OV1

China – UK, WRDMAP
Integrated Water Resources Management Document Series

Overview Paper 1:
Integrated Water Resources Management (IWRM)

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中国水利 CHINA WATER

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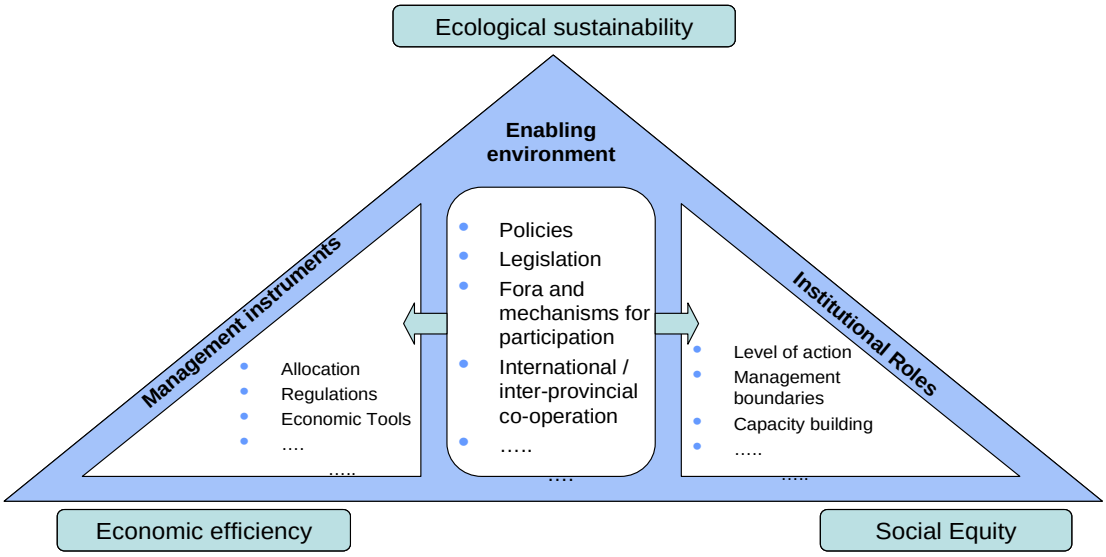
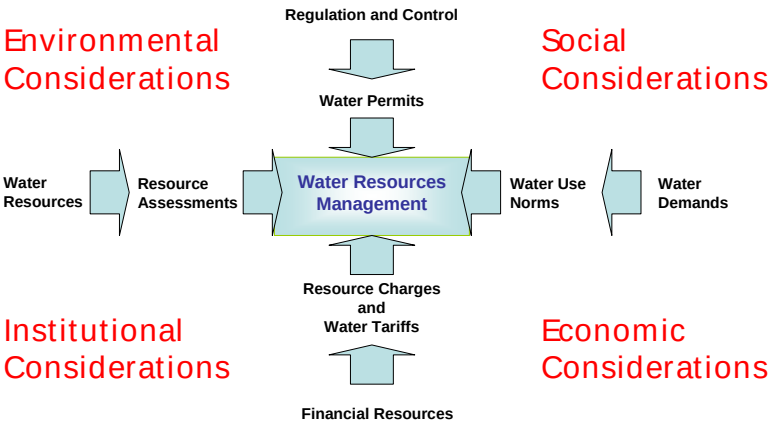
Integrated Water Resources Management (IWRM)

(Basics after Global Water Partnership)



Driving Elements of Integrated Water Resources Management



(Second figure after WRDMAP)

Preface

This document (OV1 – Integrated Water Resources Management [IWRM]) is one of a series that have been prepared to help inform water resources professionals at various levels of government and different organisations of the basics of integrated water resources management (IWRM) and water (resources) demand management. These documents are intended to provide guidance in support of existing national and provincial standards and documents.

This particular document is classified as an overview (OV) document that helps provide the framework and setting for the other documents in the series as is presented in the tabular section below. These other documents provide more detailed on specific topics and are also referred to in this document, where appropriate.

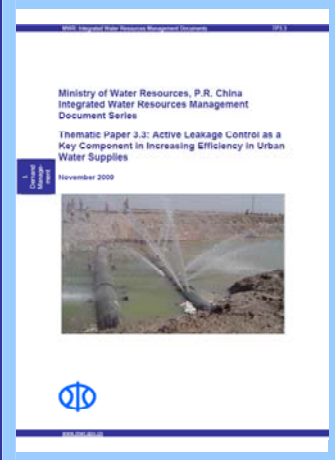
It should be emphasised that the document series has a focus on dry season water resources management although IWRM encompasses all aspects of water sector development and management including flood management. The documents also have a strong focus on water demand management as is presented in OV2.

The documents have been produced in Chinese and English with the former being in both hard copy and digital formats and the latter being only in digital formats. The digital versions are available at the websites listed on the back page of this document. In total there are over 70 documents in both languages.

Examples of the document series are presented below.

Overview Documents on IWRM and Water Demand Management

Thematic Paper



Advisory Note

Manual

PLUS

Examples

Thematic Paper (TP):

These are position papers related to selected topics of water resources management: they cover international best practice; background to the topic from experience in other countries; and current practices and issues as are believed to exist in China.

The thematic papers are intended as a source of information and to provide material or a basis for the development of Advisory Notes.

Advisory Note (AN):

These are a major output of the project and should be seen as the backbone of the IWRM or WDM dissemination programme.

An AN, which is subject matter related, is a structured compendium of advice on issues related to the topic and covers how to undertake or perform a particular aspect of water resources management at the municipality and county levels. This is classed as being the operational level of water resources management.

Example (EG):

The examples are provincial level case study reports related to different topics. Some of these have been developed into concise documented examples to support the Advisory Notes.

Manual (M):

The Manuals are more comprehensive documents related to topics that have been investigated in considerable depth.

A full list of the document series is presented in Appendix C.

The Ministry of Water Resources have supported the Water Resources Demand Management Assistance Project (WRDMAP) to develop this series to support WRD/WAB at provincial, municipal and county levels in their efforts to achieve sustainable water use.

Summary

The need for an integrated approach to water resources management is widely recognised nowadays. The reasons for this are made clear in the following description of the water resources situation in many countries, given by Dr Mei Xie, formally from MWR and now from the World Bank Institute.

"Supply management is dominating past and current water management. Without demand management, supply management alone has caused negative externalities, making the opportunity cost of water to rise to unsustainable levels. As demand for scarce water resources increases, new sources of water need to be obtained, often at greater cost than previous sources, and with greater potential ecological and social consequences. Water service providers, particularly in developing countries, struggle with financial sustainability, as inefficient operations and low quality of service create a vicious cycle where dissatisfied users refuse to pay water tariffs, limiting the service providers' ability to maintain infrastructure effectively and causing service quality to decline. Poor service quality in turn exacerbates poor productivity of water, and leads to the depletion of aquifers and pollution of water bodies. Artificially low water prices fail to encourage conservation and efficiency, and allow wasteful practices and inefficient operations to continue.

The current water issue is often more a crisis of governance than a crisis of physical scarcity, as scarce water resources are allocated inefficiently, unregulated pollution compromises water quality, weak water service providers fail to serve the public, and social and environmental concerns are left unaddressed. Without a significant shift in the way water resources are managed and water services are provided, the current water crisis will only worsen. Given the above shortcomings with traditional WRM approaches, Integrated Water Resources Management (IWRM) has emerged as a means of addressing the global water problems and working toward a sustainable future for water management." [Dr Mei Xie, 'Integrated water resources management (IWRM) – Introduction to Principles and Practices'.]

Water is a core developmental issue, and integrated water resources management (**IWRM**) has been defined as '**a process which promotes the coordinated development and management of water, land and related resources in order to maximise the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital eco-systems**'.

Improved integration of the efforts of all the relevant actors toward commonly accepted goals for their water resources is necessary to improve the quality of water bodies and the security of the basins and aquifers on which they depend.

Key elements can be distilled from several definitions of IWRM:

- *"IWRM is a coordinated process that brings together stakeholders.*
- *It focuses on both economic and social welfare and equity as well as protecting ecosystems.*
- *It uses scientific data /tools to provide sound base for judgment.*
- *It emphasizes proper governance involving democratic participation.*

It is important to note that IWRM is a process, not a product, and that it serves as a tool for assessment and program evaluation. IWRM does not provide a specific blueprint for a given water management problem but rather is a broad set of principles, tools, and guidelines, which must be tailored to the specific context of the country or region or a river basin." [Mei Xie, op cit]

IWRM takes a flexible and dynamic approach to planning and management. This document draws on international to illustrate the wide variety of solutions adopted in different situations. Case study examples demonstrate different approaches and highlight how successful, or otherwise, these have proved.

This document (OV1) covers the following topics:

1) IWRM – Basics and Drivers

2) IWRM Elements

3) Enabling Environment

4) Institutional Framework

5) Infrastructure

6) Management Instruments

7) IWRM in China

Appendix A Oft-cited International Cases

As mentioned in the Preface, it should be emphasised that the document has a focus on dry season water resources management although IWRM encompasses all aspects of water sector development and management including flood management.

The Ministry of Water Resources has developed this series of papers and guidance notes to support WRD/WAB at provincial, municipal, and county levels in their efforts to achieve sustainable water use.

Contents List

1 Introduction

1.1 Basics

As is recognised by all, the competition for available water resources in much of the developing world is growing rapidly due to ever-increasing and often conflicting demands from agriculture, industry, urban water supply and energy production, and a growing awareness of environmental issues. Even in developed countries, competition for water resources can create conflict, and the impact of climate change is likely to aggravate most situations throughout the world.

The demand for more water to be provided is driven by factors such as population growth, urbanisation, dietary changes and increasing consumption accompanying economic growth and industrialisation. Inter-sector co-operation becomes more important as water resources become more limited and contaminated.

The traditional fragmented approach to water resources management is now universally considered to be no longer viable and a more holistic and coordinated approach to water management is essential. This is the basis for the Integrated Water Resources Management (IWRM) approach that has been accepted internationally as the way forward for efficient, equitable and sustainable development and management of the world's limited water resources.

The definition of Integrated Water Resources Management needs to be clearly understood from a conceptual perspective. Two useful definitions are presented in the boxes below.

Defined by the **Global Water Partnership (GWP)**, Integrated Water Resources Management (or IWRM) is:

"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."

Perhaps a more functional definition is used by the United States Agency for International Development (USAID):

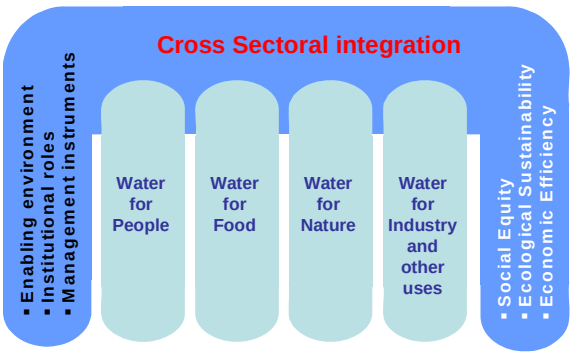
"IWRM is a participatory planning and implementation process, based on sound science, which brings together stakeholders to determine how to meet society's long-term needs for water and coastal resources while maintaining essential ecological services and economic benefits."

The main issue is the ability to implement the well meaning concepts and implied essential considerations and essential actions inherent in this statement to achieve the 'improved water resources management' position.

IWRM is purely a recommended 'process'. A process that encompasses and integrates many aspects of what one might call traditional water resources management.

However, IWRM places much more emphasis on social equity, ecological sustainability and economic efficiency than has been the case in the past.

This is depicted in the figure below.



IWRM and cross-sectoral integration or improved communication/ co-operation /collaboration (after GWP)

Moreover, the 2003 World Bank 'Water Resources Strategy Paper' provides the useful additional guidance that says: *"The main management challenge is not a vision of integrated water resources management but a 'pragmatic but principled' approach that respects principles of efficiency, equity and sustainability while recognizing that water resources management is intensely political and that reform requires the articulation of prioritized, sequenced, practical and patient interventions."*

This need to be pragmatic should be borne in mind when advocating IWRM concepts and principles.

The basic elements and concepts of IWRM have been promoted by different organisations in different ways for many years. The start of IWRM is generally attributed to the 1992 Dublin Conference, but this was just a high-profile recognition of the basic key messages and principles which had been known for decades and had been promoted by the UN since the 1950s. However, when it was 'born' is not the issue, the main factor is the adoption of the basic concepts.

It should also be noted that IWRM is often seen in the context of Integrated River Basin Management. This is covered further in Section 1.3.

The IWRM concepts and principles can be used to address specific areas of water resources issues be they skewed towards flood management or water quality management issues. The complexion will depend on the problems that exist but it is likely that all issues would be covered to different degrees of comprehensiveness.

Owing to the nature of the Water Resources Demand Management Assistance Project during which this document was produced, the focus of this document and others in this series is on those aspects of IWRM which are not related to flood situations, and those which are mainly related to quantity rather quality of water.

The sections below are ordered in a manner that reflects the main aspects of IWRM.

1.2 Environment

The natural evolution of water resources development within a river basin often follows the path of:

1. Initial development without any control. Water is used as needed, and effluent returned to river wherever convenient. Basic urban and individual water abstractions, industrial water needs and irrigation water taken from rivers and groundwater as development slowly takes place.

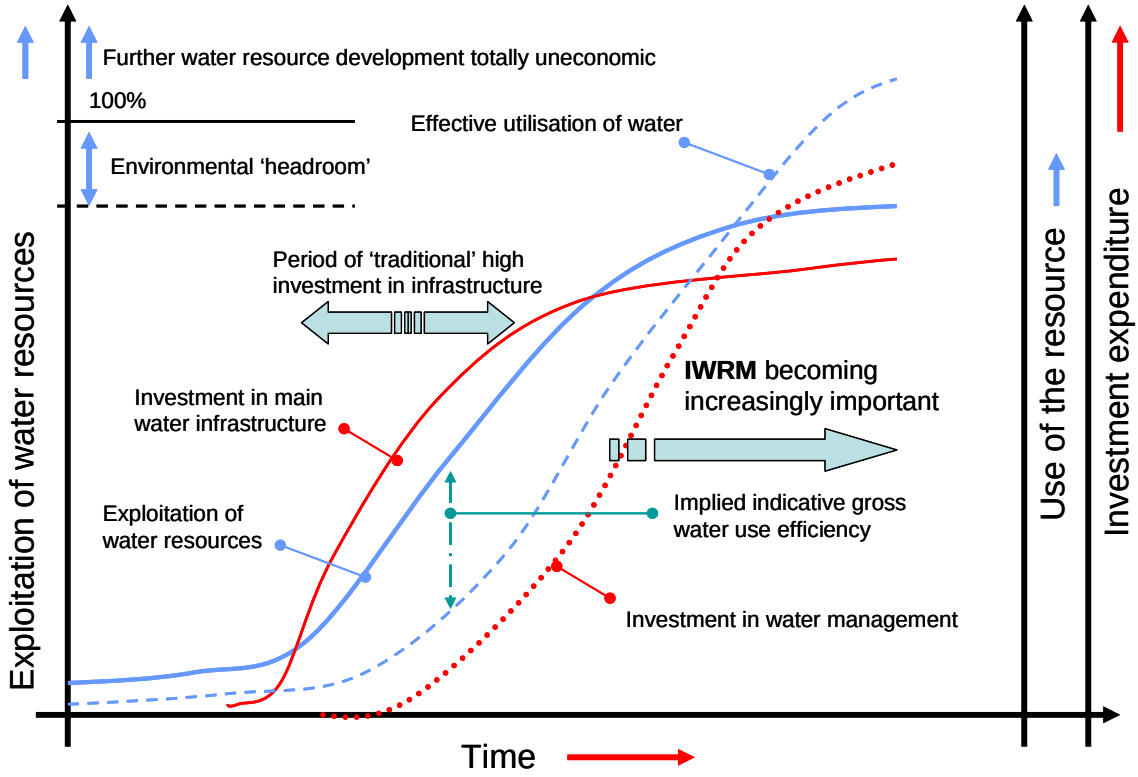
2. As awareness of a potential limit to the natural water resource – and its capacity to absorb effluents - becomes apparent, then there is increasing imposition of Government controls on what can be done in terms of abstractions and discharges, leading to the establishment of permitting systems to control further access to water resources, and to control the quality of effluent discharged into surface and groundwater bodies.

The consequences of this progressive process of development will often include:

- Well-established use of the water resources, often with significant investment associated with these uses of water (such as irrigation water distribution systems, industrial plants constructed at a particular site specifically to use the water resources, urban water collection systems constructed and linked to water distribution systems, etc.)
- Possibly, so much established use of the resource that in periods of low resource availability there are conflicts between users as supply is insufficient to meet all demands
- Degraded water quality in some locations due to chemical contamination from effluent discharges, and/or reduced flows due to abstractions
- Environmental degradation due to reduced flows and/or poor water qualities.

The development of a water stressed situation and the development and management emphases or approaches that are responses to the changes are presented in the figure below.

Development Trends in the Water Sector

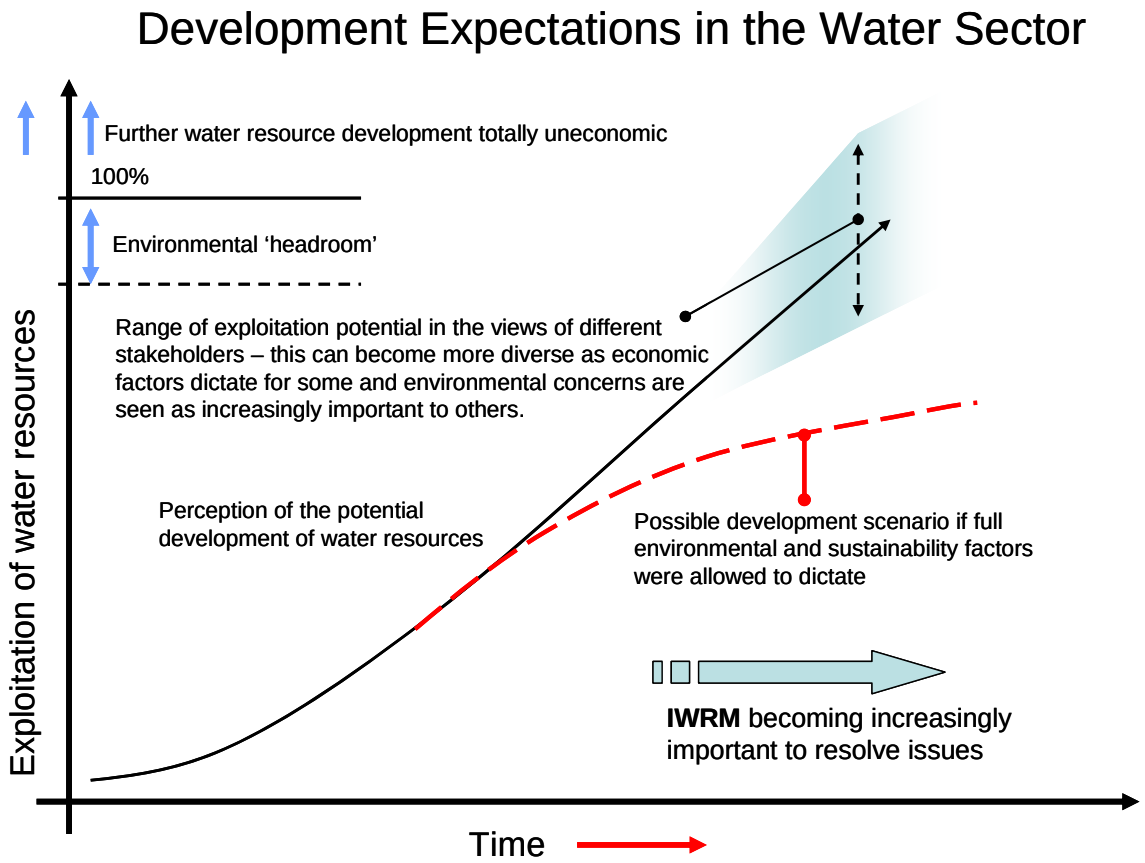


These consequences have the tendency to induce pressures to improve systems of control and planning for water resources development, and in particular to:

- Improve the efficiency of water use – in terms of the added value for each unit of water used as well as reduced wastage of water
- Preserve the natural environment, especially areas of important bio-diversity value
- Improve the quality of the river system – ecological, morphological and chemical

These issues have a complexity and inter-relationship that defies solution in isolation, and so the usual approach nowadays is to follow a process of integrated water resources management (IWRM).

Once a particular situation has been reached in the development of water resources, the perceptions of the future development scenarios will differ in the minds of different stakeholders. This will vary from the optimistic to the pessimistic viewpoint and will also depend upon whether the viewpoint is 'economically driven' or 'environmentally driven'. These perspectives have to be reconciled and increasingly, as a water stressed situation is being evidenced, a precautionary approach needs to be followed. This is indicated schematically in the figure below.



The concept of a river basin as a management or planning unit has gone through several stages and is still being developed. From initial examples of the 18th century to its advent as the overriding concept behind developing water policies, it is acknowledged as the most sensible technical approach. It was originally associated with ideals of the late 19th century, then it supported the ideas of full control of the hydrologic regime and multipurpose dam construction in the 1930–1960 period.

After that it partly lost its way in a water sector infrastructure development frenzy and was revived to address principally water-quality and flooding problems in the 1980s, before re-emerging in the 1990s as the cornerstone of Integrated Water Resources Management (IWRM), strengthened with the focus on watershed- and ecosystem-management approaches. [The dates presented relate to USA and Western Europe development timeframes]. The difference between boundaries of river basins and administrative units has made it difficult to use the river basin as the basic unit in many developing countries.

1.3 Institutions

An often-seen impediment to effective water resources management is the institutional structure and the difficulties with inter-sectoral co-operation in many countries.

As water resources become more stressed, a greater intensity and effectiveness of water management is required. This requires the introduction of increased water

monitoring requirements, tighter control on water use, the need for significantly increased efficiencies of use, increased charges for water, pollution control and many other features of modern day water management.

However, as all the above become more demanding and inter-related and as many water users are affected, inter-sectoral conflicts begin to increase. This requires more inter-sectoral co-operation, but the old legislation, mandates and responsibilities of ministries and departments do not lend themselves to effectively addressing the new management requirements. Thus an improved 'enabling environment' is required.

Co-ordinated development and management of water resources implies joint planning activities by the many sectoral bodies. It is universally accepted that the natural unit for IWRM is the river basin, though this will rarely be an administrative unit for the individual sector agencies or national ministries involved. This is further complicated by the vertical and horizontal institutional separation that often exists at administrative levels and boundaries.

In many countries the piecemeal development of line ministries has often resulted in strong ministries of irrigation, ministries of water resources, ministries of works or construction and ministries of agriculture. There is then often overlain a ministry of environment and a ministry of natural resources. The sectoral responsibilities often overlap and as new initiatives related to water resources management take place, they are either difficult to place or become somewhat duplicated with different emphases in different departments. Co-operation between line agencies and their related departments at different administrative levels extends the issues to all levels of activity.

River basin authorities are common in the many parts of the developed world. For major international rivers in Africa, Asia and Latin America some form of organisation has been created that covers multinational representation. Even with the substantial resource inputs available to them, most such authorities have encountered serious political difficulties and institutional complexities in establishing any kind of control over the management of the water resources.

A river basin organisation can take many forms: Advisory committee; Authority; Association; Commission; Council; Corporation; Tribunal; Trust; Federation. Examples of these different forms exist around the world. The different forms generally reflect the institutional roles each organisation is to provide in the water sector.

However, the idea of a new tier or organ of bureaucracy, mixed with difficult challenges from de-centralisation and public /private partnerships, poses too many additional problems for most governments to take on board.

Improved co-operative and collaborative processes between existing organisations needs to be the first solution to be attempted.

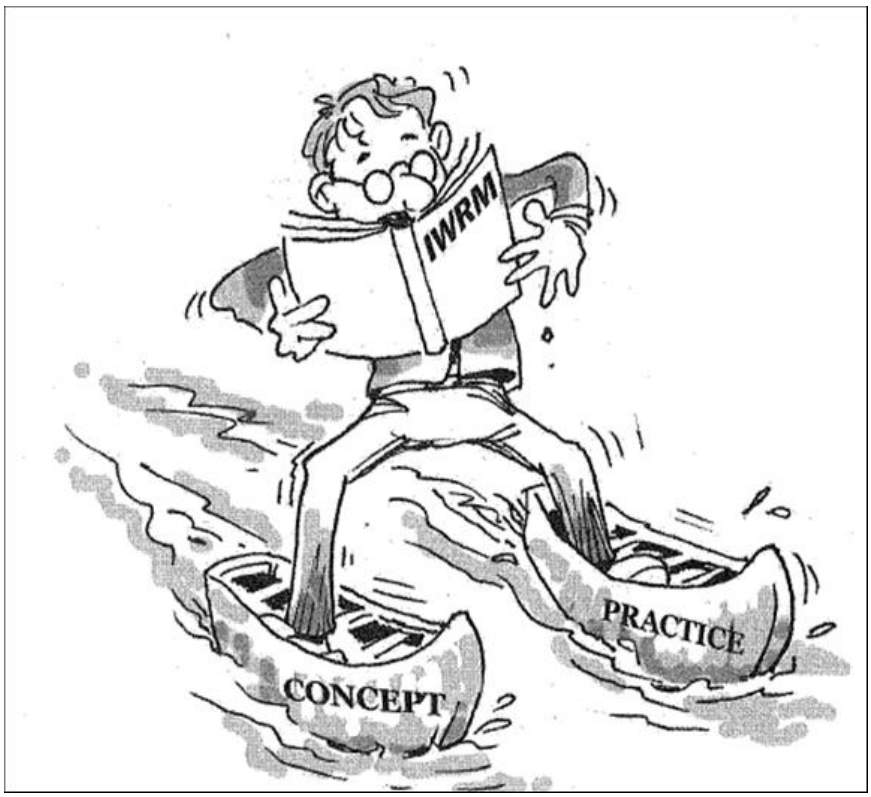
1.4 Perspectives

The process of taking a holistic approach to addressing issues of water management in a river basin requires a wide range of understanding of the natural behaviour of the hydrology of the basin, environmental considerations and how the developments of the past have affected these natural processes. This needs to be supplemented by a perception or viewpoint as to how future demands on resourced can be met and managed.

IWRM is often found to be discussed in the context of national water resources or related to international river basin management organisations. It is true that in most situations the enabling environment for IWRM rests at the national level, however, the processes of IWRM are as applicable at any level.

Additionally, although IWRM strongly advocates that sound water resources management is best practiced on the basis of hydrological boundaries and units, the translation of this to administrative units is not too problematic. IWRM concepts and processes can still be adopted within administrative units and should still bring significant benefits.

The conceptual jump necessary to make IWRM practical is one of scale. Instead of envisaging IWRM as a complex legislative and institutional system under the control of one “super agency”, it needs to be viewed as a progressive process in which the end point is reached through a web of individual initiatives that gradually remove the sectoral constraints.



Picture from V.Pangare: Global Perspectives on IWRM, 2006

Sometimes, the word 'integrated' is immediately a deterrent to many in being able to consider the basic objectives of IWRM - the word is viewed purely from an institutional perspective and is IWRM is solely seen as a driver for institutional disbanding with a loss of status, roles and budgets etc.

It is useful to consider the manner in which the word 'integrated' has been seen in the context of IWRM over the years.

Different types of integration in the historical development of the concept of IWRM

- Integration of WRM in the broader development context
- Sectoral integration – integrating different use of water / different water using sectors
- Integration of the (biophysical) resource base
- Spatial integration (upstream /downstream inter-linkages)

Source: Biswas, October 2004 (IWRM: for sustainable use of water: 50 years of international experience with the concept of integrated water management).

Integrated River Basin Management (IRBM) is, as stated by Hooper, "IRBM is a subset of IWRM. It is how IWRM is worked out nationally or internationally across borders at the river basin scale. IRBM is defined as an integrated and coordinated approach to the planning and management of natural resources of a river basin, one that encourages stakeholders to consider a wide array of social and environmental interconnections, in a catchment/ watershed context".

There are many other terms and descriptions that carry similar messages such as:

- Integrated river basin development and management;
- Integrated watershed management;
- Total catchment management;
- Ecosystem management;
- Natural resource management (often ill-defined and can be very broad).
- 'Integrated Urban Water Cycle Management' (IWCM).

The basic concepts of IWRM apply to all the above.

Recently, the concept of Adaptive Water Resources Management has also been introduced. While IWRM is widely accepted as the appropriate framework to deal with complex water resources management issues, the scientific base for IWRM is not believed to be fully developed yet, and does not elaborate on water management under uncertainties (GWP-TAC, 2000), nor does it fully develop approaches and methods towards adaptive water management strategies. Thus, some view IWRM as lacking both empirical knowledge and concepts to transfer successful experiences across basins and frontiers effectively.

However, it is believed that the consideration of 'uncertainties' is inherent in water resources evaluation and in any management practice. It is therefore believed that

IWRM as a concept is a valid approach to improved water resources management particularly in the face of increased 'uncertainties'.

Some international literature states that IWRM is too complicated to be implemented. Although it is accepted that the complete adoption of all the ideas and approaches inherent in IWRM across the whole water sector would be very difficult to implement in many situations, it is believed that if water managers and stakeholders understood the fundamental elements of IWRM and gradually applied such elements to their water management situation, benefits would result to all. For example, the inability to apply economic instruments effectively does not mean that other concepts and features of IWRM can not be implemented, even if to different levels of achievement/ effectiveness. IWRM cannot be achieved overnight; it can take years to change mindsets and approaches.

In Appendix A are presented some international examples related to IWRM and IRBM.

2 IWRM Elements

2.1 Introduction

For most water resources managers, 'Water Resources Management' is seen to encompass:

- Surface water management (reservoir development and operation, water allocation, etc);
- Groundwater management (including development, monitoring and control systems);
- Surface water quality management;
- Groundwater quality and salinity control;
- Drought (risk) management (drought forecasting, preparedness, warning, contingency measures, protection, recovery etc);
- Flood risk management (flood forecasting, preparedness, warning, control, proofing, protection, contingency measures, recovery etc);
- Hydropower management (from a water resources perspective)
- Environmental water allowances;
- Coastal zone management;
- Salinity control and management;
- Economic/ Financial regulation (tariffs, water valuation etc);
- Administrative regulation (abstraction / discharge permitting systems);
- Irrigation system management;
- Urban and industrial water supply management;
- Wastewater collection and treatment;

- Water saving and water use efficiency improvement programmes;
- Desalination;
- Reporting and information dissemination;
- *…. plus other items.*

IWRM provides the concept and framework for undertaking the above more effectively.

An IWRM approach generally requires positive change in the 'enabling environment', in institutional roles, and in management instruments. Fundamentally, it is about change in water governance, i.e., the range of political, social, economic and administrative systems that are in place to develop and manage water resources and deliver water services, at different levels of society. Hence, IWRM can also be considered to be Integrated Water Resources Governance – which helps in enforcing the fact that it is more than what is traditionally taken to be 'management'.

The Global Water Partnership (GWP) has developed a comprehensive framework for IWRM. This is sometimes called the '*framework for action*'. Essentially one needs to address the 'enabling environment' and reconfigure 'institutional roles and functions'. Thereafter, it is a matter of applying various 'management instruments'.

The GWP have produced a good document entitled 'Integrated Water Resources Management', Technical Advisory Committee (TAC) publication Nr 4. This is available in both Chinese and English and is a highly recommended explanatory document for IWRM. [*Note this document tries not to reproduce what is contained in TAC Nr 4 but to add further value. However, for consistency of explanation, some material has been used from TAC Nr 4*].

The main elements and aspects of IWRM are summarised below based on GWP documentation:

The IWRM framework

IWRM elements (ex GWP):

- Economic efficiency in water use: Because of the increasing scarcity of water and financial resources, the finite and vulnerable nature of water as a resource, and the increasing demands upon it, water must be used with maximum possible efficiency;
- Equity: The basic right for all people to have access to water of adequate quantity and quality for the sustenance of human wellbeing must be universally recognized;
- Environmental and ecological sustainability: The present use of the resource should be managed in a way that does not undermine the life-support system thereby compromising use by future generations of the same resource.

Enabling Environment

- Policies – setting goals for water use, protection and conservation.

- Legislative framework - the rules to follow to achieve policies and goals.
- Financing and incentive structures – allocating financial resources to meet water needs
- Forums and mechanisms for participation

Institutional roles and functioning

- Creating an organisational framework – forms and functions.
- Building institutional capacity – developing human resources.

Management Tools

- Water resources assessment – understanding resources and needs (surface water, groundwater, quantity and quality).
- Plans for IWRM - combining development options, resource use and human interaction.
- Efficiency in water use – improved supply and use efficiency as well as re-use.
- Social change instruments – encouraging a water-orientated society.
- Conflict resolution – managing disputes, ensuring sharing of water.
- Regulatory instruments – allocation and water use limits.
- Economic instruments – using value and prices for efficiency and equity.
- Information management and exchange – improving knowledge for better water management (and sharing that knowledge).

This IWRM framework is represented by the triangular figure presented inside the cover of this document; this relates the three objectives to the enabling environment, institutional roles and management instruments.

The list of 'Management Tools' is by their nature a summary of elements of water resources management actions and activities. They should not be considered to be separate items and need to be considered to be either 'integrated or inter-related'.

These management tools or instruments are described in TAC Background Paper Nr 4 under slightly different the titles, but covering essentially the same topics:

- Water resources assessment: availability and demand;
- Communication and information systems;
- Water allocation and conflict resolution;
- Regulatory instruments;
- Direct controls;
- Economic instruments;
- Encouraged self–regulation;
- Technology.

Approach to implementing IWRM

It is important to note that IWRM is a process, not a product, and that it serves as a tool for assessment and programme evaluation. IWRM does not provide a specific blueprint for a given water management problem but rather is a broad set of principles, tools, and guidelines, which must be tailored to the specific context of the country or region or a river basin or catchment.

It should also be noted that 'management' is generally seen to be 'development and management'.

Water as a resource and its development and management is specific to the geographical, historical, cultural and economic context of any country. Hence IWRM processes will differ from country to country, and there is no "one size fits all."

Additionally, IWRM is imprecise; it has to accommodate uncertainty in:

- The inherent variability of the water resources system;
- The imperfect knowledge of the system;
- Political and economic factors;
- Human actions and responses; and now,
- Climate change.

In defining an approach to IWRM, there is a need to establish:

- A framework of objectives and priorities for the water resources management process – and this could include political objectives (such as relative importance of environmental sustainability, urban water supply reliability, cost of urban water supply, availability of water for agriculture) as well as objectives of principal stakeholders
- Development of policy, legislation, institutions and regulations to provide mechanisms for water management to address problems such as:
    - Establishing what is appropriate water use, and water use efficiency
    - Establishing water quality objectives
    - Establishing appropriate environmental objectives
    - Regulating the planning processes to maintain compatibility of planning approvals with implementation of agreed water management measures
    - Regulations to allow control over water use and discharges, with monitoring and enforcement measures to make sure regulations are obeyed
- Analysis to quantify what needs to be done through IWRM processes in order to meet the objectives. The analysis should also develop an appropriate implementation programme and a planning control process design so that the strategy can be implemented.

IWRM is most commonly reported or 'designed' from a national perspective. However, the principles of IWRM can easily and possibly more importantly refer, for example, to a wider involvement of stakeholders, the simultaneous consideration of different water uses, upstream/downstream effects and impacts, and the cross-sector coordination of different local government levels and departments.

Considering IWRM, it is important to be aware of the meaning of the term "management". This term has both process-related and institution-related connotations. The former indicates management functions like planning, controlling, organizing and leading. The latter makes reference to a group of individuals or a particular organisational arrangement ("the management") that has decision making and implementation authority and can issue orders and directives to subordinate organisational members. Here, misunderstandings can arise with regard to the management term used in IWRM. The view of IWRM requiring an "integrated management" is often exclusively interpreted in a way that calls for one overarching umbrella organisation – e.g. a river basin agency - that assumes overall decision making power over the various sector related organisations.

However, this must be perceived as only one option in the context of IWRM. A more acceptable option that is generally less expensive and 'intrusive' is to achieve improved water resources 'management' through better and increased co-ordination, cooperation and collaboration between existing organisations and stakeholders.

This requires strong commitment by all parties and an overarching 'champion' to drive the change within a suitable 'enabling environment'.

2.2 Economic Efficiency

As stated in GWP TAC Paper Nr 4, based on Dublin Principle IV, **Water has a value as an economic good**; '*Many past failures in water resources management are attributable to the fact that water has been – and is still – viewed as a free good, or at least that the full value of water has not been recognized. In a situation of competition for scarce water resources such a notion may lead to water being allocated to low-value uses and provides no incentives to treat water as a limited asset. In order to extract the maximum benefits from the available water resources there is a need to change perceptions about water values and to recognize the opportunity costs involved in current allocative patterns.*'

However, Dublin Principle IV indicated that that "*.. it is vital to recognize first the right of all human beings to have access to clean water and sanitation at an affordable price*". There has been much debate on this issue - does it mean that the poorest domestic consumers and farmers must pay at least as much for every litre of water they receive as the industrial unit using it to produce steel or electronic goods? This principle has been modified to - water is to be managed as an "economic and social good" and there is a clear distinction between the "value" of water and the charges or tariffs for different consumer groups. Ability-to-pay is an important factor reflecting the need to consider water also as a 'social good'.

The GWP TAC4 Document on "Integrated Water Resources Management" (IWRM) contains a good summary section describing 'Water as an economic good'. For more details, reference should be made to GWP TAC2 "Water as a Social and

Economic Good: How to Put the Principle into Practice". [http://www.gwpforum.org/gwp/library/TAC2.PDF].

There are several aspects that are explained in the TAC documents including:

- Water has a value as an economic good;
- Water value and water charges are two different things;
- Goal of full cost recovery;
- Managing demand through economic instruments;
- Financial self-sufficiency versus water as a social good.

However, putting the theory into practice in a developing environment with wide income disparities raises many problems.

The most general statement is normally: "*The value of water to a user is the maximum amount the user would be willing to pay for the use of the resource.*" However, those who believe that water is a social good would say that this is an incomplete and misleading economic analysis. Willingness to pay depends largely, although not entirely, on the ability to pay. Thus even with the same basic need for or value of water, the rich will get more and the poor less.

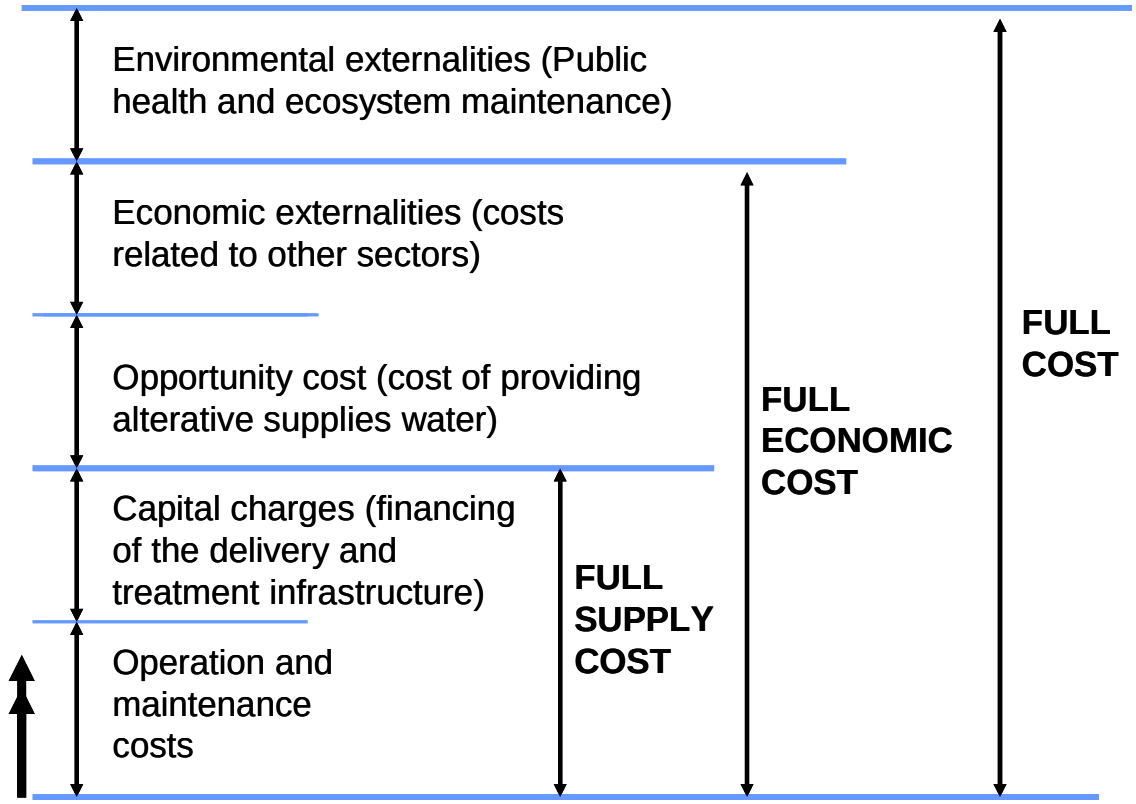
The 'value' of water might in some situations be considered as infinite (or very high) for all practical purposes—for example, in a drought, when people are dying of thirst, or when a reservoir runs dry at the end of the season after all irrigation and agricultural inputs have been provided except the last irrigation that is required to ensure a crop yield. However, the ability to pay factor is critical.

