Environmental Conservation **28** (4): 368–377 © 2001 Foundation for Environmental Conservation DOI:10.1017/S037689290100039X

Issues, perspectives and need for integrated watershed management in China

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Date submitted: 10 January 2001 Date accepted: 14 September 2001

Summary

Water management issues at the scale of whole river basins are becoming significant public concerns in China. Adverse aspects of basin-wide mismanagement of water resources in China are reviewed and analysed with respect to watershed management organizations, systems and policies, legislation and implementation of law, public participation, and other pertinent fields. Several critical issues in watershed management should be addressed in the immediate future, including divided jurisdiction and overlapping responsibilities of water management agencies, water pricing, lack of attention to non-point sources, absence of legislation regarding both watershed organizations and public participation, and illegal implementation of existing environmental laws and national policies concerning agriculture and farmers. Based on those analyses and worldwide practices, conceptual frameworks for integrated watershed management in China, including organization, legislation and institutions, are put forward both for the short and the long term. As a national focus, the Three Gorges Project is expected to have potentially disastrous environmental impacts. Mismanagement in the Three Gorges watershed is indicated, including piecemeal approaches to management, absence of legislation and a watershed approach that is disintegrated by administrative boundaries.

Keywords: China, watershed management, Three Gorges

Introduction

In recent decades, more and more countries and regions around the world have increasingly adopted watershed management as an important approach to sustaining social and economic development; the countries include UK, USA, France and some developing countries (Kneese & Bower 1984; Newson 1992; Spulber & Sabbaghi 1998). This management has several characteristics, namely integration of water quality and quantity management, creation of corporate bodies, comprehensive power with legal supervision, effective public participation, integration of watershed management, poverty elimination and regional development (Kneese & Bower 1984; Newson 1992; Spulber & Sabbaghi 1998), which offer potential lessons for China's watershed management. China is now confronted with the question of how to sustain its water resources. At the scale of river basins, water resources mismanagement is becoming an increasingly serious issue (Ministry of Water Resources 1997, 2000). For example, the Yellow River is so heavily exploited and poorly mismanaged at the basin level that it has frequently dried up since 1972. This paper will focus on watershed management issues in China.

A watershed is a hydrologic unit that has been described and used both as a physical-biological unit and as a socio-economic and socio-political unit for planning and implementing resource management activities (Dixon & Easter 1991). In this paper it refers to a sub-drainage area of a major river basin. A river basin is similarly defined, but is larger in scale. Integrated watershed management is the process of planning, guiding and implementing a course of action involving natural, human and other resource uses in a watershed, taking into account the social, political, economic and institutional factors operating within the watershed and other relevant regions to achieve specific social objectives (Dixon & Easter 1991). A watershed often provides a logical spatial unit for natural resources management (Lal 1999), while it frequently cuts across administrative boundaries that complicate integrated management (Sun 1989). Therefore, coordination and cooperation are inherent to, and central tenets of, watershed management (White 1992).

The creation of water conservancy organizations in China's major river basins can be dated back to the late 1920s and the early 1930s, when the Huai, Yellow and Yangtze River Water Conservancy Committees were formed (Zheng 1984). In the 1950s, China set up organizations addressing all seven of the major rivers of China, namely the Yangtze, Yellow, Pearl, Huai, Hai, Songhua and Liao Rivers (Fig. 1). These organizations ushered in a new era of integrated watershed management in China. Between 1966 and 1976, some organizations, such as those of the Pearl and Huai Rivers, were abolished and resumed in the late 1970s. In the mid-1990s, water pollution control on the basis of whole basins, namely in the Huai River and Taihu Lake, indicated that integrated approaches and strategies could start a new era in China's watershed management.

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https://doi.org/10.1017/S037689290100039X Published online by Cambridge University Press



Figure 1 Diagrammatic map showing the location of the seven major rivers of China.

A review of what is known about watershed mismanagement is the first step in identifying the approaches and strategies suitable for China. The aim of this paper is to give an overview of watershed management issues and suggest how the problems might be addressed, in particular using the Three Gorges watershed as a case history of piecemeal approaches, absence of legislation and other forms of mismanagement.

Critical issues in China's watershed management

Fresh water is a strategic resource that structures a nation's natural and cultural landscape and is a major determinant of regional economies and demographic patterns (Naiman *et al.* 1995). Critical water-related challenges that face China include uneven spatial and temporal distribution, and shortage of water resources, water pollution and waste in water use (NEPA [National Environment Protection Agency] 1995).

