Ministry of Water Resources

Ministry of Environmental Protection

EU – China
River Basin Management Programme

Technical Report 075

No.1 Document Water Resource Supply Security

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July 2012

EU-CHINA

Document Information:

Document No:	T-075
Date of Draft:	15 June 2012
Date of Issue	31 July 2012
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1 Introduction

This report compiles the background to the technical work on water resources, water demands and water allocations that has been identified during the Strategic Knowledge Exchange (SKE) on strategies for implementation of the Government of China 2011 No.1 Document on "Accelerating Water Conservancy Reform and Development in China (No.1 Document) between the EU China River Basin Management Programme (RBMP) and the Development Research Centre (DRC) of the Chinese Ministry of Water Resources (MWR). The report draws on a number of strategic and other studies undertaken both in China, in EU Member States and elsewhere. These studies have informed the development of the Water Resources Security element of the SKE Strategy Analysis Paper published as RBMP Technical Report 081 No.1 Document Strategic Knowledge Exchange - An EU Perspective and Overview.

1.1 Strategic studies

There are a number of recent studies that have examined various aspects of water resources planning and management in China. These studies have been undertaken over a much longer duration and with more resources than have been available for this SKE. The common themes from these studies have been taken forwarded and consolidated into recommendations in the Strategy Analysis Paper.

The main recent China specific studies (see Chapter 2 for summaries) identified during the SKE are:

- Asian Development Bank – TA 7621 Strategy for Drought Management, culminating in the report "Drying-up - What to do about droughts in the People's Republic of China" published during the course of the SKE in April 2012.

- Department for International Development (DfID) – China – UK, Water Resources Demand Management Assistance Project (WRDMAP) which over the period 2005-2010 produced a series of Advisory Notes, Thematic Papers and Guidance Notes in an Integrated Water Resources Management Document Series to support Water Resources Departments (WRD) and Water Affairs Bureaus (WAB) at provincial, municipal and county levels in their efforts to achieve sustainable water use.

- World Bank – 47111 "Addressing China's Water Scarcity Recommendations for Selected Water Resource Management Issues". This report synthesizes the main findings and recommendations from over 30 technical reports, case studies, and background papers prepared for the World Bank's Analytical and Advisory Assistance (AAA) program entitled "Addressing China's Water Scarcity: From Analysis to Action."

- Australia China Environment Development Program – Water Entitlements and Trading Program (WET), 2006.

Other broader-based studies, which again include the themes of demand-side management and risk-based approaches to water resource planning include:

- 2030 Water Resources Group - Charting Our Water Future Economic frameworks to inform decision-making (2009).
- UN World Water Development Report (WWDR) – Managing Water under Risk and Uncertainty (2012).
- World Resources Institute; Freshwater Sustainability Analyses.
- European Environment Agency - Towards efficient use of water resources in Europe (2012).

The common theme from all these studies and reports is the need for strategic water resources planning to move away from relying on supply-side infrastructure options to meet increasing demands towards a more balanced approach in which demand-side management and constraining the growth in new demands as well as requiring greater water use efficiency in existing demands lies alongside supply-side infrastructure to deliver the strategy. International best-practice now requires a more risk-based approach to water resource assessments and water allocations.

In England and Wales this has been enshrined in what is called the “twin-track” approach, while in China the Three Red Lines in the No. 1 Document now include maintaining water quality as a fundamental objective, so this now becomes a “triple-track” approach for China.

1.2 Technical studies

Technical studies required to underpin robust water resource planning are available from agencies within MWR, from international agencies and from the academic sector, in both China and elsewhere. The disparate nature of these studies, and sometimes the more academic rather than practical focus means that the outcomes are rarely brought together into single bodies of work that can inform the development and application of strategy.

1.3 Key issues for Water Resource Security Strategy

The basic assumption for water resource security planning is that there should be sufficient resources available to meet the anticipated demands. If the resources available, once the essential environmental requirements of rivers and lakes have been allowed for, are insufficient, then some form of intervention is required to achieve a balance. In China this has traditionally been the construction of additional supply-side infrastructure, but increasingly (and as required by the No. 1 Document) more attention is being given to demand-side measures through water allocations and the promotion of water use efficiency targets. To date water pricing does not seem to have been widely implemented as a measure to control consumption and demand.

The key issues are then:

- What are the design conditions for planning? Should these be based on the supplies available and demands expected for average years, or the supplies available and demands expected during drier than average years?

- Having set the appropriate design conditions, what water resources are required to meet environmental requirements, and then what is then available for consumptive and non-consumptive uses?

- Having identified the water resources available, how are these allocated between the individual consumptive and non-consumptive sectors? If drought conditions do occur, what is the management response at national, regional and local level?

- What technical analysis is available to inform the planning and management decisions? In particular what forecasting tools are available to set water resource allocations for the coming dry season?

- In times of drought how are restrictions to the agreed allocations calculated and implemented by the various administrative and other bodies?

One of the recurring themes from the recent strategic studies from ADB, DfID and the World Bank is the need to distinguish between water scarcity and drought, and related to this the difference between risk management and disaster management.

Water scarcity is a result of water demands exceeding the available supplies. Assessing water scarcity needs to take into account the natural seasonal variability of river flows, especially for those river catchments with distinct wet and dry seasons, where dry season flows may approach zero. In areas of low rainfall, annual totals can be highly variable both spatially and from year to year.

Whilst the concept of water scarcity is sometimes applied more to surface water systems than to groundwater, it is equally important to areas, where groundwater is the major water resource. Overexploitation of groundwater is an increasing problem. When abstraction exceeds long-term recharge the magnitude of water use is not sustainable and can lead to the mining of groundwater, falling groundwater levels, decline in baseflow to surface water courses, risks to water quality and higher power usage for pumping.

Water scarcity should not be confused with drought, which occurs as a result of a shortfall of rainfall as compared with the rainfall that normally occurs (long term average seasonal or annual rainfall).. A systematic assessment of water scarcity provides the basis for a risk-management approach to water resource planning which internationally has become the main policy approach for water resource management, and when droughts do occur the basis for drought management. Risk management seeks to allow for a given level of risk that the water resources available will be not be able to meet all allocations in full and that resilience is built into the system to deal with part of that risk. The data and analytical approaches used to assess the risk and make water allocations are also available to underpin managerial and operational decisions when droughts do happen.

Droughts are a normal feature of the various climatic conditions across China; they have occurred in the past, they occur now and will continue to occur in the future, perhaps with more widespread and significant effects as a result of climate change. In the past, drought management in China has tended to be more reactive than proactive, with water allocation restrictions and emergency supply-side measures only being implemented once drought conditions have occurred and the impacts are being felt.

Another feature of international water resource planning best-practice is transparency and stakeholder engagement. Consultation and the publication of documents in the public domain are a requirement of the WFD, and are referred to explicitly in the No. 1 Document.

1.4 Structure of the report

The remaining chapters of this Technical Report refer to various studies, policy documents and published strategies to illustrate examples of international best-practice that could inform the approach to deliver the water resource planning objectives of the No.1 Document.

The following chapters of the report cover:

- Key features from recent studies on water resource issues in China
- Water resource assessments
- Demand forecasts
- Approaches to risk-based management in Water Resources Planning (to include natural variability, climate change variability, and threats from pollution – for instance Water Safety Plans)
- Planning (to include water allocation, strategic planning and drought planning)
- Next steps for water resources analysis to underpin delivery of the No.1 Document and the Three Red Lines

2 Recent studies on water resources in China

There are four recent studies which contain a wealth of technical, policy, and institutional information and analysis of the water resource sector in China. Key features of the analysis and recommendations from these studies that feed into implementation of the No.1 Document are reproduced and/or summarised in this chapter.

2.1 World Bank – Addressing Water Scarcity in China; Analytical and Advisory Assistance programme (AAA)

The overarching objective of the Analytical and Advisory Assistance (AAA) programme was to assist the Government of China to develop, adopt, and implement an integrated set of policy and institutional reforms needed to more effectively address China's water scarcity and build a water scarcity-saving society. Specifically, the AAA aimed to:

- improve the understanding of key water-related policy and institutional issues and recommend specific policy and institutional reforms to address them
- engage concerned parties, including Government policy-making entities and other stakeholders, to raise awareness and establish consensus on integrated water resource management
- create an enabling environment for the recommended actions by reducing cross-sectoral and inter-jurisdictional differences and enhancing cooperation on the ground.

The AAA built on the large number of existing and ongoing studies in China and international experiences in integrated water resource management. Analytical studies undertaken for the AAA focussed on the key areas where incremental work was requires to fill gaps in understanding of the issues and actions required to address them. The thematic studies included:

- Water Pricing, Willingness-to-Pay and Affordability
- Water Pollution Emergency Prevention and Responses
- Water Rights and Compensations for Ecological and Environmental Services in River Basins
- Strategic Direction for China Urban Water Sector
- Economic Valuation and Policy Analysis -Hai River Basin Case Study
- Policy Framework for Water Resources Management in Chongqing.

The final report was published in 2009 and synthesises the main findings and recommendations from over 30 technical reports, case studies, and background papers produced under the AAA Programme. The main messages from the final report are quoted below and include:

- *China needs to move from a traditional water management system with the government as the main decision-maker towards a modern approach to water governance that relies on (a) a sound legal framework, (b) effective institutional arrangements, (c) transparent decision making and information disclosure, and (d) active public participation .*

  Improving water governance will require the government to reform existing laws and regulations, strengthen law enforcement, reform and unify the organizational framework for better decision making at the national level and greater local ownership and participation at the river basin level, and strengthen legal provisions for public information and participation.

- *To allow greater scope for market-based approaches, China needs to establish clear property rights for water.*

  Prerequisites include the development of basin-level water resource allocation plans that give first priority to ecological needs, the conversion of traditional water allocation entitlements into tradable water rights, and the strengthening of water administration by clarifying the conditions, procedures, rights and obligations of the state, communities, enterprises and individuals for the withdrawal, consumption, protection and transfer of water rights.

- *To provide appropriate incentives for the adoption of water saving technologies and behaviours, water prices need to be allowed to rise to reflect its full scarcity value.*

  The first step is for water and sewerage prices to at least cover the financial needs of the water supply and sewerage enterprises. The social impact of the price increases, especially those affecting the poor, can be addressed by implementing an increasing block tariff approach and other social protection measures for residential consumers.

- *To enhance incentives for the protection of water sources, China needs to vigorously pilot market-oriented mechanisms for ecological compensation.*

  Mechanisms such as the payments for ecological services approach will improve the effectiveness of ecological compensation and reduce the financial burden on the government of providing adequate incentives for protecting the upstream ecosystems that are essential for the long-term supply of good quality water.

- *To control and solve China's serious water pollution problem, the government has to use all available legal, institutional and policy instruments to mobilize the public and motivate polluting sectors to comply with applicable regulations.*

  This will require a strengthening of the wastewater discharge permit system, more aggressive use of the litigation systems to protect the public interest, greater attention to the control of non-point pollution from agriculture, and better preparedness for water pollution disasters.

"Some of the recommendations, such as the reforms of river basin commissions and the water resource fee management as well as water quality monitoring and disclosure, may not be in line with sectoral or local interests but we believe that they are essential for the nation to effectively address the emerging water scarcity crisis." says **Jian Xie**, World Bank Senior Environmental Specialist and Principal Author of this report.

2.2 ADB – Strategy for Drought Management (TA 7261-PRC) leading to "Drying Up – What to do about droughts in the People's Republic of China"

The objective of the ADB Technical Assistance (TA) was to review and analyse the history and impacts of drought in China, review the existing legal and institutional frameworks; policies' regulations and emergency responses to drought and make recommendations regarding the potential for a drought risk management strategy for China. This was a different, more strategic-based approach than the type of emergency action that has been and still is the common response to drought management in China.

Information, research, forecasting, monitoring and planning, and changing attitudes and funding mechanisms were identified as the key at the national and provincial levels, whilst planning, water saving/efficiency and conservation and education will be the key at the water use end. The TA Final Report concluded that considerable changes in attitudes and thinking would be required to implement such a change.

Recommendations from the TA Final Report follow through to the report "Drying Up" which consolidates the highlights from several recent ADB technical studies that provide good references for examining how the PRC could address water security issues, especially drought and environmental degradation.

The key messages from "Drying Up" which are recurring themes in the No.1 Document are:

- Droughts are natural occurrences in China with some regions being particularly prone to and at risk from drought conditions. Water shortages caused by economic development and unconstrained water consumption are exacerbating the effects of dry periods and droughts. Whilst such water shortages can be addressed by major capital infrastructure, the report notes that a more cost-effective and environmentally sustainable approach would involve three tracks:
    - First, prioritize risk assessment and reduction plans, of which demand management is essential.
    - Second, make optimal use of infrastructure by including non-structural technical options and non-traditional infrastructure to bring demand down to sustainable levels.
    - Third, reform water management at the local level in order to achieve the healthy ecosystems - the long-term benefit of demand management.

- A risk reduction approach to droughts would spare the PRC much of the unnecessary hardships currently experienced. Droughts cannot be prevented, but the severity of their effects can be reduced through better systems and demand management. The PRC has the national systems for monitoring and forecasting droughts, but its early warning system must be further developed so that sub-national governments can respond early and quickly. Provinces and cities should assess the risks associated with current water resource extraction rates and demand levels. Unsustainable consumption rates put populations, industries, and economies at greater risk during a drought. This is unnecessary risk. More conservative consumption in normal times can create water savings in reservoirs and natural ecosystems, which will be useful in droughts and for long-term ecosystem rehabilitation.