Conversely, once a person (or a crop) receives enough water the value placed on additional units rapidly falls and can even become 'negative' where irrigation is provided during harvesting for example. These situations are 'instant' situations and generally a more long term balanced determination of water value should be the basis for assessments together with the concept of subsidising the poor. Nevertheless, in a water market situation, water values could become very high during drought periods and price the poor out of supplies.

Another factor which often dictates in many countries is a political dimension which may or may not be reflected in policy. In many countries there can be a reluctance to impose high water charges on the agricultural sector which generally pays significantly less for a unit of water than does industry for example. In certain situations this can relate to the 'ability to pay' factor (as the productivity of water is usually much less in these situations) but is more often being dictated by a 'willingness to pay' despite being able to pay. In developing countries, the government does not want to precipitate rural unrest by major price increases whilst in developed countries the reluctance might be owing to political lobbying by rich farmers or by loss of political support (votes) in a politically sensitive part of a country.

In most situations, the focus is on costing water rather than valuing water. This is particularly so in developing countries. However, as water becomes limiting to economic and social development, valuation needs to be considered more seriously.

In relation to costing water, the diagram below represents from TAC Paper Nr 4 is often used.



Factors related to costing water

Ideally, the price charged for water should equal its economic and environmental costs of supply, plus the cost of disposing of wastewater, and should therefore vary from location to location, and sometimes according to time of use. Dealing with marginal opportunity costs and marginal environmental costs can become very complicated since secondary benefits also need to be considered. The full cost may be 5-10 times more than the full supply cost, but it is very difficult to calculate and can be very variable

Although 'full cost recovery' is often stated as a goal, in many situations in developing countries recovery of the 'operation and maintenance' is the closest that the income from charges reaches. Thus the difficulties associated with exactly determining environmental costs are not encountered. This is particularly true in large scale irrigation systems.

Water sector tariffs are the means for a service provider to recover the various costs that it encounters in the provision of a service. In the urban sector, tariffs are charges for water and sanitation services. They are most commonly cash charges.

However, for rural communities it is common to contribute labour to local infrastructure projects but they are seldom charged for water apart from simple contributions to operation and maintenance costs.

In the irrigation sector where irrigation is provided by a 'scheme', irrigation service charges are generally charged. Where irrigation is based on groundwater, it is the farming community normally pays for the operation (power) and maintenance costs of the facilities. However, this can vary from situation to situation.

From 'China Water Sector Briefing Note Series' (DFID), Briefing Note 3' key elements of a charging regime are:

- The amount that is paid by users, and how they are charged (e.g. flat rate or by volume). Users tend to be treated according to their type of use, such as: domestic, commercial, agricultural or industrial. Three elements, tariff levels, structures and subsidies, determine how much a specific user is charged. The tariff 'level' is the amount charged, typically monetary (i.e. the number of Yuan). The tariff 'structure' is the way the total price to a user is calculated. For example, the structure may be a flat payment per connection, or it may vary by connection size, or by number of cubic meters of water received, or per mu of irrigated land. Finally, 'subsidies' are reduced prices or rebates targeted at specific groups.
- How the payment amount is decided (the processes by which tariffs are set). Appropriate mechanisms for setting tariff levels, structures and subsidies ensure that tariffs do not cause undue hardship; public understanding and acceptance of the process assists by raising payment levels and timeliness

The 'effective tariff rate'

When assessing a tariff regime, it is important to consider the effective tariff rate, that is, the net amount households will actually pay. This is a function not only of the amount households are charged but also the extent to which tariffs will be pursued and collected and the participation rate for subsidies.

2.3 Social Equity

With increasing levels of development people's expectations of, and reliance on, a reliable supply of water increases. Water has always been a vital part of daily livelihoods but becomes increasingly more important as levels of affluence increase and particularly where that affluence is highly linked to water. Additionally, good health is a vital factor with increasing health-related costs and the increased importance of being well to maintain employment.

Fragmented water management practices have often failed to yield sustainable livelihoods i.e. they have produced gains for certain sections of society whilst being accompanied by adverse effects on other sections without effective balances and trade-offs.

The GWP states the challenge of water resource management as balancing the use of water resources as a basis for livelihood and the protection and conservation of the resource.

Equity basically means all people must have access to water of adequate quantity and quality. The best way to ensure equity is through the participation in water management by all stakeholders but this can often be difficult and recourse should at least be made to ensure good representation. Ensuring that the poor, especially women, have a fair share of water means that they must be represented in the institutions that make water resource allocation decisions. Alternatively, there must be established a communication route to enable their 'voice' (opinions, viewpoints) to be heard.

Stakeholders must therefore be involved in preparing and implementing IWRM for it to be effective and sustainable. Their interests in, importance to, and influence over any water related decision must be accommodated. Local community participation builds ownership and trust in water management systems whilst input provides an important source of experience and ideas that can lead to improved and sustainable solutions.

The definition of stakeholders is presented in the box below. A full appreciation of the way stakeholders are affected, have an influence on or should be included in water resources management decisions needs to be understood by all parties.

What is a stakeholder?

A stakeholder is any person, group or institution that has an interest in a development activity, project or programme. This definition includes both intended beneficiaries and intermediaries, winners and losers, and those involved or excluded from decision-making processes.

Stakeholders can be divided into two very broad groups:

- **primary stakeholders**: those who are ultimately affected, i.e. who expect to benefit from or be adversely affected by the intervention, MWR, Water Departments, EPB, WUAs, water users.;
- **secondary stakeholders**: those with some intermediary role. In an enterprise project these might include some of: DFID, Women's Federation, banks, Ministry of Finance, local government, business service providers…

Key stakeholders are those who can significantly influence the project, or are most important if project objectives are to be met. Both primary and secondary stakeholders may be key stakeholders.

Participation of primary stakeholders is essential in projects which are expected to have a direct positive impact on defined groups of people.

Stakeholder participation is a process whereby stakeholders – those with rights (and therefore responsibilities) and/or interests - play an active role in decision-making and in the consequent activities which affect them.

Local institutions or processes are the foundation for any water resources management plan and should be continually involved through implementation, monitoring and enforcement.

There is general consensus that effective stakeholder participation in IWRM activities is essential. The key issue is how to manage that participation such that the cooperation received from the supporting partners with the main IWRM implementing agency is whole-hearted and full.

It appears that the most effective way to gain real cooperation is through a bottom-up approach, whereby the water resources management issue and process is carefully explained to all stakeholders, they consider the matter, and nominate representatives to a coordinating committee (or similar) that oversees the IWRM processes as carried out through an implementing agency that is guided by the coordinating committee. However, this takes a lot of time, and in many cases the culture is not there for this to be successful without a lot of effort.

Where the time and resources are not available to develop stakeholder participation from the bottom level upwards, then the top-down approach can be used but care is needed. It is necessary for the lead agency:

- To spend time explaining the process to stakeholders, so they see advantages to them in working together, and it is not done just because they were told to do it;
- To make sure the vulnerable sectors are fully-represented in the process, and that their point of view is fully heard in the process;
- To allow for a wider public consultation in the process as some representative groups might have not been included in the initial compilation of the stakeholder groups

For the top-down approach and for full stakeholder participation there is still the need to maintain open communication with all involved, and to concentrate on providing information on water management issues as would be the case with the bottom-up approach.

An example of a good top-down approach is that provided by the Water Framework Directive (of the European Union), with its requirement to widely consult with stakeholders, and to appropriately document the stakeholder consultation process.

2.4 Ecological Sustainability

In almost all countries that have been through or are going through the industrial development cycle, ecosystems have been largely neglected in the process. This is particularly the case with regards to water dependent ecosystems.

The water needs of humans and natural ecosystems are commonly viewed as competing with each other. Certainly, there are limits to the amount of water that can be withdrawn from freshwater systems before their natural functioning and productivity, native species, and the services and products they provide become severely degraded.

Water managers and political leaders are becoming increasingly aware of these limits as they are being confronted with water quality issues, competition for water resources, increased pressures on endangered species, and changing societal values concerning ecological protection.

Ecological degradation has generally been an unintended consequence of economic development and water management, stemming from a lack of understanding of water flows and water qualities necessary to sustain freshwater ecosystems. Additionally, there has been a lack of awareness and control of water abstraction from, and effluent discharges to, the natural environment.

However, when ecosystems have been badly affected by development activity over the decades, an issue is which 'ecological status' is to be made sustainable? In many situations in many countries an 'ecological recovery' programme is required prior to establishing a water management system based on 'ecological sustainability'.

Many 'water managers', although in agreement with the concept of 'ecological sustainability' are inactive on the issue since:

- It is not their area of knowledge;
- The question is seen to be too large and complex to understand;
- It often conflicts with the demands of industry and economic development that are often key political drivers;
- It is unclear what ecological status is to be 'sustained' and who decides this;
- It is not understood how to meet ecosystem needs.
- It is not appreciated how difficult it is to 'recover' or 'reinstate' and ecosystem. (Often damage can be irreparable).

The IWRM process where numerous stakeholders are involved in water resources management should address many of the above issues. However, it is often found that few have the knowledge of or answers to the above. Even where the knowledge might exist and examples are known of major ecological issues in other countries (e.g. the Aral Sea or the Murray Darling), this does not sometimes influence actions.

The new European Water Framework Directive (see Section 8) has its main aim of establishing 'good ecological status' in the natural drainage systems and water bodies in member States. The WFD is currently under implementation and combines a mixture of ecosystem re-instatement and ecosystem protection for numerous highly developed European countries. One could argue that such countries should be in a position not to require such a directive if better water resources management had been practiced by them in the past.

3 Enabling Environment

3.1 Policies

National policy and legislation often embrace the principles of equity, sustainability and efficiency. These are the main themes of IWRM. However, in many countries,

especially developing countries, implementation and enforcement of the legislation is poor. As a result, water users (including local governments) are not being held accountable for their actions, and the degradation of water resources continues.

Some of the basic IWRM policy requirements being (ex GWP):

- Water policies accord with overall national economic policy and related sectoral policies.
- Economic and social policies take into account water resource implications.
- Water policies support economic efficiency, social equity and environmental sustainability in water development, management, and use.

Most water sector policies generally relate to meeting the demands of domestic water supply, livestock, agriculture (irrigation), industry, mining, energy, fisheries, environment, wildlife, recreation, tourism, forestry, navigation and transboundary water resources. The requirements being to provide for all of these users/activities, while at the same time safeguarding the environment and water resources for future generations

Water sector policies normally cover the management instruments that are required:

- Technical instruments
- Economic instruments
- Administrative instruments
- Legal instruments
- Regulatory instruments
- Participatory instruments

Issues of regulation and the appropriate role for the public and private sectors, have been rethought in developed countries in recent years leading to extensive industry restructuring and privatisation, and often, the establishment of new regulatory agencies. The concept of the regulator is not so highly advanced in developing countries

IWRM is among today's core environmental policies in all European countries that are transposing the Water Framework Directive (WFD). This Directive came into force on December 22nd 2000 (Directive 2000/60/CE) and lays down objectives to be achieved within the set deadline of 2015, such as:

- Good status of surface, groundwater and coastal waters (good ecological and chemical status of surface water, quantitative and chemical status of groundwater). The concept of good status refers to the structure and the running process of aquatic systems as well as to the degree of concentration of substances according to established eco-toxicological criteria.
- Focus upon safeguarding ecosystems. This implies result-oriented planning and implementation of diagnosis reports as well as on-site restoration.
- Commitment to getting the public involved and to dissemination of information.

Since the beginning of the 2000's, this Directive has induced water managers and policy makers in European countries to develop entirely new approaches and operational methods.

3.2 Legislative Framework

Water legislation should (according to the GWP Technical Note 4, 2000):

- *Be based on a stated national water resources policy that cuts across sectoral and stakeholder divisions, addresses water as a resource and stresses the societal priority for basic human needs and ecosystem protection;*
- *Secure water (use) rights to allow private and community investment and participation in water management;*
- *Regulate monopolized access to raw water and water services, and prevent harm to third parties;*
- *Present a balanced approach between resource development for economic purposes and the protection of water quality, ecosystems and other public welfare benefits;*
- *Ensure that developmental decisions are based on sound economic, environmental, and social assessment;*
- *Ensure the possibility of employing modern participatory and economic tools where, when and to the extent needed.*

The guiding characteristics of IWRM legislation and institutions should be, according to the GWP (Technical Note 7, 2003):

- **Open and transparent** (the institutions should work in an open manner, interacting freely with stakeholders, using simple language and showing clearly all steps towards policy formulation)
- **Inclusive and communicative** (broad participation is achieved through wide social mobilisation and dissemination, using appropriate channels for each stakeholder group)
- **Coherent and integrative** (clear political leadership and vision, clear mandates for institutions, and a consistent approach across all stakeholders to tackling issues)
- **Equitable and ethical** (strongly based on ethical principles of society, delivering policy in an equitable manner)

In a similar vein, the IWRM process is recommended to have the following key characteristics:

- **Accountable** (institutions take responsibility for what they do, and also are responsible for performance to water users and other stakeholders)
- **Efficient** (not only economic efficiency - also political, social and environmental efficiency is needed)

- **Responsive and sustainable** (policies must deliver what is needed on the basis of demand, clear objectives, an evaluation of future impact and, where available, of past experience. The institutions should also be built with an eye toward long-term sustainability. Water governance must serve future as well as present users of water services)

International best practice aspires to these targets, and in some cases gets close to achieving them – at least in theory e.g. the Water Framework Directive (WFD).

The EU Water Framework Directive (WFD) provides a mandatory process for preparing a River Basin Management Plan that meets a lot of these requirements. Specifically required are:

- A clear focus of the Plan on achieving "good" quality ecological status in all relevant water bodies within a planning horizon
- Nomination of a body that is clearly responsible for the management of the River Basin Plan (the "competent authority")
- A requirement for publication of the plan, and a well-documented process of public consultation concerning the Plan
- A regular process of plan review every six years to analyse progress, and to re-focus the plan in the light of new developments, and the impact of measures already taken

The EU Water Framework Directive is part of fundamental legislation for the EU, and must be transposed into national legislation on accession to the EU. Following it is therefore mandatory for all member countries.

However, the WFD does allow for some degree of flexibility in interpretation between the member states in the EU. The differences in interpretation between different States sometimes even overshadow the key objectives of the WFD. For example, non-achievement of 'good status' may even be allowed since there are some broadly worded derogation provisions which allow some member states to delay implementation of some elements of the directive. It is also evident that there are incongruities between the ideals underlying public engagement and the realities of applying complex environmental legislation.

3.3 Financing

Financing relates to the development and capital costs of hydraulic infrastructure, operation and maintenance costs as well as the basic costs associated with the management of the water resource.

As stated by GWP:

"When looking at the investments needed for water resources infrastructure, one has to distinguish between the different actors who bear the responsibility for ensuring (but not necessarily providing) each type of investment:

- *Investments to reduce the spatial and temporal imbalances in water availability, to protect people from extreme flood and drought events and to*

provide public goods are the responsibility of public authorities, be they national or sub-national;

- *Investments designed to deliver water to a large number of users (households, industry, energy producers or irrigators) and remove waste or surplus water are the responsibility of local or regional governments, special irrigation institutions or water authorities of various types; and*
- *Investments that enable each user, on their own property, to solve their own water problems fall within the realm of personal responsibility."*

In practice, most IWRM managing organisations are accountable to central government bodies. This may not be good practice, as the whole object of IWRM is to develop self-sufficiency in water management, and so the management body should be primarily accountable to its stakeholders – especially those providing the bulk of the funding as major water users.

In many countries there is an increasing emphasis for the private sector to take a key role and responsibility in the delivery of water to water users. However, conditions for private sector involvement in the sector need to be established such that risks are transparent and minimised. In particular a sound and stable policy and legislative framework needs to be in place, transparent and signed up to by all.

Centrally Funded or Self-funding?

A key principle of IWRM is that water management should basically be paid for by the water users – through fees and charges for access to and use of water, or for permission to discharge effluents to water bodies. This is considered the only fair and equitable approach, and one that should have the support of everybody. However, where a culture has developed whereby much of life's infrastructure is provided through centrally-funded facilities, this is difficult to implement.

Another problem is the "funding gap" in developing facilities and services to allow a good and responsive service to be provided to users such that they are happy to pay for the good service provided. Good service provision needs adequate funds to support both infrastructure improvement and effective management however, whilst this is being established, central government funding is often required. However, the aim should be to transfer the financing to the direct beneficiaries of the eventual 'good service provision'.

In many countries basic water resources management activities are funded through water abstraction charges (in China, Water Resources Fees managed through MWR) and effluent pollution charges (managed through MEP). Other water charges exist in the form of irrigation service charges and urban water supply and sewerage charges based on a tariff system. However, these latter charges are higher than the former and have a more specific role in relation to the services provided.

Water resource fees (WRF) (often termed 'water abstraction charges' or 'water resource management charges') are a form of economic instrument. They are the charges made by water management authorities (usually Government) to licensed water users for the right to abstract water from surface water (SW) or groundwater (GW) sources. WRF charges are based either on the licensed volumes of

abstraction, regardless of the volumes actually used, or on actual volumes abstracted, as measured by metering or other means.

WRF charges can comprise some or all of the following components:

- The administration and other costs of water resource management (WRM).
- The opportunity cost (economic value or scarcity value) of water.
- The environmental value of water (the 'environmental premium')

There is also a fourth component: the cost of the technical measures (usually, infrastructure developments) to make water more available for abstraction and use, such as dams and storage reservoirs, inter-basin transfers and river training. Unlike the other three components, however, this is not a 'resource charge'. Even though sometimes included as part of an overall WRF charge, it is essentially an infrastructure or service charge. A suitable nomenclature for such charges is the term 'water resource development charges', which is used in South Africa to distinguish such charges from what are termed 'water resource management charges' in that country.

In most countries WRFs at present take account of only the first component and, in some cases and to a limited extent, the fourth component. The charges made normally reflect mainly what might be termed the 'overhead' costs of water resource management and development (i.e. the first component). Such overhead costs cover, for example, the administration and management of the water resource, the control and regulation of its use, and hydrological and hydro-geological data collection and analysis.

A WRF tariff can include the following components:

- An initial charge for being issued with a licence to abstract water; what the UK Environment Agency (EA) terms 'The Application Charge'. This is usually only a modest amount.
- A basic charge per unit volume, based on either the licensed volume of abstraction or the actual volume of abstraction; what the EA terms 'The Annual Charge'. In most WRF systems this is the core element of the overall charges.
- Various possible adjustment factors to be applied to the basic unit volume charge (the 'Charge Factors' in the EA system), to take account of various aspects of the water use, including:
    - Differences between the seasons (e.g. summer and winter) in the availability of surface water resources, with the charge per m3 being higher in the season(s) of lower water availability.
    - The degree of consumptive use of each type of water use, with charges being reduced for those uses with high return flows (e.g. power station cooling water) and increased for those with low or negligible return flows (e.g. spray (sprinkler) and trickle irrigation).

- The quality of the water abstracted; for example, a lower charge for brackish water used for cooling purposes than for fresh water.
- The location of the abstraction; for example, charges may be higher where the pressure on the available water resource is greatest.

- Different rates of charge for different categories of water user. For example, agricultural users are often charged a lower WRF rate than other users or are even exempted from charges completely (this is the most common situation globally, but such users are charged the same amount in the UK).
- Different rates of charge for surface water as compared with groundwater.

As this document has a prime focus on Ministry of Water Resources related activities, the issue of effluent discharges and the use of the associated funds is only covered briefly here.

Charges for the discharging of effluent in to the drainage network are linked to the issuance and holding of effluent discharge permits. As for water abstraction permits there is normally a administrative charge for the issuance of a permit. However, there is generally also an annual charge based on the volume and form of effluent discharged by a permit holder.

Effluent discharge charges are generally based on the implementation of the "polluter pays principle". Frequently the amount of effluent-related fee payable is linked to the BOD load of the effluent discharged either onto land, watercourse or both.

3.4 Forums

A very important issue related to the effectiveness of IWRM relates to an enabling institutional setting and the active involvement with forums (location for discussion) and stakeholders. Numerous forums can be established to provide a means of improved communication with and participation of stakeholders on different subjects related to IWRM.

As stated earlier, a stakeholder is any person, group or institution that has an interest in a development activity, project or programme. This definition includes the intended beneficiaries and intermediaries, winners and losers, and those involved or excluded from decision-making processes.

Based on the importance of having full cooperation from all stakeholders, it is common practice now to have the overall body responsible for planning a relatively “independent” organisation (not closely tied to one particular aspect of water management) and supervised/managed by a committee with representatives from most of the principal stakeholders in water management. Much of the work of the IWRM Plan will be done by the institutions that have traditionally done the work – the new body is mostly a co-ordinator of activities, and perhaps a gatherer and analyser of monitoring data to assess the impact and effectiveness of the new regime.

This is the approach being tried in South Africa – largely – although the new Catchment Management Agencies do retain close links with the Department of Water Affairs and Forestry which were historically responsible for all aspects of WRM.

The Danube and the Rhine have their international commissions to perform a similar role. The establishment of the Murray-Darling Basin Authority in 2008 also fits this trend.

At the local level the creation of new 'overarching' and 'impartial' organisations would be difficult to justify. Hence, means of achieving inter-sectoral local level organisational consultation, co-operation, and collaboration is essential if IWRM is to be practiced locally.

From a paper entitled *'Developing and managing river basins: The need for adapative, multilevel, collaborative institutional arrangements' F. Molle (IWMI/IRD), P. Wester (Wageningen UR), and S. Carriger*, the following has been abstracted:

'In "coordination-based," collaborative approaches to basin governance---common in Australia, the European Union and the Western USA, but also emerging in countries such as Brazil, Morocco, Mexico and South Africa - user and community organizations, government organizations, and stakeholder initiatives develop coordination and negotiation mechanisms at the basin or sub-basin level. This can mean a coordinating organization, for example, Mexico's Basin Councils, or it can be a mix of legislation, stakeholder platforms and institutional linkages.
A coordination-based approach to governance can have several advantages:

- *Legitimacy---if it recognizes existing institutions with good stakeholder representation and buy-in.*
- *Participation---if it gives water users the space, capacity and power to participate in water management decisions that affect them.*
- *Flexibility---because coordination-based arrangements involve diverse organizations and in general less rigid institutional structures, they are better able to adapt to changing needs and circumstances.*

Collaborative, multilevel governance can help to reconcile stakeholder values and objectives by ensuring that information becomes available to all stakeholders and that conflicting actions are flagged in advance and duly debated. However, this requires suitable processes, rules and other institutions. It also works best when there is a culture of democratic debate and not too severe imbalances of power.

When creating new rules, roles, and rights, it is crucial to recognize that stakeholders have different levels of access to resources, knowledge, political representation, and institutions; otherwise the institutional outcome can privilege the elite. Of course, if the goal is equity, just focusing on improving participation and coordination is rarely enough; there is a need to redistribute resources, entitlements and opportunities---tasks that must involve the state.'

Constraints to collaborative governance

- *It may become more difficult to achieve as the size of the basin increases, and decision-making can be cumbersome and coordination costs high.*
- *Existing organizations must have legitimacy, relevant capacities and adequate resources.*
- *Political changes in participating jurisdictions can upset agreements.*
- *Stakeholder participation in basin management is not straightforward, and including the poor and achieving substantive stakeholder representation has proven elusive in practice.*
- *In countries with strong, centralized government control, collaborative arrangements may not be feasible.*

Source of the above text in italics:
http://www.iwmi.cgiar.org/Assessment/files_new/publications/Discussion%20Paper/CA_Issue_Brief_12.pdf

Many of the above observations and conclusions that pertain to key elements of IWRM are relevant in most countries. Achieving stakeholder participation is not always easy and requires considerable commitment and support. In situations with strong line agency institutional structures, collaboration is difficult without specific agreements and commitment by both or all parties. However, despite the acknowledged difficulties, effort should be put into achieving some degree of collaborative governance to improve water resources management.

3.5 International Co-operation

As indicated earlier, the IWRM process is applicable at the international level and the local level.

At the international level, the establishment of international co-operation can often be difficult when it relates to water sharing activities. Often the solution is the establishment of a river basin commission such as the Mekong River Commission comprising representatives from the different riparian states. Such an organisation, particularly related to developing countries is often supported by international funding agencies.

There exist legal frameworks for improving the management of shared water resources. For instance, the Convention on the Law of the Non-Navigational Uses of International Watercourses, adopted by the United Nations General Assembly (UNGA) in May 1997 (but not yet in force), and the draft articles of the Law of Trans-boundary Aquifers, which were reviewed by the UNGA in December 2008. These propose legal frameworks for managing shared surface and groundwater resources based on international water law principles. These principles aim to enhance the management of shared water resources by encouraging: the equitable and reasonable utilization of water resources, greater cooperation among all riparian countries, the regular exchange of data and information, and the prevention and

resolution of conflicts arising over shared water resources, among others. These principles being in effect integrated water resources management (IWRM).

Furthering IWRM from an international perspective requires considerable effort in establishing multi-lateral and bi-lateral agreements between the States involved, all in the context of different perspectives and objectives. Achieving consensus can take a great deal of time but is nonetheless important from an IWRM viewpoint.

Having IWRM operational at the national level should be beneficial to reaching international consensus on issues.

4 Institutional Framework

4.1 Organisational Framework

'Institutions and institutional structures emerge out of a specific context. For example, a strong civil engineering body capable of planning, designing and constructing infrastructure to tap available water is appropriate when the objective is developing water resources. The problem is that such organizations - whose capacity and structure are oriented towards basin development---can be slow to adapt as the basin's water resources become increasingly committed. They continue to do what they do best---build infrastructure---with the result that basins become developed to the point where ecosystem integrity is threatened. In such basins, institutional arrangements need to be reoriented towards improving water productivity of existing uses; dealing with stakeholders competing for a limited supply of water, including the environment; and regulating water quality and ecosystem health'. Source: *'Developing and managing river basins: The need for adapative, multilevel, collaborative institutional arrangements'*,

In many countries organisations are in the process of change to better address the issues of water demand management, improvements in allocation practices and paying more attention to social and environmental considerations.

The basic requirements of an organisation framework to support IWRM are (ex GWP):

- *Clearly defined responsibilities and the authority to carry them out. Absence of jurisdictional ambiguities and overlapping functions between organisations.*
- *Coordination mechanisms between organisations responsible for sectors that impact and are impacted by water resources development, management and use.*
- *Coordination mechanisms between different levels of government—from local, to province, to basin, to national.*

One of the most problematic issues related to the introduction of IWRM is the institutional setting, the organisational framework and the need for an apex organisation. For any system of 'management', a management structure and hierarchy is required with clear responsibilities and accountabilities assigned and understood. This needs to be considered from a horizontal sectoral perspective and a vertical administrative perspective.

Where IWRM is being followed at an **international level**, the lead or apex organisation is normally a newly created commission or suchlike with representatives from each member state all with a specifically designed mandate to probably be responsible for resolving issues related to the sharing and management of international rivers, lakes and perhaps aquifers. This has a cost implication but there are many international examples to follow.

Where IWRM is being instigated or followed at the national level there is sometimes the recourse to the creation, if not already in existence, of a national water council or suchlike with representation from various ministries and led by a senior politician. The form of this organisation is often important. Too many representatives or control from one ministry tends to reduce the IWRM effectiveness of the organisation.

Without an 'apex' organisation at the national level and simple reliance on the existing institutional structure and perhaps long established ministries with the main task of leading IWRM being assigned to one ministry creates additional challenges to establishing effective IWRM processes.

Trying to implement effective IWRM at the local level when central ministry level organisations have not officially signed up to the 'concept and processes' makes local level establishment of effective IWRM even more problematic.

In some situations, in the national context, river basin authorities, commissions or catchment management agencies have been formed in the context of improving water resources management and in line with the recommendations inherent in IWRM (although river basin organisations often predate 'IWRM'). In many respects this makes IWRM easier to consider and follow in the river basin organisation', however, it does not always mean that such management processes and decisions are acceptable to the often parallel political administrative organisations.

In many countries of the world, one of the biggest impediments to the functioning of an effective IWRM process relates to inter-sectoral conflicts and organisational aversion to co-operation, collaboration and compromise.

Basically, IWRM requires:

- A leading group or entity with multi-sectoral respect
- Inter-sectoral co-operation
- Technical skills to optimise water management in terms of hydrology, water supply and demand management, engineering and environmental issues
- Full cooperation of the wider community in order to implement measures needed for optimum management – such as the farming community to implement land management practices to reduce land drainage, entry of contaminants into drainage channels etc
- Vision in order to develop a long-term programme that will eventually lead to optimum management and a sustainable situation
- Ability to manage large investment programmes where these are needed

Institutionally, this will mean most of the IWRM tasks will be performed by organisations already experienced in their roles, with the coordination and planning being the missing and difficult link.

The IWRM roles will be different at different levels, be it national level, major river basin, river reach or catchment area, irrigation scheme management group or urban water management entity. Some will deal with policy issues, others with directives and others with hands-on water allocation and distribution or environmental protection.

The IWRM process needs to be clearly led and coordinated by an agency that has strong support of all stakeholders in the IWRM process, the strong support of central government, strong technical, consensus-building and administrative skills, and access to financial credit sufficient to manage the implementation of the components of the IWRM process. This 'agency' should manage the whole planning and implementation process, but leave much of the implementation of the components of the process to agencies and stakeholders.

It is important that the lead agency should be seen as unbiased in order to gain support of all stakeholders. In the past, the tendency has been to use a water management agency (often an organisation developed to provide bulk water supplies for irrigation or hydropower) to perform this role – and this can lead to great difficulties in persuading environmental organisations, for example, that the new process is truly equitable and giving appropriate weight to environmental and social concerns.

Top Down

A top-down system of stakeholder involvement is one dominated by a senior co-ordinating organising body instructing organisations and water users to work together to develop systems for IWRM. This is the process that is most widely adopted – but also, in most cases, gives rise to difficulties in execution. The reason that it is used is that it is the easiest approach: existing water management organisations are mandated to carry out IWRM activities by contacting other stakeholders, and working out a methodology for working together in order to deliver IWRM.

The problem with the use of existing water management institutions in a role that is supposed to be even-handed in developing a truly integrated approach is that its former role will obviously introduce a bias in how any plan is developed and delivered, as the people and institutions will favour the areas where they had previously worked. There will also be the perception of bias from other stakeholders, which is hard to overcome in order to get whole-hearted support of the other aspects of water management.

Bottom Up

A bottom-up process is one where the initiative to cooperate in IWRM comes from those directly involved in the various IWRM processes seeing the advantages and benefits of working together, and the methodologies are developed and energised from the lower levels of the organisations involved. This has obvious advantages in

terms of balance and lack of bias, and new institutional structures can be developed which are controlled by a balance of interests.

The primary disadvantage of this approach is the lead time (and resources) necessary to develop knowledge and skills of stakeholder's representatives from the lowest levels, and to build up the effective participation from all sectors in the planning process. There is also the need to build new institutional and governance structures. However, the biggest obstacle is that if the upper administrative levels are not signed up to IWRM then the lower level stakeholders will be reluctant to adopt the process.

Whether the emphasis is on a top down or bottom up approach, it is essential to decide when, how, and why particular stakeholders are to be involved at each stage of implementation. Decisions need to be made on which groups are going to be consulted, on what and when; which groups are going to be encouraged to participate, and when. At one stage it may be beneficial for some groups to be provided with information, but not consulted. At another stage, these groups may be consulted on impact and progress. At yet another stage, these groups may be encouraged to participate in decisions to be made on implementation.

Consideration needs to be given to the establishment of cross sectoral and/or multi-stakeholder working groups. In addition communication plans need to be drawn up and implemented to involve and disseminated information to stakeholders.

4.2 River Basin Organisations

One of the elements of IWRM is that water should be managed on the basis of a hydrological unit. This might be a full river basins, an aggregate of river basins or a catchment within a river basin. From a technical perspective this makes analysis, planning development and management easier to make effective. However, seldom do administrative boundaries coincide with hydrological boundaries. In many counties, river basin organisations have been established that are intended to complement facilitate water sector development and water resources development among and between the mainstream international or local government organisations that function on the basis of administrative boundaries.

The establishment of a river basin organisation enables integrated river basin management (IRBM) to be practiced. As stated earlier, often there is a degree of confusion between IWRM and IRBM. IRBM should be seen as a subset of IWRM, and is how IWRM is practiced nationally or internationally across borders at the river basin scale.

From the paper entitled *'Developing and managing river basins: The need for adapative, multilevel, collaborative institutional arrangements'*, the following has been abstracted:

Based on "River basin development and management" by F. Molle, P. Wester and P. Hirsch, the question as to *"whether the creation of a basin organization can improve water management in a basin, and if so what kind of basin organization is appropriate, depends on the particular challenges to be addressed e.g. flooding,*

infrastructure development, conflict resolution, pollution control, power generation and trade, and the institutional arrangements already in place.

The use of the term River Basin Organisation should not be taken to mean that these organizations only deal with rivers; they should also be involved in the management of the lakes, wetlands, aquifers, and land within the hydrological boundaries of a basin. There are many different types of "RBOs" and the acronym "RBO" covers a wide range of institutions. A Basin Organisation does not have to be a monolithic organization that brings the majority of basin functions under one roof, in fact such organizations are rare. Basin Organisations can also be more loosely constituted bodies that bring together stakeholders from various agencies and water use sectors".

Basin Organisations can play a role in:

- *Instituting integrated (rather than sectoral) planning of water resources development, protection, allocation and ecosystem restoration.*
- *Decentralizing water management functions from national or state level to basin level.*
- *Negotiating the complexities of managing transboundary rivers, lakes and aquifers.*
- *Overseeing activities that have basin-wide impact---for example, constructing or operating large-scale water infrastructure for multiple uses, coordinating pollution prevention, and organizing flood protection.*
- *Promoting equitable water utilization and benefit sharing.*
- *Developing joint projects (e.g. power generation and navigation).*
- *Controlling externalities---as more and more of a basin's water is committed and interdependencies among basin water users increase, consistent basin-wide monitoring and enforcing become increasingly important.*
- *Providing a mechanism for stakeholder involvement, effective dialogue and cooperation, and for coordinating between different organizations, levels of decision-making, and sectors.*
- *Providing a platform for basin data collection and knowledge dissemination.*
- *Developing funding mechanisms.*
- *Contributing to a better socio-economic development and integration.*

"Water management is informed by a whole host of formal and informal institutions; attempting to impose a new more coherent structure---particularly a centralized structure---on this multiplicity can create conflicts with existing line agencies and loss of democratic and accountability mechanisms. It may be better to identify conditions under which existing organizations and institutions can play an effective role in addressing basin challenges, understand what can be done to strengthen them or adjust their mandates, and ensure effective coordination and negotiation

mechanisms between them. Responsibilities among various organizations at different levels (national, basin, local) must be defined clearly to avoid overlaps and increase effectiveness.

New "RBOs" or platforms may be considered competitors by existing agencies, and, if they have not been endowed with specific powers, they are likely to remain cosmetic; this has happened with some "RBOs" promoted and funded by development banks or cooperation agencies without much in-country buy-in. For example, the embryonic river basin organizations in Vietnam, to whose design not even provincial water authorities have made a significant contribution, are largely international agency driven bodies established through a centralized state. They have very limited funding and are not endowed with specific powers."

Criteria for successfully functioning Basin Organizations:

- *A well-defined mandate and the legal, political, and administrative power to carry it out. In particular it needs to be clear at what level decision-making authority is vested and mechanisms for resolving conflicting interests between levels.*
- *Adequate staffing and capacity building, especially for environmental issues, which are often new and informed by limited data availability.*
- *Strong, broad-based political and stakeholder support.*
- *Sustainable funding---BOs need to be financed, whether out of user or polluter fees or through government subsidies.*

Source of the above abstract shown in italics:
http://www.iwmi.cgiar.org/Assessment/files_new/publications/Discussion%20Paper/CA_Issue_Brief_12.pdf

Experience has shown that the above abstracted observations and conclusions can be accepted as being relevant in almost all countries. The relevance to the situation in China, both to some large river basin organisations as well as newly created smaller river basins being trialled is believed to be important to note.

4.3 Capacity Building

Capacity building is a vital aspect of IWRM. It is important to ensure that all stakeholders understand the concepts of IWRM and the way it relates to their roles and activities. Without this knowledge it is unlikely that IWRM will achieve its purpose. It cannot be over-emphasised how much effort is required to change perspectives and establish belief in the need to do things differently. This particularly applies to:

- Commitment to multi-sector co-operation and consultation;
- Incorporation of ecological considerations in approaches and decision making;
- Willingness to share information and data;

- Accepting the need to consider poverty and gender issues.

Various web-sites contain basic tutorials and information on IWRM e.g http://www.cap-net.org/

Apart from the general awareness training required to establish IWRM in the psyche of stakeholders, technical training is also required. This training needs to cover the integrated approach to water resources management where broader considerations are taken, beyond the traditional approaches.

IWRM needs excellent technical skills and organisational / administrative skills to implement successfully. This will often mean that a lot of specific training or recruitment is needed to make sure the requisite skills are available to the organisations preparing and implementing any IWRM process.

When organising capacity-building training programmes, it is important to try to have attendees from different sectors and levels at the events. The establishment of a training of trainers system should be undertaken with a trainer resource based drawn up for the numerous topics that comes under IWRM and for it, where possible, to be multi-sectoral in content.

In addition, together with the development of training programme a knowledge management system should be established with material being made available at a special web address.

IWRM establishment should not be seen as a project. Training needs to be established as a sustainable activity with an adequate annual budget. The subject is extremely broad and stakeholders are frequently changing in terms of personnel. The training process in itself should be seen as a means of creating cross-sectoral partnerships on a personal basis. It is evidenced that IWRM performs best when champions are groomed and those champions have personal relationships with champions in other sectors.

Overseas study tours can sometimes be useful in allowing IWRM champions to see how IWRM is being implemented in other countries. No two situations will be the same and there can be useful cross-fertilisation of ideas particularly in relation to problem solving between countries and situations. Similar learning experiences can be achieved with selective within-country visits on particular subjects.

For the implementation of the Water Framework Directive in the EU the planning and its implementation is being undertaken very largely without extensive training and skills development programmes. There are efforts made to familiarise staff with the new objectives and methodologies, and there is some institutional re-organisation to accommodate the new roles. Where investigations are needed that are beyond staff capabilities, consultants tend to be employed to provide the analysis and support required.

For the implementation of radically new structures and approaches, such as in South Africa, the brunt of the work falls onto the consultant community to provide the guidance and training required – and perhaps to provide the staff needed to lead the new agencies in the short term.

Where there is not an already strong consultant community then the challenge of equipping the responsible organisations with the skills needed can be a daunting one.

In the UK there have been regional centres of excellence established on various aspects of IWRM and this provides a useful alternative approach to the often 'capital city centric' system that is normally to be found. However, there has only been limited consultancy involvement, primarily related to specific detailed studies.

5 Infrastructure

5.1 Introduction

Hydraulic and associated infrastructure is a vital aspect of IWRM.