Watershed management organizations

China has a combined watershed management system based on both river basin and administrative boundaries (Fig. 2). On the one hand, China set up river basin commissions for each of the seven major rivers. These commissions are the principal scientifically-administrative, advisory and consulting agencies within the basins concerned, and are focused on flood mitigation, sediment and drought control, water pollution along the sub-basin borders, water resources programmes and other related affairs. On the other hand, each provincial water resources bureau has equivalent power within its provincial

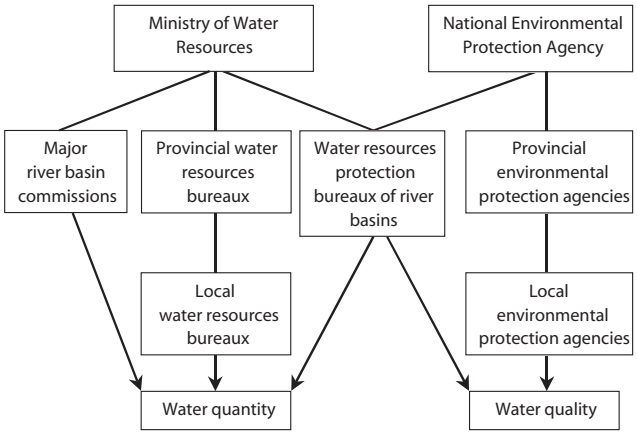


Figure 2 Main institutional framework of watershed management in China (Fang Ziyun, personal communication 2000).

boundary and considers watershed management planning only for its own provincial benefits. As a result, provincial and local water resources bureaux have been playing dominant roles in water resources management, while river basin commissions have not played the roles expected. The commissions have little authority over administrative and economic issues in each basin, and there is little coordination of water issues with provincial water resources bureaux, environmental protection agencies and other agencies involved.

The limited effectiveness of watershed management organizations has led to several unsatisfactory outcomes (World Bank 1997), such as lack of legal frameworks for managing water resources along river basin boundaries and water resources

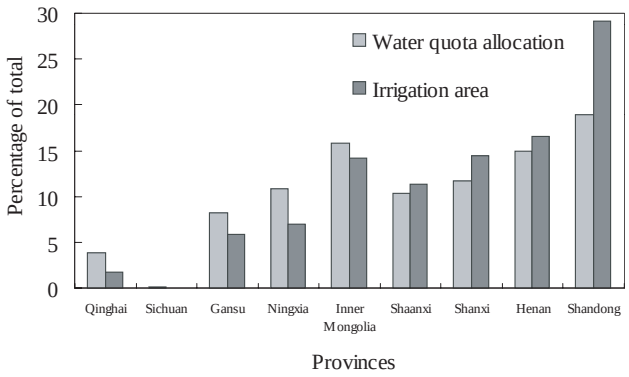


Figure 3 Water quota allocation by the State Council and irrigation area (1997) in the provinces along the Yellow River. The upper reaches of the Yellow River, approximately from source to Hekou, include five provinces, namely Qinghai, Sichuan, Gansu, NingXia and Inner Mongolia. The middle reaches, almost from Hekou to Mengjin, include three provinces, namely Shaanxi, Shanxi and part of Henan. The lower reaches, from Mengjin to the end, include two provinces, namely part of Henan and Shandong.

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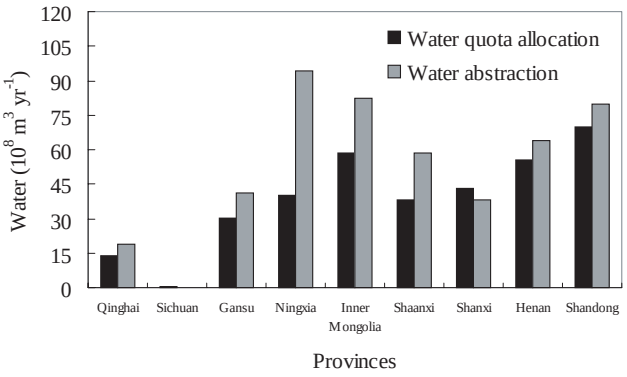


Figure 4 Water quota by the State Council and actual water abstraction (1997) by the provinces along the Yellow River.

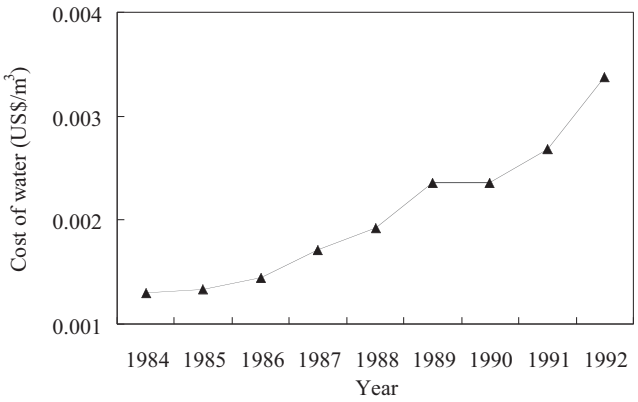


Figure 5 Costs (US$ 1 ≈ ¥ 8.30, January 2001) of abstraction of water in Weishan Irrigation Zone, Shandong Province. Reproduced from Zhang *et al.* (1998).

