, though the manner of accounting for such factors is open to many questions.

Box 82: Economic evaluation of water quality objectives for the Rhine and Danube

The basin-wide economic analysis for the Danube basin plan focused on water quality measures to achieve the requirements of the EU WFD. This was closely linked to national procedures and considered only those economic issues that were of relevance on the basin-wide scale, which enabled international comparison. These were referred to as horizontal economic issues, with a focus on financial analysis of the cost recovery, cost effectiveness and cost-benefits of different measures in the riparian countries, in order to achieve the 2015 baseline scenario.

Box 83: Cost–benefit analysis by the World Bank for the Espírito Santo Water and Coastal Pollution Management Project

The World Bank conducted a cost–benefit analysis to determine whether additional funding for the Espírito Santo Water and Coastal Pollution Management Project in Brazil was financially and economically feasible. The project consisted of a water supply component, and a sewage and wastewater treatment component which were analysed separately to determine costs and benefits.

A financial and an economic analysis were conducted, with the financial analysis focusing on the revenues that would be received and expenses incurred by the state water utility. The economic analysis included costs and benefits accruing to the economy as a whole, including the customers of the water utility. Costs were based on investment, operating and maintenance estimates. Financial benefits included tariffs based on number of customers and per capita consumption, while economic benefits included a more consistent water supply and customer savings. Benefits such as savings in medical costs due to decreased illnesses from properly treated water, or improvements in quality of life, were not included.

Several assumptions were made, including the population of the area served, percentage of population connected, and per capita water consumption and sewage. The net present value (NPV) of costs and benefits was then calculated using a discount rate of 10 per cent, and internal rates of return determined. In this case, the NPV was positive from both the financial and economic analysis, indicating a viable investment.

	NPV of cash flow (000 US$)			IRR
	Benefits	Costs	Net benefit	
Financial Analysis				
Water	123,771	88,197	35,574	26%
Sewerage & WW treatment	136,253	126,800	9,453	11%
Total	260,024	214,997	45,027	15%
Economic Analysis				
Water	172,374	67,687	104,686	32%
Sewerage & WW treatment (with avoided cost estimation)	197,695	121,671	76,023	18%
Total	370,068	189,358	180,710	22%
Sewerage & WW treatment (with WTP estimation)	191,310	121,671	69,639	17%

Source: World Bank (2009c).

Although cost–benefit analysis is complex in its range of considerations, it is largely static in its approach to uncertainty, as costs and benefits are determined as a single value or range of values which are then discounted to reflect NPV.

REAL OPTIONS

Real options valuation is evolving as a decision-making tool for water resources management which acknowledges uncertainty when evaluating a set of options, and thus can contribute to a more robust cost–benefit analysis. It combines decision analysis with the concept of financial options, where an investor buys an option which gives the right, but not the obligation, to buy or sell shares at a fixed price at a later time. This allows an investor to manage risk by making a smaller investment now, deferring a further investment decision until more information, such as the price of a stock, is known.

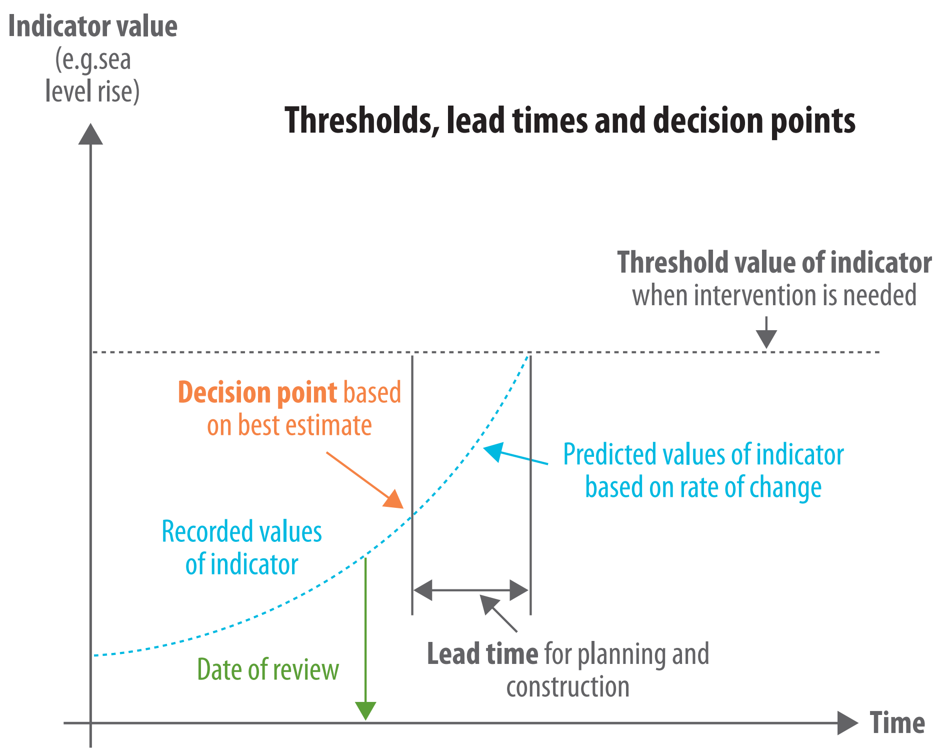
Real options valuation can respond to uncertainty and the resolution of uncertainty by acknowledging two realities in large investments.

- **Compound decisions:** Real options valuation allows for flexible decision-making that is common to all stages in projects with multiple stages of investment. A preliminary investment may be required to preserve the option for the full investment at a later date, but preliminary investment does not obligate subsequent investment. For example, investment to carry out preliminary planning steps for the development of new water resources or flood management infrastructure can be made, while keeping open the options of deferring or abandoning construction at a later point.
- **New information:** Real options valuation incorporates the resolution of uncertainty as information is learned some time in the future. For example, the economic characteristics and water requirements of a developing area or changes in climate patterns might become more clear ten years in the future, and lead to a different decision.

The benefit of a real options approach over NPV is that NPV often results in systematic underinvestment because the flexibility to make subsequent decisions according to new circumstances and information is not acknowledged in an NPV analysis.

The use of real options in water resource management is not widespread, and few practical examples exist. The approach is however gaining momentum in water resources, and has been applied in similar contexts such as decisions on whether to purchase and develop mineral resources. Application involves developing a decision analysis tree, including nodes for future decisions and nodes for uncertainties that may be resolved. The NPV is then calculated so the ability to make an informed decision in the future is taken into account.

Figure 35: Adaptive decision-making with real options for the Thames Estuary 2100



Box 84: Flood risk management on the Thames

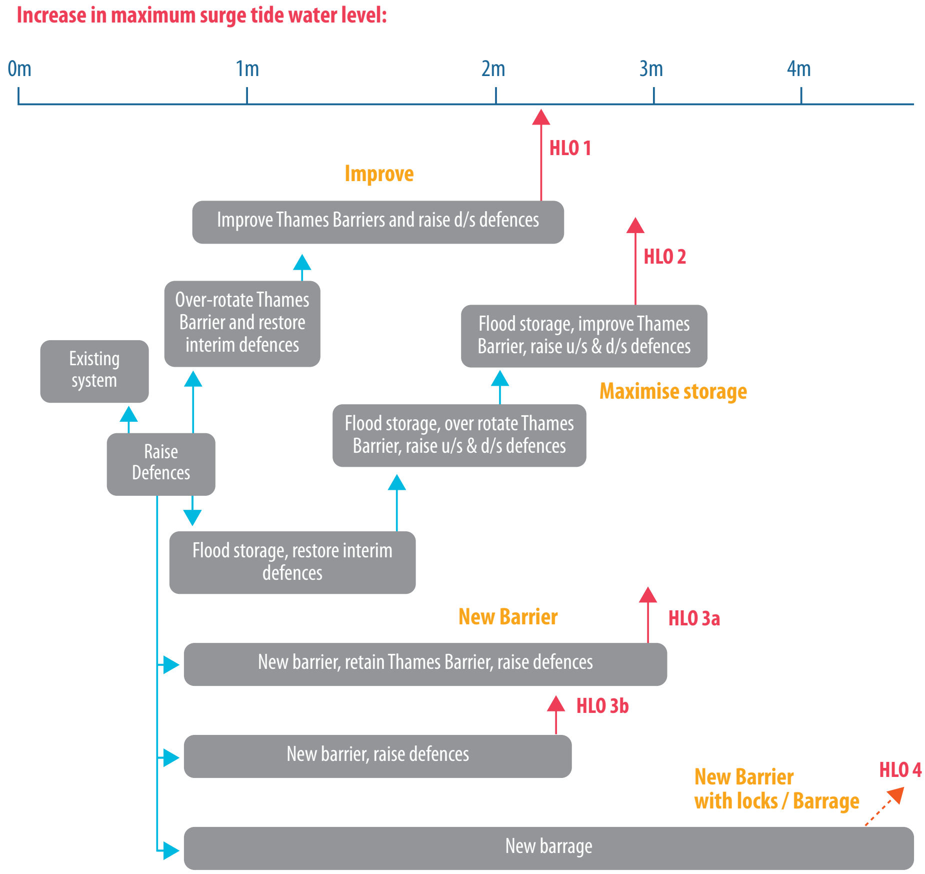
From 2004 to 2010, the Environment Agency, UK developed a tidal flood risk management plan for the Thames estuary for the next 100 years (known as Thames Estuary 2100, TE2100). The Thames estuary floodplain contains 1.25 million people (one-sixth of London's population), about £200 billion of property, and key transport and infrastructure assets, including the London Underground, 16 hospitals and eight power stations. The value of assets at risk and the long lead times involved in developing solutions emphasize the need to plan in advance for the effects of climate change, including sea level rise and increasing frequency of storm surges.

The severe uncertainty over the future impacts of climate change meant the ability to adopt a flexible strategy and formally value this flexibility within the decision process was critical. The TE2100 team adopted a real options analysis as the framework to incorporate the uncertainty of climate change and the value of flexibility into decision-making. Through consideration of real options (these are alternatives or choices that become available through an investment opportunity or action) the TE2100 team identified options to cope with different levels of sea level rise, and the thresholds at which they will be required. The options were designed to implement the small incremental changes common to all options first, leaving major irreversible decisions as far as possible into the future to make best use of the information available.