As stated in GWP Policy Brief Nr 7:

"*Taking an integrated approach to water development and management can help countries attract financing for infrastructure, get the most benefit from those investments, and ensure their sustainability. It may also reduce the need for additional infrastructure by improving water efficiency. But the popular perception of Integrated Water Resources Management (IWRM) has focused on its management aspects and overlooked its application to water resources development.*

***IWRM is an approach that considers both 'hard' (infrastructure) and 'soft' (institutional) investments together**. Neither hard nor soft is effective alone. Too great a focus on the hard investments can result in infrastructure that cannot be maintained or managed in a way that contributes optimally to economic growth and poverty alleviation. Too great a focus on soft investments can leave populations without essential services or protection from climate variability.*"

5.2 Hydraulic System Development

The development of hydraulic infrastructure is normally the first phase of the development of water resources. This generally becomes more expensive as the most accessible resources closest to various demands centres are harnessed.

Initially, in most countries, investment in hydraulic infrastructure is based on government funding. As the asset stock increases (see Section 5.4), the associated maintenance burden on the government plus the continued investment required for the increasingly expensive development cost of harnessing each new m3 of water becomes a major issue. Hence, in many developed countries as many costs as possible are being transferred to the water user either directly or through the transfer of assets and new source development to the private sector who then 'on-sells' the cost.

Many innovative systems of involvement of the private sector are now established. These generally combine various combinations of design-build-finance-own-operate-transfer-manage etc., however, they are generally more applicable to urban water supply and sewerage systems rather than main resource harnessing infrastructure e.g. dams, barrages etc or major gravity fed irrigation systems.

The latter are still predominantly financed by central or regional governments. Additionally, as the cost of development of each m^3 of water supply increases, the economic attractiveness of demand management also increases. However, there are other factors that influence this situation, see Section 6.10.

Historically, when hydraulic infrastructure was developed, inadequate 'soft' side arrangements were made such that the full potential of the 'hard' investments were not realised. The 'hard' investments have often then deteriorated and a process of rehabilitation and perhaps redesign is necessary to enable the 'soft' aspects to be fully effective. IWRM is a process whereby such 'mistakes' can be minimised when new hydraulic infrastructure systems are developed.

It is important for all stakeholders are involved in the decision making process associated with the development of water resources and hydraulic infrastructure and associated schemes. The adoption of IWRM approaches can accommodate this.

5.3 System Operation

In many countries system operation has followed the top down approach whereby the 'implementers' of hydraulic infrastructure become the 'sole operators'. It is vital that system operation is considered at the time of system design. System operation involves a broad range of stakeholders.

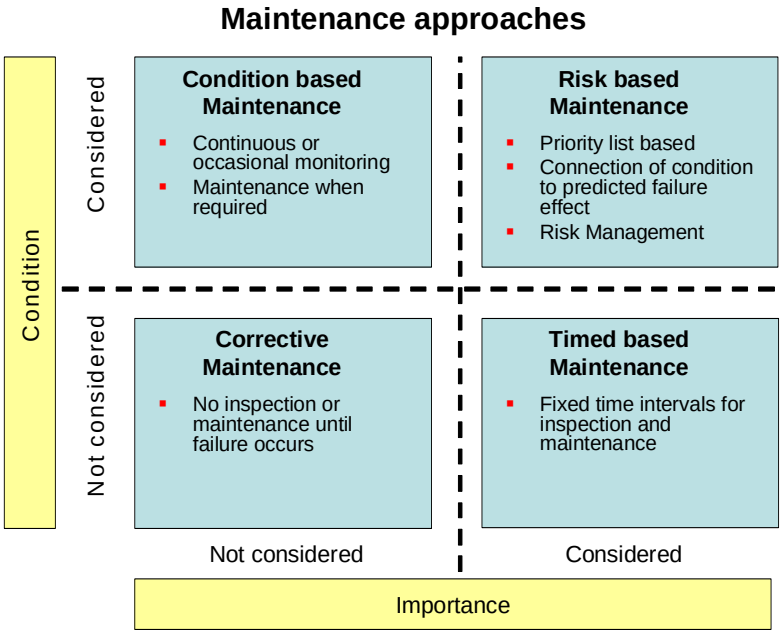
On completion of the construction of hydraulic infrastructure, 'operators', water users and other stakeholders need to be involved in decision making and in drawing up system operation rules.

During system operation water user groups need to be established that have an active role in the operation of the whole system.

System operation should be fully funded by the water users. However, the cost of system operation should be made transparent and 'value for money' needs to be demonstrated. IWRM enables this requirement.

5.4 System Maintenance

Maintenance of hydraulic infrastructure is an important aspect of service provision to water users. Without good maintenance there is a risk of poor, irregular or even total cessation of water supply. Some of the possible approaches to system maintenance are presented in the figure below.



In a traditional approach, maintenance is usually only corrective maintenance, or if the organisation responsible is operating in a reasonable manner, maintenance may be some level of 'timed-based maintenance' on top of the traditional 'corrective maintenance'. This is the situation particularly if the maintenance of hydraulic infrastructure rests with an organisation that has no accountability to the end water users and the end water user's opinions are never sought.

IWRM, if practiced correctly, should result in improved maintenance either changing to a condition based maintenance approach or a risk based maintenance programme. The involvement of the stakeholders in the maintenance decision-making process would enable both risks to be identified and prioritisation to be better practiced in the context of the impact on the water user. The co-operation of stakeholders should encourage an effective maintenance approach to be established. This leads on to the need to establish an asset management system to assist in this respect (see next Section).

The involvement of stakeholders in maintenance programmes also provides the basis for delegating some of the maintenance tasks (and associated costs) to the end water users and perhaps other stakeholders and reducing the onus on government funding and organisation. Stakeholder involvement can be in the form of:

- Reporting asset condition and potential incipient failure;
- Provision of labour for maintenance;
- Provision of materials for repairing infrastructure;
- Financial contribution towards maintenance activities.

Greater stakeholder participation in water management activities and also in contributing to the cost of water supply and are both inherent principles of IWRM.

5.5 Asset Management

'*Asset management (AM) is a multidisciplinary area that involves many activities including inspection and data collection, condition assessment, performance evaluation, prediction of future performance, planning and prioritizing maintenance and repair operations, and evaluating alternative technical and economic policies.*' (D.J. Vanier, November 2004).

An asset Management System in the water supply sector can comprise:

Infrastructure asset management

- Asset modelling (e.g. canal, trunk main performance, life assessments, plant reliabilities)
- Risk assessment (.. of failure, either temporary or permanent)
- Investment planning (risk reduction, performance increases etc)
- Strategy Development

Infrastructure operations

- Incident investigation and logging
- Operational safety and compliance
- Asset inspection
- Integrity management

Supply and Demand Management

- Leakage and/or pressure management
- Metering systems/ services
- Network planning and analysis

GIS and Modelling

- Data management
- Hydraulic modelling linked to network planning and leakage assessments etc.

Asset management information will also provide useful knowledge base for the preparation of IWRM Plans and general water resources management decision making.

Asset management strategies need to be developed and operational asset management priorities agreed and established. For each asset, asset life cycle factors need to be determined taking into account aging, early aging, repair,

refurbishment, planned replacements, emergency replacement, inspection and maintenance requirements.

Because of the importance of asset performance in relation to water supply efficiency more scientific attention should be assigned than is currently the normal situation. The involvement of stakeholders in this is again important.

6 Management Instruments

6.1 Introduction

Although the GWP Toolbox and other literature separate various highly inter-related water resources management activities into what some take to be separate items, it should be emphasised that this is intended to facilitate explanation of various elements of IWRM.

All the 'management instruments' or 'tools' outlined by GWP covered in the following sections are inter-related. In understanding each one, the other items should always be borne in mind. They are not 'tools' which can be used separately or independently – they need to be used together in a coherent programme.

IWRM Management Tools

IWRM provides the concept and framework for undertaking the above more effectively.

The topic of water (resources) demand management (WDM) is covered separately in Section 6.10 and encompasses most of the IWRM management tools. [*It is presented as a separate section owing to its importance in relation to the current*

water resources management issues in China. There is also a more detailed document, OV2, covering WDM more fully].

The IWRM tools are expanded upon below, note IWRM Planning is covered before the section on water resources assessments.

6.2 Water Resources (IWRM) Planning

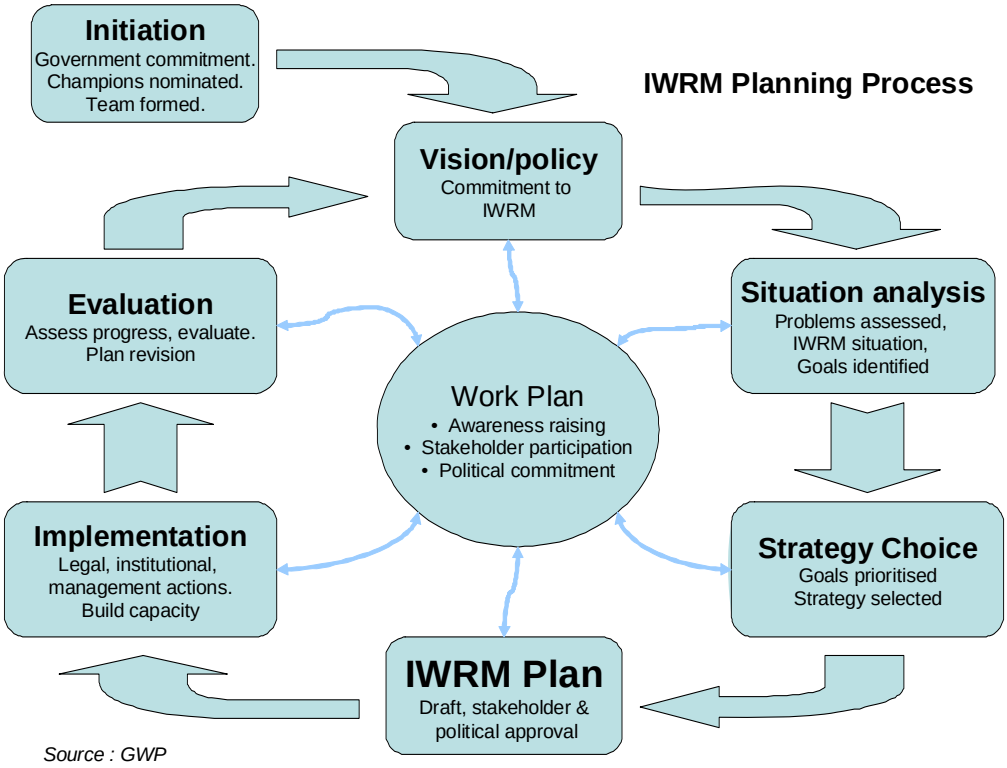
- River basin profile or characterisation
- River basin plans including:
- Assessment of environmental, social and economic aspects
- Risk assessment and management.

The IWRM planning process is a multi-staged undertaking that needs to include:

- Process initiation
- Steering committee establishment
- Planning Process management team establishment
- Stakeholder involvement plan development and implementation
- Communications plan development and implementation
- Vision Statement and Goals Articulation
- Situational Analysis and IWRM Plan Framework:
  - Being fully aware of water resources availabilities (see Section 6.3)
  - Being fully aware of the current status of water resources development and the manner in which water is being used;
  - Being fully aware of economic, social and ecological issues related to water resources development
  - Foreseeing the needs and strategic directions for water resource management. This will require multi-stakeholder workshops for consensus-building;
  - Data gathering to support situational analysis to provide the necessary scientific, socio-economic data required in IWRM plan
- River basin profile or characterisation (through stakeholder consultation)
- Strategy Formulation as shaped by the preceding steps, research, focus group and technical stakeholder inputs;
- Evaluate IWRM Plan options through scenario development and analysis etc.
- Develop IWRM Plan in co-operation with stakeholders
- IWRM Plan review, validation and ratification through stakeholder workshops and policy-level input followed by formal endorsement and adoption.

- Plan implementation, monitoring and evaluation, feedback to stakeholders and into the next round of plan development.

The basic planning process is presented in the figure below. This also shows the need to regularly update the IWRM Plan based on the monitoring and evaluation of the effectiveness of the earlier plan. (*Note the EU Water Framework Directive has a requirement for new river basin plans to be prepared every six years after the completion of the first plan (which was aimed to be prepared in 8 to 9 years*).



Source : GWP

IWRM planning needs to be more strategic than what is normally perceived as planning. The difference between strategic planning and traditional planning is summarised in the box below.

Traditional versus Strategic Planning

Traditional Planning (a " program" approach)	Strategic Planning (a "process" approach)
1. Generally based on current known problems.	1. Tends to be more anticipatory and preventive
2. Assumes continued sector/sub-sector development to meet projected needs (targets and programming)	2. Aims to be responsive to changing external environment and internal sector/sub-sector capacities (foresight)
3. Focuses on activities, predominantly those implemented by government entities	3. Focuses on goals, objectives and results, attained by government, private and cooperative entities
4. Tends to be agency-based, separate and partial (each agency prepares its own plan)	4. Aims to be comprehensive and integrated in scope (synthesis of all plans)
5. Emphasizes structural solutions	5. Aims for balanced integration of both structural and non-structural solutions
6. Tends to be compiled within agency planning departments (secretive and top-down)	6. Involves government, non-government and the general public in an open dialogue to set goals and select actions (participatory and bottom-up)
7. Tends towards fixed schedules and target-setting (rigid)	7. Represents a dynamic/recurring reiterative process (flexible)
8. Often fails to address inter-agency and inter-jurisdictional issues	8. Emphasizes communication, cooperation, coordination and feedback
9. Tends to repeat the past (repetitive)	9. Strengthens teamwork (partnerships) and provides new learning opportunities
10. Generates data and formal statistical records rather than interpreting and evaluating information	10. Requires information, monitoring, evaluation and reporting to support the reiterative process towards expected results

A brief guide on the preparation of IWRM Plans from the perspective of the Global Water Partnership (GWP) is given below.

IWRM planning at national level

Some of the key aspects that need considering in the context of the delivery of IWRM Plans at the national level include:

1) Raise awareness about IWRM and build political will and support for the process. It is not easy to embark on an IWRM transformation process. As IWRM challenges existing ways of doing things, the first step is to build awareness and understanding of the needs for change among decision-makers and practitioners. Building a broad consensus and understanding what reforms are needed and how they can be implemented is an essential part of the process. The Vision to Action process has helped to do this in many countries. Identification of a national “champion” or key senior person responsible for completing the plan and with adequate resources is an important first step in the process.

2) Ensure a framework for broad stakeholder participation. Partnerships and strong multi-stakeholder groups and forums for participation in the development of National IWRM Plans are essential, due to the cross-cutting nature of IWRM. An IWRM plan

should not be an isolated exercise of a water department. It has to involve all the important governmental and non-governmental stakeholders in the water sector. Broad participation and communication with all stakeholders is essential in the process that builds understanding and mobilises the actors.

3) Overview of on-going activities that the IWRM plan can build on. Several important elements, useful activities and documents will be in existence already and preparing a plan is very unlikely to start from scratch (zero). Among these could be Sector Reform Plans, proposals for legal reform, Water Action Plans, partnership development activities, ongoing capacity building at water institutions etc. The IWRM Plan process can greatly benefit from such related documents, activities or processes.

4) Identify and prioritise the water resources management issues and challenges to be dealt with, and establish a consensus and common understanding of these among the stakeholders. Balancing human livelihood and development needs with the sustainable use of the resources is the final aim of the process.

5) Identify Water Resources Management Functions required to deal with the priority issues. Functions could comprise, formulation of policies for international cooperation on trans-boundary waters, water allocation and wastewater discharge permits, water resources assessments, monitoring, enforcement, mediation, training and access to information.

6) Identification of management potentials and constraints at all levels, central, local and community levels based on the functions required to handle the main water resources issues.

7) Prepare strategies and plans for the IWRM framework in terms of precise actions and processes needed to improve and supplement the policies, legislation and financing – the framework of rules by which water is managed, and the institutional roles and capacities of those who manage, and the management instruments that they will use. For the delivery of water and sanitation services, set guides for balancing public/private sector involvement, amending regulatory frameworks accordingly and identify financing and tariff options.

8) Ensure adoption of the IWRM Plan at the highest political level. An IWRM plan will typically suggest an action that goes well beyond the responsibilities of a particular ministry or department, and it may propose changes to central government institutions. It is therefore essential that it be adopted at the level where inter-ministerial co-ordination takes place.

9) Initiate capacity building. Once the IWRM framework has been planned, high priority areas for capacity development within existing institutions can be identified. The process of preparing plans should itself be seen as a capacity building learning by- doing process and whilst external experts may be needed to provide support the process should be well founded within local expertise.

10) Prepare portfolio of implementation projects and a financing strategy of the plan. The planning has to be followed rapidly by implementation in order to become useful. The planned changes in institutional structures, human resource development,

improved knowledge and a capability to use the appropriate management instruments will have to be implemented together with changes flowing from water services reforms. The Plans will have budgetary and legal implications and proposal documents setting out the required changes and likely costs should be included in the plan. This should allow budget allocations/changes to be made and help in the consideration of any support required from external funding agencies and donors.

The planning process developed by the European Union for their "Water Framework Directive" (WFD), and as used for development of IWRM plans for the Rhine and the Danube, has ecological assessment of the component water bodies of the river (and groundwater) systems at its core. Although the WFD requires that all countries in the European Union undertake water resources plans, these plans are to be based on river basins. Thus although the WFD is requiring national level adherence to the WFD, practically, the work is based on local level activity and analyses. It should also be noted, that in many cases the term 'river basin' is used loosely and can relate to a number of adjacent river basins (in the true sense) that all flow into the sea.

Example – IWRM planning in Europe

The driver for IWRM planning in Europe is the improvement of the water environment (lakes, rivers and aquifers). The assessment process used within the Water Framework Directive has three main components:

1. Water quality assessment
2. Hydro-biological assessment
3. Hydro-morphological assessment

The Directive requires that the condition of all water bodies is assessed using a specific set of criteria, whereby each water body is reviewed, and put into a class to describe its quality. A River Basin Plan has then to be developed to make sure all water bodies achieve "good" status – where this is practicable. Therefore the Plan is intimately focused on the results of the assessment, and how to rectify circumstances that cause the assessment of the status of the water body to be less than "good".

The use of the assessment is basically to:

- Identify what measures are needed for inclusion in the IWRM Plan in order to achieve objectives, and
- Measure the success (or otherwise) of the Plan.

The use of assessment in the EU Water Framework Directive approach is to:

- Divide the river system into distinctive water bodies
- Assess each water body, to determine its status (good, or less than good are the two key ones) [this being the process of characterisation].
- Identify what needs to be done to change the "less than good" water bodies into "good" status

- Collate all measures needed for the full basin
- Define the appropriate Programme of Measures, how it is to be implemented and monitored.

This provides a basic example of the use of assessment. It is not imperative that the IWRM Plan be entirely driven by the assessment system in the way that the WFD river basin planning process is, but it can provide a clear, well-defined and logical route to development of a Plan to address key water management issues – and be appropriately focused on outcomes, and not individual projects or processes.

The objective of having an "assessment" system as an integral part of the process of IWRM planning is to provide a quantitative and objective way of describing what is "wrong" with the present system, and what might be practicable to be done within an IWRM Plan to put that right.

Using an assessment system would also provide a framework for judging the impact of the IWRM Plan, and a means of judging how well the programme is meeting its objectives.

Any IWRM process must have clarity in its objectives – a description of what is trying to be achieved through the IWRM process. This will be something relating to environment (good ecological quality of rivers), water quantity management (effective and efficient use of water resources, without damage to the environment, for example), meeting water demands or something similar. These can all be quantified, and therefore will need prior assessment to determine the measures needed in the IWRM Plan, and a means of measuring the success of the Plan.

The process of monitoring and evaluation of the IWRM Plan is an important activity. It should be noted that in most countries, there are numerous planning activities carried out in the water resources sector. Often the implementation of these plans is piecemeal and unstructured. However, the monitoring and evaluation of plans is seldom undertaken. All plans should be regularly audited to provide management feedback.

IWRM planning at local level

Most reported examples of IWRM relates to national level situations. IWRM can also be applied at the river basin and catchment level. However, it is best carried out on the basis of hydrologically defined areas. Undertaking any form of water resources planning on the sole basis of administrative boundaries is problematic. One of the basic concepts of IWRM is that water resources planning, and ideally management is carried out on a hydrological boundary basis.

The basic elements of IWRM at the river basin and catchment level are similar to that discussed above for the national level situation. Also, as indicated above, the water resources planning as per the WFD is required to be undertaken in relation to hydrological units.

As long as the enabling environment is in place, the application of IWRM at the local level can be very effective at improving water resources development and management.

It should also be noted that effective IWRM planning at the national level requires similar approaches to followed at the local level otherwise the national level planning will be ineffective, especially where locally intensive initiatives such as WDM are being implemented.

However, there is no reason why the IWRM concept and approach cannot be applied in some form or other to particular / specific river basins or even catchments within a country. This might be decided upon if the level of water stress is, or is expected to be severe. This might relate to water shortages, water quality issues etc. IWRM is frequently taken up where problematic or critical situations are prevalent.

In the UK, with the Environment Agency, a system has been established called Catchment Abstraction Management Strategy (CAMS). These are local level catchment planning exercises that basically follow the IWRM approach and are directed at resources assessments in the context of the management of abstraction permits. These CAMS are reviewed on the basis of a six year interval that is equal to the plan review process of the WFD for river basin planning. The CAMS are seen to sit within the river basin planning process although the CAMS are not as comprehensive in their analytical content.

IWRM monitoring

The arrangements for monitoring and evaluation of the implementation of the IWRM Plan are very important and need to be defined in the plan itself. It is recognised as good practice world-wide to keep such a plan "open" – subject to regular review and updating as circumstances change, as problems with plan implementation develop or it is found that elements of the plan are much more successful than anticipated.

In order to keep a careful eye on these matters it is important to monitor carefully key indicators of the plan implementation, and its success.

Developing a well thought out strategy for monitoring and evaluation of the plan implementation is key to an effective review process. Parameters to be monitored for this purpose need to be defined in advance, and an appropriate programme of data collection started to make sure accurate, reliable and timely data are provided to the review process.

Parameters that might be included in such a programme include:

- Implementation of individual components of the IWRM plan
- Indicators of the impact of the plan measures.

How to measure implementation of components of the plan would obviously depend on the nature of the component – for engineering measures it could be contracts let or disbursement of funds. But measures such as changes to land use to improve conservation of sediment and reduce storm runoff could be monitored through uptake of financial incentives to make these changes – and through measurement of sediment in the rivers draining areas where such land management changes have been implemented.

Once indicators of projected plan achievement have been agreed upon, it is important to establish a sound data collection system that provides the feedback to enable the indicator to be easily and unambiguously judged. These data are needed in sufficient detail, and promptly, in order to evaluate the impact of Plan activities to make sure things are on target to meet overall Plan objectives.

It is very important that monitoring systems for the Plan are considered in detail, and included in the plan itself in order that appropriate data are available to measure the impact and effectiveness of the Plan. This will require a separate "monitoring and evaluation" component of the Plan.

Plan implementation monitoring reporting should be made through an agreed programme of reporting, and made freely available to stakeholders. This would normally be as an annual report, which would summarise measures taken, measure physical progress compared to Plan targets, and report the impact of the Plan through key measures developed in the monitoring and evaluation component of the Plan.

Summary

A good IWRM Plan needs to be:

- Founded on clearly specified goals and objectives supported by a reasoned explanation for their setting
- A holistic approach to water resources development and management incorporating both structural and non-structural measures
- Balanced and integrated in relation to surface water, groundwater, quality and quantity aspects
- Undertaken on the basis of a hydrologic planning units
- Complete and transparent in dealing with social, economic and environmental considerations and analyses
- Focused on the key issues of water management in the region evaluated on the basis of a hydrological unit identified through analyses and through stakeholder consultation;
- Based on clear understanding of the causes of the key water management issues, so that the assessment helps to define the Plan components which are targeted at improving the assessment through Plan implementation
- Objective and quantifiable, with standard methods of measurement and relatively easy to measure and process to an index describing the status of the water body/region
- Easily understood by stakeholders, so they readily accept the assessment as a key index of what needs to be achieved under the Plan
- Implemented through a process that includes a high level of stakeholder consultation and participation

- Based on monitoring that is possible to maintain during the implementation of the Plan, and reasonably rapidly updated so that the assessment reflects the current condition of water management in the region
- Regularly reviewed and modified or updated in an adaptive manner

6.3 Water Resources Assessment

- Water resources knowledge base
- Water resources assessment covering water quantity, quality, groundwater and surface water holistically
- Modelling in IWRM
- Developing water management indicators

Water Resources Knowledge Base

In general, the objectives of this knowledge base are to compile information on water resources needed for planning and monitoring and for coordinating with other stakeholders. These information management needs in IWRM include to:

- Provide basic hydrological and hydrological data (rainfall and other climatic data, river flows, river levels, water qualities, groundwater levels and qualities, reservoir levels and releases etc)
- Provide information for improved understanding of the hydrological systems of the basin
- Provide information for understanding patterns of water use, and changes in natural flow systems caused by man's intervention
- To help forecast possible future patterns of river flow or water availability to guide real-time water management decisions
- To monitor the impact of external factors on water management activities
- To monitor the impact of water use and management activities on the river basin and groundwater bodies
- To provide information for stakeholders on matters of relevance to their involvement in water management processes
- To monitor the implementation of an IWRM plan (or similar), and allow informed discussion of impacts and modifications of the plan for more effective and efficient implementation in the future.

In many countries, the elements that make up a complete 'water resources knowledge base' will be held by different agencies, generally government departments. This often gives rise to issues relating to data sharing and even conflicting data sets. An important aspect of IWRM is the establishment of stakeholder co-ordination and participatory procedures to address these issues.

Water Resources Availability Assessment

Water resources assessment systems should consider water quantity, quality, surface water and groundwater holistically. All aspects are inter-related to varying degrees based on the hydrological characteristics and water use situations in an area. Any water resources assessment is reliant on the availability and quality of adequate data sets and can be improved through the use of water resources simulation modelling (see later).

Linked to any water resource assessment, a sound knowledge and data set related to climatological elements is required. This is primarily rainfall data but temperature, evaporation, relative humidity etc can also be important.

It is quite possible to have a number of quite divergent objectives for an IWRM Plan for a particular region and there will thus be a tendency to have detailed resource assessments inset within a 'whole river basin' water resources assessment.

In the European Union the main issue has of recent years been river water quality and in some places groundwater quality, and hence the assessment mechanisms are currently focused on returning the aquatic habitats to a condition that would support diverse species, and undo a lot of the damage done by worsening river water quality over many decades or industrial and other activity. In other situations it is quite likely water quantity is more of an issue, and so the assessment would have a different focus. However, the key drivers are the sustainability of water resource supplies to meet current and future demands whilst also protecting the environment and ensuring social equity.

The issue of climate change needs to be taken into account in all considerations of long term supply-demand balances and in terms of sustainability.

Water Quality Assessment

There are many systems used around the world for assessing water quality. There are only two basic approaches though:

1. To set targets based on uses for the water bodies (e.g. as fisheries, or for potable water), or

2. To set targets to return the water to "natural" conditions.

For each approach, normally there would be a wide range of physical, chemical and biological parameters that are measured (such as the temperature, pH, total dissolved solids, oxygen demand, nitrogen content, heavy metal concentrations) and compared to the upper limit values allowed for the type of water body.

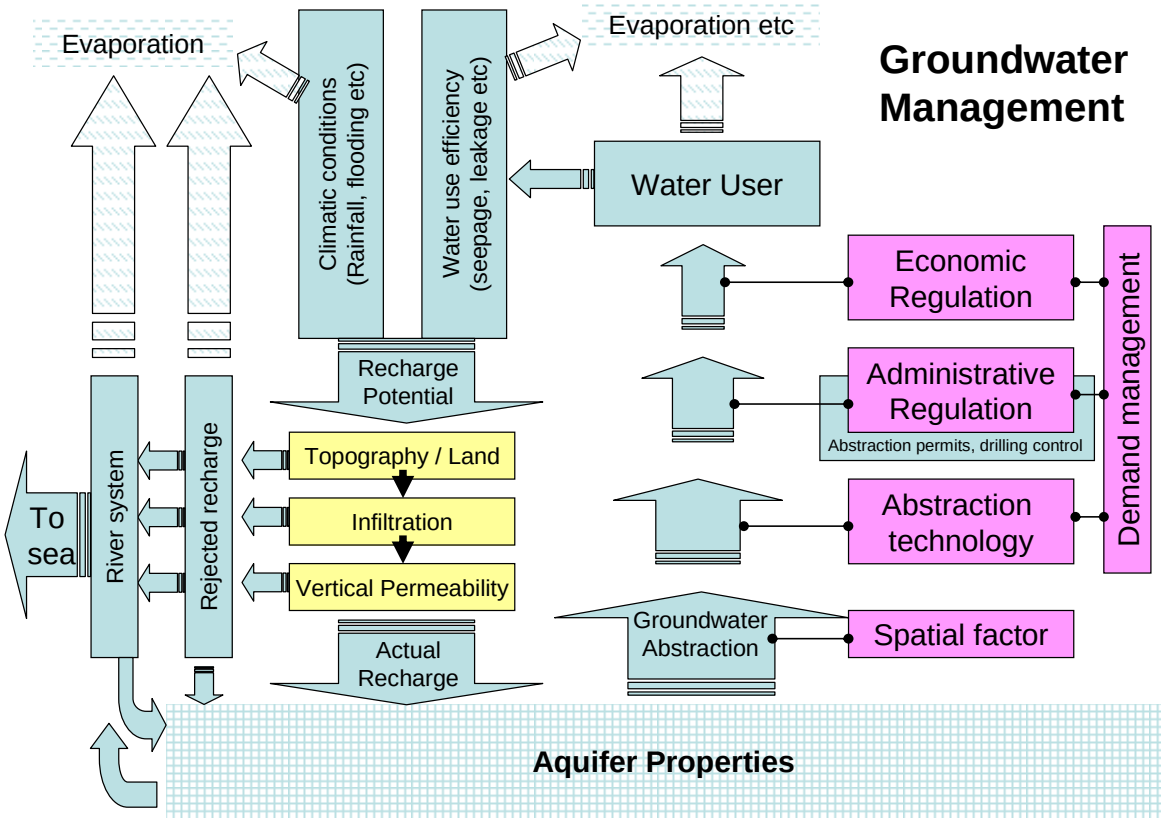
Many of the differences in assessment systems will be between the "allowable" concentrations of measured parameters, and how the various parameter based measurements are aggregated into a single, overall measure of water quality. In many countries, water quality status is now also being judged on the basis of biota counts (or the analysis of aquatic life in the river systems) (see the section on ecological assessment below).

Water Quantity Assessment

Where the quantity of flow within a river system is a key water issue, then there will need to be a system of assessment based on water quantities. A particular problem with river water quantity is the essentially variable nature of runoff, in that a lack of water in a river might be due to a particular drought event as much as excessive abstraction. In this case assessment might need a number of years of monitoring to provide an accurate assessment of the condition of the river system.

Assessment would consist of measuring stream flow at key locations in the river system, and comparing the discharge with the "environmental flow" requirement. Quantification of the "environmental flow" requirements of a water body considerably assists the water quantity assessment process. The "environmental flow" is the minimum flow within a river needed to conserve the habitat, and in perennial watercourses is typically set at about the 95% level (the flow which is exceeded some 95% of the time under natural conditions) – but it can also be set through habitat assessment or modelling to identify more specifically the problems of low flow in a river reach, and consequently identification of the water level at which there begins to be a real impact on the habitat as the river water level drops.

In relation to groundwater, the key issue is groundwater levels in relation to aquifer characteristics (See TP2.6/1). Aspects to be considered during any assessment includes the recharge characteristics, lateral groundwater movements, connectivity with the river systems and abstraction volumes.



Groundwater resource assessments require a sound knowledge of aquifer types, extent and properties to improve the reliability of any assessment.

Ecological Assessment

The assessment of the ecological status of a water body will usually involve detailed study of the biology of the water and bed sediment – sampling phytobenthos, macrophytes and macro-invertebrates for example. Comparison between observed populations and expected values will then provide an index of the health of the water body – and the index can be computed from a number of different sampling measures in order to provide a more reliable index of the health of the ecosystem. This does require:

1. Work to develop “expected” values of particular species and

2. Extensive fieldwork to take samples for analysing populations

In practice, it is recognised that while ecological sampling is the best way of determining the condition of the water body, there is generally not a lot of reliable background data or well-established techniques for interpreting data. This is a growing science, and many organisations are undertaking investigations to establish effective and efficient ecological monitoring systems.

Water uses and demand forecasting assessments

In almost all situations, water use knowledge is poorly known and has not been the focus of data collection programmes and information is not systematically stored and analysed. The larger the proportion of the available resource that is being used the more important it is to have a good understanding of water usage both spatially and temporally.

Water usage needs to be known in its widest sense and by component parts. Water is delivered from a source to an eventual water ‘consumer’. Knowledge is required of the size of water that is not consumed and what the destination of this quantity of water is estimated or measured to be. In addition the quantity of water actually consumed and also ‘lost’ from the broader water system needs to be known. Such information is often poorly known and more effort is required to rectify the situation. (See also Water Use Efficiency of Section 6.4).

Such information is essential for any water demand management programme. The better the knowledge basis the better will be the design of a WDM programme and the greater the likelihood that it will be effective. (See Section 6.10)

For all water resources planning, demand forecasting is an essential element. Demand forecasts are based on a knowledge of current water use, any planned demand management programme and predictions of changes in population, economic development and activity in the irrigated agricultural sector.

Other Assessments

There are potentially a number of other water management issues that might dominate an assessment of the management of a river basin, such as:

- Flood risk (relating to probability of occurrence related to floods of different magnitude and duration linked to hazard analyses).
- Agricultural impacts of waterlogging and/or salinisation
- Groundwater depletion or quality deterioration.

Where these are dominant problems, assessment of the condition of the catchment should be made against indicators of the current condition of one or several of these topics.

Water Resources Modelling

A water resources system comprises all features of a river basin that influence the availability and utilisation of the water resource. The water cycle in any river basin is driven by precipitation, and evapotranspiration, which are the primary inputs or drivers, and can be strongly influenced by water utilisation. The natural catchment area is characterised by its area, topography, geology, land use, soils, shape and river network.

The primary role of mathematical simulation models in water resources assessment is to assist in the evaluation of alternative resource management and development scenarios. This is achieved by simulating the effects that these management or development scenarios would have on resource availability in various parts of the basin. Typically models are used in conjunction with statistical techniques to quantify impacts, and to permit other forms of analysis such as economic analysis to be carried out. Models permit the integration of complex processes and interactions, aid understanding and provide insights to impacts that would not otherwise be possible.

Models can be used to identify issues and constraints in ways that are easily understood by a wide range of stakeholders. They should be viewed as forming part of a decision support system (DSS).

Basin water resources simulation models can also assist in identifying areas in which additional monitoring would be advantageous, and can be used to test the sensitivity of results to uncertainty in various aspects of model inputs or control assumptions. Understanding the impacts of uncertainty in model inputs on results produced clearly informs assessments of the robustness of particular management or development strategies, and helps in assessing the risks associated with these, thereby improving the entire decision making process.

Most water resources system simulation models focus on water quantity. Water quality issues are often modelled / analysed separately, although there are models that have ‘quality models’ linked to the main quantity model.

Finally, simulation modelling is often used as a tool to assist in design of water resources allocation rules and/or decision making.

6.4 Water Use Efficiency

- Improved efficiency of use
- Recycling and reuse
- Improved efficiency of water supply

Water use efficiency improvement includes any measure that reduces the amount of water used per unit of any given activity, consistent with the maintenance or enhancement of water quality. This is the main basis of water demand management. (See Section 6.10).

Water use efficiency and water conservation are allied concepts. Water conservation can be defined as any socially beneficial reduction in water use or water loss (Baumann et al. (1979)).

Water supply efficiency and water use efficiency are recognised as increasingly important in terms of sustainability. This applies to the irrigation sector as well as urban water supply and industrial sectors.

Since in most developing countries between 50% and 80% of water is diverted for irrigation purposes, water use efficiency is critical.

However, the objectives of increased efficiency in water supply and use needs to be fully developed. Some of the factors to consider being:

- Are the losses associated with the 'inefficiency' currently being re-used by other water users?
- Are the losses associated with the 'inefficiency' currently a key source of water for local ecological conditions?
- Are the quantities of water 'saved' to be used elsewhere in the same sector or another sector that has a higher water consumption rate?
- Are the quantities of water 'saved' to be part of a sustainability initiative?
- Is the investment in water saving measures being sector driven without an assessment of return on the investment?
- Are there clearly defined policies and decision making processes to ensure that investment in increased water supply and use efficiency is being properly targeted?
- Is the concept of beneficial and non-beneficial water 'losses' being followed?

Without an IWRM approach there is the likelihood that investment in increasing water supply and use efficiency is not being optimised, and is unlikely even to have the impact on water resources that is expected.

Another important factor is that in many countries there is no real information system that accounts for or enables one to determine true water losses.

In irrigation schemes there is often no knowledge of the actual losses in the system and estimates are often given of 50% or 70% overall irrigation efficiency. There is often no reason for the system managers to really 'know'. In most countries, increased irrigation efficiencies are said to be achieved through canal lining programmes.

Canal lining or pipework distribution programmes are easy to implement, involve most responsibility being assigned to contractors, whilst the intervention is popular with farmers since in addition to more water in the canal system and tail farms can be better supplied, there is a reduced maintenance burden. However, the investment might not be the most cost effective solution. More importantly, there is seldom any process of quantifying the water 'saved' and estimates are not very scientifically estimated. There is likely only be a benefit in terms of water saving of the losses were previously used by 'non-beneficial' vegetation, or drained to a saline aquifer. There may be other management benefits from canal lining, but these may no justify the high cost involved

The traditional irrigation efficiency value often does not take into account re-use within the scheme, nearby or within a basin, or possibly all three. Consequently, decisions intended to increase water use efficiency that have been based on classical efficiency calculations often do not result in real water savings. However, many planners mistakenly justify and authorise irrigation improvement projects that are designed to improve a system's classical irrigation efficiency expecting that this will generate real water savings. The savings exist mostly on paper, and the mistake is compounded when "paper" water savings become the basis for expanding the area irrigated or authorising water transfers (for example to urban or industrial users), and thus can actually the reduce the water available.

In the urban water supply sector, only in the more advanced and open water supply networks and management systems is information known about the true state of water 'losses'. How much is lost in properties and how much is lost in different parts of the supply area. Additionally, there is often the tendency for the 'supply company management' to report low system losses since to do otherwise would reflect badly on the overall management of the system.

Water saving in the urban sector however can have a firmer economic justification since the water lost has often had high delivery and treatment costs associated with it.

Water supply or water use efficiency is never static and cannot be assumed to be always increasing due to awareness programmes or even investment programmes. Potential water savings can decay over time due to equipment breakdown, lack of maintenance, or decline in behavioural compliance with conservation activities. Seldom does this seem to be the mentioned in the planning process but does need to be appreciated and accounted for.

In many irrigation schemes, the irrigation system itself may be deemed to be efficient immediately after construction whilst the farmers are inefficient in their water use. With time, farmers might improve their irrigation practices but the system infrastructure deteriorates and increased system losses take place.

Water re-use is an important aspect in the consideration of over-all water use efficiency. Sometimes water re-use is designed but in other situations water re-use is less obvious.

The use rate or re-use rate is simply the gross water use (for an individual user or an entire industry) divided by water intake. As recirculation increases, the use rate also rises, making it a good indicator of one aspect of water use efficiency.

Increasingly in developed countries water use audits are carried out. The adoption of such procedures in all situations should be considered. During the undertaking of water use audits, cost effective water saving measures for customers with high savings potential can be recommended or even stipulated as a mandatory improvement to be undertaken within a certain time frame. Owing to time variant factors, regular audits should be carried out of major water users to check both supply system and use efficiencies.

Water supply and use audits can be made a requirement of water abstraction permits, an administrative regulatory system. Apart from the undertaking of audits 'self-reporting' of water use efficiency can be made mandatory.

Measures that can be considered in the urban sector include:

- Planning and design measures
- Leakage reduction
- Optimised distribution
- Pressure management
- Metering
- Application technology (sprinklers, drip etc in irrigation sector; low use washing machines etc in urban sector)
- Efficient usage (human activity)
- Re-use and recycling
- Retrofitting
- Water auditing
- Water efficiency advice
- Education and Information
- Regulatory measures

In the irrigation sector the measures might include:

- Planning and design measures
- Canal leakage reduction
- Optimised distribution and irrigation scheduling
- Flow metering

- Application technology (sprinklers, drip irrigation etc)
- Usage condition improvement (farming activity including such practices as land levelling, plot size optimisation, mulching)
- Re-use
- Water auditing
- Education and Information
- Regulatory measures

Water supply and water use efficiency is an important aspect of water demand management, see Section 6.10.