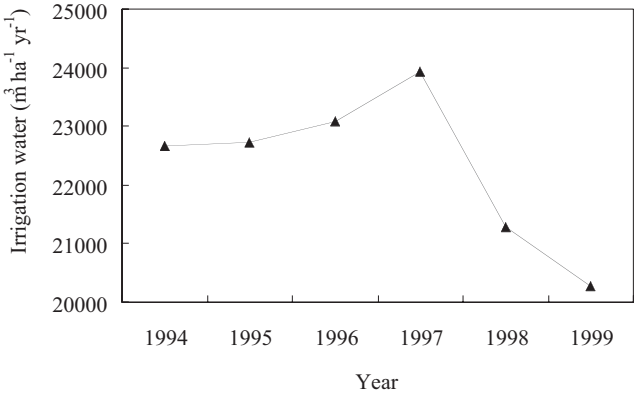


Figure 6 Water quantity irrigated in a unit of land in NingXia Autonomous Region.

being planned to maximize provincial benefits within provinces but benefits being sub-optimal at basin level. For example, in 1987, the State Council issued a water allocation scenario for the Yellow River, which was approximately equivalent to the agricultural irrigation areas of each province (Fig. 3). However, the provinces located in the upper reaches, such as Ningxia and Inner Mongolia, disregarded the scenario and abstracted far more water than their quotas (Fig. 4). This is partly because the Yellow River Water Conservancy Commission has insufficient power to supervise the scenario, which is regarded as one of the key reasons for the drying up of the lower reaches of the Yellow River (Ministry of Water Resources 1997). Such unsatisfactory outcomes imply that watershed management organizations should be more integrated and improved.

Watershed management systems and policies

The Ministry of Water Resources, which is in charge of the management and development of water quantity, not only has overlapping responsibilities with the National Environmental Protection Agency that is responsible for water quality protection and management (Fig. 2), but also shares other roles with several other agencies, such as those addressing agriculture, forestry and traffic. For example, the forest bureaux may be in charge of river basin planning upstream, but the agriculture bureaux may often share this responsibility with them. Energy departments and construction bureaux may also be responsible for the planning and management of reservoirs upriver in some special cases, such as electricity generation and tourism planning (NEPA 1995; World Bank 1997). The separation of water quantity management and pollution control, and the fragmentation of national and local agencies are regarded as the main institutional issues in the water sector (NEPA 1995; World Bank 1997) in China; in particular, river basins are separated by administrative boundaries with overlapping roles. This multi-agency sharing of water resources management leads to a situation where all agencies are partly responsible for their respective interests but none is readily liable for the damage (He & Chen 1998).

As for water pricing policy, low prices and even in some cases cost-free use have led to wastefulness in agriculture, industry and domestic sectors, and water shortages (NEPA 1995). For example, in the Yellow River Basin, the cost of irrigation water abstraction is so low that 1000 tonnes of the water of the Yellow River are no more costly than a bottle of mineral water in the supermarket. This low rate for water abstraction (Fig. 5) has led to water waste. For example, more than 22500 m^3 of water are used annually per hectare of land in Ningxia Autonomous Region (Fig. 6) for widespread flooding irrigation (Ministry of Water Resources 1997, 2000). In some cases, this rate reaches 33000 m^3 ha^{-1} yr^{-1} or more (Ministry of Water Resources 1997, 2000). In the late 1990s, raising water prices, reuse and recycling and other approaches were put forward as solutions to water issues in China, especially north China. However, poor management of available water resources, pollution, water shortages and other problems remain significant and growing concerns (NEPA 1995).

Legislation and implementation of law

The past decades saw the instigation and improvement of legislation and development of environmental standards for water

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Figure 7 Industrial effluents and disposal during the 1980s and 1990s in China. The data from before 1990 are not comparable with those after 1991, because disposed industrial effluents before 1990 did not include that reused or recycled. However, that does not affect the relative change during the 1980s and 1990s, respectively. (Source: Editorial Board of China Environment Yearbook 1990–1999).

management in China. For example, 426 environmental standards had taken effect by late 1999 (Editorial Board of China Environment Yearbook 2000); however at least three shortcomings have yet to be addressed. The first is the absence of legislation for particular river basins. According to the Water Pollution Prevention Act (1984, revised 1996, amended 1997), 'Protection from water pollution should be planned on a basin-wide or regional basis' (Item 1, Article 10). Regulations and development scenarios have been constituted for the recovery of Taihu Lake, and the Huai, Songhua and Liao Rivers. However, no acts or laws integrating resources development with environmental protection have been formulated for any particular river basin. In addition, rules of organization regarding river basin organizations are absent, which implies that there is no legal base for the stability, responsibilities and missions of river basin commissions. In this respect, another serious problem is the absence of any procedural laws related to public participation or community involvement. The second aspect is that the existing laws and regulations have created a legislative and judicial context that does not allow the integration necessary to resolve complex issues related to fresh water. In some ways, the Water Pollution Prevention Act has been successful; for example, there has been long-term growth in the rate of disposed industrial effluents and continuous decrease in the gross industrial effluents in China (Fig. 7). However, the Water Pollution Prevention Act's focus on point-source pollution shifted emphasis away from other equally harmful and pervasive forms of environmental deterioration, such as non-point source pollution. Implementation of the law is also the third significant concern; more attention is needed to enforcing the existing laws that were designed to improve water management.

