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EU – China
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No.1 Document Flood Security Analysis

Flood Risk Strategy Team

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EU-CHINA

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Emperor Da Yu

Emperor Da Yu or Yu the Great, an expert on flood control living 2200-2100 BC harnessed the Yellow River and was as reward crowned emperor of China

1 Introduction

1.1 Background

Flood disasters have throughout the history of China played an important role in the well-being of people and productivity of society. In many Chinese policy- and planning documents flood disasters are classified as one of the gravest natural disasters, which even today is seen as posing threats to about two thirds of the Chinese population, 35% of the arable land, 90% of the large and medium-sized cities and 80% of the gross output value of industry and agriculture[1]. Many of the great floods in history have caused serious losses and resulted in heavy impacts on China's economic development, social conditions as well as the ecological environment.

Historical records show that for more than 3000 years floods have caused large damages and many casualties in the major river basins in China. In the century 2200 – 2100 BC an engineer with the name Yu, specialized in flood control, as the first managed to harness the floods of the Yellow River. As reward he was crowned to be emperor of the country, and renamed Da Yu (Yu the Great). However, the Yellow River kept creating flood problems, in particular due to the large amounts of sediment transported from the Loess Plateau along the middle reaches of the river and deposited where the river emerges from the Taihang Mountains west of Kaifeng, the former imperial city, and present day Zhengzhou. Here the Yellow River built an inland delta, which over time has formed the north and east China plains. Sedimentation in the river bed led again and again to the river breaching its dikes and shifting its course to the sea causing major floods. Historically the Yellow River has seen 10 major shifts of its course since 70 AD, at times flowing northeast across the current Hai River basin to the sea north the Shandong Peninsula and at times southeast across the Huai River plain to discharge south of the Shandong Peninsula. Today the Yellow River runs between dykes for almost 1000 km from Zhengzhou to the coast, but still poses a colossal flood risk, because its river bed along the upper part of this stretch lies up to 20 m above the surrounding land.

The Yangtze River also has a history of catastrophic floods, but never as serious as those of the Yellow River, because the river bed never was allowed to build up significantly above the surrounding terrain and it also had two natural buffer basins in the Dongting and Poyang Lakes. Nevertheless the floods in 1931 by the Yangtze and Huai Rivers resulted in a death toll of 145,000 people and again in 1954 of 50,000 people. Towards the end of the century improved flood control, increased flood protection and better warning systems has reduced the death toll of major floods. Nevertheless, a loss of about 3,000 people in the 1998 Yangtze floods and similar numbers in recent floods in the SongHua and the Huai Rivers are not acceptable.

[1] Current Situations and Challenges of the System of Flood Control in China. DRC internal document, 2012

In contrast to the reduced loss of lives, the economic flood damages and losses have increased steadily during the last few decades due to the socio-economic development, higher value of private and public assets especially in the major cities, and higher value of crops per unit area in agriculture. For instance the economic loss due to the floods of tributaries on the Yangtze River in 2010 amounted about 375 billion RMB or about 40 billion Euro.

Although the flooding on the major rivers largely has been harnessed, it is foreseen that climate change will increase the hydrological and flood risk on the small and medium-sized rivers and tributaries due to more erratic and more intensive local rainfall. Together with the ever increasing socio-economic growth, strong urbanization, insufficient spatial planning and uncontrolled land use, flood damages as well as casualties are due to increase, if drastic measures are not taken. This basically is sufficient reason to implement a major reform and a change in flood management in China.

1.2 The flood security analysis report

In this flood security analysis several conclusions and recommendations are given regarding flood management in China and the inspiration China may gain from EU policy and practices embedded in the EU Water Framework Directive (EU WFD) and the 2007 Flood Risk Assessment and Management Directive (Floods Directive).

The analysis is part of the Strategic Knowledge Exchange between the EU China River Basin Management Programme (RBMP) and the Development Research Centre (DRC) of the Ministry of Water Resources (MWR) that has enabled key concepts of integrated river basin management developed for the EU WFD to be made available to water strategy policy makers within the MWR.

The SKE addresses three priority areas of water security:

- Flood Security
- Water Resource (Supply) Security
- Water Ecology Security.

This report initially identifies the key issues in flood prevention, protection and mitigation in general (Chapter 2), then describes the key elements of flood risk management (Chapter 3), highlights the EU Flood Directive and the current situation in China (Chapters 4-6) before synthesising the analysis and drawing recommendations (Chapter 7).