Water use efficiency needs to be viewed from many different perspectives since economic, social and environmental factors relate. In different countries and different situations each of these factors have different influences on water saving decision making.

6.5 Administrative Regulation

- Regulations for water quality
- Regulations for water quantity
- Regulations for water services
- Land use planning controls and nature protection

Regulatory Instruments - General

A wide range of regulatory instruments are at the disposal of water authorities when setting up water management structures and procedures. These instruments fall into three main groups: direct controls, economic instruments and encouraged self regulation. In practice, authorities typically need to employ a mix of instruments to achieve effective and low-cost regulation of water use.

Types of regulatory instruments

Direct controls e.g. management rules, standards & norms for implementing legislation, permitting, water rights

Economic instruments e.g. prices, tariffs, subsidies, incentives, tradable permits, water markets, taxes

Encouraged self-regulation e.g. benchmarking, controls over false or misleading information, community management, public awareness

Until recently, the emphasis of most governments has been primarily on direct regulation in water resources management. However, economic instruments offer several advantages such as: providing incentives to change behaviour, raising

revenue to help finance necessary investments, establishing user priorities and, in many cases, achieving management objectives at the lowest possible cost. Experience worldwide has shown that a prerequisite for successful application of economic instruments is an effective system of water governance. These are all key aspects of IWRM.

Administrative regulation - Quantity

This principally covers the allocation of water resources to water users. This can range from international water sharing agreements through regional water allocations to water abstraction (withdrawal) permitting to the rotation of irrigation water supplies to farmers.

The sharing of water resources in areas where these very resources are a pre-requisite for prosperity have long been a major cause of disputes between competing parties. A major contributor to the on-going problems is a lack of clarity on what basis such sharing should be made, with contributing factors being:

- Where the water comes from
- How the water has been used in the past
- The dependence on these particular water resources

In practice, another particular problem is that upstream riparian states have a particularly powerful hand as they have first use of the water, and it is their actions in releasing water to downstream users that is to be settled through any dispute resolution procedures. With the hydrological variability of water resource availability added to this, it is also recognised that “agreements” in place and followed in years where water is plentiful become much harder to implement in times of drought, when there are much greater pressures on the upstream riparian user to take more than would be allowed under the sharing agreement.

Internationally, recent emphasis has been based on the basic principles of treating water as an economic good and of allocating it among the sectors accordingly. Issues to consider related to economic principles include marginal cost pricing, social planning, user-based allocation, and water markets. Clearly in all countries the government must play an important regulatory role, but how effectively it does so depends on the relative influence of various stakeholders and segments of society.

User-based allocation is generally more flexible than state allocation, but collective action is not equally effective everywhere; it is most likely to emerge where there is strong demand for water and a history of cooperation. The outcome of market allocation depends on the economic value of water for various uses, but moving toward tradable property rights in water may ease the process of inter-sectoral reallocation by compensating the "losers" and creating incentives for efficient water use in all sectors. Increasingly there is seen a need to adequately address the issue of environmental water allocation - fear of irreversible environmental degradation is increasingly a key concern for governments. This is a critical issue in many parts of the country.

Implicit allocation systems provide water through top-down, government-driven planning processes, in which the quantities of water for specific development projects or sectors are determined and then become accepted practice. Explicit allocation is a system of time-bound licenses or permits to specific users, whose supply is then secured for a defined quantity of water for a stated period. Current practices are a mixture of the two, however, the linkage is often not as strong and transparent as perhaps it should be.

In Section 8, various examples are presented of issues related to international and inter-provincial water sharing (or allocation) agreements. These agreements are based on historic water resources data on availabilities as well as on projected demands. It is believed that many of these could become controversial as a result of the potentially changed water resource bases owing to climate change impacts. Such changes are likely to be related to both precipitation as well as natural storage in glaciers and through runoff changes owing to changes in snowpack characteristics. These changes will need a review to any water sharing agreement whilst changed demand scenarios might also require consideration. The main examples presented relate to:

- Murray-Darling, New South Wales and South Australia
- Colorado River, USA, its States and Mexico
- Indus System, India and Pakistan
- Cauvery System, Karnataka and Tamil Nadu (India)
- The Jordan River, Syria, Israel, Jordan and Palestine

Within a country, water allocation is based on elements of water sector policy and the supporting regulation that generally also encompasses ‘water rights’.

A water rights system fundamentally involves identifying the total available resource and then assigning the rights to that resource among different groups

It is important to define ‘water rights’ in the international context. From ‘Wikipedia’:-

“Water right” in water law refers to the right of a user to use water from a water source, e.g., a river, stream, pond or source of groundwater. In areas with plentiful water and few users, such systems are generally not complicated or contentious. In other areas, especially arid areas where irrigation is practiced, such systems are often the source of conflict, both legal and physical. Some systems treat surface water and ground water in the same manner, while others use different principles for each.

There is a fundamental difference in the nature and source of water rights between land-based and use-based rights.

Land-based or riparian rights:

Riparian rights are based on land ownership, and are protected by property law. Riparian rights state that only the owner of the banks of the water source have a right to the 'undiminished, unaltered flow' of the water. Riparian rights are only transferable when the

riparian land ownership title is transferred to a new owner.

Use-based rights:

Use-based water rights are protected by the law of torts. Use-based rights state that land ownership is not essential, as long as water users have legal access to the water source. There is a hierarchy of use, where the first user has the strongest rights (first in, first served). Rights users can only enforce rights against users with lower ranks (those who came later). Use-based rights are usufructuary, fully transferable to anyone.

'Water rights' allocation should give first priority to people's basic needs for life, while other priorities may change with social and economic development and water conditions, and so be determined according to local needs. Rights allocation is based on allocation of river basin water resources, and should employ indicators for macro control of total water amounts and micro-management indicators on use in sectors and administrative units. Initialization (establishment) of water rights registration and management includes standardizing systems for regulation, circulation (transfers), adjustment, and termination of rights.

The water use management system includes standards for allocation of water rights and water amounts; improving the water allocation system among large water users and rights for public uses; guaranteeing public water use for disasters, public safety, public health, and emergencies related to health, ecology and environment; ecological water use; improving allocation systems for specific aspects of water use such as energy and adjustments during droughts and emergencies.

Some of the issues related to water rights as presented in the Water Entitlements and Trading Project (WETS) Mid Project Report (August 2007) being:-

- Security: if the rights of users are recorded and protected by law, equity issues associated with unfair water distribution can be addressed more easily. In large irrigation schemes, for example, secure claims to water would help prevent head – tail problems, where those at the head of a system take too much water, while those at the end are left with little or none at all.
- Transparency: the transparent allocation of clearly defined rights provides users with greater confidence that rules are being followed by others, and provides service providers with greater clarity (and accountability to users) about their obligations and duties.
- Water efficiency and farm productivity: farmers are more likely to invest in improved land and water management if they have secure title to water (and land). While land in China is not privately owned, leases are long and land distribution is generally equitable.
- Livelihood diversification: farmers are also better able to exploit employment opportunities in the wider rural and/or urban economies if rights are secure, and enforcement improves reliability. Livelihood diversification is particularly important for poorer farmers because it helps spread risk and reduce vulnerability.

- Building blocks for other reforms: clearly specified rights provide the foundation for other reforms – both regulatory and market based. In addition, the establishment of formal water rights can give rise to strong pressure for improving the data and monitoring systems needed for management.

Abstraction Permits

Water rights are defined in the water abstraction permits or licences. Water abstraction licences are, internationally, also referred to as water withdrawal permits in some countries.

A summary of an abstraction permit system is given by FAO (Rome):

Water abstraction licensing - basics

A workable water abstraction licensing scheme is one in which users are able to comply with its provisions and the water authority is able to administer and enforce it efficiently and effectively. Such a scheme aims to formalize users' water rights in an environment where there are concerns about scarcity, pollution, or competing uses, or where other doubts have arisen because water abstraction is unregulated. In such a system, water can be allocated among diverse users and diverse water use sectors in accordance with the government's priorities and plans.

Licensing of water abstraction is intended to assure the availability of a sufficient quantity of water of a satisfactory quality for the maximum number of diverse users, and at the same time to protect the environment and provide for future needs. Once the scheme is implemented, the users have a degree of certainty – subject only to river flow – that they will have access to water for their needs, which maximizes the potential benefit of water in a particular region or country.

Under a water abstraction licensing scheme, each actor has his/her/its particular role. The users apply for licences, use water, discharge waste water (where applicable), and pay fees. The water authority evaluates applications, issues or denies licences, keeps records (including a register of licences), monitors the operation of the scheme, finds, investigates, and punishes miscreants, and resolves appeals (although in some cases, another organ – such as a specially constituted appeal board – is assigned this last task).

A summary of the basic system in England and Wales is summarised in the box below. This is not untypical of other international situations.

England and Wales Abstraction Permits

If you want to remove or abstract water from a surface source (e.g. river, stream or canal) or from an underground source and take more than 20 cubic metres a day, you will almost certainly need an abstraction licence.

An abstraction licence gives you a right to take a certain quantity of water from a source of supply (inland water such as rivers or streams or an underground source).

It also guarantees that no one else who applies for an abstraction licence can take the share of water that is already allocated to you. An abstraction licence does not guarantee the

quality of the water or that the amount authorised for abstraction will always be available. The quality and quantity will often depend on the weather, climate and other factors outside the control of the licence issuer.

An abstraction licence will specify where you can take the water from (the source), the quantities that you can take, and what you can use the water for. It will also have conditions to protect other water users and the water environment.

Abstraction licences are issued for a time-limited period, normally 12 years. These licences carry a presumption of renewal; however, you will need to re-apply for your licence and satisfy us that you still need the water and that you have been using it efficiently. In addition, we will consider what impact the abstraction has on the environment.

…. Also….

If you wish to abstract water from an underground source, such as a well or borehole, you will usually require a groundwater investigation consent to construct and then carry out a pumping test before you can apply for an abstraction licence. This will help us to tell whether the water you want is available and, by monitoring the surrounding sources and groundwater dependent features, it will help us to assess the impact on other water users and the environment. You will need to provide an analysis of the pumping test results with your application. The groundwater investigation process alone may take several months.

Abstraction permit licensing is clearly linked to water allocation and water resources planning and is associated with demand management practices. Consequently, an important factor is acquiring the knowledge of the amount of water being abstracted, when it is being abstracted, what is it being used for and what is being returned to the environment (or elsewhere) and in what quality condition.

Water Use Data related to Abstraction Permits

Data Collection:

In many advanced systems, responsibility for the compilation of water management data lies with the water user, and the data are then submitted to the supervising water management agency to hold. The water management agency would normally also carry out independent checks on the information provided, with the authority to penalise if inaccurate information is provided. This is by far the most cost-effective system, and can be implemented as part of the conditions attached to the permit for water use, or effluent discharge.

Data Analysis:

Data analysis will be needed as part of the administration of the permit system, to make sure licence conditions are met, and the appropriate fees collected for use of the water, or as penalty for breach of permit conditions.

There should also be data summaries prepared to summarise water use and similar factors, and also so appropriate data is fed into the hydrological databases and information processing systems to improve understanding of the river and groundwater hydrology.

Data Reporting:

Data reporting will often be restricted as data from individual permit holders may be commercially sensitive. As a result, it would be normal procedure to hold individual data in a confidential storage system, but deliver processed statistical data to reporting systems similar to those used for dissemination of hydrological information.

Effluent Discharge Permits

The link between water quality and its suitability for use has often been ignored in water management but increasingly instances are reported of water sources becoming contaminated and unsuitable for use without extensive treatment. This has properly brought water quality to the attention of water managers as an important factor.

The most common method of limiting or controlling pollution entry to the environment is through effluent discharge control enforced by an effluent permitting or licensing system.

Most effluent discharge permits are based on 'end-of-pipe' effluent standards and measurements.

An effluent discharge permit may be directed at the act of discharging waste into a water medium or the execution of activities or processes which result in the act of discharging waste. In both approaches the emphasis is on preventing water pollution by minimizing the polluting potential of waste releases into a receiving water medium.

A permit requirement in respect of the undertaking of a potentially polluting activity or process, however, reflects a more radical preventative approach to water pollution control insofar as it may result in a proposed activity or process from ever moving past the feasibility stage.

While the philosophy of approach differs substantially, the mechanics of implementation of the two approaches to an effluent discharge permit mechanism are essentially the same.

The initial focus in any discharge permit programme is the setting and achievement of national effluent limitations or standards (pollutant concentrations and/or loadings) appropriate for the types of discharges and enterprises.

The granting - or refusal - by the government of a waste discharge permit is the resultant of a process which is structured in legislation as a sequence of steps. The enforcement of this process, the associated standards and the adherence to the conditions of a permit are all vital if the environment is to be protected.

Technology based limits for municipal wastewater treatment facilities are normally defined as a minimum of secondary treatment level.

For industrial sources, national effluent guidelines are normally developed based on the demonstrated performance of a reasonable level of treatment that is within the economic means of specific categories of industrial facilities.

Where national effluent guidelines are not developed, a performance-based approach is normally applied to a specific industrial facility based on the permit issuer's best professional judgment.

Some of the reasons for having control on the quality of effluent discharged into a drainage system include:

- Prevention of adverse effects on the collection system
- Protection of personnel working in the collection and treatment systems;
- Preventing adverse effects on treatment processes;
- Preventing interference with the disposal or beneficial use of residuals; and, often the most important reason…..
- Preventing adverse effects on receiving bodies of water. (Water quality goals for a water body are defined by water quality standards).

Water quality waste-load allocations are the basis of the surface waters quality management practices. These are similar to the Chinese system of allocating chemical oxygen demand (COD) within a river system.

There can be many flaws in an effluent permit management system if not applied rigorously, thoroughly and without proper legislation. One major issue is the consideration of the total pollutant load in a system and its analysis in relation to the assimilative capacity of the receiving body of water. There is a tendency for pollutant control to be solely focussed on managing end of pipe discharges without due consideration of the serious potential impacts of total loads.

This situation often arises where institutional responsibilities are restricted to specific roles wherein the 'end-of-pipe' is the limit of responsibility of an organisation.

Another approach to water pollution prevention and control is through to allow in the water abstraction (or utilisation) permit process the concern for the polluting impact of "return flows" - on the water body into which the effluent is discharged, and well drilling, on the quality of groundwater. However, this 'integrated permitting approach' can only be considered if the same organisation issues the water abstraction permits and the effluent discharge permits. In some situations, an integrated pollution control permit is employed.

Monitoring of effluent discharges is required. In many countries, this responsibility is assigned to the entity responsible for the discharge. The manner of monitoring is normally specified in the effluent discharge permit and the information is communicated to the permitting authority. The permitting authority can carry out audits as and when considered desirable.

Supply Company Regulation

Direct control is achieved by government bodies or independent regulatory agencies establishing laws, rules or standards which water and land users and water service providers are required to follow. This is often known as command and control regulation.

A variety of regulatory approaches can be used across the range of operating models. In some cases, “autonomous” regulators try to control publicly owned providers as if they were privately owned. In other cases, mayors or ministers approve prices through informal, non-transparent processes.

Direct regulation can only be effective if the agency involved has enforcement capacity and the regulations are regarded by the regulated and the general public as necessary and appropriate. Over-stringent regulations which impose high costs on the regulated utility can lead to non-compliance or evasion, so undermining the whole regulatory endeavour.

Typical rules and standards used as direct control in the water supply sector include regulations for:

- Water quality – standards to ensure public health and prevent spread of water borne diseases
- Water quantity – minimum standards of availability and pressure of supply
- Service levels – hours of supply, planned and unplanned interruptions

In addition, performance targets may be set to encourage and reward improved efficiency and service delivery.

Self-regulation

Self regulation is closely associated with ensuring that the utility provider adopts best practice management throughout the company. Best practice management includes aspects such as:

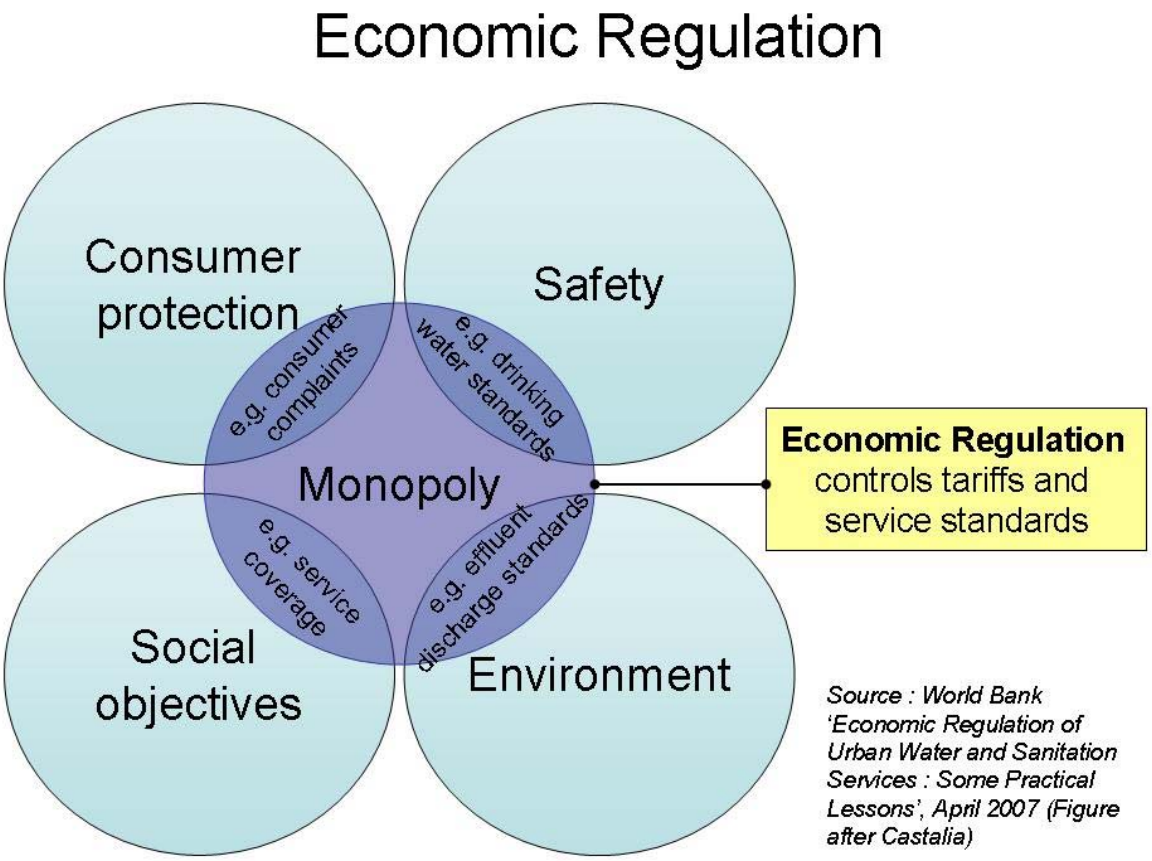
- A robust management information system integrating business processes and information across the entire business chain (suppliers, internal departments, customers, etc.) so that information is reliable and readily available to support management in decision making
- Benchmarking activities or outcomes against peer group service providers to highlight areas of poor performance
- Customer focused service delivery to ensure that the utility is geared to meet the needs of customers rather than the workforce - often expressed through a Customer Charter or Code of Practice
- Twinning or partnering with a successful water provider for exchanging experiences

6.6 Economic Regulation

- Pricing of water and water services
- Pollution charges
- Water markets and tradeable permits
- Subsidies and incentives

Economic regulation is required in relation to water service providers but also in relation to any aspect of water use that attracts a charge.

Economic regulation also addresses the problems posed by natural monopolies by compelling service providers to keep costs down, charge fair prices, and provide good service. An effective system also designates an entity to implement and enforce the regulations. Together, these functions remain limited in scope. To complement and reinforce economic regulation, a supportive policy environment and good governance of service providers are required.



In terms of a definition for 'economic regulation' reference is made to World Bank report 'Economic Regulation of Urban Water Supply and Sanitation Services', 2007. In most situations, water sector economic regulation is seen in the context of such situations.

Economic regulation is best thought of as the legal controls placed on water and sanitation providers in order to overcome the problems inherent in an essential, monopoly service. This points to a core definition of economic regulation as …the rules and organizations that set, change, monitor, and enforce allowed tariffs and allowed service standards for water providers.

Water is an essential service, and is generally worth a lot more to people than it costs to supply.

Private providers could take advantage of this by overcharging and making high profits at the expense of consumers. In some cases, this opportunity for profiteering may be limited by competition. In the case of large-scale piped provision, however, competition is not feasible.

Economic regulation can usefully be thought of as mimicking the pressures that competition provides in other markets. In other words, it can help to stop tariffs from increasing above the level required to recover reasonable costs and make the service provider bear costs that are considered excessive.

Based on the World Bank Water P-Notes, Issue 6 of June 2008, a good regulatory system should be (a) coherent; (b) predictable and credible; and (c) legitimate, transparent, and accountable.

- Coherent. Regulatory decisions must be consistent with each other and with underlying assumptions. For example, when higher service standards require higher costs that must be covered by higher tariffs, a coherent system ensures that customers receive the value promised and that providers recover costs.
- Predictable and credible. When regulations are clear, predictable, and visibly enforced, providers are more willing to invest to improve and expand WSS services.
- Legitimate, transparent, and accountable. Regulatory processes and regulations must be understood and accepted by consumers. Lack of transparency leads the public to question the legitimacy of both regulations and regulators, and to feel that their interests are not being protected. Such situations can become volatile.

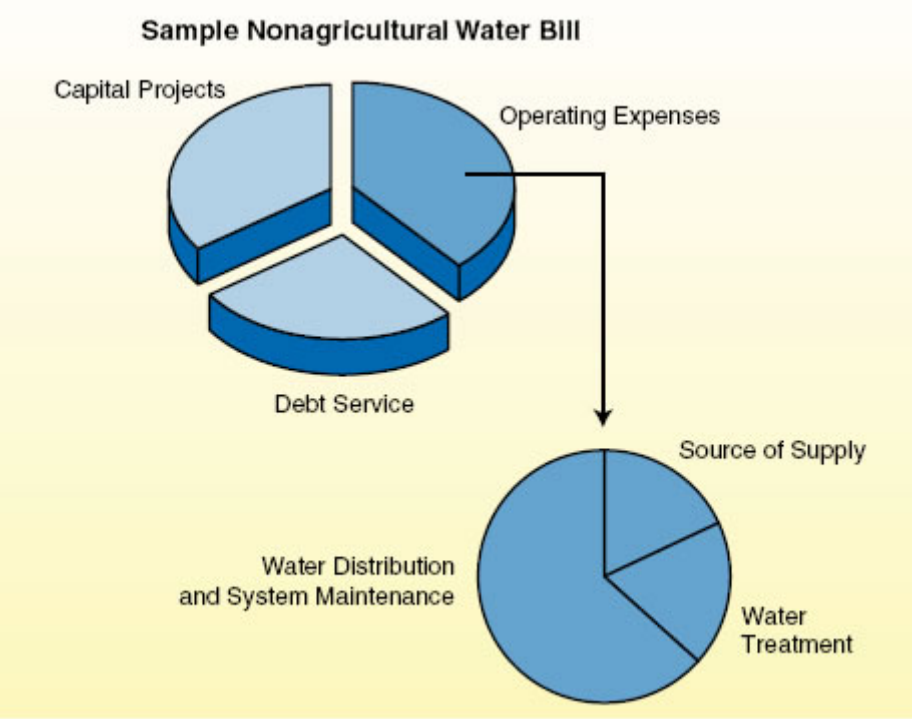
Charges related to the use of water resources can be evidenced in:

- Water abstraction licensing and associated charges;
- Effluent discharge licensing and associated charges;
- Penalties or fines for infringement of water abstraction or effluent discharge licenses;

And in relation to service providers:

- Charges for supply of water by a service provider for example by an urban water supply company or an irrigation scheme authority;
- Charges for the acceptance and handling of wastewater by a sewerage company (normally a water supply and sewerage company);

The charges that a water service provider applies are based on a number of different cost streams that relate to the provision of the service. Typical costs are summarised in the diagram below in relation to a water supply and sanitation service provider.



However, a service provider might also set prices in order to reduce demand. A regulator needs to review this with a different perspective. However, any additional charges must be shown to have a benefit to customers.

In relation to the use of pricing in demand management, a number of studies provide general evidence that price elasticity of demand is sufficiently high in many developed countries to make the topic of water pricing an important one from an efficiency standpoint, i.e. that raising price from current low levels to one based upon marginal cost will in fact result in substantial net savings. A World Bank/Overseas Development Institute study reports that in a number of developed countries - Canada, United States, Australia and Great Britain - empirical analysis has shown that the price elasticity of demand for water by households is between -0.3 and -0.7, (i.e. a doubling of the price of water would reduce consumption by between 30 and 70 percent). A similar range of elasticities is reported from studies of a number of developing countries in Asia and Latin America. There is also much empirical evidence about the potential substitution of capital for water in industry. For example, substantial increases in industrial water prices in Japan in the mid 1970's stimulated major investments in recycling, and sharp reductions in consumptive water use.

However, the studies invariably relate to the urban water supply sector where costs per unit of water consumed is high and normally well measured.

In relation to tariffs in the urban water sector the following are the basic principles that can be followed:

Common tariff types and structures

Non-volumetric tariffs. These are tariffs which do not require actual usage to be assessed. Such structures are appropriate where it is not practical or not cost effective to assess usage levels (e.g. because of the costs of installing meters and collecting usage information relative to the value of that information). Common examples of non-volumetric tariffs are flat fees per resident, or per household (for example for community latrines), or per sewerage connection, or fees based on the diameter of the household water connection, or irrigation fees per area of irrigated land, or per volume of crop grown.

Volumetric tariffs. Here, actual volume is required to be measured. Common examples include flat rate, rising block and seasonal tariffs. These are presented in simple terms below:

(i) 'Flat rate' or 'linear'. This is the simplest form of volumetric tariff. As the name suggests, a single rate is charged per unit of usage (e.g. per cubic meter of water used). This structure has the advantages of being easily understandable, generally perceived to be fair, and is simple to administer.

(ii) Rising block tariffs. This is where there are increasing tariffs per unit of water for higher levels of consumption. Rising block structures can be used to signal the true cost of water to customers using large volumes of water, while allowing subsidised prices for "essential use".

(iii) Seasonal tariffs are tariffs which change depending on the time of year. They are appropriate where the demand/supply balance differs significantly by season.

In the irrigation sector, pricing water to achieve a reduction in consumption is not possible since the basic cost of water supplied is very low and socio-politically very difficult to increase by the factor of 10 that may be required to have an effect in most developing countries. Additionally, there is often no accurate volumetric measurement method which would be demanded if charges impacted more severely. Management systems and infrastructure on large-scale irrigation are usually too rigid to allow farmers to take less water, so they would not be able use less even if very large increases in price were introduced.

In the irrigation sector the various charging systems are generally not as sophisticated and can be:

- Charge per unit of water delivered to a farmer / field (by month, season or year);
- A charge per unit of time that the farmer receives an irrigation supply (often this is seen as a proxy to a 'volume' delivered);
- A charge based o n the area of land being irrigated;
- A charge based on the both the area of land cultivated and the type of crop grown.

Effluent Discharge Charges

A charging mechanism can complement a system of effluent discharge permits allowing the discharge waste into water bodies or on or under the ground. Charges - or "fees" – in this context are conceptually and practically distinct from the fees payable upon the filing of an application for a permit. These are paid once only, and their rationale is to cover, at least nominally, the administrative costs of processing applications.

Charges on the other hand are payable at regular intervals so long as a permit is in force, and they can be - but are not necessarily - calculated so as to reflect the basic characteristics of the waste which is discharged, and hence internalise to some extent the external effects generated by the discharge.

Flat charges payable at regular intervals are also sometimes used in view of the greater ease of administration required, and can be then be differentiated by the categories of waste.

Charging can also be practised independently of a system of waste discharge permits, as an alternative approach to achieving pollution control goals essentially through a financial mechanism.

Most charging systems relate to the quantity and quality of the effluent being discharged.

Subsidies and Incentives

Where the charges for water and/or water services are continually increasing, there are often a greater number of people who are unable to meet the rising charges. This often creates concern within government organisations. Some of the basic options for addressing the issue are:

- Keep basically to the old price structure and to continue offering low prices for some services but cross subsidise internally from other water users who are being charged higher tariffs.
- Funding price subsidies from general tax revenue rather than from transfers within the firm or industry.
- Relying on social safety nets rather than price subsidies.

Whichever option a government chooses should stand up against the following four tests:

- Do subsidies reach the people the government most wants to support?
- Are the costs clear and measurable?
- Are the administrative costs as low as possible?
- Is the revenue raised from the source that entails the least cost to the economy?

In many countries, governments often regulate not only the overall level of prices charged by service organisations but also the relationship between prices for different services or customers. Thus cross subsidies can be far reaching and complex.

6.7 Social Change and Water Aware Society

- Education curricula on water management
- Training of professionals
- Training of trainers
- Communication with stakeholders
- Water campaigns and awareness raising
- Broadening participation in water resources management

An increased awareness of water resources issues is believed to be necessary for all, particularly as resources become constrained and water qualities an evident problem. As this situation worsens it is generally the poor and disadvantaged who are most severely affected since they can neither move away from the problem not use money to solve the problem.

"*The core message is Integrated Water Resource Management – that is, integration across sectors, applications, groups in society, and time.*"

"*. . . conflicting and competing demands between different user groups for water must be resolved and this resolution may be painful (involving losses for some, gains for others), and difficult*"

Poor or marginal communities risk losing out to larger, more focused, and better organised competitors (major or commercial agriculture, industry, etc.) in water user forums. IWRM policies can have adverse effects on particular groups (for example, through increases in water prices, reductions in irrigation supplies and coverage, cultivation of crops no longer viable), for whom mitigation measures will need to be devised. It is important to ensure that communities – and the individuals and households who make them up – become winners rather than losers in IWRM. This will entail focusing on the community and intermediate level; strengthening communities' skills in decision making and negotiation – while at the same time helping local level support agencies to provide the necessary backup.

It is relatively easy to protect universal rights to basic supplies for domestic consumption; in many countries it is much more difficult and often impossible to protect rights to water for irrigation (which are essential for rural livelihoods). Adequate and appropriate funded compensation or other support may be needed to offset the loss of livelihoods, and enable rural households to adapt to their changed access to water.

Approaches to address these issues:

- Extend water management to community level (establishment an enhancement of the roles of water user associations (WUAs);
- Identify the role of water in all aspects of livelihoods and develop supply packages tailored to genuine needs;
- Work on gender and equity mainstreaming, focusing on the needs of poor and vulnerable groups. IWRM can assist in alleviating poverty not only through its addressing equity issues and community management, but also for example by its assessing demand levels and poverty-water conditions, and by its reducing pollution affecting poor households.
- Appropriate compensation for cancellation of unsustainable de facto rights (from general government funds), and compensation where water is transferred to higher value users (from resource fees collected, through water markets, or – failing those options - from general government funds)

Once designed, IWRM policies, implemented in rural or urban areas, are devised to meet the needs of particular communities. These may be communities whose water is regulated by water user associations, associations set up to meet the needs of urban residents, village associations, retail user groups, or civil society organisations.

For successful implementation of IWRM, it is essential to work with these organisations, ensuring that their representatives are involved in the design, implementation and monitoring of activities, and that their members participate in project decisions affecting their daily lives.

In order to achieve the required outreach and impact, extensive training programmes are required to build awareness and knowledge in the local communities. A system of training of trainers needs to be established to support the process.

Effective and Efficient Management

One of the key objectives of stakeholder involvement in the integrated water resources management process is to improve the efficiency and effectiveness of the water management procedures adopted. The interest, skills and resources of stakeholders is the target: if these can be used effectively, and used to develop a synergy with the work of the main water management agency leading the water resources management planning, then the work becomes much more effective, and duplication of activities is reduced or removed, and less resources are wasted through competing and conflicting plans and management actions. (This is reflected in the potential of improved water quality management through improved co-operation between WABs and EPBs, but can apply to many areas where improved co-operation and collaboration would bring benefits to all).

Examples of how these efficiency gains can be made include:

- The development of a permitting system that integrates requests for abstraction permits and for discharge permits, so that the impact of either can be assessed on flows and water quality downstream
- Working with farmers to improve land use practices to reduce runoff rates following storm rainfall will reduce soil loss from fields, improve soil moisture

retention (thus reducing irrigation water requirements) reduce the need for fertilisers as well as reducing work in removing sediment from river channels and reservoirs.

IWRM and living conditions

Living conditions are strongly affected by water conditions. For example, when:

- Households are threatened by drought or floods
- Households depend on the cultivation of food or natural products whose water resources are unreliable
- Land used for cultivation is subject to erosion or degradation
- People live far away from supplies of safe water
- Households have to spend a high percentage of their income on water
- Water supplies are contaminated
- There are high levels of water-borne disease

Because IWRM is based on a systematic assessment of demand levels in relation to available water resources, it can enable an assessment to be made of water-related living conditions in a particular river basin.

Assessing living conditions in relation to water use improves our understanding, which can help us in:

- Addressing equity issues –promoting as fairly as possible the distribution of water in relation to the needs of different groups of water users
- Creating frameworks for reducing conflicts over water supply and use
- Reducing pollution levels affecting social conditions
- Protecting shallow well owners or poorer households through enforcement of permit conditions for larger abstractors

In all these areas, social change can result in changes in living conditions to improve people's living standards.

IWRM can bring additional benefits:

- Since it is based on demand-led approaches, it enables people to state what their water needs are. These needs can then be incorporated in water policies
- Because it requires community management of water, this means that water issues can be addressed quickly and efficiently

In order to increase awareness, water related publicity campaigns need to be a continuous feature of IWRM Plans and activities. This needs to cover all aspects of water from water saving to water quality, pollution and health issues.

These programmes and campaigns can be taken into schools and introduced into the standard curricula.

6.8 Conflict Resolution

- Conflict management
- Shared vision planning
- Consensus building

The wide range of issues that are brought together through the process of IWRM have a number of inherent conflicts – for example:

- Competition for water from different countries or regions;
- Competition for water from different users, such as agriculture and industry;
- Competition between adjacent water users where it is the same or associated source;
- Needs to use water bodies for effluent disposal, and the pressures from conservation interests to preserve habitats and bio-diversity;
- Water charges, who pays, how much and who uses the income?

With a process built on consensus, there is a very great need to establish a system of equitable handling of such disputes, with transparency in resolving conflicts and mechanisms to arbitrate to reach a compromise that can be accepted by all. Such dispute resolution systems need to be explicitly built into IWRM agreements, and clearly accepted by all parties. There is probably a need to have a series of levels to the dispute resolution process – from bilateral negotiation mediated by technical experts from within the management agency through to appeals processes to finally binding arbitration.

In many countries traditional dispute resolution has not been satisfactory in either government or public arenas, particularly where natural resources and business practices are involved. A wide range of mechanisms have evolved to avoid “going to court”, globally consider that last resort by most all parties on either side of a contentious issue. They range from consultation to negotiation to mediation to arbitration, with many variables to facilitate reaching a common understanding and amicable resolution. These mechanisms are often referred to as alternative dispute resolution (ADR) options. In many countries legislation at national and state/provincial levels has been enacted to provide parties and even courts with more favourable means to resolve the dispute.

For the case studies cited in Section 8 of this paper, there have been instances where dispute resolution procedures were needed.

For the Indus dispute between India and Pakistan, the Agreement (which was mediated by the World Bank) had a dispute resolution mechanism specified, which has been followed recently to resolve the arguments over a hydropower system India has installed on one of the tributaries to be used by Pakistan. The process specified

in the Agreement involved the two parties agreeing to adjudication by an agreed independent specialist, provided through the offices of the World Bank.

For the Cauvery dispute in India, adjudication was provided by Central Government – a tribunal which has eventually reported, but after 16 years all parties have appealed against the decision to the High Court.

For the Jordan River dispute, there is little hope of a solution except through a much wider political settlement.

For the Murray-Darling basin, disputes have been largely resolved through the appropriate management of the Central Government (federal) bodies, leading dispute resolution negotiations between the States. The federal Murray-Darling Basin Authority, established in 2008, has responsibility for developing a Basin Plan containing specified sustainable limits on abstractions across the basin. Once issued the conditions in the Basin Plan will be legally enforceable.

The Indus Basin agreement shows what can be accomplished if there are formal dispute resolution procedures embedded in the formal water-sharing agreements. It is also very important to identify a high-level adjudicating body that will be perceived as impartial to oversee the process, and where necessary, persuade the disputants that the mediated agreement is the best solution for all parties. However, there will always be some parties that disagree with an 'agreement'.

The issue of the impact of climate change is likely to require the review of many water sharing 'agreements'.

At the local level, disputes and conflict can exist with regard to access to or provision of water. Means of resolving disputes and conflicts need to be established by local organisations and for an agreed forum for dispute resolution put in place and be accessible by all.

In the irrigation sector, water user associations are being increasingly established and should play a role at local level dispute resolution. In some countries, WUA Federations have been established that even larger or broader disputes to be addressed. In many countries, the administrative and consultative procedures between WUAs, WUA federations with government agencies responsible for water delivery also need to be agreed upon in the context of dispute resolution.

Similar establishment can be established in urban water supply areas where water user groups or customer representative organisations can be formed to enable discussion and dispute resolution to be better effected with a water supply company (WSC). Such an organisation might also be consulted by a water sector regulator in the execution of it's regulatory role.

6.9 Information Exchange

- Information management systems
- Data sharing - national and international

The collection, processing and dissemination of information concerning the hydrology, water management and the impact of water management actions in relation to people, the environment and local economies is fundamental to good IWRM. Many practices relating to information management around the world are firmly fixed in procedures developed before the widespread advent of computers and communication between computers through the World Wide Web. Consequently, the approach to information management for IWRM has required fundamental re-evaluation, and the strengths of new systems for management of information can be used to great advantage in the achievement of the aims of IWRM.

Sharing water resources data is considered by many to be an indispensable component of effective, broad water resources management. However, it is recognised that in many countries to implement the sharing of data which covers such a large quantity and broad variety of data is a difficult task because of the technical complexity and, more critically, non-technical factors, such as data policy, standards, and sharing circumstances.

In many of the old systems access to data was problematic, for example access to basic hydrological and other related information was tightly restricted. Some reasons for this in different part of the world have been:

- National security. Some items of information were believed to be vital for national interests, and therefore a culture built up of strongly limiting access to basic data.
- Data integrity. In processing hydrological information there are a number of quality assurance checks needed to make sure of information consistency and that it is representative, and there were delays in finishing all such tests, leading to reluctance to release information that had not been thoroughly tested.
- Value and cost. The data are expensive to assemble, and potentially of high commercial value, and hence in some cases access was restricted to make sure appropriate payments were made for the information.

The sharing of information about water management between stakeholders in the overall IWRM process is widely understood to represent best practice. This is because:

- Sharing of information builds confidence in partners, and improves cooperation between partners
- It encourages openness, transparency and the confidence that IWRM is in the best interest of all parties
- It improves efficiency and effectiveness of the work of individual stakeholders as they have access to the “full picture” and are not hampered by a lack of detailed understanding of other elements of IWRM outside their own main sphere of interest

It is notable that most analyses of water management systems promote data-sharing strongly. The Aarhus Convention (the UNECE Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental

Matters) has been signed by 40 (primarily European and Central Asian) countries and the European Community and ratified by 41 countries. This convention grants the public rights regarding access to information, public participation and access to justice, in governmental decision-making processes on matters concerning the local, national and transboundary environment. It focuses on interactions between the public and public authorities. The World Bank and Asian Development Bank strongly promote data sharing in matters relating to environmental monitoring – the European Union requires it.

These days, most effective data sharing systems are web-based. These can offer free access to information, or have access to information restricted to "registered" users, or those who make necessary payments for information. All these are relatively easily set up and once established dissemination of information is very effective and prompt.

Some of the water management related data that could be shared by a web based system includes:

- Climatological and hydrological data
- Information on the operation of water management systems, including reservoirs, diversions, groundwater abstraction systems
- Information on permits for abstractions (both surface water and groundwater), including precise location, quantities allowed to be abstracted, conditions applied to the abstraction licence, the purpose of the abstraction, etc
- Information on actual amounts abstracted under each abstraction permit (including when abstractions made)
- Information on discharge permits into water bodies, including precise location, nature of discharge, conditions applied to discharge permit, purpose of discharge, etc
- Information on actual discharges made under each permit, including nature of contaminants, quantities, and impact on the receiving waters

While much of this information is administrative, it is also important that it is added to hydrological information as it can impact on the understanding of the hydrological data, and its interpretation in terms of the underlying hydrological systems.