Public participation or community involvement

In China, the public has little access to planning and management processes. In the legal instruments, some guidelines and principles are given, but the procedural laws do not back these up. During planning, public access, even that of the parties concerned, is forbidden or restricted. For example, a project involving water transfer from south to north China is planned for implementation at the present time, but the public, including the researchers, have been refused access to the planning process. In a public opinion poll by Jiang (1999), only 10% had heard of this grand water transfer project. In addition, the principal opponents, who are usually experts, tend to be excluded from the lists of planners. Therefore, planners strive to collect only evidence that favours project feasibility, while objectors are restricted to planning, or may to some extent be ignored. Besides, project design and implementation are under the sole control of some planners; the local communities cannot enter into the procedures involved, even less alongside the teams of scientists, planners and development specialists involved identify the possible problems and solutions.

Easter and Dixon (1991) noted that 'planning for watershed management has often been approached from the engineering perspective, largely by planners who do not come from the watershed areas. The residents in the watershed—the watershed community—are often seen as obstacles or part of the problem, and in some cases, they are ignored. Not surprisingly many watershed management schemes formulated under these assumptions have failed. Once people are seen as legitimate (although sometimes 'illegal') users of the watershed resources, they will become part of the solution rather than the problem'. In fact, public involvement in the legislative and regulatory process and close cooperation amongst parties involved can help to insure efficient use and development of basin resources (Kneese & Bower 1984; White 1992; Lee & Dinar 1995; World Bank 1997). We believe that the lack of effective public participation is at the origin of many water management issues and should be accepted as a key to successful watershed management in future.

Local governments' illegal implementation of national policies concerning agriculture and farmers

In rural areas of China, fees charged by some local governments have aggravated the economic burdens of the peasantry, compelling peasants to bring barren and erodible lands under cultivation, or destroying forests in order to support livelihoods. Such charging policies have contributed to severe deforestation, and environmental deterioration in the form of soil erosion and non-point source pollution (NEPA 1995). In the Yangtze River Basin, the major non-point sources of water pollution are fertilizers and pesticides from agricultural applications, waste residues, acid rain, and soil erosion (Yangtze Valley Planning Office 1988). Soil erosion affects 562 000 km^2 of land, 31.2% of the whole basin (Editorial Board of the Yangtze River Journal 1989, 1990). Widespread human-induced deforestation and soil erosion led to disastrous floods in 1998 (He & Jiao 1998). In this

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context, it is of vital importance for fulfilling soil conservation and water pollution control programmes that local governments legally implement national policies concerning agriculture and farmers in order to mitigate the heavy burden of farmers.

In addition, shortage, incompleteness and unreliability of data, lack of access to the data by researchers, equity in watershed planning, and absence of funds, are among the other issues adversely affecting China's watershed management.

Conceptual frameworks of watershed organization, legislation and institution

If a workable plan for integrated management of fresh waters, including economic, social and political considerations, is to be developed, decisions must be based on an understanding of freshwater ecosystems and on more effective and comprehensive laws and policies (Ludwig *et al.* 1993; Naiman *et al.* 1995). For watersheds, it seems that questions about the appropriateness of different organizational forms, styles and performance have rarely been asked. Lessons, practices and experiences of watershed management indicate that all the major options in institutional arrangement need to be considered before the one best fitting the conditions of a particular watershed can be determined (Dixon & Easter 1991; Gibbs 1991). Following this, we believe it is possible to make some proposals for integrated watershed management in China with respect to watershed organization, legislation and institution in order to address the problems outlined.

Conceptual framework for watershed organization

We argue that the separation of water quantity management and pollution control and the fragmentation of national and local agencies have done great harm to the appropriate development and management of water resources. In order to address that issue, we maintain that management organizations of a size suitable for river basins or sub-basins should be set up, rebuilt or improved to satisfactorily address the integration of water resources development and protection. Such organizations should have at least three characteristics, namely comprehensive administrative authority related to the economic and social development within each river basin, substantial independence in both watershed management and administrative expenditure, and strong coordination functions. In this context, we make proposals for an organizational framework for watershed management.

