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2. IWRM

Thematic Paper 2.7: Water Allocation Issues

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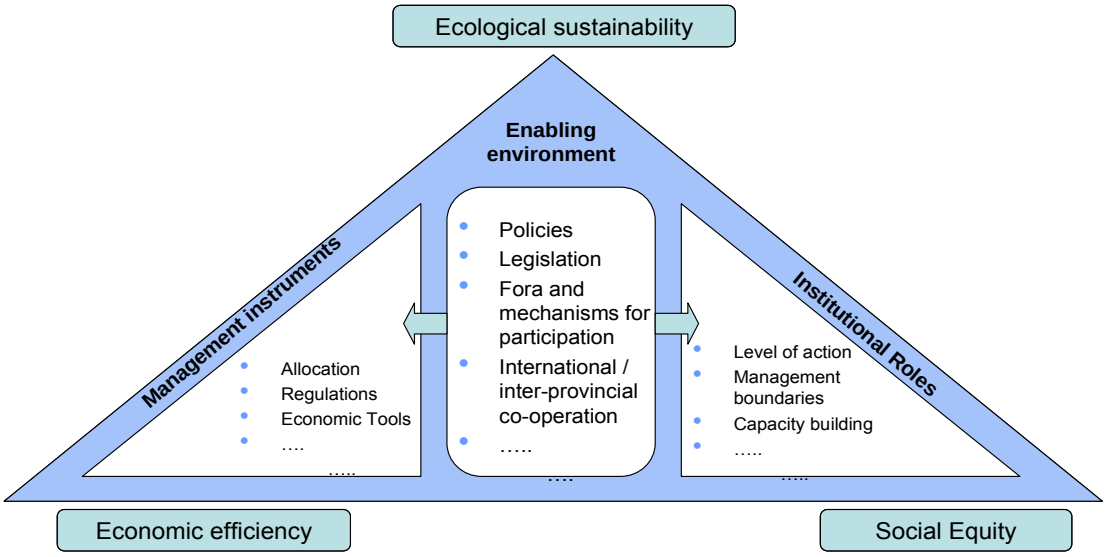
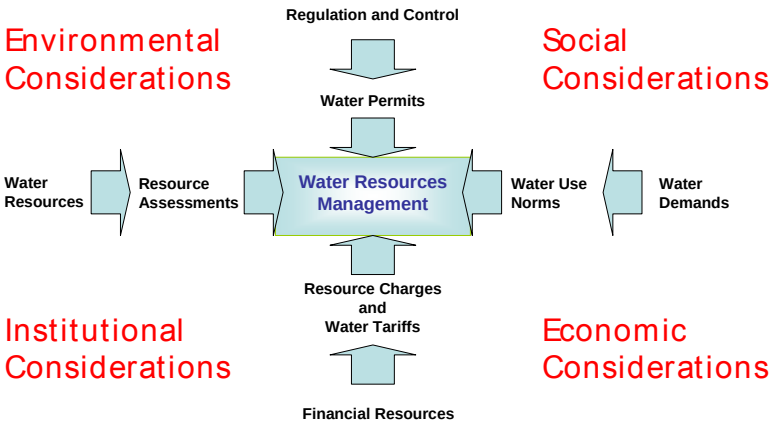
Integrated Water Resources Management (IWRM)

(Basics after Global Water Partnership)



Driving Elements of Integrated Water Resources Management



(Second figure after WRDMAP)

Summary: The objective of the Thematic Paper is to review the topic of water allocation outlining the often complex and inter-related issues that should affect any water allocation process.

The document provides an overview of water allocation practices. It presents features of international water allocation practices with specific reference to England and Wales as well as Australia.

Information is presented on the background to water allocation in the country and covers some of the issues often encountered.

The content structure of the Thematic Paper is:

- Introduction: explaining why water allocation is important in a water stressed situation
- Water allocation: covering forms of allocation, water rights, water allocation practices and legislative background
- Water allocation planning: as pertaining to the current situation
- Summary and observations
- Appendix A: Related topics: outline of environmental allowances and the use of simulation modelling

This document is one of a series covering topics on sustainable water resources planning, allocation and management. Details are given in the bibliography.

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.

1 Introduction

1.1 Background

The objective of the Thematic Paper is to review the topic of water allocation outlining the often complex and inter-related issues that should affect any water allocation process.

Water allocation is generally considered to be the process of allocating or sharing water between different users or consumers based on a set of principles defined in a water allocation policy statement.

However, the word 'allocation' is also used to mean the quantity of water allocated to different users or consumers. This is also referred to as the allotment of water. Thus in English, the word 'allocation' can mean either the process of allocating water, or the amount of water allocated.

Water resources allocation is a decision making process, involving the distribution of available water resources in respect to:

- location (from where it can be taken and sometimes where it can be used),
- time (when water can be abstracted),
- purpose (what it can be used for and sometimes how it should be used),
- user (who can abstract it and who can use it)

….. whilst all of this has to be in line with government policy.

In the context of integrated water resources management (IWRM), the allocation process, linked to the water

abstraction permitting system, is termed a 'regulatory instrument'.

The process of water 'allocation' is used in various situations however, all are inter-related. These can be:

- Long term water allocation planning (5 to 10 years perhaps)
- Short term water allocation planning (one year or seasonal etc)
- Water rights allocation, generally linked to water abstraction permits or sometimes water tickets or similar

Whatever the allocation aspect there is a need to have a sound knowledge of water resources availability as well as water user demand characteristics and those associated with the environmental needs.

Water allocation will need re-consideration when changes take place in water resources availability as well in water use characteristics, perhaps brought about through demand management.

Water allocation between users needs to be based on various priorities or supply principles that are normally set by government policy.

Water allocation needs to be decided by a process involving stakeholders, whilst the stakeholders must use any water allocation in the manner as defined by the water right or other form of agreement.

The Ministry of Water Resources (MWR) is responsible for water resources management. The MWR and the main river basin organisations have been involved in water allocation planning for many years. Considerable progress has been made on the topic of 'water rights' within the context of the situation in the country. Many years ago a water abstraction permit system was introduced across the country with the aim of basically placing a cap or upper limit on resource abstraction.

The system of water abstraction permitting has recently been strengthened through State Council Decree No 460 (SCD460) that supports the 2002 Water Law, updating and replacing 'SCD119' (associated with the old 1988 Water Law).

However, the institutional responsibilities of the past, and to some extent currently, has meant that issues such as environmental allowances and groundwater allocation have not been integrated adequately into overall water resources management and water allocation practices. Additionally, water abstraction permits (WAPs) were often being issued in many places without a sound knowledge of resource availability. The issuance of WAPs sometimes being in the hands of those not fully conversant with the status of water resources availability in the area concerned.

Increasing pressure on water resources, and the government's desire to pay more attention to environmental issues has created a need for improved water allocation policies and practices.

Sound water resources management is essential to ensure the sustainability of resources and the equitable and optimum allocation of the available resources. All elements associated with water allocation need to be given more attention. Water allocation planning and the capping of abstractions are important aspects

receiving considerable current attention by the MWR.

Water allocation is considered to be best undertaken within the conceptual framework of **integrated water resources management (IWRM)**. Water allocation must also take into account any water demand management (WDM) interventions.

1.2 Stress on water resources systems

Over a concentrated period of development in the last 50 years, water resources have been over-exploited in many parts of the country, particularly in the north. The over exploitation is evidenced by the severely impaired ecological status of many rivers, whilst groundwater levels have continuously declined in many parts implying that in many areas current water usage is unsustainable.

The situation has been aggravated by the levels of pollution that have been discharged into the environment primarily by industries and sewage effluent from the large urban centres that have developed. This contamination of the environment and pollution of water resources has consequently reduced the quantity of fresh water available for 'allocation' to meet the demands of potential users. The situation is further complicated by the often conflicting demands of hydropower and irrigated agriculture.

1.3 Addressing water stress

Increasing stress on water resources makes it more important to establish abstraction licensing systems, with effective consideration of water allocation and water rights at all levels of water management. Importantly, all elements must be seen as inter-related and addressed in an integrated way.

A system of river basin management, water abstraction licensing and basic water allocation has been established at various levels of effectiveness over the years. However, there has generally been less linkage between the local water abstraction licensing system to the top-down water allocation system. Additionally, knowledge of how water allocation procedures should take into account both ecological needs and allowances for the future would appear to be limited.

Water allocation is frequently dominated by surface water considerations. The issue of groundwater allocation needs to be given more weight. Surface water allocations can impact on groundwater conditions, whilst to optimise on the total water resources regime the **conjunctive use** of surface water and groundwater is important.

2 Water Allocation

2.1 Background

It is useful to consider an international definition of 'water allocation'. In the UK, it is taken as the volume of water that a license (water abstraction permit) holder may take over a defined period of time.

Water allocation must take into account beneficial use of water, equitable distribution and the principle of 'no significant harm to people or the environment'. Water allocation is inextricably linked to the issue of 'water rights'. Water allocation relies heavily on a sound knowledge of water resources availability. Uncertainty in the knowledge of water resource

availability should be accommodated through the introduction of a tolerance allowance, sometimes referred to as a 'contingency', 'uncertainty' or 'headroom' allowance.

A good summary of the basics of water allocation is given in the paper by Wang, Zheng, and Wang '*A harmonious water rights allocation model for Shiyang River Basin, Gansu Province*', and is presented in Box 1.

Box 1 Extract from Wang et al. paper summarising the basics of water allocation

Introduction

In recent decades, much attention has been focused on water rights systems for supporting improvements in water resources management in China (Gao, 2006). An initial allocation of water rights to determine annual water use caps for different users in a reasonable and transparent way underpins better water resources management. Water conservation, environmental protection, rational development and utilisation of water resources, conflict resolution and the development of water markets all depend on the definition and allocation of water rights. Developing and implementing a modern system of water rights across China is a complex task however.

Initial Water Rights Allocation Principles

Allocation principles for the basis for water rights allocation, setting out clearly the multiple objectives of water utilisation. A set of reasonable and acceptable principles are also needed to ensure political and public acceptability. There are a number of water rights allocation principles applied in different countries, including those of riparian ownership, prior appropriation and public rights. International experience highlights how these principles have evolved according to local context (Ge 2002). In regions with relatively abundant water such as Europe and Eastern America, riparian principles have dominated. Conversely in regions of relative scarcity such as western America, the prior appropriation doctrine has dominated, supplemented by riparian rights. In Japan both 'upstream priority' and 'first in time, first in right' principles have been implemented together. In China, water allocation principles have also evolved according to changing political and economic priorities. International comparisons provide some lessons, but there is no simple blueprint for China (Ge, 2002).

The adoption of water rights allocation principles depends on history, the objectives of water resources management and actual conditions of water resources in a river basin. In order to achieve the rational and efficient use of water, it is necessary to select principles according to 'facts on the ground'. In China such experts as Wang (2001), Liu (2003), Lin (2002), Ge (2003) and Ge (2004) have put forward different water rights allocation principles. This paper seeks to reclassify and compare them, and aims to determine a set of principles that can guide the initial allocation of water rights in China, focusing on a 'Basic Water Demand Guarantee', 'Sustainable Development' and 'Fairness and Efficiency'.

Basic Water Demand Guarantee

Basic water demand can be defined as the water needed for basic living, basic ecology, basic economic (development) and basic crop production. These universal entitlements are needed to support human existence, key environmental services and food security. Generally, in water allocation, basic water demands should receive the highest priority, be reserved in advance and satisfied first.

Sustainable Development

There is now a common consensus that water resources allocation and development should be informed by an understanding of system sustainability. In this paper, the sustainable development principle focuses on 'ecological' water demand. This in turn is divided into 'basic' and 'exclusive' demands. Basic demand refers to the water needed to maintain the basic (out-of-stream) ecology of a basin and to ensure safe water quality and flows, and should be satisfied under the Basic Water Demand Guarantee principle outlined above. 'Exclusive' ecological water refers to the water needed to restore and develop the ecology of a basin – both within and outside the water course. This is determined by the objectives set for ecological restoration and available water in the river basin.

Fairness

There are several important factors that affect people's perception of fairness with respect to water rights allocation. These include prior use and customary rights, population served, the irrigation area, the contribution of water to livelihoods and production, water shortages experienced and future needs of different stakeholders, including environmental needs. For water use to be considered 'fair', all of these factors need to be considered and balanced against one another.

Efficiency

The efficiency principle relates to the economic efficiency of water use. Efficiency criteria include the productivity of water use, in terms of (for example) revenue or output per unit of water consumptively used.

In most cases there are contradictions between fairness and efficiency in water allocation (Wang, 2006). Fairness requires that the water allocated to stakeholders is relatively equal and proportional, while efficiency requires that those stakeholders with higher water use efficiency and greatest 'income or revenue per drop' should get more water. However, it is difficult to satisfy both at the same time. From a legal and ethical point of view, fairness should be the main priority in initial water rights allocation, with efficiency then addressed through water trading. Fairness embodies the factors listed above, and is approached most readily through consideration of current patterns of water use in relation to other factors.

Integrated Surface Water and Groundwater Management

An initial allocation of water rights needs to consider interactions between surface water and groundwater, as these systems are often inter-related in the water cycle. For example, groundwater can provide base flow to rivers, and irrigation returns can provide significant groundwater recharge.

Source: Wang Z, Zheng, H and Wang X, 2009, 'A harmonious water rights allocation model for Shiyang River Basin, Gansu Province', Journal of Water Resources Development, June 2009.

From the earliest times, water resources have been allocated on the basis of social criteria - maintaining a community or communities by ensuring that water is available for human consumption, for sanitation, and for food production. Societies have invested capital in infrastructure to maintain this allocation. Yet social change, including changes in (and more understanding of) how goods are distributed, has raised new issues in water allocation with a strong economic focus.

Population and industrial growth has made water scarcity a major problem in many provinces and water pollution, while by no means a recent problem, is more widespread and serious than ever before. Inefficient use of water, poor cost recovery for operating and maintenance expenses, the mounting cost of developing new water sources, and problems with the quality of service in agency-managed systems has led to a search for alternatives that make water allocation and management more efficient.

Strategies to address water scarcity involve temporary measures to manage periodic episodes of shortage, or permanent measures to resolve chronic situations of over allocation. Potential conflicts resulting from low water conditions/availability or peak user demands can be managed using voluntary or mandatory restrictions on water use e.g. ‘drought orders’. Their implementation may reflect a prioritisation of uses or may be imposed uniformly on all users. Such topics are normally an element of a drought management plan (DMP) rather than a water allocation plan.

Improvements in the coverage of the hydrometric network are often advisable to improve the knowledge of the available resources. Similarly monitoring of **actual water use**, especially of heavy water users, is often critical in the development of equitable water resource allocation.

2.2 Forms of allocation

Internationally, recent emphasis has been placed on the basic principle of treating water as an economic good and of allocating it between the sectors accordingly. Issues to consider related to economic principles include marginal cost pricing, social planning, user-based allocation, and water markets. In all countries the government must play an important regulatory role and allocate water between sectors and users.

