Policies and Measures on Flood Mitigation in China since 1998

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Abstract

Since the devastating floods in the Yangtze River in 1998 Flood mitigation has attracted nationwide attention. The central government immediately proposed a series of policies and measures, including enclosing mountains to plant trees, transforming land back into forests, demolishing polder fields to channel flood water, transforming farmland back into lake, supplying laid-off laborers for rehabilitation, relocating people to form new townships, reinforcing key levee and dredging river beds. Since then, the China Government adopted positive fiscal policies to increase investment in the water infrastructure development and reinforcement. In addition, the total financial input from the central government in the water sector from 1998 to 2002 was 3-4 times of the average in past several decades. This study discovered that the enhancement of the basic infrastructure and the improvement of flood defense capability have not only offered reliable flood prevention system and safety for the riparian people, but also strongly and directly improve the entire social-economic development of the areas that used to be under the threats of the flood disasters.
Key Words: Policies, Measures, Flood, Disaster mitigation

Introduction

China is a country suffering from frequent flood. As a natural hazard, floods cause most serious danger and greatest losses in China. The 1998 flood along the Yangtze River and Songhua River caused severe damage to the people's lives and properties and brought billions of economic loss to the country. According to the latest statistics, the area threatened by floods is around 1.06 million km2 in 1999, in which there are 840 million people with a GDP of 6562.8 billion RMB, which account for 11.2%, 66% and 80% of the national total respectively. 407 cities, 61% out of the total, are located in the area, the population of which is 76% of the national total urban population. There is dense population and relatively more advanced social and economic development in these areas, which have become the main location of China's social and economic activities. Due to special geographical location and climate conditions, China is a country with frequent floods. The pressure of a large population and relatively high utilization of flood detention areas have made China one of the countries suffering most severe flood disasters(Fan B., 2000).

Since the devastating floods in the Yangtze River in 1998, flood disaster prevention and reduction has attracted nationwide attention. The central government attached great importance to this issue. The premier working meeting timely proposed measures for post-flood reconstruction, namely enclosing mountains to plant trees, transforming arable land back into forests, demolishing polder fields to release floods, transforming farmland back into lake, supplying labor as contribution, relocating people to build townships, reinforcing key levees and dredging river beds(Center Committee of the Communist Party of China and the State Council, 1998; The State Council. 1999).

The major policies, measures and financial input since 1998

1. Enclosing mountains to plant trees, transforming arable land back into forests

One major reason for frequent water disasters in China is the serious destruction of the ecosystem and environment. Such big lakes as the Dongting Lake and Poyang Lake in the Yangtze River basin have suffered from continuously increasing sedimentation, over 60% of which is from the cultivated slopes in the upper and middle reaches of the river. In Sichuan and Chongqing alone, the annual sediment running into the Yangtze River amounts to 533 million tons. The annual sediment from Shaanxi running into the Yellow River amounts to more than 500 million tons (General Office of State Council, 1999).

It is imperative to implement ecological rehabilitation in the upper and middle reaches of the Yangtze River with focuses on water and soil conservation by transforming slope fields into terrace fields, enclosing mountains and plantng trees, transforming farmland into forests and grassland on a large scale.

2. Upholding the flood control policy of "combining storage and release and focusing on release"

The structural flood control system of major rivers in China is an integrated flood control system with stem levees as basis, key reservoirs and multi-purpose projects as core and flood detention and storage zones as reserve. It is combined with such measures as river course management, barrier abolishment in river courses, storage and discharge capability maintenance and improvement in flood detention and discharge zones, and flood diversion to reduce the amount of water. It also supports water and soil conservation and ecological improvement.

The water structural system built during the past 50 years, such multipurpose water projects as the Gezhouba and Geheyan Projects built recently in particular, store a large quantity of flood water during the peak, which reduce the pressure on the levees in the downstream and obtain obvious flood control and disaster reduction benefits. It is imperative to continue to develop key water control works in the mainstream and tributaries of the Yangtze River to increase the flood regulating capacity. The on-going Three Goreges Project should be sped up. According to the construction schedule, the flood control capacity of the Three Goreges Project will reach 11-13.8 billion m^3 in 2007 and 22.15 billion m^3 in 2009 after completion, which will play an important role in flood disaster reduction.

After many years of training, the mainstream of the middle and lower reaches of the Yangtze River has been preliminarily stabilized. But some sections still change dramatically. Over 300km have serious levee break and threaten the levee safety, which should be brought under control immediately. The Yangtze River course training should follow the principle of overall planning and integrated management, which should take into consideration of flood control as well as navigation, water drawing and requirement of economic development along both banks.