Excluding provincial and local water resources bureaux, there are three types of watershed management organizations in China. One type particularly emphasizes the scientific research and advisory work that are characteristic of most river basin commissions. Another type includes the organizations involving several ministries for water pollution control of whole basins, such as those of the Huai River and Taihu Lake. The third type, constituted by water resources development agencies, also has some management functions, as does the Development Company of the Three Gorges Project; these agencies might be transformed into basin-wide firms, as is the case with the Development Company. Apart from the Three Gorges Watershed, the Wujiang Valley of the Yangtze River (Li *et al.* 1989) and Hongshuihe Valley of the Pearl River (United Nations Environment Programme 1991) may also be suitable for a basin-wide firm-based approach.

Considering there are four types of management organizations in China, we propose that the leading group involved in water pollution control together with the river basin commissions, and including several central government ministries and water resources protection bureaux, could be formed into revised river basin commissions. The commissions might consist of representatives from the ministries, provinces and public concerned. The commissions could coordinate the parties concerned and appoint certain agencies, such as water resources development agencies, as executives of their planning and management programmes. The executive agencies of the commissions would have the authority to implement relevant laws and to supervise and arbitrate on water issues. The relevant local bureaux, such as local water resources bureaux and environmental protection agencies, would submit monitoring and other management data to the river basin commissions and their executives for sound decision-making.

However, the Yangtze, Pearl and Songhua Rivers are very great in size, and commissions of sub-basins with appropriate size are likely to be more appropriate. River basin commissions of these rivers could be in charge of the coordination of whole basins. In the case of the Yellow River, drying up of the lower reaches and severe soil erosion complicate water management, and indicate that this system requires special attention.

Conceptual framework for legislation

According to the Water Pollution Prevention Act, watershed management organizations are legally in charge of watershed planning, but it is unclear whether organizations can supervise actual implementation of watershed planning. Without clear legislation, the watershed organizations' work of planning and management are not fully supported by local bureaux and agencies. Besides, the proposed watershed management organizations with comprehensive power should be supervised and regulated through the legislation. Therefore, legislation should confirm functions and missions of watershed organizations if management programmes are to be more effective. However, it is worth mentioning that the legal instrument for a certain river basin, such as the Yellow River Act, which is at present being drawn up, should be adaptive to its social, cultural and economic systems, and should not be spatially uniform as it was before, even for sub-basins within the same major river basin.

The legal act for a specific river basin may be derived from basic laws for environmental and natural resources to be composed or from the Water Resources and Water Pollution

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Prevention Act. The legal act should clearly establish relationships between rights and obligations for watershed organizations and the parties concerned. The rights may also be derived from the National Constitution in special cases, such as Three Gorges watershed. However, integrated watershed management requires public support, and public participation in the legislative and regulatory process will improve efficiency and effectiveness of water management (World Bank 1997). In this context, procedural laws are necessary for effective implementation of integrated watershed planning and management, especially for public involvement, without which substantial non-compliance with laws is only to be expected.

Conceptual framework for institutional arrangements

Institutions have a critical role to play in improved water resources management (Sun 1989) and in China institutional reform should aim at facilitating integration of water quantity and quality management on a basin-wide level. We propose that a national watershed management commission be set up directly under the State Council and that river basin commissions also be established for each particular basin with the comprehensive functions indicated. The national watershed management commission might be formed by reorganization of the Ministry of Water Resources, or be formed of certain ministries and representatives from certain basin commissions, experts and the public. Its function may also include leadership, instruction or coordination, as in the National Watershed Forum of the USA (US Environmental Protection Agency & Department of Agriculture 1998). At the basin level, river basin commissions with comprehensive power and regional agencies would be legally responsible for planning the day-to-day operation of quality management systems, for the design and construction of appropriate management facilities and controls, and for data collection and research. In greater detail, these agencies would be responsible for water abstraction, flood control, drainage, navigation, hydropower discharges, water quantity and quality maintenance, coastal pollution, and soil and water conservation and recovery. The commissions would be able to set water tariffs for each function so that they could recover their operational costs and develop new projects to control water flows and pollution (World Bank 1997).

Conceptual framework for the long term

Institutional reform should lead to reconstruction or otherwise improvement of river basin commissions involving each of the main interest groups and the formation of a corporate river valley authority might be the long-term objective. However, watershed management institutions should be diverse and adapted to local conditions and public choices. For example, if the existing management framework was very effective, it would be unnecessary to give up the existing management approaches. Even in the areas where integrated approaches are in place, integrated strategies should be adapted to local conditions, such as natural resources abundance or absence, and economic and social development levels. River basin commissions that have involved several ministries, such as that of the Huai River, could be improved through strengthening their functions and through the construction of corporate bodies, as in England and Wales (Spulber & Sabbaghi 1998). The legal act for a river basin should give the commission authority for the economic and social development of the river basin concerned. In the long term, commissions/agencies would be established with powers to plan and implement management programmes for entire regions, and usually be river basins or single sub-basins (Kneese & Bower 1984). However, it is unlikely that purely corporate valley authorities like the Tennessee Valley Authority in the USA would prove widely acceptable even in the long run. River basin commissions with certain corporate bodies as their executives might be better suited to China. Also, for river basins that experience conflicts over certain resources, special agencies could be established, as is the case for looming conflicts over water allocation within the Yellow River Basin.