Implicit allocation systems provide water through top-down, government-driven planning processes, in which the quantities of water for specific projects and administrative areas are determined. These then become accepted practice with inter-annual variations based on a long term water allocation plan.

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.

User-based allocation is generally more flexible than implicit 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.

Market-based allocation is a new approach which depends on the economic value of water for various uses. This can lead towards 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 to be a need to adequately address the **issue of environmental water allocation** since fear of irreversible environmental degradation is increasingly a key concern for governments. This is a critical issue in many parts of the country.

Current practices in the country are generally a combination of the first two systems, but the focus now is on

developing explicit allocation, based on a system of water rights. The advantages and disadvantages of the various systems are described in Table 1.

Table 1: Advantages and disadvantages of different allocation systems

Advantages	Disadvantages
Administrative or Planned (Public) Water Allocation	
• Provides means to promote equity objectives; • It CAN protect the poor; • It CAN address environmental needs; • Can be based on historic water rights or water allocations (?); • Can fully reflect water rights; • Can reflect the aggregated permit agreements; • Can be easily modified based on political or socio-economic needs;	• Fails to consider true water costs; • Can fail to drive water demand management; • Can lead to waste and resource mismanagement; • Penalties on misuse or over-use can ignore the true economic benefits that are being squandered; • Sometimes works against true public intervention; • Can induce poor performance in government operated irrigation schemes or urban water supply systems; • Often inflexible and 'deaf' to needs; • Inter-sectoral allocations unclear; • Water pricing simple and does not reflect true worth.
Water User based Allocation	
• Provides potential flexibility to adapt allocation to meet local needs both spatially and temporally; • Local knowledge can drive decision-making better; • Can create better response to emergencies; • Can be advantageous within the local political system; • Has the potential to address poverty and equity issues; • Creates a feeling of ownership and worth.	• Requires a transparent institutional structure; • Inter-sectoral re-allocation can be impaired; • Inter-user-group re-allocation may be difficult without 'public administrative' intervention or the creation of a federation of water user groups; • Can require knowledge levels beyond the scope of users; • Can adversely impact on poor groups or disadvantaged if there is a lack of transparency in the decision making process for whatever reason.
Water Users must have the power to make decisions on water rights; *Some form of ownership rights on water infrastructure strengthens the system*	
Market Driven Allocation	
• Can be economically efficient (low financial return use to high financial return use); • Both buyer and seller should be benefiting. • Encourages water use efficiency in both the potential buyer and seller – creates the environment for investment in water saving technologies and other water saving approaches; • Increase the empowerment of water users	• Definition of water rights needs to be very clear; • Impact on third parties such as farm labour when there is a transfer from agriculture to industry; • Lack of equity in the relationship between industrial might and poor farmer leading to perhaps unfair trading conditions; • Difficulties in ensuring third party

(as long as they have rights);
- Increases flexibility within water users;

compensation allowances are made or defined properly;
- Use rights inherently carry capitalised value e.g. irrigation system infrastructure – how to allow for this?

There is a need to really differentiate between 'water markets', 'spot water markets' and simple 'water rights trading', be it permanent or for a specified time period. It is believed that the necessary conditions are not yet in place for true markets to operate, especially in relation to the institutional and legal frameworks for trade. At the moment, all that is possible is simple water transfers.

Marginal cost pricing

- In an ideal world is theoretically correct
- Avoids under-pricing water;
- When water is scarce water prices must rise;
- Creates realistic revenue streams;
- Constrains over-use and mis-use, driving increased efficiency in water use and system performance;
- Can incorporate pollution charges
- Numerous use incentives can be incorporated.
- Difficulties in defining marginal costs;
- Inadequate knowledge of costs and benefits by sector, location and possibly time step;
- Difficulties aggravated by short term and long term considerations especially in the context of costs for sourcing new water;
- Equity, poverty issues not easy to include.. Needs safety net allowances incorporated;
- Requires considerable volumetric supply information.

BASICALLY often too complicated and 'data hungry'

2.3 Water Rights

Water allocation is inextricably linked to water rights of one form or other. There many definitions of 'water rights' and these have developed over the years. This has been the subject of much discussion in the water sector in the country over recent years.

A water rights system is a legislated control on water resources that identifies the quantity of water that can be abstracted from a particular water resource under defined conditions and is specified, for each abstractor, in the form of a water abstraction or withdrawal permit. More information on water abstraction permitting or licensing systems is to be found in Thematic Paper TP4.1.

A basic definition of 'water right' is given in Box 2.

Box 2 Definition of 'Water Right'

"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 are fundamental differences between the nature and source of water rights in different countries, including that they can be land-based rights, use-based rights, or rights based on ownership of water bodies."

Source: 'Wikipedia'.

A further description of water rights is given in Box 3 taken from a review of international water rights undertaken through the Productivity Commission of Australia.

Box 3 Review of international water rights systems

"Governments manage water resources by issuing 'rights' (licenses, allocations, entitlements) to control water use. Water rights vary enormously, within and between jurisdictions, in their duration, security, flexibility, divisibility and transferability.

There are two basic systems used to ration the (variable) supply of water in the jurisdictions studied:

- *Governments devise plans to share the volume that is available for consumption among the holders of each class of right. Water rights are defined in volumetric terms, with a statement of the probability that the nominal volume will be delivered in full in any given year.*
- *Governments and courts recognise historic claims to access fixed volumes of water on a strict priority basis determined by the length of time each right has been held.*

Governments generally also seek to ensure that sufficient water is available for a variety of environmental purposes.

In jurisdictions using the 'planning' approach, governments explicitly set out to achieve a balance between the economic, social and environmental objectives of the community, despite uncertain community preferences and environmental effects.

Thus in the Australian jurisdictions studied, licences can be varied to obtain additional water for the environment. The timing and volume of water requested by right holders may also be varied administratively.

In those jurisdictions with secure and tradeable permanent water rights, such as California and Colorado, agencies obtain additional water for the environment by purchasing existing rights from the current right holders; harvesting additional water; or investing in water savings programs.

Both systems have strengths and weaknesses: in particular, the benefits of clear private rights versus the flexibility of governments to manage the resource.

The economic, social and environmental interests of those affected by water resource management decisions are more likely to be satisfied if sound governance arrangements and processes are in place.

Restrictions on water trading and 'exchange rate' problems can adversely affect the efficient transfer of water rights to higher valued uses.

Subsidies and differences in the level of cost recovery in the pricing of infrastructure potentially reduce the efficiency of water trading.

Water rights arrangements are complex, with many inter-relationships and dependencies in their provisions. It is important that care be taken in seeking to adjust any one component of a system, as there would usually be ramifications for the integrity of the system as a whole."

Source: http://www.pc.gov.au/research/commissionresearch/waterrights/keypoints

There are many key requirements of a water rights system. Some of these, summarised from the Productivity Commission Report (Australia, 2003) being:

*"**Universality**: All water resources are covered by the system of rights;*

***Predictability of volume**: Users have a reasonable expectation of the volume of water that will be available*

to them (although this is difficult to ensure owing to climatic variability);

***Enforceability**: The right is protected from the encroachment by others;*

***Certainty of title**: There is a legal recognition and protection of rights;*

***Duration**: The time period over which users possess the right specified;*

***Detached from land title and use restrictions**: The right is separate and free of any requirements to hold land or any restrictions on how the right may be exercised;*

***Divisibility and transferability**: The right may be sub-divided and is freely tradable to others."*

The full report in English can be downloaded from http://www.pc.gov.au/data/assets/pdf_file/0006/8457/waterrights.pdf. It covers an analysis of systems in various parts of Australia, Colorado, California, Chile, Mexico and South Africa.

Differences between a rudimentary water rights system and a well developed system are summarised in Box 4.

Box 4 Characteristics of Water Rights Systems

Symptoms of a rudimentary water rights system	Characteristics of a well developed water rights system
Water rights poorly defined	Water rights well defined
No reliability in the conditions of the right	Reliability fully specified and protected (*but climatic variability has to be accommodated*)
No process for complaint on rights infringement	Fully transparent system for complaint supported by the law
High level of discretion held by upper water resources managers	No discretion for resource managers once rights have been granted
No compensation for changes to the water delivery compared to rights conditions	Fully guaranteed, compensation for any changes
No fixed duration and can be cancelled at any time	Perpetual title (*although this has limitations in terms of water resources management flexibility (England and Wales are moving away from 'perpetuity titles')*).
Rights cannot be divided or transferred	Can be divided, official process fully transparent
Rights tied to specific land, unable to be traded	Fully tradable to established conditions and process fully transparent
Restrictions on how water can be used	No restrictions on purpose, location or the way water is used.

Source: Developed from 'Comparing Water Rights Systems – China and Australia'; R Speed; Water Resources Development, June 2009.

An important prerequisite of any water rights system is a sound knowledge of the available resource that can be allocated under the system. If this is not well defined, then a margin of uncertainty needs to be determined and allowed for so that resources are not over-allocated.

If available water resources are over-allocated within a water abstraction permit system this can be difficult to

rectify. It can lead to serious over exploitation of the resource and result in conflict between water users, as well as between the users and the abstraction permit issuing authorities.

If the uncertainty in resource availability is high, and not accommodated within the water rights and water abstraction permit system, then it will not be possible to attain the 'good' water rights system characterised in the above table.

It should be pointed out that in countries such as the UK and Australia there is still a continuing process in the improvement and modification of the water rights conditions and water abstraction permit systems.

Additionally, not all countries will want to progress towards all the characteristics of a 'good water rights system' as defined in Box 4. Factors such as government systems, the status of the legislative system and the knowledge of the resource and efficiency of water use can all be influencing factors. A staged development of a water rights system normally takes place, often by default.

2.4 Conflict

There are many areas of potential conflict or disagreement in relation to a water allocation and water rights system. For example, when conflict is caused by chronic water shortage, water abstraction permits may be cancelled or revised with or without compensation, permanent water conservation measures may be mandated and alternative water supplies may be provided. The design of a water allocation process should be such as to minimise the potential occurrence of such conflict.

With increasing demand on diminishing volumes of available and usable water resources the dangers of increasing conflicts between users and between sectors increases. Resolving such conflicts is an issue in itself and is often initially undertaken through a process of inter-agency consultations. Such conflict resolution is difficult if there is a lack of clarity and formal acceptance of a system of water rights and of the basis and process of water resources allocation. The situation can be aggravated by inconsistencies in the legislative measures in place. In some countries 'national apex organisations' help to resolve conflicts (or such organisations at different administrative levels). However, this is not an alternative to a clear and accepted basis for water allocation based on a well developed and established water rights system.

Improved knowledge and certainty of both water resource availabilities and water use through hydrometric monitoring systems and water use monitoring can assist in this area.

2.5 Water allocation in practice

England and Wales

Water resources management in England and Wales is governed primarily by the water abstraction and impoundment licensing system. Water allocation is based on the water abstraction permitting system; an explicit system.

The present permitting system for control of water abstraction in England and Wales was introduced by the Water Resources Act 1963, with changes as a result of the Water Act 2003. The Environment Agency (EA) administers this system. A summary of

the main features of this permitting system is given in Box 5.

Box 5 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."

Source: Environment Agency

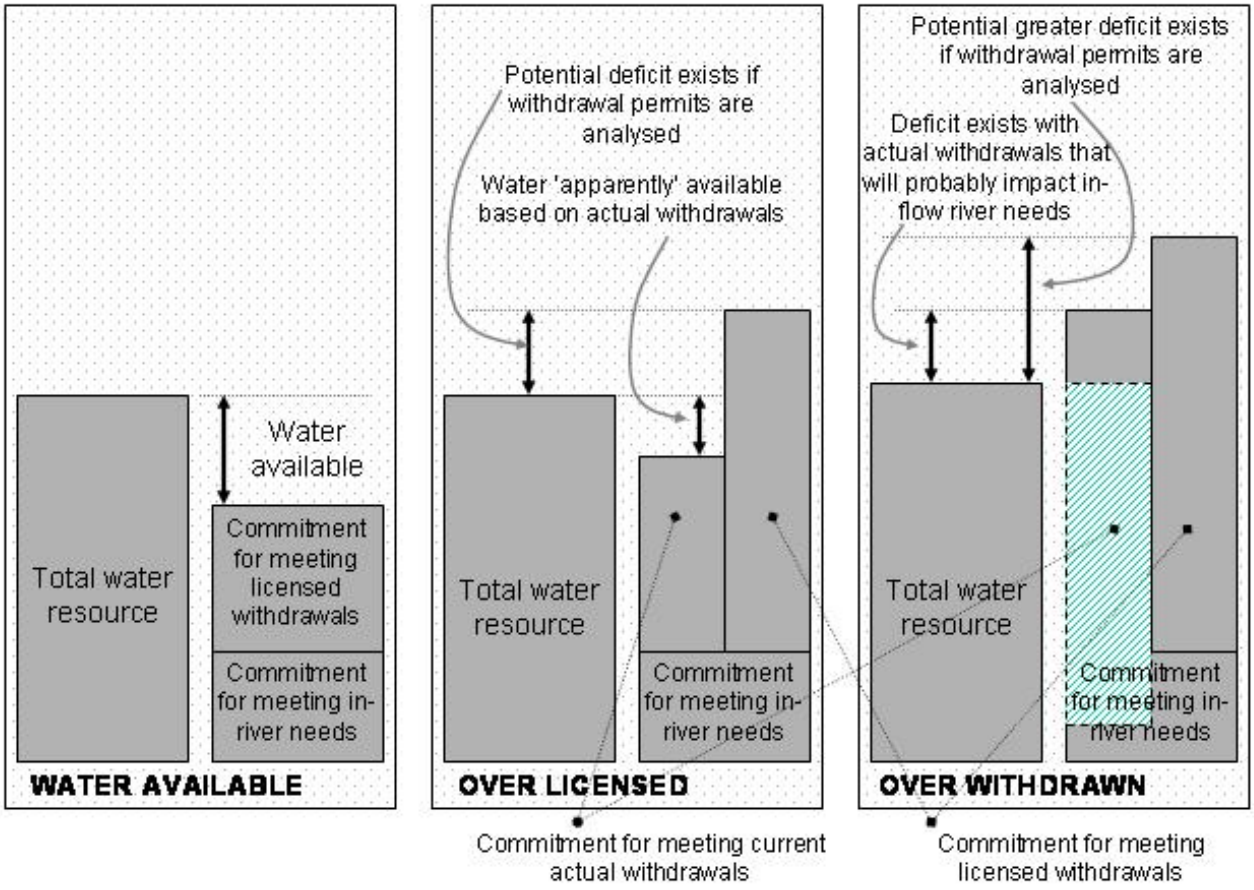
Developments in the system have taken place over the last 10 years or so to account for the fact that in many areas water resources have been over-allocated and if permit holders abstracted their full quota there would have been insufficient resources to meet such a demand in many catchments or areas. Some permits are now being revoked but with compensation allowances being provided.