It is necessary to dredge the river beds of the Dongting Lake and its four major tributaries, the Poyang Lake and its five major tributaries and the Songzikou section of the Yangtze River, demolish barriers in the river courses for flood discharge so as to ensure smooth flood release. The earth dredged from the river beds can be utilized to reinforce levees and foundations, fill in ponds and construct safety platform in the flood detention and storage zones. Dredging is required to go through scientific analysis and get approval according to certain procedures.

At present, it is a priority to reinforce the reservoirs with hidden faults to eliminate potential risks and fully generate flood control benefits.

3. Demolishing polder fields to release floods and converting farmland into lake area

Based on preliminary statistics, in the 1998 floods, over 2000 polders broke in the lower and middle reaches of the Yangtze River, including 479 polders with the area above 1000 mu, 2.83 million mu arable land was inundated. Except for the Mengxi Polder in Hubei and Anzao Polder in Hunan, which were required to be protected in the plan, the rest broken polders were flood discharge and detention polders and ordinary polders as planned. The affected people in those polders were 2.53 million. To raise the flood discharge and detention capabilities, with a view to the available conditions and possibilities, the broken polders should be demolished to release floods and transforming fields back into lake area.

4. Strengthen the development of safety facilities in the flood detention and storage zones

The floods in the Yangtze River are characterized by high peak and large volume. But the discharge capacities of the river courses are limited. So it is an effective measure to utilize flood detention and storage zones to divert and store extra flood water to ensure safety of key areas. The major problems with flood detention and storage zones are as follows: dense population, economic development and safety facility development lagged behind, incomplete facilities for flood entrance, unrealized compensation after flood diversion, difficulty in timely utilization with required quantity. So it is imperative to further strengthen the development of flood detention and storage zones. Roads, communication systems and safety zones should be built in the flood detention and storage zones and villages and townships should be developed in the nearby highland or key polders.

To prevent floods in 1954, 50 billion m^3 water were diverted in the middle stream of the Yangtze River.

With the regulating capacity of the Three Gorges Project and the effects of demolishing polders and converting farmland into lake area, the water diversion will reduce to 32 billion m^3 if the 1954 floods occur again, including 21 billion near Chenglingji shared by Hubei and Hunan provinces, 6.8 billion near Wuhan city and 4.2 billion near Hukou city shared by areas along both banks. The Yangtze River Commission consult with relevant provinces to readjust flood detention and storage zones. Other originally planned flood detention and storage zones retain their functions to prevent above standards floods.

Priorities should be specified and phases should be followed to readjust defined flood detention and storage zones. All flood detention and storage zones should strengthen the development of roads, communication systems and safety facilities, and execute strict control of population growth and management of industrial structure. Compensation measures should be materialized to ensure that floods can enter into the those zones, minimize losses and guarantee compensation.

5. Reinforcing stem levee, constructing high-standard levees and dredging river beds

As a lesson from the devastating floods in 1998, it is recognized that reinforcing levees and regulating river courses are important measures to raise flood control capacity. The total length of levees in the middle and lower reaches of the Yangtze River is around 30000 km, which is the basis of the structural flood system. Out of this figure, there are over 8000 km major levees, which are the priorities for immediate rehabilitation. For the time being, the focuses of levee reinforcement should be on raising the height and width of the levees not high enough, seepage treatment for the foundation, dealing with potential faults within the levee body and reinforcing structures crossing the levees their joints with levee body. The significance and risks of the levees should be categorized to implement in stages. The local governments along the river should make detailed arrangement for the four priorities, namely rehabilitation of destroyed water works, seepage treatment of levee foundation, prevention of key section levee break, increase of height and width of weak levees which were used in the 1998 flood season. 1) Develop first grade levees along the Yangtze River stem and Yellow River stem. Reinforcing levees with high standards is a solution once for one hundred years; 2) Carry out second grade levee rehabilitation for the major tributaries and lakes. 1009 km of second grade levees should be reinforced in the Yangtze River basin, 763 km in the Yellow River basin, 3160 km in the Songhua and Neng River basin; 3) The hidden works in the main levees of the Yangtze River. In 1998, the State Council decided that “on the first and second grade levees and key levees in the Yangtze River basin, the crossing levee structures, foundation reinforcement and seepage treatment, throwing stones to strengthen foundation will experience difficult construction and pose high requirement for technologies (hidden works on the main levees of the Yangtze River) ”.