Three Gorges Watershed

Concept framework for integrated watershed management in the Three Gorges watershed

The Three Gorges are located in the upper reaches of the Yangtze River (Fig. 1). In 1993, China started to construct the Three Gorges dam and create the 600-km long reservoir that will be completed in 2009. The Three Gorges watershed in this paper is not that of the administrative context, namely the one spanning about 20 counties or county-level cities, but the hydrological unit (Fig. 8). It includes the main stream from the dam to the end of the reservoir and all the minor river basins, but does not include two major tributaries, namely the Jialing and Wujiang Rivers that are respectively 158 776 km^2 and

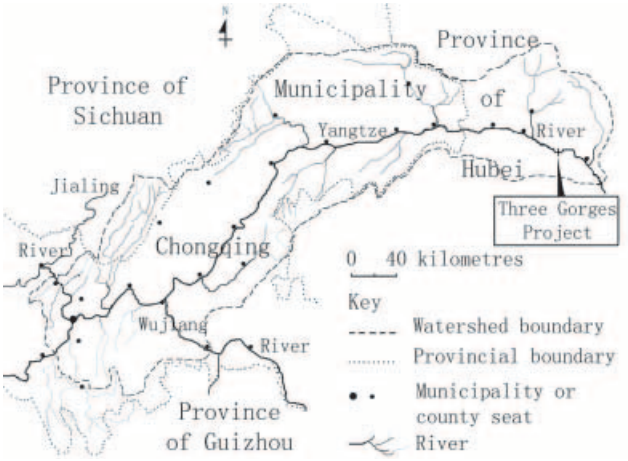


Figure 8 Diagrammatic map of the Three Gorges Watershed, Yangtze River.

https://doi.org/10.1017/S037689290100039X Published online by Cambridge University Press

86 976 km^2 in area. Its regime covers most of the Three Gorges area on the basis of administrative boundaries, which is about 57 939 km^2 in area. The Three Gorges Watershed is one of the most economically depressed areas, with a high population density of 335 persons/km^2 and only 0.76 *mu* of arable land per caput (1 *mu* = 1/15 ha; NEPA 1998). Agriculture is the mainstay of the local economy, with industries and markets being weak, and the income per caput being only 53% of the national average (Wu *et al*. 1989). Of the land in this area, 78% is mountainous, and about 40% of this mountainous land is under cultivation (Chen 1998), while one-third is on mountainsides with slopes of 25° or greater and should therefore not be being farmed at all according to the Soil and Water Conservation Act (1991). In addition, with a fragile environment and widespread over-cultivation, the land in the Three Gorges Watershed suffers moderate to severe erosion, with soil erosion areas accounting for 58.2% of the total (Environmental Impact Assessment Office of China Academy of Science & Changjiang Institute of Water Resources 1996). Therefore, sound management will be the key to sustainable development of this Watershed, because of severe environmental issues and the high population pressure.

Review of watershed management in the Three Gorges Watershed

On the one hand, there exist several agencies concerned with project development. The top decision-maker in the project is the National Construction Committee for the Three Gorges Project, which is responsible for coordinating the corresponding agencies, emigration resettlement policies, planning for and supervising their implementation. The Parent Company for the Three Gorges Project acts as the constructor and manager, and also has responsibility for financing the project and actual payment for it. The Economic Development Office of the Three Gorges Area has worked with the relevant local governments to coordinate the various affairs concerned. On the other hand, environmental protection in the Watershed is under the charge of several agencies in local governments. The Ministry of Land and Resources, the Ministry of Water Resources, the Environmental Protection Agency, the Changjiang Water Resources Commission, and the Yangtze Valley Water Resources Protection Bureau also have some authority over natural resources and environmental management in this Watershed. There are several adverse impacts on watershed management in this Watershed at present and these will persist after project completion.

Piecemeal approaches, such as separation of project construction, resources management and pollution control, from natural resources development and environmental protection, may not fully recognize the interactions and interdependencies among components, such as water, forest and land in the Three Gorges Watershed. For example, water resources bureaux are answerable for the development and management of water supply, while environmental protection agencies take charge of environmental protection, including water pollution control. Not only do both kinds of local bureaux overlap in matters of water resources management, but also many other agencies, such as those in agriculture, communication and forests, share roles with them. The piecemeal approach is likely to cause each of the parties involved to strive for their several interests but to shirk their responsibilities for any losses after the Three Gorges Project is completed. In this context, for example, we can not help asking what agency, whether environmental protection agency, land or other bureaux, should be responsible for landslide and soil-erosion impacts of the project.