- Use an optimal mix of infrastructure for saving water instead of just spending it. The current infrastructure path in the PRC is still navigating toward increasing water supply while opportunities for saving water are vastly under-explored. Provinces, cities, and industries can invest in technologies and systems that can increase available supply by saving water and with greater cost effectiveness than building storage.

- Demand management offers short-term gains in increased supply capacity and availability and long-term gains in more productive ecosystems. Strategic management is the key to achieving specific results, whether they are near-term results (such as water savings) or long-term results (healthier and more productive ecosystems). The traditional way of managing water resources is a large part of the problem - too many agencies are managing a shared, crucial resources and sometimes with contradictory and possibly conflicting interests. Water resources need a reliable system of user rights and allocations that consider the needs throughout a watershed irrespective of jurisdictional boundaries.

The following schematic from the TA Final Report (Figure 1) gives a good illustration of the difference between the current reactive approach and the more risk based and proactive approach to drought management:

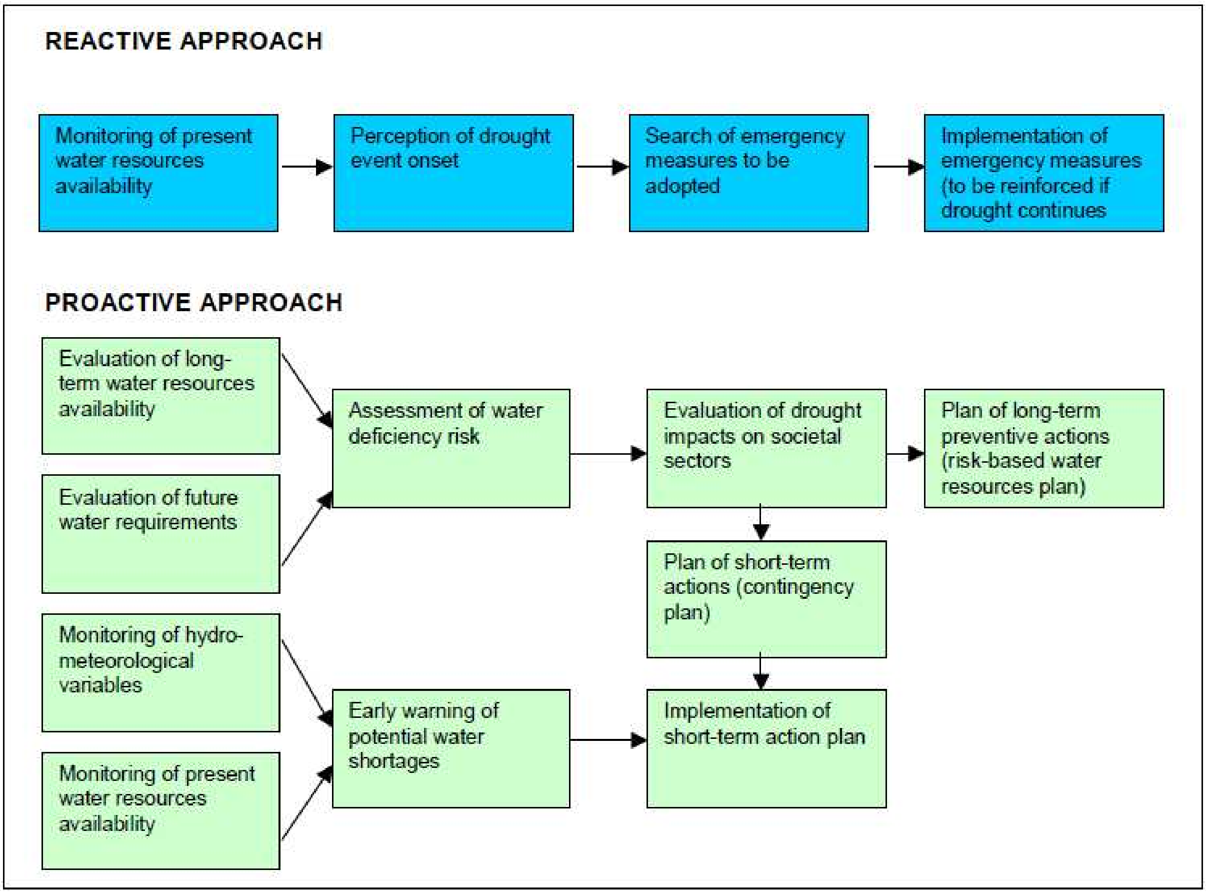

Figure 1 Contrasting approaches to drought management

2.3 DfID – Water Resource Demand Management Assistance Project (WRDMAP)

The project aimed to support the reforms required by the 2002 Chinese Water Law which has been enacted to, amongst other aspects, improve livelihoods through equitable access to and sustainable use of water resources, particularly for poorer people.

Integrated water resources management (IWRM), river basin management, demand management and the creation of examples of water saving societies are key elements of WRDMAP. As with the ADB and the World Bank studies referred to above, these are recurring themes in the No.1 Document.

The 5 year project involved developing and implementing pilot studies for the first three years in the provinces of Gansu and Liaoning. The results and water resources management improvements generated over this time have been broadly disseminated both within the two provinces and also throughout China during the remainder of the project.

A key output of the Water Resources Demand Management Project (WRDMAP) is the IWRM Document Programme prepared to help inform water resources professionals at various levels of government and different organisations of the basics of integrated water resources management (IWRM) and water (resources) demand management. These documents are intended to provide guidance in support of existing national and provincial standards and documents. During the course of the five year project capacity building was undertaken at central, provincial, municipality and county levels based a number of case studies, three in Gansu Province and three in Liaoning Province. This process enabled a detailed assessment to be undertaken of current practices in relation to the then current water sector legislation and identify areas where general guidance would probably be useful for a broader number of water sector professionals in the country. These guideline documents would serve as the foundation material for a nationwide dissemination programme, initiated during the course of the project and to be continued by the Ministry of Water Resources thereafter. These documents have been produced in Chinese and English with the former being in both hard copy and digital formats. The digital versions are available from the website (www.wrdmap.com); in total there are over 70 documents in both languages.

The Document Series comprises different elements as summarised below:

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

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

Advisory Notes (AN)
These are a major output of the project and should be seen as the backbone of the IWRM or WRDMAP dissemination programme. An AN, which is subject matter related, is a structured compendium of advice on issues related to the topic and covers how to undertake or perform a particular aspect of water resources management at the municipality and county levels. This is classed as being the operational level of water resources management.

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

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

A list of these reports can be found at http://www.wrdmap.com/documents/WRDMAP_Guides_v2.pdf.

2.4 Water Entitlements and Trading (WET) Project

The Water Entitlements and Trading (WET) Project was a joint initiative between the MWR and the Australian Department of Agriculture, Fisheries and Forestry. The objectives of the project were to:

- Review the current systems, laws, and practices in China related to water entitlements and trading
- Provide recommendations on a framework for water entitlements and trading that can be implemented across China

- Identify the steps to implementation, including developing plans to implement the framework in two pilot catchments.

The report makes recommendations on the key policy and technical requirements necessary to implement a water entitlements and trading system in China. The water rights framework developed promotes a system for allocating water that is consistent and transparent, and which recognises:

- long-term and annual rights to take water at the regional, abstractor and farmer levels
- ecological requirements for water.

2.4.1 Water Resources Allocation Plans and Environmental Flows

Water resources allocation plans (WRAPs) underpin the entire WET system. They are the mechanism for allocating water amongst regions and for setting a cap on abstractions. They are also the tool for providing for environmental flows. WRAPs should be a regulatory instrument, providing clear direction for resource managers in how to allocate and manage the resource. The WET report includes detailed analysis and recommendations on the requirements for making and implementing WRAPs.

Flow regimes are critical for ecological health. The requirement for environmental flows should be considered during the water allocation process and flows should be set based on the best available science, recognising the importance of maintaining natural variability – in terms of duration, timing, frequency and size of flows – to the extent possible. Environmental flows are much more than just a fixed percentage of the mean flow. The report outlined a methodology for identifying ecological assets and determining (and providing) the flows that are important to their health.

2.4.2 Allocation and management of water rights within irrigation districts

The WET study produced draft guidelines for the allocation and management of water within irrigation districts. These guidelines detail a process for allocating water to water user associations (WUAs). This process includes both the allocation of long-term rights as well as the annual allocation process. The guidelines also make recommendations in respect of the process for establishing and managing WUAs, in a way consistent with the requirements of a WET system.

A pilot study in Hangjin irrigation district in Inner Mongolia Autonomous Region was used to demonstrate the allocation of water rights within an irrigation district. The water available to the district was allocated amongst WUAs in the district, and an annual planning system was developed.

2.4.3 Other aspects of water entitlement and trading systems

In addition to these key components, work was completed in respect of the following:

- Water abstraction permit management
  The requirements for permit specification and registration were identified.

- Public water supply management
  This study involved an assessment of the current approaches in China to allocating water for public water supply, and the role of abstraction permits in this process.

- Water resources management modelling
  An assessment of suitable modelling tools to support a WET system in China was completed.

- Water accounting
  The report includes an overview of the Australian approach to water accounting. It considered the current situation in respect of water information management in China and identified improvements that could be made.

A review of the 2006 Ordinance on Management of Water Abstraction Permit and Water Resources Fee (Decree 460 [2006] of the State Council) made as part of the WET project is included as Appendix 1.

3 Water resource supply security in Chinese context

3.1 Introduction

The Chinese Government has been attaching great importance to the reform and development of water affairs. The No.1 Document defined a clear implementation calendar to promote long-term economic development and social harmony and stability by initialising water sector reform and development and establishing the institutional framework for water infrastructure management and development within the next 5 and 10 years or even longer period.

In the No.1 Document, the Three Red Lines were proposed:

- The first red line sets **water quantity** objectives in rivers, lakes and groundwater. It requires the "total quantity control of water abstraction"
- The second red line sets objectives for **water use efficiency**. This will accelerate the development of national standards regarding water use quotas for high water consumption industries and the service industry
- The third red line sets maximum permissible **pollution load** for Water Functional Zones, which are catchments, reaches of rivers or lakes that must meet specific water quality standards.

In terms of water supply security the objectives are enshrined in the first two of the Three Red Lines.

This will accelerate the development of national standards regarding water use quotas for high water consumption industries and the service industry. It is only through the aggressive promotion of water efficiency that increases in demand can be kept to the levels set in the No.1 Document, namely less than 635 billion m^3 in 2015 and 670 billion m^3 by 2020.

3.2 Situation and challenges

3.2.1 Population growth and urbanisation

China's large and growing population, combined with further urbanisation and industrialisation, means that water supply security is becoming increasingly threatened (Figure 2).

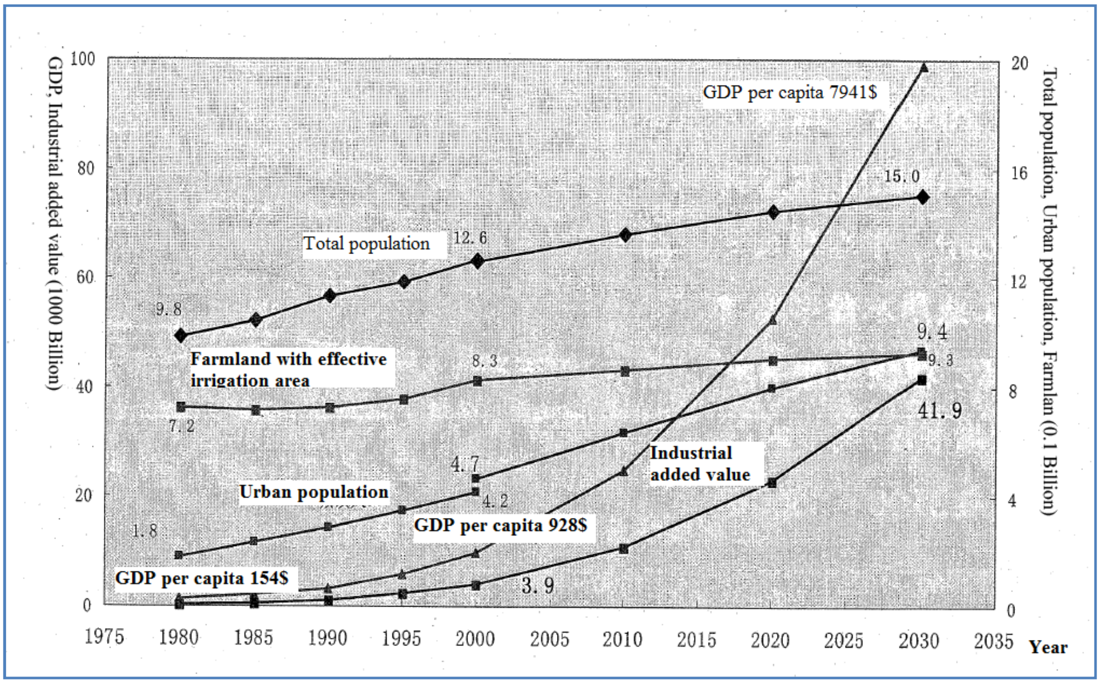

Figure 2 The history and trends of population and economy

3.2.2 Estimation of the water resources

The total water resource in China is 2,850 billion m^3, of which the surface water amount is 2,750 billion m^3 (96%) and the underground water amount is 825 billion m^3. The non-overlapping water amount between the underground water and the surface water is 100 billion m^3.