6. Prevent geological disasters

The middle and upper reaches of the Yangtze River and Yellow River basins suffer from frequent geological disasters. Landslide and mud flow have caused great losses of life and property. It is imperative to carry out geo-environment assessment, formulate plans for geological disaster prevention, implement projects and measures for geological disaster prevention and control while regulating the rivers.

7. Develop non-structural flood control systems

Non-structural flood control systems refer to laws and regulations, administrative management and economic lever, and other technical measures excluding projects utilized in flood storage and discharge with the purpose of flood disaster reduction. Non-structural flood control systems are very crucial for structural systems to reap full benefits and achieve desired results of flood control and disaster reduction. They also provide risk management for flood control zones, especially areas suffering from floods frequently, and pursue a management mode that will have least impact and cause least losses to human survival and development.

Regarding information collection, China will introduce foreign advanced monitoring and measuring technologies and equipment to rehabilitate hydrological stations and realize automatic data collection so as to raise the quality and speed of hydrological data collection. As for communication, based on wide use of the national public communication network, such technical measures as satellite, micro-wave and integrated communication will be adopted to supplement and improve flood control communication network so as to strengthen its function. In computer software research and development, decision support systems for flood control and drought relief at the central, river basin,

provincial and city levels will be established with such measures as decision support systems and expert systems to improve flood control dispatching and achieve scientific decision-making.

8. The governmental and international inputs to the flood mitigation

From 1998 to August 2002， the financial input into water infrastructure development from the central government amounted to 165.2 billion yuan, which accounted for 70% of the total central government investment in the water sector since 1949. Among these, 28.2 billion yuan was invested in heightening and reinforcing the 3576 km levees along the middle and low Yangtze River, the investment was 10 times more than the total investment in levee projects in almost 50 years before 1998. Secondly, the state invested6.49 billion yuan in the construction of 'hidden projects' of the major levees along the Yangtze River in 28 Hubei, Hunan, Jiangxi and Anhui. The river course control project covered river sections with the total length of 630km, all of which were ones with most serious piping, seepage and levee break during the 1998 floods. Thirdly, 19.6 billion yuan was invested to regulated the Poyang Lake and Dongting Lake, four streams in Hunan province, namely Xiang, Zi, Ruan and Li streams in the middle and lower reaches of the Yangtze River.Fourthly, 10.1 billion yuan was invested to demolish polders to release floods, converting farmland into lake area and relocate people to build townships. In addition, the financial input from the provincial government also huge. For example, the Hunan province gradually established a multi-level, multi-stakeholder and multi- channel water investment system, the total input is over 24 billion yuan, including 10 billion yuan from the central government.

In the past 5 years, US$ 19.05 million has been granted by international agencies or foreign countries for disaster response and relief, disaster rehabilitation and management, Institutional Strengthening, education and research, capacity building, development of an integrated flood management system, Capacity Building for China Disaster Reduction organization. Further more, US$440 million loan from the World Bank was mainly used to strengthen and reinforce the Yangtze River Levee.

The effect of the major policies/ measures in flood mitigation

After large-scale construction of water works since 1998, the flood control capacity of the main levees in the lower and middle reach of the Yangtze River was improved greatly. Both the enhancement of basic infrastructure and the improvement of flood control capability not only offer reliable flood prevention for the riparian people, but will also strongly improve the entire social-economic development. The 2002 floods along the Yangtze River, though less in intensity, tested the effectiveness of these policies and measures to reduce the casualties and economic loss.

1. The flood situation in 2002

In 2002 the flood mainly occurred in Hunan province. The climate in Hunan Province was in anomaly with apparently increasing rainfall. Till 30 August, the rainfall in the provincial level accumulated to 1463mm，36mm larger than 1427mm, the average annual record in history, 32 percent larger than that of the same period in 2001, whilst the biggest precipitation reached to 1996mm. After entering into the flood season, the precipitation in the whole province reached to 1243mm， 45 percent larger than that of the same period of last year which was 880mm, whilst the precipitation in Yueyang City, Yongzhou City and Zhangjiajie City was 1432mm、1309mm and 320mm respectively with the biggest one of 1695mm， 75%, 48% and 34% larger than their corresponding historical records. Major characteristics of 2002' flood in Hunan Province are showed as below (The Hunan bureau of water resources, 2002).

1) The flood came earlier and finished late. From April to middle May, unprecedented overcast and rainy day appeared and lasted for a long time with continuous rain amounting to 36 days. In May 14, the water level of Chenglingji station of Dongting Lake reached flood warning level, 42 days earlier than that of the year of 1998.