This situation led to the development of 'Catchment Abstraction Management Strategies' (CAMS). The principal aim of CAMS is '*to provide a framework for resource availability assessment and produce a licensing strategy which aids the sustainable management of water resources on a catchment scale.*'

The first cycle of CAMS commenced in April 2001 and concluded in March 2008. This improved the understanding

of water resource availability in England and Wales. All catchments have been defined as 'water available', 'over licensed' and 'over withdrawn' under specific climatic conditions. These situations are explained in Figure 1.

Figure 1 Abstraction permit relationships to resource availabilities



CAMS contributes to achieving a sustainable balance between the water needs of abstractors and of the environment, although it does need further strengthening to meet all the requirements of the EU Water Framework Directive.

The main drivers for the introduction of CAMS are presented in Box 6

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As more licences are granted, there is decreasing reliability of available water for those seeking new licences. At the start of the assessment a water balance is calculated for each CAMS area based on its characterisation and ecology. The elements of the water balance calculation are river flows, groundwater recharge, abstractions, discharges, and a resource allocation for the environment and any other water uses or features that require protection.

Box 6 CAMS – Basic drivers

The defining principles of EA's approach to sustainable resource management are:

- secure the proper use of water resources for all purposes, including environmental need;
- protect the environment by:
  - identifying a minimum flow or groundwater level below which abstraction may be prevented;
  - protecting flow and level variability from low to high flow conditions;
  - protecting habitats that are dependent upon river flows or water levels;
  - recognising that some watercourses or wetlands are more sensitive than others to the impact of flow or level changes;
- ensure no derogation of existing protected rights;
- protect other legitimate river users' interests;
- be able to incorporate existing and future local requirements such as flows to estuaries;
- take account of water quality considerations throughout the catchment in both surface water and groundwater.

In some cases, site-specific operating rules for managing river abstractions have been developed. Conditions are included in licences that require abstraction to stop or be reduced when a river flow or level falls below a specified level primarily due to climatic/ hydrologic conditions. These are known as 'hands-off' flows and 'hands-off' levels, they may be set to protect local features or larger catchment scale features.

To ensure that flows do not fall artificially below a certain level and to maintain flow variability across the range, 'hands off' flows are applied on a tiered basis. As more of the available water is allocated to abstraction, licences are issued with increasingly restrictive 'hands off' flows, to ensure sufficient water continues to be available for the environment. A consequence of this management regime is decreasing reliability of abstraction licences such that, in drier years, the licences with higher 'hands off' flows will be prevented from abstracting more frequently as lower flows are experienced.

The EA are conducting a review of selected water abstraction licences in England and Wales to identify where environmental damage may be occurring or could occur as a result of abstraction. This is known as Restoring Sustainable Abstraction (RSA).

The introduction of time limited abstraction permits or licences is intended to allow for more allocation control and re-allocation control in the future.

The renewal process provides the mechanism to review licences in the light of any changed circumstances since they were originally granted. When licences reach the end of their time limit, there is a 'presumption of renewal'. This means that the licence will be renewed, if the three renewal tests can be met and there are no other legal obstacles.

The three renewal tests are:

- **Environmental sustainability** - The CAMS process will identify environmentally unsustainable abstractions within catchments and will also identify the preferred

strategy for dealing with them. For the majority of licences, there are not expected to be any significant environmental changes that would prevent the renewing of the licence/permit.

- **Continued justification of need** - This is an assessment to see if the abstraction is still required, based on the reasonable requirements of the licence holder, and to check that the maximum levels of abstraction authorised in the licence are still reasonable.
- **Efficient use of water** - Efficient use of water means using the right amount of water in the right place at the right time. It is essential to achieve the proper management of water resources. Licence holders are required to demonstrate efficient use of water when an application is made to renew an abstraction licence. (Recognised sources give efficiency examples, eg: http://www.waterwise.org.uk/).

Licenses are gradually being reissued to a common time frame, with a six-year validity, so that they can be reviewed consistently in the context of the same assessment of water resource availability.

Stakeholder and public participation are now implemented through a river basin planning process, with opportunities to influence water resources management. At times, additional small focus groups might be necessary to discuss specific issues.

Through the use of web-based access data and information related to water allocation decision making is thus open to the public.

Box 7 England and Wales – License (permit) notification system

"Applications for full licences to abstract or impound water

Notices detailed below include all current applications for full licences to abstract water and licences to impound water.

Also listed are notices of any proposal by the Environment Agency for such a licence for its own purposes.

Notices on this page are published for a period of 28 days (first day, 10am-last day, 12pm) during which any representations must be made in writing or via email to the Environment Agency.

Each notice contains: details of how to make a representation and the closing date for their receipt.

Examine your area CAMS from the CAMS homepage - access from the related link on this page.

Catchment Abstraction Management Strategies (CAMS) are six-year plans which record how we are going to manage water resources in your area.

If you intend to apply to us for a licence to abstract water, or if you would like to know how you can influence the way in which we manage our water resources over the next six years, your local CAMS document is an invaluable source of information."

Source: http://www.environment-agency.gov.uk/

Australia

Australia has an economy that is heavily dependent on irrigated agriculture but has experienced ever increasing problems, particularly recently, of decreasing resource availabilities and increasing demands giving rise to water related conflicts.

In 1994 the agreements were put in place for a reform of the water sector. These included the implementation of a comprehensive system of water entitlements backed by the separation of water property rights from land titles, allowing the trading of water entitlements and making allocations of water for the environment as a legitimate user of water, based on the best scientific water available. In 2004, further provisions were put in place to strengthen this process. (*Note, the Australian 'water entitlement' is synonymous with 'water right'*).

These reforms have resulted in the adoption of various measures[1] including:

- *Adopting catchment-based statutory 'water resources plans', to define the sustainable limits of a catchment, cap total water abstractions and provide water for the environment;*
- *Granting volumetric 'water access entitlements' to individual abstractors, in accordance with the limits set by the catchment plan, with defined levels of reliability;*
- *Specifying the rules for determining annual 'water allocations' for the holders of water access entitlements, based on annual availability;*
- *Allowing for trading of water resources entitlements and water allocations between users, in accordance with rules to protect other users and the environment from adverse impacts; and*
- *Providing for compensation (financial) where changes are made that affect the value of an entitlement.*

An important difference in the water entitlements system in Australia compared to many countries is the fact that the entitlement is a share (or percentage) of the available resource and not an absolute defined volume.

Recent changes have been made to the 'water abstraction license' (these apply initially to the Murray Darling from July 1st 2009). This is changing to a four level license as per Box 8.

Existing license holders will continue to own a secure, personal property right in water (the new Water Access Entitlement). For most licensees, the proposed changes will make little or no significant difference. However, the changes will improve the opportunities for those who wish to participate in the water trading market, making it explicitly clear to buyers and sellers what exactly is being bought and sold.

It is interesting to note some of the similarities between the measures being followed in England and Wales and Australia despite the fact that the resource conditions and the water use characteristics of the two regions are significantly different. This particularly relates to the growing need to carry out scientific resource assessments in support of abstraction permits and the need to pay much more attention to ecological requirements. In both countries the issue of climate change is driving further considerations.

[1] Developed from 'Comparing Water Rights Systems – China and Australia'; R Speed; Water Resources Development, June 2009

Box 8 Water access entitlement

"This is the ongoing right to a specified share of the water resource and is set out on the water licence. Your water right will be expressed in unit shares language (as it is interstate) and is an asset that can be sold or transferred permanently or for a limited period.

Water Allocation

This reflects your right to take a specific volume of water for a given period of time, not exceeding 12 months. This right will specify the actual volume of water you are able to use. The actual volume may vary from year to year depending on how much water is available. This too, is an asset that can be sold.

Water Resource Works Approval

This is a permission to construct, operate and maintain works (such as a pump, well or dam) to take water at a particular location in a particular way. This permission is not transferable to another location. The requirement to meter the amount of water taken from the resource will be connected to this approval.

Site Use Approval

This is permission to use water at a particular location in a particular way. This is not transferable to another location."

China

Water allocation is specified as one of the water management requirements in the Water Law (2002).

Water resources allocation is not only a major issue at the river basin level, water allocation takes place to provinces, to municipalities, to counties and to users/permit holders. Water allocation on the basis of administrative boundaries as opposed to hydrological boundaries makes the necessary systems more complex. In many instances at the local level, water allocation is seen as purely the development of reservoir operation rules. However, again at the local level, when a reservoir operator is interrogated the reservoir operation rules might not be always be strictly adhered to.

Water allocation and water allocation plans need to take into account a number of other plans required as part of the Water Law. These are also normally hierarchical between administrative levels with river basin organisations also having, in the most part, similar plan requirements. Coordination and compatibility of plans is therefore essential to ensure that allocations are consistent and inter-related.

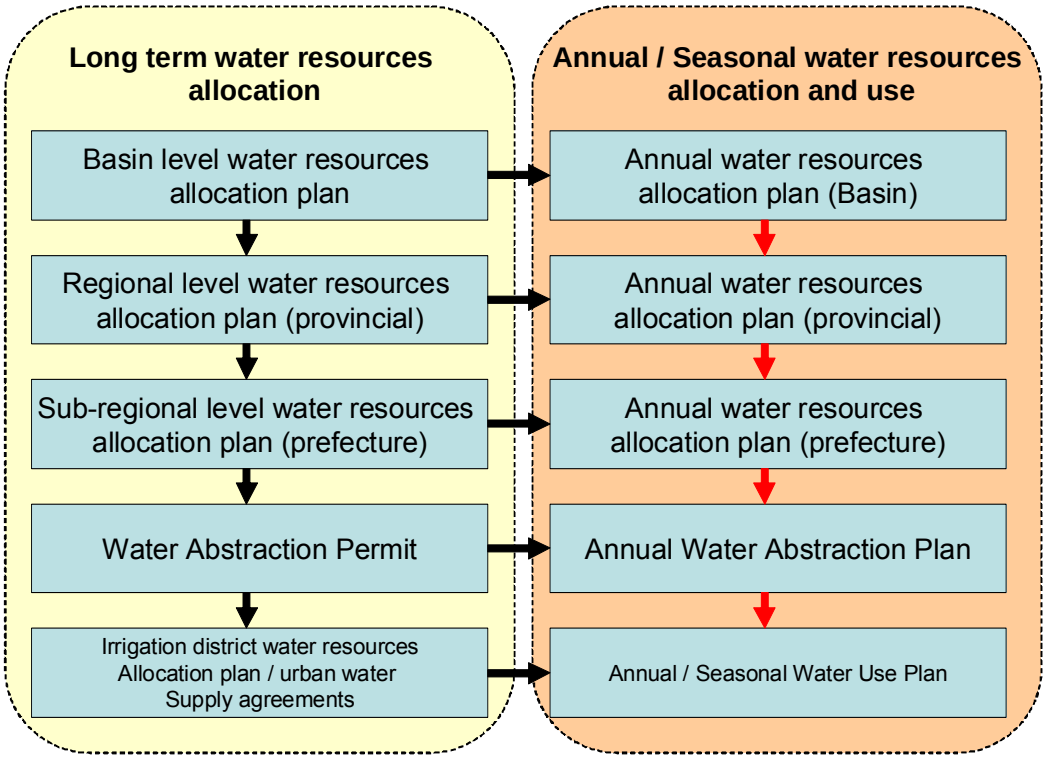
The water allocation process is indicated in the Figure 2 showing the inter-relationship of the need for user demands (as should be reflected in water abstraction permits) to balance with the top down water allocation process from river basin to province to prefectures or municipalities to county levels.

The top down allocations are laid down in medium term water allocation plans and modified through annual water allocation plans (see Section 3). At the upper level (or macro level), the water resources allocation is undertaken by the main river basin organisations.

Seven major river basins have been defined in China, with institutional arrangements established for many years. Water allocation in these seven river basins is the main focus of attention at the central level. The seven river basins cut across provincial (administrative) boundaries and allocation within the river basin is first made on the basis allocation of

'available water resources' to the various provinces within a river basin.

Figure 2 Water allocation framework



Source: After 'WET (2006); AusAid'

Within the provinces, the allocated water assigned to the province is generally then assigned to municipalities (using administrative not hydrological boundaries), thereafter water resources are assigned to counties. Therefore, the original water allocation between provinces will inevitably have an impact at the county level. The process of water allocation within the province and within a municipality will often require the consideration of hydrological boundaries. This whole process can be quite complex. There are also some smaller river basin organisations that have been set up that modify this process, e.g. the Shiyang River Basin Management Bureau.

The long or medium term water allocation plan should be the basis for deciding what additional water abstraction permits can be granted (i.e. **the cap**) whilst at the same time for defining the reliability of estimates made. This medium to long term planning will be undertaken at the various administrative and main river basin levels and needs always to be internally consistent. The long term allocation plan should also clearly define the assumptions made in the determination of the available and usable resource as well as how it should be monitored.

The legislation makes a clear distinction between annual water allocation plans and drought (management) plans. In certain areas in the southern provinces water allocation plans are specifically designed for a dry year and hence

serve the purpose of a drought plan. This is since in a normal year there is sufficient water available not to require a specific annual water allocation plan.

Water allocations are related to demand centres. Demands are generally classified into categories, such as domestic, agricultural, industrial and environmental. In addition, there is a distinction between in-stream demands (such as hydropower or environmental) and out-of-stream demands. The precise classification system and nomenclature varies from place to place, depending on the nature of the demands. In China, for example, agriculture is referred to as primary industry.

The basic classification of water users on which sectoral allocations are based in the country is presented in Table 2. There are reportedly some local variations of this classification.

Water abstraction permits are issued lat different administrative levels for abstraction from both surface water and groundwater. Groundwater permits are generally well-specific and hence there are numerous issued for small quantities of water. Surface water permits are normally for much larger quantities and can be classified as bulk water permits since they are subsequently used by multiple users.

There is a tendency for 'water allocation' to be thought primarily as an allocation process of surface water resources rather than such a process being inclusive of consideration of groundwater and the opportunity for conjunctive use. Conjunctive use enables the consideration of the optimisation of the use of overall water resource availability.

The annual water allocation plan should be based on:

- Medium to long term allocation plan;
- Abstraction permit aggregated values;
- Last year's annual water allocation plan together with feedback on issues related to it;
- Actual water usage of each water abstraction permit in previous year (based on the metered usage as required by SCD460);
- Proposed water usage for water abstraction permit holders (water use plans).

At the local level, the degree of control of the allocation process tends to depend on the scarcity of the resource. In the Shiyang River Basin, a very water stressed region, a process of issuance of 'household water rights certificates' has been introduced. These define the volume of water that a household is entitled to (in what is assumed to be an average 'hydrological year') based on the area of land irrigated, the crops being irrigated with additional allowances for livestock requirements. This takes 'allocation' down to the lowest possible level. The value of these certificates should then relate to the water abstraction permit conditions for the tubewells serving the area (although this can be complicated in practice as some households have land in several tubewell areas). In most areas, each tubewell requires an individual water abstraction permit.