The analysis presented in this report is synthesised in three RBMP reports:

- RBMP Technical Report 074 - No.1 Document Flood Security Strategy Analysis
- RBMP Technical Report 081 - No.1 Document Strategic Knowledge Exchange - An EU Perspective and Overview
- RBMP Technical Report 090 - Potential Development and Research arising from No.1 Document Strategic Knowledge Exchange

2 Major issues

The No.1 Document states that with flooding largely under control in the major rivers attention must be directed to better governance of medium- and small-sized river basins and tributaries, meaning strengthening of flood control/defences/resilience. Without sound guidance on integrated measures to strengthen flood resilience, this change of focus is likely to lead to an excessive focus on the infrastructure dominated measures taken on the major rivers, with the risk of incurring huge investments, large recurrent operation and maintenance costs, and equally important to "export" the flood risks and impacts to downstream areas. EU may contribute experience on strategies such as "Keeping water in the Landscape", "Making Room for Rivers" and the risk based approaches taken to focus efforts.

From the initial analysis of the No.1 Document and related reports, speeches etc., it can be observed that the focus of flood management in China still leans heavily on structural solutions and on water conservation. In many Chinese documents and reports information is given on the huge number of dams and reservoirs (almost 90,000) in China, and on the physical achievements regarding the total length of embankments, the number of hydraulic structures, sluice-gates, intakes, pumping stations etc. The major tasks and results achieved in this field are recognized and acknowledged. Nevertheless, a further broadening of the view on "integrated flood management", also triggered by several statements in the No.1 Document that are incentives for such broadening.

One relevant and recent development in China is the policy of returning land to the river in order to accommodate large floods and increase flood conveyance. This applies to floodplains, lake areas, and retention areas, for instance in the Yangtze River basin including Dongting Lake and Poyang Lake. This is encouraging as it shows that the concept and policy shift are well understood in China. In the No.1 Document this is presented as "to maintain harmony between water and people" (Chapter 2, Article 5). However, this level of understanding may exist at the national level and within the major River Basin Commissions, but not necessarily at the provincial and regional levels of administration. Consequently, much land is still being taken away from the water system for agricultural, industrial or residential development, without sufficient compensation for flood conveyance. It may thus be concluded that the implementation of the policy shift needs more specific attention at the regional level.

In brief, the vision is that a paradigm shift is needed from the present approach focusing on Flood Control with mainly structural (hard) measures to a more integrated approach of Flood Risk Management, with a combination of hard and soft measures, structural and non-structural, engineering and management measures. In practice this also means a shift from trying to reduce the cause of floods, i.e. the hydrological/flood hazard, to reducing the potential damages. And potential damages are important factors with regard to the financial feasibility of protection measures as they govern the investments to be made in relation to the desired level of protection (flood frequency/probability).

In the following chapters specific attention will be paid to the relevant components of such paradigm shift. A shift that should correspond with the request for reform, development, and policy changes as reflected in the No.1 Document. It also corresponds with statements of minister Chen Lei in his various speeches, for instance the one at the Global Water Partnership China Round Table meeting of April 20 2012, where the Minister explicitly referred to “a change from administrative management to integrated management”.

The analysis therefore explicitly focuses on a shift from the structural approach that has been applied for centuries both in China and in Europe, aiming to reduce the hydrological flood hazard by building infrastructure such as dams, reservoirs, canals, diversions, barriers, dike systems, etc. Instead it is recommended to take a broader approach of flood risk management, which incorporates a balanced combination of engineering infrastructure solutions and soft non-structural and management types of measures, such as the “Living with Water” and “Room for Rivers” concepts emerging in Europe. This shift and broadening of approach leads to a number of relevant issues, which are illustrated through summary of examples of flood risk management and control projects in either Europe or Asia, where such issues successfully have been implemented.

It will be clear that in the strive for reform and modernization of the flood management in China it makes no sense to pay attention to elements in flood management that are already common practice in both the EU and China. Therefore, the focus has been on identification of new elements that could improve and broaden the flood management approach in China. At first instance inspiration has been sought from the No.1 Document, where specific statements are given on the necessary reform and change of policy and management. Consecutively such new elements and relevant issues have been identified on basis of the EU WFD, recent ADB studies, EU, UK and Dutch documentation on the subject

3 Elements of flood risk management

In China and other parts of the world floods have traditionally been controlled or mitigated by a combination infrastructure, including storage reservoirs, often serving multiple purposes, dikes, levees, embankments and retention basins. In China the MWR 11th Five Year Plan (2006-2011) broke with this approach realising that it is neither necessary nor possible for human beings to control all floods, because the more control of floods by human beings, the greater the revenge to human beings by floods. Instead MWR introduced a strategy of "Leaving Space for Floods" in socio-economic development and uphold this as the guiding principle of flood control, in other words controlling human activities to leave more space for flood storage and conveyance. A similar strategy is presented in the EU Floods Directive based on the "Room for Rivers" program in the Netherlands, and the "Living with Water" concept in the UK.