In the recent two decades, the precipitation of the four northern water resource zones including Huanghe, Huaihe, Haihe and Liaohe has dropped by 6% on average, the river runoff has decreased by 17% and the total water resources have reduced by 12% (Figure 3).

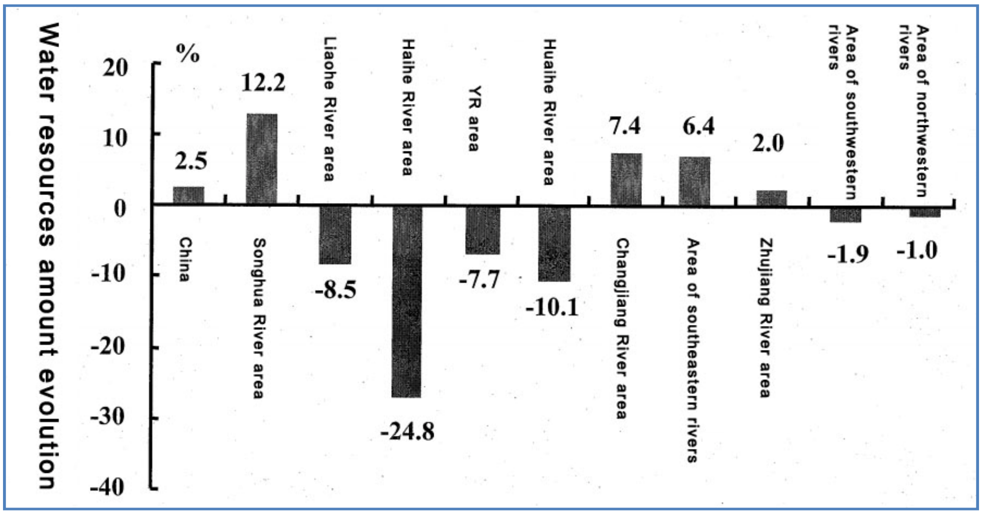

Figure 3 Comparison between assessment results of the period from 1980 to 2000 and the period from 1956 to 1979

3.2.3 Increasing of water use and competing demand

The national water consumption increased from 440 billion m^3 in 1980 to 570 billion m^3 in 2006 with the annual growth being 1.5%.The annual growth of urban domestic water consumption was 6.7%, of industrial water consumption 4.4%, while agriculture as the largest consumer remained almost constant (Figure 4).

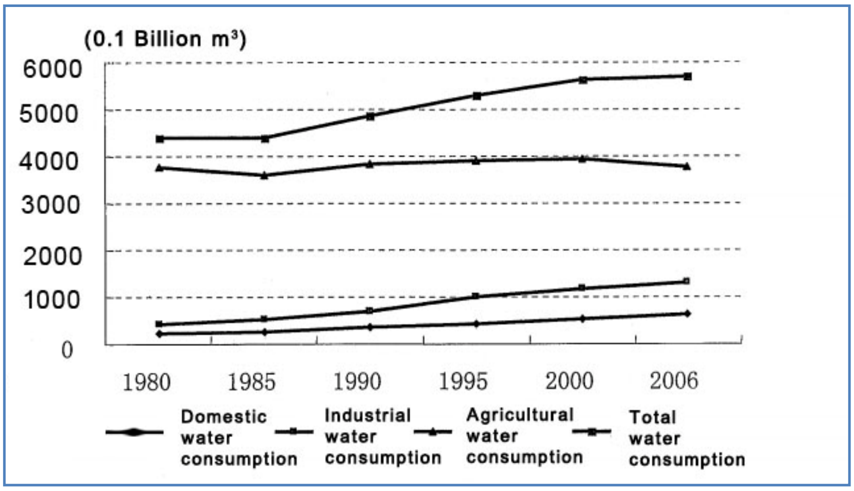

Figure 4 The history of domestic, industrial and agricultural water consumption

3.2.4 Over use of water in many places

The development and utilisation rate of the national water resources is 19%, that of northern China is 48% and that of southern China is 13%, while the Hai River basin reaches up to 106% (Figure 5).

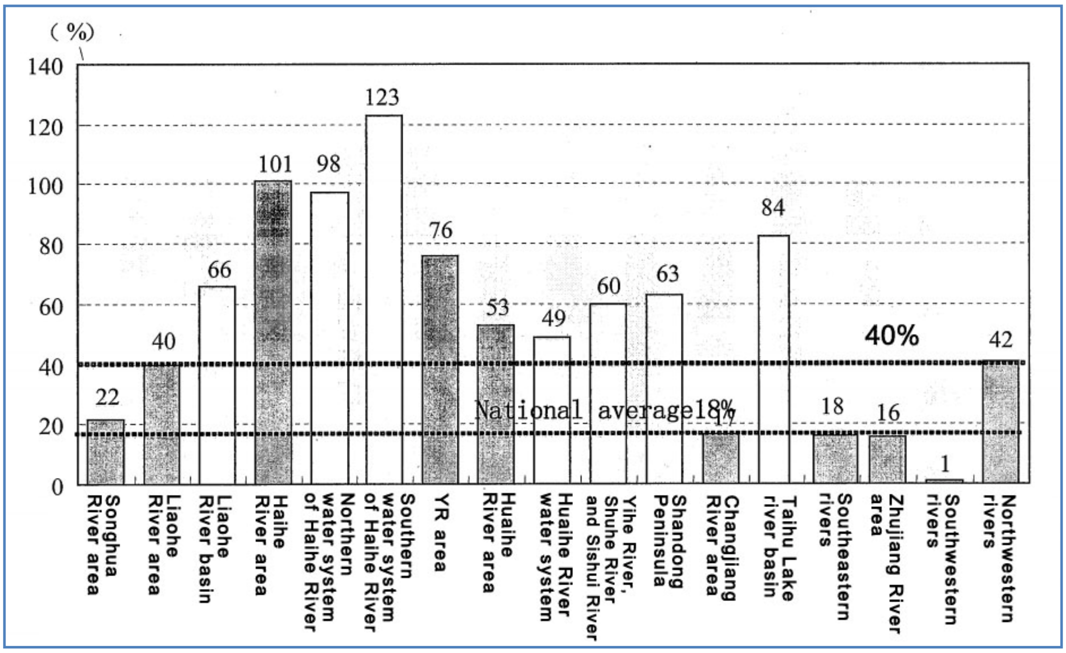

Figure 5 The water resources development and utilisation rate by river basin

The national water resources is 570 billion m^3, which the actual water consumption is 395 billion m^3, which equals to 49% of the available water resources. The overuse problem of water resources in North China is serious (Figure 6).

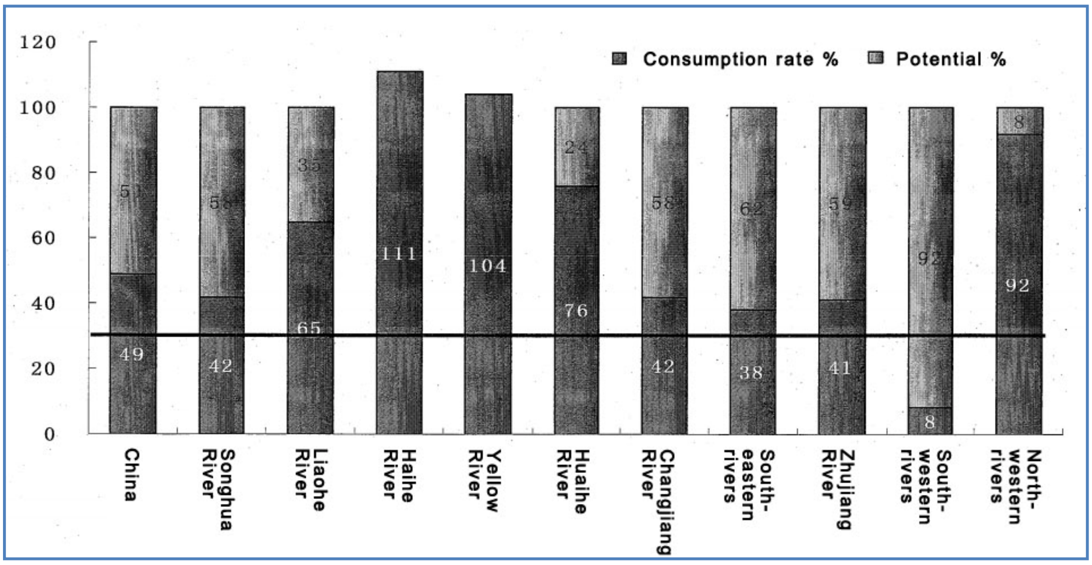

Figure 6 The water consumption rate by river basin

3.3 Water resources gross control

The basis for control is given in Article 47(1) of the Water Law:

"The country exercises a system combining gross control and quota management for water use"

3.3.1 Definition and requirements of gross control

For gross control it is necessary first to solve the issue of the relationship between man and nature, namely, to define the gross amount of water available for economy and society on the conditions of overall coordination of water for life, productive uses and ecological environment.

The gross control demands that the available gross amount of water available in river basins should be allocated to regions to set the overall and specific water drawing and use restriction indexes and the macroscopic direction requirements for water drawing licensing levels.

The gross control requirements were raised in such aspects as water quantity, water quality, the maximum water quantity and the minimum discharge, and specific indexes were defined for regional section control and management of major water users, thus establishing a control system for water drawing licensing management and even water resource management.

The gross control is realised in many aspects: planning, water allocation, water drawing licensing, water drawing licensing management, water function zone layout management, water resources dispatching, etc.

For the first phase of water allocation 25 rivers and tributaries have been selected (Table 1).

Table 1 Preliminary list of rivers and river basins planned for gross control (2010-2012)

Number	**River Basin Commission**	**River Basin**	**1st order rivers**	**2nd order rivers**	**3rd and lower order rivers**	**Provinces and Autonomous Regions**	**River Basin Area (km²)**
1	Songliao River Water Resources Commission	Songhua River	Nen River			Inner Mongolia、Heilongjiang、Jilin	298,500
2		Songhua River	Lalin River			Heilongjiang、Jilin	19,923
3		Songhua River	Second Songhua River			Jilin、Liaoning	73,416
4		Liao River	Dongliao River			Jilin、Liaoning、Inner Mongolia	10,364
5	Hai River Water Resources Commission	Hai River	Jiyun River			Beijing、Tianjin、Hebei	10,288
6		Hai River	Daqing River	Juma river		Beijing、Hebei	10,154
7		Hai River	Zhangwei River	Zhang River	Zhuozhang River	Shanxi、Henan、Hebei	11,206
8	Yellow River Conservancy Commission	Yellow River	Huangshui	Datong River		Qinghai、Gansu	15,130
9		Yellow River	Wuding river			Inner Mongolia、Shaanxi	30,261
10		Yellow River	Wei River			Gansu、Ningxia、Shaanxi	62,500
11		Yellow River	Wei River	Jing River		Gansu、Ningxia、Shaanxi	45,400
12	Huai River Water Resources Commission	Huai River	Huai River			Henan、Anhui、Jiangsu	187,000
13		Huai River	Yishusi	Yi River		Shandong、Jiangsu	11,392
14		Huai River	Yishusi	Shu River		Shandong、Jiangsu	5,970
15	Taihu Basin Authority	Taihu Lake				Jiangsu、Zhejiang、Shanghai、Anhui	36,895

Number	River Basin Commission	River Basin	1st order rivers	2nd order rivers	3rd and lower order rivers	Provinces and Autonomous Regions	River Basin Area (km²)
16	Changjiang Water Resources Commission	Changjiang River	Han River			Henan、Hubei、Chongqin、Sichuan、Shaanxi、Gansu	154,804
17		Changjiang River	Jialing River			Sichuan、Chongqin、Gansu、Shanxi	159,357
18		Changjiang River	Tuo River			Sichuan、Chongqin	27,631
19		Changjiang River	Chishui River			Yunnan、Guizhou、Sichuan	19,231
20		Changjiang River	Min River			Qinghai、Sichuan	135,411
21	Pearl River Water Resources Commission	Pearl River	Xi River	Hongshui river	Beipan River	Yunnan, GuiZhou	26,590
22		Pearl River	Bei River			Jiangxi、Guangxi、Guangdong、Hunan	46,710
23		Pearl River	Dong River			Jiangxi、Guangdong	35,340
24		Pearl River	Han River			Jiangxi、Fujian、Guangdong	30,112
25		Pearl River	Xi River	Huangni river		Yunnan, GuiZhou	8,164
The total number of rivers			**25**			**Total area**	**1,471,749**

3.3.2 Water drawing licensing gross control indexes

It is stipulated in Article 7 of Management Regulations on Water Drawing Licensing and Collection of Water Resource Fee (See also Appendix 1):

