

LESSONS LEARNT FROM THE 1998 FLOOD AND FUTURE STRATEGY

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The summer of 1998 saw an exceptionally serious flood in the entire history of China which affected three valleys of the Yangtze River, the Nenjiang River and Songhua River. Under the leadership of the Chinese government, people throughout the country made joint efforts and finally won the fight against the flood, which drew worldwide attention. However, the flood caused serious economic losses and human deaths.

The flood was caused by different factors such as abnormal changes of the climate, a large amount of concentrated precipitation, and the convergence by floodwater peaks from both up and downstream. Another important factor contributing to the flood was damage to the environment in varying degrees by irrational exploitation of natural resources, which intensified both the disaster situation and its affect on society. Natural disasters can be effectively reduced through reasonable interventions in the relationship between social development and disaster reduction; done by human being to adjust its activities to be in harmony with nature and to strengthen environmental protection. In this way, it is significant to summarize the experience and lessons learnt from the 1998 Flood in the search for useful strategies in fighting and reducing future disasters.

Lessons learnt from the 1998 flood

Following the increase and local concentration of the population, the exploitation of flood prone areas, and the rapid development of social economy, losses caused by floods have been clearly increasing. Given this situation, the issue of reducing damage from disasters is one with which people are becoming more concerned. We considered it necessary to make an analyses of the lessons learned from the 1998 Flood by study of the relationship between the exploitation of natural resources, the protection of the ecological environment, and the relationship between the development of social economy and disaster reduction, all put forward through the study of socialization of disaster mitigation. The following are the main problems we found by these analyses

Low standards set for flood prevention

Since the foundation of the People's Republic of China, we have formed a flood prevention system with different scales in the valleys of the important rivers of China. These prevention systems can control, at the preliminary stage, the expected annual floods in vast plain areas including the North China Plain, the Middle and Lower reaches of the Yangtze River, the Northeast Plain, the Pearl River Delta and the Sichuan Basin; included are temporary measures for the diversion, detention and storage of flood water. This system covers a large area and has played an important role in past flood prevention on various flood scales. However, the flood prevention standards of the major rivers of China are mainly set for floods expected to occur once per 10 to 20 years. The flood safety standards of some important parts of rivers must be set for floods expected to occur once per 40 to 60 years. Then measures of diversion, detention and storage of floodwater must be made with sacrifice on both regional and local interests.

Protection of cities are the main focus in our flood prevention. However, among the 639 cities throughout the country threatened by floods to varying degrees, 85% the cities have low flood prevention standards which are designed to meet floods scaled at once per 50 years; and 65% of these cities can not meet floods expected to occur once per 20 years. Clearly these cities have not reached the present state of normal flood

control demands.

The Plain of the Middle and Lower Reaches of the Yangtze River is one of China's most important political, economic, and cultural centers which occupies an important position in the development of the country's social economy. Since the 1950s, 3,570 km of dykes on the main river and 30,000 km of dykes on branches of the river in this area were strengthened. Also, a number of flood diversion projects and storage areas were constructed to provide effective floodwater storage exceeding 50 billion m³. The River was realigned and the meandering part of the River in the Jingjiang area was straightened; 105 large and many middle and small sized reservoirs were built to make the total flood retention capacity reach 130 billion m³ or even more. These engineering and non-engineering measures have enabled the Middle and Lower Reaches of the Yangtze River to deal with normal floods. The Jingjiang section, Chenglingji section and Hukou section of the river, can only stand floods scaled at once per 10 years; and the major branches can only withstand floods scaled at 10 to 20 years. Also, projects on the main river branches in the Sichuan Basin can only hold floods at the scale of once per 5 to 10 years.

There are 13 cities in the Yangtze River Valley having low standards of flood protection. At present, only the two cities of Wuhan and Shashi have seen rapid development of flood protection projects, while other Cities like Yueyang, Changsha, Huangshi, Chengdu and Hefei have only made slow development in city flood prevention engineering work. This work is absolutely unworthy of these cities' political and economic positions and also is a potential threat to the economic development of this area. Some middle and small sized cities are even less fortified against floods at all, so that floods of even small size have often brought complete damage.

Besides, due to the shortage of finance and management, many of the existing projects are now on the edge of hidden danger or being worn out for many reasons such as lack of poor funds, management and so on, so they can only reluctantly survive with emergency reinforcement in the flood season.

