STRATEGIC STUDY
FOR WATER MANAGEMENT
IN CHINA

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中国水管理战略研究

张 海 仑
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Preface

Since 1996 I have organized and participated in a number of cooperative projects funded by UN focusing on study of water issues in China. At the third session of the Committee on Natural Resources held in New York in May 1996, Mr. Miguel Solanes, the international expert of water law, and I jointly suggested that a study on water management in China be carried out and the UNDP soon promised to provide funds for the project. The project was executed by UN Department of Development Support and Management Service (UNDDSMS) and implemented by the former Nanjing Institute of Hydrology and Water Resources, Ministry of Water Resources. In the same year I was invited by Mr. Yuri Steklov of the Division of Natural Resources of Economic and Social Commission for Asia and the Pacific (UNESCAP) to take part in the drafting and compiling one of the series publications concerning the assessment and utilization of water resources in member countries of the region and demand by user sectors. My task was to revise the draft "Water Resources and the Utilization in China " and to provide additional information to it which was published in 1997 by UN.

In view of satisfying progress of the water management project in China, UNDP and the Ministry of Water Resources jointly initiated a project entitled "Policy Study of Water Management in the Huaihe River Basin" in October 1997. UN Department of Social and Economic Affairs and the former Nanjing Institute of Hydrology and Water Resources were appointed as the implementing agencies. Being the team leader of the national expert group, I worked together with UN experts headed by Mr. Jacob J. Burke and the project was successfully completed in 1998.

At the invitation of Mr. San Lin and Mr. Le Huu Ti, as the consultant of UNESCAP in 1999 and 2000 I prepared documents on two important issues, namely "Water Allocation Policies and Practices in China" and "Flood Control and Management for Large Rivers in China", which were discussed in regional seminars and then published in 2000 and 2001 respectively by UN. In 2002 WMO and Global Water Partnership (GWP) jointly initiated the "Cooperative

Program on Flood Management", I was invited to contribute a case study in China, which was completed in early 2003.

Also in October 2002, the International Symposium and Sub-Regional Workshop on Strategic Planning and Management of Water Resources for Social-Economic Development was held in Beijing, my presentation on the projected water demand in China attracted the attention of the participants at the seminar. The following year, Dr. Donald A. Wilhite, director of US National Drought Mitigation Center, invited me to contribute a chapter to his book entitled "Drought and Water Crisis: Science, Technology and Management Issues". In cooperation with Professor Ke Lidan and Professor Zhang Shifa, my chapter "Drought and Water Management: Can China Meet Future Demands?" was completed in September 2003 and the book is planned to be published later this year.

As the out put of the project "China's Flood and Drought Disaster" a monograph with the same title was completed and published in December 1997 with the great support from National Flood Control and Drought Mitigation Headquarters, which was a product under the joint efforts of experts of both in and outside my institute. I had explored on the internet and also contacted a number of international agencies trying to seek as much relevant information as possible on the same subject for my reference, but the result was not very satisfactory. Thus many friends suggested that the monograph be translated into English, however I had to give up the idea because of huge amount of work involved. To make some compensation, I concluded the revised paper " Flood and Drought Disaster in China " and the table of contents of the monograph is attached in this book as reference for those who are interested in this important subject in China. The paper " Flood and Drought Disaster in China" was presented at the "International Conference of High Impact of Weather and Climate" held in Seoul in March 2004.

Any individuals or agencies who are interested in China's water issues, such as flood control, drought mitigation, water resources planning and development, and river basin management can easily touch the essence of the above subjects by going through not very long text of this book. Personally, I'd like to recommend several useful arguments from different chapters in this book, such as the strengthening and reinforcement of capacity building in legal and institutional system in water sector; the importance of involvement of

stakeholders in the whole process of planning and management in flood control; the important issue in river basin management lies in the establishment of a democratic consultation and cooperation mechanism instead of the mere change of organizational framework; the enforcement of demand oriented water management to avoid overestimation of water demand in water resources management to meet the challenge of water crisis, etc.. I hope that these arguments will draw the attention of the readers and will be useful in practice of water management.

I also hope that this book will help any individuals and agencies outside of China, who are interested in China's water issues, to gain a basic understanding of the important issues of water sector in China in a shortest time and benefit them when they are faced with enormous practical problems. The book may also serve as a reference for professionals, graduates, and postgraduates of water related specialties of universities.