The No.1 Document states that flood control shall shift from large river to small- and medium sized rivers and tributaries, which calls for new approaches, because small- and medium sized rivers or tributaries are the locations where run-off is generated and by rapid discharge to larger rivers creates the large recurrent floods.

A different way to describe the new flood risk management strategy is that it will "retain water in the landscape", meaning that run-off of flood flows should be retarded and reduced in order to reduce the need for downstream flood protection. Traditional infrastructure solutions are designed for rapid downstream discharge of flood waters increasing the risk of downstream flooding and eventually loosing water by discharge into the sea.

3.1 Types of flooding

In general, in most countries in the world including China, different types of flooding can be distinguished:

- Fluvial flooding, i.e. a lack of discharge capacity of the river system, resulting in overtopping of the river banks, backwater effects, etc. In such cases the rainfall causing the flooding is mainly of regional character and takes place upstream of the area suffering the flooding

- Pluvial flooding, i.e. intense rainfall and/or typhoons, and lack of local drainage capacity, with direct flooding of the local area as a result, notable examples being flash floods in mountainous areas and urban flooding

- Tidal flooding, high water levels caused by spring tides and /or monsoon effects, that may cause flooding in low-lying areas/deltas or cities near the sea often intensified by backwater effects of rivers

- Combined floods, with a combination of either of the three modes given above, often affecting the big estuaries or deltas in Asia, such as the Yangtze, Mekong and Salween and the cities located within these like Shanghai, Saigon, Bangkok and Dhaka

The major floods recorded in China's history, causing large damages and many casualties, were related to fluvial flooding in one of the major river basins like Yangtze, Yellow, Hai, Huai, SongHua, and Pearl Rivers. The same basically applies to the floods recorded in the last decades. Almost every year there is a flood disaster in either basin, and the flood risks are increasing gradually due to climate change as well as more intensive land use and urban and infrastructure development.

Pluvial flooding including flash flooding in mountainous areas and urban flooding, however, are on the increase due intensive development, including afforestation of slopes, construction work on steep slopes, reclamation of lakes and wetlands and increase of urban areas with inadequate draining systems.

3.2 Integrated River Basin Management

A key lesson from Europe is the continued development and application of Integrated River Basin Management. The No.1 Document signals the need to shift focus of flood control from the mainstreams to tributaries and sub-catchments. Flood control engineering in one place may bring security, but may also enhance flood risks downstream. The need for Integrated River Basin Management is further strengthened by the shift from heightening dikes to giving more space to the river through widening the river bed or creation of retention areas upstream.

In the EU the development of river basin management plans under the Water Framework Directive, and of flood risk management plans under the Flood Directive, are both elements of integrated river basin management. The two processes should use the potential for synergies and benefits taking into account the Water Framework Directive objective to achieve good ecological and chemical status, and ensuring efficient and wise use of resources.

Both directives require the appointment of competent authorities in order to ensure clear lines of responsibility for implementation and reporting. EU Member States must coordinate their flood risk management practices in shared river basins, including neighbouring non-member states, and shall in solidarity not undertake measures that would increase the flood risk in neighbouring countries.

In China there is a long history of establishing a specific competent authority to deal with flooding. For the Yellow River this was set up two thousand years ago, while a comparable authority for the Yangtze River was established in 1925, and since the 1970s competent authorities to harness the other five major rivers have been established. These approaches are useful in building relationships between provinces and across international river boundaries. Integrated river basin management is only possible when taking the stakeholder approach seriously. In China progress on stakeholder engagement has been made in the past ten years after the adoption of the principle "putting people first" and a "scientific outlook on development".