Table 2 Water allocation (user) classification and hierarchical structure

Water users' classification					Notes
First-level	Second level	Third level		Fourth level	
Out-stream	Domestic	Urban domestic water			Only for urban domestic water, not including public water
		Rural domestic water			Only rural domestic water, not including water for livestock
	Industry	Agric-ulture	Field irrigation	Paddy field	Rice
				Irrigable land	Wheat, maize, cotton, vegetable, edible oil crop etc
				Vegetables field	Vegetables
			Forestry, livestock and fishery water	Irrigated fruit land	Fruit trees, nurseries, agro-forestry, etc.
				Irrigated pasture	Cultivated pasture, irrigated native pasture, forage reserve, etc.
				Livestock	Large and small livestock, poultry
				Fish ponds	Fish pond recharge
		'II' Industry		High water consumption industry	Textile, paper making, petrochemical, metallurgy, chemical industry, foods industry
				General industrial	Everything except high water consumption industry and thermal (nuclear) industry
				Thermal (nuclear) power	Circulating and through flow types
		'II' Building industry			Civil engineering construction, pipeline and equipment, Building installation, buildings fitting and decoration
		'III' Tertiary industry			Tertiary industry water and consumption for fire and special use, etc.
	Environ-ment	Urban environment			Landscape irrigation, replenishment of urban channels and lakes, sanitary, etc.
		Rural environment			Replenishment of lakes and wetlands, re-vegetation / re-afforestation, groundwater recharge
In-stream	Industry	Hydropower			Hydropower industry
		Navigation			Inland river and inland lake navigation
		Aquaculture			Freshwater aquaculture (except fish pond) other water requirements are considering in in-stream environment water
		Others			Moving timber in river, tourism, etc.
	Environ-ment	Maintain river channels' function			Ecological base flows, sediment transport, aquatic biota, etc.
		Estuarine environment			Scouring silt in harbours, control of saline intrusion, estuarine organisms

Source: 'Technical Specifications for Water Demand Forecasting of the National Water Resource Comprehensive Plan', 2008

Note: Some of the classification of environmental water use, e.g. landscaping might not be universally considered to be 'environmental'.

For surface water systems, a single water abstraction permit normally covers an entire irrigation scheme or a single reservoir. However, in surface water irrigation systems the allocation process is an implicit one, largely defined by to the standard irrigation schedules. For the reservoir situation, the allocation of the 'permitted volume' is based on the reservoir operation rules.

In the urban water supply sector, the situation can be as complex. There can be several parties involved in the allocation process ranging from the abstractor (the holder of the abstraction license) through to the water delivery company that might serve more than one system, possibly a water treatment company and a water supply service delivery company. In the urban situation, supplies have a priority and the

conditions of the abstraction permit are met in all but a drought situation.

The systems for water allocation are better than in many other countries. However, there is room for improvement in the systems for sharing data and knowledge between organisations and tiers of government. Potential areas for improvement are described later in this document.

2.6 Water allocation issues

Some of the water allocation issues encountered at the provincial, municipality/prefecture and county levels during the course of WRDMAP often mirror the issues encountered elsewhere in the world and the topics indicated as currently being addressed in both UK and Australia.

A number of the issues have been identified during the course of WRDMAP. These are briefly described below.

Water resource and demand assessments

- A lack of knowledge of the true amount of **available water resources,** either surface water or groundwater, and of the interaction between the two (abstracting water from one can impact on the other);
- There is seldom a **'capping'** or 'upper-bound' on the resource that can be allocated that is clearly defined.
- **Environmental allowances** seem to be seldom considered unless driven by a central level directive for a specific river or ecologically sensitive area. Environment allowances, with a strong ecological focus, should be considered for all river systems, in order to provide some factor in the overall allocation process;
- Explicit statements related to **resource sustainability** and resources withheld (or planned to be held) for future users are seemingly not always considered;
- **The concept of uncertainty (and risk)** in resource assessment does not seem to be a concept that is always included in the allocation process;

Institutional arrangements

- A lack of **coordination** between those issuing water abstraction licences and those responsible for resource assessments (and water resources monitoring) – also a required link between allocation plans and water abstraction plans (based on permit information) together with other related plans;
- Not all permit issuing departments follow the **full requirements of SCD460**. Often this is because of the burden of the process for small abstractors.
- There can be **pressure** to issue a new permit for a strategic new water user, particularly an industrial user.
- There can obviously be conflicts where, as in many cases, the **'regulator', the 'resource manager' and the 'service provider'**, who is the water abstraction permit holder, are all the same organisation (or in the same organisational structure). This can affect an approval process as well as having financial implications.

Planning processes

- **Plans**: what they are, what they are for and the need to implement and audit them (see Section 3);
- There is a need for an agreed process where water allocation policy is translated into a water allocation process whereby **clearly defined principles** enable clear cut decisions to be made in meeting competing needs between users and between sectors.
- There could be **better coordination and consistency** between the allocation processes being implemented at different administrative and hydrological planning levels;
- **Water abstraction permits not generally being digitised** and not held in a GIS hence the information is not easily usable and clearly makes management of the system difficult. This leads to a belief by some local water resources professionals that the WAP information is unreliable – and hence the preference for the top down approach to allocation. In addition, the hierarchical process sometimes can mean that more weight is given to top down information;
- Sometimes the top down 'implicit' allocation is **not thoroughly checked** against the 'explicit' WAP system. It is likely that the implicit allocation would prevail.
- Over the period since water abstraction permits were first issued in the 1980s, there has often been an **over-allocation** of resources in many areas;

Implementation of allocation plans

- Even where water allocation plans are well designed, there is then the **issue of implementing the plan** effectively and auditing the impact of the plan. This applies to long term/medium term plans as well as annual plans.
- **Control of abstractions** to the conditions of the water abstraction permit is reportedly difficult (although all abstractors are required to have a means of measurement of abstractions and to report such volumetric data);
- Reducing the volume specification of a water abstraction permit, or **revocation of the permit is often problematic** even though they are time limited There is sometimes **illegal abstracting** of water, which exceeds or is not covered by the water abstraction permit system.

Box 9 The 'regulator', the 'resource manager' and the 'service provider'

Basically a service provider is an organisation that supplies water to an end user (e.g. a Water Supply Company to a household or commercial property; a resource manager is an organisation that manages the water resource (e.g. a Water Resources Department) and a regulator is a body that supervises the performance of the service provider or maybe even the resource manager (this could be a Water Affairs Bureau). In England and Wales, all three entities are totally separate organisations, with the service provider for urban supplies being 100% private sector.

The above list of items are not unusual issues and as indicated earlier, many of them are still being addressed in many developed countries although some have been resolved in one way or another. It is also appreciated that

conditions are different in different provinces and even different parts of each province and hence the 'issues' above might not always apply.

Many of the above issues should not be problems since they are variously covered by legislation (see Section 2.7). It is more a question of putting the requirements and stipulations of legislation into practice. Even where there are clarifying central level and even provincial level directives and advice, it is often difficult to turn these robust practical systems. This is often due to capacity and resource constraints but also due to data and information deficiencies and difficulties with enforcement.

2.7 Legislation and water allocation

The need for effective and equitable water allocation is covered by the Water Law (2002). The main elements that relate being Articles 23, 45, 46 and 47.

Through necessity, there needs to be some flexibility in the water allocation plan. The 2002 Water Law states in Article 23:

"The local people's governments at all levels shall organize in a rational manner the development and comprehensive utilization of water resources in view of the local water resource conditions, on the principles of unified allocation and development of surface water and groundwater, tapping new sources of supply and reducing consumption with high priority placed on reducing consumption, and sewage treatment for reuse."

In Chapter 5 of the Water Law, Articles 45, 46 and 47 stipulate the requirements and process of water resources allocation to be followed. This is repeated in Box 10.

The Water Law is quite thorough in defining the requirements, however, one of the issues has been how to consistently apply the provisions of the Law and ensure all the plans inter-relate. This not only applies to the different forms of plans specified but also the requirements that plans are required at different administrative levels. There are requirements for comprehensive plans and drought management plans in the Law increasing the considerations required when establishing a process of 'water allocation'. When establishing criteria and recommending the process for water allocation, the requirement to undertake water allocation planning at different administrative and hydrological levels needs to be taken into account.

Box 10 Chapter V of Water Law : 'Water Resources Allocation and Water Saving'

Article 45. In regulation and storage of run-off and allocation of water, the **water allocation plans shall be formulated based on the basin**, in accordance with the basin master plans and the mid-and-long-term master plan of water supply and demand.

A plan for the allocation of water covering provinces, autonomous regions and municipalities directly under the Central Government and a preliminary plan for the regulation of water under the circumstances of urgent droughts shall be formulated by the administrative organization consulting with relevant people's government of provinces, autonomous regions and municipalities directly under the Central Government, and shall be submitted to and approved by the State Council or its authorized department and then be implemented. A plan for the allocation of water covering different administrative divisions and a preliminary plan for the regulation of water under the circumstances of urgent droughts shall be formulated after consultation by the department of water administration of the people's government at the next higher level and local people's government concerned, and shall be executed after being submitted to and approved by the people's government at corresponding level. Water allocation plans and contingency plans of water allotment for drought emergencies for inter-provincial, inter-autonomous regional and inter-direct municipal level shall be formulated by basin management agencies jointly with the people's governments of the concerned provinces, autonomous regions and municipalities directly under the Central Government, and implemented after being submitted to and approved by the State Council or the department authorized by the State Council. Water allocation plans and contingency plans of water allotment for drought emergencies for other inter-administrative area levels shall be formulated by the departments of water administration of the people's government common to the concerned administrative areas at the next higher level jointly with the local people's governments concerned, and implemented after being submitted to and approved by the people's governments at the corresponding levels.

The local people's governments concerned must carry out the water allocation plans and the contingency plans of water allotment for drought emergencies after they are approved.

Construction of water resource development and utilization projects on administrative area boundary rivers shall conform to the approved water allocation plans of the basins concerned and be approved by the department of water administrations of the people's governments at the next higher level common to the concerned local people's governments at or above the county level or the basin management agencies concerned.

Article 46. The department of water administration of the local people's governments at or above the county level or the basin management agencies shall draw up annual water allocation plans and water operation plans in accordance with the approved water allocation plans and the predicted annual inflow to carry out water allocation in a unified manner, to which the local people's governments concerned must conform.

Annual water allocation plans for state-designated major rivers and lakes shall be included in the annual national economic and social development plan of the state.

Additionally, a part of Article 47 states "Development and planning departments of the local people's governments at or above the county level jointly with departments of water administration at the corresponding level shall determine the amount of water that can be used in their administrative areas and formulate the annual water use plans in accordance

Source: Water Law (2002)

with the water use quotas, economic and technical conditions and the water allocation plans, and shall control the total annual water use within their areas".

Recently the Ministry of Water Resources has issued the 'Interim Measures for Water Quantity Allocation', promulgated on 12th May 2007 and became effective on the 2nd January 2008. Article 2 of this document states:

Box 11 'Interim Measures for Water Quantity Allocation'

Article 1 The present Measures are enacted according to the Water Law of the People's Republic of China for the purpose of making water quantity allocation, promoting the optimal allocation of water resources, and rationally developing, utilizing, saving and protecting water resources.

Article 2 The water quantity allocation is the allocation of the total usable amount of water resources or the total distributable water quantity to administrative divisions level by level, so as to determine the shares of consumable water quantity for life and production as well as the shares of water taking and using quantity (hereinafter referred to as "share of water quantity") of administrative regions. The "total usable amount of water resources" includes the usable amount of surface water resources and the exploitable amount of underground water resources, deducted by the repeated part of these two amounts. The "usable amount of surface water resources" refers to the maximum consumable and usable water quantity except for that for river courses among the local surface water resources, on the premise of ecological and environmental protection and sustainable utilization of water resources, and via economically rational and technically feasible measures; and the "exploitable amount of underground water resources" refers to the water quantity that is obtained from underground aquifers by way of well drilling and can be continuously utilized within a foreseeable period, via economically rational and technically feasible measures, and on the premise of not causing ecological or environmental deterioration.

The "distributable water quantity" refers to the water quantity as determined for allocation on the principle of facilitating the administration, being good for the operation and the saving and protection of water resources, and coordinating supply and demand and by fully considering the water for life, production, ecology and environment in a river basin or administrative division whose water resource development and utilization degree has already been very high or whose water resources are very abundant, or in a river network region with complex water flow situations, or in any other river basin or administrative region that is not suitable for the water quantity allocation in light of the total usable quantity of water resources.

The share of water quantity for an administrative division, which is determined through water quantity allocation, is the basis for implementing the system of integrating the overall water using amount control with the quota management.

Source: 'Interim Measures for Water Quantity Allocation', Ministry of Water Resources

This is seen as a very thorough description of the requirements and method for water resources allocation. In covers many of the issues that are raised in this document that do not seem to be universally being applied effectively enough. However, the issue is the ability to implement the legislation at all administrative levels.

However, these are "interim measures for water quantity allocation" that are

currently being revised to a final document at central level. At the provincial and other administrative levels it likely that the finalisation of this document is awaited. In addition there will need to be detailed guidelines for the practical application of the requirements of the legislation.

Although there have been many studies undertaken in recent years in relation to water rights issues and water abstraction permitting has been strengthened with the introduction of **State Council Decree 460**. One area that has received very little attention in the context of recommended guidelines or administrative orders is the issue of ecological or environmental flow requirements. On this topic, there is a need for close institutional cooperation between the Ministry of Water Resources and the Ministry of Environmental Protection in order that the required data and water quantity and effluent discharge management enables environmental allowances (or environmental allocations) to be defined and then met. It is believed that additional legislation may be required to enable this process.

3 Allocation Plans

3.1 Background

Long term water allocation planning should relate to the broader topic of water resources planning. In the international context, water resources planning at the river basin level are seen as essential live elements of water allocation planning and water abstraction permit management systems.

Annual water allocation plans are based on the medium or long term allocation plans and take into account storage situations and issues related to the previous year's annual allocation plan. Annual allocation plans can themselves be over-ridden in drought situations when drought plans, if prepared, take precedence. Drought plans are also a requirement of the Water Law.

The river basin water allocation plans are primarily designed to provide the basis for regulating runoff and storages and tend to have a surface water focus. They are based on the river basin comprehensive plans (that are seen as being akin to an integrated water resources (IWRM) plan for the river basin).

As indicated earlier, the need for stakeholder involvement and participation in a transparent decision making process of water allocation is a requirement of the 'Water Framework Directive' in Europe and is being translated into practice in England and Wales and other countries including Australia and South Africa. For more information refer to Thematic Paper 2.2 (see bibliography).

3.2 Water allocation plans related to other plans

The Water Law specifies the requirement to produce a number of water management related plans (see Section 2.7). These are presented in the Box 12.

Box 12 Requirement for plans

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 (Art 14, 15)
- Special plans (flood prevention, water logging, irrigation, water supply etc..) – 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 (long term (Art 45)) - (annual (Art 46 and 47)) Water Law**
- 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 includes:

- Water Environment Function Zoning – Water Pollution Law
- Water Pollution Prevention and Control Plans – Water Pollution Law (Art 10); (Ministry of Environmental Protection)
- Agriculture/Irrigation Plans, Land Use Plans, Urban Development Plans

Note: An IWRM planning process has the function of co-ordinating 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.