In the past six or seven years, my work has not been assigned by anyone else, nor did I have to spend much time doing organizing and coordinating work. I have enjoyed complete freedom to budget my time and plan my work, which was an ideal working circumstance for me. Thus I owe particular thanks to the leaders of former Nanjing Institute of Hydrology and Water Resources for their respect and support. I'm also thankful to my friends in UN and experts in and outside of NIHWR for their close collaboration with me in the work. (All the individuals who made their contributions to the articles will be listed respectively in the book)

I am grateful to Nanjing Hydraulic Research Institute, who provided financial support to the publication of this book. This kind of financial support is a good policy, which would encourage those, particularly the retired scientists and engineers who have accumulated experiences and thoughts to have their books published.

I started learning English and laid down a good foundation of English while studying at Suzhou Middle School. Next year, the school will celebrate her Millennial Classic Education and Centennial Modern Education. I extend my heartfelt congratulations to my Alma Mater, to which the publication of this book is dedicated.

The year 2004 happens to be my parents' one hundredth anniversary of birth. My father passed away during the Cultural Revolution at the age of only

67. And when my mother was dying, I was at the post in UN and could not come back to see her in her last days because of my work. This has made me fell compunctious ever since. With the publication of this book, I express my everlasting memory for my parents and wish to console their spirits in the heaven: your dream that all your children and grandchildren would live a happy life has come true in the good time of opening policy and reforms. May you rest in peace forever.

10. Oct. 2004

前　言

1996年以来，我主持和参加了一系列由联合国资助研究中国水问题的合作项目。先是1996年5月在纽约召开的联合国自然资源委员会第三届会议期间，我和联合国水法专家Miguel Solanes先生一起建议对中国的水资源管理进行研究，以提高和改进水资源的管理，当即得到联合国开发计划署对资金支持的承诺。此项目后由联合国发展支持和管理服务部(UNDDSMS)作为执行单位，原水利部南京水文水资源研究所具体实施。同年应联合国亚太经社会(UNESCAP)自然资源司Yuri Steklov先生之邀，参加了亚太各成员国水资源评价和利用系列出版物的编写，具体任务是修改和补充“中国水资源及其利用”分册(1997年联合国出版)。

鉴于中国水资源管理项目的顺利进行，1997年10月开始，联合国开发计划署和水利部又启动了“淮河流域管理项目”，并指定联合国经济和社会事务部(UNDESA)和原水利部南京水文水资源研究所作为实施单位，我作为中方专家组长和以Jacob J. Burke为首的联合国专家组合作于1998年完成了淮河流域政策研究。

1999年和2000年先后应San Lin和Le Huu Ti先生邀请作为项目专家为UNESCAP撰写了“中国水资源配置的政策和实践”以及“中国大江大河的防洪管理”，经UNESCAP组织的会议讨论后先后于2000年和2001年由UNESCAP发表出版。2002年世界气象组织和全球水伙伴共同发起“供水管理方案”，我应邀提供了中国实例，并按要求于2003年提供了报告。

2002年10月在北京举行的“水资源战略规划与管理国际研讨会”上，我对中国用水前景的发言引起了与会者的注意，翌年美国国家抗旱中心主任Donald A. Wilhite博士邀我为他主编的“干旱及水危机：科学，技术和管理问题”一书提供中国的实例，我邀柯礼丹和张世法合作撰写了一章，取名为“干旱和水管理：中国能满足将来的需求吗?”此书定于2003年年内出版。六七年来与国际组织如联合国教科文组织和世界气象组织合作过程中，还写了不少有关中国防洪、抗旱、水资源利用、流域管理等宏观战略及对策措施的文章，此书包括了上述工作的部分成果。

“中国水旱灾害”是一项重大科研项目，完成之后，出版了专著。它是在国家防办组织领导下、全国同行和所内外不少专家共同努力的产物。我曾从网上并和有关国家的专业组织联系，希望找到类似的研究成果作参考，花了不少时间，但结果很不理想。专著出版后不少同志建议把它译成英文，但鉴于一百万字的翻译工程过于浩大而只好作罢。因此在编辑此书时又将在2004年3月在汉城举行的国际天气和气候对人类影响大会上发表的“中国水旱灾害”短文加以补充，再附上专