In an integrated river basin management approach flood security must be addressed from source to sea within a river basin, thus involving the following elements:

1 Flood forecasting and early warning systems

2 Watershed rehabilitation and protection

3 Keeping water in the landscape

4 Creating space for fluvial floods

5 Flood storage and retention basins

6 Urban flood management strategies

7 Hydro-meteorological networks

8 Spatial planning

3.3 Early warning systems

Early Warning Systems (Figure 1) are important components in flood control and flood risk management as mentioned in the No.1 Document as well as in many other reports and papers on flood management in China, including the recent ADB report “Flood Risk Management in the People’s Republic of China”. In the 7 major basins covered by the River Basin Commissions, including Tai Lake, flood early warning systems are operational already. However, as this strategy report also addresses the middle-sized and smaller river basins, where early warning systems not yet are common practice, further attention will be paid to this issue.

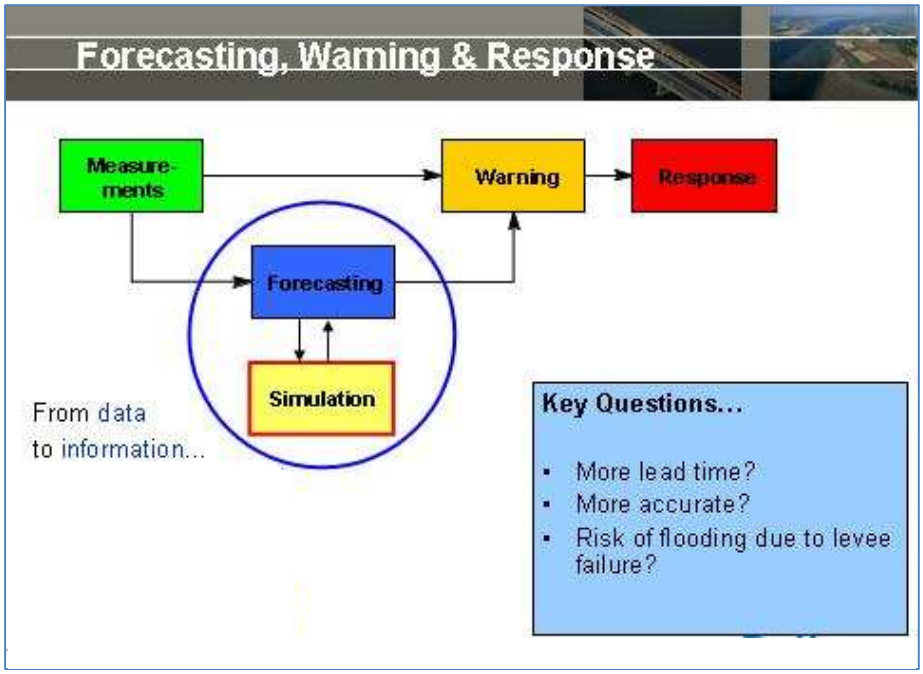


Figure 1 The concept of flood early warning systems

One of the most well-known flood early warning systems (FEWS) is developed by Delft Hydraulics (now Deltares) (Figure 2). The philosophy of Delft-FEWS is to provide an open platform for managing the forecasting process. Delft-FEWS incorporates a wide range of general data handling utilities, while providing an open interface to any external model.