2) Frequent rainstorms with short interim. Since the start of flood season, 6 large rainstorms occurred in Hunan province. As example, only in Xiangjiang River, 6 flood peaks occurred successively whilst the water level of Changsha Station was 36.13m on 17 May, 36.72 m on 19 June, 37.62 m on 4 July, 34.99m on 28 July, 37.06m on 10 August and 38.38m on 22 August, respectively. The rainfall in many

places exceeded the its record, appearing more severe one by one and short interim between floods with the shortest one of 2-3 days and longer one around 10 days.

3) Floods occurred simultaneously in several rivers. On 19 August, floods above the warning level appeared simultaneously in Xiang River, the mainstream of Zi River and east and south Dongting Lake. Among them, the water level of the whole Xiang River exceeded 2 to 4 meters above the warning level whilst the one in Changsha station reached 38.38m as the third highest record since 1949. For the whole Zi River, it was 2.5 to 4.4 meters above the warning level whilst Taojiang station had the water level of 44.31meter as the second highest one since 1949. The water inflow of Yichang station exceeded 40000 m3/s on August 14 with the biggest flow of 49200 m3/s. As the water inflow of the Dongting Lake increased accordingly, the lake level exceeded the dangerous level while peak level of 34.91m appeared in Chenglingji gauge station at 23:00 on August 24, being the fourth highest record since 1949.

2. The flood control capacity of the levee is improved

The levees reinforcement raised the flood control capability of the lower and middle part of the river. Both the reinforcement of the Yangtze River stem levees and the implementation of the Three Gorge Project symbolize that a framework of flood control in the Yangtze River is formed with levees as foundation and control-type water works like the Three Gorge Project as backbone project. By comprehensive regulation of the flood control system, it will be in safety in case of 1998 type flood occur in the middle and lower reaches of the Yangtze River, whilst the safety of key areas will be guaranteed in case of the occurrence of 1954 type flood.

In the collapse of civil polders in 1996, only in the lake area within Hunan Province, there were more than 1 million people had to stay in the levees for half a year, brought lots of problems for social security and hygiene as well as epidemic prevention. In 1998, while the water level of Chenglingji section was still under 33 meter, major labors in the polders were assigned to fight flood on the levees, made the production almost halted. Inhabitants paid great attention to even minority change of water level almost all the time, packed up all their properties in case of emergency transfer. When the water level arrived at 35 meters, the elders, women and children within the polders were all transferred to safety areas. However, during the flood in 2002, neither one people nor one house within the polders transferred only but part of the labors as the safeguards. The inhabitants lived in calm and normal order.

3. The flood fighting capacity is improved

The reinforcement of the Yangtze levees released the restraint of the so many years' floods to the safety of riparian people, enhanced the storage and discharge capacity of the rivers and lakes, shorten the battle line of flood fighting in levees, relieved the pressure and difficulty of flood control, decreased the consumption of labors, materials and money. During the flood season in 1998, the embankments and the lock gates started in emergency when the water level of Chenglingji Station arrived at 33 meters. At 35.94 meters of water stage, 70 km length of the main Yangtze levee were put in use temporarily as blocking bank with the highest one as 2.5 meter and the deepest depth of water as 1.8 meter. Only in Hunan Province, 35000 soldiers and policeman and 2.3 million local inhabitants struggled to fight the flood. 3.016 million m^3 sand and scree as well as 93.26 million textile bag, of which the value is about 1.104 billion Yuan, were consumed. In 2002, although high flood stage occurred twice in the Yangtze River with the highest level reaching to 34.91 meter in Chenglingji Station, the emergency happened only accounted for 1/4 of that of 1998 while 1/3 for heavier emergency. Especially, emergency cases decreased dramatically like seepage and leakage of banks and bases, the instability of slides and buildings. Along the 142km Yangtse River levees, only 3000 prepared safeguards participated in the flood fighting while the prepared materials for flood control were hardly in use owing to the successfully implementation of the mentioned measures.

1.467 billion Yuan is assisted from the central government for the resettlement of the people living in places suffering from high frequency of flood and water logging disasters in Hunan province. As the results, there are 333 civil polders removed, which located in 29 counties/ cities of Changde City, Yiyang City, Changsha Municipality, Yueyang City and Xiangtan City as well as 150,000 households as 558,000 people resettled. These effort increased 2.7 billion m^3 flood storage volume in the Dongting lake and strengthened the flood control capability. Only in the flood season of 1999, it

decreased direct economic loss as 0.516 billion Yuan and the cost of flood control around 40 million Yuan.