Access to basic hydrological information and reports is freely available through the web in the United States, since tax-payers have already made payment for all services of data collection. This has made stakeholders much better informed, and produced very positive results.

Example USGS : Co-operative Water Programme (Information System).

Increasingly, the Nation's water resources are vital to the long-term health of our citizens and the stability of our economy. These resources—our rivers, lakes, and aquifers—supply our drinking water, support our industries, transport our products, and provide us with recreational opportunities. Management of these resources is a complex task involving all levels of government and a multitude of laws, regulations, and competing interests. The U.S. Geological Survey (USGS) Cooperative Water Program has been providing basic scientific information needed by water-resources managers across the Nation since 1895.

The USGS Cooperative Water Program is an ongoing partnership between the USGS and non-Federal agencies. The program jointly funds water-resources projects in every State, Puerto Rico, and several other U.S. Trust territories. USGS employees use nationally consistent procedures and quality-assurance protocols in conducting cooperative projects. These standards ensure that all data from the Cooperative Water Program are directly comparable from one region to another and available from USGS databases for use by citizens, public officials, industry, and scientists nationwide. Agencies, or "Cooperators," that participate in the Cooperative Water Program are primarily State, Tribal, county, and municipal agencies with water-resources management and policy responsibilities. In 2003, more than 1,400 Cooperators participated in the program.

In terms of funding, the USGS contribution to the Cooperative Water Program in federal fiscal year 2003 was $78.4 million; $64.4 million is from the Cooperative Water Program federal appropriations, and an additional $14.0 million is from two USGS bureau-level appropriations. These other two appropriations cover some of the administrative and facilities costs attributable to the Cooperative Water Program. Although the Program originated as a 50:50 fund-matching arrangement, Cooperator funds have grown faster than USGS funds in recent years. In 2003, Cooperative Water Program funds totaled $215.8 million. Cooperators contributed $137.3 million, or nearly two-thirds of that total.

However, it is interesting to see the situation in Australia. The issue of data and information sharing as summarised by the National Water Commission in February 2008. Despite recognising the value of better coordination and integration of data management systems, these remain highly fragmented and inconsistent between states. The National Water Initiative has been set up to facilitate this process.

The situation in Australia is presented in more detail in the box below:

“Benefits of improved water data sharing”: National Water Commission (Australia) position:

As drought and climate variability continue to affect Australia’s stressed water supplies, access to reliable water data, current and historical, is a critical component in the development of effective and sustainable water management. Access to water data is a vital underpinning requirement to facilitate delivery of agreed outcomes of the National Water Initiative (NWI), which predicates the need to improve the arrangements for managing and sharing water data and information. The National Water Commission (the Commission) espouses the adage ‘that if you can’t measure it, you can’t manage it.’

It is not surprising, given our federal system of government, that the procedures, standards and protocols for exchanging data between agencies, the states and territories and the

Australian Government are currently inconsistent, subject to variable access and utilise licensing arrangements peculiar to individual jurisdictions….

In Australia, over 600 different agencies hold relevant water resources information and at present, no mechanism exists to distribute and merge this data. The present data sharing arrangements amongst jurisdictions are insufficient to determine progress against national objectives under the NWI and nor do they provide data for national holistic assessment, compromising Australia's ability to ensure sustainable use of water resources.

Whilst each state or territory has developed data management systems, the current initiatives aim to link these using comparable standards and would provide improved efficiency in meeting data requirements under the NWI. Shared data would foster the development of innovative mechanisms and management, provide benefits to river managers and facilitate a clearer understanding of system losses due to theft or leakage.

At the local level, users would have access to real-time data to better schedule and utilise irrigation procedures and modelling routines would enhance prediction of water delivery to conservation assets. With broader access and interoperability, data quality would improve and productivity and efficiency could be more precisely monitored by local users.

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6.10 Demand Management

As indicated in Section 6.1, Demand Management needs to be seen in the context of IWRM. Demand Management encompasses many of the 'IWRM Management Tools'. [See also 'Water Demand Management' document OV2 in this series].

However, in most situations the main demand management tools are related to increased water supply and water use efficiency linked to administrative instruments. These are supported by economic instruments (to finance demand management or influence) and social instruments (to promote knowledge of how and why to save water), as well as the other IWRM management tools.

This is demonstrated in the linkage shown below between potential WDM tools and IWRM tools (see figure below – shading indicates IWRM tools as related to WDM).

Demand Management Tools

Note: Degree of shading indicates IWRM tools as related to WDM, ie 'Efficiency in Water Use' 100%.

The increasingly high cost of developing new water supply schemes, the lack of available resources, and the sense that there is great scope for making better use of existing supplies, are the basis of demand management (DM) as an alternative thrust of water policy. However, there can be resistance to DM by many politicians and professionals in the sector.

DM is a key element of IWRM and is enabled by the wider approaches of IWRM especially the emphasis on stakeholder participation, the creation of a water aware society and economic and administrative regulation systems.

Demand management is defined as:

"*The adaptation and implementation of a strategy (policies and initiatives) by a water institution to influence the water demand and usage of water in order to meet any of the following objectives: economic efficiency, social equity, environmental protection, sustainability of water supply and services, and political acceptability*"

In parallel with water demand management, water conservation (WC) is a key process. This can be defined as:

"*The minimisation of loss or waste, the preservation, care and protection of water resources and the efficient and effective use of water.*"

It is important to recognise that water conservation should be both an objective and a strategy in water resource management and water services management.

DM seeks to maximise the services provided by water from a given volume, mainly by curbing inessential or low value uses through price or non-price measures.

The full menu of DM measures would include:

- enabling conditions (institutional and legal changes, utility reforms, privatisation, macroeconomic and sectoral economic policies affecting major water users);
- non-market incentives (Administrative Regulation – see Section 6.4) - (restrictions, quotas, norms, licences, public information, exhortation, demonstration projects);
- market-based incentives (Economic Regulation – see Section 6.5) - (water tariffs, pollution charges, water markets, auctions, water banking); and
- direct projects and programmes (canal lining, leak detection and repair, modernisation of water works, investment in recycling, etc.)

DM is not to be automatically preferred to supply-side investments in every case. However, taking DM seriously does entail a systematic identification of all DM options as part of water strategy, and a comparison of all options using a common methodology and criteria, e.g., the cost of a unit of water supplied or saved.

Demand-side and Supply-side DM

Demand management techniques can applied to both supply side (by WSCs) and demand side (by customers / users). Supply side DM measures in an urban and industrial water supply setting include:

- Regulations / Guidelines
- Infrastructure optimisation
- Town planning policies
- Different levels of service
- Loss minimisation, (i.e. reducing unaccounted for water, canal lining)
- Reuse and reclamation options
- Conjunctive use (surface water groundwater) systems
- Metering (bulk and districts)
- Pressure management
- Dual distribution systems
- Promotion of good irrigation practices
- Education, awareness, and training

DM measures applicable to end-users (demand-side demand management) include:

- Regulations / Guidelines
- Metering

- Different level of service
- Irrigation scheduling and crop selection
- Auditing
- Incentives
- Minimising and metering institutional water use (own use)
- Loss minimisation (domestic plumbing or irrigation systems leak reduction)
- Retro-fitting existing systems (replace plumbing or irrigation systems with efficient systems)
- Effective pricing
- Effective billing
- Customer education and awareness, social marketing campaign
- Acceptance of re-use of water

Water conservation measures

Taking water conservation, the broader considerations in relation to water resource management are generally:

- Water catchment management
- Dam storage optimisation (e.g. suppression of evaporation)
- Protection of water resources from over-utilisation
- Social awareness and education, social marketing campaigns
- Managing land use
- Water quality management
- Drought contingencies

Promotion of a culture of DM in water management organisations

However, it is often not the technological and practice approaches that are the issue with the establishment of good demand management practices but the development of a demand management culture with the water management organisations and in the minds of water (resources) managers themselves.

This can be divided into two aspects: changing attitudes; and providing institutional support. Possible ways of achieving these are outlined below

1. Create a culture of DM within all water management and water services institutions
    - Educate and create awareness on DM objectives and principles for all officials and employees working in water institutions.
    - Ensure that water institutions demonstrate efficient water usage and are not directly responsible for the inefficient use and wastage of water.

- Promote and ensure the regional co-operation and co-ordination amongst water institutions
- Ensure the implementation of water conservation principles by all public sector and provincial institutions.
- Ensure that tariffs implemented by water institutions promote DM
- Develop and propagate regulations relating to the functions of water institutions that will promote DM
- Ensure the inclusion of DM functions into job descriptions employed by water institutions.
- Develop water efficiency rating for water institutions
- Develop guidelines and model DM strategies for all water institutions

2. Support water management and water services institutions to implement DM.

- Develop policies and guidelines for water institutions that will allow for the funding of water DM initiatives
- Develop a database and library of knowledge, information and case studies and ensure easy access to all interested parties
- Develop incentives and rewards for initiatives
- Promote the development of new technologies that promote DM
- Identify and remove constraints to DM principles
- Develop a national political awareness and commitment on the principles and policies of DM.

Promotion of a culture of DM amongst all users

The need to establish a demand management culture in all water consumers and users is also critical. This is akin to elements of the establishment of a 'water saving society', and includes activities to:

- Create an ongoing awareness on the value of water and the need for water conservation for all consumers and users at county and provincial level.
- Facilitate education strategies on DM.
- Enable and promote the payment of water and water services by all consumers and users.
- Enable consumers and users to understand how, where, quantity and impact of water they use.
- Introduce regulations that limit the wastage and inefficient use of water by consumers and users (through abstraction permits and norms).
- Enable the development of benchmarking for efficient water usage for all water usage sectors (norm development).

DM across International and Provincial borders

When it comes to the national and international level, broader considerations are necessary to promote co-operation and participate with other countries and provinces. Countries and provinces in the same basin should develop consistent DM strategies.

- Revisit and review existing protocols and agreements in terms of DM principles
- Make DM a priority issue within discussions and negotiations with neighbouring countries and provinces.
- Support neighbouring counties and provinces in developing and implementing jointly water conservation strategies.
- Develop intra- and inter-basin water catchment management strategies.
- Transfer and share information, technology and knowledge amongst neighbouring counties and provinces.
- Undertake study tours between countries to understand each other's situation and to develop co-operative arrangements.

Constraints to demand management

Demand management is normally much more difficult to implement than supply development and management. Apart from organisations being established originally with a brief to 'develop and manage supply side resources', this aspect is generally found to be more 'interesting' and rewarding by water managers. Demand management is often difficult to implement, often does not get much political support, involves more stakeholders, involves more 'soft skills' and is often an initiative where it is difficult to show results.

The problems associated with the implementation of DM as seen from the perspective of the water management organisation in the Republic of South Africa (mainly from Department of Water Affairs and Forestry) are presented below. This is believed to be typical of most countries, and these issues and factors need to be taken into account when designing and implementing water demand management programmes.

Generic obstacles and constraints to demand management and water conservation

- Financial constraints. Money is made available for supply side management measures but very little is made available for DM/WC initiatives
- Resistance to change by water institutions
- The principle often adopted in water resources management is to allocate all available water to consumers irrespective if water is not used efficiently.
- Officials and industry sectors protect their personal interests
- Most engineers and local development organisations serving the water supply industry promote the development of infrastructure without adequately reviewing DM/WC measures as alternatives
- Water institutions own supply-side measures
- Water conservation measures are perceived only as drought relief mechanisms
- Fears that water conservation will result in reduced service levels
- Supply side management options appear easier to implement
- Supply side development has a greater political attraction plus perceived greater employment generation
- Existing planning practises choose the cheapest solution in implementation without regard to operating and running costs. (i.e. new housing developments)
- Lack of understanding of principles, scope and potential of demand management
- Demand management strategies are often incorrectly perceived and implemented as punitive measures to the consumers
- Lack of integration and co-operation between the various institutions in the water supply chain, particularly in the water services sector
- Lack of ring fencing of the water services functions or the lack of integration and co-operation within the different departments of local authorities.
- Lack of knowledge and understanding of the consumer and water usage patterns
- Lack of adequate knowledge of the drivers causing the growth in demand
- The relative low price of water, particularly in the agriculture sector
- The low level of payment for services by a significant number of consumers and users

Note the ‘Water Demand Management’ document OV2 takes the above table further presenting suggested means of addressing the above mentioned ‘obstacles’.

6.11 Climate Change

Water resources managers face many challenges, including climate change, The Intergovernmental Panel on Climate Change (IPCC) has provided estimates of how climate may change, but more understanding of the processes driving the changes, the sequences of the changes, and the manifestation of these global changes at different scales could be beneficial. Since the changes will likely affect fundamental drivers of the hydrological cycle, climate change may have a large impact on water resources and water resources managers.

Climate change impacts on water resources development and management will affect many elements including:

- Water resources availabilities;
- Frequency of droughts;
- Water demands;
- Severity and frequency of flooding;
- River and lake water qualities;
- Sea level rise:
- Coastal storm surges;
- Ecosystems

'*Climate change could affect all sectors of water resources management, since it may require changed design and operational assumptions about resource supplies, system demands or performance requirements, and operational constraints. The assumption of temporal stationarity in hydroclimatic variables should be evaluated along with all other assumptions*'. (USGS 2009 Climate Change and Water Resources Management: A Federal Perspective).

In the UK (England and Wales) allowances are already made for potential future climate change impacts on water resources, both from a supply perspective and a demand perspective.

It is interesting to see the changes to system design being allowed for in relation to the potential increases in the severity of flooding and in terms of sea level rise.

For Flood Discharges

The limited number of catchments researched to date supports applicability of a 20% allowance to the 2080s for peak river flow volume. Research is ongoing to assess regional variations in flood allowances. Current research thus far does not provide any evidence for the rate of future change but as a pragmatic approach it is suggested that 10% should be applied up to 2025, rising to 20% beyond 2025. For studies covering larger catchments (e.g. Thames/Severn/Humber) or some specialist studies, a scientifically justifiable range of peak flows and their probabilities should be subject to sensitivity testing, with further specialist advice sought for such analysis.

Flood related Design Allowances

Water related aspect	Indicative sensitivity ranges			
	1990-2025	2025- 2055	2055-2085	2085-2115
Peak rainfall (Small catchments)	+5%	+10%	+20%	+30%
Peak flows (Large catchments	+10%		+20%	
Offshore wind speed		+5%	+10%	+10%
Extreme wave height		+5%	+10%	+10%

Sea Level Rise Design Allowances

UK region	Net sea level rise (mm/year)			
	1990-2025	2025- 2055	2055-2085	2085-2115
South / East	4.0	8.5	12.0	15.0
West	3.5	8.0	11.5	14.5
North	2.5	7.0	10.0	13.0

Source: England and Wales, Defra; Flood and Coastal Defence Appraisal Guidance: FCDPAG3 Economic Appraisal - Supplementary Note to Operating Authorities – Climate Change Impacts, October 2006.

The values above are presented for interest. However, it is believed that similar allowances need to be developed for use in different parts of China.

7 IWRM in China

7.1 Drivers and Perspective

Driver - General

The Minister for Water Resources in a major speech presented at the Annual National Water Resources Forum held in February 2009 espoused many of the aspects of IWRM and (WR)DM that the project (WRDMAP) has been promoting over the last four years. This is encapsulated in the 'Six Transitions' advocated for changes to water resources management practices.

The Six Transitions for improved water resources management being stated as:

1. Change quickly from water supply management to water demand management;

2. Focus on conservation rather than new source development;

3. Change quickly from treatment and recovery to pollution prevention (change from reactive management to proactive);

4. Accelerate transition from unstructured and unplanned development to rational and ordered development (through improved and effective planning)

5. Accelerate transition from 'extensive utilisation' to 'effective utilisation' of water resources;

6. Accelerate the transformation from 'administrative (water resources) management' to 'integrated (water resources) management.

Nothing specific is indicated in relation to economic efficiency apart from the reference to demand management.

Driver – Economic Efficiency

As stated in Section 2.1: '*Because of the increasing scarcity of water and financial resources, the finite and vulnerable nature of water as a resource, and the increasing demands upon it, water must be used with maximum possible efficiency.*'

In most parts of China the 'easy to develop' water resources have been developed. Recourse is being taken to larger dams and major transfer schemes. The unit price of water associated with such developments is high. Hence, the focus on demand side management is inevitable since the cost per unit of water 'released' from a 'wasteful' user will be much smaller. In the coastal areas, the options for desalination are becoming more viable as the installation and operation and maintenance costs decrease and the costs of water from other sources becomes more expensive.

Over the last few years, significant increases in water charges have taken place, particularly in urban and industrial water supply systems in the larger cities. This is starting to have some impact on demand. However, in many smaller cities, service supply is often poor and this needs to be rectified.

In the agricultural sector, which uses over 70% of the nation's water resources, charges for water are less than other sectors. This is not untypical of other countries of the world. Charging for irrigation water is always problematic owing to the rural poverty that often relates.

The objective of full cost recovery is normally understood but difficult to achieve in many areas owing to ability and willingness to pay factors. The price controls imposed by the Price Bureau have to be taken into account.

As a consequence achieving 'maximum possibly efficiency' in relation to water resources is currently being driven by other measures within the demand management 'arsenal' of measures.

The other issue with full cost recovery is that as the more complex resources are being developed, the ability to achieve full cost recovery from the sale of water in these situations becomes much more difficult.

Nevertheless, the aim of considering water as an 'economic good', taking account of social equity considerations should remain.

Driver – Social Equity

As stated in Section 2.1: '*The basic right for all people to have access to water of adequate quantity and quality for the sustenance of human wellbeing must be universally recognized.*'

This is a key element of the Millennium Development Goals MDGs. (MDGoal Nr 7, 'Ensuring environmental sustainability', Target 10 being – '*By 2015, halve the proportion of people without sustainable access to safe drinking water and basic sanitation*'. Significant improvements have already been achieved in China, however, further improvements are possible and this is a key focus of development initiatives.

Areas of concern in relation to social equity relate to:

- Initiatives being taken to bring water use into a sustainable condition is impacting primarily on the agricultural sector and often on the poorest;
- Continued economic development, with more focus away from the eastern coastline is resulting in water transfers taking place from the agricultural sector to the industrial sector. Again the main impact is on the rural poor;
- Inadequate attention to water quality management is resulting in poor water quality in some areas, both of surface water and groundwater. This generally affects the urban poor more than others.

A more rigorous approach to the social aspects of IWRM, including social impact assessments and identification of mitigation measures, as well as greater participation in planning might go some way to relieving these concerns

Driver – Ecological Sustainability

Deteriorating water quality in many of the country's rivers over the last 20 or so years has reduced of late, however, there is still a recognised need for improvement. A major national pollution project was started in March 2009:

'*A project to improve water quality in China has been launched by the government, which says it is the largest expenditure on environmental protection since the founding of the People's Republic in 1949.*

The project, which has an estimated budget of more than 30 billion Chinese yuan (around 4.4 billion US dollars) over 12 years, aims to counter the deteriorating water quality affecting millions of Chinese people and their livelihoods.

The Water Pollution Control and Management Project — known as 'Water Special Project' — will focus on the treatment of whole river basins instead of the conventional approach of end-pipe treatment, according to Meng Wei, chief engineer of the project and director of the Chinese Research Academy of Environmental Sciences.". Science and Development Network (SciDev.Net).

Apart from water pollution of the river system, groundwater pollution is occurring in urban and industrial areas, many instances being a result again of the same earlier focus on 'end of pipe' pollution control. Diffuse pollution is also causing problems whilst actual pollution monitoring and effluent control needs improving.

Nonetheless, significant funds are currently being allocated to improving wastewater treatment facilities across the country and this should pay considerable dividends in terms of improved water qualities. However, more attention will need to be given to the effective operation of these facilities.

As indicated earlier, one of the issues related to ecological sustainability, or in some cases, ecological recovery where possible is the apparent lack of institutional ownership of the issue itself.

Perspective

It should be noted that the International Water Management Institute (IWMI) has recognized China as a leader in Asia for adapting Western IWRM concepts. However, it is believed there is still considerable scope for improvement.

7.2 Enabling Environment

Legislative framework

Water quantity and quality control, protection and management are supported by current water and environmental laws and regulations, primarily 2002 Water Law, 2008 Water Pollution Control Law, and 1989 Environmental Protection Law and each mandates specific ministries to carry out the laws through provincial levels, such as MWR and MEP and their corresponding departments and bureaus in the provinces, except for the 2002 Water Law that identifies several ministries to cooperate on several important topics like protecting and enhancing water resources quality, protection and management. However, the Water Law is still seen by many as a law related only to the Ministry of Water Resources and associated government departments.

This line agency legislative structure generally results in a lack of recognition of legislation between sectors. This is clearly an issue that should be addressed.

Although there are numerous central level laws and regulations and also many provincial and municipality laws and regulations there is seemingly a lack of structure to the overall system. This particularly relates to the supporting legislation found at the local level. Guidance might be improved to lay down a logical structure and encourage consistency whilst adherence to a programme of supporting legislation might pay dividends.

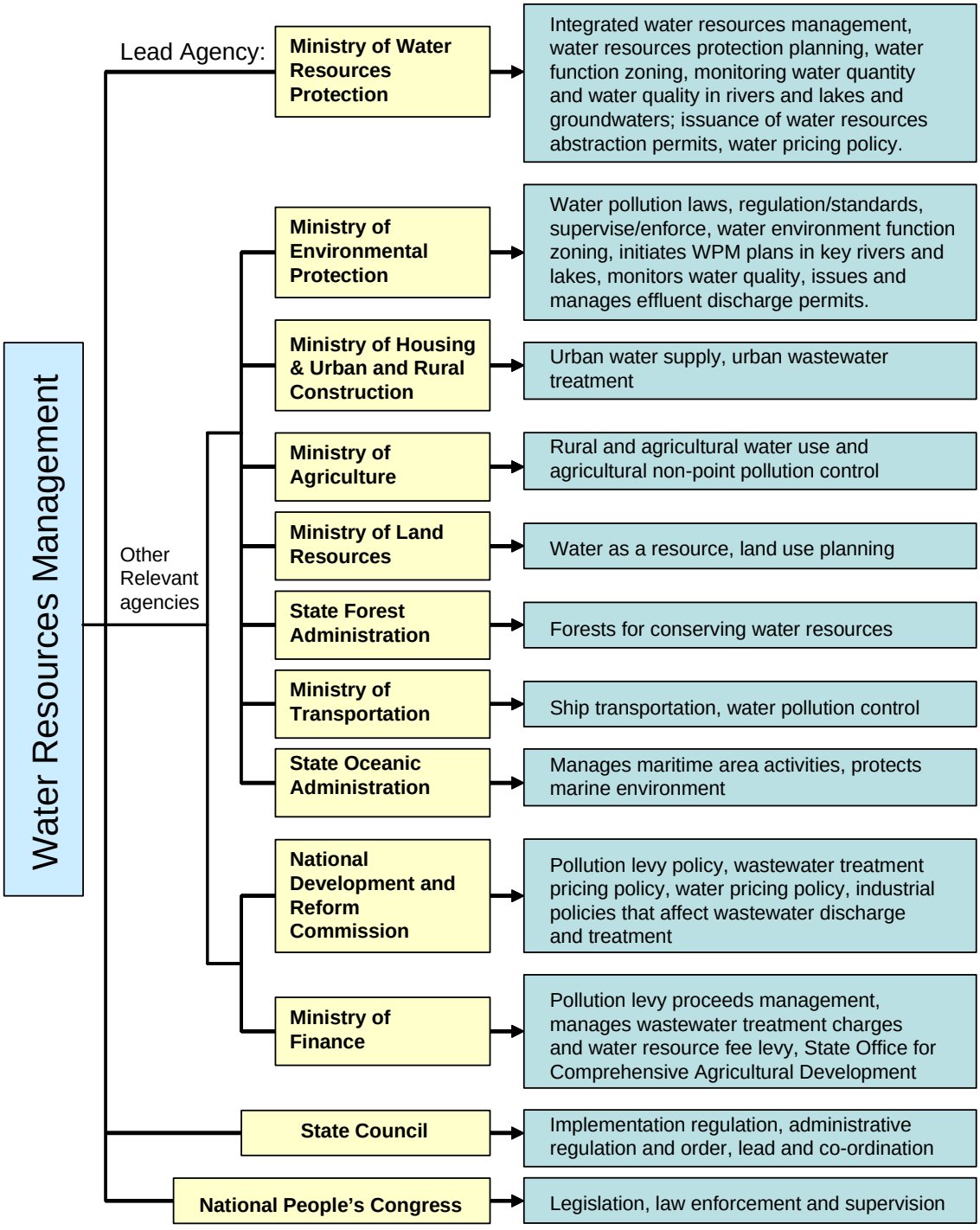
Institutional Framework

The institutional framework related to water resources development management provides a challenge to IWRM. There have been changes over recent years with the establishment of Water Affairs Bureaus (a broader role than the earlier Water Resources Bureaus) and the change of SEPA to the Ministry of Environment (MEP).

However, as stated in the World Bank Report, 'Water Scarcity in China', - '*Despite the recent trend of combining various water-related agencies into a more unified water bureau in some city governments and converting government-owned water utilities into corporations, China's water resource management system is characterized by extensive vertical and horizontal fragmentation. Horizontally, at every level of government several institutions are involved in water management.*

At the central level, the NPC and the State Council play an overarching role through enactment of laws/regulations and supervising their implementation and coordination. In addition, a dozen ministries/authorities are involved in various ways in water management: the Ministry of Water Resources (MWR), Ministry of Environmental Protection, State Oceanic Administration, Ministry of Housing and Urban and Rural Construction (MHURC), Ministry of Finance, Ministry of Agriculture (MOA), Ministry of Land and Resource, Ministry of Transportation (MOT), the State Forestry Administration, and National Development and Reform Commission (NDRC).

A common metaphor to describe the current system is that "nine dragons manage the water." Within this system, there are overlaps and conflicts in responsibilities, as the boundaries between institutional jurisdictions are not always clear. This unwieldy system has increased the administrative cost for coordination among different institutions and affected the effectiveness of water management.'



Source : World Bank 'Addressing Water Scarcity' 2009

Source detail: World Bank, 'Addressing China's Water Scarcity', Section 'Water Resources Management in China: An overview of Determinant Variables', (Figure 3.1), 2009, AAA Project.

Some of the key areas where co-operation between ministry departments is vital include:

- Water quality management: MWR and MEP
- Groundwater management: MWR and MLR
- Demand management in agriculture: MOA and the Price Bureau (DRC)
- Demand management in the urban and industrial sectors: MOC, MOH and the Price Bureau (DRC)

Whilst overall, the overseeing involvement of the various offices of the Development and Reform Commission needs to be accommodated.

Within the Ministry of Water Resources, the main departments involved in water resources management are:

- Department of Planning and Programming
- Department of Policies, Laws and Regulations
- Department of Water Resources (National Water Conservation Office)
- Department of Soil and Water Conservation
- Department of Irrigation, Drainage and Rural Water Supply
- Department of Safety Supervision
- Department of Construction and Management
- Office of State Flood Control and Drought Relief Headquarters
- Bureau of Rural Hydropower and Electrification Development

In the Ministry of Environmental Protection (MEP) there are several departments with a role related to water resources management.

- Department of Pollution Control (most relevant division to water resources management)
- Department of Nature and Ecology Conservation
- Department of Environmental Impact Assessment
- Department of Policies, Laws and Regulations
- Bureau of Environmental Supervision (effluent discharge permits and fees)
- Department of Human Resources Management and Institutional Affairs
- Department of Education and Communication

Capacity Building

The Ministry of Water Resources has a structured training programme. This is managed by the Department of Human Resources.

The main functions of the department include:

- To draw up plans and relevant policies on human resources development in the water sector, and organize and guide the reform of personnel management system of the Ministry and its subordinate institutions
- Take charge of recruitment of public and civil servants in the Ministry
- Study and draft criteria for professional and technical positions, and plan managerial, professional and technical posts
- Be responsible for professional qualifications in water sector
- Human resources planning and institutional management of the Ministry and its subordinate institutions;
- Draft and implement plan of further education and training

Many of the above functions need to be able to respond to the changed skills and knowledge bases required for the implementation of IWRM as well as any planned increase in focus on WDM.

Some of the areas where capacity building is probably required being:

- Stakeholder consultation, participation and improvements communication practices
- Water quality management
- Groundwater management
- Economic analysis
- Environmental topics including aspects related to the aquatic environment (where direct services and advice cannot be obtained from others)
- Various forms of simulation modelling
- GIS (but equipment and software is also required)

Capacity needs to be built at all administrative levels as well as in some of the associated technical institutes and organisations that support the line departments of the MWR.

In addition, it is believed that capacity building could also be achieved by increasing the amount of on-line technical and administrative advice that can be provided to water resources and other water sector managers and professionals.

7.3 Management Instruments

Water Resources Planning – Integrated Water Resources Management Planning (IWRM Plans).

The 2002 Water Law stipulates a requirement for numerous water resources related plans. These are summarised in the box below. Many of these plans are inter-related and should be based on the same data and have consistent objectives.

The 2002 Water Law requires the preparation of a large number of plans for water management. These include:

- Master Plans/ Regional Plans – Water Law (Art 14, 15)
- Comprehensive Plans – Water Law - (flood prevention, water logging, irrigation, water supply etc..); Water Law (Art 14, 15)
- Special Plans –Water Law (Art 14, 15)
- Water Resource Development and Utilization Plan ...Water Law (Art 30).
- Water Functional Division Plans – Water Law (zoning) (Art 32);
- Mid-and-long-term Water Supply and Demand Master Plans– Water Law (Art 44);
- Water Allocation Plans (annual) – Water Law (Art 45);
- Drought Management Plans (Contingency Plans)– Water Law (Art 45);
- Water Use Plans - Water Law (Art 47).
- Water Saving Plans – Water Law (Art 53)

Other relevant laws relating to Water Resources Departments:

- Conservation of water and soil Plan - (Water & Soil Conservation Law (Art7)
- Flood Control Plans – Flood Control Law (Chapter II)

Other relevant legislation and planning requirements include:

- Water Pollution Prevention and Control Plans – Water Pollution Law (Art 10);
- Water Environment Function Zoning – Water Pollution Law (recognition of);
- Agriculture/irrigation plans. Land Use Plans. Urban Development Plans etc
- Rational plans for the placement of industry

An IWRM planning process has the function of coordinating this planning work, and making sure that the plans produced are consistent, develop a synergy and promote effective and efficient water and river basin management.

The large number of plans is generally viewed as the responsibility of the various water resource departments to prepare and then implement. The Water Law refers to coordinating the planning with other sectors but this is not very explicitly explained nor, as far as is known, followed up with advice and/or explanatory notes. Ensuring that all such plans that are required at different administrative levels and jurisdiction inter-relate and dovetail together requires considerable coordination and communication. When the issue of the phasing of the preparation of plans and the time it takes to prepare each plan in addition to consistency in data usage and assumptions, the task is not simple.

As water resources management becomes more critical as resources become extremely limited and pollution concerns increase putting constraints on economic development, livelihoods and the environment, the need for an IWRM planning approach becomes essential.

An issue is that the Water Law does not refer directly to IWRM Plans (planning). In order to address this issue, IWRM Plans could be seen to approximate to the 'Comprehensive Plans' that are a requirement of the Water Law. Within the context of the Water Law, the IWRM Plan is seen to be the Municipality Comprehensive Plan as defined by Articles 14, 15 and 17 of the Law. Note Article 17 relates to the approval process for the Comprehensive Plans.

Meeting "water-demands" in an economically efficient, socially equitable and environmentally sustainable way is a daunting task that is seen internationally to require an IWRM approach. This explicitly challenges conventional water development and management systems. It starts with the recognition that the traditional top-down, fragmented and supply led approach to water management is unsustainable and imposes high economic, social and ecological costs on human societies and the natural environment. To address this a broader water resources planning approach is really required and hence advocating IWRM planning.

An IWRM Plan is not a conventional investment plan or list of capital projects to meet development challenges related to water infrastructure, rather it sets out the changes that have to be taken to ensure the appropriateness and sustainability of such capital investment. This would seem to be compatible with the objectives of the 'comprehensive plans'.

Water Resources Assessments

Water resource assessments are critical in the whole process of water resources management. In China there has tended to be a far greater knowledge base related to surface water resource systems than groundwater systems. This is owing to an institutional factor whereby groundwater resources used to be the responsibility of the Ministry of Land Resources and has only recently been transferred to the Ministry of Water Resources. In consequence, groundwater knowledge is not as well developed in the Ministry of Water Resources as is the knowledge of surface water systems. In addition, groundwater data is still both collected and held by the two sectoral departments. This data separation is not conducive to effective groundwater management. This issue can be addressed through the adoption by both parties of IWRM principles.

Additionally, traditional water resources assessment approaches are increasingly inadequate where resources are under increasing stress and linkages between surface water, groundwater and water use characteristics are increasingly interwoven. The data requirements become increasingly more important in terms of accuracy and scope to support resource assessments.

The use of water resources simulation modelling to assist in quantifying resource availabilities and usage is becoming increasingly important. Such skills and approaches are as yet not commonly found at the local level where such analyses are becoming increasingly important to be carried out.

Additionally, apart from the need to be able to undertake tasks such as flow naturalisation, the issue of climate change must also be taken into account. The skills to undertake such assessments are also uncommon. However, guidance could be given to adopt existing analysis techniques – see 6.11 Climate Change.

Water resource assessments have also been dominated by quantity issues. Rarely are water quality assessments carried out in anything other than the most basic manner apart from by special studies by research organisations. There is again the issue of sectoral responsibilities and data bases, this time between the Ministry of Water Resources and the Ministry of Environmental Protection. The separation of relevant data sets and a shortage of knowledge and skills related to water quality assessments and modelling compounds the issue.

Most of these factors are appreciated by local water managers, however there is often a lack of knowledge and confidence as to how to accommodate and integrate all the diverse factors. The issue of uncertainty is a further complication that is found to be difficult to accommodate at the local level.

Water Use Efficiency

The main focus in China in relation to improving water use efficiency has been the instigation of the establishment of a Water Saving Society (WSS). For a definition or description of the WSS, see the box below.

Definition of a Water Saving Society

"*To build the water-saving society is the most radical and effective strategy for China to deal with the challenges of drought and water shortage. Through the process of building the water-saving society, it will increase resources efficiency, improve ecological environment and enhance the sustainable abilities, so as to achieve harmonious co-existence of human and nature, facilitate coordinated economic, social and environmental development, and promote a society of development, well-being and better environment.*

To build the water-saving society is a main task of the scientific development concept, and a strategic method to implement the basic national policy of resources saving and protecting. It is also an imperative to adhere to the harmony of human and nature and achieve sustainable development. In these years, the achievements of building the water-saving society are obvious, but the water-saving level is still far from meeting the severe water challenges. The traditional practice of promoting the water-saving by mainly depending administrative measures is no longer suitable for the current situation. The water-saving work has to be run through the whole process of the national economic development and people's work and life. We should proactively promote the water-saving measures, develop the water-saving agriculture, industry and service industry, and improve water efficiency and effectiveness by building the water-saving society".

Source: China Global Water Partnership

As stated by the Chinese Global Water Partnership in 2006:

"*Nowadays, more than 100 pilot projects of water saving society development for demonstration have spread all over China. However, the process of developing the water saving society will be a long period and a complex process and is concerned with entire society, every sector, entities and every body. The development of water saving society requires and involves IWRM, water efficiency, participation of all stakeholders, optimum allocation of water, effective water governance and complete*

management system, clear water right and reasonable water price, water reuse and employment of new technology etc.."

All municipalities have water saving plans prepared, normally on an annual basis. As far as is known, the reporting on the achievement of such plans is not very systematic and in many instances not supported by field level audits.

Some of the aspects that should be covered by water resources departments / bureaus should be the establishment of:

- The procedures introduced to estimate current water usage (theoretical (water use norms) and in reality)
- The principles by which areas of water saving are identified as being possible
- Any basic criteria used to relate water saving to physical interventions
- Any basic criteria used to relate water saving to changes in community attitudes
- Methods whereby information is gathered in relation to water use
- Format of estimation of annual water saving and the format of reporting – existing and how to improve the process with increased accuracy and transparency. The reporting would take into account the information requirements of the various administrative levels as well as the required feedback to stakeholders
- Use of measurements / audits in refining basic water saving criteria assumptions (see above)
- Information feedback to the review of water use norms, and the productivity of water for each use
- Assessment of the impact of water saving publicity campaigns, in whole and in part
- Preparation of annual water saving reports

Administrative Regulation

Considerable attention has been given over recent years to the administrative regulation of water resources.

As stated in the World Bank Report, 'Water Scarcity in China', '*Water rights can be characterized in many different ways. Essentially, they are an entitlement (or a de facto "property right") of an individual or entity to a share of a common water resource. Beyond this, however, are the legal and institutional arrangements surrounding the 'right'. These arrangements define and give meaning to a water right—both for the right holder, for other water users, for the government (as resource regulator), and for all those with an interest in water resources (WET 2006). In this 'report', water rights are not used to refer to legal ownership rights (which are typically held by the state, as is the case in China). Water rights refer to rights to allocate, take, or use water.*'

A water right includes three basic components:

- The amount of water that may be extracted
- The amount of water that may be consumed (or lost to the system), and
- The amount of water that must be returned with defined quality to the local water system

These three components define the parameters of a given water right.

China had introduced a water abstraction/withdrawal/drawing permit in the 1988 Water Law and State Council and MWR regulations to implement the provisions using standardized forms and procedures from central (and major inter-provincial rivers through basin commissions established by MWR) to provincial and local levels. During the implementation of the 1988 Water Law, the State Council issued two important decrees, Decree 119 in August 1993 on the water permit system that includes requirement to measure water abstracted and supplied to users, and Decree 35 in October 1997 on the industry policy for the water sector that among other issues, clarified the fees and charges to be paid for abstraction of water. The 2002 Water Law retained the need for water abstraction permitting and subsequently more comprehensive guidance has been issued in this respect.

Thus, in February 2006, State Council Decree 460 (SCD 460) entitled “Regulation for Water Drawing Permit and Collection and Management of Water Resources Fee” was issued effective April 2007. [water abstraction permits (WAPs); water resource fees (WRFs)]

In August 2006, MWR prepared a report entitled “A Practical Guide to Water Withdrawal Permit System and Collection and Management of Water Resources Fee” providing a lengthy explanation on how water resources departments at local levels are to implement SCD 460 and including new permit and registry forms, instructions and procedures. The report, called the “Blue Book” was widely distributed to all provincial offices. To further supplement the Decree, MWR issued its Ministerial Decree No. 34 entitled “Measures for Administration of Water Abstraction Permission (Permits)” on April 2008.

The WAPs and WRFs with the requirement for volumetric measurement and annual reporting provide important mechanisms for water management at the basin to local level, providing the permit system is carried out as required under the water law and SCD 460 and appropriate data and information is accurate and timely gathered, processed and made available to respective agencies.

In many countries, a well-functioning water use or withdrawal permit system is essential to effective water resources development and management. Such a system creates a type of “water right” in the holder to the extent of the provisions and conditions of the issued permit – as long as it is in good standing. Certainly in China under the 2002 Water Law, it is an important tool that goes far beyond a means to identify the allocation of water to various uses in agriculture, industry, municipal, etc. It is a tool that integrated with water resources data and information, water resources management planning, water allocations amongst inter-jurisdictional bodies like provinces, issuance of water sector and use quotas and others provided for under

the current water law, provided the legal and institutional framework to manage and control the water of a nation, basin and local jurisdictional levels.

A vital aspect should be the establishment of a WAP audit process to be executed by all WAP issuing authorities on an annual basis based on a defined sampling process.

Economic Regulation

Most if not virtually all water resources harnessing and delivery infrastructure has been funded by the State. Some private sector involvement has occurred in the urban water supply and sanitation sector and the desalination sector, however, these are the exceptions.

Full cost recovery in relation to the 'sunk' infrastructure investments has not been on the agenda. However, increasingly there is pressure to recover all operation and maintenance costs from water users / consumers and there will probably be a gradual transition to start recovering some of any future investment costs.

Economic regulation is not as well addressed to date mainly it is believed because the issue cuts across several sectors and would normally strongly address the issue of accountability.