As shown above, individual responses to increasing flood risk arising from sea level rise were assembled into portfolios of responses to deal with differing levels of climate change (expressed in metres of sea level rise).

The real options analysis recognized that information about uncertainty changes over time, such as from learning or research. The TE2100 Plan therefore includes a monitoring and evaluation strategy. If monitoring reveals that climate change is happening more quickly (or slowly) than predicted, the implications for decision points are established. The strategy can be reappraised in light of the new information and options can be brought forward (or put back). This helps ensure adaptation decisions are made at the right time. In developing the TE2100 plan it was important that this flexibility did not detract from performance of the strategy if it is not needed.

The initial experience with real options approaches in the Thames confirms they are well suited to the development of flood management strategies that need to be flexible to deal with the severe uncertainties in climate and demographic change as the reality of these changes become known.



Note:
Each box represents one or more portfolios of responses.
The arrows indicate paths for adapting options for different sea level ranges.

Source: Environment Agency (2009).

CHAPTER 13
DEVELOPING THEMATIC PLANS

13.1 Purpose of thematic plans

Water management thematic plans are a mechanism for identifying and addressing specific priority issues. This allows greater attention to be paid to assessing the issues and formulating objectives and actions than is feasible during preparation of a strategic basin plan.

The process of developing and evaluating management options is typically done by:

1. Identifying options and assessing their contribution to achieving agreed objectives.
2. Evaluating and ranking the options against clear technical, financial, social, ecological, economic and institutional criteria.
3. Evaluating the level of robustness to alternative futures reflected by the uncertainty-based scenarios.
4. Consulting relevant stakeholders to solicit diverse perspectives and preferences.
5. Selecting the most feasible options.

In formulating options it is important to consider the implications of different approaches as they relate to the river basin plan and other (existing or future) thematic plans. This is an iterative process, by which there is convergence on workable and feasible thematic plans and objectives.

This chapter considers six different, but related, categories of thematic plan that are typically included under the umbrella of water resources management:

- water allocation plans
- water demand and utilization plans
- water environment and conservation plans
- water quality management plans
- flood risk management plans
- infrastructure and development plans.

The objective and content of different thematic plans will vary with the complexity of the issues and options within any basin. In many basins, it may not be necessary to have separate plans to address all of the above issues, while in others there may be a need for a hierarchy of progressively more detailed plans for any one of the categories listed above. Similarly, an issue of critical cross-thematic importance might be dealt with in detail in the basin plan itself. There is then no hard and fast rule – water managers need to structure their basin plan, and thematic plans, to suit the situation.

The following sections consider the role and purpose of these groups of plans, the typical process for formulating a plan, the matters a plan will usually address, and some illustrative examples. These sections also look at the critical issue of how these plans may interact and overlap with other thematic plans and with the river basin plan.

Figure 36: The relationship between the river basin plan, thematic plans and other plans

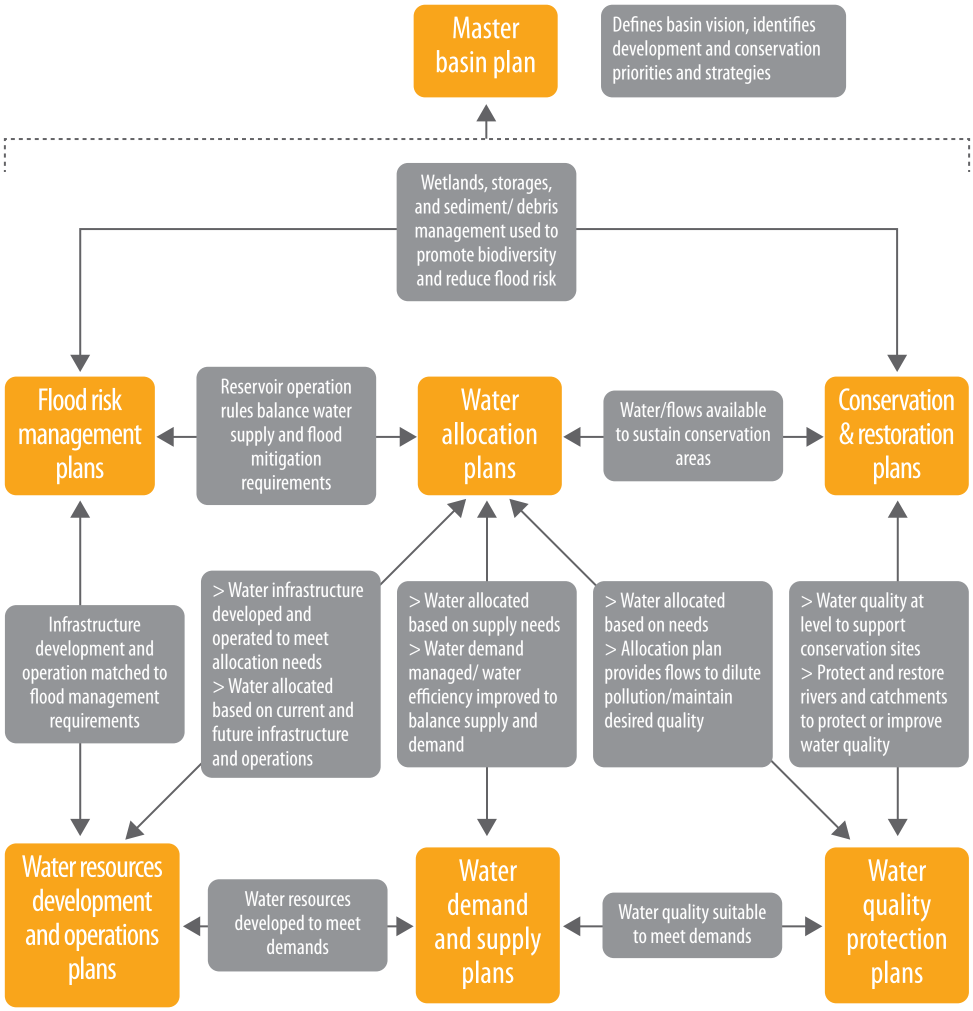
13.2 Interactions between thematic plans

Clearly there are significant interactions between different thematic plans. Ideally, the basin plan will provide guidance on how competing objectives will be prioritized between plans. Regardless, it is important that in preparing a plan consideration is given to how the plan will affect, and be affected by, other activities within the basin. This includes:

- Considering how thematic plans can be structured to support the objectives of other thematic plans. For example, protecting and managing wetlands (under conservation plans) should be done in a way that also improves flood management outcomes.
- Ensuring that plans do not operate at cross-purposes. For example, new water infrastructure should not be constructed in a location that has been designated as a conservation area.
- Generally ensuring that the objectives of different plans are consistent with one another. For example, it must be ensured that water quality (as managed under water quality protection plans) will be suitable for the purpose (such as drinking water supplies) for which it is allocated under a water allocation plan.

Some of the key interactions between different thematic plans are shown in Figure 37.

Figure 37: Linkages between thematic plans



13.3 Environmental conservation and restoration

This section considers plans related to the conservation or rehabilitation of sensitive or otherwise important ecosystems. This can include plans at a basin scale, or local management and action plans, and includes activities both in the river channel, and in the catchment area at large. Specialist plans may be developed to address issues related to:

- ecosystems within the river channel and the riparian zone
- wetlands
- management within the broader catchment
- urban rivers and the urban environment
- improving connectivity within a river system, such as plans related to the removal or modification of dams and other in-stream infrastructure.

ROLE AND OBJECTIVE

Protecting the health of the natural environment is now a core objective of most water resources management systems, and is commonly recognized in both basin and water allocation plans. Environmental conservation and restoration plans ('conservation plans') provide more detail about specific ecological priorities and objectives and the actions and strategies to be implemented to achieve those objectives.

Ultimately, the purpose of these plans is to protect and/or restore river assets and services that have been identified as being of value. Plans may contribute to protecting and improving any of the range of assets and services that rivers provide. This may involve protection of the ecological values of the basin, for example by protecting or restoring areas or species of high conservation value. Alternatively, a plan may have as its goal improving productivity within a basin, for example by increasing fish habitat and stocks. Conservation plans can also act to improve the flood mitigation capacity of a basin, for example by restoring wetlands which can perform a flood retention role, or to improve water quality, for example by managing the upper catchment to reduce diffuse pollution.

Conservation plans may address issues related to:

- **protection –** to maintain river assets and functions and prevent activities that may have a deleterious affect
- **restoration –** to return river assets and functions to their natural condition, prior to human disturbance
- **remediation –** to improve river assets and functions to some desired condition (but not necessarily related to their natural condition).

Box 85: Functions of wetland management planning

The Ramsar Secretariat in its guidelines for managing wetlands lists the following ten functions of wetland management planning:

1. Identify the objectives of site management.
2. Identify the factors that affect, or may affect, the features (of the wetland).
3. Resolve conflicts.
4. Identify monitoring requirements.
5. Identify and describe the management actions required to achieve the objectives.
6. Maintain continuity of effective management.
7. Obtain resources (generally funding).
8. Enable communication with and between sites, organizations and stakeholders.
9. Demonstrate that management is effective and efficient.
10. Ensure compliance with local, national and international policies.

Source: Ramsar (2007).

KEY ELEMENTS OF A CONSERVATION PLAN

A conservation plan may be given effect through protective measures and/or restorative measures. This can include actions within the watercourse as well as in the broader catchment area.

Protective measures can include actions or rules to avoid negative impacts on the assets and functions of value. This can be by way of preventing harmful activities from occurring (for instance, preventing new development), or by removing existing causes of poor health (such as shutting down factories that discharge pollutants). A plan may do this by limiting or prohibiting:

- access of people or vehicles to certain regions
- construction, agriculture or other development
- discharge of pollutants
- fishing, mining, the removal of vegetation, or any other extractive industry.