4. Regional economic development

From 1998 to August 2002，the financial input into water infrastructure development from the central government amounted to 165.2 billion yuan, Among these, the central government bonds were 114.8 billion yuan, including 78.4 billion yuan or 68% for flood control projects. The reinforcement of main Yangtze levees by national bonds increased 31.9 billion Yuan of the gross output value of industry and agriculture of the 4 riparian provinces with a lot of working opportunities offered directly and different rise of income per capita within the beneficial areas. Owing to the large-scale water works construction, the related materials consumption within Hunan Province each year are increased such as around 650,000 tons of cement, 50000 tons of steels product, above 60,000 tons of oil. It effectively improved the development of related industries as construction materials, metallurgy, mining, machine, transportation, oil and chemical industry, and injected new energy for the national economy development.

The implementation of renovation projects in the four rivers improved the investment circumstance within the protected areas, increased the income of people. For example, after 6 years foundation, each economic index of Shaoyang Development Zone were still in stagnant due to the threat of floods. After the implementation of flood control banks in the north part of the river in 1998, miraculous development emerged in the development zone. Till 2001, the GDP increased to 0.225 billion Yuan with annual increase rate as 17.9% while the gross output value of industry and agriculture added up to 0.338 billion Yuan with annual increase rate as 23.8%. The net income of farmers reached to 2563 Yuan with annual increase rate as 7.8%. The increase of land value is more apparent while the price of land used to be less than 100,000Yuan per mu before the bank construction, but quickly rise to 400,000 Yuan per mu.

5. Life of inhabitants were improved

By the government compensation, many immigrants built their new house, gained a basic change of living environment. Firstly, the living conditions of the farmers within the lake area had been improved basically, prevented them from the flood disasters that suffering for a long time. Lots of farmers moved into new houses, while half part of them lived in 2 to 3 storied buildings. The situation of being homeless in case of severe floods disappeared totally. Secondly, the appearances of lake area villages took place great change owing to the quicken urbanization. Cement roads were built in most of the new-built villages instead of the old earth roads while their inhabitants could enjoy tap water. Thirdly, The construction of projects also provided working opportunities for the abundance local county labors, raised the income and consumption capability of farmers. In some places, there are even new-built schools, kindergartens, hospitals and cultural center, as well as new installed program-controlled telephone and cable TV. The living and production conditions of resettled immigrants were improved greatly. In addition, the construction of projects encouraged the infrastructure improvement, such as constructing the water taking and supply facility, rebuilding and enlarging of docks, building new roads to the docks and new steps along the banks, protecting and glorifying of environment.

6. Effect of water projects in the four main rivers in hunan province

The implemented water projects in the four main rivers in Hunan province came into effect: protected land area of 2.39 million mu, protected population of 4.62 million, avoided the loss of production value of industry and agriculture as 37.64 billion Yuan and real asset valued 209.88 billion Yuan, achieved the benefit of flood control as 22.33 billion Yuan. These projects had taken great action for the prevention of flood and water-logging disasters and the protection for the safe life of people. In 1999, although high water level occurred in the lower and middle reach of the Yangtze River, which was only less than the second highest record in history in 1998, the reinforced embankments have apparent stronger ability to control flood. As a result, the number and severe degree of disasters caused by floods like piping, scattering soak and embankment breach decreased dramatically, reduced the difficulty for flood control and the demand for labor and materials (State Development Planning Commission P.R.China). For example, the embankment of Xiang River in the downtown of Xiangtan

City has total length of 56.7km, with flood control standards used to be lower than 20-year frequency flood. Since 1998, the embankment achieved the standard of against 100-year frequency flood after the reinforcement of Xiang River. Although experienced 7 successive floods in 2002, there was no collapse of even one levee, one civil polder and no death. The value of flood control materials was less than 1/50 of that of 1994, 1/10 of 1998. In recent three years, the investment in Changsha City added up to nearly 0.3 billion Yuan, with contruction of a batch of essential water works in high standards. For example, Changshanwan levee in Changsha city meets the standard of against 200-year frequency flood.