All these plans need to be consistent, compatible and cross referenced. Many of these plans relate to water allocation plans, be they medium to long term water allocation plans or annual allocation plans. Of particular note for the former are comprehensive plans, mid and long term water supply and demand plans. In relation to the annual water allocation plans, the water use plans, water saving plans, water abstraction plans and drought management plans are important.

Issues that relate to all these **water management related plans**, required in the most part to be undertaken at the different administrative levels, are:

- There is often no specific timetable for preparing each plan or any specified schedule for their completion so that one links or relates to another
- In many cases, the plans might be reported to be 'in process' or 'not yet started'. When this situation exists it is difficult to achieve the consistency between the plans of a particular administrative level and between administrative levels.
- There is sometimes no common understanding as to what exactly should be within each plan and what the required interfaces between the plans should be.
- Implementation of plans is sometimes weak. There is a tendency to accept a "business as usual" approach. (Clearly if this approach is adopted, the importance placed on producing a plan can be diminished)
- There is often no official audit of plans, either annual or medium/long term, hence the ability to improve on a previous planning process might be compromised.
- Some people view the legal requirement for the plans as unclear and hence insufficient importance is placed on them.

Explicit water allocation planning with a strong management system of water abstraction permits is the only way of ensuring that effective water resources management is being practiced. Clearly both need to be carefully related to water resources availabilities in the planning process. The top down allocation will relate to regional water resource availabilities seen from a macro scale, whilst the permit system will generally relate to the localised detailed water resources assessments made at the local level at which most permits are issued. However, it is essential that parties responsible for the two resources assessments also coordinate. This would also apply to long term resource assessments and inter-annual assessments used to tailor annual water allocation plans.

3.3 Planning process

The standard process for allocation planning is to identify all demand centres and characterise these in the context of the sources of supply, the possible variability of demands as well as the factors listed below. This provides a matrix of demand centres and different supply sources.

This process enables an assessment to be made of the pressure on different supply sources based on different reliability factors for each source, and results in the ability to assign risks of unmet demand to different demand centres. This will also be influenced by economic or socio-economic priorities for the security of supply to particular demand centres.

Factors to take into general account when undertaking water allocation planning are:

- Water resources
  - Hydrology, water resources availability;
  - Current reservoir regulating capacity;
  - Approaches to assess reservoir storage impact and other operational considerations;
- Water uses

- Current and future water use quotas and factors impacting on demands – taking into account inter-sectoral requirements and priorities;
- In-stream flow requirements such as dilution of effluent inflows, habitat preservation, recreation, aesthetics and conservation;
- consumptive and non-consumptive water demands, and return flows from users to water bodies;

- Management arrangements
  - Trade offs between humans and nature, between development and protection (among various users);
  - Joint use of surface water and groundwater (conjunctive water use);
  - Scarcity and drought management (methodologies to take account of such periods);
- Governance arrangements
  - Administrative systems and the role and jurisdiction of related institutions;
  - Water rights and the legal system;
  - Rules governing the sharing of limited stream flow and storage among users to determine who has the right to use the water and in what priority – with inter-sectoral considerations.

Since most water allocation planning is currently undertaken on an administrative boundary basis, the demand centres and supply sources may not always lie within the same administrative area or even the same hydrological unit (river basin or catchment unit).

During water allocation planning the demand centres and supply sources should be clearly defined and discussions and technical cooperation needs to take place between different administrative and technical organisations, both 'vertically' and 'horizontally' to account for these situations. This requires the whole approach to be systematic so that the demand centre and supply source characterisation is transparent.

This approach will ensure that solutions will take account of the inter-relationships between various demand centres and the pressure on different sources so that the allocation will be within sustainable and reliable limits.

A schematic representation of the preparation of a water allocation plan is given in Figure 3. This relates more to the medium to long term water allocation planning process, introducing the documents that should be referred to and the stakeholder consultation process that should be followed. Many of these elements are a part of general water resources planning.

The annual plan would be based on, but simplified from this medium term water allocation plan. Figure 4 shows the allocation process required for reconciling water use 'demands' (from a bottom up approach) and the water resource availabilities, at each level (from the major river basin organisations down through the administrative hierarchy).

Figure 3 Schematic of water allocation planning process

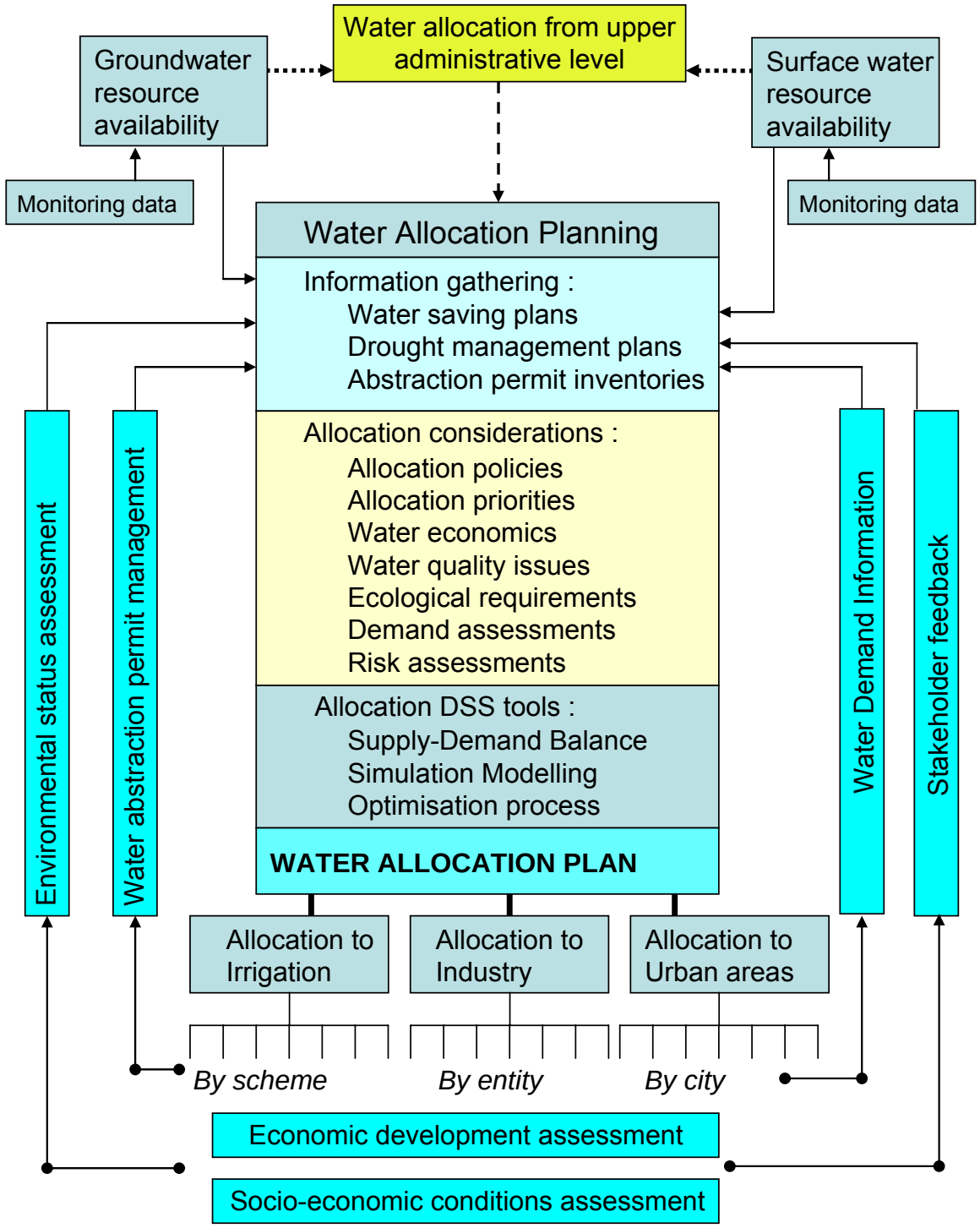


Figure 4 Water allocation process through administrative levels

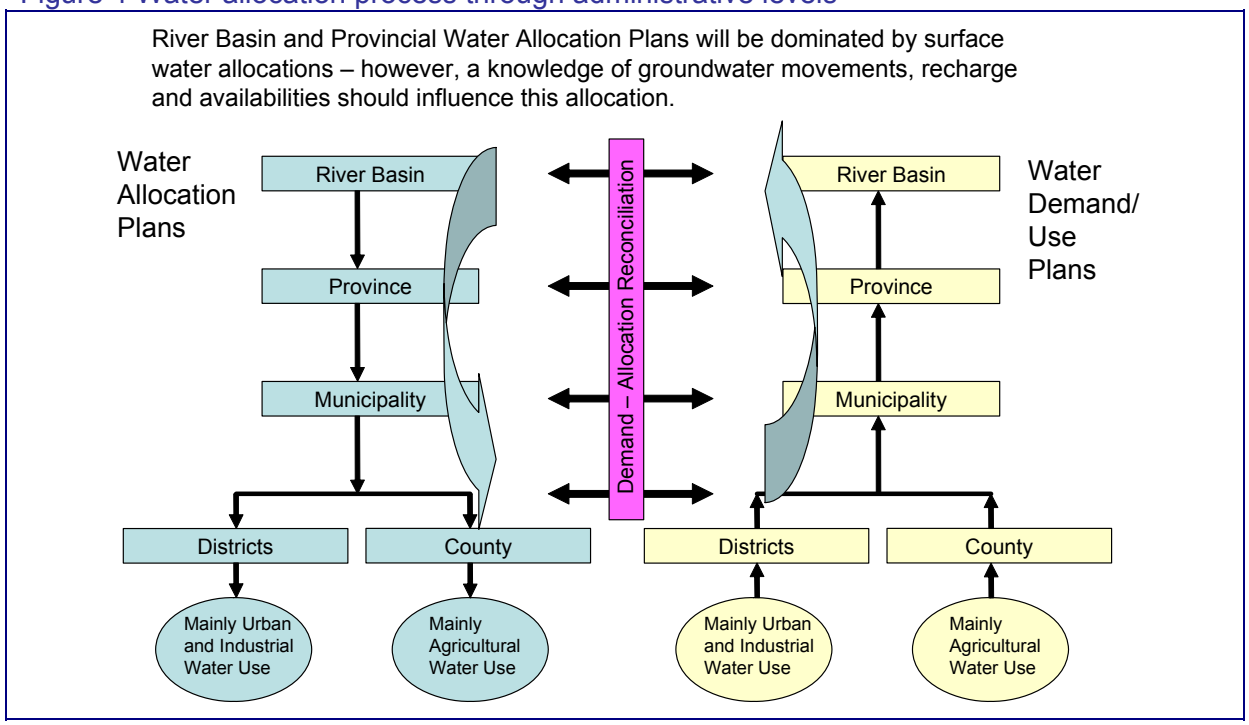
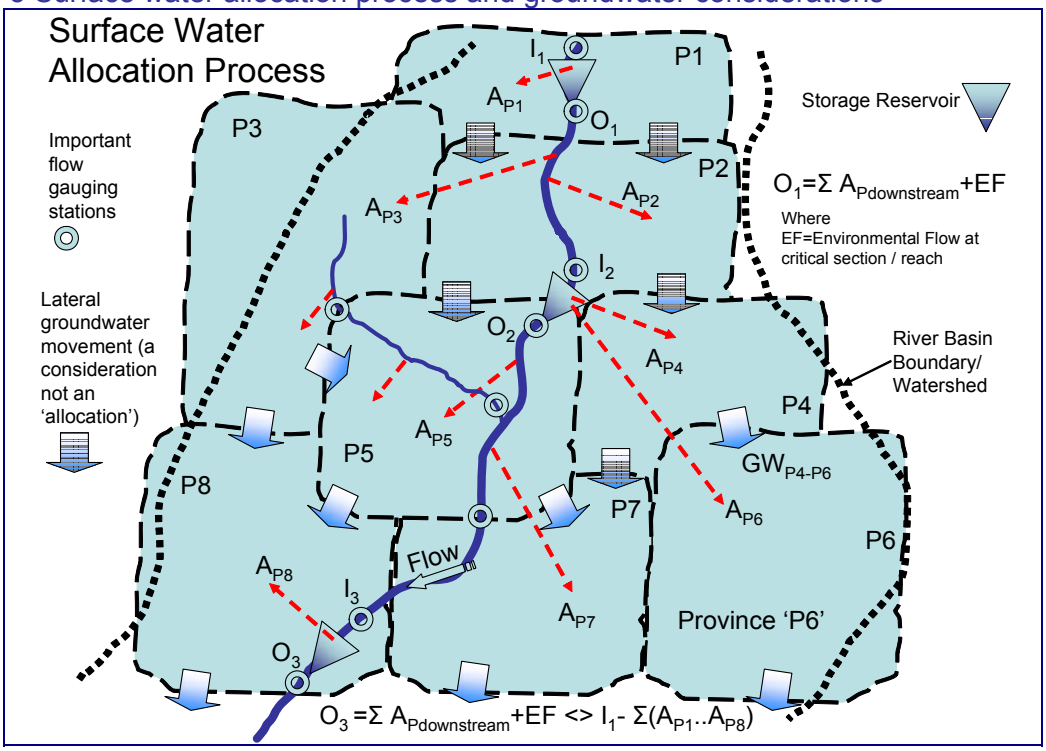


Figure 5 illustrates some of the practical complexities of the process in relation to the allocation of surface water resources from source to demand centre. This form of information is required not only where source and use are in different administrative units, but also where water is abstracted from one source and the return flows enter another resource. The 'receiving resource' can be either another natural channel or groundwater.