Irrational exploitation over the areas with high risks of flood

Along with the increase of population and economic development, the pressure and demand for the use of agriculture are growing, which has speeded up the exploitation and construction of traditional flood diversion areas resulting in high flood risks. Flood disasters do not occur every year; and sometimes a relatively long period without a flood threat lends to lessen people's vigilance. Because of the lack of long-term plans and meaningful management, some out-of-order phenomena have appeared like construction of towns and enterprises which has helped the development of the local economy, but seriously hindered the effective use of flood detention areas and added significant difficulties to the control of floodwater. In the 6 existing flood detention and storage areas of Dujiatai, Minhu, Zhangduhu, Baipiaohu, Xilianghu and Dongxihu near the city of Wuhan, there is now a total population of over 1.4 million people, cultivated land of 200,000 hectares, with fixed assets of over 4 billion RMB. Before the 1950s, the diversion area of Dujiatai was once the natural overflow area of the Yangtze River and its branch, the Hanjiang River. But since the 1950's Dujiatai has been developed into a cultivated area with 26,000 hectares of agriculture, 5,800 hectares of breed land and 104,500 residents. Similarly, the diversion area of Jingjiang had only 170,000 residents before the beginning of rapid development; but now the population has increased in the 1990s to 450,000 and the fixed assets of this area have reached 1.7 billion RMB. Now, the population has risen higher to 600,000, so the area can no longer play its flood relation role in the flood season. This has undoubtedly enlarged the pressure and risks of the control capabilities of the trunk stream of the Yangtze River and has aggravated the possibility of damage caused by floods in many cities in the middle and lower reaches of the river. The result is that a total number of over 5 million residents will have to be evacuated in flood emergencies. However, there is ever increasing construction including some protective embankments - built around houses or fields in riverside and lakeside areas - and other non-standard projects which will be obstacles to the release of floodwater. Examples are the amusement parks and swimming sites in the river course in Hunan Province which now occupy 28% of the previous floodwater release area. Because of the irrational exploitation of the historic areas of diversion, detention, and storage of floodwater, the capacities

of flood control and storage on the Yangtze River have clearly decreased. Compared to 1954, the 1998 floodwater from the upper reaches of the Yangtze River was almost equal in volume. And the 1998 floodwater on the middle and lower reaches was even less than the 1954 flood, but the water level was over 1 meter higher. The general volume of floodwater storage in some protective embankments, diversion, and detention areas, lakes and some dyke breached areas reached as high as 102.3 billion m³ in 1954. While in 1998 only 18 billion m³ could be stored; one sixth of the flood storage available in the 1950's.

Urbanization has increased the risks of floods

Urbanization is an inevitable result of social development. The present size of all cities and towns in China have been enlarged by many times since the 1950's; and a large number of newly built economic development zones have further reduced the space for storage and release of floodwater. There were once over 100 lakes near Wuhan, which once earned it the name of *City of Lakes*. But now the number of lakes has been reduced to 27, with 8 lakes having disappeared entirely by filling and leveling in just the last 10 years. The fact is that because of the increase of the value of urban land due to the development of the social economy, flood damage in urban areas will be inevitably enlarged under the same disaster conditions compared with flood damage in rural areas. Taking Hunan province as an example, in the 3 years from 1994 to 1996, the annual increase of damage caused by floods reached 20 billion RMB yuan. The total losses in these 3 years reached 120 billion RMB yuan of which the direct losses caused by urban flooding accounted for 60% of this total. In order to protect cities from being inundated, risks of floods will have to be transmitted to the rural areas, which will further worsen the flood prevention situation in these rural areas.

Destruction of the ecological environment has lowered the capacity for the control and storage of floodwater

The forest in the upper reaches of the Yangtze River plays an important role in conserving the River's water source and in maintaining water and soil harmony. However, the long-term irrational use and exploitation of the natural resources in these upper reaches of the river have resulted in serious damage to the forest. This has caused a series of ecological problems, which have worsened the environment; and has also brought about negative impacts on the flood control in the middle and lower reaches of the River.