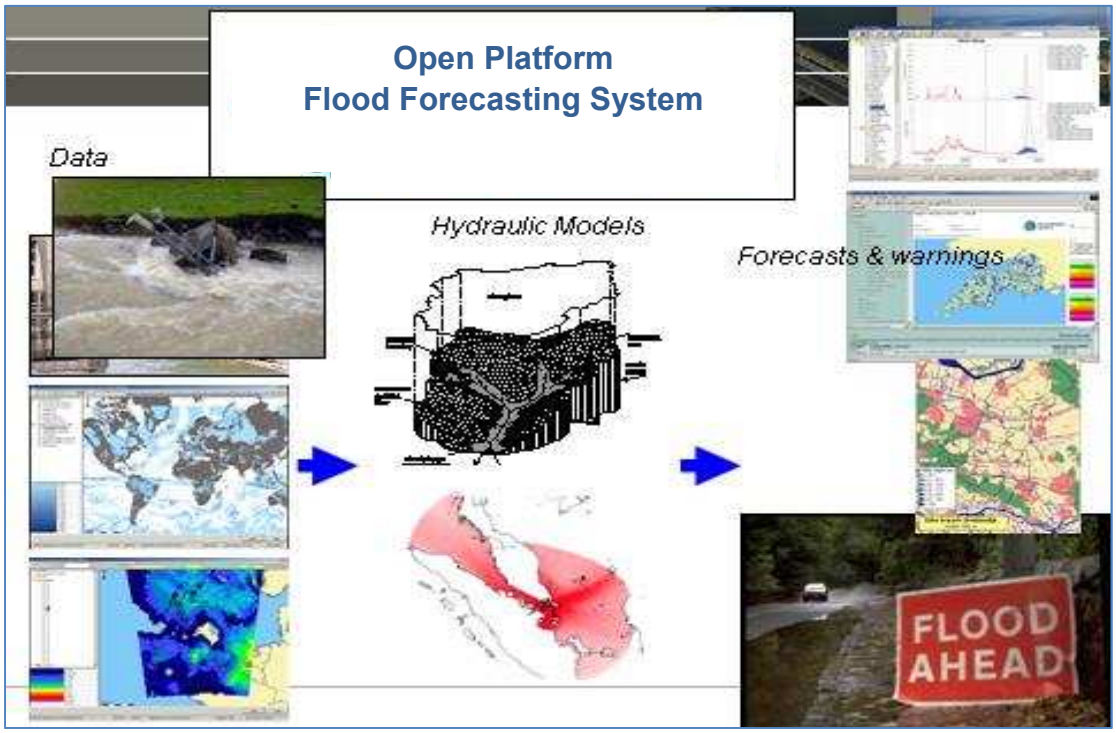


Figure 2 Open platform flood forecasting system

On the SKE hard disk several documents and presentations regarding the Delft-FEWS are stored, including information on the content and the process of Flood Early Warning Systems, their use and the benefits.

3.4 Watershed rehabilitation and management

Watershed rehabilitation management and erosion control are efficient measures to increase the resilience of a watershed. This includes to measures that aim at retention and conservation of water and soil in the watershed, to slow down the runoff and reduce the flood peaks. Such measures may be afforestation/reforestation, soil conservation, erosion control, slope stabilization, and special agricultural technology like contour ploughing, terracing, etc. The main objective is generally to maintain the vegetation cover, and increase infiltration in the vulnerable parts of a watershed in order to retain as much water as long as possible.

3.5 Keeping water in the landscape

“Keeping water in the landscape” may also be practiced further downstream in the river basin by controlled flooding of natural or artificial retention basins or simply re-connecting rivers flowing between dikes and embankments with their floodplain. This will enable harvesting of the benefits of floods in terms of deposition of sand and silt, removal of dissolved nutrients, increase of soil moisture making flood recession agriculture possible and increased recharge of groundwater.

The buffer capacity of retention basins will reduce the flood peaks and slowly release flood waters thus increasing the possibility of productive use of the flood waters. The Dongting and Poyang Lakes on the Yangtze River are paramount examples of the significance of such natural buffer capacity.

3.6 Flood storage and detention basins

Flood storage in reservoirs and detention basins are the artificial version of keeping water in the landscape and will have the same functions, but under better control.

3.7 Making room for rivers

Making room for rivers is increasing practised in Europe to reduce bottlenecks in the river system. Many rivers are constrained between dykes, by development of infrastructure along the river banks or by residential areas gradually encroaching on the flood plains leaving steadily less room for the river and increasing the flood risk and hazard proportionately. Making room for rivers is typically achieved by shifting embankments further away from the rivers as an alternative to increasing their height and the hazard in case of collapse.

3.8 Urban flood management

In the No.1 Document as well as in most of the relevant documents on flood management, urban flood management is mentioned as one of the important new focus areas. Although the process and activities for urban flood management largely follow the same approach as for integrated flood management, the measures may be quite different (Table 1). Moreover flooding standards in major cities may differ from rural areas since the potential damages generally are much higher (Appendix 1 and Appendix 2).

Table 1 Typical measures for urban flood (and drainage) management

Preventive:	**Reactive:**
River training	Flood warning
Canal construction	Evacuation
Dikes / bunds	Emergency drainage
Polder systems / pumping stations	Buffer capacity
Hydraulic infrastructure	Flood compensation (by govt)
(Flood proofing)	Flood insurance

A variety of relative small-scale measures that fulfil these requirements, as well as best-management practices and low impact development measures exist. These measures mainly aim at delaying the runoff from the urban environment. Examples are: Green roofs, detention basins or ponds, retention basins, infiltration basins, filter strips, infiltration trenches and filter drains, infiltration pits, semi-permeable rather than fully paved surfaces and constructed wetlands.