Figure 5 Surface water allocation process and groundwater considerations

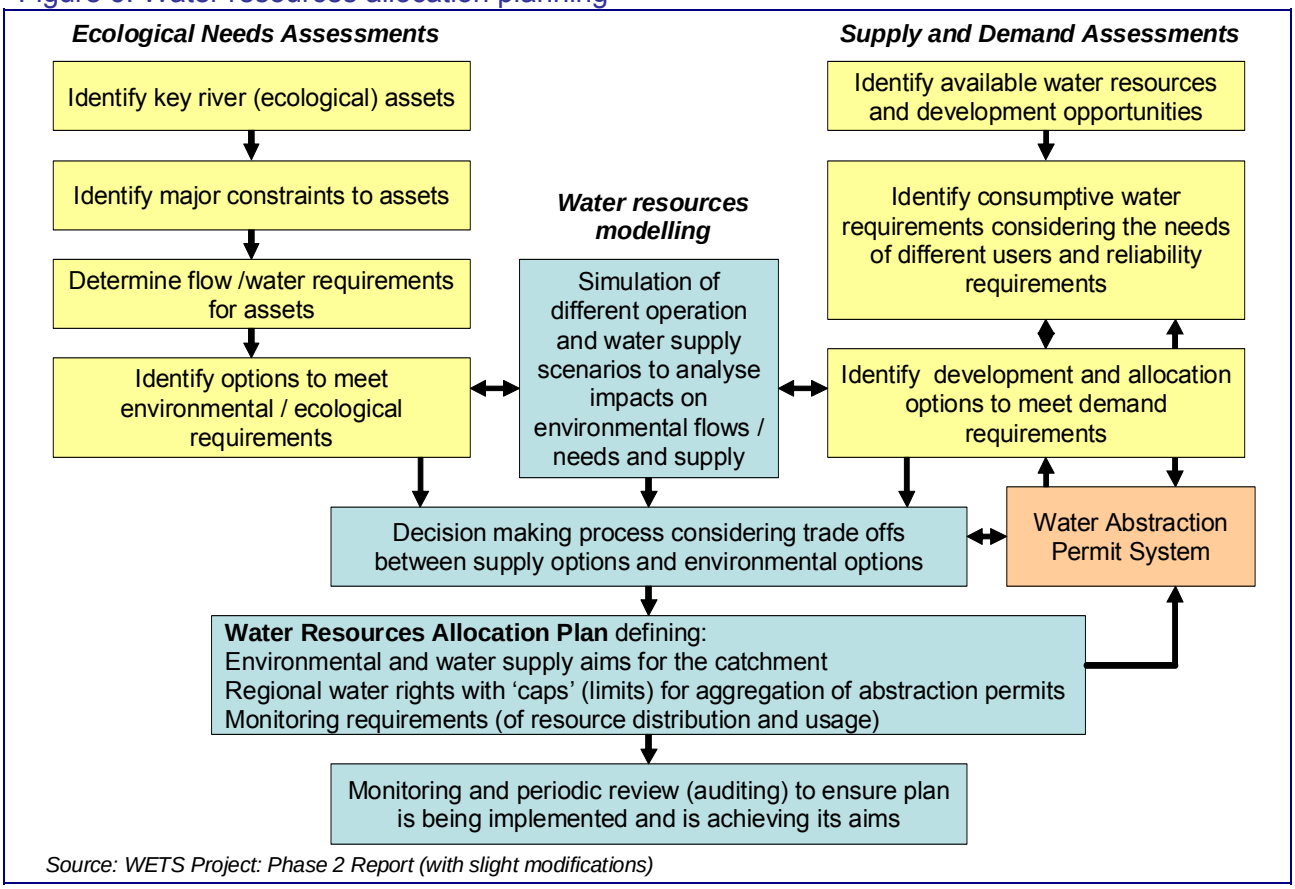


There is also a need to consider reservoir operation, natural stream flow, environmental requirements and transfers across the various 'boundaries'. The potential complexity of the situation is clear. Substantial assistance in the preparation and auditing of a water allocation plan can be provided by good hydrometric and groundwater monitoring systems.

It is important to know the movement of groundwater between administrative areas and the location of the main sources of recharge for that groundwater body. These are all factors that can be estimated and should be an element of the overall water allocation process. The availability of water resources system simulation software and the increasing level of technology and skills based in the water resource management departments means that simulation modelling can play a major role in assisting in water allocation planning currently and in the future. The use of simulation modelling can help in the water allocation decision making process through the rapid evaluation of 'what-if scenarios'. It will also enable a better understanding of the whole allocation process in the context of resource availabilities and water resources demand management. (See TP1.1 and AN1.1 in this document series).

Figure 6 is an alternative presentation of the planning process for water resources allocation and is taken from the Water Entitlements and Trading Project (WETS). This highlights the emphasis that should be placed on environmental /ecological assessments, highlights the central role of water resources modelling which is normal from an international perspective.

Figure 6: Water resources allocation planning



Source: WETS Project: Phase 2 Report (with slight modifications)

With the numerous demand centres, water resource sources and the constraints of the supply-demand linkage options a complicated system will often exist. When the water allocation principles presented in Section 2.1 are also laid on top of this the situation becomes even more complex. Appendix A describes some tools that can used to address this complexity.

Optimised allocation of water resources by use type, space and time is the general approach to address the match between water resource availability and water demand. The objective functions in the optimisation process need to be carefully agreed upon and will relate to policy frameworks. In some situations, the maximisation of economic returns is the prime driver, however, in the current situation, ecological and social requirements need to be more sensitively considered.

An alternative approach to addressing the complexity is to use a multi-criteria technique to assist in the prioritisation process. (For more information on multi-criterion decision analysis see TP7.1, AN7.1 listed in bibliography)

However, in many situations, a water allocation process has already been developed over time and established source/demand, and often prioritisation rules have been developed informally. The water allocation process becomes one of reviewing the existing systems to make them more efficient and compliant with government policies.

Most of the above descriptions relate to the medium to long term water resources planning process. These assessments and associated plans would be expected to be used to define the criteria for the allocation of water abstraction permits. The work would also provide the basis for agreements on environmental allowances and associated targets.

3.4 Annual allocation plans

There is normally a need for an annual water allocation plan to be developed. As indicated earlier this should be based on the more thoroughly developed medium to long term plans, earlier annual water allocation plans and feedback on the efficacy of the earlier plans.

Specific items for annual water allocation planning include:

- Previous annual water allocation plans and feedback on issues encountered in relation to these plans (stakeholder consultation)
- Water use plans
- Water abstraction plans (in some countries these would be equivalent to water allocation plans)
- Hydrology, water resources availability

An annual water allocation plan would also consider the possible completion of the development of new sources, groundwater or surface water, as well as accommodating the impact of maintenance programmes that might affect the reliable yield from a reservoir or possible short term supply constraints in a water transfer system.

In addition the annual water allocation plan needs to take account of end of year storages from the previous year based on surface water (including reservoir and snow pack information) and groundwater monitoring networks. Finally, it may be the possible to take account of long term weather forecasts or predictions.

The annual plan should also take into account any changes in demand that have official approval, assuming of course that water resources exist to meet these new demands. This would normally relate to newly-issued water abstraction or impoundment permits, and should be included in the annual water demand (or water abstraction plan) for an area.

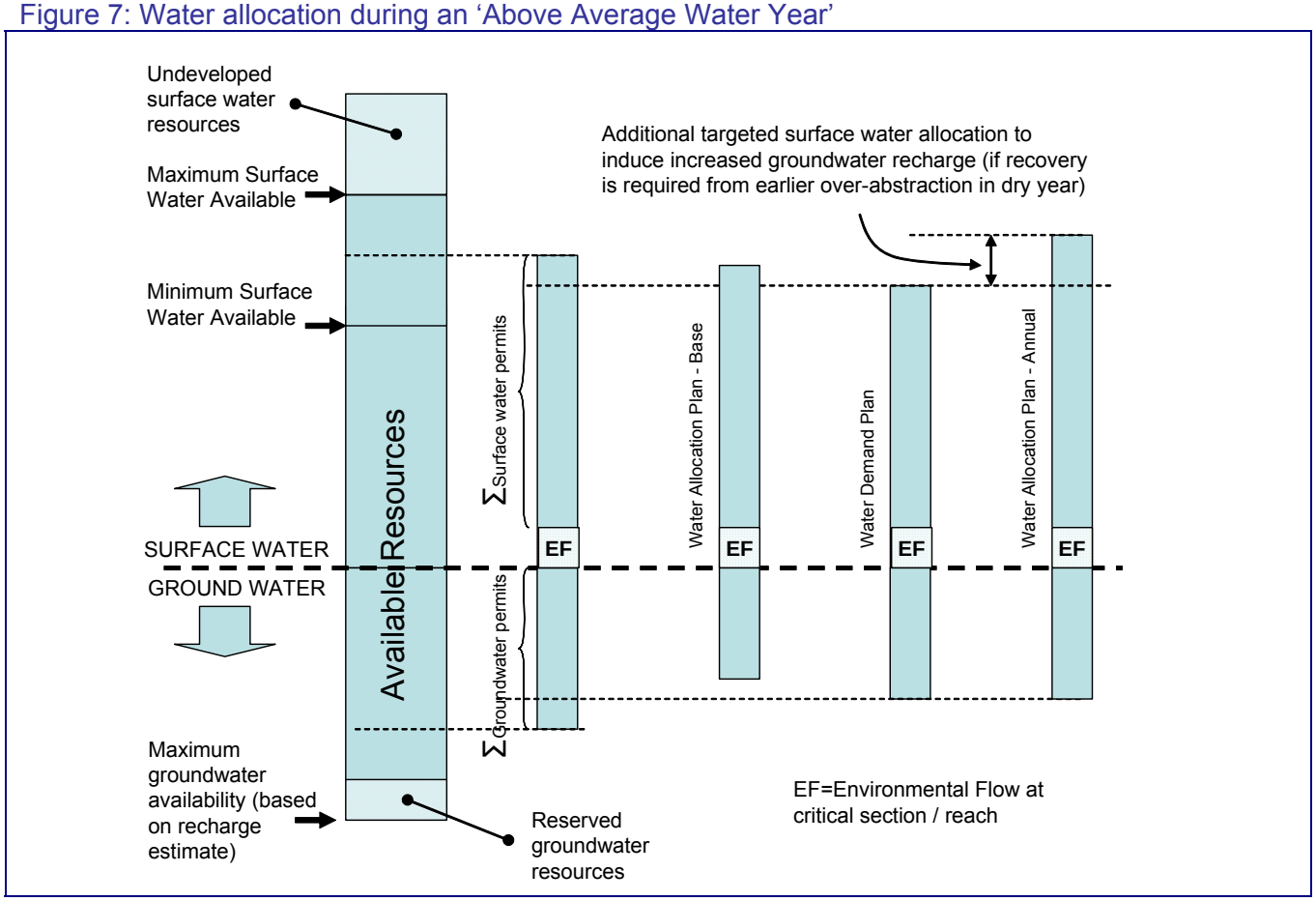
A knowledge of the above factors might also enable a judgement to be made of the potential for using conjunctive use approaches (optimising use of surface water and groundwater resources) to refine the water allocation process to enable more demands to be met while mitigating any potential adverse impacts on the environment.

The process of preparing annual plans from the medium-term plan is illustrated in Figures 7 and 8, covering wet and dry years.

In a wet year, Figure 7 indicates (on the left of the diagram - 'available resources') the currently available resources as well as the options for developing further unutilised resources.

The base water allocation in this figure relates to the medium term plan, and it can be seen that this is less than the demand, but it is also less than the available resources (because this is for an above average water wet year). This means that additional groundwater can be allocated in the annual plan to meet these demands. In addition, some surface water can be allocated to a targeted groundwater recharge scheme (see right of figure 'water allocation plan – annual').

Figure 7: Water allocation during an 'Above Average Water Year'



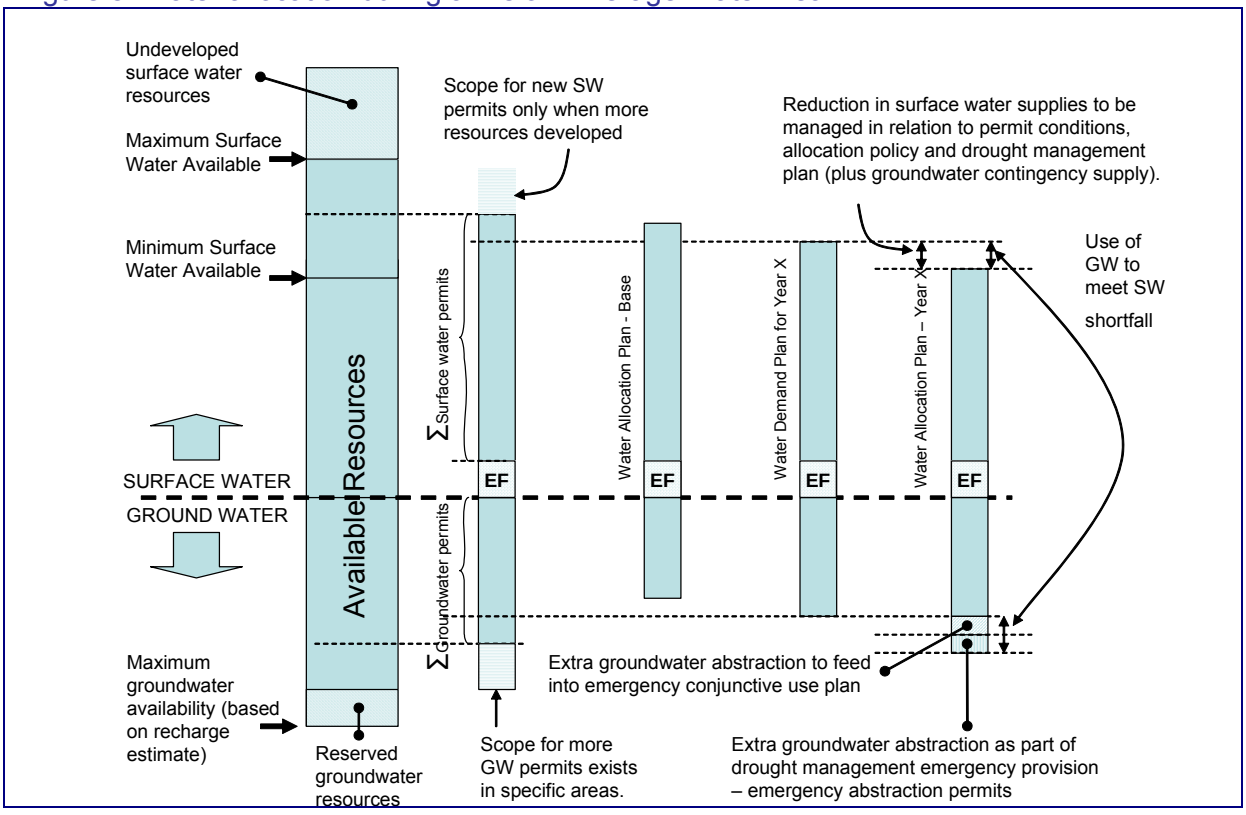
The situation in a dry year is shown in Figure 8. Here the amount of surface water that can be allocated in the annual plan is close to that shown as the minimum surface water available and this is less than the medium term allocation plan indicates.

This means that there is a shortfall in water which can be allocated in the annual plan (which needs to be managed as described below). It may be possible to abstract extra groundwater to meet this short-term shortfall – which can be 'replaced' by additional recharge in wet years.

Elements of this situation would be incorporated into the annual allocation consideration and would cover the need to prioritise allocations to certain users and constrain supplies to others, in most cases - the agricultural sector.

At the same time, the situation would warn water managers of the potential need to think seriously about the potential need for preparations for a drought. Initial actions would be to consider additional abstraction from groundwater which, in a drought situation would require the issuance of 'emergency permits'. However, it should be emphasised that water resources allocation is not normally considered to be an element of drought management (which is an emergency response activity).