The forest cover in Sichuan Province was once 19% in the 1950s; it was 13% in the 1970s, and 12 % at the very beginning of the 1980s. Among the present vegetation, primeval forests almost no longer exists. In areas with dense population and high traffic conditions, almost no forest is left due to human activity.

Soil erosion has occurred following the disappearance of this forest and the improper cultivation of sloping fields. In the 500,000 sq km valley of the Yangtze River in Sichuan Province, the area of soil erosion in the 1950s was 90,000 sq km; the eroded area reached 340,000 sq km in the 1980s with an annual amount of erosion of 500 million tons of silt. Over 16 million m³ of this silt has been deposited in the province's large and small sized reservoirs.

This serious erosion has impoverished the local land, petrified and gritted the sloping fields, and has also transported silt to the lower reaches of the river lifting the riverbed which further impedes the smooth release of floodwater. The area and volume of lakes located in the middle and lower reaches of the Yangtze River are on the way to decline with serious siltation. The total area of lakes here was 26,000 sq km in 1949; but only one half this volume is left today. There were once 1,066 lakes in Hubei Province with an area of 8,300 sq km; and now only 309 lakes are left with only an area of 2,656 sq km. The area of the silted lakes and especially the water absorbing sands around the lakes have been further reduced through cultivation to alleviate pressures from the increase in the local population. All of this has resulted in a clearly weakened capacity for the control and storage of floodwater and severely increased the threat from floods.

Another example is Dongting Lake, which plays an important role in the diversion and storage of floodwater in the middle and lower reaches of the Yangtze River. The Dongting Lake area and volume have encountered large changes over time and its capacity for water storage has declined dramatically in the past 100 years since 1825 as shown in Table 1. The direct losses of the lake area caused by flood were 277 million RMB in 1980, 1 billion RMB in 1990, and as much as 2.8 billion RMB in 1991. Though the natural growth and decline of the lake area in size may have been due to natural causes, human activities have

undoubtedly speeded up the process of lake recession, which is definitely harmful to flood mitigation in the Yangtze River Valley.

Table 1
Changes of Area and Volume of Dongting Lake Since 1825

Year	Area (sq km)	Volume (100 million cu m)
1825	6,000	Not known
1896	5,400	Not known
1938	4,700	Not known
1949	4,350	293
1954	3,915	268
1958	3,141	228
1971	2,820	220
1977	2,740	178
1983	2,691	174
1992	2,620	162

The low degree of the socialization of disaster mitigation

The causes of floods include both natural and social factors. The experience gained in fighting against floods in recent decades, both inside and outside China, has shown a very important problem which deserves close attention: We have not been able to prevent the losses caused by floods from becoming more serious even though we have raised the design and construction standards of flood control projects. Lessons learnt from engineering practice tell us that the issue of flood prevention and disaster mitigation covers more than one single area or department and there exist many conflicts between different interests. Also the valley's of major rivers always extend across several provinces or cities, so that contradictions are always ready to appear for the planning of flood prevention and mitigation measures between different departments in upper and lower reaches of the river; and on the right and left sides of the river. The contradiction between the development of flood release and storage areas, and the flood prevention function of these areas is even sharper. Also, the development of flood diversion and storage areas has become a main obstacle to the normal use of flood diversion areas and this obstacle can not be solved through the construction of water conservancy projects. Besides, there still exist some destruction of the ecological environment, rivers, and lakes by even some of the best conceived projects. The present systematic study and recognition of the law and risks of floods and the capacities of preparing for and fighting floods are insufficient. The lack of investment in disaster mitigation has restrained our capacities for flood control and mitigation; flood control has been left behind the goal of the economic development.

The Future Strategy

Lessons learnt from the 1998 Flood have shown us that the emphasis of flood loss-reducing efforts should be based on how social development can affect floods and flood disasters, so that corresponding measures may be taken on the basis of controlling the natural flood. This is why we should work actively to adjust the social development in a flood-control-oriented way. China is now undergoing an overall and rapid

development in its social economy, and it will continue to be threatened by floods in varying degrees in the coming 21st century. With the development of the new social economy, the vulnerability of China to flood hazards will increase proportionally. And the economic losses caused by floods will keep growing and keep causing broad social dislocations.