Depending on their objective and the local issues, plans may cover a range of issues, or may focus on a single threat to ecosystem health. Strategies can include total bans on certain activities (such as preventing the removal of anything from within designated conservation zones), standards that must be met (for example, for discharge of pollutants), or limits on the extent to which activities can be undertaken, such as capping the amount of vegetation that may be cleared within a catchment area.

Where a conservation plan includes an objective of restoring or remediating ecosystems, the plan may provide for actions including:

- the revegetation of the riparian zone – for example, planting trees in areas that have become degraded through poor grazing practices
- reintroduction of fauna – for example, through the reintroduction of fish species lost because of overfishing or loss of habitat
- removing physical limiting factors, such as by the construction of fish passages or the removal of dams, to restore longitudinal connectivity, or mitigating the thermal effects of dams by altering operational rules or retrofitting infrastructure
- rehabilitation of channel form – for example, by removing levee banks to improve habitat and restore the connection between the channel and adjacent wetlands, or by reinstating meanders, riffles or other natural features of the channel that have been lost
- in-stream habitat improvement structures – to provide physical diversity, and through it (artificial) habitat, to compensate for losses arising from prior modification, for example, by constructing fish shelters (Gordon et al., 2004).

Box 86: Reedy Creek wetlands management plan

The Reedy Creek wetlands are located in the lower reaches of Australia's Murray River. The 2006 management plan for the wetlands is aimed at 'maintaining and improving wetland ecological values, such as habitat (wetland fringing and aquatic vegetation) for the benefit of waterbirds, native fish, frogs and macroinvertebrates through native vegetation restoration'.

The plan identifies various management objectives, the priority of each, and the actions proposed to achieve each objective. The following table summarizes aspects of the plan.

Management objectives	Actions	Monitoring	Priority
Vegetation: Regeneration/ maintain wetland aquatic species	Revegetate with reeds in shallow areas Revegetate riparian zone	Vegetation survey Monitor water quality	Medium
Fish: Restore native fish habitat	Restore riparian vegetation Increase structural woody habitat	Fish survey Macroinvertebrate survey	Medium
Birds: Maintain open water habitat in autumn as refuge	Avoid impacting on open water regime (no action required)	Bird survey Observation of water levels	Low
Minimize groundwater impact on wetland	Monitor impact of restored hydrology and adapt management accordingly	Monitor water quality and groundwater	High
Water quality: turbidity	Expand reeds in wetland to minimize resuspension of sediment	Monitor water quality	Low
Manage stock access	Construct fences Develop grazing management plan	Vegetation survey Frog monitoring Bird monitoring	High

KEY CONSIDERATIONS

In preparing a conservation plan, the following issues should be considered:

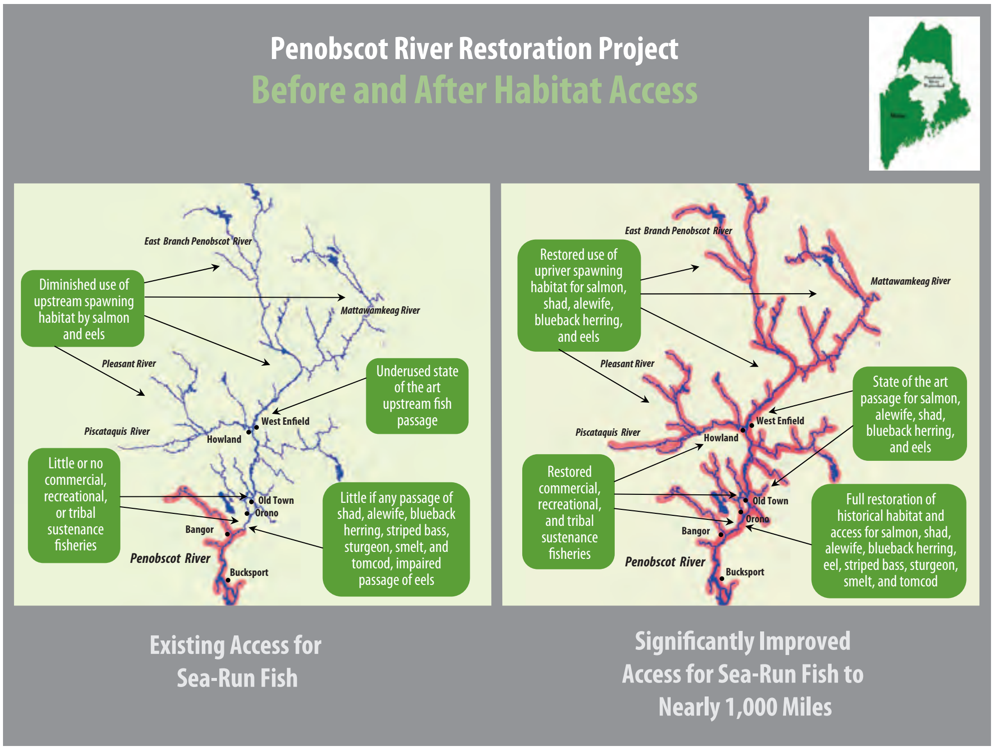
- **What is the most efficient use of resources?** The planning process should consider what measures are likely to achieve the best outcomes (e.g. in terms of improved ecosystem function) given financial and other constraints. As a general rule, it is easier, quicker and more cost-effective to protect streams that are currently in a good condition, than it is to restore streams that are already degraded (Rutherford et al., 2000). As such, it will often be appropriate to focus first on preventing further decline in the condition of the river or catchment, before attempting to restore degraded areas.
- **What are the limiting factors to river health?** The health of a river and its assets will be determined by a variety of factors. A conservation plan must recognize which of those factors managers have the capacity to influence, and what is outside of its scope. For example, a wetland management plan (and its implementing institutions) might have powers over activities within the wetland itself, but little or no control over the amount of water that reaches the wetland, or the quality of that water. There can be little point in investing significant time and money in revegetating a degraded wetland if it is a lack of water that is the root cause of the decline in health, and if water will not be available to sustain the revegetated area.
- **What level of river health is realistic?** Conservation and restoration objectives should make allowance for both the current condition of the river and existing or planned development within the catchment (for example, as proposed by the basin plan).

Box 87: Agreement on restoration of the Lower Penobscot River

The *Lower Penobscot River Multi-Party Settlement Agreement* forms the basis for a significant dam-removal and fish habitat restoration project. Signed in 2004 by PPL Corporation (a dam and hydropower owner/operator), a number of federal, state and tribal governments, and a collection of conservation groups, the agreement sets out a blueprint for the restoration and management of the Lower Penobscot River, the largest river basin in the US state of Maine.

Under the agreement, the Penobscot River Restoration Trust is entitled to purchase three existing dams from PPL Corporation. The purchase was completed in November 2010 at a cost of US$24 million. Two of those are to be decommissioned, and a state-of-the art fish bypass constructed at the third. Fish passage is also to be improved at four other existing dams. In return, PPL Corporation has the option of increasing power generation at six existing reservoirs. Various government approvals are still required prior to implementation of different parts of the agreement. However, the agreement provides a level of certainty to all parties about future plans and objectives for the basin.

The objective of these works is to restore habitat for a range of sea-run fish, by restoring the connection between the river and the ocean and allowing migratory fish access to historic spawning sites that have been blocked since the construction dams. Once completed, it is expected that the project will result in an increase of fish habitat of approximately 1,600 km.



Source: Penobscot River Restoration Trust, www.penobscotriver.org

LINKS WITH THE BASIN PLAN AND OTHER THEMATIC PLANS

Where one exists, conservation planning should be guided by the basin or regional strategic environmental plan. Likewise, the overall basin plan should provide guidance on ecological and conservation goals and priorities for the basin.

Conservation plans may influence, and are influenced by a number of other thematic plans:

- **Development plans:** to the extent that conservation and development objectives need to be reconciled, to ensure that development is not planned in areas of high conservation value, or that conservation areas are not established in areas likely to be affected by regions tagged for future development.
- **Water quality and water allocation plans:** these plans can affect the extent to which there is an appropriate flow regime, and water of sufficient quality, to support dependent ecosystems. As such, these plans can be critical to maintaining the ecosystems that are protected under a conservation plan. Equally, the protection and restoration of ecosystems can play an important role in maintaining or

improving water quality and meeting the objectives set by allocation and water quality plans relating to the provision of water suitable for consumptive use.

- **Flood risk management plans:** conservation areas can act as natural flood retention sites and can form an important element of a flood risk management strategy. The role of wetlands in particular in managing flooding can be an important justification to support their retention or rehabilitation.

13.4 Water quality management

The interconnected nature of water quantity and water quality is often cited as one of the cornerstones of IWRM. Increased flows in rivers dilute effluents, reducing the impacts on downstream users and the environment. Faster flowing rivers may limit algal blooms and increase reoxygenation, whereas slower flowing rivers may increase the assimilation of pollutants through absorption and sedimentation. Reduced inflows into estuaries promote seawater intrusion and may alter the redox potential, pH and chemistry of bottom sediments, causing a variety of water quality and environmental problems.

Conversely, increased runoff may increase nonpoint-source pollution, enhance erosion and result in higher sediment loads, which may reduce storage capacity in reservoirs. Floods may remobilize bottom sediments, carrying pollutants further downstream. Increased flows through wetlands may reduce the assimilation of pollutants. In many countries, effluent returned to rivers provides an important source of water for downstream users, and the treatment and reuse of wastewater is inherently part of water allocation plans and systems operation. Complex chemical, biological and physical interactions in water affect the way pollution impacts water users. Environmental flows and protection of environmental assets in turn increase the assimilation of pollutants, addressing a range of water quality problems.

However in spite of these links, or perhaps because of their complexity, water quality, water allocation, flooding and environmental plans are not often seamlessly integrated and conjunctively implemented, and in most cases water allocation planning dominates basin planning processes. Water quality plans must nevertheless encompass consideration of river flows as well as measures to protect the environment. This section details the generic approaches towards water quality thematic planning, highlighting the links to these other thematic plans.