Figure 8: Water allocation during a 'Below Average Water Year'



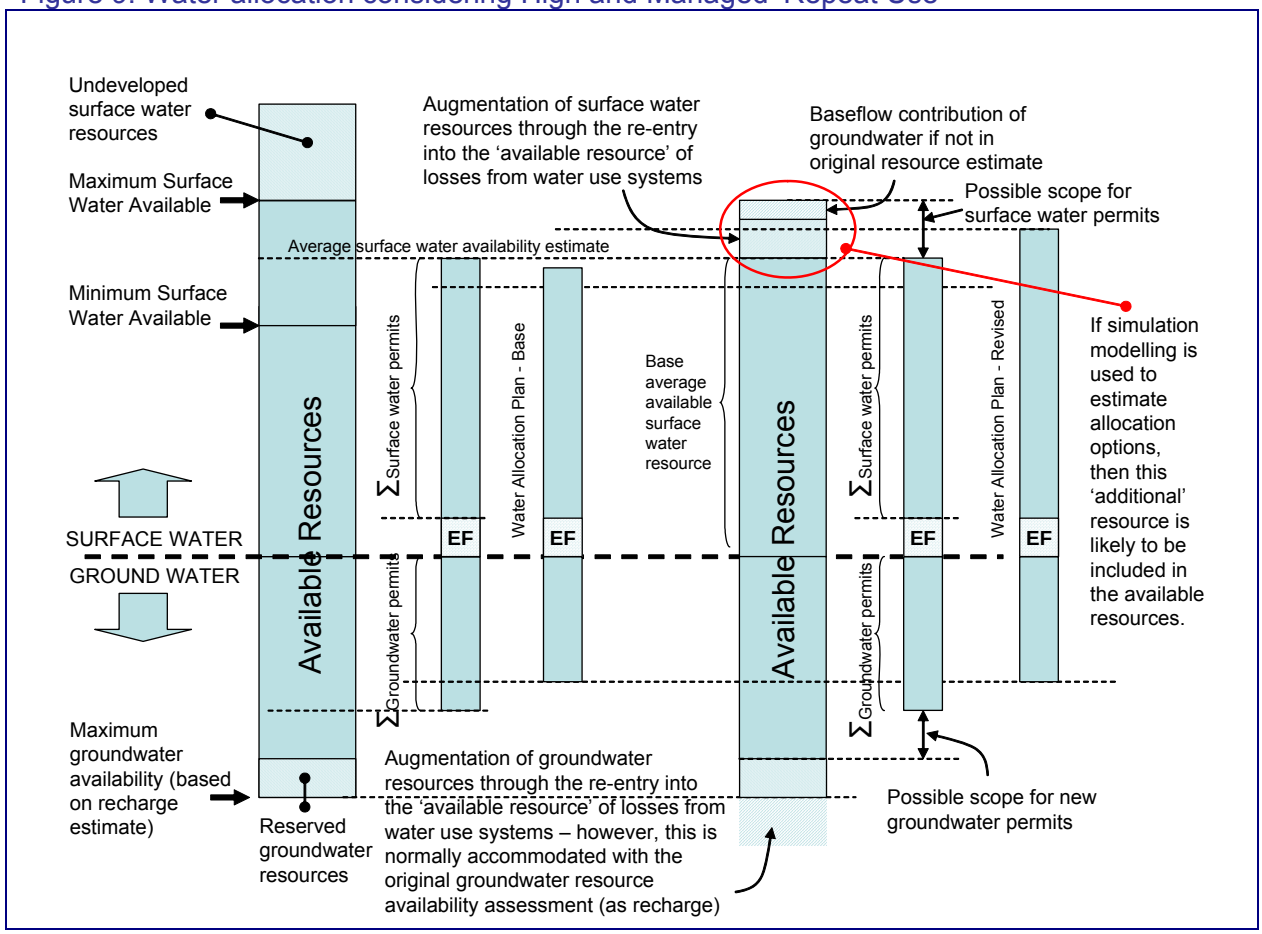
Figures 7 and 8 both indicate that the environmental flows or environmental allowances, 'EF', are unaffected by the conditions. This should be the normal situation and reductions in EF should only be a response when conditions are classified as a drought, however there may be pressures to reduce some elements of the environmental

allowance during dry years. (See TP 2.5 and AN 2.5).

Figure 9 shows a more sophisticated water allocation process which takes account of managed reuse of water between water users (ie between permit holders). This requires more detailed assessments using simulation modelling where the interaction between surface waters and groundwater is more accurately assessed and where water re-use considerations are incorporated in the analysis.

This water re-use is *between* users (eg groundwater users benefiting from recharge resulting from seepage losses from surface irrigation) rather than water re-use by the permit holder. Reuse *within* in permit is normally specified in abstraction permit conditions.

Figure 9: Water allocation considering High and Managed 'Repeat Use'



3.5 General considerations

Preparation of a Water Allocation Plan will need to take account of the following particular issues

Water allocation objectives

The basic aims of the allocation plan need to be clear. The development of a water resource allocation plan needs to be guided by a clear understanding of the aims of the planning process. For the basin plan, such aims would typically relate to strategic whole-of-

basin outcomes. Basin-wide strategic aims may then be supplemented in regional plans by aims that are relevant at a regional level.

Allocation planning aims tend to be aspirational and it may not always be possible to meet all aims to the extent desired. Conflicts are likely to exist between aims relating to supply of water and aims relating to environmental protection. Where such conflicts occur, water planning authorities will need to make trade-off decisions to achieve an appropriate balance between the competing aims. When such trade-off processes have been finalised, the revised aims should be clearly stated in the basin or regional plan so that **there is a clear statement of what the plan is designed to achieve**.

Water resource assessments

There is a need to take into account both surface water and groundwater resources together when considering allocations. This should be undertaken both in terms of resource availabilities, their respective uses and potential for conjunctive uses. In the past, most allocation was related to surface water allocation irrespective of groundwater.

Only genuinely available water resources can be allocated. It is important to consider the timing of demands against the timing of availabilities. There is often a danger of considering surface water elements that are actually 'un-manageable' flood flows.

How to deal with uncertainties and risk? This includes the often inadequate knowledge of the actual quantities of surface waters or groundwater resources that are available for allocation. Inter-annual variations need to be accommodated and the rapid onset of droughts. Added to this is a need to consider the risk to a resource by the failure of water control infrastructure or potential contamination of the resource - should there be a cap or upper limit of resource allocation to cover uncertainty, inter-annual variability and the assignment of flows or resources for future usage.

Stakeholders need to be aware of the risks associated with the allocation process and if possible the level of uncertainty that might exist. Allied to this is the need to consider how risk and uncertainty can be reduced through improved information.

Demand management

Water allocation must take account of all water demand management interventions and activities.

A constraint of allocation is often the continued use of ageing irrigation and other conveyance infrastructure that have high seepage and evaporation losses. How these issues of system inefficiency should be taken into account is an important issue for water allocation. Many of these losses are non-consumptive and can be reused (as highlighted above in Figure 9). It is important not to reallocate water 'saved', if it is in fact already being reused by other downstream users.

Allied plans and systems

Water allocation plans need to be developed in conjunction with drought management plans. Drought management is a distinct issue from water allocation, but the two plans must be consistent.

The topic of water rights trading, related to 'water saved' as per SCD460, will also need to be

considered – how can such practices be accommodated within a water allocation system?

Environmental flow allocation

What is an appropriate balance between environmental and human water consumption? This is clearly an issue that must involve the resolution of conflicting values by society as a whole. It can only be partially informed by science, which is still struggling to describe and understand the environment and the impact of water diversions upon it. It will be some time before the public is in a position to take a comprehensive approach to the discussion of environmental flows or ecological allowances. In many areas, the research needed is only just beginning.

In addition, most public discussion to date has concentrated on the water needs of surface systems. There is now growing recognition of the importance of the environmental water needs of ecological systems dependent on groundwater. This is just one of the issues that is likely to become more prominent in the future. (It is already of importance in the Shiyang River Basin in Gansu Province).

For many consumers and stakeholders, the need to describe clearly the benefits of allocating water for the environment is a significant issue. While every m^3 of water used for production can be readily translated into economic benefits, no such direct calculation can be done easily for the environment. There is at present no accepted method for assessing the value of the benefits that environmental allocations provide. Internationally, rudimentary attempts have been made to compare the direct short-term benefits of water use for the environment with the potential economic gains from using the same volume for industry or agriculture.

Water quality management

In addition to the need to identify the ecological or environmental flows, the issue of the dilution requirements in river flows needs to be taken into account in the allocation process. Consideration should be given to the 'water pollution control plans' of the departments under the Ministry of Environmental Protection. In the State Council's 'Organisational Reform Plan' approved at the 11th People's Congress, the Responsibilities of the MWR were stated.

Amongst the responsibilities is, under Article II.3: *"Be responsible for water resource protection. Organize the preparation of water resource protection master plans, organize the drawing up of water function zone division system for important rivers and lakes and supervise its implementation, verify and approve the assimilative capacities for water bodies, put forward recommendations on restricting total pollutant discharge, provide guidance on the protection of drinking water sources"*. The allocation planning should take into account the residual flow needs to maintain the required assimilative capacity of rivers and lakes.

The assimilative capacity of a given river reach for the minimum river flow condition is estimated for any desired water quality parameters/goals (e.g. BOD, DO etc.) by computing the maximum load the river can assimilate without deteriorating the river water quality beyond the permissible threshold as specified for the designated usages. The river water quality model such as QUAL2K can be

used in calculating this requirement (see Document AN1.5 in this series).

Re-allocation compensation

In many countries a process of water re-allocation is taking place. This can be:

- From one water user to another in the same sector;
- From agriculture to industry (note the different water use characteristics need to be considered);
- To environmental restoration; and
- From one river basin or catchment area to another.

Who should pay and how much is another often unresolved issue. This question particularly arises in river systems in which the water resource has been over-allocated to consumptive uses. Reducing allocations will incur costs on water users and, in some cases, make enterprises economically unviable or at least reduce profitability. Added to this are issues of what should be paid for, what should the level of charges be and what such monies should be used for.

Such compensation mechanisms are not currently practiced but their consideration should be in the mind when undertaking any re-allocation. In some countries the use of water banks has been established to facilitate the process.

Stakeholder consultation

There is also a need to decide who should make major decisions and how different interests should be represented. What responsibilities or involvement should be assigned to provincial and municipality authorities, or communities? How should national and international concerns be dealt with? Which sectoral organisations need to be consulted and how? This is particularly important in the context of the development of a water allocation system within an integrated water resources management (IWRM) context.

Water users who rely on the water allocation process need to be made aware of the security of supply assumed in the allocation process.

Climate change

In some areas, climate change might affect the water allocation process. This needs taking into account in long term plans.

3.6 Feedback for review of the plan

For the water allocation process to be effective, feedback will be essential to systematically improve the allocation planning with time. The main annual feedback should be a report summarising actual water use compared with the allocated amount spatially, temporally and by user. This is implied by the Water Law.

There could be a need for further information to improve the water allocation process and this might include:

- Improved awareness of the need for efficient water allocation by stakeholders (see TP2.2).
- Major water users to provide monthly water use data annually (this should be part of the water abstraction permit management system anyway – SCD 460 requirement. However, such

information needs analysis then aggregation).

- Need for expansion of the river gauging network to match allocation detailing, feedback on system performance.
- Permit management system (and water resource fee data on water use) to be linked to allocation volumes (see EG4.1).
- Feedback on drought severities, supply cutbacks or delivery failures (see AN 2.5).
- Require “major” public suppliers to report water use by category (domestic, commercial, industrial, institutional, agricultural, “non-account”) quarterly, based on a calendar year. (Such organisations should have these records for their business planning)
- Establishment of a requirement for government organisations to undertake water audits of major water users (basically a requirement of the abstraction permit system (SCD460) but not often carried out and not documented and reported systematically enough). This would include re-use situations.
- Establishment of wetland areas with their water requirements specified - volumes and timing needed for critical ecological systems). Annual water supply performance to be provided.
- Review of water rights and/or water abstraction permit allowances/details if allocation problems exist or develop
- Continually review locations where environmental flows should be defined (and monitored) in relation to ecological needs (and the monitoring system) (see AN2.4/2)

Avoid over allocation

4 Summary and Observations

Although a sound basic water allocation system exists in the country, comprising many of the key elements employed internationally as best practice, water allocation planning and execution across all provinces has room for improvement.

Some of the key issues that could be addressed are presented below are.

Allocation planning

- **Water allocation plans** need to be seen as vital water management documents, designed accordingly, implemented in practice and audited to improve future plans.
- All efforts should be made to ensure water resource **related plans are consistent**, both between plans and between administrative and planning levels
- **Water resources simulation modelling** should be used more extensively

A solid and integrated water allocation process needs to be established linking water resources assessments, of both groundwater and surface water, to the water abstraction permit information system. It is recommended that this is done through a GIS which will require the digitisation of WAP information. The GIS can be used to represent sources and demand centres spatially and thus make the allocation planning process more robust.

Auditing of plans, both long term and annual, should be a systematic process and lessons learned communicated to key stakeholders.

Resource assessments

- Water allocation needs to be related to sound water resource assessments with a cap or limit imposed on uses both of surface waters and groundwater
- Surface water and groundwater should be treated as a common or integrated resource in the allocation process
- **Water resources simulation modelling** should be used more extensively

Water resources assessments need to be undertaken at each administrative level as scientifically as possible. Resource assessments of both surface water and groundwater need to be made and their interaction understood. In the process an accurate knowledge is required of the current levels of water use since this is generally a large proportion of the existing resource that is being allocated. Different types of water resources need to be clearly defined, be it total water resource, available water resource, developed water resource etc. The spatial linkages or discontinuities between available resource and demand centre needs to be clear. As indicated earlier, the use of a GIS facilitates this.

The use of water resources modelling needs to be encouraged and supported. This also helps understand the resource situation.

Allocation system integration

- The strongest link possible should be made between the top down water allocation process and the requirements as specified in the **water abstraction permit** management system

Those undertaking resource assessments and water allocation planning at the macro scale need to work closely with all parties that are responsible for issuing and managing water resources abstraction permits. If the latter is considered by the former to be inaccurate or incomplete, the issue needs to be resolved. More attention needs to be given to having integrated information systems. Water abstraction permit (allocation) conditions need to reflect both resource conditions and use characteristics.

Environmental allocation

- **Environmental allowances** should be incorporated at every administrative level of the water allocation process, not just the requirements for the main channels of the main rivers. If for some reason no allowance is to be made, this needs to be stated and the reason given in the allocation plan. Advice needs to be given as to how ecological allocation allowances can be made and prepared between MWR and MEP departments amongst others.

The subject of environmental flows, assimilative capacities and total load assessments needs to be the subject of special attention by a task force from MWR and MEP together with expert bodies. A *modus operandi* needs to be agreed and this should then lead to an agreed approach to the identification of environmental allocations.