> *"To implement water drawing licensing, it's necessary to adhere to considerations of both surface water and groundwater and the principles of combining sourcing and saving with the latter coming first and combining gross control and quota management.*
>
> *The gross water consumption for those approved for water drawing in any river basin shall not exceed the availability of water resources of the basin.*
>
> *The gross water approved for drawing in an administrative region shall not exceed the water quantity available for drawing and use of the region issued by the river basin organ or the superior water administration; and the gross groundwater approved for drawing and use shall not exceed the groundwater quantity available for draft in the region, which shall also meet requirements by exploitation and utilisation of groundwater. "*

It is stipulated in Article 15 of Management Regulations on Water Drawing Licensing and Collection of Water Resource Fee:

> *"The approved water allocation plan or the signed agreement is a reference for determining the water drawing licensing gross control of river basins and administrative regions.*
>
> *For rivers and lakes crossing provincial ….. borders, if no water allocation plan has been developed or no agreement has been signed yet, the water drawing licensing gross control indexes of relevant provinces, …., should be proposed by river basin management agencies in accordance with water resource conditions of river basins, comprehensive plans of water resources, comprehensive plans of river basins and middle/long-term water supply and demand plans, in combination with present situations of water drawing and water supply and demand of relevant provinces ….., and through negotiations with water administrations of the People's Governments of relevant provinces ………., and then submitted to the competent water administration under the State Council for approval. The water drawing licensing gross control indexes of administrative regions of cities or counties should be set by competent water administrations of the People's Governments of relevant provinces ….. in accordance with water drawing licensing gross control indexes of such provinces …. in combination with local present situations of water drawing and water supply and demand, and submitted to relevant river basin management agencies for reference. "*

3.3.3 Current challenges in gross control

The current challenges in achieving gross control are:

- Demand for ecological and environmental discharge in watercourses

- Connection between comprehensive plans of water resources and water drawing licensing gross control indexes
- Connection between water allocation plans and water drawing licensing gross control indexes
- Connection between water quantity approved in water drawing licenses and the annual water drawing allocation plans
- Connection between water drawing licensing gross control indexes and reasonable water quotas
- Centralised management and allocation of water quantity and quality, groundwater and surface water
- Management of free acquisition and transfer transactions of water drawing rights.

3.4 Water resource fee

3.4.1 Overview

According to Management Regulations on Water Drawing Licensing and Collection of Water Resource Fee (April 15, 2006):

> *"The water resource fee shall be prepared by the competent price authority of the people's government of each province …….. along with finance and water administration departments at the same level, and submitted to the people's government at the same level for approval and to the competent price authority and finance and water administration departments under the State Council for filing. However, the water resource fee for water infrastructure directly under the Central Government or crossing provinces …., that are required to be approved by the river basin management agencies, shall be prepared by the competent price authority under the State Council along with finance and water administration departments under the State Council."*

Article 29 In preparing the water resource fee, the following principles shall be observed:

1 Promote rational exploitation, utilisation, saving and protection of water resources;

2 Adapt to local conditions of water resources and local economic and social development levels;

3 Make overall planning of rational exploitation and utilisation of surface water and groundwater to avoid overdraft of groundwater;

4 Take full account of differences in different industries and sectors.

The standard of water resource fee is reference to these principles developed around a very big difference, such as Beijing is 1.1 CNY/m^3, but in Guangzhou only 0.12 CNY/m^3.

Article 36: The water resource charge shall be included in the budget in full, in accordance with the approved departmental budget co-ordination arrangements by the financial sector, mainly for the conservation, protection and management of water resources and can also be used for the rational development of water resources.

The main purpose of the water resource charge includes the following aspects: operation, maintenance, equipment, staff salaries and other costs.

3.4.2 Water prices

In China the water rate consists of three parts, namely:

- a sum of resource water rate
- environmental water rate
- engineering water rate.

The resource water rate is the water resource fee, based on the scarcity of water resources. The environment water rate, derived from environmental remediation and compensation, is a governmental institutional charge, including a sewage treatment fee and a pollutant disposal fee. The engineering water rate includes two parts to cover the cost of bulk water infrastructure and cost of piped water supply, respectively.

Though China has demanded that the urban water supply to implement a two-part water pricing mode combining supply capacity and volumetric pricing or a hierarchical volumetric pricing mode (increasing block tariffs or similar) step by step, the volumetric pricing mode is being implemented and some cities are implementing or will implement the hierarchical water quantity pricing mode. Changsha in Hunan Province, for instance, implemented the hierarchical water quantity pricing mode from 1 February 2012. Other cities, like Guangzhou and Beijing, will try the hierarchical water quantity pricing mode as well. However, there are still few implementing the hierarchical water quantity pricing mode at present.

The water rate is different for different water users, which can be categorised into five categories by use nature: domestic, industrial, administrative institution, business service and special sectors like bathing and car washing. Generally speaking, the domestic water rate is the lowest while the special sector water rate is the highest.

It's stated in Management Measures for Urban Water Price (23 September 1998):

> *"A seasonal water rate can be implemented in any region featuring tourism or seasonal consumption".*

At present the seasonal water rate is scarce in China, but it's still being implemented in some places. For example, the seasonal water rate is being implemented in Baoding, Hebei, and other regions, like Jiangsu Province and Dongguan, Guangdong Province, are planning to exercise the seasonal water rate step by step.

3.4.3 Irrigation water charges

Generally the total water rate is paid in accordance with the irrigation area reported by farmers at the beginning of each year and the water rate per mu estimated on the basis of experience. The water rate may also be paid at the end of each irrigation season, but in that case it may be difficult to collect. In some river basins, it is necessary to buy a water ticket in advance in order to receive irrigation water.

The fee for irrigation water charge is low averaging only 57% of the costs of supplying irrigation water. In addition the collection is low, so in total the agricultural water charges collected in 2005 covered only 38% of the actual supply cost.

In particular, the water charge has declined dramatically since the taxation reform in rural areas. Besides, the agricultural water charge is deducted or exempted by local governments in some economically developed regions. Wenling and Yongkang of Zhejiang Province and Dongguan and Foshan of Guangdong Province have stopped collecting the agricultural water charge since 2004 and all exempt agricultural water rates are paid from the local budget. Such practices have had a huge social influence, making it more difficult for water administrations in other places to collect the water charge.

4 Water resource assessments

Robust assessments of water resource availability are an essential component of all aspects of water resource planning. Such assessments rely on good historic time-series of rainfall, evaporation and river flows at appropriate spatial and temporal scale, together with accurate records of abstractions (from surface water and groundwater), diversions and effluent discharges, and groundwater levels.

One of the main differences between current EU best-practice and China is the transparency of the analysis and its availability in the public domain for scrutiny and comment.

With increasing risks from climate change, unsustainable exploitation of natural water resources and increasing demands, the need for reliable assessments becomes even more important, and will be an essential component of work to deliver the No.1 Document. Work undertaken for the SKE suggests that assessments of surface water resources in China is already in line with EU best-practice, however there do appear to be major differences in the interpretation and use of the outputs from that analysis and the approach to dissemination in the public domain combined with stakeholder engagement. For groundwater resources, the approach seems to be less integrated and there appear to be major uncertainties about the current status of groundwater resources (except that in northern China they are considered to be massively overexploited), the current level of abstraction, and estimates of long-term recharge from which assessments of sustainable abstraction could be made.

The following chapters draw on recent experience in England and Wales, which has been brought together to meet the requirements of the WFD and therefore is consistent with the EU WFD Common Implementation Strategy. These technical studies provide the quantitative evidence-base for the Water White Paper published in the UK by the Department of the Environment, Food and Rural Affairs in December 2011. The Water White Paper is a strategic policy document prepared by the Government that describes a future for water management in which the water sector is resilient, the environment is protected, and in which water is valued as a precious resource that underpins future environmental, social and economic welfare. The White Paper is based on a series of technical papers on water resource assessments, environmental requirements, scenarios of future demands, and the risks to water resources from climate change. These technical studies themselves draw on the work to meet the requirements of the WFD. These studies and the consolidation into the policy document give a useful template from which the approach to deliver the No.1 Document can be developed.

4.1 Surface water

Current EU best-practice for WFD resource assessments has evolved over time. In England and Wales, the process has evolved from Catchment Abstraction Management Systems through to the Resource Assessment and Management Framework that underpins the 1st round of WFD River Basin Management Plans.

The process involves the following steps:

- Use of observed flow data combined with infilling techniques such as rainfall-runoff modelling or some form of statistical analysis such as Low-Flows 2000[1] to establish a long timeseries of observed river flows at all points of interest down to River Basin Districts
- Using observed records for artificial influences (in this case abstractions, discharges, reservoir releases, and any diversions) to calculate the "naturalised" flow, that is the flow that would have occurred if there had been no man-made interventions
- Calculate the characteristics of the naturalised flow regime for each point of interest.

The same approach has been followed for all River Basin Districts in England and Wales and the results have been used to populate a Water Resource GIS. The GIS system is then made available to regional and local staff to interpret the outputs and identify and correct any gross errors in the input data – see Chapter 4.4.

The hydrological analysis that now provides the flow regime characteristics under naturalised conditions has evolved over many years and is based on the following components:

- Long time series of observed river flows, subject to regular quality assurance and comparative analysis to ensure consistent data quality
- Development of regional and national hydrological processes (such as Low Flows 2000) and specific rainfall-runoff modelling applications
- Assessment of the potential changes to observed river flow and groundwater regimes at national scale that might occur as a result of climate change (such as The Future Flows and Groundwater Levels (FFGWL) project, which undertook a consistent assessment of the impact of climate change on river flows and groundwater levels across England, Wales and Scotland using the latest projections from the UK Climate Impact Programme[2].

4.2 Groundwater

Assessments of groundwater availability and hence the magnitude of the sustainable abstraction that can be supported by a given aquifer unit are often more difficult than assessments of surface water availability. Whilst recording changes in groundwater levels over time does give an indication of whether a groundwater body is being overexploited or not, the assessment of groundwater availability

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[1] A decision support tool designed to estimate river flows at ungauged sites and to aid the development of catchment and regional water resources http://www.ceh.ac.uk/products/software/CEHSoftware-LOWFLOWS2000.htm.

[2] http://www.ceh.ac.uk/news/news_archive/Future-Flows-Groundwater-Levels_2012_25.html

can be improved by new survey technology combined with modelling. Denmark, which depends crucially on its groundwater resources for all water supplies and therefore has a thorough knowledge of its groundwater resources, has during the past 10 years mapped all groundwater priority areas using air-borne geophysics and subsequently developed a national groundwater resources model to assess impacts of groundwater abstraction on both surface and groundwater resources observations using traditional and more recent innovative measures, and the construction and use of numerical groundwater models. These can be very data hungry to set up and calibrate and require periodic review and updating to ensure that they are still appropriate. The underlying principle for groundwater planning is that reliable base data well-distributed in both space and time are required, whether for high-level assessments or for modelling

Many documents report the steady decline in groundwater resources across China's main aquifers and that abstraction exceeds long-term recharge and hence is unsustainable. There are various academic papers in the international literature on groundwater issues, but there does not seem to be any national assessment of groundwater resources across China. For long-term sustainable water resource planning, particularly in rural regions, where water supply security relies entirely on groundwater, robust assessment of groundwater that pulls together the interests, responsibilities and current work programmes of the various Ministries and other Agencies is urgently required:

- Past and current status of groundwater resources through analysis of observed groundwater levels. If the location and number of observation boreholes is insufficient then a programme to drill and equip monitoring boreholes is urgently required
- Groundwater surveys applying modern geophysical methods to identify potential freshwater aquifers as the interface of freshwater and saline water in areas suffering salinity intrusion
- Assessment of long-term recharge, together with estimates of inter-annual variability
- Assessment of potential impact of climate change on recharge and variability
- Quantitative analysis of groundwater abstractions
- Analysis of groundwater quality and past trends to identify areas where groundwater quality has been compromised
- Regional assessments of groundwater.

In addition to the components of a fundamental groundwater resource assessment programme recent academic papers suggest other features of groundwater status and areas for further work that are relevant to water resource security.

The research undertaken for the SKE points to the urgent need for a comprehensive and systematic analysis of the status of groundwater resources and groundwater quality across the whole of China. Some academic studies have already been undertaken, using case studies at a small scale, but there do not appear to have been any large-scale assessments Whilst there is no doubt that in some regions the exploitation of groundwater is unsustainable, it is often these regions where rural water supplies are almost entirely reliant on groundwater.

Two side impacts of falling groundwater levels are the decline of vegetation and the increased power required for abstraction, especially for irrigation. The implementation of steps to achieve more sustainable rates of groundwater abstraction, and eventually rises in groundwater levels, would also achieve reductions in power consumption and of greenhouse gas emissions.

4.3 Environmental Flows

A parallel exercise is needed to assess the environmental flow requirements for each point of interest, expressed in terms of an Environmental Flow Indicator. A full discussion of how environmental flows can be set is included in the RBMP Water Ecology Security Technical Report 078.

4.4 Assessment of water resource availability, review and publication

4.4.1 Current status

The assessments of surface water and groundwater are combined with the assessment of environmental flows to provide assessments of the water that is available for other uses, in particular abstraction for consumptive and non-consumptive uses without causing unsustainable environmental impacts. The requirements of minimum flows to maintain water quality requirements will have been addressed through the environmental flows.