著的目录，以供国外有兴趣者查考，也算部分了却了心愿。

国外任何对中国的防洪、抗旱、水资源和水管理有兴趣的机构和个人，可以从此书不多的篇幅中，直截了当地接触到问题的核心，在遇到浩如烟海的实际问题面前，能很快对一些重要问题心中有数。本书各篇中，我觉得还有一些值得向读者推荐的观点。如水管理中应加强法制、体制方面的能力建设；防洪中如何使与利益相关者能参与从规划到管理的全过程；流域管理中的重要问题在于建立真正的民主协商和合作机制而不仅仅是组织形式上的改变；要认真实施需水管理，防止对需水的过高估计，才能指导实际等等。强调这些问题的重要性，引起大家的重视，以便在今后的理论和实践中不断深入将是十分有益的。这本书也可供与水有关专业的管理人员、科技工作者、大学生、研究生研究参考。

这六七年的工作不是上级交代一定要完成的任务，也不需要去做十分费神的组织协调工作，工作环境十分宽松而自由。这要感谢当时所领导对我的尊重和支持，也要感谢所有参与这些工作的联合国朋友和所内外专家们的亲密合作。（对各个项目作出贡献的同志将在书中一一标明）

本书的出版得到了南京水利科学研究院出版基金的资助，在此深表谢意。这种资助方式对于鼓励那些已有一些经验积累和想法，想出书的人，特别是已退休的科技人员，不失为一个好政策。

我的英文基础是在苏州中学学习时打下的，在这本书将要出版时，正值江苏省苏州中学“府学千年，新学百年”双庆。饮水思源，也谨以此书对母校表示热烈的庆贺。

今年又恰好是我的父亲和母亲百年诞辰，我父亲故于文化大革命期间，享年仅六十七岁。母亲病重去世时我任职于联合国，又因工作的原因也未能在临终时见上最后一面，至今仍觉深深的内疚。今天我也以此书表达我对他们的永远怀念，并告慰他们在天之灵：你们一生冀望儿孙们过上幸福生活的愿望，在今天改革开放的大好形势下已经实现了，你们可以安息了。