Although price rises are taking place in the urban water supply sector, the control is still primarily with the price bureaus. However, a growing issue is as water tariffs in the urban area are increasing, customers are not seeing the service delivery improving.

Source: China Daily

In the agricultural sector, prices are kept relatively low owing to the affordability issue related to many farmers.

In relation to water resources fees, linked to water abstraction permits, increases have been taking place however, the level of fee is variable between provinces as one should expect since the charges should reflect scarcity. However, the one issue that has not been resolved and is highly variable is whether WRFs should apply to irrigation, and if so, should it be applied equally to surface water abstractions and groundwater abstractions. (These issues are covered in separate 'Notes').

It is believed that only in particular urban areas, and probably only in domestic water supply systems, is price at a level that is having any influence on demand.

Social Change and Water Aware Society

In the water resources management sector in China, the development of a 'Water Aware Society' is seen to be related to the national policy for the establishment of a 'water saving society' (WSS), as described above.

Some of the areas where social considerations are essential in the establishment of a water saving society include:

- Improved awareness of farmers of the cost of water

- Improved awareness of farmers on the water use requirements of different crops, why water saving is important and what agronomic practices can be adopted to achieve such goals
- Improved awareness of farmers and farmer organisations in improved water management and greater control in water use
- More emphasis in abstraction permit management and more relationship of this to public awareness of the importance of water and water rights
- More emphasis on stakeholder involvement in drought management
- Water pricing studies in the agricultural (irrigation) and urban water supply situations with affordability and willingness to pay considerations to the fore; the requirements of safety nets / subsidies being an essential consideration

Establishment of water users' associations (WUAs) in the irrigation sector is a major way by which public participation is being encouraged.

There are also major, regular, propaganda campaigns linked to the establishment of a 'water saving society'. These campaigns seem to have a strong focus on urban areas. These tend to have a 'water saving day or week' focus with pamphlets, radio and television being the media focuses for information dissemination.

Conflict Resolution

In China, as in most countries, differences and disputes can arise under any circumstances with the traditional practices of addressing and resolving them either by administrative or judicial means; if a government agency is involved, it normally has the first opportunity and best capability to address the situation due to its familiarity with the subject matter and understanding of the local conditions. If the parties to the dispute cannot resolve the matter, or if one party refuses an administrative solution, then the issue can be taken to the relevant court for decision under the judicial process.

Often water matter disputes can occur between or within agencies of the government due to jurisdictional reasons or ambiguity or gap in the law, between a water agency and persons/organisations using water or subject to an agency jurisdiction over water, or between persons or organisations sharing a common water supply or conveyance system. These water disputes arise due to interference with a party's expected rights or jurisdiction over water or its use. Many disputes among any of the three groups of parties arise through over-enforcement or under-enforcement of water laws and regulations or due to ambiguities, gaps or overlaps amongst various laws, regulations or implementing agency actions or inactions.

Where the water dispute arises between two administrative agencies, such as between ministries (to include divisions or departments of ministries), BMAs, or provincial departments and bureaus at provincial, prefecture or county levels, the parties are directed to enter into consultations to resolve the matter.

Where a water dispute arises between units, between individuals or between units and individuals it shall be resolved through consultations, unless the consultations fail or one of the parties does not want to go through a consultation process. In that

case, a party can either apply for mediation by people's government or authorized department of government, or may file for a civil lawsuit. Mediation by a third party is specifically available or they can resort to the judicial system.

Information Management

For a nation as vast, diverse and geo-hydrologically complex as China with a long history of water and river basin management efforts, the issue of data and information collection, processing, management and sharing is a key element to sustainable social and economic development. During the past two decades of rapid changes to the legal, institutional, economic, technical and scientific planning, utilization and management of water and related resources and protection of the eco-environment, the presence or absence of relevant, adequate, accurate and timely data and information is directly linked with the application and utilisation of knowledge and analytical capabilities to improve over-all decision making.

With escalating demands being placed on available water resources throughout the country as an input, catalyst or transporter of wastes, national focus on protecting and preserving the environment and potential adverse impacts from climate change, integrated water resources management and especially integrated river basin management as required under the 2002 Water Law is highly dependent upon a first-class data and information management system at all levels.

As resources reach the limit of their exploitation potential, the need for accurate data becomes more important. Similarly, as more water is used, re-used and polluted the extent and scope of data increases.

Water related data is currently collected, processed, stored and managed by many different organisations. This creates definite shortcomings in horizontal data sharing/movement (between sector organisations) but also sometimes vertical issues (between departments at different administrative levels).

Organisations that hold water related data are presented in Section 7.3.

The issue data and information sharing is considered extremely important in the Chinese situation, made more important by the institutional separation that seems to exist.

Monitoring and Evaluation

With all plans, of which there are many in the water sector in China, a process of monitoring and evaluation of the implementation activities is required. Such monitoring and evaluation work needs to be aggregated and analysed and lessons learned disseminated to water managers on a broad basis.

This issue also needs to be addressed.

7.4 Climate change

A considerable body of research exists on climate change in China, much of it conducted through the Laboratory for Climate Studies at the National Climate Centre

of the China Meteorological Administration. Useful summaries of some of that work are provided by Ren (2008a, 2008b). Ren (2005) provides an excellent overview of climate changes in China over the last fifty years. Ren (2008) has also presented a review of likely changes in climate in China over the next century, drawing on the results of various climate modelling studies. Much work has focussed on the impacts of climate change on water resources in China.

Ren et al (2008) reported on the potential impact of climate change on water availability in three river basins in northern China. The basins were the Huai, the Hai and Shiyang. Ren reported that the climate had become drier in the Hai and Huai basins in the past 50 years, while in the Shiyang basin the climate had become slightly wetter. In the future, Ren indicated that precipitation was likely to increase in all three basins, and that particularly in the Huai basin, the frequency of precipitation extremes would increase. He also indicated that the severity of drought in the basins would decrease in future.

7.5 IWRM Best Practice Characteristics

Integrated water resources management (IWRM) is a concept that is intended to improve the effectiveness and efficiency of water resources management particularly in water-stressed situations. The stress may be related to quantity or quality, surface water or groundwater, supply or demand. Internationally, IWRM is pursued most concertedly in situations where there is a high appreciation of the importance of environmental conditions, a high level of stakeholder participation in decision making, or where public involvement is an inherent part of the political system.

The basic premise behind IWRM is that difficult issues are more easily resolved through taking a holistic approach with improved stakeholder involvement, communication, co-operation and collaboration. Appropriate measures and solutions can be more effectively decided upon and implemented in this manner.

However, there has to be an enabling environment in place, a desire to change and be innovative, adoption of improved technological approaches for water resources management and much more attention given to social, environmental and economic factors and weight than is normally the case.

There is a relatively good IWRM enabling environment established at the central level in the country in terms of overarching legislation (the Water Law) and many established institutions. In addition, the application of many of the basic tools associated with IWRM, regulatory instruments, economic instruments etc are in many ways well advanced in many parts of the country. There is also an increasing realisation that more attention needs to be given to demand side management.

However, the concepts, principles, knowledge, attitude and practices of good water resources management must be adopted by all water sector professionals and managers at all administrative levels. Change cannot be effected without champions in the industry at all levels. Change requires capacity building and often supporting finance, all driven by the champions.

The attainment of IWRM aims and objectives cannot be achieved overnight. Neither is it necessary to ‘tick all the boxes’. An IWRM approach will evolve into a form that

will fit the particular water resources situation, the culture and the limitations imposed by the particular 'enabling environment'. Nevertheless, it is always considered worthwhile to try to improve the enabling environment to increase the support to the overall approaches of IWRM. In all international situations there can be successes and failures with regard to particular aspects of IWRM in different countries or situations. Often modified or fresh methods will need to be considered, but this does not undermine the concept of IWRM.

Where there might be deficiencies in the enabling environment, more importance should be placed on the targeted application of the management tools to ensure their effectiveness For example, if the institutional set up related to the water sector makes a particular aspect of water resources management difficult, more attention needs to be paid to stakeholder involvement and data sharing through communication, co-operation and collaboration than might otherwise be the case. One should work the best one can within a particular enabling environment, but identify its shortcomings or impediments in relation to desired changes in water resources management and try to modify (or request that others modify) the enabling environment accordingly.

Water resources development and management has been a vital part of the overall economic and socio-economic system in China for thousands of years. There is more history related to the control and development of water resources than almost any other country. Today, some of the largest water sector infrastructure and supply schemes in the world have been, or are being, successfully completed. However, it is believed many aspects of water resources management could be improved.

The areas of potential improvement in water resources management are seen to be:

- A more integrated approach to water resources management considering quantity or quality, surface water or groundwater, supply and demand
- A more simplified and less fragmented planning framework with an overarching IWRM plan to provide the inter-relationships
- A greater focus on water demand management together with adequate data and information to support it
- Improved linkages between water resources availability, water allocation and water rights (and the water abstraction permit system)
- Improved correspondence between water demand management / water saving and water abstraction permits (through transparent and sound water use norms)
- A more co-operative environment for the management of surface water and groundwater qualities
- Overall improved groundwater management – with improved knowledge of hydrogeological and recharge factors
- More understanding of environmental issues and how to make environmental allowances, particularly related to the aquatic ecology
- More understanding and application of economic analysis in decision making with all relevant items being costed and considered in the process –

consideration at least given to the concept of 'full cost' recovery and of the user / polluter pays principle

- Socio-economic and gender related factors need to be given more attention both in the decision making process and in the implementation of measures
- More communication with and participation by stakeholders in relation to water resources management and particularly in relationship to water demand management factors
- Establishment of an environment (conditions) to improve data availability, data sharing and the scope of data that is required to support more scientific analytical tools
- A more co-ordinated approach to the development of local level legislation in support of national legislation (and thus creating a more consistent and timely enabling environment)

Many of the above would greatly gain from improved data sharing mechanisms / protocols, the introduction of GIS and water resources and other simulation software packages. All items require good capacity building to ensure that new systems are effectively used.

All of the above would benefit from an IWRM approach to water resources management. Many of the above deficiencies that can be encountered in different parts of the country are principally a consequence of the remarkable economic growth that has taken place over the last twenty years or so that has resulted in certain parts of the country experiencing major increases in stress on water resources in terms of water availability and pollution. Possibly changes in approach to water resources management has not kept pace with other developments in the country. However, recent changes in terms of administrative and economic regulation, the establishment of a 'water saving society' and the adoption of water demand management principles are rapidly addressing the problem. However, more can always be done in any country. For example, Australia in the Murray Darling area and the whole of Europe are currently, yet again, having major new initiatives to improve water resources management in their respective areas. The changes are being effected based on the IWRM concept and associated principles.

The potential benefits of IWRM are an improved water resources management system that meets managed demands in a sustainable manner, taking into account environmental and socio economic conditions without adversely impacting on economic development. This is worthy of consideration by all parties.

Appendix A

International Initiatives and Case Studies

The following sections cover selected international experience related to IWRM. This is done in the following structure:

A.1 Initiatives

- Dublin Principles
- Helsinki and Berlin Rules
- Water Framework Directive
- Global Water Partnership

A.2 International case studies

- Rhine (Northern Europe)
- Danube (Eastern Europe)
- Colorado (USA and Mexico)
- Indus (India and Pakistan)
- Jordan (Syria, Israel, Jordan and Palestine)

A.3 National case studies

- Tennessee Valley Authority (USA)
- Murray Darling Basin (Australia)
- Republic of South Africa
- Cauvery System (India)

A.4 Application to developing countries

A.5 Donor / International Funding Agency adoption of IWRM

Many of the examples or case studies can be classified as Integrated River Basin Management (IRBM). As stated by Hooper, "*IRBM is a subset of IWRM. It is how IWRM is worked out nationally or internationally across borders at the river basin scale. IRBM is defined as an integrated and coordinated approach to the planning and management of natural resources of a river basin, one that encourages stakeholders to consider a wide array of social and environmental interconnections, in a catchment/ watershed context*". *Source: B Hooper, 'Integrated River Basin Governance – Learning from International Experience, IWA Publishing , 2005.*

A.1 Initiatives

Dublin Principles

Integrated Water Resources Management (IWRM) is generally taken as having gained momentum at the 1992 Dublin International Conference on Water and the Environment at which the Dublin Principles were developed to try to address the above basic 'concerns':

At the International Conference on Water and the Environment (ICWE), held in Dublin, Ireland in 1992, over 500 participants representing 100 countries and 80 international and nongovernmental organizations, the following principles were recommended to guide global water management and development efforts:

Principle 1 "Ecological": Fresh water is a finite and vulnerable resource, essential to sustain life, development and the environment.

Principle 2 "Institutional": Water development and management should be based on a participatory approach, involving users, planners and policy-makers at all levels.

Principle 3 "Gender": Women play a central part in the provision, management, and safeguarding of water.

Principle 4 "Instrument": Water has an economic value in all its competing uses and should be recognized as an economic good.

Later that same year, the Dublin principles were incorporated into the Agenda 21 recommendations put forth at the UN Conference on Environment and Development (UNCED) in Rio de Janeiro. Since then, these principles have strongly influenced the development of IWRM.

The World Bank's Water Resources Strategy Paper of 2003 quotes an OECD finding that "*even the most advanced countries are far from full compliance with the Dublin Principles*".

However, the IWRM approach, based on the Dublin Principles, has been endorsed at many subsequent international water related conferences and meetings.

It should however be noted that the basic elements and concepts of IWRM have been promoted by different organisations in different ways for many years. The basic key messages had been in existence for decades and had been promoted by the UN in the 1950s.

Helsinki and Berlin Rules

Experience with problems of sharing water resources has long indicated that there are a large number of factors to be taken into consideration before an "equitable" solution can be found. The international legal community had sought to provide clarity to the situation, and the "Helsinki Rules" were adopted by the International Law Association at their fifty-second conference,

held at Helsinki in August 1966. Their work has been adapted by the United Nations Convention on the Law of Non-Navigational Uses of International Watercourses in a document that was approved by the United Nations General Assembly by a vote of 103-3 on May 21, 1997.

The basic premise of the approach is that each basin State is entitled, within its territory, to a reasonable and equitable share in the beneficial uses of the waters of an international drainage basin. The Helsinki Rules state that when sharing resources amongst jurisdictions within the river basin "the relevant factors which are to be considered include, but are not limited to:

1. The geography of the basin, including in particular the extent of the drainage area in the territory of each basin State;

2. The hydrology of the basin, including in particular the contribution of water by each basin State;

3. The climate affecting the basin;

4. The past utilization of the waters of the basin, including in particular existing utilization;

5. The economic and social needs of each basin State;

6. The population dependent on the waters of the basin in each basin State;

7. The comparative costs of alternative means of satisfying the economic and social needs of each basin State;

8. The availability of other resources;

9. The avoidance of unnecessary waste in the utilization of waters of the basin;

10. The practicability of compensation to one or more of the co-basin States as a means of adjusting conflicts among uses; and

11. The degree to which the needs of a basin State may be satisfied, without causing substantial injury to a co-basin State."

The rules do not provide a means of quantifying how all these factors should be built up into a final allocation – as circumstances change from basin to basin, and from time to time.

In 2004 the International Law Association revised their rules as the 'Berlin Rules' to cover all freshwaters.

International experience suggests that there is no hard and fast way of deciding of equitable distribution of water resources, and that there is considerable potential for long-running and acrimonious disputes. Particular problems seem to arise when:

- The use of water is critical to development, and
- Different parts of the basin have developed at different rates, so that the circumstances arise where future water needs do not reflect the pattern of water use in the past

However, there is still potential for successful water allocation decisions – such as the Indus basin where the allocation of tributary river systems to the main disputants seems to have achieved singular success in an environment where the two countries have long running territorial (and other) disputes (See later).

Of the Helsinki factors, the two most important in the case studies cited herein appear to be:

- The hydrology of the basin, including in particular the contribution of water by each basin State
- The past utilization of the waters of the basin, including in particular existing utilization

The Colorado (and Cauvery) experience suggests that water allocation should take more recognition of likely future water needs – after all the allocation rules are likely to gain in importance with development of the basin, and therefore need to be at their most robust with significant additional development – it is easy to overlook this when negotiating the allocation under immediate political pressures.

Many of these principles are seen to be applicable when water allocation is being agreed between provinces of one State for example.

European Union (EU)

Currently, an often referred to example of IWRM is related to the EU Water Framework Directive (WFD), a key European Directive (legislation) related to improving water management. For a description of this legislation, see, for example the web-page http://www.defra.gov.uk/Environment/water/wfd/.

The Water Framework Directive is the most substantial piece of EU water legislation to date and is designed to improve and integrate the way water bodies are managed throughout the numerous States of Europe.

It is designed to:

- Enhance the status and prevent further deterioration of aquatic ecosystems and associated wetlands, which depend on the aquatic ecosystems
- Promote the sustainable use of water
- Reduce pollution of water, especially by ‘priority’ and ‘priority hazardous’ substances
- Ensure progressive reduction of groundwater pollution

It promotes IWRM in all its aspects – with particular emphasis on the need to manage water issues on a catchment (river basin) basis – although the WFD does not have balanced coverage of WRM topics. Fundamental to the WFD requirements is the requirement to prepare a River Basin Management Plan to a standard format, and covering a wide range of issues.

The river basin management planning process involves setting objectives for each water body, and developing Programmes of Measures to meet those objectives. It aims to:

- Help better manage the water environment and look at how the water and land environments interact and how interaction between water bodies occurs
- Help ensure that management is based on a better understanding of environmental processes
- Consider cost effectiveness and social and economic impacts when deciding which programmes of measures will be used to protect and improve the water environment
- Provide a defined time frame to meet the objectives for each water body
- Improve links to other planning activity, for example that of land uses
- Encourage more people to get involved in management and planning by widespread consultation and by communicating what is being done

However, IWRM is a concept or recommended process, the WFD is a law. IWRM is in a large part formulated to address issues of governance. The WFD was developed to provide a more consistent approach to improved water resources and environmental management across the European States. IWRM has a focus on development and management whilst the WFD has a focus on consistent environmental protection.

Main focus of the WFD:

- Expanding the scope of water protection to all waters, surface waters and groundwater
- Achieving “good status” for all waters by a set deadline
- Water management based on river basins
- A “Combined approach” of emission limit values and quality standards
- Setting prices correctly
- Getting more stakeholders (including the citizen) involved more closely
- Streamlining legislation across the States

What is not covered in the WFD:

- No mention of water for economic development

- No mention of thorough cross-sectoral co-operation in water policy goals
- No mention on requirements for mitigation of floods and droughts
- No mention of demand management or water allocation;

These are all taken to be covered by other aspects of European guidance or national policies etc.

Hence, IWRM encompasses a much broader approach than stipulated in the WFD but the WFD does follow IWRM concepts. However, the WFD presupposes many IWRM practices are already in place to ensure that the tenant of the WFD is effective, e.g. inter-sectoral co-operation (or at least no barriers). The WFD is nonetheless a good example to view in the context of putting IWRM further into practice. It is perhaps early days to say whether or not it is a success. Certainly it has a great deal of momentum and considerable useful water resources related research has been undertaken.

There are elements of the WFD that are of interest to the China situation in relation to water quality management targets and approaches, however, IWRM is a far more important concept/ approach to be established.

Under the EU Water Framework Directive the first requirement is to establish which organisation would be responsible for the planning process – the designated "competent authority". This underlines the importance of establishing early on exactly how the IWRM plan is to be managed and directed.

In the EU the water management agencies continue to be funded from central government sources, and this does not seem likely to change in any of the major countries in the immediate future. For example, in the UK the Environment Agency (EA) in 2006/07 had an operational budget of around £1.0bn, of which £603m was grant from the Agency's sponsoring Government Departments. Additional money is raised from the issuing of licences and permits such as abstraction licences, waste handler registrations, navigation rights and fishing licences and from licensing data for which the Agency is owner. Much of the EA budget is for flood defence work.

The river basin management approach contained within the EU Water Framework Directive does not clearly spell out accountability issues. It has presumed that Governments will nominate the "competent authority" to manage the process, but then does not prescribe funding or accountability systems. The default is that the competent authorities are most likely to receive the bulk of their funding from central government, and be primarily accountable to central government – but with a requirement that stakeholders actively contribute to the management (and particularly the planning) process.

Stakeholders

The EU has made a process of stakeholder consultation compulsory in the formulation of river basin management plans under its Water Framework

Directive. This means that the approach will be essentially a top-down one, although there is a significant history of consultation and involvement of stakeholders within the management process in many of the countries – developed through a bottom-up process.

An example of the extent of stakeholder involvement in water management is provided by the United Kingdom. Here there is significant water management involvement from:

- Water users associations, such as drainage area boards, irrigator associations, and fisheries associations
- Main water users, such as the main bulk water providers (in an earlier institutional format of 30 years ago there was a combined bulk water provider and water management agency, and many of the informal links between the two bodies remain)
- The local government planning process has statutory consultation on water-related planning issues
- Regulators, such as the regulator of the bulk water supply companies (Ofwat)
- Non-government organisations and environmental groups such as English Nature and the Royal Society for the Protection of Birds

The water management process is led by the semi-autonomous body (the Environment Agency) supervised by the Department of Environment, Food and Rural Affairs. The EA manages both water quantity and water quality and is hence in charge of water abstraction permitting and effluent discharge permitting, recovering fees from each in the process.

This historic system has led to active contributions being made to the river basin planning process from a large number of different interest groups and agencies, with consensus largely obtained on objectives, and the process needed to meet the main river management objectives.

The institutional arrangements in the United Kingdom, specifically England and Wales, facilitate an IWRM approach. Additionally, only parts of the region are sometimes water stressed, there is no subsistence agriculture requiring irrigation water whilst living standards are relatively high enabling full cost water charging to be adopted.

Global Water Partnership

The Global Water Partnership is a working partnership among all those involved in water management: government agencies, public institutions, private companies, professional organizations, multilateral development agencies and others committed to the Dublin-Rio principles.

Global Water partnership (GWP)

GWP was founded in 1996 by the World Bank, the United Nations Development Programme (UNDP), and the Swedish International Development Agency (SIDA) to foster integrated water resource management (IWRM), and to ensure the coordinated development and management of water, land, and related resources by maximising economic and social welfare without compromising the sustainability of vital environmental systems. During the past 12 years, the GWP Network has become active in 13 regions and over 70 countries (including China). In response to an invitation by the Ministry of Water Resources, GWP China was established in November 2000.

The network is open to all organisations involved in water resources management: developed and developing country government institutions, agencies of the United Nations, bi- and multi-lateral development banks, professional associations, research institutions, non-governmental organisations, and the private sector.

Today, this comprehensive partnership (GWP) actively identifies critical knowledge needs at global, regional and national levels, helps design programmes for meeting these needs, and serves as a mechanism for alliance building and information exchange on integrated water resources management.

The mission of the Global Water Partnership is to "*support countries in the sustainable management of their water resources.*"

The GWP's objectives are to:

- Clearly establish the principles of sustainable water resources management
- Identify gaps and stimulate partners to meet critical needs within their available human and financial resources
- Support action at the local, national, regional or river basin level that follows principles of sustainable water resources management
- Help match needs to available resources

In 2003, the Global Water Partnership conducted a baseline survey of 108 countries to measure their success with IWRM. PRC was one of only 11 countries in the developing world to have earned the highest rating possible, having "*made good progress toward integrated approaches*." Kazakhstan and the Kyrgyz Republic were the only other Asian countries to fare as well. However, there are still areas where improved water management could be achieved with further adoption of IWRM principles.

It is believed that PRC should aim to be in the developed country category and not the developing country in relation to water resources management, historically an area of strength in the country.

Between 2002 and 2008 GWP China established four Water Partnerships in the provinces of Fujian, Hebei, Shaanxi, Hunan and one partnership for the nine Provinces of the Yellow River Basin to bring stakeholders from different sectors and disciplines together. Since 2006 the GWP China Yellow River Partnership has provided a platform for stakeholders to collectively address the issue of restoring the health of the Yellow River.

A.2 International Case Studies

Rhine (Northern Europe)

The Rhine Basin in Northern Europe is shared primarily between upper riparian states of France and Switzerland (also Italy, Liechtenstein, Austria, Luxemburg, and Belgium), the main riparian country of Germany, and the Netherlands which it flows through to the sea. The current population of the basin is approximately 50 million. It has been developed throughout the ages, with significant management issues developing concerning water quality, use for transportation, and flooding. These issues led to the development of an international agency, the International Commission for the Protection of the Rhine (ICPR), to coordinate actions to improve management of the river and its sin. The ICPR was established in 1950 nevertheless the Rhine deteriorated further with an absolute low around 1970.

The Rhine River is Western Europe's largest river basin, with an area of 185,000 km^2 and mean annual discharge of 2 200 m^3/s.

For decades, industrial and domestic waste flowed untreated into the river, and the Rhine was one of Europe's most repelling waste dumps. Fish disappeared and it was dangerous to swim.

Since 1950 the ICPR has had a secretariat to coordinate measures implemented and financed by individual countries to:

- Improve the chemical and ecological condition of the river
- Provide holistic flood protection and flood prevention measures, and
- And more recently, to support coordinated implementation of other measures required by EU legislation.

The catalyst for improving the Rhine water quality came in 1987, when an accident at a Basel chemical plant let tonnes of toxic pesticides leak into the river. Thousands of fish died and some species disappeared.

Concerted efforts by all the basin countries have contributed to restore the river's health. The return of fish (trout and salmon) is a clear sign that the water quality has improved. But, although the water quality itself is now good, the natural habitats of the river can be improved. A clear passage for migrating fish is needed so the salmon can return. A new project to restore salmon in the river has been delayed, since hydroelectric power stations have limited access to spawning grounds.

A critical issue is the Enabling Environment. The European Community concluded the Convention for the Protection of the Rhine and the 1963 Agreement concerning the International Commission for the Protection of the Rhine against Pollution. At the 25th meeting of the Convention, the riparian States considered it necessary to conclude a new Convention for the Protection of the Rhine. The negotiations were completed in January 1998 and the Community signed the new Convention in April 1999 in Berne. (This repeals the April 1963 Agreement concerning the International Commission for the Protection of the Rhine against Pollution, the Additional Agreement of 1976 to the Agreement of April 1963 concerning the International Commission for the Protection of the Rhine against Pollution and the 1976 Convention for the protection of the Rhine against chemical pollution).

The aims of the new Convention are as follows:

- Sustainable development of the Rhine ecosystem through:
  - maintaining and improving the quality of the Rhine's waters, and its natural function;
  - protecting species diversity ;
  - reducing contamination;
  - conserving and improving natural habitats for wild fauna and flora;
  - ensuring environmentally sound management of water resources;
  - taking ecological requirements into account when developing the waterway.
- Protection of drinking water;
- Improvement of sediment quality;
- Flood protection;
- Coordination with measures to protect the North Sea.

The riparian states undertake to:

- Cooperate in taking actions to protect the Rhine
- Implement programmes and studies concerning the river
- Identify the causes of and parties responsible for pollution
- Ensure that technical measures liable to have a serious effect on the ecosystem, as well as discharges of waste water and hazardous substances, are subject to prior authorisation
- Reduce the risks of environmental accidents

The International Commission for the Protection of the Rhine (ICPR) is made up of representatives of the Contracting States. It is chaired by those States in turn. It takes decisions unanimously and communicates them to the Contracting Parties. The tasks of the ICPR are as follows:

- Prepare studies and programmes on the Rhine ecosystem
- Make proposals for actions
- Evaluate the effectiveness of the actions carried out
- Coordinate warnings and alerts
- Inform the public as to the state of the Rhine and the results of its work

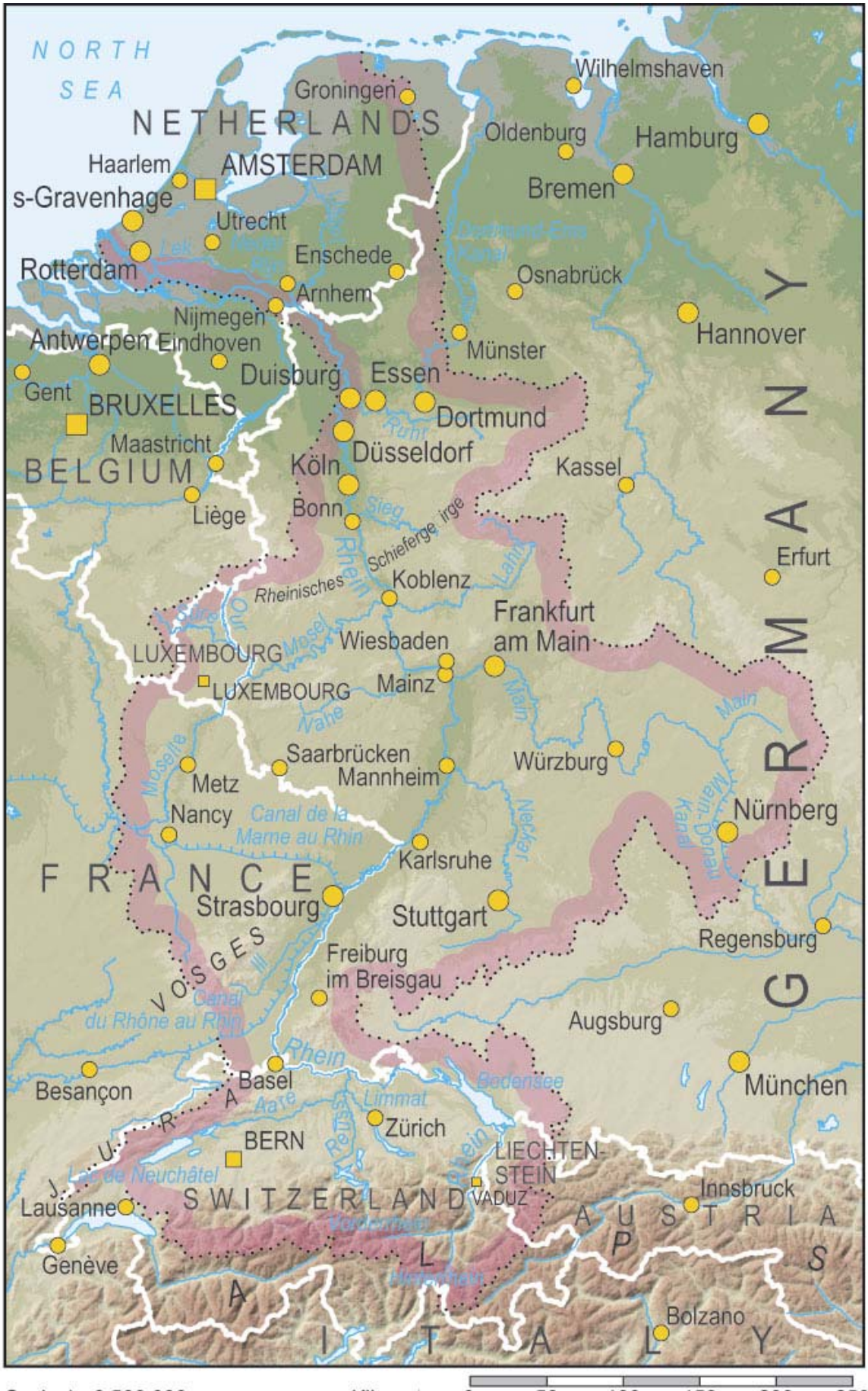
The national governments are therefore responsible for the implementation of measures agreed upon in a trans-boundary context. In the political arena many different views representing governmental and non-governmental bodies exist. The various forms of uncertainty can be a bottleneck for progress and this uncertainty must be clarified to stakeholder. The participative process must be done on several levels. Firstly, the goals are set at the higher level and later stakeholders need to be involved during the planning and implementation stages at the lower level.

The ICPR has developed a programme “Rhine 2020” on the sustainable development of the Rhine, which succeeds the successful Rhine Action Program. The focal points of future Rhine protection policy are the further improvement of the Rhine ecosystem, the improvement of flood prevention, and groundwater protection. The continued monitoring of the state of the Rhine and the further improvement of water quality continue as a core activity. The programme is based on an integrated approach. The targets of the programme are:

- Ecological restoration – to restore connectivity of fish habitats from Lake Constance to the North Sea for migratory fish as well as tributaries
- Reduction of the risk of flood damage (25% reduction by 2020), plus reduction of flood peak levels downstream of Baden-Baden by 70 cm
- Water quality improvements such that treatment of water from the river for drinking is simplified, fish caught in the river are fit for consumption, and dredged materials do not adversely affect the environment
- Groundwater protection such that groundwater quality is assured, and balance between abstractions and recharge is achieved

This programme is consistent with the needs of the EU Water Framework Directive.

This is an example of the creation of an organisation to provide an overarching management role of specific aspects of international water resources and a target of an integrated ecosystem that will enable a rich variety of animal and plant life to thrive in the Rhine Basin. The procedures follow IWRM concepts. Significant achievements have been made to date and it is hoped that the “Rhine 2020” vision is achieved.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Osnabrück
Arnhem
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Hannover
Antwerpen
Eindhoven
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Frankfurt am Main
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Danube (Eastern Europe)

The Danube basin, covering 810,000 km^2 – about one-third of continental Europe outside Russia – is the most international river basin in the world, extending over all or part of the territories of 18 countries. The Danube River itself crosses ten countries and is Europe's second longest river after the Volga, flowing over 2,857 km from Germany's Black Forest to the Romanian and Ukrainian Danube Delta on the shores of the Black Sea.

The Danube River is shared by 13 European countries, and in 1998 the International Commission for the Protection of the Danube River (ICPDR) was formed to:

- Safeguard the waters of the river for future generations
- Provide naturally balanced waters free from excess nutrients
- Eliminate risks from toxic chemicals from the river
- Develop healthy and sustainable water bodies, and
- Significantly reduce the risk of damage from floods
- Sediment management: releases from flushing of dams.

However based on a UNESCO assessment, in the Danube Basin, the current core problem is seen to be:

- Development that is ecologically unsustainable aggravated by inadequate water resources management in places.

And the direct causes being:

- Municipalities: inadequate management of waste water
- Industry: ecologically unsustainable industrial and mining activities
- Agriculture: inadequate land management and improper agricultural practices
- Wetlands and floodplains: loss of wetlands and floodplains

The ICPDR is formed of a secretariat, and:

- An ordinary meeting group for taking political decisions
- A standing working group to provide political guidance, and
- Technical working groups (Expert Groups) to prepare technical background documents.

The Groups are formed from representatives of the “contracting parties” (the 13 riparian countries and the European Union which have signed the commitment to protect the Danube River) with contributions from organisations with observer status with interests in the conservation of the river system.

ICPDR has developed a river management plan which outlined how the organisation would meet the requirements of the EU Water Framework Directive with respect to the river system, confirming that the ICPDR would adopt the role of “competent authority” for coordination of activities throughout the basin.

IWRM management is seen as more institutionalised, complicated and comprehensive than many other international river basins, but it’s complexity and the EU/non-EU distinction of riparian countries and income disparities presents even more significant challenges to implementation.

Stakeholders

Management of water issues in the Danube basin is, of necessity, a multi-national concern, and there are many issues of water management beyond the control of a single Government, and so a coordinated and collaborative approach to problem solution is essential. There is no single authority to impose a plan, only a co-ordinating agency to guide, inform and co-ordinate.

The ICPDR has put a lot of effort into explaining water management issues to a very wide range of stakeholders in the basin, with public relations and publicity of issues seen as a very important part of the process of developing

a common plan and approach. This seems to have met with success, assisted by the EU-wide initiatives related to the implementation of the Water Framework Directive.

As indicated by a recent UNESCO Report : "*The main problem in the DRB is the water quality rather than quantity. Nine countries (six EU members and three concession countries) are at different stages of implementation of the WFD. The other contracting parties of the ICPDR are also working towards the common goal of improving the quality of water resources. However, marked differences in economy, sociology and topography complicate the tasks of the states.*

For this reason, neither WFD nor ICPDR goals are yet to be implemented uniformly throughout the region, and there is still a substantial amount of work to be done at the national level. However, members of ICPDR consider the sustainable utilization of water resources as the overriding priority and work together to this end."

Some of the lessons learned to date as indicated by the WWF (GWP Toolbox Nr 219):

- It is important to work at the local, national and basin level at the same time in order to gain understanding, respect and attention.
- Effective partnership building is essential through diplomatic skills, managing expectations, supervision (rather then control), and a readiness to involve others and their priorities.
- Finding important social and economic links to wildlife issues is essential for gaining maximum "buy in".
- Base work on sound science e.g. WWF's mapping of floodplain restoration potential for the entire Danube basin was a major breakthrough and enabled the formation of a vision based on hard scientific fact.

The Danube River Basin management example indicates the increase in co-operation difficulties when economic and socio-political differences exist. This probably affects the drive towards ecologically sustainability objectives.

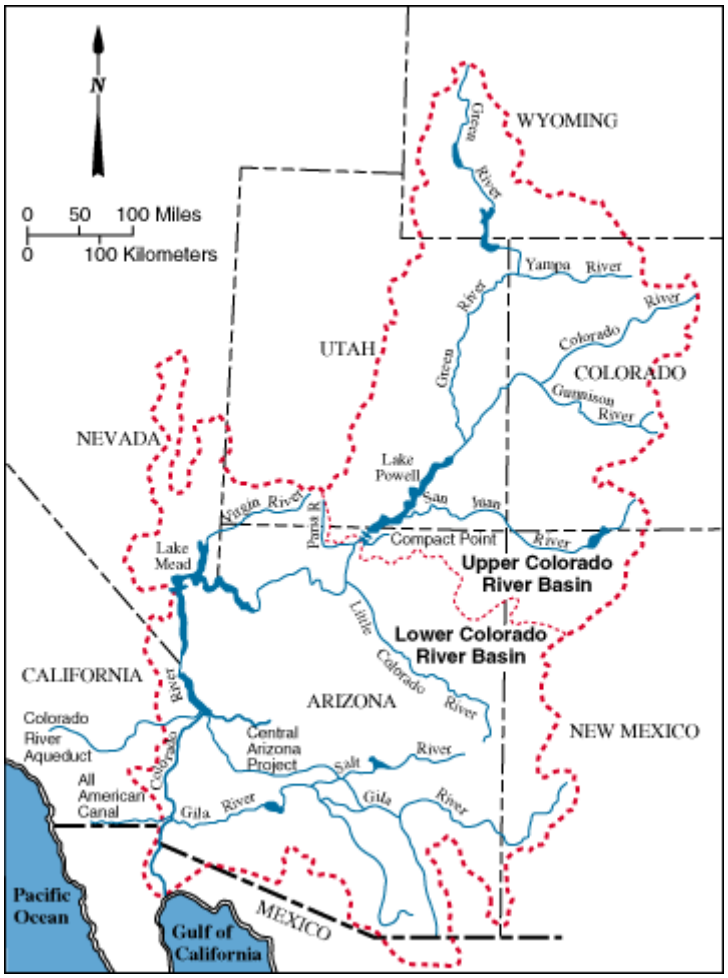
Colorado River, USA, its States and Mexico

Another example with a long history of issues related to international water sharing and water resources allocation relates to the Colorado River.