ROLES AND OBJECTIVES OF WATER QUALITY PLANS

Water quality management plans aim to ensure that the water supplied remains fit for the uses it is put to. The plans are almost invariably underpinned by polluter pays principles, and identify what effluent or nonpoint-source controls should be put in place, and by whom.[1] In some cases water quality plans may include incentives, like waste discharge charges or site specific discharge standards, to encourage polluting industries to move to less impacted parts of the basin.[2] In other cases water quality plans primarily aim to protect the environment.

Typically, the planning process aims to identify priority substances, pollution sources and river reaches for management attention. Often this is used to focus investments in pollution control infrastructure or urban wastewater treatment, or simply to ensure closer policing of existing pollution management legislation. However, in some cases water quality planning may entail the determination of allowable effluent loads for priority substances in heavily impacted river reaches.

More recently, water quality management planning has become central to achieving environmental objectives, and overarching environmental objectives are seen to include water quality objectives. This recognizes that water quality plays an important role in determining environmental health, and that protecting environmental assets improves the assimilation of pollutants.

THE PROCESS OF DEVELOPING A WATER QUALITY MANAGEMENT PLAN

Water quality management plans are typically developed through the following steps:

1. A water quality situation analysis

This identifies key water quality concerns, or 'priority substances', by comparing measured concentrations with water quality guidelines that describe the potential impacts on water users. These impacts include human health risks, reduced yields on irrigated crops, increased costs of water treatment, increased industrial production costs and environmental degradation. Economic analyses may be conducted to put a value on

1 There are some cases where water quality problems are natural in origin, but have been exacerbated by the operation of the basin to secure water supplies. In these cases there is no polluter per se. In other cases pollution problems are exacerbated by the operation of the system, and the polluters cannot be held entirely liable for the impacts on water users.

2 This has most often met with limited success.

deteriorating water quality, which may be used to motivate investments in management. A good example of is to be found in the Danube Basin Analysis (ICPDR, 2012), which was developed under the EU WFD. The WFD required, as a first step in the basin planning process, an economic analysis of water use as well as the identification of 'pressures' affecting water bodies.

Priority substances addressed in these situation analyses generally fall into the following categories:

- salinity
- nutrients and algal growth
- hazardous substances like pesticides, herbicides, radionuclides and pharmaceutical products
- fecal contamination from partially or untreated human waste
- organic wastes and decreased dissolved oxygen concentrations.

Water quality situation analyses usually aim to identify which of these should receive priority attention, by assessing the proportion of time when certain water quality concentration thresholds are exceeded. Water quality situation assessments therefore tend to be based on the risk that impacts may occur, and very rarely on the actual measurement of the impacts.

2. Causal chain analyses

Causal chain analyses link the observed water quality issues and priority substances to human activities. They aim at identifying the source of the pollution and hence the interventions that may be put in place to address the problems. Causal chain analyses may assess the efficacy of effluent discharge standards or nonpoint-source controls, if these are effectively implemented and policed, or if these standards are sufficiently stringent. In other cases these analyses trace the processes that lead to water quality problems. Many causal chains also address the underlying social, institutional and economic causes of pollution. In Australia, the Water Act of 2007 requires that the key causes of water quality degradation in the Murray-Darling Basin must be identified as part of a water quality and salinity management plan. The GEF's TDA methodology explicitly requires causal chain analyses (Bloxham et al., 2005).

In some cases causal chain analyses recognize that water resources development and use may exacerbate or cause water quality problems. In the Zwartkops Basin in South Africa, runoff from the high mountain areas has a low salinity, whereas runoff in the middle reaches of the catchment is naturally saline. Diversion of the water in the mountainous regions to meet urban demands means that the salinity in the middle reaches of the basin has increased. The Zwartkops water quality situation analysis consequently noted (DWAF, 2001*b*) that establishment of environmental flows in the upper reaches of the basin would address the salinity in the middle reaches. Similar problems are noted in many river systems, particularly where downstream flows are only aimed at meeting water demands. Any return flows from these users invariably increases pollutant concentrations in ever-decreasing river flows.

3. Establishing water quality targets

Water quality targets establish the desired end point of the management process. These can be set as global goals, for example in the EU WFD which specifies that all European waters must be in a 'good' ecological state by 2015, or at key points in the basin, for example in the Murray-Darling Water Quality and Salinity Management Plan (MDBC, 2001), which specifies a basin-wide goal for the lower end of the system, as well as end-of-valley targets for twenty sub-basins. In this case, sub-basin targets must be aligned with the end of basin target. Specification of a single environmental goal (as in the case of the WFD) recognizes that both water quality and habitat must be protected. However, in heavily modified water bodies, irreversible habitat changes may mean that environmental goals cannot be achieved. In these systems the WFD specifies that 'good chemical status' must be achieved.

In South Africa, water bodies must be classified in one of three classes, and 'resource quality objectives' must be established for each class and each significant water body. Resource quality objectives may be a set of narrative (or descriptive) as well as numerical objectives. South Africa's *Guideline to the Water Quality Component of a Catchment Management Strategy* (DWAF, 2001b) indicates that resource water quality objectives (RWQOs) should be set according to the needs expressed by stakeholders (both water users and polluters), and that these objectives should be developed iteratively with assessments of the additional investments that might be needed to realize them. The Orange-Senqu River preliminary TDA indicates that an in-stream RWQOs for the Vaal River system increase downstream and near known pollution sources in response to these requirements.

In many cases, recognizing that highly variable flows influence in-stream water quality, targets are specified not as an absolute maximum, but as a percentage. For example in the Murray-Darling basin the salinity target for the mouth of the river is set at 800 EC units for 95 per cent of the time. Targets may also be set as total pollution loads, for example the *Danube River Basin Plan* (ICPDR, 2009a) sets targets for total nutrient loads to the Black Sea.

Setting appropriate targets is further complicated where the water is treated before it is supplied to the user. For example, trace metals are often toxic to humans in quite low concentrations, but are easily removed in water treatment processes. As such in-stream targets may be set according to the 'treatability' of the water, as well as the type of treatment available and the access of the population to treated water.

4. Determine allowable waste loads or management interventions

Water quality targets are usually met by managing the pollutant loads reaching the river system. For point sources this may entail setting maximum effluent concentration standards and/or pollutant loads, while nonpoint sources and the risks of accidental spills are usually managed through establishing best practice guidelines. In some cases these interventions are aimed at implementing existing legislation, for example the *Danube River Basin District Plan* prioritizes financial support for the implementation of the EU Urban Wastewater Treatment Directive, as well as directives aimed at controlling and reducing the use of agricultural chemicals. However, in other cases the determination of allowable waste loads requires the calculation of site-specific discharge standards based on complex water quality modelling and expected river flows.

As site-specific allowable waste load limits are dependent on flows in the receiving rivers, they are consequently affected by the operation of the river system as a whole. For salinity, this can be done on a basin-wide basis, as the conservative nature of salts means that basin-wide operational models can be linked to salinity models. A good example is found in South Africa's Vaal River system. In this system a salinity model has been linked to a system operating model. This has allowed the introduction of a salinity dilution option, which allows for the dilution of salts in the middle reaches of the river to a target 600mg/L total dissolved salts, with releases of good quality water from further upstream. Options to meet this target can be integrated seamlessly with water availability models to ensure that both water demands and salinity targets can be met.

However, for nonconservative substances which are assimilated by in-stream processes, the complexity of the models required often precludes this kind of seamless integration across the whole basin. In these cases, allowable waste loads have to be determined on minimum flows, or some statistical measure of the probability of low flows. In the United States, allowable loads of biological oxygen demand have been calculated on a Q^7_{10} basis: that is, the tenth percentile of river flows taken over at least a seven-year period. These are usually applied to shorter river reaches where priority problems have been identified. In some areas highly variable flows mean that this simple statistical parameter is inadequate, as severe water quality problems may be experienced during low-flow periods.

In some cases, allowable waste loads have been determined based on instantaneous flows in the receiving waters, and higher effluent loads are allowed during flood events. In these cases waste dischargers may measure upstream flows and quality and adjust their effluent flows accordingly. This is usually only contemplated for nonhazardous substances which are assimilated by in-stream processes. However, the core principle that 'dilution is not the solution to pollution' seems to hold in most cases, and this approach has not seen widespread application.

5. Outline an intervention plan

An intervention plan outlines what pollution management controls will be put in place, by whom, and when. This is usually influenced by the prioritization of the water quality issues (perhaps assisted by the economic analysis), the costs of the interventions required and the human resources available for implementation. These plans may be sector-specific, addressing a particular pollution sector, or may address multiple contributions to the priority pollution problems. The intervention plan may also indicate how waste loads in any sector are shared or even traded among the various pollution sources, and how new sources could be added to the system.

Box 88: China's water quality functional zoning

Along with rapid socio-economic development and urbanization, water shortage and water pollution have become constraints on a sustainable national economy in China. The deterioration of water quality in some urban water supply source areas has direct impact on the people's health. The layout of water supply and water drainage is currently not reasonable; the relationship between development and protection is discordant, the objective of water region protection is not clear, and water use conflict among different regions and sectors is difficult to solve.

In 2000 the Ministry of Water Resources initiated the work of national water functional zoning. A two-tier classification system is adopted within the water functional zoning. This results in four primary zones and, under the 'development zone', a further seven sub-zones. For each zone, a water quality target is set, based on the national water quality standards, which include five different classes, ranging from class I (the highest) to class V (which is deemed to only be suitable for use in agriculture).

Using the river basin as the basic unit, the first-tier zones are as follows.

- **Protected zones:** Source areas of main stream and major tributaries, source area for important water transfer projects, key source area for water supply, and water regions significant for the protection of natural ecology and endangered species. Water quality should be kept as level I and II.
- **Reserved zone:** The water resources use ratio is not high and is reserved for future development and water protection. This zone should not be damaged, and water quality should not be worse than the current water quality.
- **Development zone:** This zone could be developed to meet the water demands of domestic use, agricultural and industrial use, fishery use and recreational use. Water quality should be consistent with the requirements for the use as set by the second tier of zonation.
- **Buffering zone:** Zones designated for solving conflicts between provinces and regions.