Further, watershed management on the basis of administrative boundaries will not lead to integrated management. In the development of the Three Gorges Watershed, the development scheme is multi-objective, while the existing management authorities each have single, or a few, functions. None of the authorities is responsible for the integration of economic development and environmental protection; instead, the corresponding power is under various bureaux of local governments (namely Chongqing Municipality and Province of Hubei). One of the numerous issues created by the existing institutional arrangement is that of where the financial sources lie for compensation for environmental damage induced by the Three Gorges Project within the boundaries of Chongqing Municipality, if the Province of Hubei or other agencies derive the revenues of hydropower generation. The separation of the beneficiary and impacted party will be one of the most significant sources of conflict. Even where an integrated management authority were set up, the situation where the authority might be a single combined scientifically-administrative, advisory and consulting body should be avoided.

In addition, the present legislation is not adapted to watershed management in the Three Gorges Watershed, which is a situation similar to that of nation-wide issues considered above. If according to the Water Pollution Prevention Act, water pollution prevention is to be addressed at river basin or region level, it is important to highlight that at present no act exists or is expected to be constituted concerning integrated watershed management in the Three Gorges Watershed; there are no procedural laws for planning, management and public participation. Besides, the policies concerning agriculture and farmers implemented by some local governments have indirectly added to environmental degradation in this agriculture-dominated area (He & Chen 1998).

Generally speaking, project construction and progress are satisfactory on the whole, as in integration of emigrant resettlement, poverty elimination and regional development. However, closer and early attention is needed to other facets of the undertaking, for this project is of national, and potentially worldwide influence.

Proposed organization, legislation and institution of integrated watershed management for the Three Gorges Watershed

Organization

Presently, there exist three kinds of opinions on managing the Three Gorges Watershed (Office of the National

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Assessment Committee for Three Gorges Project 1990). The first is that two parties, namely the Province of Hubei and Chongqing Municipality (a municipality directly under the Central Government in 1997), should be responsible for watershed management issues. The second maintains that an agency directly under the Central Government should be constituted to manage all the related affairs. The third advocates that the Three Gorges Watershed should be put under an administrative region, such as a new province or special zone (Li 1992). We do not fully agree with any of the three opinions. We argue that the third proposal is unnecessary for several reasons. Firstly, putting the Three Gorges Watershed under a Three Gorges Special Zone or Province (Li 1992) is a strategy that failed to handle migration resettlement and related issues successfully already in the mid-1980s. Secondly, if the part of Hubei Province located in the Three Gorges Watershed were put under Chongqing Municipality, the shortcomings of large areas of this municipality would become more serious than they are. Lastly, worldwide experience indicates watershed management issues may be addressed by powerful watershed organizations on the basis of watersheds (Kneese & Bower 1984; Newson 1992; Spulber & Sabbaghi 1998). Therefore, integrated management across administrative boundaries will be one of the most important options. We propose three kinds of possible organizations that might be responsible for the integrated management of the Three Gorges Watershed and these are now discussed.

One organization is the Chongqing-Hubei Cooperation Commission. In this case, two parties could respectively be responsible for development and management issues within their boundaries. As occasion required, two parties and ministries involved would head a leading group to handle environmental issues. We believe it would be easy to operate and would represent a kind of a transition between management strategies. This approach should be viewed as provisional and of low effectiveness, because the two parties would tend to strive for their separate interests and shirk their prospective responsibilities for losses after the Three Gorges Project is completed. Another possible organization is the Three Gorges Watershed Authority, whereby the Construction Commission for the Three Gorges Project, as national representative, might be integrated with local government and the public, and the Development Company for Three Gorges Project might be rebuilt as one corporation of the Authority. The Authority could be in charge of comprehensive development and management issues, and responsible for environmental issues attributed to natural resources development. The Authority could be a corporate body and made financially autonomous, and might be directly subject to the State Council for resolution of complex benefit conflicts, as in the Tennessee Valley Authority (Selznick 1984). The Authority would be supported strongly by the Central Government in spite of possible great resistance at the start-up. The third possible organization is the Commission for Three Gorges Watershed Management. The Commission would be composed of the Province of Hubei, Chongqing Municipality, the ministries involved, the public representatives and other parties concerned. Several corporations, as its executives, would have comprehensive authority over natural resources development and environmental protection, including coordination, supervision and arbitration roles. The local bureaux involved, such as the local Environmental Protection Agency, could offer the relevant information to the Commission necessary for sound decision-making. This proposal would be similar to the watershed management framework prevailing in France (Kneese & Bower 1984; Newson 1992; Spulber & Sabbaghi 1998).