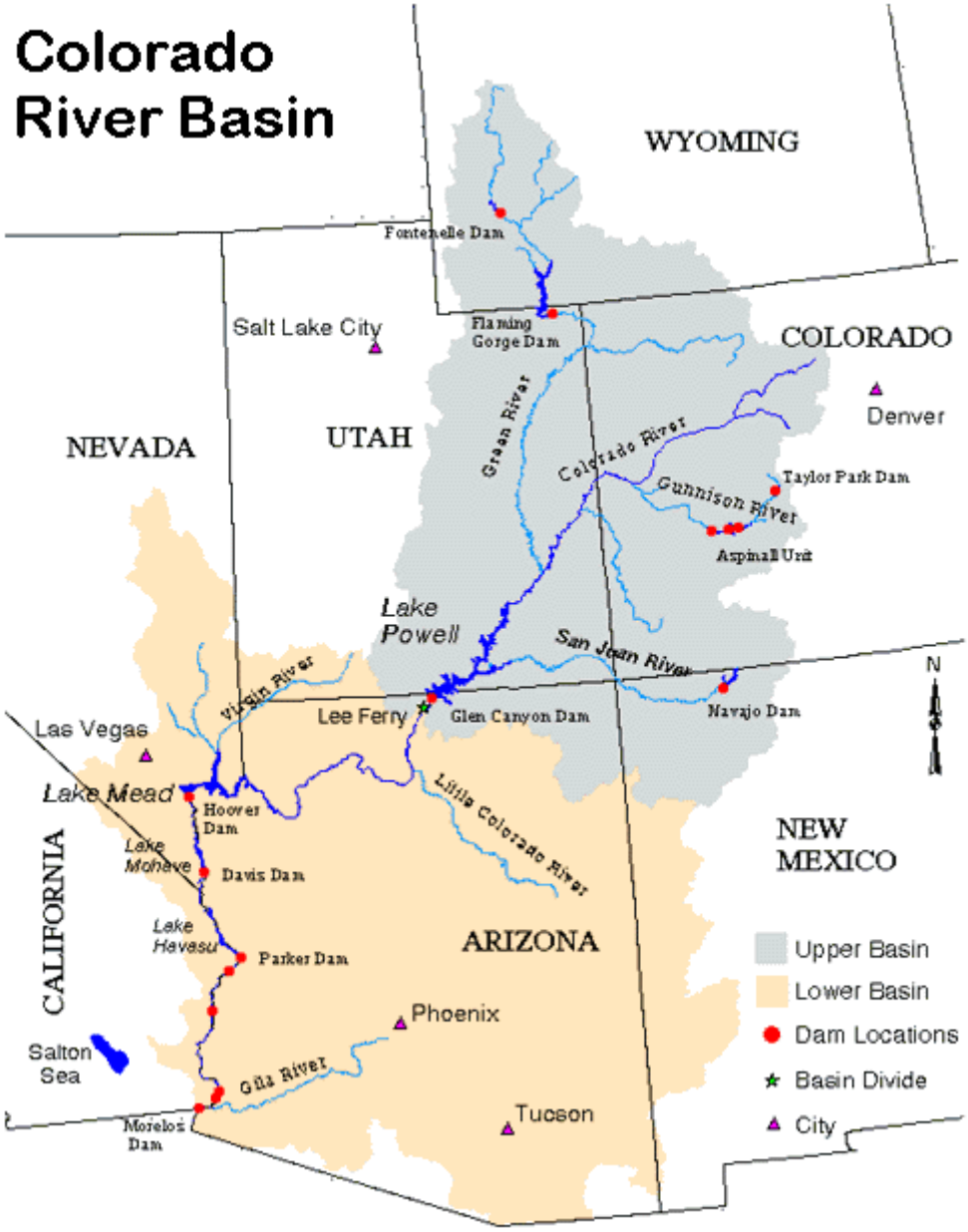
The Colorado River rises in the USA, and flows south to Mexico. It is heavily used in the USA. Located in the south-western United States and north-western Mexico, the Colorado River is a 2,330 Km (1,450-mile) river with its headwaters in the Rocky Mountain National Park in north-central Colorado. The river is the primary source of water for a region that receives little annual rainfall. The Colorado River Basin offers a major renewable water supply in the south-western United States. About two-thirds of the water flowing in the Colorado River and its tributaries is used for irrigation, and the other one-third

supplies urban areas, evaporates into the atmosphere, or provides water to riparian (streamside) vegetation.

Today nearly 17 million people depend on the Colorado's waters. The basin population has expanded dramatically in recent years, with most growth occurring in urban areas, where about 80 percent of the region's residents live. Phoenix and Tucson, Arizona, and Las Vegas, Nevada are the largest cities in the basin, and they use the Colorado River and its tributaries as their primary source of water.



Water from the Colorado River is taken from its primary route and transported to locations far from the Colorado River Basin. For example, water is diverted eastward across the Rocky Mountains to Denver and other cities in Colorado. The Colorado River Aqueduct carries water to metropolitan Los Angeles, and the Central Arizona Project supplies the Phoenix and Tucson areas. The All-American Canal provides water for the Imperial Valley of southern California, a productive agricultural region converted from a desert.



In 1922, seven of the States in the USA settled a growing argument about use of the waters of the river with the “Colorado River Compact” of 1922, sharing the water equally between upper and lower States, meaning the upper States (Utah, Wyoming, Colorado and New Mexico) needed to leave some 9,250 Mm^3 of water annually in the river at Lees Ferry for the downstream states (California, Arizona and Nevada). Sharing of water between States in each Group was not resolved, and led to a long-running dispute between Arizona and California (two of the lower States) about shares as each State competed fiercely for water to drive development.

No attention was given to the downstream riparian country, Mexico, until the 1944 United States-Mexico Treaty for Utilization of Waters of the Colorado

and Tijuana Rivers and of the Rio Grande allotted to Mexico a guaranteed annual quantity of water from these sources (1,850 Mm^3 from the Colorado).

The treaty does not provide specifically for water quality, and this did not constitute a problem until the late 1950's. Rapid economic development and increased agricultural water use in the United States spurred degradation of water quality received by Mexico. Much of the increased water use is intended for producing agricultural products for export. With a view to resolving the problem, Mexico protested and entered into bilateral negotiations with the United States. In 1974, these negotiations resulted in an international agreement, interpreting the 1944 Treaty, which guaranteed Mexico water of the same quality as that being used in the United States. This included construction of desalting and salinity control projects, including the Yuma Desalting Plant, to improve Colorado River quality.

Recent work has produced the "Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lakes Powell and Mead" were adopted at the end of 2007 and hailed as the most significant change in management of the river since the 1922 Colorado River Compact. (The Colorado River provides water for more than 30 million people and 2 million acres of irrigated land in the South-western United States and northern Mexico).

A recent study on the Colorado (July 2009) has indicated that …

In 2000 reservoirs fed by the river were at 95 per cent of capacity. In 2009 they had dropped to 59 per cent of capacity. If climate change results in a 10 per cent reduction in the Colorado River's average stream flows, as some recent studies predict, the chances of fully depleting reservoir storage will exceed 25 per cent by 2057. If climate change results in a 20 per cent reduction, the chances of fully depleting reservoir storage will exceed 50 per cent by 2057, said the study.

'On average, drying caused by climate change would increase the risk of fully depleting reservoir storage by nearly ten times more than the risk we expect from population pressures alone,' said study author Balaji Rajagopalan. 'By mid-century this risk translates into a 50 percent chance in any given year of empty reservoirs, an enormous risk and a huge water management challenge,' he said.

'This study, along with others that predict future flow reductions in the Colorado River Basin, suggests that water managers should begin to re-think current water management practices during the next few years before the more serious effects of climate change appear,' said Rajagopalan.

The Colorado River is a critical source of water for seven Western states, each of which gets an annual allotment according to a system that has sparked conflict and controversy for decades. But in an era of **climate change**, even greater difficulties loom. There have been studies undertaken to try to investigate the climate change issue which could result in a worsening situation with Lake Mead behind the Hoover Dam and resource availabilities in the Colorado River in general.

The US State Department of Natural Resources announced in September 2009 that a new study would shortly be undertaken to investigate climate change impacts on the Colorado River, to be part of the "first-ever comprehensive evaluation of water demands" on the river. The impacts of this on the existing compact remain to be seen.

It is likely that climate change impact on international water sharing is going to be a major future topic where IWRM principles will be to the fore. Often such issues are addressed in the USA first.

Indus System, India and Pakistan

The Indus Waters dispute has its origins in the partition of India on independence in 1947: the division of land split extensive irrigation systems which meant a complex agreement on sharing the waters of the basin was urgently needed. The result was a treaty between the Republic of India and Islamic Republic of Pakistan, signed in 1960 and mediated by the World Bank which became a signatory as a third party.

The Indus System of Rivers comprises three Western Rivers - the Indus, the Jhelum and Chenab and three Eastern Rivers - the Sutlej, the Beas and the Ravi; and with minor exceptions, the treaty gives India exclusive use of all of the waters of the Eastern Rivers and their tributaries before the point where the rivers enter Pakistan. Similarly, Pakistan has exclusive use of the Western Rivers. This division meant extensive construction works were needed in Pakistan such that all systems could be fed through "their" rivers. As a result Pakistan also received one-time financial compensation for the loss of water from the Eastern Rivers, and the World Bank provided considerable assistance in the commissioning of the construction work needed in Pakistan.

The countries agree to exchange data and co-operate in matters related to the treaty. For this purpose, the treaty creates the Permanent Indus Commission, with a commissioner appointed by each country. Disputes continue, but the dispute resolution systems are used.

In May 2005, however, a disagreement between the two countries over India's construction of a run of the Baglihar river hydroelectric project on the Chenab River, an Indus tributary, was referred to a neutral third party for resolution. While both sides have adhered to the terms of the IWT in the past, rising demand for water in each nation could unsettle this stable relationship, as foreshadowed by the involvement of a third party for the first time in the treaty's history. The text of the IWT could allow each party to find flexibility to address rising demands. Given both the historic and economic significance of the Indus River for each nation, addressing these issues could benefit each side and prevent conflict. This was reportedly resolved in 2007 however, in 2009 Pakistan contended that flows downstream of Baglihar were below agreed volumes.

In September 2009, Pakistan decided to approach the World Bank to request the appointment of a neutral expert to resolve a new dispute with India over the Kishanganga hydroelectric project if bilateral efforts fail to settle the matter, according to a media report.

Under the treaty, if both countries fail to jointly appoint a neutral expert, the World Bank can appoint a person whose decision is binding on both sides. Differences over the sharing of river waters have emerged as a major irritant in relations between India and Pakistan since last year.

The selection of the mediator or third party is therefore important. The World Bank is respected by both India and Pakistan and both countries are the recipient of financial support from the World Bank in water and other sectors.

The Jordan River, Syria, Israel, Jordan and Palestine

The Jordan River originates in four countries, Israel, Lebanon, Syria and Jordan. Four rivers converge to make up the Jordan:

1. the Hasbani River, which rises in south Lebanon and has an average annual flow of 125 million cubic meters per year (mcm/yr),

2. the Dan River, in Israel averaging 250 mcm/yr,

3. the Banais River from the Golan Heights, averaging also 125 mcm/yr,

4. the Yarmuk River (originating in Syria and Jordan), which adds on average, 400 mcm/yr.

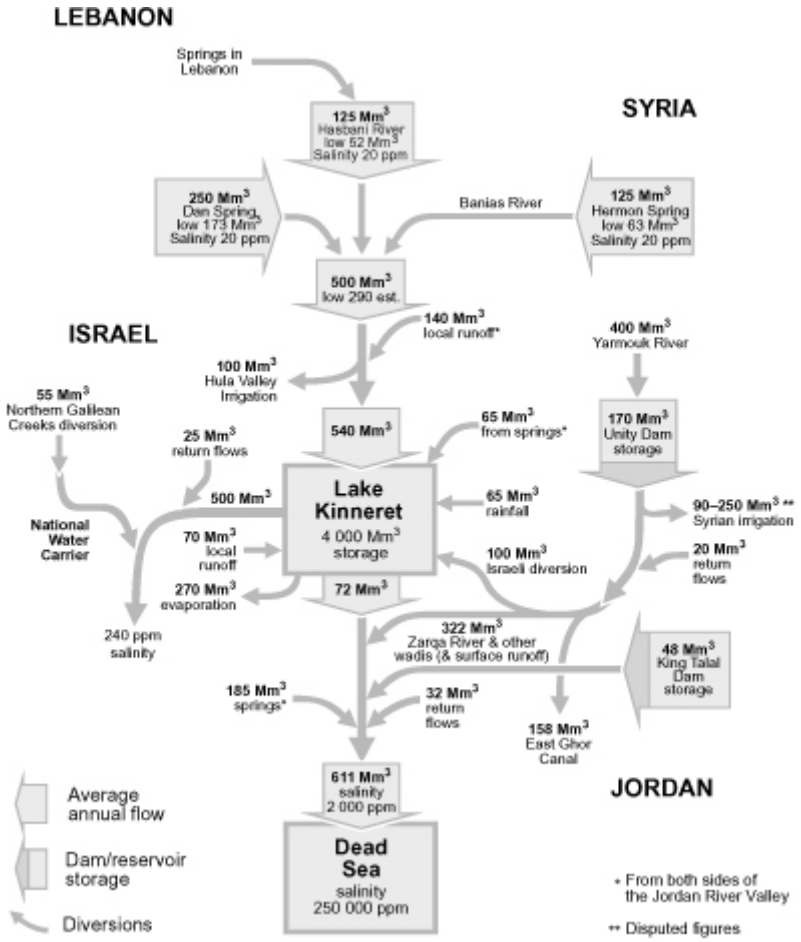
For the rest of the southern flow (320 km) to the Dead Sea, the Jordan is joined by spring flow and intermittent tributaries especially along the West

Bank. The final flow of the Jordan River, when it reaches the Dead Sea at 400 meters below sea level, is on average 1,470 mcm/yr.

Past conflict over the Jordan River Basin includes skirmishes and a war, in 1967.

The Yarmuk River floods every winter in Jordan, but the water is not caught and runs off; which means 100 to 240 mcm/yr of water goes is reportedly 'wasted' although a proportion could well replenish groundwaters. Political cooperation with Israel is important because the Sea of Galilee is entirely within its border. If Israel agreed, Jordan could channel the flood waters to the Sea of Galilee, and it would benefit both countries. Israel's main source of water is from the Sea of Galilee, and with more freshwater flowing in from the Yarmuk, it would decrease the Sea's salinity by 20 per cent. This would be of great advantage to Israel. Jordan would also benefit because it receives 40 per cent of Yarmuk River, and during the summer it would have more water. Diversion of the water would also give both countries access to cheap waters compared to other alternatives. The Yarmuk Diversion Project would benefit both countries.

A schematic of the surface water flow system described above is presented below.



However, the aquifer systems, replenished from the surface water resources need to be considered.

Israel, the West Bank, and Gaza are part of the Jordan River Watershed and utilize three primary aquifers: Coastal, Mountain, and Northern.

The Cenomanian-Turonian Mountain Aquifer system underlying and largely recharged from the West Bank is by far the most important source of water in this area. The aquifer system is highly permeable due to its geological nature. The Coastal Aquifer extends from Gaza in the south to Mount Carmel in the north along some 120 km of Mediterranean coastline. The width of the aquifer varies from 3-10 km in the north to about 20 km in the south, where it constitutes the chief resource of water for Gaza. The depth to groundwater in Gaza ranges from 60 m in the east to 8 m or less near the shore.

Mountain and Coastal Aquifers

The mountain aquifers supply:

- Yarkon-Tanninim Aquifer This supplies Israel with about 340 million cubic meters of water annually, which are used by the Jerusalem-Tel-Aviv area. Palestinians use about 20 million cubic meters a year.
- Nablus-Gilboa Aquifer This supplies Israel with about 115 million cubic meters a year, largely for agricultural irrigation in the kibbutzim (communes) and moshavim (cooperative settlements) in Galilee.
- The Eastern Aquifer This supplies about 40 million cubic meters annually to the Israeli settlements in the Jordan Valley, and about 60 million cubic meters to the Palestinians.

The Jordan River and the aquifer systems of the area are at the forefront of border disputes and the question of the existence of States and water resources issues have already been a key element of past wars.

From an article by 'Share the World's Resources': http://www.stwr.org/land-energy-water/water-wars.html

Israel gets two thirds of its water from territories that it has invaded: the Golan Heights and the West Bank. It takes water from the Jordan and stores it in the Sea of Galilee in contravention of international law, which states that water should not be diverted from its catchment basin. This water is then transported to Israel's cities, farms and industries.

The river Jordan flows from the Golan Heights in Syria and from the Lebanon, through Jordan, Israel and Palestine. In 1949 Israel began taking water from the Golan Heights and in 1951 invaded, driving out the villagers and ignoring UN Truce Supervision protests. In 1953 the Eisenhower Administration prepared a unified plan for the use of the Jordan River, granting Israel use of 33% of it. But Israel wanted more than that, so in September 1953 Israel began secretly constructing a pipeline to divert the Jordan from the Golan Heights in defiance of the US. The US found out and applied sanctions. Israel suspended work on the pipeline briefly, US aid was resumed and then Israel continued to work on the diversion project, which was soon complete. Syria and Jordan protested against Israel's appropriation of their water and the PLO attacked the pipeline. Israel subsequently ignored several UN Security Council Resolutions and occupied the Golan Heights in 1967.

In 1982 Israel invaded Lebanon and took control of the Hasbani and Wazzani rivers which flow into the Jordan. They also took control of the Litani river.

A quarter of Israel's remaining water comes from underground reservoirs in the West Bank, which Israel occupied in 1967. This water supplies 30% of Tel Aviv households. Israel uses 17% more than the 1.9 billion cubic meters of water it obtains from renewable sources, so it is causing the water table level to drop.

In 1994 Jordan and Israel signed a peace treaty in which Israel agreed to share the water from the river Jordan with Jordan but in 1999 Israel cut Jordan's supply by 60% because there was a drought.

The 1997 United Nations Convention on the Law of the Non-Navigational Uses of International Watercourses states clearly how these waters are to be shared: equitably and reasonably.

Hence, in the international context, water sharing can be extremely problematic and will only get more difficult as a result of climate change and ever increasing water demands based on population growth and increased prosperity despite demand management practices. The key elements of IWRM will need to be carefully followed,

A.3 National Case Studies

Tennessee Valley Authority (TVA)

According to a World Bank report (Miller and Reidinger, 1998) "The Tennessee Valley Authority (TVA) represents a successful example of comprehensive river basin development. Established more than 65 years ago to guide the development of the resources of the Tennessee River Basin, TVA continues to operate a wide variety of water, power, economic development, and environmental programs within the region. The integrated development of the watershed's resources, combined with TVA's unique institutional capacity, helped transform the Tennessee Valley from one of the poorest regions in the United States in 1933 into a region with a strong, diversified economy and a healthy environmental base."

The TVA's jurisdiction covers most of Tennessee, parts of Alabama, Mississippi, and Kentucky, and small slices of Georgia, North Carolina, and Virginia.

The primary function of the TVA in the initial stages was the construction of a network of 26 dams and reservoirs to control the waters of the river system, and to develop considerable hydropower production. The structure of the organisation was to have a central core to set policy, and operating arms to implement the policy. These operating arms have typically included a power organisation, a natural resources programme (including water), and either an agriculture division (earlier years) or an engineering design or construction division (later years).

The TVA was originally established as a navigation and flood control agency, with power production a by-product. The power system has become dominant – to the extent that 98% of its revenue now comes from sale of energy, and so it has lost its original "multi-purpose" focus. It continues to work with grass-roots stakeholders on ecological projects, and strategic planning issues, but there is no direct stakeholder involvement in upper levels of management of the agency. The TVA's distinct characteristics remain (according to World Bank, 1998):

- "*Focus on unified, regional development*
- *Multiple missions*
- *Autonomy*
- *High standards of professional excellence*
- *Grassroots participation and support*

- *Strong regional identity.*"

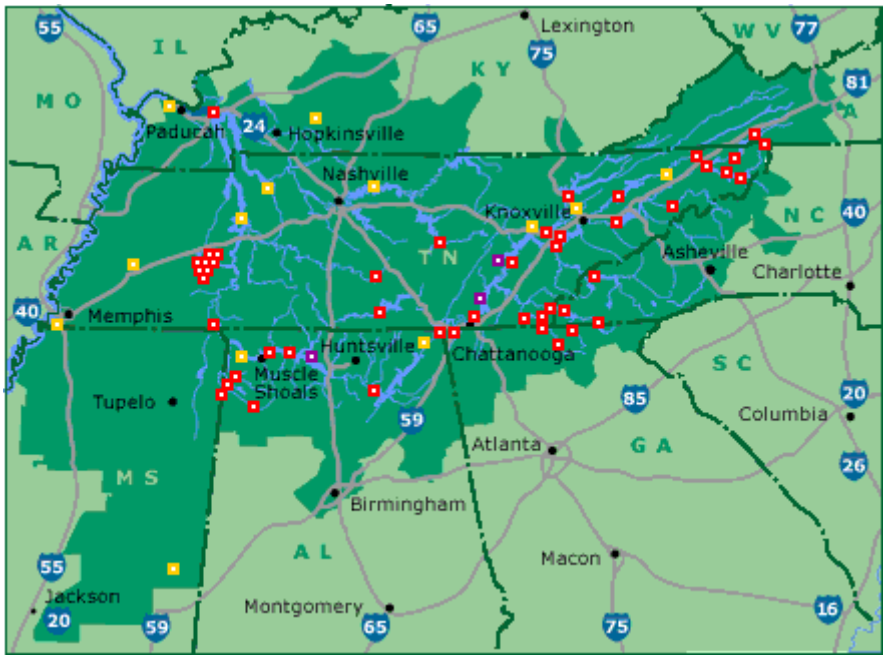
The TVA encountered many setbacks and failures and was involved in many controversies, but it brought electricity to thousands of people at an affordable price. It controlled the flood waters of the Tennessee River and improved navigation, as well as introduced modern agriculture techniques.

Today, the TVA ranks as America's largest public power company, with a generating capacity of 31,658 megawatts. Seventeen thousand miles of transmission lines deliver power through 158 locally owned distributors to 8.5 million residents of the Tennessee Valley. The TVA has become a major recreation provider as well. The reservoirs behind its dams provide opportunities for fishing, sailing, canoeing, and many other activities, while some 100 public campgrounds provide facilities close to the water's edge.

While the TVA is very widely cited as a very innovative approach to regional development in the 1930's, its specific mandate and institutional structure has not proven a great success in its attempts to become more responsive to environmental and sustainability issues, true stakeholder representation in development of planning, and fostering a truly integrated approach to basin development. It is a mega-commercial organisation.

There is no formal stakeholder consultation process in the TVA. Historically, the top-down approach to water management was used, with development of the Tennessee Basin decreed by Government, and implemented by a Government Agency that developed into primarily an energy supplier. This has sat increasingly uncomfortably with the general tendency for wider involvement in water management from stakeholders – especially increasing concerns with environmental management, habitat preservation and bio-diversity issues. These problems of organisational focus and mandate are not yet resolved, and lead to some management issues.

However, having been initially established as a river basin organisation with a focus on water resources development it has tried to be environmentally considerate. It is interesting to see how the organisation has developed over the last 75 years -TVA's power mix as of 2004 was 11 fossil-powered plants, 29 hydroelectric dams, three nuclear power plants (with five reactors and one restarting), and six combustion turbine plants. TVA is one of the largest producers of electricity in the United States and acts as a regional grid reliability coordinator (see map). Fossil fuel plants produced 62% of TVA's total generation in fiscal year 2005, nuclear power 28%, and hydropower 10%. Thus perhaps no longer a river basin organisation in the traditional sense, that is one having a prime focus on water and the environment.



Murray Darling Basin

The Murray-Darling Basin is 3,370 km long, drains one-seventh of the Australian land mass, and is currently by far the most significant agricultural area in Australia. The name of the basin is derived from its two major rivers, the Murray River and the Darling River. Most of the 1,061,500 km² basin is flat, low-lying and far inland, and receives little rainfall. The many rivers it contains tend to be long and slow-flowing, and carry a volume of water that is large only by Australian standards.

The Basin is now home to nearly 2 million people and has a gross product of over US$20 billion. Around 40 percent of Australian farm production originates from the Murray-Darling Basin. Hence agriculture and irrigation is vital in the river basin (the basin contains 75% of the irrigation in the country).

A number of issues have arisen through competition for the resources of the basin, and the main issue has evolved through the years:

- Initial issues concerning navigability of the river (conference in 1863)
- The severe drought that extended from 1895 to 1902 largely brought the colonies and states together. A conference organised by the non-government interests and held in Corowa (Conference) in 1902 – provided the catalyst that eventually resulted in a workable agreement between the states in 1915.
- Sharing of the waters, and a guaranteed minimum flow for the State of South Australia through the River Murray Waters Agreement of 1915
- Salinity issues developing, with amendments made to the River Murray Waters Agreement in 1982
- **A growing need for integrated management of the basin**, with the Murray Darling Agreement of 1992

- Continuing environmental degradation and the severity of potential climate change impacts led in 2007 to Federal takeover and creation of the Murray Darling Basin Authority

The Murray Darling basin is extensive and is characterised by flat gradients and very variable runoff. Much of the catchment has low rainfall and high potential evaporation, so little runoff is generated much of the time. Despite this, there are numerous wetlands (developed due to low gradients, and high water tables). Agriculture in the basin is supported through widespread use of the water for irrigation, meaning that over the years the use of the water resources has amounted to nearly 50% of the annual average runoff – some 96% of this for irrigation (World Bank, 2005). The basin is shown in figure below.

Rainfall data indicates that over the last eight or so years that the system has returned to a drier period following an unusually wet period between 1950 and 1990 during which a lot of water resources related development took place.

As stated by R Cullen of the Brisbane Institute in 2007:

"*The history of water development in the Murray-Darling Basin is a history of articulate interest groups seeking to have the waters used for their particular advantage. There has always been a tension between the upstream States and the downstream State who have had differing views. This has not changed over the century since the Corowa Conference of 1902 where the challenge was to develop a workable mechanism to manage the shared resources of the Basin.*

The partnership of six Governments attempting to manage the Basin, developed over a century of conflict about water, worked adequately in a time of expansion and growth, but over the last decade has shown itself unable to come to terms with over allocation and cope with a drying Basin.".

Some 3.2 million Australians rely on the Murray Darling for their every day drinking water. The basin also provides about 40% of the country's agriculture with water for crops like cotton, rice and wheat.

Management of salinity within the basin is a major problem. This, coupled with the need to carefully manage the distribution of the limited water resources amongst the competing irrigators has been the main historical challenge, and has led in the past to significant environmental degradation that has also needed to be addressed. The management of the situation was, until the 2007 Water Act, not made easier by having responsibilities for water management constitutionally devolved to the States of Australia, and five states (New South Wales, Victoria, South Australia, Queensland and the Australian Capital Territory) being closely involved in the basin.

In 1917 the River Murray Commission was set up to manage water distribution between the three southern Basin States, New South Wales, Victoria and South Australia, according to an agreement that they had approved in 1914. Later, growing awareness of increasing salinity problems focussed attention on the need to take account of processes occurring in the water catchment and so the Murray-Darling Basin Ministerial Council and the Murray-Darling Basin Commission (MDBC) were established in 1986 and 1988 respectively. The MDBC was formed to take over the co-ordinating roles for water management, and for integrated catchment management measures.

In 2008 the Commission was replaced by the Murray Darling Basin Authority (MDBA) bringing responsibility for planning the integrated management of water resources for the entire basin under a single federal agency.

Over the years, catchment management bodies have been formed at sub-basin levels responsible for protecting water quality and riparian and floodplain conditions through efforts to improve land stewardship and through actions such as riverbank protection projects and tree-planting. Water Management Committees are community-based advisory committees composed primarily of water users – mostly the irrigators' organisations. They advise on water allocations, environmental flows, and in some cases flood protection, river facility operations, and/or water pricing.

In general, the Murray-Darling Basin water resource management successes in gaining inter-governmental cooperation and commitment, instituting mechanisms for stakeholder participation, and generating trusted data are considerable. In terms of devolution of authority, stakeholder participation, and financial self-sufficiency, the arrangements have also been generally successful. Water resource management is driven by policy elites and audit groups in each state, but all actual management is carried out at regional levels in local offices with almost complete authority for policy implementation (including water sharing). Management and operation of dams and irrigation schemes has been transferred to entities designed for completely localised day-to-day management and financial sustainability.

The Murray-Darling Basin generates about 40 percent of the national income derived from agriculture and grazing. Over the years the economic drivers have been extremely strong and environmental issues, although recognised were possibly not seriously enough addressed. The development that made the economic productivity of the Basin possible has also caused many biophysical changes. Some of these changes have reduced biodiversity and threaten the potential of economic production in the future.

Despite all of the attention given to water management in the river basin, the decades of research, development and different institutional arrangements, there are reportedly still major water management and stakeholder co-operation issues. Hence, IWRM is not an easy process particularly in a situation with major economic demands on water in a region suffering frequent droughts.

True and effective IWRM is easier said than 'done'.

The future…?

The latest Murray–Darling Basin Agreement (Schedule 1 to the Commonwealth Water Act 2007) is an agreement between the six governments with jurisdiction over the basin. The Agreement requires that a strategic plan for the integrated and sustainable management of water resources across the whole Basin is prepared – the Basin Plan.

Key elements specified in the Water Law and Agreement are:

- The central government Minister for Climate Change and Water is responsible for approving the Basin Plan and tabling it in the Australian Parliament, and for accrediting State Water Resource Plans developed under the Basin Plan.
- The Murray–Darling Basin Authority advises the central government Minister and is responsible for preparing and updating the Basin Plan. It has only six members: a part-time Chair, a fulltime Chief Executive, and four part-time members – all independent technical experts.
- The Ministerial Council chaired by the central government water minister with one member from each of the five basin states. The Council has policy and decision-making roles for matters such as state water shares, and the funding and delivery of natural resource management programs, as set out in the Murray-Darling Basin Agreement. The Council has an advisory role in the preparation of the Basin Plan.
- The Basin Officials Committee comprises one official from each of the six Basin governments. The MDBA's Chair and Chief Executive are non-voting members of the committee. The committee is responsible for providing advice to the Ministerial Council, and for implementing policy and decisions of the Council on matters such as state water shares and the funding and delivery of natural resource management programmes. The committee has high-level decision making responsibilities for river operations and an advisory role in relation to the Basin Plan.
- The Basin Community Committee, supported by Irrigation, Environment and Indigenous subcommittees, advises the MDBA and the Ministerial Council on community matters relating to the Basin water resources, particularly during the preparation of each draft Basin Plan.
- The National Water Commission will audit the effectiveness of implementation of both the Basin Plan and State Water Resource Plans at least every five years.

The Commonwealth Water Act 2007 requires the Murray–Darling Basin Authority (MDBA) to prepare and oversee the Basin Plan. This plan is a legally enforceable document that provides for the integrated management of all the Basin's water resources. Some of the main functions of the Basin Plan will be to:

- set and enforce environmentally sustainable limits, known as 'sustainable diversion limits' (SDLs), on the quantities of surface water and groundwater that may be taken from Basin water resources
- set Basin-wide environmental objectives, and water quality and salinity objectives
- develop efficient water trading regimes across the Basin
- set requirements that must be met by state water resource plans
- improve water security for all uses of Basin water resources.

The plan will provide a fundamental framework for future water-planning arrangements, and will be based on the best and latest scientific, social, cultural and economic knowledge, evidence and analysis. In preparing the plan, the Murray–Darling Basin Authority will consult extensively with Basin state and territory governments, key stakeholders, and rural and regional communities across the Basin.

SDLs will limit the quantity of surface water and groundwater that may be taken from the Basin water resources as a whole. There will also be SDLs to limit the quantity of surface water and groundwater that can be taken from individual water resource plan areas and particular parts of water resource plan areas within the Basin. These areas will be defined in the Basin Plan and will draw upon current state water resource plan areas.

The Basin Plan will provide for SDLs to vary, in terms of water volume, in different years.

The SDLs will take into account the best available science, and the 'precautionary principle'.

Given the stresses on the Basin environment, it is likely that the Basin-wide SDL for both groundwater and surface water will be set at a level below the current level of use. The state governments have agreed that the risk of any future reductions in the availability of water will be shared according to a framework set out in the National Water Initiative (2004), as amended by the Intergovernmental Agreement on Murray–Darling Basin Reform (2008).

Broadly, these agreements mean that the risk of any reduction in size or reliability of a water allocation will be borne as follows:

- by water entitlement holders, if the reduction is the result of seasonal or long-term changes in climate, or of periodic natural events such as bushfires and drought
- by a government, if the reduction is the result of changes in that government's policy
- by water entitlement holders and governments (according to a specific formula), if the reduction results from improvements in knowledge about the environmentally sustainable level of take of water.

The Basin Plan is also required to include water trading rules to improve the overall operational efficiency of trading water rights to promote more effective use of water. The water trading rules will deal with a range of matters including:

- the removal of barriers to trading water rights
- the terms and processes for trading water rights
- the manner in which trades of water are conducted
- the provision of information to enable trading to take place

The trading rules will interact with the policies and procedures of individual state governments and their licensing authorities, and the trading of irrigation and water delivery rights by infrastructure operators.

An example of the working of an effective allocation system is shown in the box below.

Water allocation in the Murray Darling River basin

"River Murray irrigators will most likely receive a lower water allocation this season than they did last year, new data shows.

Water Security Minister Karlene Maywald yesterday released the latest predictions for the year ahead based on several inflow scenarios.

The Water, Land and Biodiversity Conservation Department modelling shows irrigators are guaranteed the 2 per cent allocation which was granted at the start of the season, until the end of March 2009. There was a 75 per cent chance the allocation would be increased to 30 per cent, another cut on the 32 per cent received last year.

Mrs Maywald said the projections were subject to change each month as the availability of water changed.

Final allocations each month will depend on the volume of rain received in South Australia and the upper catchment of the River Murray interstate in winter and spring.

There is an 85 per cent chance irrigators could receive as much as 11 per cent of their allocation by the end of September, compared to 16 per cent at the same time last year."

Source: "Adelaide Now". July 2008

The Basin states will play a major role in putting the Basin Plan into operation by developing and implementing water resource plans that are consistent with the Basin Plan.

Catchment management authorities, natural resource management boards and related institutions, industry associations, enterprises, non-government organisations, Indigenous communities, householders and individuals will all also have an important part to play.

Stakeholders

The management of water in the Murray-Darling has evolved bottom-up from primarily a single-purpose users association (the irrigators) through acknowledgement of the needs of other users, and recognition of the needs of the environment, through to the present integrated approach that seeks to achieve environmental recovery through measures taken by a wide variety of stakeholders for the common good. While a lot of the pressures to develop the new approach have been environmentally driven, there is a wide recognition that most commercial enterprises in Australia have to be seen to

embrace corporate responsibility and to be supportive of environmental and sustainability issues to thrive which greatly encourages this trend.

The new set-up, building on the progress with the Murray-Darling Initiative, is very much a collaborative programme focused on active stakeholder participation in the Basin Plan. Indications are that there is now much more cooperation from all sectors to meeting environmental concerns and contributing to programmes for the greater good.

All the approaches inherent in IWRM are being followed in the Murray Darling, however, the institutional and stakeholder issues related to water sharing and restrictions on water allocations are difficult to impose when they are so intrinsically linked to economic prosperity.

It will be interesting to see if all the major issues of water resources, quantity and quality can be resolved.

Republic of South Africa

The Republic of South Africa the National Water Act 1998 makes provision for, amongst others, the implementation the framework for Integrated Water Resources Management (IWRM).

A feature of this approach is the establishment of Water Management Areas and Water Management Institutions that will allow water resources management to move from a central decision making level to a catchment and local level.

The average rainfall of South Africa is just over half of the world average. The rainfall is strongly seasonal and highly irregular in occurrence (The rainfall decreases from east to west, from over 1 000 mm in the east to 50 - 100 mm in the Namib and Namaqualand areas in the west). As a consequence of the uneven rainfall distribution and the topography, more than 60% of the river flow arises from only 20% of the area. It is estimated that 9% of the country's precipitation finds its way as runoff into rivers and streams.

Based on the present trends in water use and population growth, South Africa is expected to reach the limits of its economically usable, fresh water resources by the year 2030. For many years, RSA was driven by supply side solutions and it only in the last few years that more attention has been given to demand side measures to improve water use efficiency.

The National Water Resources Strategy approved in 2004, has embraced many of the principles of IWRM. Specific proposals and intentions include:

- Clarifying the national framework for managing water resources
- Targeting sustainability of the resources, and equity in exploitation of the resources through measures which are both resource-directed (the ecological status of water bodies) as well as source-directed (limits and controls over water-use activities at the source of impact)

For resource protection, a new system of classification of water bodies is being established, which will classify water bodies as “natural”, “moderately used / impacted”, “heavily used / impacted” and “unacceptably degraded”. For each resource a Reserve is to be identified that is needed for basic human and aquatic environment needs. Resource quality objectives are identified that become a focus for determining a management strategy for the resource.

Some 19 water management areas are being established (all by 2011), based on the major river catchments, and each will have a “catchment management agency” (CMA). These will be statutory bodies with responsibility for managing water resources and coordinating water-related activities in their region. They will develop catchment management strategies to provide the

framework for managing water resources in the catchment. The CMAs would have powers delegated by the Department of Water Affairs and Forestry (DWAF).

The new strategy also seeks to divide the existing responsibilities of DWAF by separating out the functions of development and management of major water resources development schemes. In line with generally-recognised best governance practice it is important that the water regulator is independent of any bodies that directly use the water resources that they regulate. However, there are issues to be resolved related to the boundaries and jurisdictions of the CMAs and water supply demand centres.

South Africa is in the early stages of developing a comprehensive water resources management system based on IWRM concepts. The country has diverse hydrologic and economic input factors: On one hand, there are highly developed technologies under operation and the institutional framework is well-established. On the other hand, especially in the livelihood of refugees and rural areas, South Africa is clearly to be characterised as developing country. An effective IWRM model so developed will therefore be a good example for other developing and transformation countries.

Water management in South Africa has also evolved from systems dominated by the needs of irrigators, to ones that recognise the importance of maintaining healthy rivers to safeguard the rural population's health, as well

as the ecology of the region – which has very strong economic importance as well as amenity value.

With the recent transition of the political systems in the country to full representative democracy there has been a strong change to more diverse representation of interests in the sphere of water management. The controlling agency, the Department of Water Affairs and Forestry reflects the change in balance from the initial “water affairs” to encompass ecological affairs as well.

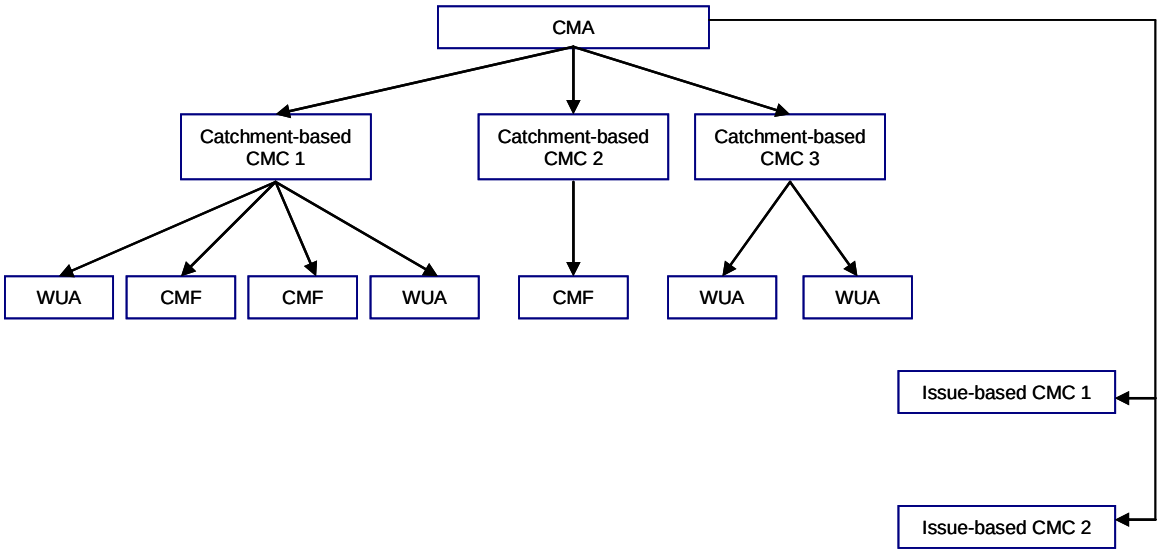
The new collaborative approaches being tried in South Africa – with 19 regional catchment management agencies – has not yet had time to settle and it is too early to evaluate its success, but the initial impression is that the collaborative approach being used, with wider understanding of the pressures driving water management decisions and joint actions to develop solutions should foster improved water management within the region.

In South Africa, the Department of Water Affairs and Forestry is the leader of the water and forestry sectors. It currently performs both implementation and regulatory functions. Its focus is increasingly becoming policy development, macro planning, regulation, sector leadership, oversight and monitoring. A substantial number of its current implementation functions are being transferred to water and forestry institutions within the sectors – for IWRM this means the catchment management agencies (CMA). The CMA is intended to be a self-financing body, with costs of technical and administrative staff met from fees for services provided to water users – and those with discharge permits. Management of the CMA would be through a governing board of stakeholder representatives.

The CMA has responsibility for meeting targets, with DWAF playing a leadership and regulatory role to ensure that Government objectives are met. Thus ownership of individual IWRM plans lies with the CMA. Ultimately, the CMA will carry out functions such as water resources planning in the catchment, registration, water charge collection, and water authorization. Public participation and representation in the establishment process and in the later Governing Board and activities of the CMAs are legally required. In the Governing Board the interests of water users, potential water users, local and provincial government and environmental interest groups will be represented.