Development zones are further divided into seven sub-zones, related to drinking water source, industrial water use, agricultural water use, fishery water use, recreational water use, transition zones and pollutants discharge control zones.

- Drinking water source zones should meet the requirements of urban domestic water use, and water quality should be level II or III.
- Industrial water use zones should meet the requirements of industrial water use, and water quality should be level IV or maintain the current water quality.
- Agricultural water use zones should meet the requirements of agricultural water use, and water quality should be level V or maintain the current water quality.

KEY ELEMENTS OF A WATER QUALITY PLAN

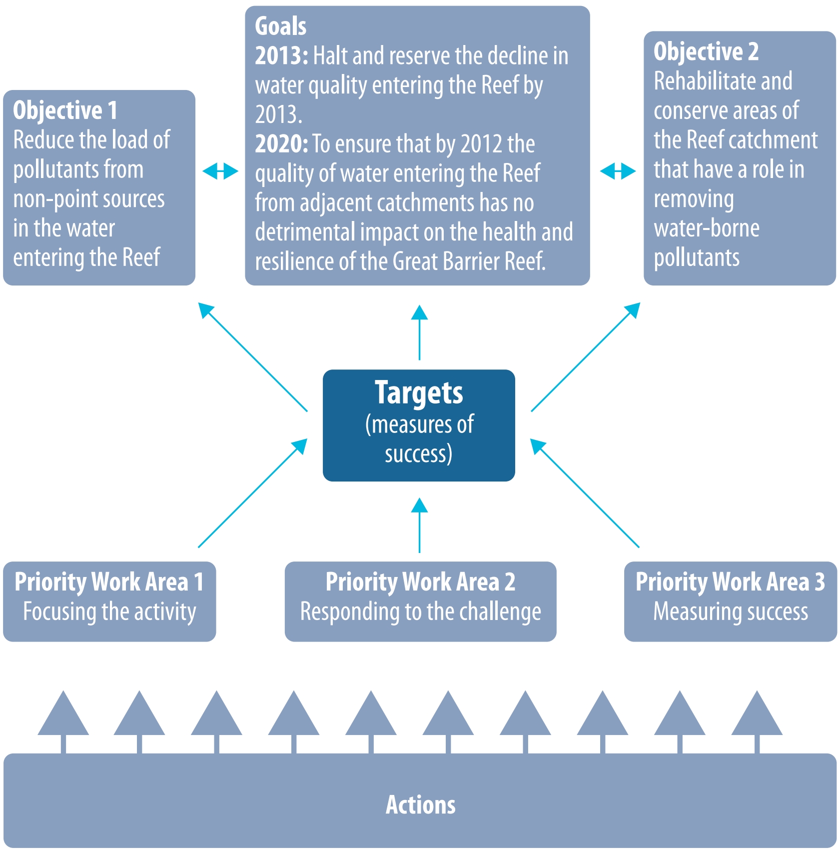
Water quality plans are founded on the following elements:

- **What are the priority substances or issues in the basin?** This is based on both the nature and severity of the impacts noted, as well as the economic implications of poor water quality. For example acute human health impacts may be accorded a higher priority than small reductions in yields for irrigated crops.
- **What are the causes of deteriorating water quality?** This is based on understanding the cause–effect relationships behind the priority substances and issues, identifying point and non-point sources, the root causes of failing pollution control systems and the links with system operation and river flows. These causes identify the most appropriate management interventions.
- **What is the target water quality for the priority substances?** These are typically a set of numeric, statistical and / or narrative targets set for multiple points in the basin.
- **What are the allowable pollutant loads or required interventions?** These specify the amount of waste load that may reach each river reach. These are determined through complex water quality models and certain assumptions of river flows. For non-point sources this may entail the specification of best management practices to be followed.
- **How will the required interventions be rolled out?** This plan outlines who does what and when. This may be linked to the identified priorities, as well as the costs and scope of the interventions required.

Box 89: Protecting water quality for the Great Barrier Reef

Poor water quality, and in particular the impact of high nutrient and sediment loads and of pesticides, is one of the most significant threats to the health of the Great Barrier Reef. The goal of the Reef Water Quality Protection Plan (Queensland Government, 2009) is to halt and reverse the decline in the quality of water entering the Great Barrier Reef from the neighbouring catchments. The plan sets as a target that by 2013 the total nitrogen and phosphorus loads and the amount of pesticides at the end of the reef catchments will be reduced by 50 per cent, and that there will be a minimum 50 per cent groundcover of dry tropical grazing land. In addition, it proposes that by 2020 there will be a 20 per cent reduction in sediment load.

Responsibility for implementation of the plan is shared across a range of federal, state and local government bodies. Key actions include efforts to identify the major sources of the pollutants, research into improved agricultural practice to reduce total pesticide and fertilizer inputs, and the promotion and adoption of best agricultural practice across the reef catchments.
Source: Queensland Government (2009).



LINKS WITH OTHER THEMATIC PLANS

Water quality plans may respond to water allocation, flood and environmental thematic plans in various ways. Water quality plans, and specifically the determination of allowable waste loads, is contingent on certain assumptions of river flows. As such, water quality plans often use minimum flows generated from water allocation plans or planned environmental flows as a basis for assessing the assimilative and dilution capacity of the receiving rivers. Similarly, floods may be used to create opportunities to discharge waste, or in some cases to scour sediments that have accumulated in storage reservoirs. However, seamless integration and trade-offs between these plans and water quality and water availability are rare.

There are nevertheless some examples where dilution using good-quality water from upstream storage has been offset against the reduced water availability, and quality and quantity plans have been integrated seamlessly. In other cases the potential impacts of certain system operation rules on water quality have been recognized, and accommodated in water allocation plans – usually by providing for environmental flows. There is also increasing recognition that the protection of key environmental assets has clear water quality benefits and that environmental and water quality goals can be mutually supportive.

13.5 Water allocation

'Water allocation plan' in this section refers to a plan that determines water resource availability, and how that water is to be managed and shared amongst different users. This can include:

- **long-term water allocation plans**, which define the water available over the long term to different regions, sectors or users
- **seasonal or annual allocation plans**, which define the amount of water available to different regions and/or water entitlement holders at a particular point in time, based on annual or seasonal availability
- **drought management plans**, which define the way water will be allocated and managed during periods of water scarcity
- **licensing or reallocation plans**, which define a process for redistributing water amongst users, typically to achieve particular policy objectives
- **environmental flow management plans**, which define how water will be allocated and managed to provide water for ecological purposes, usually to achieve defined environmental objectives.

In some instances, these matters are addressed in whole or in part in the long-term water allocation plan directly, whereas in others they are dealt with in separate documents. Plans may be prepared at the basin level, a regional level and/or a sub-catchment level depending on the situation.

It is now common for water legislation to require the government (or its delegates) to prepare water allocation plans, and plans are often legally binding documents, defining the rights and obligations of different parties. In the case of transboundary rivers within federal systems, or international rivers, the legal situation often dictates that water is allocated by an agreement, rather than a plan. In those cases, the agreement will still need to address most of the issues discussed below.

Box 90: Allocation plans in the Murray-Darling basin

In Australia's Murray-Darling basin, the process of allocating and managing the available water resources is handled by a series of related plans and programmes. *The Murray-Darling Basin Plan* (currently being drafted: MDBA, 2011) will define the sustainable diversion limits for different subcatchments across the basin: that is, it will identify what water can sustainably be abstracted from the system over the long term. This plan then sets the bounds on what water is available across the basin.

The *Basin Plan* will also include an environmental watering plan, which will prescribe how water reserved for the environment will be managed (for example, the criteria for deciding when to release environmental flows). As a separate exercise, the Federal Government Water Department has a major programme under which it is investing approximately A$8.9 billion to improve water use efficiency and to increase the water available for the environment. For the time being and in the absence of a basin plan, funding is being allocated to increase flows based on 'no regrets' targets that have been identified for different parts of the basin: that is, to areas where there is a high level of confidence that improved environmental flows are required. Once the basin plan (and the sustainable diversion limits) are finalized, the programme will need to be adjusted to ensure that water buybacks and other efficiency measures are targeted in those regions where water is to be reallocated to the environment.

The sustainable diversion limits will be given effect through water allocation plans – prepared by the state governments – for the subcatchments across the basin. These will define the water available for allocation to different users. In some states, a further level of 'operational plans' is also prepared, which define the detailed dam operation rules and individual water entitlements within a subcatchment.

ROLE AND OBJECTIVE

In simple terms, a water allocation plan is the mechanism for determining who can take water, how much they can take, from which locations, when, and for what purpose. Fundamentally, this consists of determining:

1. How much water is available for allocation: this can include assessing different locations, different sources (such as groundwater, surface water and interbasin transfers), for different times of the year, or under different climatic conditions.
2. How that water should be shared amongst competing users: the water allocation process may define the entitlements of different administrative or geographic regions, different sectors and/or individual water abstractors and users.

A water allocation plan should provide the answer to these two questions.

By defining shares of water, the objective of a water allocation plan is typically to achieve one or more the following:

- to ensure water is available to meet social and developmental requirements
- to share the available water resources in an equitable way
- to reduce conflicts between competing users over access to water
- to provide a level of certainty – to governments, water abstractors and users – to allow those groups to plan their affairs based on the water supply they can expect
- to ensure that water is used within the sustainable limits of the system, for example ensuring water is not taken from groundwater systems at a rate faster than it can be replenished
- to provide the water and flow patterns required to maintain the geomorphological and ecological processes required to achieve desired environmental outcomes.