7. Improvement of ecosystem and environment quality

The project constructions improved the ecological condition of the riparian areas, promoted the harmonious coexistence between man and nature. As major regulated lake of the Yangtze River, the Dongting Lake at present has recovered to the lake area as 554 km2. Several used civil polders now are in uninhabited and become the heaven of birds, like Xiaojicheng polder in HuaRong County, Qingshanhu polder in hanshou County, Xiaomaojiahu polder in Yueyang County. At present, Dongting Lake is named as nature wetland reserve with the variety of near-extinct birds reaching 55 types. It has rare swans and white crane revisit again as well as migration of whitebait which disappeared for many years. After three to four years removal of the Xiaojicheng polder in Huanrong County, there is starting to have herd of deer emerge. The scenery is joyful with flourishing grass, abundant water and melody voice of birds.

The necessary attention and improvement on the current actions for the policy makers

1. Sand silting is still serious trouble of danger

As typical river-type lake, sand silting is the serious trouble for the Dongting Lake. Nan County, named as pan bottom of the Dongting Lake, is one of the most serious areas of sand silting. With 6 rivers across and low level in the polder, most areas in the county are below sea level of 26 meter to 30 meter. Sand silting had made most of the around rivers became suspended rivers to the ground. Similar situation is popular in other places in the lake area. Among the three inflow tributaries of the Yangtze River to the Dongting Lake as Songzi River, Taiping River and Ouchi River, the Ouchi River is suffering serious silting with silt most from the Yangtze River. In order to relieve the silting, not only should to actively launch ecological construction like return farmland to forest in the upper reaches, but also dredge the river course and reinforce and heighten levees in the lake area. The dredge of the Dongting Lake is a long and hard task but a goal reaching in one step, needing long-term plan and more investment.

2. The inner flooding in the polder is still serious

Compared to the accidental flood, the inner flooding in the polder is usual disaster for the local people. Although the removal of polders and resettlement of immigrants make the lake water flow smoothly and protect the safety of inhabitants within the lake, but its function to relieve the inner flooding is not in apparent performance. According to the designed drainage capability of the polders in Nan County, three-day rainfalls within 220 mm should be drained totally in three days. The fact is that many polders will suffer disasters from inner flooding in case of one-day rainstorm. The annual cost of a village for drainage is usually above 500,000 Yuan within the Dongting Lake. At the mean time of increasing the investment of drainage infrastructure in the lake area, more important is to make scientific plan of the present polders surrounded by dyke, to restore the wetland reasonably. The main reason for inner flooding within the polder is the loss of regulation function of inner lakes as well as irrational plan of dyke-surrounded polders. In general, 1/10 acreage of each polder should be leave for regulation of logging water.

Conclusion

Due to the extensity in destroying the productivity and infrastructure flood is the most devastating disaster in China. Since 1998 the Chinese Government staged a series of policies and measures to reduce the flood risks. In conclusion, there are five changes that have been brought to the people along the flood prone areas due to the above-mentioned flood control policies and measures:

1) The flood defense capability of lower and middle parts of the rivers is raised. The polders used to

block floods were removed and returned back to the lakes, and it then enhanced the storage and discharge capacity of the rivers and lakes. After large-scale construction of the dykes along the Yangtze River in the past 5 years, the ability to defend flood by the main dykes in the lower and middle reaches of the Yangtze River was improved greatly. The 5 years treatment of anti-seepage of reservoirs has increased the flood defense capacity due to the increased water storage capacity in the upper river basins.

2) The benefits are far greater than the investment. The pressure and difficulty of flood defense is relieved, the battle line of flood defense in dykes is shorten, therefore, less manpower is required during flood seasons, and materials and money needed by disaster response and relief have been substantially decreased by the governments at different level.

3) It has effectively boomed the local economic and social development. The flood control measures have quickened the urbanization and encouraged the adjustment of the regional economic structure. The large-scale flood control projects changed the local industrial structures and stimulated the backward economic and social development in the riparian areas. The projects also improved the investment circumstance and have driven upgrading of the basic infrastructure of the cities.

4) The living conditions of the farmers within the lake areas have been improved substantially. The measures have not only prevented them from being back to poverty line each time after the flood disasters, but also ensured them security for investing for long-term business schemes. Under the government subsidy, many farmers built and moved into their new houses. The situation of being homeless in case of great floods disappeared.

5) These flood control measures promoted the harmonious coexistence between the human being and the nature. For many centuries, the human society has excessively explored the natural resources and the ecosystem of land, forest and water have changed their interdependence patterns and become more fragile. Floods and droughts become more frequent. The resettlement of the inhabitants and return of the farmlands back to wetlands and lakes reflected the resolution of the government and the people to live harmoniously with the eco-system and to keep away from the threat of floods.

However, The necessary attention should be paid on the problem such as sand silting in the lake or river channel, and the inner flooding in the polders.

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