The Chinese Government has recognized the close relationship between post-disaster reconstruction and reconstruction of the environment by seriously analyzing the cause of the 1998 Flood. A set of action guidelines have been put forward, including: *improving reforestation by prohibiting hunting and grazing on mountains and returning farmland to forests; removing some embankments to discharge floodwater and returning some farmland reclaimed from lakes back to their original state; work for relief and to build new towns for displaced people; and strengthening dykes and dredging silted rivers and lakes.* These guidelines aim at changing the past disordered state, and restoring and maintaining the original natural conditions to effectively control the conclusion that floods and droughts are getting worse. The goal is that an overall plan of disaster prevention and mitigation can be implemented by combining the plan with the reconstruction of the ecological environment and the development of the social economy.

To this end, the Chinese Central Government has worked out a program for the reconstruction of the national ecological environment and has convened a symposium on resources, environment, and population emphasizing that ecological construction should be brought into line with the overall plan of the nation's economic and social development. A great amount of funds have been invested in various ways by both the central and local governments to reinforce comprehensive development control in an attempt to steadily harmonize relations between human being and nature through long term efforts. The strategies on flood prevention in the near future are as follows:

1. Practice guidelines of improving reforestation by prohibiting hunting and grazing on mountains and returning farmland to forests; and enhance the work on maintaining water and soil to improve ecological environment and forbid cutting the natural forests in the upper and middle reaches of big rivers. Perform a good job of returning some farmland reclaimed from lakes back to their original state; and restore the capacities for the release and storage of floodwater by removing all unqualified projects of shoals, embankments, and dykes. Priority should be given to the reinforcement and heightening of dykes in harnessing rivers so that these dykes are able to prevent the biggest floods in up to 50 year events. Speed up the construction of flood control projects on major rivers and finish the repair of unqualified reservoirs as soon as possible. Enhance the control of the general situation of the lower reaches of rivers and mend broken dykes. Strengthen the construction of flood safety projects in floodwater storage and detention areas. Organize disaster victims to work on self-relief and effectively resettle residents in flood storage and detention areas by building safe areas and platforms and by transferring people to build new towns in line with local flooding conditions.
2. Enhance the harnessing of big rivers and lakes and increase agricultural capacities through the construction of infrastructure with emphasis on flood control, irrigation and water conservancy. Continue projects of building shelter belts, reforestation of the Taihang Mountain, desertification prevention, control in the areas of the seashore, control of the upper and middle reaches of the Yangtze River, and control of the "3 norths" (Northeast, North and northwest China) with the emphases on maintaining water and soil, preventing land from desert encroachment, and improving ecological environment. Carry out the construction of synthetic flood control projects in villages and towns with better economic conditions and more enterprises.
3. Concentrate on the construction of some key flood prevention projects and effectively enhance the capacities of flood control of large and middle sized industrial areas, main lines of transportation: hubs of communication; lifeline projects; and other important facilities. Improve the construction of flood control systems and enterprise projects; enhance the management of prediction of emergencies to prevent the impending disaster. Standardize the flood prevention capacities of

buildings and facilities in cities to meet official regulations. Complete the construction of flood control projects in the country's major flood-prone cities, and make distinct improvements of flood prevention capacities of other cities in similar situations.

4. Focus work on flood control in the valleys of the Yangtze River and the Songhua River, which were seriously stricken during the 1998 flood. Enhance the overall capacities and work out the general program of flood prevention throughout the Yangtze River Valley. Standardize in a uniform way flood control systems in river trunks and branches; upper and middle reaches of rivers; and left and right sides of rivers. Harness both water and mountains, strengthen dykes, establish areas of flood diversion and storage, and resolve contradictions among administrative areas in the exploitation of river natural resources and flood control. Flood prevention over the Yangtze River Valley must be stressed for the improvement of regional social, economic, and human ecological systems. Agriculture in the present natural lake beaches and river shoals must be strictly forbidden while doing the job of returning some farmland reclaimed from lakes back to their original state. Establish a data base and information system in a uniform standard over the whole of the Yangtze River Valley by introducing periodic investigations and utilization of technologies of remote sensing and geographic information systems (GIS) to steadily improve the system of monitoring and predicting of floods. Establish an overall management system and a powerful official unified management of water resources and establish administration patterns for the 21st century by which sustainable economic, ecological, and social developments can be realized.