This essential feature of the WFD classification system is to give an assessment of the current ecological status of all water bodies through an understanding of monitored flows and ecological impacts. Characterisation of risks of failing to achieve good status objectives or of allowing ecological status to deteriorate by the target date of 2015 needs to incorporate predictions of how these pressures may change in the future.

In England and Wales a precautionary fully licensed water allocation scenario was considered as the worst case prediction – assuming abstraction rates increase to their licensed limits, but holding discharges at recent actual rates. A further assessment was then made taking account of the potential impacts of climate change on river flows and groundwater.

A key feature of the approach was to assess water resource availability under two different abstraction conditions:

- **Recent actual**: this condition represents the abstraction and discharges experienced in recent years
- **Fully licensed**: this condition allows for all abstractions and discharges at the rates permitted by existing abstraction licences.

For the implementation of WFD in England and Wales, the initial review of GIS results focused on:

- hydrological risk maps comparing artificial influences (groundwater and surface water abstraction and discharges) with Environmental Flow Indicators defining allowable abstraction impacts for WFD screening of rivers, lakes and estuaries

- areas where, based on this assessment, there may be water available for further abstraction licensing
- areas where there would be a requirement to reduce abstraction, if it was necessary to meet the WFD flow screening indicator, together with an estimate of the quantity of reduction required
- components of WFD groundwater body classification: i.e. groundwater abstraction pressures and impacts on the groundwater balance – to combine with the assessments of risks to wetlands and saline intrusion which had already been reviewed.

Having estimated natural flows and environmental flow requirements, the resource assessment continues with the calculation of flows influenced by abstractions and discharges according to various scenarios, and then with the comparison of scenario flows against environmental flow requirements to produce the resource availability summary for specified scenarios.

4.4.2 Scenario assessments

Scenario flows are all based on the combined (or 'net') impact of all discharges minus all abstractions on natural flows. The three scenarios considered are:

Recent Actual (RA): both abstractions and discharges at 'typical' recent actual rates. This scenario provides an indication of current flows which should be consistent with the currently observed condition of the ecology

Full Licensed (FL): abstractions increased to full licensed limits but discharges held at 'typical' recent actual rates. This is a worst-case precautionary scenario and is used to underpin decision making for abstraction licensing, and also to characterise future flow risks for WFD

Future Predicted (FP): this scenario was introduced to provide a more credible prediction of future flow pressures and risks. It is initially estimated for 2015 (the default deadline for WFD objectives) based on regionally and sectorally defined abstraction rate growth factors which are applied to recent actual values, subject to licensed limits.

4.4.3 Outcome of the assessments

The risk-based approach for WFD assessments requires assessments of available water resources to be made at different levels of risk. Typically the assessments are based on selected percentiles of the flow duration curve, with Q_{95}, Q_{70}, Q_{50} and Q_{30} being the most usual comparators. Basing the assessment of available water resources on the magnitude of the natural flow available for 95% of the time (Q_{95}) provides environmental protection in all but drought years and means that abstractors have reasonable certainty that their requirements will be met in full. A typical example of the results for England and Wales is shown in Figure 7.

The precise flow percentile that is appropriate for the different river basins in China will need to be assessed to ensure that the percentile chosen provides the appropriate balance between environmental protection and the social and economic requirements of the various water users.

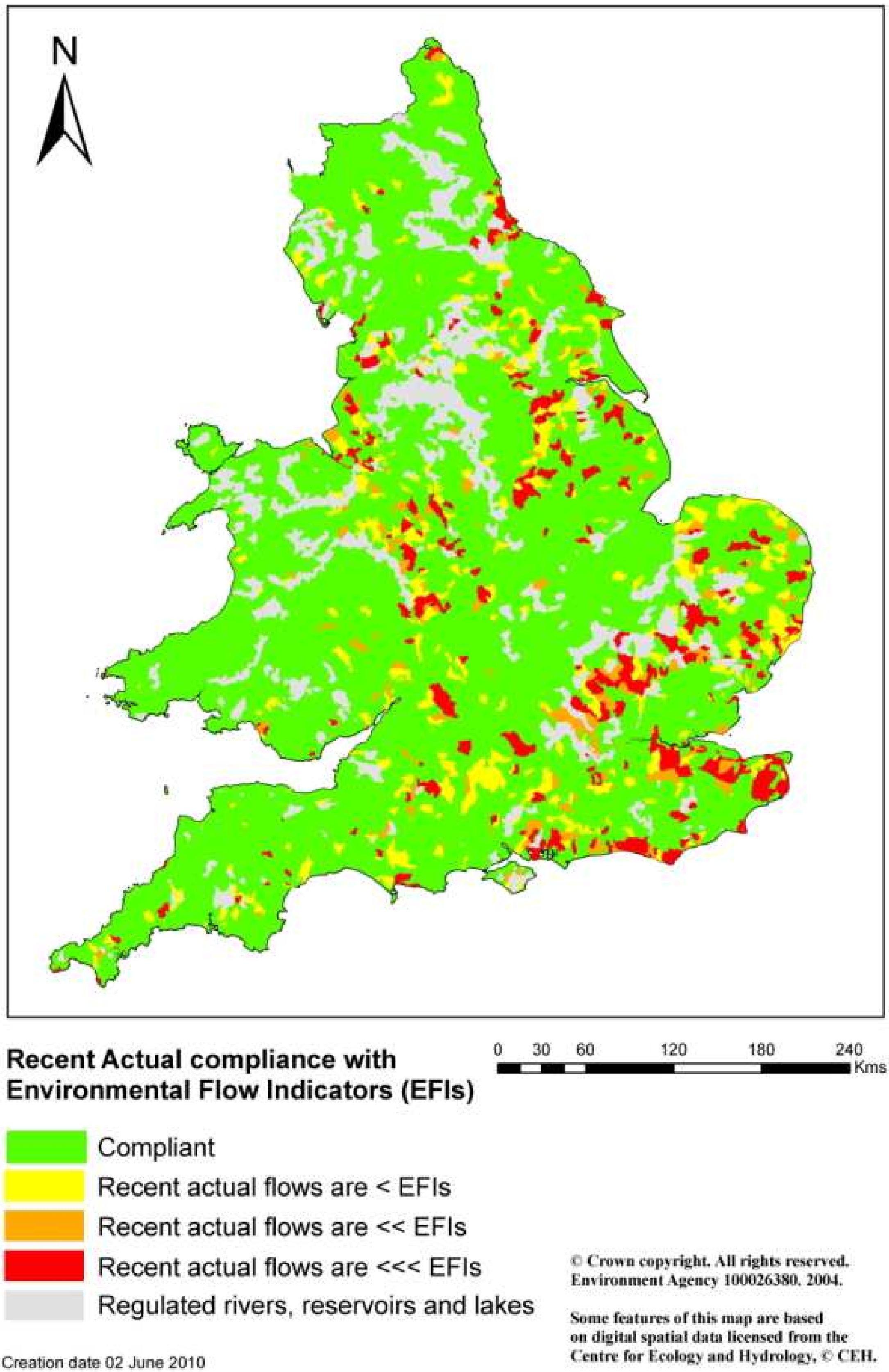

Figure 7 Water resource security in England and Wales. Source: Managing Water Abstraction (June 2010)

5 Demand forecasts

WRDMAP Thematic Paper 1.8: Water Demand Forecasting (May 2010) provides an excellent reference document. It compares existing practice in China with international practice. The paper notes that demand forecasting practice in China tends to be based on norms for each sector of demand, rather than ranges to allow for uncertainties. In addition and especially for consumptive agricultural demands it is necessary to consider water requirements not only in a “normal” year” when direct rainfall may provide an important component of crop water requirements and hence reduce the demand for irrigation water, but also in a “dry” year when rainfall will supply a smaller component and more irrigation will be required.

The paper also recognises the importance of water demand management and the need for demand forecasts to allow for different targets for water use efficiency. Forecasts also need to account for the impact of achieving greater water use efficiency on the net abstraction (total water abstracted minus the water returned, either though wastewater discharge or through leakage from irrigation canals and over-application to irrigated crops draining back into surface watercourses), rather than just the gross abstraction.

Demand forecasts are undertaken for a range of different purposes over different time horizons and at different spatial scales. For strategic water resource planning forecasts of demand for each of the main sectors are required typically at the scale of the WFD River Basin District. The importance and hence the selection of each sector will depend on the socio-economic and physical characteristics of the area for which the forecast is being calculated, and will generally include:

- Domestic consumption for both urban and rural communities
- Large-scale industry
- Power industry
- Small-scale industry
- Service and business sectors
- Large-scale irrigation
- Small-scale and subsistence agriculture.

An important feature of any application developed for strategic demand forecasts is the flexibility to allow for different assumptions on growth, unit water consumption (for example per capita consumption, water use per unit of output (such as tonnes produced or GDP, or water use per unit area), and water efficiency targets.

The relationship between growth and forecast demand is complex. There are various factors that determine how much water people, industry, businesses and agriculture will use in the future. The factors include population growth, the migration from rural areas to urban areas, increasing affluence and the purchase of water using appliances, water efficient technology, and incentives for people, irrigators and industry to use water wisely. The demand forecasts also need to be able to account of water efficiency targets set by government and/or regulators. It is also becoming increasingly evident that water use efficiency can have other side benefits such as reduced energy use for heating water in both domestic premises and in industrial production.

A demand forecast therefore requires information on population growth, where and in what types of accommodation people will live, technological advances in industrial production processes and irrigation, and the overall growth in the economy. One way of combining these sorts of assumptions into a coherent framework for strategic studies is to develop scenarios of possible societal futures, which then give a range of possible future demands. This identifies an envelope of possible future demands within which the actual future may lie, with no single scenario more likely to occur than any other. The UK Foresight Programme was created in 1994 to help the UK Government to think systematically about the future (http://www.bis.gov.uk/foresight). The programme has delivered advice to the government about how to ensure contemporary political, policy, regulatory, and strategic planning decisions are robust to future uncertainties. The Foresight Programme informed the development of the scenarios used for recent water resource planning in England and Wales.

Scenarios are a tool for thinking about different possible futures, and can be used to inform policy making. Using scenarios to explore and rehearse uncertainties may highlight a number of issues of potential options which require further detailed investigation or analysis. The scenarios used in the assessment considered a range of potential future scenarios based on different types of society (conservationist through to consumerist) and governance (growth-focused through to sustainability focused).

A typical set of scenarios developed for England and Wales is illustrated below, based on different types of society (conservationist through to consumerist) and different types of governance (growth-focused through to sustainability-focused). Whilst the assumptions behind each of these scenarios will not necessarily apply to China, the examples illustrate the type of issues that could be considered to develop scenarios to inform long-term strategic planning. The overall approach to scenario development is outlined in

- **Sustainable behaviour** Individuals pride themselves in being as efficient as possible and being seen as ‘green’ is a positive attribute. This drives demand down in most sectors. But as it is primarily achieved through good will of individual citizens, the savings could be seen as more vulnerable than those achieved under some other scenarios.

- **Innovation -** The core drivers of demand here are the level of regulation and the resulting technological innovation. This is a world where society expects Government and scientists to solve the problems of climate change and resource shortfalls so they can carry on living their lives as they wish. Although sustainable development is at the core of the scenario, this is delivered through means other than a shift in societal values.

- **Local resilience** - This scenario is driven by a need to implement efficiency measures in order to get by. The level of efficiency savings that can be achieved are controlled by the limited technology available and by limited funds for investment in the technology that does exist. The Government has neither the capital nor the political will to invest in strong regulation under this scenario and hence the drive to find improvements is limited. In addition to this, because people's drive to use less (of everything) is controlled by the need to survive rather than a desire to protect the environment, the savings they are prepared to achieve are limited.

- **Unconstrained demand** - The focus on growth and consumerism under this scenario is clearly reflected in the water demand figures. The scenario shows what could happen to demand where neither society nor Government takes action to control the demand for water (or many other goods). With the focus on cutting costs, water and energy efficiency measures are often forgotten or are at least given a lower priority. The result is a very large increase in demand.

The demand scenarios illustrated in Figure 8 are defined on one axis in terms of societal attitudes and behaviour around consumption. At one end of the axis, consumption patterns are constrained. At the opposite end, individuals exist in an intensified 'desire' economy in which there is greater consumption of goods. The second axis refers to international governance systems. At one end, governance systems and decision focus on long term sustainability concerns, such as climate change and resource depletion. At the opposite end, governance is based on rules to maximise economic growth.

Figure 8 Demand scenarios

The change in total water demand resulting from projection of the four scenarios from 2008 to 2050 is illustrated in Figure 9.