Legislation and policy

Watershed management practices and experiences indicate that effective legislation, avoiding ambiguous responsibilities, is the key to successful watershed development and management (Kneese & Bower 1984; Newson 1992; Spulber & Sabbaghi 1998). Although comprehensive development programmes are being applied in the Three Gorges Watershed, a corresponding management authority is not yet set up and the existing management agencies are multitudinous but of low effectiveness. We make a proposal that the Authority be set up by constituting the Three Gorges Watershed Act, which could be derived directly from the Constitution (1982, revised 1988, 1993, 1999), or Act of Environmental and Natural Resources (to be composed), or the Water Resources Act (1988) and Water Pollution Prevention Act. The Act could clearly provide for the corporate organization, administrative scopes, and other related rights and obligations of the Authority. Also required would be the procedural laws for public participation, especially that of local communities.

Watershed management should be integrated with poverty elimination and regional development. The Three Gorges Project will involve over 1 200 000 emigrants, while the economic situation of this watershed is below China's average. Therefore, special policies will need to be put into practice. According to system theory, the whole watershed could be treated as an integrated nature-society system (Expert Group on Eco-environmental Impact Assessment of the Three Gorges Project 1988). A multi-objective, multi-functional development programme should be constituted for integration of emigrant resettlement, poverty elimination, regional development and environmental protection and recovery. Local governments could also legitimately carry out the national family plan and national policies concerning agriculture and the peasantry.

Institution

Whether it is by means of a 'Commission for the Three Gorges Watershed' or a 'Three Gorges Watershed Authority', we argue that the aim must be to facilitate integration of resources management and environmental protection on a watershed basis, and that the Commission/Authority should be an agency directly under

https://doi.org/10.1017/S037689290100039X Published online by Cambridge University Press

the Central Government and be a corporate body. The Commission/Authority and its executives should be legally responsible for the functions, and be charged with the corresponding obligations, including water quantity and abstraction, flood control, hydropower discharge, water quality maintenance of the reservoir and minor tributaries, soil and water conservation and recovery, regional allocation of the industries, fisheries, water resources planning, navigation, and water flow maintenance. Further, in order that the Commission/Authority could recover operational costs and develop new projects for resources and environmental protection, the Commission/Authority should be able to take charge of aspects including setting water tariffs, issuing permits for pollution effluents, and imposing water abstraction fees including the monitoring, flood control, drainage, pollution effluent, fining and other related fees. By way of exception, the National Flood & Drought Prevention Headquarters should direct regulations related to water quantity during the flood seasons and years of severe drought. In this context, however, the Commission/Authority would have wide powers and should thus be restricted by laws and supervised by other agencies.

Further discussion

The proposed framework could deal effectively with disintegrated watershed management and piecemeal approaches issues that prevail in China. However, we have to emphasize again that sustainability and effectiveness of any appropriate institutional arrangement should rely substantially on the choice of the local public, a participation in decision-making that is the base of our proposals. As far as feasibility is concerned, the Huai River case has provided lessons and highlighted the need for the proposals that we have discussed. Integrated water pollution control in the Huai River began in 1995 with a basin-wide pollution control plan formulated, and interim regulations promulgated; it was the first such control to be exerted at basin level anywhere in China. The Ministry of Water Resources and NEPA head the programme's central-government leading group, which includes members from the four basin provinces and other relevant central agencies. The Huai River Basin Agency is supposed to be jointly run by NEPA and the Ministry of Water Resources in order to control pollution in this river basin, and this programme once reached its target and the pollution effluent emission was within national standards. However, the plan is not sustainable because river water quality is still low, and polluting industries have since resumed or moved elsewhere. This is because the plan and its regulations did not provide detailed rules, effective institutional arrangements and public participation procedures. For example, this plan does not deal with the costs and financing of load reduction, determine how industries are going to reduce their loads, take measures to reduce the unit cost of treatment and make it more affordable to industries, or have efficient public participation. Additionally, in the water pollution control for the Songhua and Liao Rivers, and Taihu Lake, some regulations or programmes were constituted, and the Yellow River Act is now being drafted. These are the important bases of our proposed frameworks that aim to address deficiencies in these cases. As for the Three Gorges Watershed, attempts to integrate resources development and environmental conservation so as to avoid or alleviate fatal damage and assure sustainable development of this watershed were made in the mid-1980s. The Chongqing Municipality was separated from Sichuan Province and put directly under the Central Government in 1997 mainly because of the Three Gorges Project and the watershed management issues of this area. These facts imply that integrated watershed management is eminently feasible and the proposals outlined above addressing many deficiencies in China's watershed management might be an important precedent for the seven major river basins as a whole, as well as the Three Gorges Watershed.

Acknowledgements

The authors wish to thank Dr Yang Rentai (US Environmental Protection Agency) and Professor Fang Ziyun (Yangtze Valley Water Resources Protection Bureau) for their assistance with data collection and their suggestions. This study is supported by China's National Key Program of Science Development (Project No. G1999043603).

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