For the valley of the Songhua River, it is necessary to improve the legal system and the administration of water resources according to the law. Based on the demand of harmonious and sustainable development among the valleys population, resources, and environment, the *Flood Prevention Law* and other laws and regulations should be improved and implemented.

Prepare overall plans on the exploitation, allocation, utilization, pollution control, and recycling of water resources under the management of a unified administrative organ for the Songhua Valley to harmonize the circle between water environment, water resources, and social economy. Complete the flood control system and effectively manage water resources by adopting measures such as harnessing rivers, and mending dykes. Build areas and reservoirs for flood diversion and storage, and maintain water and soil.

Facilitate ecological construction, generally manage water resources, improve agricultural methods, and perform sustainable development with both ecological and economic benefits under the patterns of the interactions between water and land.

Transfer water from the north to the south. In detail, transfer the redundant water from the Songhua River to the heavy industrial area in the lower reaches of the Liao River; to realize the increase of the control of water volume of the valley from 18.5 billion m³ to 32.7 billion m³ by 4.4 billion m³ giving nearly 1.07 million hectares of irrigation area. Meanwhile, make full use of the group of reservoirs in the Songhua Valley to control the convergence of different flood peaks, which will be helpful to flood prevention in the Plain of the Songhua River, the Nen River, and the Three-Rivers (the Songhua River, the Nenjiang River, and the Liao River).

Plan to raise the Songhua valley flood control capacities from holding floods at the scale of once per 20 years to once per 50 years. Harness the rivers in a scientific way and use technical methods to monitor, predict, and analyze the causes of floods. Conduct effective management of the soil by studying the relations between different ecological conditions and through scientific planning.

5. Enhance the country's macro control for flood reduction and speed up the development and approval of legislation on flood prevention. Draw up synthetic flood control programs among all provinces, autonomous regions, and municipalities directly under the State Council. Zone geographic divisions according to different disaster risks. Improve standards in the collection,

processing, application, and sharing of general information on flood control; and complete the system for prediction and early warning system for serious disasters. Strengthen coordinating capacities for dealing with disasters. Draw up contingency plans and perfect the system of emergency command, management, and communication. Establish and complete the system for the storage of flood prevention materials. Introduce a system for evaluation of flooding and establish a information system in this technology.

6. Enhance the institutional socialization of flood mitigation through coordination among different department responsibilities, and between social development and the environment; and settle the contradiction between development and flood protection. Effectively undertake flood control tasks and conduct overall organization of joint disaster mitigation efforts based on the sociality of disasters. Establish and complete the socialized system of funds investment and circulation; of prediction and early warning; of transference of flood information, management and legislation; of the socialization of post-disaster reconstruction; and scientific support and security.
7. Enhance the entire national awareness of the need to prevent floods through education, training, and propaganda; and enhance education in both primary and professional disaster prevention knowledge at various levels of technology.
8. Establish an insurance system against flood by encouraging enterprises and individuals to join the system; and enhance the capabilities to resist floods. Actively promote the regularization and socialization of donations for disaster relief. Encourage people-to-people help and relief with broad participation by social organizations. Enhance capabilities for disaster mitigation for the most vulnerable groups of the elderly, women, children, the disabled, and others. Complete the medical system at both the central and local level and enhance the capabilities of emergency reaction against disasters by medical institutions.
9. Enhance scientific research on disaster prevention. Give more importance to the natural laws of the space-time distribution of the formulation, occurrence and growth of flood hazards; and the primary theory on the mutual influence and interaction between floods, environment, economy, and society. Actively promote research on applied science, and new and advanced technologies on the prevention of serious floods. Speed up the field application of scientific research. Promote the broad utilization of practical sciences, as well as new and advanced technologies including satellite remote sensing, geographic information systems, and global orientation systems in flood mitigation.
10. Encourage the use of funds and advanced technologies in the construction of projects for prevention of catastrophic floods and establish different demonstration areas or projects through cooperation in various ways. Actively promote international cooperation in the exchange of information, propaganda, education, personnel training, scientific research, humanitarian assistance, and construction to enhance governmental capabilities in disaster mitigation.

It is an important part of China's disaster mitigation work to introduce international cooperation. We warmly welcome international organizations, governments of other countries, social groups, and individuals to participate in the construction of China's disaster mitigation system through cooperation in various ways.