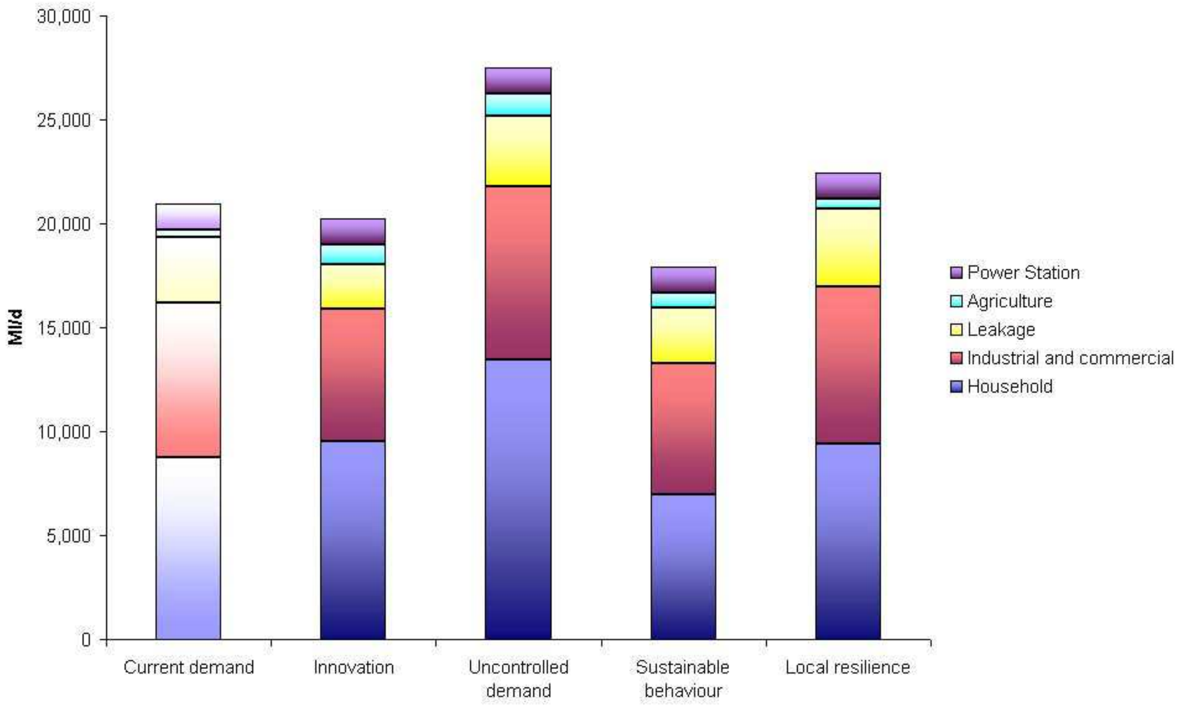

Figure 9 Scenario modelling of future water demand in England and Wales (Source: UK Environment Agency, 2011. The Case for Change – Water Availability)

Modern China has for a long time been characterised by growth-led governance moving from local resilience towards uncontrolled demand, a trend that was broken by the 11th Five Year Plan advocating economic development based on innovation and sustainable use of resources.

6 Risks

The risks inherent in long-term strategic water resource planning come from a number of sources of which the main ones are:

- The natural variability in climate and hence river flows and recharge to groundwater
- Uncertainties about the current status of water availability and demands
- Uncertainties in forecasts of future demands
- The savings in consumption associated with specific water efficiency targets, incentives and/or requirements are not met
- Potential for loss of viable water resources as a result of pollution
- That past hydrology is not a good representation of the future and observed flow timeseries may not be stationary
- Climate change has the potential to alter the availability of water resources and to change the range, duration and frequency of extreme events.

Despite the uncertainty about using past hydrology to shape future strategic plans, flow characteristics and statistics derived from observed records are the starting point for long-term strategic planning. As discussed in Chapter 4.4.3, some account of the natural variability in flow regimes can be taken into account by basing water availability assessments on flow percentiles of the Flow Duration Curve and/or a period of drought that has a given recurrence interval or return period. For public water supplies, where a very high level of reliability is expected, it may be appropriate to plan to meet unrestricted domestic demands 19 years out of 20, or a higher standard such as 49 years out of 50. For irrigation, it would be more common to plan to meet unrestricted demands in full 9 years out of 10 given the high priority given to local food security. The precise level of risk that is appropriate would need to be assessed, possibly with different standards for different sectors, and possibly for different parts of the country.

Such assessments give a baseline of water resource availability; potential climate change then impacts need to be factored in so that the potential shortfalls can be identified and appropriate mitigation measures identified.

6.1 Climate change

Significant risks to water supply security are likely to arise from climate change impacts on water resource availability. There are numerous national and international studies that use climate change models to assess the potential impacts on the depth, intensity and seasonal patterns of precipitation, the duration and frequency of drought periods, and ambient temperature. The challenge is to compile the outputs from disparate studies into a national assessment that can be interpreted as a consistent representation of the potential future climate change impacts across the country as a whole.

The recently published outputs of the Future Flows and Groundwater Level (FFGWL) project[3] cover England, Wales and Scotland are a good example of a consistent nationally based study. Possible uses for FFGWL products and datasets include:

- **Climate change adaptation policy**: by developing an understanding of the rate of change of river flows, policymakers can consider the implications for areas such as water permitting for abstractions and discharges, and adapt policy accordingly.
- **Studies of the impact of climate change on water availability**: the impact of climate change on water resources can be analysed on a consistent basis, thereby improving future planning.
- **River basin management**: understanding changes in flow will allow river basin management plans to be tested for robustness and resilience to extreme conditions.
- **Evaluating the impact of climate change on aquatic ecology**: many aquatic species are dependent on flows but poor availability of data has limited consistent assessment of possible changes.

6.2 Water quality

The maintenance of good water quality is sometimes not considered in planning for water security. The maintenance of good raw water quality for different uses is essential for a number of reasons:

- Poor raw water quality requires more advanced treatment processes with higher capital and operating costs (chemicals, power and operations and maintenance) to ensure that treated water continues to meet the required drinking or industrial water standards.
- Uncontrolled and/or accidental discharges of pollution into water courses can render raw water unfit for treatment, so water treatment works may need to be shut down to allow the pollution to pass before the works can be put back on line.

Water resource allocations have generally been based on quantitative assessments of water availability, although the WFD now requires water quality to be taken into account. Water supply security requires the risks to water quality, from diffuse pollution, from point source discharges and/or from accidental spills all to be taken into account.

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[3] http://www.ceh.ac.uk/news/news_archive/Future-Flows-Groundwater-Levels_2012_25.html

In 2004, the WHO Guidelines for Drinking Water Quality recommended that water suppliers develop and implement "Water Safety Plans" (WSPs) in order to systematically assess and manage risks. The following paragraph taken from Chapter 4 of the Third Edition of the WHO Guidelines for Drinking-water Quality (2004) captures the philosophy of the Water Safety Plan approach:

> *"The most effective means of consistently ensuring the safety of a drinking-water supply is through the use of a comprehensive risk assessment and risk management approach that encompasses all steps in water supply from catchment to consumer. In these Guidelines, such approaches are called water safety plans (WSPs)".*

Since 2004 governments and regulators, water suppliers and practitioners have increasingly embraced the WSP approach, but there have also been calls for further guidance. The WSP manual[4] published in 2009 in various languages, including Chinese, describes how to develop and implement a WSP in clear and practical terms.

[4] (http://www.who.int/water_sanitation_health/publication_9789241562638/en/)

7 Planning

Rainfall and hence river flows and recharge to groundwater varies from year to year, with a range of extreme conditions from the average to the excesses (floods) and shortages (droughts). Water resource planning therefore has to take account of this full range of conditions. Typically these ranges are based on historic records, but with the increasing likelihood that climate change will alter future rainfall and evaporation, also on projections of future climate conditions.

As discussed in Chapter 4, water resource planning on the basis of average conditions does not take account of the fact that almost every second year, hydrological conditions will be lower than average; the shape of the distribution and spread of the tails in the statistical distribution will determine the choice of hydrological conditions and hence the risk on which a strategic water resource plan is based. The appropriate choice for each river basin and/or region will depend on its hydrological characteristics, geography, natural environmental conditions and sector demands. Each demand sector may be allocated a different level of reliability or risk. Water resource infrastructure for public water supplies, for instance, will have the highest priority, with planning based on an extreme event such as the water resources available (having taken account of environmental requirements) in a1 in 50 year drought, while irrigation may be given a lower priority such as the 1 in 10 year or 1 in 5 year drought. The appropriate choice of the level of risk for planning needs to take account of numerous factors, including the economic importance of the sector, the size of the associated infrastructure, alternative sources of supply (if any), and wider socio-economic impacts.

Strategic water resource planning has to recognise the following four objectives:

- Preserve the flow regimes necessary to protect in-stream ecology and deliver the required environmental conditions
- Provide access to adequate supplies to meet the reasonable requirements of the domestic sector
- Provide sufficient water so economic activity is not constrained
- Provide sufficient water for agriculture so food security is not threatened.

The process is well illustrated by the flow schematic below (Figure 10). Note that the schematic itself draws from the Water Entitlement and Trading project and so demonstrates well the important common themes from the various projects referred to in Chapter 2.

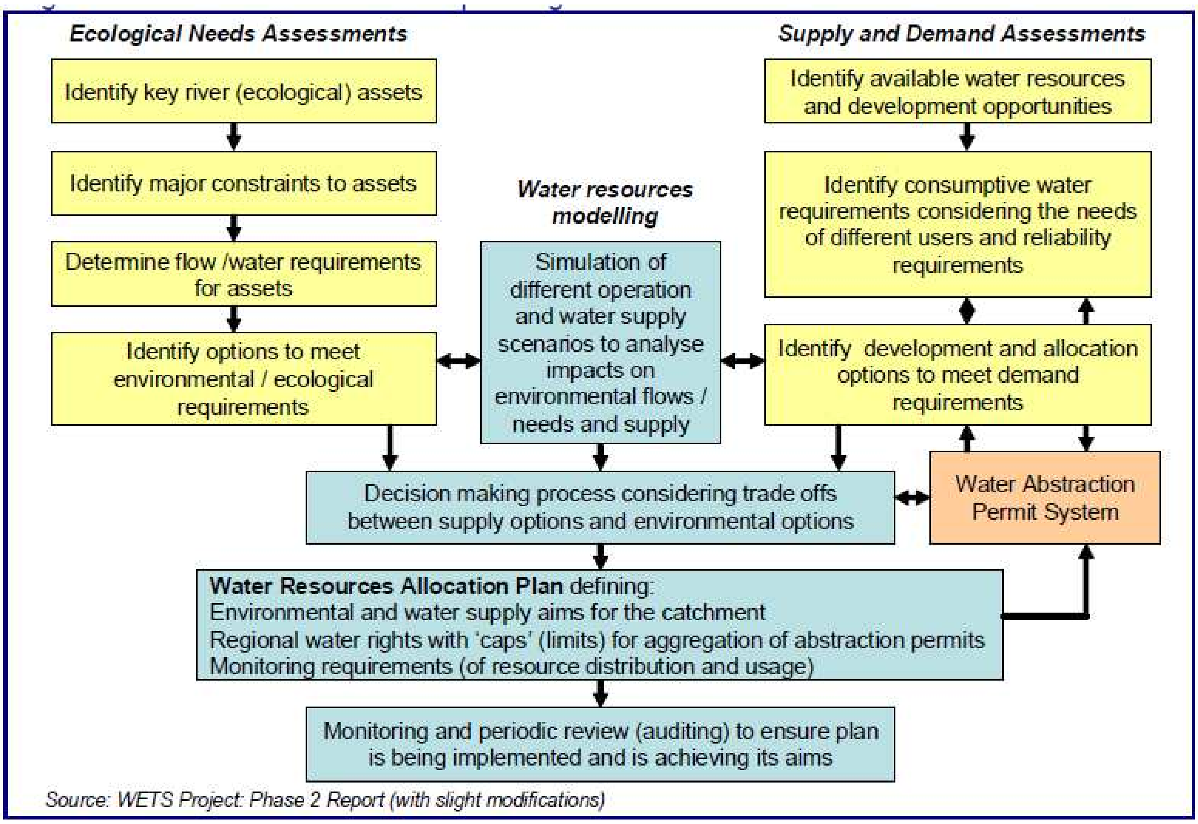

Figure 10 Flow chart for water resources allocation planning. Source: Figure 6 from WRDMAP TP2.7 Water Allocation Issues.

International best practice to water allocation now includes more emphasis on risk-based management. These risk based approaches require the development of a clear understanding of the type of extreme event that might be expected to happen in the future and take account of what has happened in the past. The likelihood of extreme events is considered alongside the estimated impact on people, the economy and the environment. It allows the focus of plans and actions to manage extreme events to be targeted on where the need and benefits are greatest. The traditional approach in China has tended to be a reactive, more disaster mitigation approach to extreme events rather than a more proactive approach. Risk management is a proactive approach focused on the design of measures that will be put in place in advance of extreme events to prevent or mitigate the level of risk exposure and, hence, vulnerability to impacts.

The concept of risk management in water planning is based on the following:

- the knowledge that extreme events will re-occur
- that the severity of the event cannot be predicted in advance
- that preparation and planning is necessary to mitigate the range of possible impacts
- that mitigation is an ongoing process involving structural and non structural measures
- that all water users have a responsibility to manage water as efficiently as possible.

Risk management in water planning seeks to build resilience in water infrastructure through structural and non-structural measures on an ongoing basis. Risk management helps to identify weaknesses in water infrastructure which makes the communities served particularly susceptible and vulnerable to the damaging impacts of extreme events and hence the opportunities for managing impacts by addressing the risk factors. Risk Management relies on strong evidence to assess the likelihood of extreme events that could jeopardise water security, together with the potential impact and losses to society and the environment. This is achieved by using the best quality information available using predictive models (forecasting) to estimate where extreme events could occur and by reviewing accounts of past events.