3.9 Hydro-meteorological networks

One of the most important components of integrated river basin and/or flood management is the collection of a comprehensive set of information and data needed for an in-depth analysis of the overall water resources conditions, the hydrology, hydraulics, morphology and water quality. Without such data and information sound planning or management of water resources is not possible, meaning that no projects can be implemented to improve insufficient water resources conditions, to improve water supply in drought situations, to reduce flooding problems and/or to improve the water quality.

Apart from spatial data like maps, GIS, satellite images, DEMs etc., hydro-meteorological info and data should be collected, generally by field monitoring, and preferably over longer periods in order to get good insight in the overall hydrology and hydraulics of a basin. In some countries monitoring in the major river basins has been executed on a regular basis for many decades already, providing a good database for water resources studies, particularly if flood frequencies and probabilities are necessary for the analysis of potential flood management measures. In other countries/basins, however, hydro-meteorological networks have yet to be set up from scratch and ad-hoc monitoring will have to provide the necessary data.

Some requirements and issues related to the set-up of hydro-meteorological networks can be formulated as follows, more or less in line with the EU WFD:

- Establish monitoring networks and programmes that can provide a coherent and comprehensive overview of the water resources conditions in a (sub)basin
- Include both surface – and groundwater bodies
- Ensure that the monitoring network is representative for the whole (sub) basin, with sufficient spatial coverage, meaning a network with appropriate density and locations
- Ensure that the monitoring related to the phenomena to be studied (peak flows and flood measurements in the wet season, low-flow monitoring in the dry season, simultaneous measurements of water levels and discharges at various locations in tidal areas, etc.)
- Ensure that the monitoring takes place with sufficient temporal coverage, i.e. timing, frequency and intensity of monitoring
- In case of interaction between groundwater and surface water, make sure that this is reflected in the monitoring programme
- Make sure to monitor or collect data regarding the impacts of water users within the basin, such as water abstraction, discharge and diffuse pollution from agriculture, water-use and point-discharge of industry, intake for domestic water supply, discharge from sewerage and/or wastewater treatment plants, etc.
- Ensure that mechanisms exist or will be established for sufficient and free exchange of data and info between various organizations that have monitoring responsibilities within the (sub)basin
- Ensure that, in case of cross-border or cross-boundary basins, consistent sets of data are collected, that coordination takes place and relevant data and info will be exchanged between the responsible organizations

- Sufficient resources, finance and manpower, should be allocated for the set-up, operation and maintenance of hydro-meteorological monitoring networks.

In the case of flood management long time-series are generally necessary to enable a good analysis of the flood conditions and flooding issues. Specifically this is the case, if flood protection measures will be designed for a specific level of flood protection, i.e. a flood with a certain probability of occurrence or measures that are based on a specific level of protection like once per 25 years for rural areas or once per 100 or more years for urban areas. The selection of a certain protection level generally is related to the flood risk, i.e. the combination of probability (the hydrological hazard or the once per N year flood) and the potential damages (direct and indirect damages, assets and potential loss of production).

The monitoring programme in such cases should include water levels and discharges (floods), but in many cases the river mechanics also play an important role in flood management. This means that also the morphological character of the river should be investigated, which will demand information and data on sediment loads and sediment transport capacity of the river. In such case also long term records will be necessary to get a good insight in the morphological behaviour. It is therefore recommended that such data are collected on a regular basis and at relevant locations in the river (basin), even if there are no immediate flood protection plans or programmes.

3.10 Spatial planning

Watershed and floodplain management measures that may be administrative and/or structural, and include land use planning, zoning, development controls, land conservation, reforestation etc.

Spatial and land use planning has two important interactions with flood risk management. Firstly, planning should avoid urban and other development in flood prone areas, secondly urban development may lead to increased and more rapid run-off due to and increase of buildings and paved or impermeable surfaces.

Consequently spatial planning, zoning and land development controls should have an important place, as urbanization and industrial/ commercial development generally will lead to an increase in the areas of paved and impermeable surfaces

Both the hydrological and the flood hazard will increase due to the more rapid runoff and more pronounced flood peaks, while the potential damages will increase due to the higher value of the residential and/or commercial development. Conclusively the watershed resilience will reduce and the flood risk may increase dramatically.

The relationship between spatial planning, urbanization and flood risk is discussed at various places in this report. This emphasizes the actual interrelations between all these issues, which is another reason for good coordination and cooperation between the institutions contributing to watershed management.

In the case of urban systems special measures such as retention/detention basins, wadis, filter strips, infiltration trenches, filter drains, infiltration pits, permeable surfaces, grass roofs, etc. may serve both watershed management/resilience and flood management at the same time.