张海仑

2004 年 10 月 10 日

Content

1 Issues in China's water resources*

Introduction

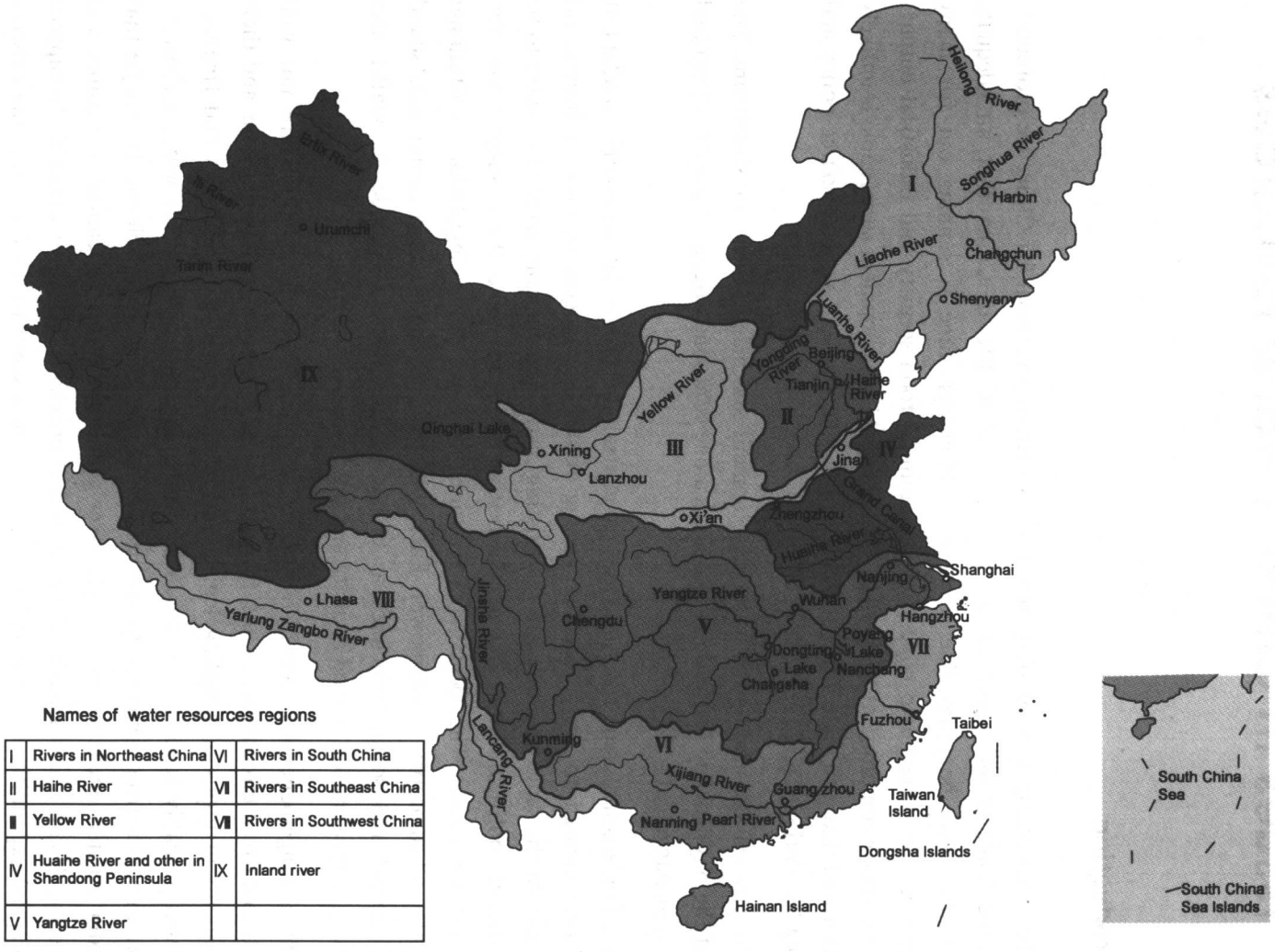
The issues of capacity building in water resource management for China are profound. They necessitate consideration of so many aspects of life in China that an adequate reconciliation may be impossible to achieve. However, time is running out for many provinces as they struggle to cope with maintaining food security and industrial output. Despite China's commitment to Agenda 21, making this development sustainable is unlikely to be met and taken to scale without fundamental adaptation of water resource policy and enabling legislation(Fig. 1.1).

The physical constraints for water development and management are significant. The scale of the physical and institutional problems alone confound attempts to apply integrated resource management.

One fundamental issue remains. How are central and provincial authorities to adapt at a fast rate enough to accommodate pressing resource management and environmental problems? At the same time how are the existing institutional arrangements for water to be given enough political, legal and administrative room to make these adaptations—the enabling environment. This begs many questions of water policy, legislation, institutional structures and appropriate manpower. Each will have to change to accommodate sound environmental and social principles as embodied in China's Agenda 21 whilst also addressing critical needs in food security and public health.

The arrangements for overall water resource management in China are not well adapted to current circumstances and there is a need to identify policy solutions and their requirements in terms of enabling legislation, institutions, human resources and finance. These will probably have to be different from the existing arrangements which essentially support an engineering approach to water resource management problems. It may be that the water related activities are simply over-geared in terms of capital structures and engineering design teams. Equally the central and provincial resources available to support more capital expenditure is limited. Therefore it makes sense to consider how the existing

* Brief summary of the issues in water resources for the project capacity Building in Water Management for China, contribution to the project includes: Jacob J. Burke and Miguel Solanes of UN Headquarters, Ke Lidan, Guo Yongsheng, Zhao Wei from the Ministry of water Resources, and Jia Zemin of Nanjing Institute of Hydrology and Water Resources.



Names of water resources regions

I	Rivers in Northeast China	VI	Rivers in South China
II	Haihe River	VII	Rivers in Southeast China
III	Yellow River	VIII	Rivers in Southwest China
IV	Huaihe River and other in Shandong Peninsula	IX	Inland river
V	Yangtze River		

Fig.1.1 Water resources regions in China

Source:China's construction in four decades(1988)

be optimized and managed before considering how to build yet more structures. This may involve more focus on the software rather than the hardware—i. e. the improved management of poorly performing irrigation schemes, the management of water demand in urban areas, and the improved management of flood prone areas. (Hydro-environmental improvement through sewage treatment will always be a burden, but there is scope for control of industrial effluent through good, enforceable environmental law)

Environmental attack on water is another big issue in China, it is annexed for easy reference.