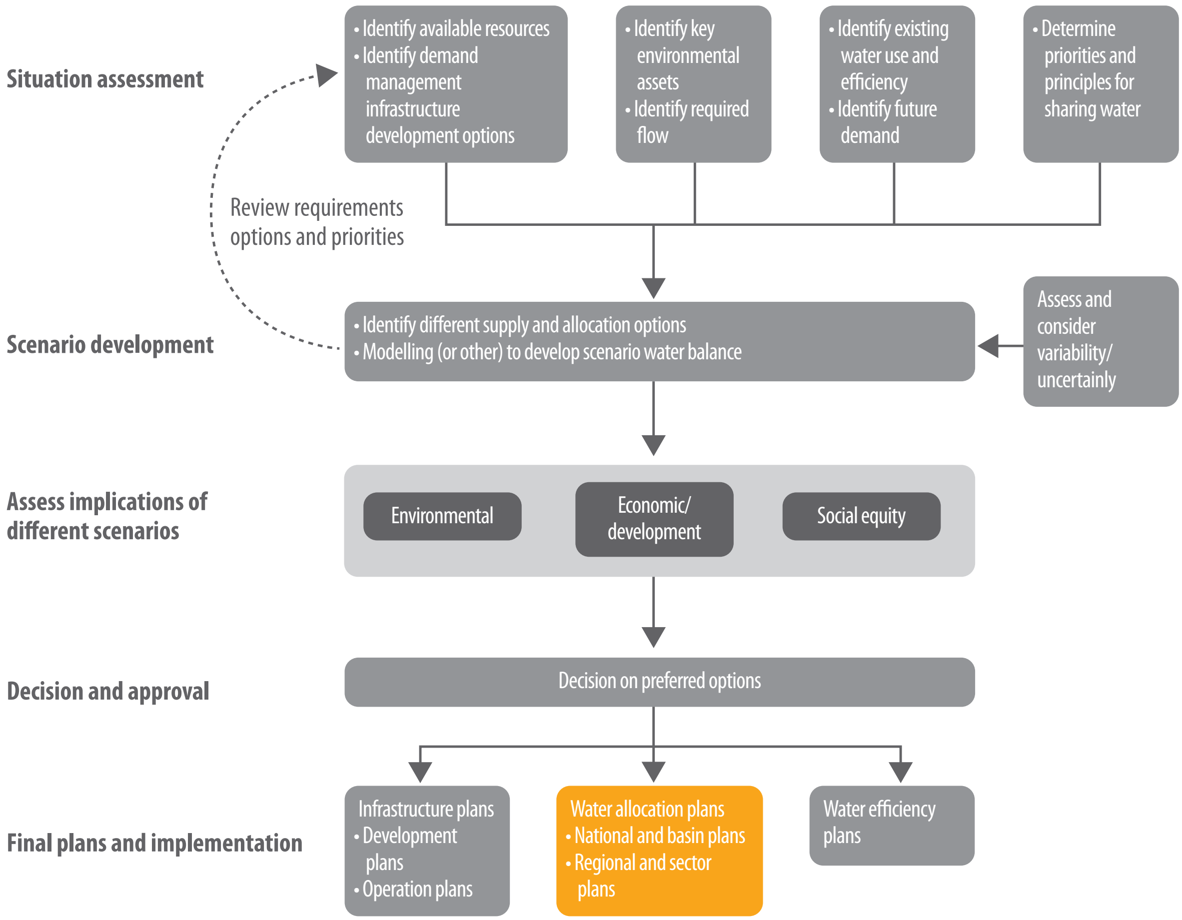
PROCESS OF PREPARING A WATER ALLOCATION PLAN

Developing a water allocation plan typically involves:

1. An assessment phase, to determine what water resources are available, the different water demands and supply options, environmental water requirements, and priorities for water supply, including the principles and process that will be used to determine how the interests of competing users will be balanced.
2. Scenario-based analysis (usually involving modelling) to determine the consequences of different water allocation and management options – in terms of water supply (including reliability) and economic and environmental outcomes.
3. Making and implementing a water allocation plan to give effect to the preferred option.

This process is shown in Figure 38. The process map is generic, and the approach adopted can vary significantly.

Figure 38: The water allocation planning process



KEY CONSIDERATIONS

The key issues that commonly need to be addressed in preparing a water allocation plan include the following:

- **Balancing developmental and environmental objectives:** the importance of providing flows for the environment – in terms of flow volume, as well as timing, frequency and duration – is now well recognized as central to maintaining river ecosystem health. Water resources development and the use of water can impact on environmentally important flows. As such, a fundamental consideration in the water allocation process is the question of how much water should be reserved for environmental needs, versus what can be taken from the system to meet other needs.

- **Prioritizing water allocation and balancing the needs of different water users:** water allocation planning requires prioritizing between different regions, sectors and individual water users. Deciding how the available water will be shared – both over the long term and on a seasonal basis – requires consideration of a range of economic and social matters. This can involve deciding how to balance the rights of existing users (perhaps with existing dependency and investment) with the rights of underdeveloped regions or sectors.

- **Reliability versus maximizing system yield:** by operating water infrastructure in different ways, it is possible to increase the yield of the system (that is, the total volume of water available over the long term). However, this increased volume may be at a lower level of reliability – there may be a greater risk that in some years there will be less water available. Allocation decisions need to consider not only how much water should be allocated but also what level of reliability is required by different users. The consequences of a water shortage can be drastically different for different sectors (such as domestic and agricultural users) or even within sectors (for example, producers of perennial crops are more dependent on a highly reliable water supply than those growing annual crops).

- **Dealing with variability:** water allocation plans and systems need to be able to adjust to seasonal variability in water availability, as well as changes over the long term, in respect of supply (for instance, climate change), demand (for example, economic growth) and priorities. This requires clear rules about how different scenarios (that is, different levels of availability) will be dealt with, as well as sufficient flexibility to be able to adjust the water allocation plan where required.

KEY ELEMENTS OF A WATER ALLOCATION PLAN

The key operational elements of a water allocation plan include the following:

- **Objectives:** The objectives should define the balance that the plan is trying to achieve in allocating water between different users, and for different parts of the basin. These can be of importance during implementation in interpreting the intention of certain provisions. They are also important when reviewing the plan, to allow for an assessment of whether the strategies adopted have achieved the plan's goal.

- **Water allocations:** quantify the total volume and reliability of water available for abstraction under existing and future water entitlements, in various parts of a river basin. A water allocation plan may define water entitlements at a regional, catchment or user level.

- **Annual allocation rules:** how the annual volume of water available to each region or user is to be determined based on seasonal conditions, including which entitlements will be given priority and when.

- **Environmental flows:** define and provide for the pattern of river flows that are needed to maintain the river's ecological values. It is now recognized that the flow pattern (the size, timing, frequency, and duration of flows) is fundamental to ecosystem function. As such, allocation plans now seek to allocate more than just a minimum flow volume for the environment: they aim to protect those flows seen as important to maintaining ecological health.

- **Operating rules:** how water infrastructure need to be operated to achieve plan objectives relating to the provision of water supplies and environmental flows.

A water allocation plan may also identify options for future infrastructure development. While the plan may not necessarily define what infrastructure will be built (that may be addressed in a separate infrastructure plan), the plan may identify where there is the potential for new infrastructure, and how water entitlements associated with the infrastructure would be allocated should it be built.

Box 91: Yellow River Water Allocation Plan

The 1987 *Yellow River Water Allocation Plan* identifies a mean annual flow for the river of 58 billion m^3. Of this, 21 billion m^3 is reserved to ensure there is sufficient flow to transport the river's high sediment load. The remaining 37 billion m^3 is allocated between the ten provinces[4] that rely on the river's water resources. The plan also specifies the amounts of this water available for agriculture, versus other purposes. These volumes are specified as long-term mean annual flows, and are available to the provincial governments for allocation to regions and users within their jurisdiction.

Province/region	Water for agriculture (million m^3)	Water for other purposes (million m^3)	Total (million m^3)
Qinghai	1161	249	1410
Sichuan	40	0	40
Gansu	2580	480	3040
Ningxia Hui	3888	112	4000
Inner Mongolia	5251	609	5860
Shaanxi	3317	483	3800
Shanxi	2911	1399	4310
Henan	4669	871	5540
Shandong	5324	1676	7000
Tianjin	0	2000	2000
Reserved for sediment flushing		21,000	21,000
Total	**29,141**	**28,859**	**58,000**

Water is thus allocated to maintain channel form (particularly to protect against flood risks), to prevent the river from drying up (as occurred during the 1990s), and to provide a clear mechanism for determining what water is available to different provinces and regions.

The plan is given effect through an annual regulation plan. The regulation plan defines the volume of water available to the different provinces for the year, based on their long term entitlement (as defined in the 1987 plan) and the seasonal conditions (including the water currently available in storage).

Source: GIWP (1987).

4 'Province' is used in this document to include an autonomous region and a centrally administered city. In China, these three types of administrative region all answer directly to the central government.

LINKAGE TO THE BASIN PLAN

Water allocation plans have a central role in giving effect to the basin plan, so much so that key aspects of the allocation plan are often incorporated in the basin plan: for example, the basin plan for the Murray-Darling basin (MDBA, 2011) is primarily a water allocation plan. Most aspects of a basin plan will link to, and depend on, the way water is allocated. This includes:

- ensuring water is allocated in a way that supports the development objectives proposed by the basin plan: for example, by ensuring water is allocated to those regions and sectors recognized as a priority in the basin plan
- ensuring water is allocated in a way that supports the environmental objectives proposed by the basin plan: for example, by ensuring environmental flows are provided to sustain key ecological assets and processes.

LINKAGE TO OTHER THEMATIC PLANS

As Figure 37 shows, the water allocation plan has important linkages to all other thematic plans. Management objectives and activities related to the following themes can all be of relevance to allocation decisions (and vice versa):

- **Water quality management:** to ensure that water allocated is fit for the purpose for which it is being allocated (for example, as a drinking water supply). In-stream water quality will be affected by the volume of water in the watercourse, which will vary with different water allocation decisions.
- **Flood risk management:** different approaches to managing flood risk will affect reservoir yield, and hence the water available for allocation for abstraction (and other) purposes. Flood releases can also (potentially) be managed to achieve other allocation objectives, including environmental flow objectives.
- **Water supply and other demand management measures:** these will affect levels of demand for water, as well as the scope for improved water use efficiency to reduce water requirements.
- **Conservation and restoration plans:** which depend on sufficient water (for instance, through environmental flows) to maintain important environmental assets and processes. There is little point in investing resources in protecting or restoring an ecosystem if it is not allocated the water required to maintain it.
- **Infrastructure and operation plans:** the operation of dams (for example, for hydropower or navigation), while non-consumptive, will affect system yield (which has implications for the amount of allocable water) and the flow pattern (which has implications for meeting environmental flow objectives).