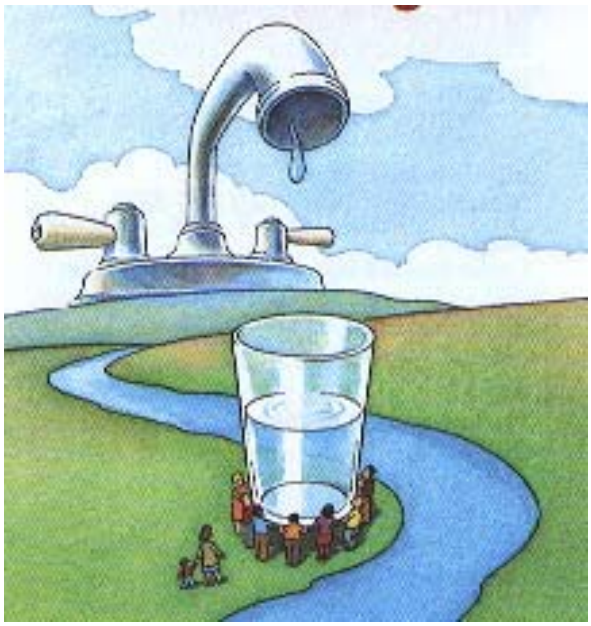
Water quality management

- Residual flow or dilution requirements (absorptive capacity) need to be considered in the terms of pollution control. This should be considered at the same time as the environmental flow requirement, and the same action by a suitable task force is needed.

Stakeholder participation

- **Strive for more stakeholder consultation and participation** not only between administrative levels but also between sectors and the public.

All organisations involved in water allocation should prepare a stakeholder consultation and participation plan to ensure that all parties affected by the water allocation process are aware of decisions and are given the opportunity to comment on changes in allocation that may affect them or perhaps the environment. A top level guidance document could be prepared to provide the framework for such an approach. The use of the internet could serve as a media for information dissemination and consultation.



Careful allocation to all stakeholders, yet allowing for environmental flow needs

Appendix A: Related Issues

A.1 Environmental Flows

Environmental flow enhancement is most challenging in overused and over-allocated systems. The most common cause of this over-allocation is administrative failure to set a 'cap' on total allocations and then keep the sum of all allocations within that 'cap'. However, in many situations, particularly the northern parts of the country, over-allocation and over use of water resources has already occurred and much damage has already been done. This creates an issue of 'reinstatement';

- who decides to what level river systems or aquifers should be reinstated and can such be guaranteed ecologically; and
- how such should be achieved; and perhaps
- what incentives should be put in place to achieve different goals at different time horizons?

There have been some studies on this issue already including studies on the 'carrying capacity of water resources'. However, this has tended to be at a national or large river basin level. Advice for municipality level situations is uncommon. Another group is developing an Environmental Index for regional categorisation of water resources allocation – again this will be of interest to large river basin situations.

Research on environmental flows has been underway since the 1970's with recommendations based primarily on a range of hydrological and hydraulic methods.

There is now general agreement among scientists and water managers that to protect freshwater biodiversity and maintain the essential goods and services provided by rivers it is important to mimic components of natural flow variability, taking into consideration the magnitude, frequency, timing, duration, and predictability of key flow events (e.g., floods and droughts). This can only be achieved on rivers with significant upstream storage.

A more 'considerate' assessment of environmental flow requirements is therefore required and this could be linked to a form of categorisation of the river system. Categorisation would need to take account of past and current levels of hydraulic regulation, inflow pollution status (and potential changes), ecological status, economic, socio-economic and social considerations.

A 'Tennant Montana' type environmental flow estimation process has been the most commonly adopted technique to date. This should be reviewed in the context of the characteristics of the particular river system. A key issue in heavily modified rivers is the need to use the Montana method on **naturalised flows** not the much reduced flows observed today. A major issue will be where environmental flow estimates based on the naturalised flow conditions are far higher than current low flow statistics indicate. The need for, process and time frame for the improvement of the aquatic ecosystems will need careful consideration. This will require considerable discussion with numerous stakeholders. (See Advisory Notes AN2.4/1 and AN2.4/2, and Thematic Paper 8.4 for additional information on this subject).

A.2 Simulation Modelling and Water Allocation

Annual planning of water allocation is often based on empirical estimation and historical statistics since this can be a relatively easy process. However, such approaches have been shown to lack science and are often subject to a water manager's experience and preferences. Additionally, surface water and groundwater are often treated separately without consideration to their interaction.

Internationally, simulation modelling of water resources is a proven method of assisting in the process of developing water allocation plans and various water resources allocation models exist.

In Canada, the **Cooperative Water Allocation Model (CWAM)** is designed within a general mathematical programming framework for modelling equitable and efficient water allocation among competing users at the **basin level** and applied to a large-scale water allocation problem in the South Saskatchewan River Basin located in southern Alberta, Canada. This comprehensive model consists of two main steps:

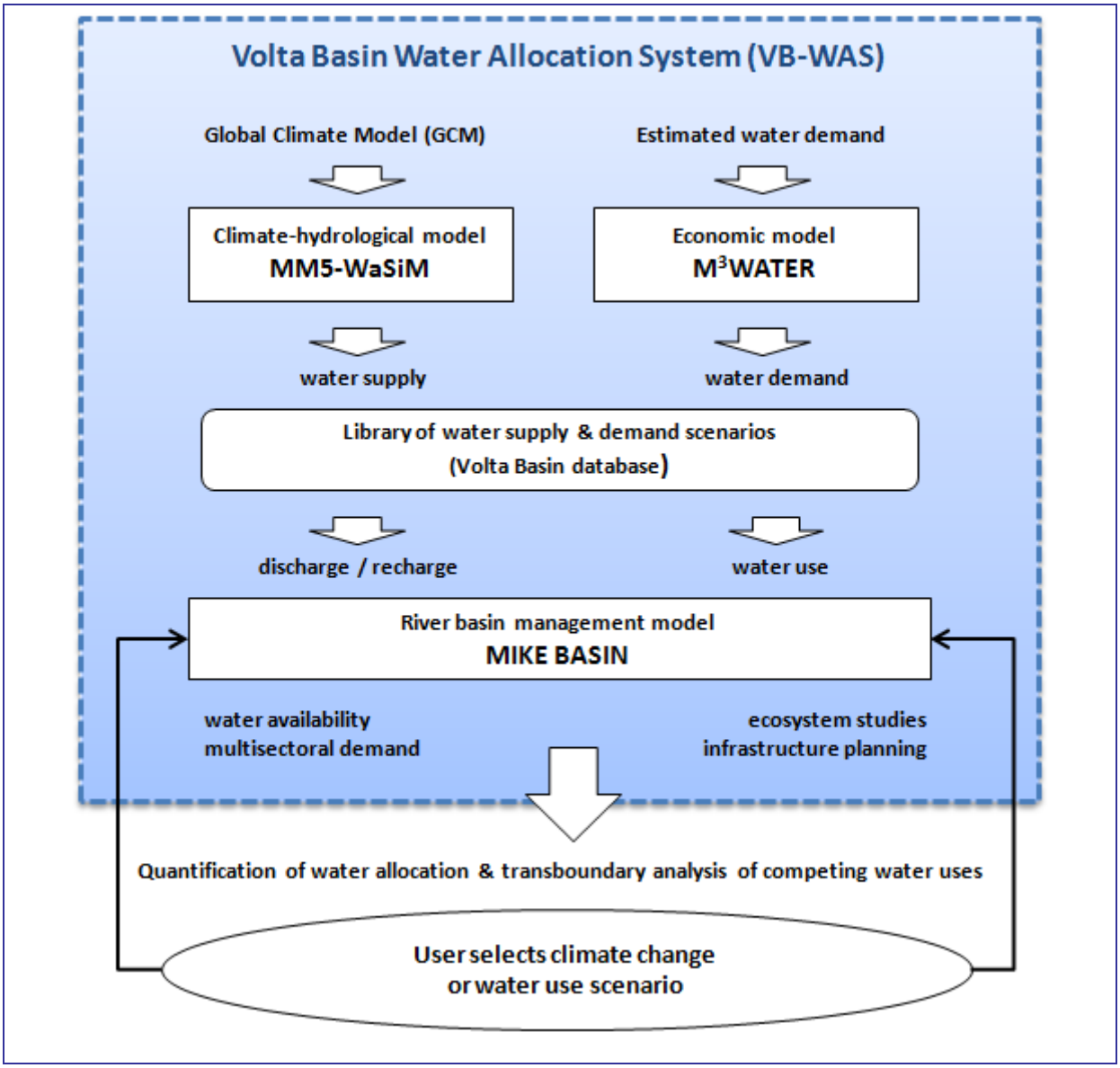
- initial water rights allocation; and
- the subsequent reallocation of water and net benefits.

The **Volta Basin Water Allocation System (VB-WAS)** - Ghana/Upper Volta. The VB-WAS is a decision support tool that allows incorporation of the impact of possible future climate conditions and projected water demand scenarios on future water resources management and infrastructure development in the basin. For example, the impact due to the increasing number of small reservoirs, further large dam development, and that of other water users, on the available water resources of the Volta basin can be assessed.

VB-WAS simulates the impact of various water users (water demand) on the water allocation (water supply) within the Volta Basin using a sequence of data coupled and fully coupled models.

The simulated historical and future discharge time series of the coupled climate - hydrological model (MM5/WaSiM) serve as water supply input data for a river basin management model (MIKE BASIN). MIKE BASIN uses a network approach, and allows fast simulations of water allocation and of the consequences of different development scenarios on the available water resources.

The water demand of different basin users (agricultural, domestic, hydropower) is dynamically simulated with the economic model (M^3WATER) assuming different policy scenarios (see diagram below).



However, all models are only as reliable as the data on which they are based. With increasing model complexity data requirements generally become greater; and there is more difficulty in fully understanding the algorithms governing the operation of the model – it becomes more of a 'black box' to users.

Additionally the ability to construct and operate models correctly requires a level of knowledge and professionalism only available in higher level organisations. Water resources allocation models have been developed in the country but are generally developed and used by central level institutes or universities (e.g. GIWP, IGSR/CAS, IWHR) although models have been developed by the Yangtze and Yellow River Basin Organisations.

Given the level of expertise needed, it is best that such modelling is initially established at provincial level. The provincial water resource departments should work with lower level departments to ensure that they establish a modelling system that is useful for all levels. Over time such

modelling techniques could also be undertaken at municipality level.

The key issue in using modelling as a tool for water allocation, as in all water resources planning at different administrative levels, is to ensure that consistent data sets and models are used at the different levels.

An indication of modelling work related to water allocation and undertaken at the local level is presented below.

Simulation modelling has been carried out under the Water Resources Demand Management Assistance Project (WRDMAP), 2005-2010, which addressed IWRM and water demand management issues, particularly related to dry season conditions in northern China. As part of the WRDMAP activities the issue of water allocation was explored in Chaoyang Municipality of Liaoning Province and in the Shiyang River Basin. In both cases a comprehensive (IWRM) management plan focused on water resources was developed - in Chaoyang Municipality by the local WAB, and in the Shiyang by the Shiyang River Basin Management Bureau.

An Advisory Note (AN1.1) in this series specifically addresses the issue of model selection to guide water resources managers at provincial level or below to decide on what type of modelling and then what software would be appropriate to their situation.

In the Daling River Basin, Liaoning Province, the water allocation system was modelled using the MIKE BASIN software.

In the Shiyang River Basin in Gansu Province, a different modelling approach was adopted using the WEAP Model. This was selected to complement a groundwater model that had already been developed by Tsinghua University for the river basin. This software has been translated into a Chinese operational software package. More details are to be found in Advisory Note AN1.3 (see bibliography).

Work by Professor Wang Z and others under the 'Water Entitlements & Trading Project (WET)' and the '948 Project, Water rights Reform Assessment and Key Technical Issues Study in China' funded by MWR developed a non-linear multi-objective model based on genetic algorithms to analyse the water allocation options in the counties of the **Shiyang River Basin, Gansu Province**.

The analyses considered trade-offs between competing needs and objectives. The multi-objective optimisation model incorporated weightings and assessed competing needs with a number of defined constraints or limits.

The conclusion of the paper '*A harmonious water rights allocation model for Shiyang River Basin, Gansu Province*', by Wang Z (2009) states:

"In view of the fact that water markets are not yet firmly established in China, allocating water rights based on existing patterns of water use, with future adjustment towards an 'optimum' via trading is unrealistic. Hence, it is more appropriate and rational to allocate initial water rights based on detailed water resources plans and future projections of water use in the basin (for the Shiyang). Plans should be adjusted periodically until water withdrawals in the basin fall within the caps proposed by the water allocation model."

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Glossary:

Abstraction	The act of diverting water from a natural surface stream or body and applying it to a statutorily recognised 'beneficial' use
Adaptive management	The process of continually reviewing and setting aside water for environmental purposes as conditions change over time, such as in the understanding of environmental needs
Allocation	The act of providing a water right to a water user or a use, or the act of modifying the volumetric entitlement of a water right. Allocations can be undertaken administratively (by planning body) or through the purchase in a market for water rights.
CAMS	Catchment Abstraction Management Strategies – an initiative of the Environment Agency for England and Wales
CAS	Chinese Academy of Sciences
Drought management plan (DMP)	A risk management tool prepared in advance of drought situation which sets out a process for identifying and warning of impending drought, promptly addressing impacts once a drought is declared
EA	Environment Agency for England and Wales
Environmental allocation	Water allocated for the specific and exclusive use of the environment. They may be defined in volumetric terms or as a share of the available resource.
Environmental flow requirements	Minimum and maximum flow targets, for certain locations, times of the year and periods.
GIWP	
IGSR	
IWHR	Institute of Water and Hydraulic Research, Ministry of Water Resources, China
IWRM	Integrated water resources management
MEP	Ministry of Environmental Protection (formerly State Environmental Protection Agency)
MWR	Ministry of Water Resources

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Glossary:

Naturalised flow	Naturalisation involves completely removing the influence of upstream water use and regulation from the observed flow records, thus synthesising a 'natural' record without anthropomorphic influence. In the USA the term 'impaired flow' is used.
Prior appropriation	Doctrine of water rights in the western States of the United States in which the rights obtained at the earliest date have a superior right — 'first-in-time-in use first-in-time-in-right'
Return flow	Water that returns to its original source after its extraction and use, mostly by irrigators and non-consumptive users
SCD460	State Council Decree No 460 (see bibliography)
WAB/WRD	Water Affairs Bureau/Water Resources Department
Water abstraction permit (WAP)	Permit or license giving official consent to abstract (see above) issued by government body (by State Council Decree 460)
Water right	A legal authority to take water from a water body and to retain the benefits of its use. The nature of such rights varies greatly. They are referred to in different jurisdictions as licences, concessions, permits, access entitlements, or allocations.
WDM	Water demand management
WFD	Water Framework Directive of the European Union

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'Introduction: The Development of a Water Rights System in China', Xuetao Sun, MWR, Journal of Water Resources Development, Vol 25, No 2, 189-192, June 2009.

'Water Resources Allocation in the People's Republic of China', Dajun Shen & Robert Speed, Journal of Water Resources Development, Vol 25, No 2, 209-225, June 2009.

'A harmonious water rights allocation model for Shiyang River Basin, Gansu Province', Prof Wang Z, Zheng, H and Wang X; Journal of Water Resources Development, Vol 25, No 2, 355-371, June 2009.

Document Reference Sheet

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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

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