1.1 The physical constraints

The total annual runoff in China amounts to $2\ 712\times10^9 m^3$, however, China has to feed about one fifth of the world population by 6.4% of the world land area and 7.2% of the world cultivated land. By the end of 2000, the water resources in terms of per capita availability was only 2 200 m^3, being one fourth of the world average, and the available water per unit area of cultivated land accounts for only 80% of world mean.

The situation is aggravated due to the uneven areal distribution of water resources between the south and the north. For the southern four regions including Yangtze River as a whole, there are 36.5% of the country's territory, 36.0% of cultivated area and 54.4% of population, but as many as 81% of total water resources with 4 170 m^3 per capita, about 1.6 times of the country's average value, and 61 950 m^3 per ha, being 2.2 times of the average. As a most outstanding one, the Haihe-Luanhe Basins have water resources merely 430 m^3 per capita, being 17% of the country's average value, and 3 760 m^3 per ha, constituting 13% that of the country.

Drought frequently afflicts China especially in Northern China plain where water stress in irrigated crops results in significant reduction in agricultural production. The historical data shows that within the 1 000 000 km^2 area of east China, there were 53 serious drought events in the past 510 years. This represents an average recurrence interval of 10 years. However, if a smaller area of 500 000 km^2 is considered, 323 serious drought events occurred in the 510 years period. This indicates an average recurrence interval of 0.66, in other words two events in every three years. From 1949 ~ 1990 the average drought affected farmland over the country is estimated at 165 000 km^2, approximately 16% of the cultivated land, It is estimated that significant losses of agricultural production occur in 50% of the drought affected land.

Flooding persistently threatens the plains in East China. This flood-prone area comprises the middle and downstream of seven major river basins, namely, the Yellow, the Yangtze, the Haihe, the Huaihe, the Liaohe, the Songhua and the Pearl rivers. The total flood prone area is estimated at 700 000 km^2. The extreme case is the Yellow River, the so

called"suspended"river, where the land surface of the downstream basin is 3～5 m lower than the river bed. It should be noted that 33% of the cultivated land, 36% of the population and 56% of the industrial and agricultural output are concentrated in this area where most of the industrialized cities of China are situated in. Based upon a 41 years of statistics(1950—1990)the average farm land flooded each year is 86 000 km^3. 60% of this area is subject to significant crop failure. This flood damage is concentrated in six provinces, namely Hebei, Shandong, Anhui, Henan, Jiangsu and Heilongjiang: which accounted for about 60% of total flooded area over the country. Flood protection in these areas is of utmost important in maintaining economic development and social stability.

1.2 The demand for water and the depletion of resources

The water shortage is becoming more acute as the demand from principal water users grows. Agriculture is the major user to water resources. In China 50% of the cultivated land is irrigated and the other 50% is rain-fed. In order to meet the increasing demand of the population growth further development of irrigation seems indispensable. The increase of water demand requires enormous capital investment, technology transfer and the improvement of management. The water use in irrigated field still remains at a low level, the irrigation efficiency over the whole nation is estimated about 40%. The limited water resources has not been efficiently used due to technical, economic as well as managerial reasons. The rate of reuse in the industrial sector for the country is about 30%～40%, in nearly 40% of the cities the rate of reuse is lower than 30%, especially for small towns.

With the rapid growth of urban population and economy the total water use including the industrial and domestic water use increased from 3% in 1949 to 25% of total water use in 2000. Since 1980s, the gap between water supply and demand in urban areas has become increasingly serious in spite of the rapid development of municipal water supply. These demands have also had significant impacts on water quality, particularly in the middle and lower reaches of the seven major river basins where baseflow reduction has increased concentration of pollutants.

In addition, the non-consumptive use in hydropower generation imposes constraints on baseflow regimes in certain rivers as competing needs of power generation and irrigation and municipal supply are accomodated.

Over abstraction of surface water and depletion of ground water continue to pose considerable constraints for sustainable development in China. This is particularly the case for the Haihe River Basin where surface water has been diverted and groundwater over-exploited for irrigation since 1970s. Overdraft of ground water in shallow aquifers has brought about the drastic reduction of surface runoff, the trend of dryness in this area is significant. As a result of surface runoff reduction, the rivers are turning to be intermittent even for median sized basins in these areas.