4 The EU Floods Directive and the No.1 Document

4.1 General

The No.1 Document and the EU Directive on the Assessment and Management of Flood Risks (EU FD) have a lot in common but also a lot of differences. The similarities mainly reflect a common viewpoint and the global approach to water resources management in general and flood management in particular.

Differences exist where the documents refer to the relatively confined infrastructural approach that has been common in both China and the EU for many years, and the new broadened approach as specified in the EU FD. Other differences may relate to very typical local or geographical conditions, to specific EU issues regarding subsidiarity, legislation, or other issues typical for either EU or China.

4.2 Similarities

A number of the most salient and/or typical similarities are that both documents recognise[2]:

- the danger and impacts of floods on people and society
- the fact that floods can not be prevented
- that human activities contribute to an increase in likelihood and adverse impacts of floods
- the need to reduce the consequences of floods
- the important relation between land use and flood risk management
- the different types of floods and their causes
- the need for flood hazard/flood risk mapping and flood management planning on basis of that
- the need for improved flood management and the need to use “best practice” and “best available techniques”
- the need for flood risk management to be considered at the river at the basin level.

[2] It should be mentioned here that similarities in the text of both documents are not always easily recognizable, since different terminology may be used for similar principles.

4.3 Differences

Equally the most salient and/or typical difference may be summarised as:

- The EU FD explicitly recognizes the need for concerted and coordinated action, while the No.1 Document is less explicit in this respect. However, the responsibilities in the water sector in China are quite fragmented, hampering good management of the resources and actions, including flood management

- The EU FD also explicitly mentions the need for cooperation with third countries, due to the relative importance of trans-boundary aspects of water resources and flood management in the EU. In the No.1 Document this is not mentioned, although it certainly is relevant for rivers as the Heilongjiang/Amur, Red River, Mekong and others

- The EU FD already uses the concept of flood risk, i.e. aiming to reduce the consequences of floods, which is not quite visible in the No.1 Document yet

- The EU FD focuses on the 3-layer safety approach i.e. Prevention, Protection and Preparedness. The No.1 Document does not explicitly recognize this approach, though implicitly in the text these elements individually can be found

- The EU FD mentions the solidarity principle in the context of flood management; in the No1 Document there even is a stronger emphasis on the responsibilities of the government to society, information of people/stakeholders, increase of public awareness, and stakeholder involvement.

- A very noticeable difference is that the No.1 Document explicitly assigns specific responsibilities for flood and drought control to Party Committees and governments at all levels, proposing a chief executive responsibility system and the principle of due diligence, where people individually can be held accountable for shortcomings in flood control

- The EU FD emphasizes the duty to exchange data on flood risk assessment, flood hazards, risks maps etc. freely between stakeholders (EU Member States in this case), whereas the No.1 Document does not pay attention to this although it is well-known in China that data and information are not shared between relevant parties

- The EU FD explicitly recognizes the various functions of the water system and the need for good relations with authorities dealing with such functions; the No.1 Document focuses strongly on water conservation and flood control, but does not pay much attention to other forms of water utilization; therefore the need for coordination and cooperation with other parties is hardly recognized

- Another difference is that the EU FD has set a specific time schedule for specific actions like the finalization of flood hazard/flood risk maps, for flood risk management plans, as well as for the implementation of measures, reports to be produced, etc.

- The EU FD also gives a relatively detailed “guideline” on the information to be provided in such products as flood risk maps, flood risk management plans, the structure of reports and related issues.

4.4 Lessons learned

It should be understood that this comparison is not meant to result in any opinion on which document is best. Each document has been written for its own purpose, focusing on the local conditions and institutional setting in the EU and China respectively. The objective from this comparison is to select issues that are useful in the exchange of knowledge and can be utilized to improve the practice of flood management in either the EU or China. In the following chapters some of these issues will be further discussed and dealt with.

5 EU Floods Directive

Both China and Europe aim at reducing the adverse consequences for human health, the environment, cultural heritage and economic activity associated with floods. To facilitate this, a management framework for the assessment and management of flood risks is required.

The European Union has put this in place through the development and adoption of the EU Floods Directive, which takes a risk based approach. This requires the EU Member States to develop four essential work areas to provide the necessary basis on which informed decision making can take place:

1 Flood risk assessments to identify flood prone areas

2 Flood mapping comprising flood hazard maps

3 Flood risk maps

4 Flood risk management plans.

Flood risk assessments are based on readily available information and studies of long term hydro-meteorological developments, in particular impacts of climate change on the recurrence of floods. The assessments include maps of river basins and descriptions of past floods and their impact.