7.1 Strategic planning

Strategic water planning is one of the inevitable consequences of implementation of the WFD and in particular the development of River Basin Management Plans. The technical, analytical and policy work, together with the consultation requirements necessary to prepare and publish River Basin Management Plans are described in detail elsewhere as part of the EU China RBMP project documentation so are not repeated here. There are however particular EU aspects and examples of strategic water planning that are referred to in following sections. Chapters 7.1.1 and 7.1.2 illustrate the commonality of water planning themes between China (No.1 Document) and England and Wales (Water White Paper and National Water Resource Strategy). Formulation of policy and strategy and successful delivery follows from the type of coordinated analysis across disciplines now required for the WFD.

Water neutrality (Chapter 7.1.3) is a relatively new concept, but is an important aspect to be considered for future planning.

7.1.1 Water for Life White Paper

The water industry in England and Wales was privatised in 1989. Since then there have been some changes to the regulatory regimes under which water companies operate, but no major reforms. In December 2011 the Department of the Environment, Food and Rural Affairs (Defra) published its Water White Paper “Water for Life”, which describes a vision for future water management in which the water sector is resilient and in which water is valued as the precious resource that it is. The paper focuses on the future challenges facing the water sector, including maintaining water supplies for people, agriculture and business, keeping water bills affordable and how Government can reduce regulation. It also recognises the need to protect rivers, streams and lakes from pollution and unsustainable abstraction, and acknowledges the critical importance of water supply and sewerage infrastructure. It is understood that the Water White Paper and its supporting documents has generated some interest in the MWR, so a brief summary of the elements that are relevant to water planning and management in China is given here.

The evidence base for the potential areas of reform set out in the Water White Paper draws heavily from technical and scientific work undertaken as part of the WFD River Basin Management Planning. Supporting documentation “Current and future water availability” describes estimates of current and future water availability, and in particular new work on the potential impacts of climate change and population growth on supply and demand. Some of this work is referred to in earlier chapters of this report. The regulatory systems of water drawing permits in China (Appendix 1) and the abstraction licensing system in England and Wales are very different, so there are less immediate parallels to be drawn.

Changes to Government policies will take account of consultation responses to the Water White Paper, and are expected to feed through to the next national Water Resource Strategy.

7.1.2 National Water Resource Strategy

The national Water Resource Strategy for England and Wales was published by the Environment Agency in March 2009. The strategy was based on consultation with a large number of organisations and individuals and examples of international best-practice. The strategy provides the strategic direction for water resources management, based on best available scientific evidence. Although the strategy was based on a balance of demand management and supply-side options the strategy is not a blueprint for any specific development, rather it highlights the issues that need to be addressed to provide a long-term water security. The strategy looks to 2050 and beyond, well past the more usual 25-year horizon associated with water company resources management plans. This long timescale is necessary in order fully to consider the implications of climate change.

7.1.3 Water neutrality

Planning for new large-scale developments is increasingly being required to embrace the concept of water neutrality which provides an additional stimulus for water demand management. The premise of water neutrality is that:

> *'…total demand for water should be the same after new development is built, as it was before. That is, the new demand for water should be offset in the existing community by making existing homes and buildings in the area more water efficient'*

Water neutrality is an important but relatively new concept for managing the demand for water. The concept of water neutrality is important for a number of factors, not least the constraints on the current and future availability of water resources (e.g. as a result of climate change) to meet unmanaged future demand for water in certain areas of current water stress and/or certain areas where future water stress is likely.

7.2 Drought planning

The main purpose of a strategic water resource plan is to identify the water resource infrastructure that is required to maintain security of supplies with a given risk of failure. When conditions more extreme than the design event might occur, then additional drought response measures are required. Typically these might include a combination of the following types of measures:

- Short-term temporary supply of additional water resources, for instance groundwater
- Relaxation of environmental demands that are triggered as river flows fall progressively through a developing drought that would otherwise restrict the volume of abstraction
- Implementation of demand management measures
- Reduction in water allocations.

Water planning in China (Drought Control Regulation of the People's Republic of China of 26 February 2009), includes a number of indicators, which characterise the severity of drought conditions at one of four levels: slight, moderate, severe and catastrophic. The categorisation is based on an assessment of the area impacted by drought conditions, the size of arable land and crops, plus the size of the population, whose access to reliable drinking water is at risk from the drought. The indicators used include the following:

- Meteorological drought index
- Hydrological drought index:
  - Reservoir storage percentage
  - Watercourse recharge (limited to major rivers in a region)
- Agricultural drought index:
  - Drought-hit crop (water shortage of paddy field) area percentage
  - Disaster area percentage
- City drought index

One of the significant differences between drought management practice in the EU and in China is the degree to which lower than average rainfall and hence flow conditions already are accounted for in strategic water allocation plans or are considered to be outside that range of conditions on which water allocations have been based, and hence some sort of emergency drought response is required. This is an example of the risk-based approaches now generally adopted as international best practice and the more proactive and disaster management response more common in China.

The risk-based approach to drought management requires taking appropriate steps ahead of a drought occurring. An appropriate risk-management approach is set out in Chapter 6 of the ADB Report “Strategy for Drought Management” TA 7261-PRC, March 2011.

8 Next steps

As noted in other documents, the No.1 Document and the EU Water Framework Directive have much in common though characterised by important differences in the administrative and legal context of China, the EU as a whole and each of its Member States. One important common element is that the changes required to deliver the objectives of the No.1 Document on the one hand and the WFD on the other hand will take time to implement consistently across all river basins.

Experience suggests that a stepwise approach can be very effective to allow the technical methodologies to be properly developed, tested and where necessary refined in pilot studies, before they are rolled-out on a countrywide basis. For some specific studies, it may be that an approach has already been developed by one of the main River Basin Commissions, in which case the pilot study would need to focus on how the approach should be adapted for another river basin with less extensive and/or reliable databases on the background geographical, physical and timeseries data that are required for the analysis.

For other studies appropriate approaches will need to be developed from scratch, drawing on existing Chinese and EU experience and best practice.

8.1 Urgent initial improvement during the 12th FYP (2012-2015)

In the short-term the focus will be to integrate the water resource, demand forecasts and water allocation activities currently being undertaken by different Government Departments, Provincial Authorities, and other agencies. This will require:

- Updated assessments of water resource availability using consistent approaches across all China, covering both surface and groundwater systems
- Assessing the risk to long-term water resource availability under different climate change futures
- Construction of high-level demand forecasts for the key sectors with clearly defined assumptions on water use efficiencies
- Assessment of the absolute costs and benefits of achieving water use efficiencies
- Development of water charging schemes and incentives for water drawing permits
- New water allocations based on the water resources available in the 1 in 10 dry year
- Integrate water resource security strategy with other strategic aims

- Design of a decision support tool to inform water allocations, drought responses and disaster responses
- Design of pilot projects to be implemented in the medium-term to develop and test the operational responses to drought.

In addition to these quantitative elements of water planning, the risk to drinking water supplies needs to be addressed through the country-wide adoption of Water Safety Plans.

8.2 Medium term improvements during the 13th FYP (2016-2020)

In the medium term (2016-2020) the following actions could be taken:

- Implement the water allocation and drought management decision support system in pilot catchments
- Implement new charging scheme for water drawing permits across China
- Monitor effectiveness of intervention options
- Update intervention options as required in the light of experience from the Pilot Studies.

8.3 Fulfilment of the No.1 Document objectives during the 14th and 15th FYP 2021- 2030

In the long-term the following should be considered:

- Review the strategy for Water Resource Security in the context of the other technical strategies, refine where necessary and develop new programme for monitoring and regulation.
- Update and refine where necessary underlying water resource assessments
- Test observed water body status against targets to identify quantity and/or quality measures to achieve compliance
- Review and update where necessary water use efficiency targets.

9 References

All documents referred to are included in the SKE external hard-drive and available from Development Research Centre at request.

List of Chinese relevant policy documents, regulations etc.

20 April 2012	Address at the High-level Roundtable on Water Resources Management Systems in China; H.E. Mr Chen Lei, Minister of Water Resources
12 January 2012	No. 3 Document: Opinions of the State Council on Practicing the Most Stringent Water Resources Management System; The State Council
June 2007	Hydrology Regulation of the People's Republic of China
15 April 2006	Management Regulations on Water Drawing and Licensing and Collection of Water Resource Fee
	Promoting Sustainable Utilization of Water Resources – Ensuring National Water Resources Security; Vice Minister Jiao Yong's explanation on the Integrated National Water Resources Plan
01 July 2003	Management Measures for Collection Standard of Pollutant Discharge Fee
2002	Water Law
23 September 1998	Management Measures for Urban Water Pricing

Appendix 1

Appendix 1 Water Abstraction Permit Management in China[5]

1 Legal context of Water Rights in China

The system of water abstraction permit and system of water resource assessment for infrastructure project are the basis of system of water resource management.

The water abstraction permit is an administrative license arrangement. Issuance and implementation of Decree 460 of the State Council in 2006, Ordinance on Management of Water Abstraction Permit and Water Resources Fee (hereinafter referred to as the Ordinance) marks a new stage that water abstraction permit arrangement of China has entered. The water abstraction permit arrangement means: a regulatory system that in accordance with pertinent regulations of Water Law of the People's Republic of China (hereinafter referred as the Water Law) issued in 2002, any unit and individual abstraction water or using water directly from a river or lake or from the underground shall apply for water abstraction permit from government, take and use water according to requirement of time, place and quantity as stated except for the circumstances specially stipulated by laws and regulations.

As the basis for approving water abstraction permit, the justification report of water resource promotes optimizing allocation of water resources. Since May 2002, water resource assessment has implemented on any new, expansion, rebuilt infrastructure project applying for water abstraction according to Regulation on Water Resource Assessment for Infrastructure Project issued by the Ministry of Water Resources and National Development and Reform Commission. In May 2005, the Ministry of Water Resources issued Guidelines for Water Resource Assessment for Infrastructure Project (trial) to regulate water resource assessment. The issuance and implementation of Decree 460 of the State Council in 2006 and the Ordinance on Management of Water Abstraction Permit and Water Resources Fee mark a new stage in water abstraction permit system of China. On the basis of these law and regulations, the legal system of water abstraction permit has been constructed soundly. The legal responsibilities of stakeholders are clearer than before.

All units and individuals that take water should be regulated under the Water Law. Where users are granted a statutory right to take water – such as agricultural collectives or persons abstraction water for livestock or domestic purposes – these uses should be accounted for in the water resources allocation plans. It is necessary that all abstractors should be regulated within the permit system, while caps should be set for the volume of water that can be taken under these authorisations. Water rights for water abstractors will be strengthened and given greater certainty and security by the definition of rights to take water at all levels, including identification of the reliability of supply.

[5] Extract from Water Entitlement and Trading Project by Dr Jiang Furen, DRC

2 Process of Application and Approval of Water Abstraction Permit

2.1 Application and Approval Procedure

Currently, the processing of application procedures goes through four steps including application, review, correction and acceptance. Currently, the procedure of handling water abstraction permit by the examining and approving agency is as follows: according to pertinent regulations of the Ordinance, the examining and approving agency carries out a review after the acceptance of the application for water abstraction. Meanwhile, for water abstraction application related to groundwater in urban planning areas, the examining and approving agency should consult the competent authority of urban infrastructure. For permit rights of water abstraction that belong to the river basin management agency, the department of water administration of provincial level located in water catchment area brings forward opinions after the acceptance of water abstraction application and the initial review. Whether the water abstraction is permitted, the department should also deliver the initial review with all application materials to the river basin management agency, and decision will be made by the river basin management agency in accordance with the review procedure.

2.2 Prescribing Powers of Examination and Approval Authority at Different Levels

On the basis of water characteristics and the actual situation in China, the Water Law has established a management system of water resource combining the river basin management and the administrative region management. The Ordinance, which has prescribed that the graded examination and approval is implemented for water abstraction, embodies the management system combining the river basin management and the administrative region management prescribed by the Water Law. From perspectives of the convenience for the public and the efficiency, the approval of grass-root water authority should be considered as possible at the time of the establishment of approval authority. However, the development and utilization of water resources involve the water abstraction and use and ecological environment in upstream and downstream basins, along the river as well as in the whole river valley.

Furthermore, in order to facilitate coordination and prevention of water disputes, the Ordinance has fundamentally prescribed limits of examination and approval authority when establishing these authority limits. In addition, it authorizes the water authority of the State Council and the provincial governments to deliver regulations on scope of examination and approval authority for river basin management agencies and departments of water administration of local governments at all levels, respectively. From the overall perspective, the hierarchical arrangement of water abstraction permit consists of five levels in total, which includes two levels of the central government, namely the Ministry of Water Resources and river basin management agencies, and three levels of the local government, namely, the water authority in provincial, municipal and county-level.

2.3 Starting Public Notice and Hearing System

Public notice and hearing of water abstraction permit is a legal system constituted by procedures that before the completion of water abstraction permit affecting legal rights of citizens, legal persons or other organizations, the examining and approving agency of water abstraction permit informs them of reasons for the decision and the hearing rights; citizens, legal persons or other organizations follow the information to express views, deliver averment and cross-examination to the examining and approving agency; and the examining and approving agency hears their views and accept evidences. Article 18 of the Ordinance prescribes public notice and hearing of water abstraction permit in detail. In addition, according to Administrative License Law, the examining and approving agency should undertake obligations of information in the specific hearing procedures, hearing organization in the legal duration and hearing cost assumption.