The competition of water resources between different areas has been increasingly acute for the water scarcity regions. In order to bring the maximum benefit of the limited water resources, it is indispensable to have a rational allocation of water. The water allocation in Yellow River is an example which was approved on the basis of overall study of water resources and water demand of riparian provinces, which has provided the basis for coordination and development planning of riparian provinces in their water use.

1.3 Operation and maintenance of hydraulic infrastructure

As of 1997 there were 84 800 reservoirs with total storage capacity of 458×10^9 m^3 and 620×10^6 ponds with total volume of 30×10^9 m^3, 276 000 sluices, 3.99×10^6 motor equipped tube wells and 474 000 pumping stations. All these projects have played a vital role to meet the basic needs of different users and to combat the flood and drought. In addition about 250 000 km dikes are the mainstay of the flood control system. However, many projects remain ineffective. For example many reservoirs fail to be fully operational in accordance with their design criterion. Many irrigation projects cannot be made fully operational due to incomplete canal systems. Generally, the facilities for the bulk of China's hydraulic infrastructure are out of date and are in urgent need of replacement or extensive rehabilitation.

1.4 Legislation and institutional arrangements

In 1988, the Standing Committee of the National People's Congress adopted the "Water Law" which was revised and adopted in 2002. In 1994 the State Council(cabinet) approved the scheme of organizational structure and posts of the Ministry of Water Resources (MWR) which was appointed as the"department of water administration" of the State and discharges the responsibility of unified management of water resources. The major responsibilities of the Ministry include: The supervision and inspection of the execution of the Water Law, the Law of Water and Soil Conservation and other relevant laws, regulations and rules; Development planning, mid-and-long term and annual planning on water resources development; Unified management of water resources of the country; Management of the rivers, reservoirs, lakes, etc.; Flood control and drought mitigation; Water and soil conservation; Water supply in rural areas. During the restructuring of the State Council and adjustment of functions and responsibilities of various ministries in 1998, it was decided that the MWR took over the responsibility of ground water management and guidance of water saving (policy formulation and planning), and more specific responsibilities in water resources protection were identified. The coordination and cooperation among different sectors is still an issue even after the restructuring of the government, which greatly affects the integrated management of water resources.

The seven major river basin organizations are agencies of MWR to perform the function of water administration in the river basin. The local water resources authority comprises four levels i.e. the provincial, prefecture, county bureaus and the village (town) water management station which assume functions and responsibilities of local water administrative management within their respective jurisdictions. The organizational framework of water management in China is given in Annex 2 of this chapter.

While the functions and responsibilities of the department of water administration are clear in relation to unified management and coordination of sectoral management of water resources, the task of implementing the Water Law has become even more pressing as China works toward economic reform and the increased role of market economy.

More significantly, the conflict of interests embodied in river basin management and administrative district management of water resources can hardly be handled by river basin authorities, who presently are not powerful and competent enough to mediate these conflicts in the integrated development of water resources of the basin.

1.5 Solutions in perspective

Water use in agricultural sector will not be able to have a substantive increase in North China, the irrigation development could be realised only through rational use of water and water saving, technically, it includes the improvement of conveyance system; the improvement of irrigation technique; the promotion of the dry farm agriculture, etc., As for the water use in industrial sector and domestic water supply, there is a high potential of water saving. The measures to be taken are mainly twofold: reinforcement of water charging systems and use of advanced technologies to improve water use in agriculture and industry. In order to bridge the increasing gap between the potential water apply and demand in north China, the project of diversion of water from Yangtze River to the north was initiated and is being implemented. However the issue of water shortage cannot be coped with if the supply oriented approach still predominates. The solution of water shortage should rely on the demand oriented approach in water management, which has legal, institutional, economical and technical implications.

1.6 Finance

The ability to fund integrated water resource management (in its broadest sense, including monitoring, planning, design and construction, operation and maintenance of both large and small scale water projects) has depended to a large degree on the ability of central government. However, in tackling the challenge of water demand into the 21st century in China, the scale of required investment is massive and significantly more than the current investment will be necessary. The ability of the central government to maintain