The formation of CMAs is something that has not been defined, with a number of alternative approaches being developed, trying to balance the traditional “technical” approach to developing a management agency with inputs from large water users and representatives of particular interest groups with a bottom-up approach to include historically disadvantaged groups. The bottom-up approach makes extensive use of “social facilitators” to generate interest and consensus on selection of representatives to help direct work of the CMA.

The diagram below shows the broad catchment level structure of the Catchment Management Agencies.



Note: CMA = Catchment Management Agency; CMC = Catchment Management Committee; WUA = Water Users Association; CMF = Catchment Management Forum

It is proposed that the Governing Board of the CMA should be constituted along the lines of:

- A DWAF representative
- At least one representative of Provincial government,
- Members from the various District Municipalities within the water management area.
- Representatives of user and interest sectors (e.g. agriculture, industry)
- A representative of a very large Water Services Provider active in the catchment
- Representatives from the CMCs established in the area.
- Experts in fields which will be relevant to the CMA e.g. legal, financial, environmental, water resources, water quality
- A representative from the NGO sector (preferably environmental and/or with expertise in community development).

The Board should ideally be made up of, at most, 15 people.

Best Practice

It is important that an IWRM Plan has a body that clearly manages the process. For full stakeholder participation, it is recent “good practice” to develop a supervision of the IWRM management body that draws from all stakeholder groups to develop an equitable approach that is inclusive, and all stakeholders feel a sense of ownership, contribution and belief in the Plan. This is hard to achieve, and South Africa is currently trying to make such an approach work.

For countries with long-established multi-purpose water management practices – such as Western Europe – development of an appropriate organisation to manage the IWRM process is relatively simple, and can work from a top-down approach without building up a feeling of exclusion from "minority" stakeholders in the IWRM process.

The South African example shows one way to address the transition from a centrally-managed to a self-financing institutional structure.

However, one viewpoint of the achievements to date indicates some of the problems being encountered.

The Mhlatuze Catchment

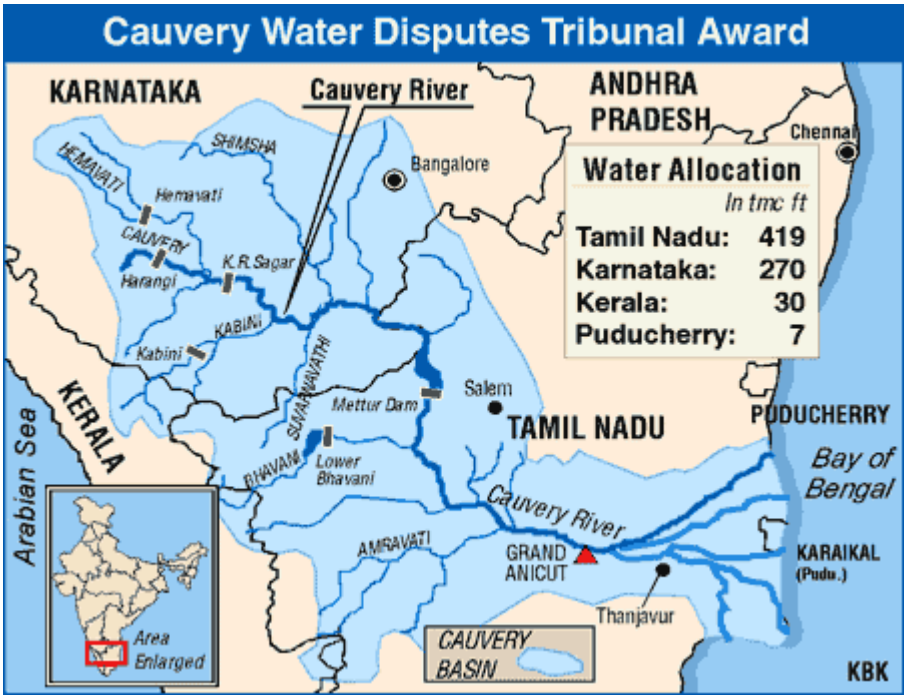
….. the Mhlatuze Catchment in South Africa, was selected as being representative of a catchment situated in one of the country's 19 water management areas (WMAs) where attempts are being made to implement IWRM. The available evidence indicates that three sets of reasons are responsible for the failure to achieve full implementation of IWRM in the Mhlatuze Catchment. First, the national custodian of water resources – Department of Water Affairs and Forestry (DWAF) – continues to experience severe internal (technical capacity) problems that hinder its efforts to successfully manage the Usutu to Mhlatuze WMA (of which the Mhlatuze Catchment forms a part) as a unit. Secondly, while IWRM is, on paper, a key part of national policy, the concept has not been fully accepted and practiced by local water managers. Thirdly, a range of institutional challenges persist because there is insufficient alignment and cooperation between the policies of different government departments and the practices of different water use sectors that impact on water.

Source: 'IWRM in developing countries: Lessons from the Mhlatuze in South Africa'. August 2007. N. Funke, A. Oelofse, J. Hattingh, P. Ashton, and A. Turton.

[The performance and impact of the CMA system being established needs to be monitored. Useful lessons will be learnt].

Cauvery System, Karnataka and Tamil Nadu (India)

The origin of this dispute lies in two controversial agreements signed in 1892 and then in 1924 between the Madras Presidency and the Princely State of Mysore. The State Government of Karnataka (which covers much of the former State of Mysore) claims that these agreements were skewed heavily in favour of the Madras Presidency (now largely the same as the State of Tamil Nadu) and therefore wants a renegotiated settlement based on equitable sharing of the waters. Tamil Nadu on the other hand, pleads that it has already developed almost 3,000,000 acres (12,000 km^2) of land and as a result has come to depend very heavily on the existing pattern of usage. Any change in this pattern, it says, will adversely affect the livelihood of millions of farmers in the state.



Among the causes of the river water disputes have been contested property rights, the difficulty in enforcing such rights, conflict of uses and a lack of willingness to compromise. Since the dispute lasted so long, there were continual increases in water use adding to the complexity of the 'principle of prior appropriation' of water rights. A co-operative outcome in such cases depends on several factors, the main one deemed to be the inter-relationship between the federal government and the two riparian states (one upstream and one downstream). Another associated factor influencing co-operation is the extent to which the claims of river waters can be elevated from those of immediate riparian peoples to those of an entire state.

Decades of negotiations between the parties involved bore no fruit and the Government of India finally constituted a tribunal in 1990 to look into the matter. The tribunal, after hearing arguments of all the parties involved for 16 years, delivered its final verdict on February 5, 2007. The dispute however, seems far from over with all four states deciding to file review petitions seeking clarifications and possible renegotiation of the order, this despite the provisions of the Inter-State Water Disputes Act of 1956

The dispute continues and as per a news item on July 10th 2009: '(IANS) Tamil film "Thambivudayan", which deals with the long standing Cauvery river water dispute between Tamil Nadu and Karnataka governments, is set to hit the screens soon.'. This demonstrates both the importance of the topic.

In India, as long as the political class in Karnataka views the Cauvery dispute as a rights issue of an upper riparian state and not as an effort at equitable sharing of water within the constitutional framework, the resolution of the dispute will remain problematic.

Hence, dispute or conflict resolution as defined by IWRM can be an extremely problematic issue particularly when socio-political issues are strong and the legislative system is 'tortuous'. However, solutions can be found with a strong political will.

A.4 Developing Countries - General

IWRM is discussed and attempted in many different countries across the world. Different conditions exist and different approaches are required. It is essential to appreciate this. IWRM practices and approaches introduced should always be evolving to yield improvements in water resources management in relation to the basic objectives of IWRM (see earlier).

It is of interest to quote an extract from IWMI – Water Policy Brief Nr 24: IWRM Challenges in Developing Countries.

"*International pressure and donor conditionalities sometimes oblige developing countries to initiate interventions without a local buy-in. There is a whole set of policy proposals widely espoused by researchers and donors and attempted by policymakers that have doubtful potential pay-off in a predominantly informal water economy like India because of the prohibitively high enforcement costs. When policing and enforcement costs of an intervention are high, there is a tendency to design interventions as a token, without serious intention to implement them. The Government of India's Model Groundwater Law is a good example. It has found no takers for the last 35 years because of the virtual impossibility of reasonable enforcement. Also, if made into a law, it is likely to create a whole new rent seeking economy at the lower levels of bureaucracy without any benefit to water resources or its users. On the other hand, we frequently see updates on India's Water Policy (1987, 1992, and 2005) which are easily adopted because of their non-binding nature but scarcely change anything on the ground; where, for example, the difficult clauses like setting up of inter-state river basin authorities are generally ignored.*

Currently, 40% of the population in the region of the Southern African Development Community (SADC) lack access to clean water and it is expected that by 2025 almost half of the SADC countries will be facing absolute water scarcity. This is in spite of the fact that sufficient water of good quality is available in many parts of the region. It is thus rather poor management and the lack of infrastructure that results in limited access to water.

In order to address this situation the political leadership of SADC adopted Integrated Water Resources Management (IWRM) as the guiding framework for the water sector. Several SADC member states have responded by initiating water reforms in their countries in line with IWRM principles. These reforms include the development of a national water policy, legislation and regulations, and the establishment of water resources authorities on the basis of river basins as units of planning.

In Africa, several countries have, during recent years, experimented with demand management ideas – in the guise of IWRM – such as pricing of water, instituting water withdrawal permits, and restructuring regional water departments as river basin organizations. Although it may be too early to write a report on these, countries like Ghana are already having second thoughts. The concerns are of four kinds: [a] most reforms have remained largely unimplemented, especially in the informal segments of the water economy that encompasses most of the users and uses; [b] implementation of reforms has disrupted customary arrangements for water management; [c] when zealously implemented, reforms – especially, water permits and water taxes – hit poor people in remote rural areas hard; and [d] 'demand management reforms' deflected policymakers from pursuing other important water-sector priorities, viz., improving water infrastructure and services."

Numerous factors can influence the form of IWRM that can be established in different countries. Some of the influencing factors are presented in the table below.

More developed countries	Lesser developed countries
Infrastructure • High level of development; infrastructure generally improving • Infrastructure decreases vulnerability to natural disasters • High ethos of infrastructure maintenance • High quality data and information; well coordinated	Infrastructure • Often fragile; frequently in a state of retrogression • High vulnerability to natural disasters • Low ethos of infrastructure maintenance • Data and information bases not always available
Capacity • Abundant scientific and administration skills available • Expertise developed to local levels • Flexibility to adapt to technological advances	Capacity • Limited scientific and administration skills available • Expertise highly centralised • Often in survival mode; technological advances may pass-by
Economy • Mixed, service driven; buffered by diversity • Economically independent and sustainable • Long term planning perspective • Wealthy; money available for IWRM and climate change adaptation	Economy • High dependence on land; vulnerable to climate • High dependence on donor aid, NGOs • Shorter term planning perspective • Limited wealth; less scope for IWRM and climate change adaptation
Socio-Political • Low population growth • Generally well informed public; high appreciation for science • High political empowerment of stakeholders	Socio-Political • High population growth; pressure on land • Generally poorly informed public; less appreciation for science • Stakeholders often not empowered; afraid to

More developed countries	Lesser developed countries
• Decentralised decision making	exert pressure • More centralised decision making
Environmental Awareness and Management • High level of expectation in planning and IWRM • Desire for aesthetic conservation	Environmental Awareness and Management • Lower level of expectation and attainment of goals • Need for basics for living

Source: Characteristics influencing IWRM, and hence responses to climate change, in more developed vs. lesser developed (after Schulze, 1999)

Thus there will be different objectives and different approaches to IWRM in developed and developing countries however the process should basically be the same.

Additionally, within a large country there can be regional differences as well as differences between the characteristics of stakeholders. In China, many of these factors can influence the situation.

A.5 Donor International Funding Agency adoption of IWRM

All donors and international funding agencies often incorporate a requirement to follow IWRM concepts in their water sector projects.

IWRM is a major component of the Asian Development Bank (ADB) water policy. In the past, ADB noted that projects tended to not be a part of a larger, coordinated strategy for water resources, or that they even considered the water uses within the project area but outside the main objectives of the project. The policy advocates IWRM as a means for re-emphasizing the importance of sustainable water resources themselves, rather than just their productive uses. To protect and manage a water resource, IWRM focuses on both quantity and quality issues.

Through its water policy, ADB pledges to help developing member countries undertake comprehensive water sector assessments, particularly at the most basic level-river basins. These assessments are critical for the overall reform process that IWRM calls for. In Appendix B is presented an interesting analytical approach to assessing the level to which IWRM has been taken up in a country, river basin or region. It relates to the ADB programme to introduce IWRM in 25 river basins in the Asia Pacific region in the period 2006 -10. The scoring system and descriptions could also be used to assess capacity building effectiveness by undertaking the scoring system on the same entity/area each year or each couple of years. It should be noted that there is no weighting given to the various elements, items such as stakeholder participation and inter-sectoral co-operation and collaboration should receive much larger ‘scores’ than some of the more technical practices that are typically carried out as a matter of course in most water resources management situations. However, the approach is useful for comparative purposes but perhaps should not be taken too literally in terms of an absolute

measure of the establishment of IWRM concepts in the water sector development and management situation.

World Bank interest in supporting the establishment of IWRM in many countries was a strong theme since the early 2000s.

A World Bank Report presenting an analysis of international examples of river basin management is : “Institutional and policy analysis of river basin management decentralisation - The Principle of Managing Water Resources at the Lowest Appropriate Level — When and Why Does It (Not) Work in Practice?” May 2005, (Edited by Karin Kemper, Ariel Dinar and William Blomquist) contains interesting international information from the case studies investigated.

“It also became apparent that, for some cases, supranational organizations such as the World Bank and the European Union influenced the development or modification of basin management programs or institutions. Both Spain and Poland have moved substantially toward IWRM (particularly in regard to water quality protection and water pricing) in response to the EU Water Framework Directive.

The World Bank’s promotion of IWRM and stakeholder involvement influenced the creation of the basin management organizations in Ceará, Brazil (the Jaguaribe case) and the continuity of the basin management corporation approach in Indonesia (the Brantas case). The Inter-American Development Bank supported the Tárcoles Commission and Sao Pãulo’s 1991 water law. A World Bank-financed project in the state of São Paulo supported the development of legislation that would have influence on the instruments for river basin management in the Alto Tietê basin and on its institutions, such as the Headwaters Protection Law and the draft water pricing law.

Basin-scale organizations have been created in each of the eight cases, but they differ in structure and type. Two of the cases featured state companies, two involved central government agencies operating within nationally-defined basin boundaries, and the other four were unique variations (one inter-governmental commission, one quasi-governmental commission, one nongovernmental basin council, and one hybrid basin committee/basin agency structure).

Because IWRM at the river basin level could involve a range of responsibilities and activities, it is not surprising that the cases studied differed in the functions they perform. Some had authority to allocate water to users and others did not. Many but not all were responsible for water quality. A few were engaged in setting and/or collecting water tariffs. Some operated dams, reservoirs, and other physical facilities. The only function performed by all was planning and coordination—all developed basin management plans and/or coordinated activities among multiple governmental and nongovernmental entities present within the basins.

Although management at the basin level is uniformly promoted as a way of increasing stakeholder involvement, there is no similarly uniform prescription for how this should be done. As expected, the eight cases demonstrated a variety of means of organizing stakeholder participation and soliciting stakeholder input into basin management decisions. Two of the cases, Brantas and Warta, had no established stakeholder organization (committee or other type) during the time of the study, although one (Brantas) had a program of outreach and communication between basin agency personnel and various individual stakeholders in the basin and the other (Warta) is now developing a regional water management council under the direction of a national law governing the structure and operation of basin management agencies. Other cases, such as the Alto Tietê and Fraser basins, had elaborate and multi-scale structures. Jaguaribe had numerous sub-basin user committees and commissions, but only the State Water Resources Management Company, which provides the technical support to these, operates at the basin scale, and Murray-Darling has a basin-wide Community Advisory Committee but not sub-basin ones.

The Guadalquivir and Tárcoles cases have representative structures incorporating a variety of stakeholders, but there were doubts about which of those bodies met regularly and whether the broadly representative ones had substantial input into basin management decisions.

Similarly varied are the means and sources of funding for the basin organizations in the eight cases. Three (Alto Tietê, Tárcoles, and Warta) rely solely on central government budget allocations at present, although there have been other sources for the Tárcoles basin commission in the past, and the basin agency and committee in the Alto Tietê are supposed to have revenue from water charges in the future. Three others (Brantas, Guadalquivir, and Murray-Darling) enjoy a combination of central government support and water user charges. One (Jaguaribe) is funded entirely by water user charges, although these are collected by the state water resources management agency and then reallocated to the basin. The non-governmental Fraser Basin Council obviously lacks the authority to levy taxes or charges on water use, and instead receives annual financial support from governments and project funds from a variety of sources."

Appendix B

IWRM Development Assessment *after* Asian Development Bank (ADB)

In the ADB Water Financing Program 2006-10, ADB developed an assessment process to judge the development of IWRM in different river basins (25 river basins). It is interesting to consider the IWRM elements identified and the scoring method employed.

As stated by ADB 'The following 25 elements are widely accepted to be important in introducing integrated water resources management (IWRM) in river basins. Incorporating these elements into institutional reforms, development strategies, and investment projects will make a significant difference for IWRM in the basin. Improvements may also be needed in the enabling environment at the national level.'

IWRM Element	Typical Interventions / Criteria
1.River basin organization	Build capacity in new or existing RBO, focusing on the four dimensions of performance (stakeholders, internal business processes, learning and growth, and finance) under the Network of Asian River Basin Organization's (NARBO) benchmarking service
2.Stakeholder participation	Institutionalize stakeholder participation in the river basin planning and management process including active participation of local governments, civil society organizations (academe, NGOs, parliamentarians, media), and the private sector, and an enabling framework for meaningful stakeholder participation in project specific planning decisions
3. River basin planning	Prepare or update a comprehensive river basin plan or strategy, with participation and ownership of basin stakeholders, and application of IWRM principles in land use planning processes
4. Public awareness	Introduce or expand public awareness programs for IWRM in collaboration with civil society organizations and the media
5. Water allocation	Reduce water allocation conflicts among uses and geographical areas in the basin with participatory and negotiated approaches, incorporating indigenous knowledge and practices
6. Water rights	Introduce effective water rights or entitlements administration that respects traditional or customary water use rights of local communities and farmers and farmer organizations
7. Wastewater permits	Introduce or improve wastewater discharge permits and effluent charges to implement the polluter pays principle
8. IWRM financing	Institutionalize models whereby all levels of government contribute budget to IWRM in the basin
9. Economic	Introduce raw water pricing and/or other economic instruments to share

IWRM Element	Typical Interventions / Criteria
instruments	in IWRM costs, stimulate water demand management and conservation, protect the environment and pay for environmental services
10. Regulations	Support the development and implementation of a legal and regulatory framework to implement the principles of IWRM and its financing in the basin, including tariffs, charges, quality standards and delivery mechanisms for water services
11. Infrastructure for multiple benefits	Develop and/or manage water resources infrastructure to provide multiple benefits (such as hydropower, water supply, irrigation, flood management, salinity intrusion, and ecosystems maintenance)
12. Private sector contribution	Introduce or increase private sector participation in IWRM through corporate social responsibility (CSR)-type contributions
13. Water education	Introduce IWRM into school programs to increase water knowledge and develop leadership among the youth, including responsibility for water monitoring in local water bodies
14. Watershed management	Invest to protect and rehabilitate upper watersheds in collaboration with local communities and civil society organizations
15. Environmental flows （flows to improve environment）	Introduce a policy and implementation framework for introducing environmental flows and demonstrate its application
16. Disaster management	Investments in combined structural and nonstructural interventions to reduce vulnerability against floods, droughts, chemical spills and other disasters in the basin
17. Flood forecasting	Introduce or strengthen effective flood forecasting and warning systems
18. Flood damage rehabilitation	Investments in the rehabilitation of infrastructure after floods
19. Water quality monitoring	Initiate or strengthen basin-wide water quality monitoring and application of standards
20. Water quality improvement	Invest in structural and nonstructural interventions that reduce point and non-point water pollution
21. Wetland conservation	Invest to conserve and improve wetlands as integral part of the river basin ecosystems
22. Fisheries	Introduce measures to protect and improve fisheries in the river
23. Groundwater management	Institutionalize and strengthen sustainable groundwater management as part of IWRM
24. Water conservation	Institutionalize a policy and implementation framework to promote efficiency of water use, conservation, and recycling

IWRM Element	Typical Interventions / Criteria
25. Decision support information	Improve on-line publicly available river basin information systems to support IWRM policy, planning, and decision-making, including dissemination of "tool boxes" and good practices

Achieving IWRM in a river basin is a long-term process, and each basin is different. This generic roadmap illustrates the incremental results of introducing IWRM elements in stages. A score of 30 out of 100 is taken as an indication of good achievement in introducing IWRM in the river basin.

IWRM Element	Score		
	0	2	4
1.River basin organization	No RBO exists yet	RBO has been formed but mandate is not well-defined; and organizational set-up and operational, responsibilities need improvement	RBO operates under a clear mandate and organizational-set-up; and improves its performance through capacity building programs
2.Stakeholder participation	No stakeholder participation in river basin planning and management process	Limited stakeholder participation in river basin planning and management process	Regular and meaningful stakeholder participation occurs in project specific or river basin planning decisions under an enabling framework
3. River basin planning	No river basin plan or strategy	No river basin plan or strategy exists yet; but there is river basin profile for basic basin information	A river basin plan or strategy exists as basis for basin investments. The plan gets updated regularly with participation and ownership of basin stakeholders
4. Public awareness	No public awareness programs for IWRM	Public awareness programs for IWRM has just been introduced; and are minimal in scope	Public awareness programs for IWRM are regularly implemented in collaboration with civil society organizations and the media
5. Water allocation	No system of water allocation resulting to conflicts in water use	Limited implementation of a system of water allocation	Water allocation among uses and geographical areas is implemented in the basin but there is scope for improvement, including for participatory and negotiated approaches, and for incorporating indigenous knowledge and practices
6. Water rights	No water rights or entitlement administration and customary rights not respected	Existing water rights or entitlements administration are partly or inefficiently implemented	Water rights or entitlements administration are implemented well, respecting traditional or customary water use rights of local communities and farmers and farmer

IWRM Element	Score		
	0	2	4
			organizations
7. Wastewater permits	No system of wastewater discharge permits and effluent charges	System of wastewater discharge permits and effluent charges need improvement	System of wastewater discharge permits and effluent charges are acceptable to stakeholders
8. IWRM financing	No government budget for IWRM	Limited government budget allocated for IWRM	Government budget for IWRM is institutionalized at some levels of governance
9. Economic instruments	No raw water pricing and/or other economic instruments exist	A system of raw water pricing and/or other economic instruments is partly or inefficiently enforced	A system of raw water pricing and/or other economic instruments is satisfactorily enforced that provide share in IWRM costs, stimulate water demand management and conservation, protect the environment and pay for environmental services
10. Regulations	No legal and regulatory framework to implement the principles of IWRM and its financing	Legal and regulatory framework to implement the principles of IWRM and its financing is not satisfactorily enforced	Legal and regulatory framework to implement the principles of IWRM and its financing is satisfactorily enforced and complied through sound implementing rules and regulations
11. Infrastructure for multiple benefits	No water resources infrastructure providing multiple benefits (such as hydropower, water supply, irrigation, flood management, salinity intrusion, and ecosystems maintenance)	A few water resources infrastructures providing benefits; but not efficiently managed	Several water resources infrastructures exist; and with scope to improve management
12. Private sector contribution	No private sector participation in IWRM	Private sector participation in IWRM is partly introduced	Several cases of private sector participation in IWRM
13. Water education	IWRM not yet introduced in school programs	IWRM is occasionally introduced in school programs	IWRM is regularly introduced in school programs; and with potential to be an integral part of school curricula
14. Watershed management	No investment to protect and rehabilitate upper watersheds	Minimal investment to protect and rehabilitate upper watersheds; with little collaboration with local communities and civil society organizations	Enough investments to protect and rehabilitate upper watersheds in close collaboration with local communities and civil society organizations
15. Environmental flows （flows to improve	No policy and implementation framework for introducing	A policy and implementation framework for introducing environmental flows	A policy and implementation framework for introducing environmental flows and to

IWRM Element	Score		
	0	2	4
environment）	environmental flows	exists but is weakly enforced	demonstrate its application is adequately enforced but with scope for improvement
16. Disaster management	No investments in combined structural and non-structural interventions	Separate and minimal investments for either structural or non-structural interventions	Substantial investments in combined structural and non-structural interventions to reduce vulnerability against floods, droughts, chemical spills and other disasters。
17. Flood forecasting	No flood forecasting and warning systems	Flood forecasting and warning systems exist but need improvement	Flood forecasting and warning systems are adequate and efficient
18. Flood damage rehabilitation	No investments in the rehabilitation of infrastructure after floods	Government provides limited budget allocation for the rehabilitation of infrastructure after floods	Government provides enough investments for the rehabilitation of infrastructure after floods
19. Water quality monitoring	No basin-wide water quality monitoring and application of standards	Partial water quality monitoring and weak application of standards	Basin-wide water quality monitoring; and adequate application of standards
20. Water quality improvement	No structural and non-structural interventions that reduce point and non-point water pollution	A few structural or non-structural interventions that reduce point and non-point water pollution	Several structural and non-structural interventions that reduce point and non-point water pollution
21. Wetland conservation	No investment to conserve and improve wetlands	Minimal investment to conserve and improve wetlands as integral part of the river basin ecosystems	Substantial investments to conserve and improve wetlands as integral part of the river basin ecosystems
22. Fisheries	No measures to protect and improve fisheries	Limited measures to protect and improve fisheries	Adequate measures to protect and improve fisheries
23. Groundwater management	No groundwater Management	Groundwater management is either just starting or is weakly enforced	Sustainable groundwater management is institutionalized as part of IWRM
24. Water conservation	No policy and implementation framework for water use, conservation, and recycling	A policy and implementation framework to promote efficiency of water use, conservation, and recycling is weakly enforced	A policy and implementation framework to promote efficiency of water use, conservation, and recycling is adequately enforced but with scope for improvement
25. Decision support information	No river basin information systems to support IWRM	River basin information systems to support IWRM are not upgraded, not working efficiently, and not publicly available	River basin information systems are up to standards but there is wide scope for improvement

Appendix C

Integrated Water Resources Management (IWRM) Document Series

Incorporating Water Demand Management (WDM)

The document set in the IWRM Series comprises:

OV - Overview
TP – Thematic Paper
AN – Advisory Note
EG – Example
M - Manual

Overview Document OV1 : Integrated Water Resources Management (IWRM)

Overview Document OV2 : Water Demand Management (WDM)

		Elements of IWRM Covered by documents		WDM related
	1	**Water Resources and Demand Assessment**		
		1.1	**Models for Water Resources Planning and Management**	
1		TP1.1	Groundwater Flow Modelling	
2		AN1.1	Models for Water Resources Planning and Management: Selection Procedures	
		1.2	**Groundwater Resources Assessment**	
3		TP1.2	Groundwater Resource Quantity Assessment	
		1.3	**Using the WEAP Model for Water Resources Planning and Management**	
4		AN1.3	Using the WEAP Modelling Software	
		1.4	**Using the MIKE BASIN Model for Water Resources Planning and Management**	
5		AN1.4	Use of MIKE BASIN Simulation Software (Issued in Chinese only)	
		1.5	**Water Quality Modelling for Water Resources Planning and Management**	
6		TP1.5	Use of Water Quality Modelling for Water Protection	
7		AN1.5	Use of QUAL2K Water Quality Model in IWRM Planning	
8		EG1.5	Water Quality Modelling in Chaoyang, Liaoning Province	
		1.6	**Data for Water Resources and Demand Assessments**	
9		AN1.6	Data Preparation for Water Resources Assessment Modelling	
		1.7	**Monitoring for Water Resources Assessments**	
10		AN1.7	Designing a Monitoring Programme for Water Quality Modelling	
		1.8	**Establishing Demands**	
11		TP1.8	Water Demand Forecasting	
12		AN1.8/1	Water Demand Forecasting	
13		AN1.8/2	Agricultural Water Use Norms	
		1.9	**Climate Change Studies**	
14		TP1.9	Climate Change and Water Resources	
	2	**Integrated Water Resources Management and Planning**		
		2.1	**IWRM Planning**	
15		AN2.1	Developing an IWRM plan	
16		EG2.1	Comprehensive (IWRM) Plan for the Shiyang River Basin	
		2.2	**Stakeholder Participation for Water Resources Planning and Management**	
17		TP2.2	Stakeholder Participation in IWRM Planning	

		Elements of IWRM Covered by documents		WDM related
18		EG2.2	Initial Stakeholder Analysis for Shiyang River Basin IWRM Plan	
		2.3	**Developing and Modelling Scenarios for IWRM Planning**	
19		AN2.3	Water Resources Scenario Development and Scenario Modelling	
		2.4	**Environmental Issues in IWRM Planning**	
20		AN2.4/1	Environmental Risk Assessment	
21		AN2.4/2	Environmental Water Allocation	
		2.5	**Drought Management Planning**	
22		TP2.5	Drought Management for Water Resources Managers	
23		AN2.5	Developing a Drought Management Plan – Guidance for Water Resources Managers	
24		M2.5	Using the Standardised Precipitation Index (SPI) to Assess Drought Condition	
25		EG2.5	Preparation of a Drought Management Plan for Chaoyang Municipality, Liaoning Province, Focused on Water Resources	
		2.6	**Groundwater Management**	
26		TP2.6/1	Groundwater Management	
27		TP2.6/2	Groundwater Monitoring and its Importance to IWRM	
28		TP2.6/3	Conjunctive Use of Groundwater and Surface Water	
29		EG2.6	Conjunctive Use of Groundwater and Surface Water in Minqin	
30		AN2.6/1	Groundwater Monitoring – River Basin to County Levels	
31		AN2.6/2	Groundwater Monitoring at Village Levels	
		2.7	**Water Allocation**	
32		TP2.7	Water Allocation Issues	
		2.8	**Economic Analysis for IWRM Planning**	
33		AN2.8	Economics for IWRM Planning	
34		EG2.8	Economics for IWRM Planning - Shiyang River Basin IWRM Plan	
	3	**Demand Management**		
		3.1	**Water Saving in Agriculture**	
35		TP3.1	Water Saving in Irrigated Agriculture	
36		AN3.1/1	Agricultural Water Saving Techniques (WMS/WAB level)	
37		AN3.1/2	Practical Techniques for On-Farm Water Saving	
		3.2	**Demand Management for Urban Water Supplies**	
38		TP3.2	Urban Water Supply Demand Management	
		3.3	**Reducing Unaccounted For Water in Urban Supply Systems**	
39		TP3.3	Active Leakage Control as a Key Component in Increasing Efficiency in Urban Water Supply	
40		AN3.3/1	Implementing an Active Leakage Control Programme for Small to Medium Water Supply Companies	
41		AN3.3/2	Asset management for Small or Medium Size Water Supply Companies	
42		M3.3	Active Leakage Control Manual for Small to Medium Size Water Supply Companies	
		3.4	**Demonstrating Water Savings**	
43		AN3.4	Auditing of Water Saving Society	
	4	**Permitting**		
		4.1	**Abstraction Licensing Systems**	
44		TP4.1	Abstraction Licensing Systems - International Experience	
45		EG4.1	Water Abstraction Permit Management: Current Practise and Alternatives for Shiyang River Basin	
		4.2	**Discharge Licensing Systems**	
			No document – see TP 8.4 for some information	
		4.3	**Regulation of Small Water Companies**	
46		TP4.3	Regulation of Small and Medium Size Water Supply Companies	
	5	**Economic Tools**		
		5.1	**Economic Issues related to IWRM**	
			No document – see other documents under ‘5’ and ‘6’	

		Elements of IWRM Covered by documents		WDM related
		5.2	**Irrigation Service Charges**	
47		AN5.2	Formulation of Irrigation Service Charges for Surface Water Irrigation Schemes	
48		EG5.2	Assessment of an ISC System: Donghe Irrigation District (Jinchang, Gansu)	
		5.3	**Water Resource Fees**	
49		TP5.3	Water Resource Fees	
		5.4	**Tariff Setting for Urban Water Supplies**	
50		AN5.4	Tariff Setting for a Small to Medium Size Water Supply Company	
51		EG5.4	Tariff Setting for Beipiao Water Supply Company	
		5.5	**Willingness to Pay**	
52		AN5.5	Willingness to Pay Surveys (Urban Water Supply)	
53		EG5.5	Willingness to Pay Survey for Beipiao Water Supply Company	
		5.6	**Affordability of Water**	
			No document – see other documents under ‘5’ and ‘6’	
		5.7	**Financial Management for Small and Medium Water Supply Companies**	
54		TP5.7	Financial Management and Modelling in Small and Medium WSCs	
55		M5.7	The Development and Use of a Model for Financial Analysis of a Small to Medium Size Water Supply Company in China	
	6	**Social Change and Water Saving Society**		
		6.1	**Water User Associations and Water Saving Society**	
56		AN6.1/1	Role of WUA in Water Saving in Groundwater	
57		AN6.1/2	Farmers Guide to Groundwater WUAs	
58		EG6.1	WUAs in Groundwater Areas	
		6.2	**Strengthening of WUAs**	
59		AN6.2/1	Administrative Steps for Developing Strong WUAs	
60		AN6.2/2	WUA Institutional Document Guides	
61		AN6.2/3	Village Level Planning of WUAs	
62		AN6.2/4	Promoting and Training of WUAs	
		6.3	**Social Issues related to IWRM**	
63		TP6.3/1	IWRM, Irrigation and its Social Context	
64		TP6.3/2	Assessing the Impact of IWRM on Women’s Status and Conditions	
65		AN6.3/1	Social Monitoring	
66		AN6.3/2	Socio-economic Monitoring in Agricultural Water Management – (Issued in Chinese only)	
67		EG6.3	Socio-economic Monitoring for Agricultural Water Demand Management in Gansu	
	7	**Balancing Interests**		
		7.1	**Multi-criterion Analysis as a tool for allocating resources**	
68		TP7.1	Multi-criterion Decision Analysis – An Introduction	
69		AN7.1	Using a Multi-criterion Decision Model for Water Resources Planning	
70		EG7.1	Simplified Multi-criterion Decision Analysis for the Shiyang River Basin IWRM Plan	
	8	**Information Exchange**		
		8.1	**Data Sharing, Management and IWRM**	
			No document	
		8.2	**Use of Geographic Information Systems in IWRM**	
71		AN8.2	Application of GIS in IWRM – (Issued in Chinese only)	
		8.3	**Monitoring and Evaluation**	
			No document	
		8.4	**Collaborative Working and Data Sharing**	
72		TP8.4	Inter-agency Collaboration for Improved Water Quality Management	
73		AN8.4	Use of Inter-agency Agreements for Collaborative Water Quality Management	

Document Reference Sheet

Glossary:

Aarhus Convention	United Nations Economic Commission for Europe, Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters, 1998. http://www.unece.org/env/pp/
CMA	Catchment Management Authority as established in the Republic of South Africa
Competent Authority	Term used under the European Water Framework Directive to denote the organisation designated by national authorities as the body responsible for river basin management planning and overseeing implementation of measures within the basin.
Dublin Principles	United Nations Environment Program Dublin Conference on Water and the Environment (1992). The Dublin Principles set out international guidelines for sustainable water resource management. These advocate a holistic approach, linking social and economic development with protection of natural ecosystems, and recognising it is the first basic right of all human beings to have access to clean water and sanitation at an affordable price.
DWAF	Department of Water Affairs and Forestry, Republic of South Africa
Environmental assessment of water condition (hydro-ecology)	Ecological assessment methods based on selected aquatic flora and fauna. It is usual to select a range of indicator species or habitats.
Global Water Partnership (GWP)	Created in 1996 by the World Bank, the United Nations Development Program and the Swedish International Development Agency. The GWP is a working partnership among all those involved in water management: government agencies, public institutions, private companies, professional organizations, multilateral development agencies and others committed to the Dublin-Rio principles
Helsinki Rules and Berlin Rules	Drawn up by the International Law Association (ILA) in Helsinki (1966). Adapted by the UN Convention on the Law of Non-Navigational Uses of International Watercourses, 1997. The 'Helsinki Rules' are a statement of customary law regarding the reasonable and equitable share in the beneficial uses of the waters of an international drainage basin. In 2004 the ILA issued the 'Berlin Rules' covering all freshwaters: surface and groundwater whether international or national resources.

Glossary (continued):

ICPDR	International Commission for the Protection of the Danube River
ICPR	International Commission for the Protection of the Rhine
Integrated water resources management (IWRM)	IWRM can be defined as a process which promotes the co-ordinated development and management of water, land and related resources in order to maximise the resultant economic and social welfare in an equitable manner without compromising the sustainability of ecosystems.
MDBC/MDBA	Murray-Darling Basin Commission established 1992, superseded by the Murray-Darling Basin Authority 2008
NGO	Non-governmental organisation
Precautionary principle	According to this principle, if there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.
Sustainable diversion limit (SDL)	Term used under the Australian Water Act 2007, Murray-Darling Basin Agreement. The Basin Plan sets sustainable diversion limits on the quantities of surface water and groundwater that can be taken from the Basin water resources.
Tennessee Valley Authority (TVA)	Established in 1933 to guide the development of the resources of the Tennessee River Basin in the south-eastern USA. TVA continues to operate a wide variety of water, power, economic development, and environmental programs within the region
Water Framework Directive (WFD)	European Union (EU) Directive 2000/60/EC designed to improve and integrate the way water bodies are managed throughout Europe.
WUA	Water User Association

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Helsinki and Berlin Rules http://en.wikipedia.org/wiki/Helsinki_Rules www.cawater-info.net/library/eng/l/berlin_rules.pdf

'RIVER Murray irrigators will most likely receive a lower water allocation this season than they did last year, new data shows.', 'Adelaide Now'. July 2008 http://www.news.com.au/adelaidenow/story/0,22606,23985331-2682,00.htm

China AAA Project : China Addressing Water Scarcity: From Analysis to Action 2006

The program was managed by the World Bank in collaboration with UK Department for International Development (DFID), the Development Research Center of the State Council of China (DRC), relevant central government ministries and local governments, and selected research institutes and universities in China. To ensure strong ownership and participation of the Chinese government, the AAA program established an advisory group and a working group consisting of government officials from key Chinese government ministries.

Major Outputs

- Diagnostic report on China water issues, covering government priorities and plans, performance indicators and evaluation, and implementation barriers.
- Background papers on international experience in integrated water resource management in Europe, the United States, Israel, Japan and Singapore.
- Case study report and policy note on water pollution emergency prevention and response in China as well as a set of 4 background papers on international experience.
- Urban water sector strategic directions study report.
- Study report and policy note on water pricing, willingness-to-pay, and social affordability.
- Study report and policy note on water rights.
- Study report and policy note on ecological compensation mechanism.
- Case study report on economic valuation and policy analysis of the Hai Basin.
- Case study report on water resources management in Chongqing.

Information (Chinese and English) can be obtained at the World Bank website:

www.worldbank.org/eapenvironment/ChinaWaterAAA

Document Reference Sheet

Selected related materials from the MWR IWRM Document Series:

Advisory Note 2.1	Developing an IWRM Plan
Thematic Paper 2.2	Stakeholder Participation in IWRM Planning
Thematic Paper 2.7	Water Allocation Issues
Thematic Paper 4.1	Abstraction Licensing Systems – International Experience

Also, see Appendix C

Where to find more information on IWRM – recommended websites:

Ministry of Water Resources: www.mwr.gov.cn

Global Water Partnership: www.gwpforum.org

WRDMAP Project Website: www.wrdmap.com

OV1

China – UK, WRDMAP

Integrated Water Resource Management Documents
Produced under the Central Case Study Documentation Programme of the GoC, DFID funded, Water Resources Demand Management Assistance Project, 2005-2010.

Documents will comprise of:

Thematic Papers

Advisory Notes

Manuals

Examples

Training Materials

IWRM Document Series materials, English and Chinese versions, are available on the following project website

WRDMAP Project Website: www.wrdmap.com

Advisory Services by : Mott MacDonald (UK) leading a consultancy team comprising DHI (Water and Environment), HTSPE (UK), IWHR, IECCO (Comprehensive Bureau), CIAD (China Agricultural University), Tsinghua University, CAAS-IEDA, CAS-CWRR, Gansu WRHB and Liaoning WRHB.

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