2.4 The Assessment of Water Resources for Infrastructure Projects as Precondition of Approving Water Abstraction Permit

Article 9 of Regulation on Water Resource Assessment for Infrastructure Project issued in 2002, and Review Opinions on Report of Water resource assessment (justification report) for Infrastructure Project are technical standards to examine and approve application for water abstraction permit (advanced). The Ordinance also takes the water resources assessment for infrastructure projects as a precondition for examining and approving water abstraction permit.

This provision defines relationship between the water resources assessment for infrastructure projects and the water abstraction permit. The former is a technical review, and review opinions issued by the review units focus on the technical aspects, but examination and approval of Report of Water Resource Assessment for Infrastructure Project has compulsory binding forces of the administrative level for the applicant and the examining and approving agency. Whether the latter decides the examination and approval depends not only on consideration of the reliability of water abstraction and the rationality of water utilization defined in review opinions on water resources assessment for infrastructure projects, but also relevant legal provisions, such as the state's industrial policies and the possible damages to a third party or social and public interests.

In terms of procedure, direct water abstraction from rivers, lakes or groundwater requires firstly application for the water resources assessment of new, expanded and rebuilt infrastructure projects for water abstraction, and then submission of water abstraction permit. Meanwhile, the approved report of water resources assessment for infrastructure projects, review opinions issued by the review units, opinions of expert review panel and individual opinions signed by experts must be attached in materials required by the applicant's application of water abstraction.

The examination of the water abstraction permit application should follow gross control principle. Article 15 of the Water Abstraction Permit Regulation prescribes that the approved plan for the allocation of water resources, or the agreement between local governments regarding water resources allocation, is for the total volume of water abstraction permitted. Where the total volumes of water abstraction have not been set, these volumes are to be set by the river basin authorities or provinces. Water resource allocations plans will provide a basis for permitting decisions, including rules for assessing impacts on existing water permits based on specified reliability.

The examination of the water abstraction permit application should also conform to the principle of quota control management. Article 16 of the Water Abstraction Permit Regulation prescribed that, the determined quota of different sectors is the main criteria for the water abstraction volume.

The water abstraction permits will be used as the primary tool for regulating the abstraction of water. The current permit system, as provided for under the Water Permit Regulation, will be used for this purpose, but several changes will be necessary to clarify and strengthen the rights associated with a permit. The amount of water available under a permit in any given year will be determined by the annual water abstraction plan, which will be prepared with reference to all water permits, and in accordance with the water resource allocation plan. So it is necessary to identify, where water is taken without a water permit and develop a process for granting permits to appropriate party and following the process and granting the permits.

3 Content of Water Abstraction Permit Documents for protecting the rights of water permit holders

The content of water abstraction permit document consists of two parts:

5 Application document

6 Water abstraction certificate.

Water Permit Application

The application for a water abstraction permit is a precondition for examining and approving water abstraction permit. It is impossible to gain the permit without any application. The applicant must provide all materials stipulated in Article 11 of the Ordinance, which in summary are: 1) the application form, 2) relevant explanation of interests with the third parties, 3) filing materials, 4) other materials specified by the water authority of the State Council, 5) report of assessment of water resource for infrastructure project, 6) its reply document compiled by the unit and 7) the justification report of water resource for infrastructure project. The justification report should also include, among others, water abstraction source, reasonableness of water utilization and ecological and environmental impact.

Furthermore, according to Article 12 of the Ordinance, the application form should include following information: 1) the applicant's title (name) and address; 2) the reasons for applying; 3) the starting time of water abstraction and duration; 4) the purpose of water abstraction, water abstraction quantity, water consumption of each month in the year, etc.; 5) the water source and water abstraction location; 6) the water abstraction methods, metering system and water-saving measures; 7) the discharging location, major pollutants in the discharging water, and sewage treatment measures; 8) other matters defined by the water authority of the State Council. The application form contains other matters defined by the water authority of the State Council, so the Ministry of Water Resources has prepared the unified formatted text of the water abstraction permit. In addition, the assessment of the status of water resources and the review opinions of local water authority in the location of water abstraction point, such as the name, main conclusion and main review opinions of the justification report, should also be provided in the application form.

Water Abstraction Certificate

The unified water abstraction certificate, which consisting of one original and one copy, is prepared by the Ministry of Water Resources. The original is held by the applicant of water abstraction, and two copies are kept respectively by the examining and approving agency of water abstraction or its mandatory supervision and management agency and the applicant of water abstraction and utilization. According to Article 24 of the Ordinance, the water abstraction certificate should record clearly the title (name) of unit and individual implementing water abstraction (name), duration of water abstraction, water abstraction quantity and purpose, source type, location of water abstraction and discharging, and discharging method, as well as discharging quantity. The content, which is the basic information of the person implementing the water abstraction, and the basic information of conditions, methods, state of water abstraction, are indispensable for issuance of a water abstraction permit. If the information recorded in the water abstraction certificate are subject to major changes, the assessment of water resource of infrastructure project and the application for water abstraction should be renewed, and submitted to the appropriate department for examination and approval. The water abstraction quantity defined therein is the maximum water abstraction quantity of rivers, lakes and groundwater under average water conditions for the units and individuals abstracting water. Furthermore, in view of water abstraction certificate being an administrative license, it must record clearly names of the examining and approving agency and the supervision and management agency, the date of certification, the duration of validity of the license and the number of the water abstraction certificate.

Comment:

However, the rights attached to a permit certificate are not clearly specified. There is a lack of clarity of the rights, in terms of the rights afforded the holder of the entitlement. There are no clear provisions dealing with what happens where an entitlement is adversely affected. The contents of permits include a maximum annual and daily volume, but no statement of reliability. To protect the rights of permit holders a transparent process for reviewing all existing water permit for validity and accuracy should be developed and implemented.

4 Development of the management and registration of Water Abstraction Permits

4.1 Issuance of water abstraction certificate.

Issuance of water abstraction certificate by the examining and approving agency to the applicant of water abstraction permit indicates the completion of the whole procedure of application and approval of water abstraction.

4.2 Registration of Water abstraction certificate.

In order to facilitate the supervision and management of water abstraction permits, the supervision and management unit of water abstraction permit should establish a file for each water permit holder, the content of which mainly includes the assessment of water resource, the examination and approval of application for water abstraction permit and the issuance of water abstraction certificate. In order to facilitate access to information, the supervision unit of water abstraction permit should establish a complete file for each water permit holder. At the same time, it should also create a “registration form of utilisation and performance of the water permit holder” and a management statement of water abstraction permit.

4.3 Management of water abstraction certificate

According to relevant provisions of laws, the examining and approving agency can implement three procedures including renewal, change and cancellation for the water abstraction certificate.

Renewal of the water abstraction certificate:

According to Article 25 of the Ordinance, the validity period of the water abstraction certificate is generally 5 years, and the maximum duration shall not exceed 10 years. On the basis of the experience from implementation of water abstraction permit system, the validity period of the water abstraction certificate is controlled within 5 years in principle. If the water abstraction certificate is expiring and require a extension, the water abstraction unit or individual should submit an application to the original examining and approving agency within 45 days as of the expiration date of the license. Before the expiration date of the license, the original examining and approving agency should decide whether to extend the duration, and if extended, reissue the water abstraction certificate.

Cancellation of the water abstraction certificate

There are two kinds of cancellation including cancellation and revocation. Four circumstances where the water abstraction permit should be cancelled are:

1 For suspension of water abstraction of over two years, the original examining and approving agency can cancel the water abstraction certificate, however, for suspension of water abstraction of over two years, which is caused by the Act of God or major technological change, the water abstraction certificate can be reserved through agreement of the original examining and approving agency

2 the validity period of the water abstraction permit is near its expiration but not yet extended, namely the water permit holder has not applied for extension of the water abstraction or the submitted application for continuation has not been approved by the examining and approving agency

3 the main body of the water abstraction disappears, including condition where the water permit holder is an individual, or the citizen dies or disappears

4 the water permit holder is a legal person or other organization, and the legal person or other organization is terminated according to law.

According to the Ordinance the water abstraction certificate will be revoked in case the water permit holder has conducted serious illegal water abstraction. If eight cases if illegal abstraction are refused to be corrected or have serious circumstances, the water abstraction certificate will be revoked. These violations include primarily: 1) water abstraction violating the approved rated conditions of water abstraction permit; 2) transferring the water abstraction right without authorization and approval; 3) discharging water quality falls short of stated requirements; 4) metering facilities have not been installed; 5) disqualification and abnormal operation of metering facilities; 6) refusal to implement decision on restriction of water abstraction quantity made by the examining and approving agency; 7) failure to file annual water abstraction state according to regulations; 8) denial of supervision and examination, or other misconduct. According to Regulation on Supervision and Management of Water Abstraction Permit issued by the Ministry of Water Resources in July 1996, generally, the revocation of water abstraction certificate should be reported to the government of county level or above for approval. The revocation of the water abstraction certificate approved and issued by the Ministry of Water Resources or its mandatory basin agency should be approved by the Ministry of Water Resources.

Changes of the water abstraction certificate
Items of the water abstraction certificate, which can be changed means primarily that the change procedure can be handled when the name of water abstraction user is changed, or the legal representative is changed, but other items are stable or equable in the validity period of water abstraction. The procedure is, the water abstraction user submits an application to the original examining and approving agency, and the original examining and approving agency should examine the application for change of water abstraction permit according to laws after reception of the change application. If the application submitted by the water permit holder is deemed to answer for lawful conditions and standards, the original examining and approving agency should handle the change procedure according to the relevant procedures of examining and approving water abstraction application and the laws, and give a clear indication in the change record of the holder.

The administrative agency of water abstraction permit should establish systems for water resources statistics and file records on scope, time and requirement of statistical data, and ensure completeness, integrity, accuracy and consistency of statistical data. The statistical data should be completed and the files should be established within the stated time to reflect practical situations at that time, and also prolong valid time of the data. Reliability should be ensured for the information completion. If there is faulty and inaccurate statistical data, complement and correction should be revised timely; if the statistical data are out of time, supervisory work should be increased to ensure this statistical form to reflect the current situation.

Comment:
However, the Ministry of Water Resources has not issued any written technical directives on the design of water resources management information system while the research reports about the feasibility of the design and water resources information sharing platform in most provinces have been developed. However, none of these platforms have been established yet. Meanwhile, the registration information of water permits is primarily recorded in the paper archives. Since the management organizations with different levels authorize the licenses based upon the granted water abstraction amount, the information about the water abstraction permits is kept in different organizations in different districts. Consequently, the publicity, sharing and real-time browsing of information between different organizations is difficult to realize. It is necessary to introduce a water registration system recommended by the Water Entitlement and Trading Project for recording the permit process and contents of permit information.

5 Trading of Water

5.1 Legislation

According to Article 27 of the Ordinance, the unit or individual having acquired a water abstraction right according to laws can transfer excess water saved through different measures within the validity period and water abstraction quota of the water abstraction permit subject to approval of the original examining and approving agency. From this regulation, the water abstraction certificate is non-negotiable and the saved quantity of water resources can be transferred, but currently there is no specific operational method due to complicated problems of technology and management involve in the transfer of saved water resources.

5.2 Magnitude of changes

In 2005, the planned water abstraction amount of industrial, agricultural and domestic water users, who are under the supervision in 27 provinces (without Fujian, Hunan province, Ningxia Hui Autonomous Region, and the Tibet Autonomous Region) and 6 basin authorities (Huaihe River Conservancy Commission excluded) reached 325 billion m^3 accounting for 82% of the gross approval of 400 billion m^3, and 58% of the total annual water consumption of 565 billion m^3. The actual water abstraction reported, however, was only 350 billion m^3.

Comments:
Generally speaking, the planned water abstraction in northern China should be reviewed based upon the actual runoff, while it should be arranged according to the demand of water users in southern China. Where water resource allocation plans include some statement of reliability, this often is limited to availability in an average year, but does not satisfactorily deal with availability in dry years. There are no clear rules for determining what level of impact on an existing user is acceptable, for instance as a result of granting of a new permit, nor is there a fixed procedure or principles for deciding how much compensation is payable in the event of a management decision that adversely affects the water available under the permit.

5.3 Procedure and content of changes of water permit diploma

Though the Ordinance allows the change of a water abstraction permit, it does not explicitly specify the internal procedure, the changeable content or the procedure. The changeable items mainly include the alteration of the name of the water users or the change of legal representative, without any other change or major change. For example, the Zhejiang Water Resources Department only permits the water users with annual water abstraction of less than 1 million m^3 to change their water abstraction within 50%, while the Taizhou Water Resources Bureau merely allows the water takers with annual water abstraction of less than 0.1 million m^3 to change their water abstraction amount within 20%.

There were increased approved water abstraction of 2.1 billion m^3 and decreased amount of 18.8 billion m^3, of which 18.0 billion m^3 is in Chongqing Municipality, for the changes of 5144 water permits in China in 2005.

Comment:
The above mentioned change sounds reasonable; however, it is not clearly defined by the law which may lead to a certain randomness of the change. Though the increased amount took up only a small proportion of the total approved amount, the change procedure and content are required to be explicitly defined in the regulations.