Box 92: China's water cap, water allocation of major river basins, and the establishment of red lines for water resources utilization

The basic situation facing China is a large population with limited and uneven distribution of water resources. China is facing a severe water resource situation because of the country's natural water characteristics and the scale of socio-economic development. In order to realize the sustainable utilization of water resources so as to support sustainable social and economic development, and maintain the good status of ecosystems, China now is carrying out a strict water resources management mechanism, establishing the controlling baseline (or the red line) of water resource utilization, formulating water allocation plan for major river basins and setting up the controlling index system of water abstraction and use.

The majority of water resources are used for agriculture. In 2009, irrigation water use was 334.953 billion m^3, accounting for 56 per cent of the total national water use. Along with rapid industrialization and urbanization in China, the water use structure has been further adjusted, and the incremental demand of irrigation water must be met through exploiting water-saving potential and finding out new sources in a few areas. In response to this, a five-year plan for national water-saving in irrigation was developed as part of preparing the five-year water sector development plan.

With the purpose of improving water irrigation efficiency and benefit, and reinforcing the overall agricultural production ability, the *National Water-saving Irrigation Plan* will identify the major food production areas, serious water scarcity areas, poverty areas and ecological fragile areas as the priority areas for developing water-saving irrigation through the construction of water-saving infrastructure and management reform. The emphasis will be on large and medium-sized irrigation districts so as to ensure national food and water security, provide support for increasing agricultural production, and increase farmers' income.

13.6 Flood risk management

Floods can cause direct damage to property and infrastructure as well as loss of life, physical and psychological injuries and mental stress. Flooding also threatens sites of valuable conservation, amenity and cultural interest. Flood risk management (FRM) seeks to mitigate these undesirable outcomes in a way that is sustainable and equitable as well as being efficient and effective. FRM is different from traditional flood defence approaches in that it utilizes a number of measures and instruments to managing risk, including those that:

- reduce or manage the source of risk by such activities upstream land management, promotion of sustainable drainage, and managing runoff from new developments
- reduce or manage the likelihood of flooding by building, operating and maintaining carefully monitored flood defences, to include flood proofing and structure elevation
- reduce the consequences should flooding occur by flood forecasting and warning, and emergency planning and response; controlling land use (avoiding inappropriate development and relocating structures in high risk zones), and raising awareness through publicity campaigns and provision of information on flood hazards
- transfer some of the risk to those in the floodplain through the provision of affordable insurance.

The constraints and opportunities placed upon the flood risk manager arising from the broader water management choices associated with water resources and conservation management will influence this portfolio and vice versa. It is this linkage that offers a unique opportunity at the level of a river basin plan to set out an integrated view of water management and the role that flood risk management plays.

Figure 39: The purpose of flood risk management

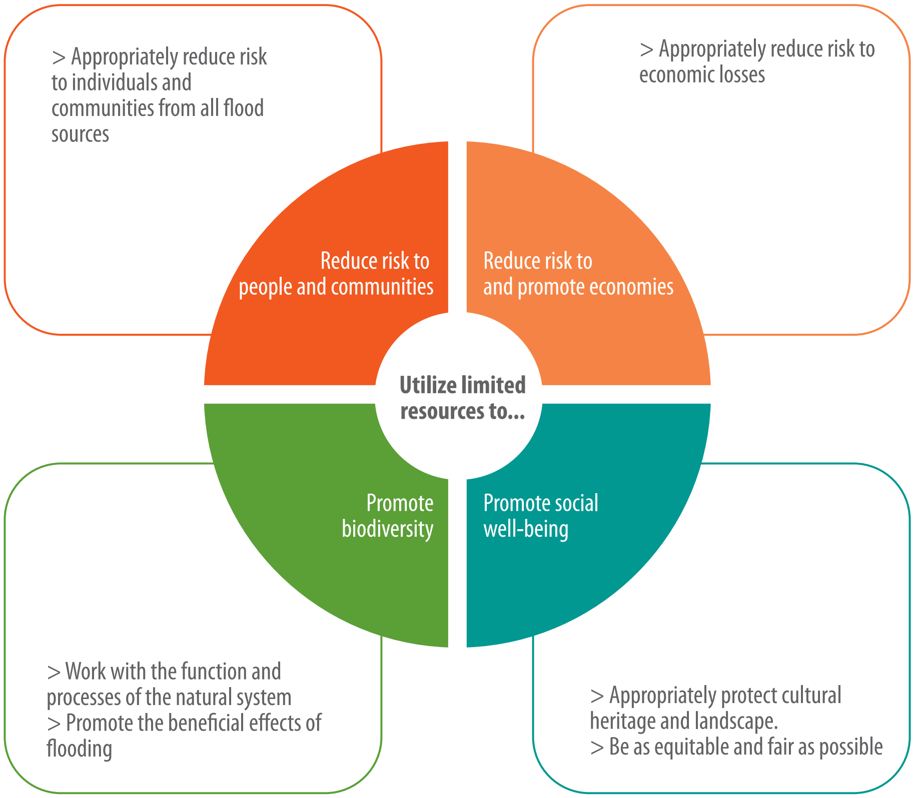
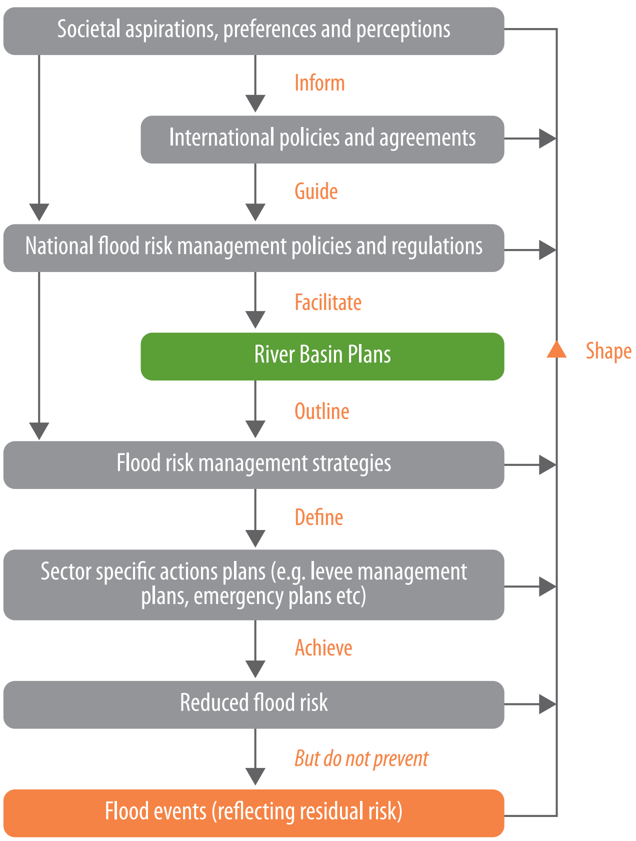


Figure 40: The flood risk planning framework – relating policy to strategy to action

Policies and regulations set the framework within which flood risk management strategies are developed and implemented.

River Basin Plans and Strategy Plans set out the long term goals and targets for flood risk management. They envision the future of flood risk management in a watershed, identify decision points together with a coherent portfolio of measures including both structural and non-structural actions.

Flood risk management measures identified in the strategy are grouped detailed and implemented.



ROLE AND OBJECTIVE

Modern FRM provides a critical contribution to the goal of sustainable development in many places around the world. Done poorly FRM can be expensive and have a detrimental impact on the environment; done well it can utilize limited resources to reduce risk appropriately whilst promoting biodiversity and broader social harmony.

Flood risk management is aimed at managing the whole flooding system (that is, river basins, subcatchments, the coast and communities) in an integrated way that accounts for all of the external pressures (climate and demographic change) and the potential interventions (engineered structures through to emergency response) that may alter present and future flood risk. FRM is therefore a continuous process of identifying, assessing and evaluating, implementing, monitoring and adapting actions to manage flood risk to acceptable levels. The actions taken should be scientifically sound, cost-effective and integrated with broader planning policies and aspirations. The FRM processes address environmental, sociocultural, economic, and ethical aspects in a transparent and participatory manner.

The shift in approach from flood control to FRM is characterized by three developments. FRM:

- deals with all flood events, not just a specific level against which protection is focused
- involves risk-informed decision-making that assesses the uncertainties and options and ultimately allocates the available resources to the areas at greatest risk
- involves an integrated, holistic approach that applies all the tools available to flood professionals.

PROCESS OF DEVELOPING A FLOOD RISK MANAGEMENT PLAN

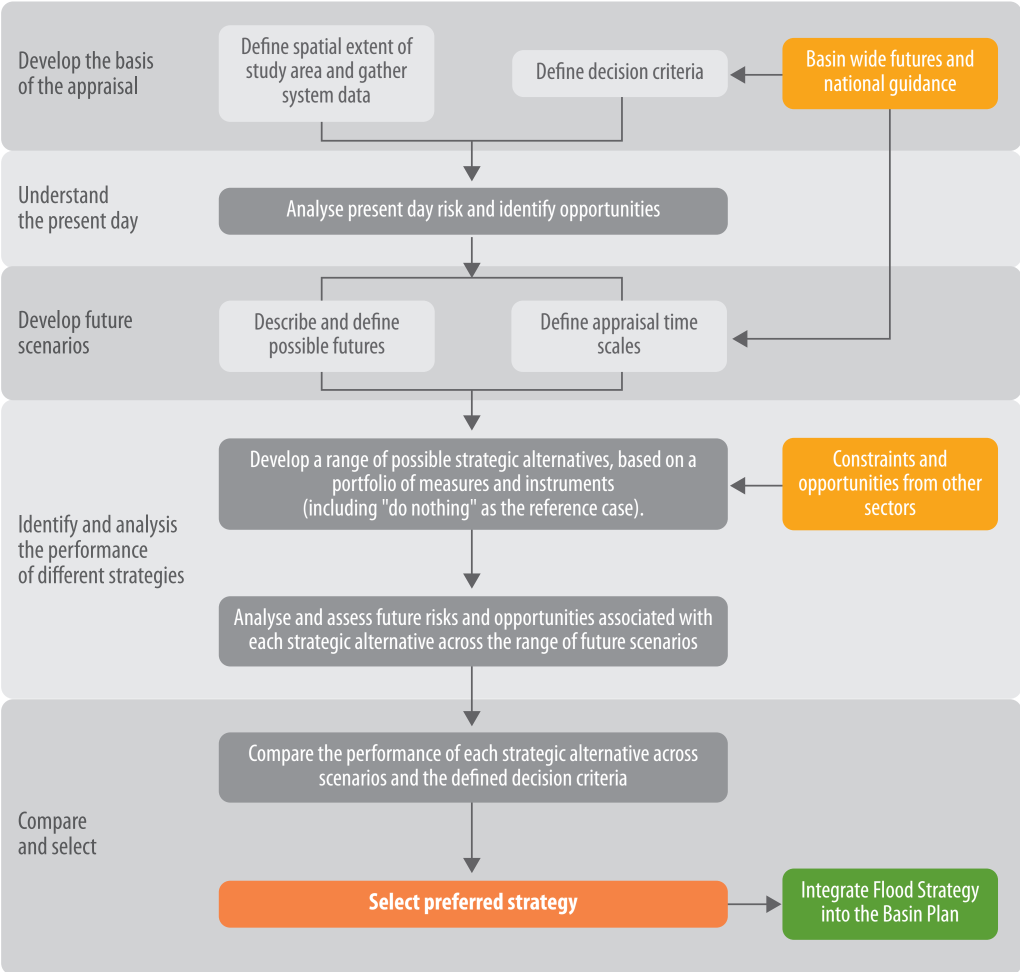
FRM requires the development of coherent policies, strategies and accompanying goals, objectives and plans across a range of plan levels, including national, regional (basin), provincial (sub-basin), and local (sub-basin) levels (Figure 40).

Within this process, basin planning has a crucial role as it translates national policies and regulations in a coherent vision for the specific basin and provides the framework within which more detailed flood risk management strategies can be developed. Within the river basin plan the trade-off between flood risk, hydropower, water resources and the environment will take place provided a framework for the flood risk management strategy can be developed.

A flood management strategy will include:

- **A whole-systems view:** A catchment view of flood defence activities, rather than a collection of unconnected individual measures.
- **Utilization of watershed boundaries and avoidance of administrative boundaries:** Recognition of the special status of transborder rivers so that their management is undertaken as a whole rather than within administrative boundaries (either regional or international).
- **Exploration of the impact of future change:** An increased understanding of the effects of environmental change on flood risk (both land use and climate) at a catchment/basin scale.
- **Innovative thinking and radical solutions:** Traditionally, flood alleviation works have been carried out locally, at the locations where flooding occurs. The most common form of flood protection works are flood embankments and flood walls that seek to contain the flood flow and prevent water spreading onto floodplains. However flood embankments and walls have a number of well-documented disadvantages. A range of structural and nonstructural options that seek to work with the natural processes of the river or coast can be used by the innovative thinker to promote a robust and flexible approach.

Figure 41: The process of developing a flood risk strategy



KEY CONSIDERATIONS

In working through this process at a basin scale there are a number of key considerations:

- **Translating national policy:** Translation of the national flood risk management policy into strategies that clearly communicate the purpose, goals and objectives of basin-level flood risk activities and how they might differ from those at the national level.
- **Envisioning the future:** How flood risk management will take shape over the coming decades, what will be the challenges presented by climate and demographic change, and how flood risk management will respond to these changes as the reality of the future becomes evident.
- **Identify hazards and consequences and assessing risk (now and in possible futures):** Identifying unique risks faced in the basin as opposed to those of national importance. The combination of the basin-level risks and the national risks forms the portfolio risk that must be considered in subsequent plan development.
- **Aligning basin with national goals:** Aligning the basin-specific desired outcomes and objectives for the risk management process with national-level outcomes and objectives. During this activity acceptable levels of risk established by national policy are examined within the context of the needs of the basin, and where appropriate, modified to reduce the level of risk to meet these local requirements. Basin strategies would not increase the risk above that specified in the federal policies without consultation with that level of government.
- **Establishing the preferred mix of management measures through the basin:** Identification of geographic regions within the basin where particular policies would apply and the bases for these distinctions. Particular economic conditions, population vulnerabilities

or regional environmental circumstances could lead to the development of subareas for flood risk management. Unless unusual reasons existed, the subareas are normally the same as sub-basins of the mother basin.

- **Outline strategy for further refinement and implementation:** Preparation of processes and procedures to guide development of implementation plans at the provincial and local levels. These processes and procedures should include specific information that must be developed at the local level and provided to the basin organizations when provincial and local proposed actions that must be supported at the basin or national level.

Basin flood planning can therefore be seen to bring together a consideration of the whole river basin, national policies and regulations and local aspirations and practicalities when managing flood risk, and not just the local measures needed to alleviate flooding at a particular location.

Strategic planning at the basin level is perhaps the most critical component in delivering good FRM. Worldwide, poor flood risk management is typically a result of constrained thinking and a lack of innovation in the mitigation options proposed. Strategy planning which takes a long-term whole-system-scale view provides the vehicle by which these constraints can be removed, and robust risk-informed goals and a coherent programme of measures can be developed. An example of the effect of channelling a major river and constructing flood defences to protect the floodplains is the Rhine, where channelling and flood protection works carried out between 1882 and 1955 are estimated to have caused flooding.

OVERLAPS WITH OTHER THEMATIC PLANS

National flood policies and resultant flood risk management strategies, plans and procedures are heavily influenced by, and must be closely integrated with, other national, basin and local guidance documents.

The importance of the horizontal integration cannot be overestimated. At the national level, for example, national flood policy must be most closely coordinated with national water, energy and environmental policies, as actions in the floodplain could significantly complement or conflict with these water-related documents. Since growth in flood risk is closely tied to the amount and location of development, it is also essential that flood policies worked in tandem with development policies and plans. It makes little sense for one part of the government to be attempting to reduce risk while another part is actually increasing the potential consequences of flooding, unless this is done in clear knowledge and acceptance of the increase in risk to secure other societal benefits.

The closer national flood policies are tied to other national level policies, the more likely it is that the flood policies will be implemented. Experience in the United States has indicated that when policies or laws are narrowly focused and not coordinated with other policies and laws relating to the same geographic region or sector, conflicts inevitably develop. Equally, and perhaps most importantly, the nature of the implementation is heavily shaped by the nature of the financial instruments or incentives used to support the policy. National-level incentives can either promote good practice or detract from it.

At the basin level the same principles apply. The flood risk management strategy that is developed must be closely coordinated with, and inform and be informed by, other basin-level strategies – particularly energy (hydro-power construction) and economic development plans. The strategy plan will lead to numerous actions, and these will require detailed implementation plans to be developed, which in turn must be closely coordinated with other sectoral and geographic planning processes, and typically implemented via multiple other organizations, not simply the flood management authority.

Ultimately, strong horizontal alignment in policy is central to achieving sustainable development. Inconsistencies in the planning process that develop at national and basin level become all too apparent at the local level where actual implementation occurs. If adequate coordination has not taken place at the national and basin levels it is unlikely to be possible to coordinate these efforts at the local level. The strong ties that exist within sectoral relationships, and the organizational stovepipes or silos that develop among similar agencies at different levels, will frequently overcome any attempts to work out conflicts at the local level.

CHAPTER 14
POSTSCRIPT

This book attempts to provide a perspective on the differences between river basin plans, but at the same time attempts to draw out many of the similarities and common traits of strategic river basin planning in stressed, uncertain, dynamic and complex environments. While this was a tremendously ambitious undertaking, the journey has uncovered some key insights that may assist those embarking on a basin planning process.

Basin planning is not for the faint of heart – it is difficult and chaotic, requiring the balancing of competing interests and critical decision-making often without adequate information. Basin planning is only likely to become a more challenging area of engagement for the allocation of resources to meet social, economic and ecological imperatives in an increasingly water-stressed world.

Planners need to act with mindfulness and humility. Basin planning is inherently a social process involving various actors (whether they are formally recognized or not), so the chances are that unexpected issues or perspectives will arise during the planning process, regardless of the technical rigour that supports the analysis. A workable plan needs to engage and possibly reflect the diversity of relevant issues and perspectives of those that will be required to act in its implementation, even where these may not coincide with the scientific opinions of the experts.

However, the planners should also trust the process. A clearly scoped and designed process with a specified timeframe and outcome should facilitate, contain and make sense of the chaos, complexity and iteration required to converge on an implementable plan. This does not imply an inflexible and static process, but rather one that adapts to emerging issues and information.

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River Basin Planning
Principles, Procedures and Approaches for Strategic Basin Planning

Growing competition for scarce water resources has driven major changes in the way river basin planning is undertaken. This has resulted in a shift away from 'technical' approaches designed to maximise water availability and led to more strategic approaches to basin planning. These approaches aim to optimise outcomes by reconciling the competing demands of different sectors of the economy, the natural environment, and society as a whole.

Drawing on experiences from around the world, this book distils best practice approaches to basin planning in large and complex basins and provides an overview of the emerging good practice. Part A includes discussion of the evolution of basin planning and provides a framework for strategic basin planning, including environmental planning. Part B describes some of the techniques involved in basin planning, including conducting a situation assessment, addressing uncertainty, techniques for identifying objectives and balancing trade-offs, and developing thematic plans.

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