Flood hazard maps and flood risk maps will be produced for river basins at an appropriate scale. These maps will indicate flood probability and return period, flood extent, flood water level and water velocity. They will indicate the number of inhabitants potentially affected, an assessment of loss of economic assets, and an assessment of other potential adverse consequences of future floods.

Flood risk management plans should take into account all relevant aspects such as costs and benefits, flood extent and flood discharge routes and areas, which have the potential to retain flood water, such as natural floodplains. Environmental objectives, soil and water management, nature conservation, spatial planning land use and navigation and port infrastructure are also considered in the plans.

Stakeholder engagement is an integral part of integrated river basin management in Europe and is a mandatory requirement under all EU Directives. All assessments, maps and plans should be made available to the public.

5.1 Flood risk management

Flood control and flood management in the classical way looks specifically at a reduction of the flood- or safety hazards, such as indicated in the No.1 Document (Chapter 3, Articles 7 and 11). This can be and is generally done by implementation of structural measures, like dams and reservoirs, embankments,

discharge control works, etc. However, the science and practice of “flood control” has recently shifted from protection against floods to managing the flood risks, or with other words: focusing on the reduction of flood induced damages.

The concept of flood risk, as opposed to a pure hydrological risk can be explained as follows. The probability of flooding is related to the statistics of rainfall and the runoff characteristics only. In flood risk management however, one looks to the whole chain from meteorology (precipitation), via hydrology (rainfall-runoff), to hydraulics (river discharge), to floods (the flood hazard or probability), and via land use, economic activities and assets, to potential damage, which finally results in the flood risk.

Flood risk as such is then defined as:

Flood risk = Probability of flooding * Potential damage

This is visualized in Figure 3.

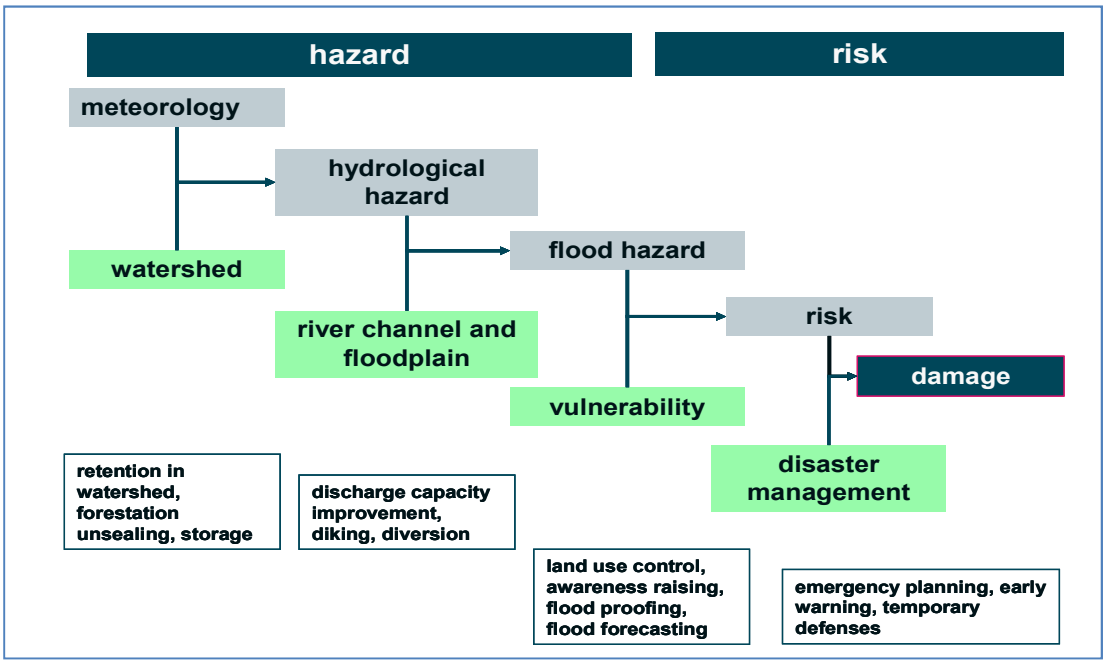


Figure 3 Approach to flood risk management (Source: Deltares)

In the classical approach the focus was mainly on the hazard side, i.e. to reduce the hydrological hazard or the flood hazard. This was, apart from watershed management measures, generally done by infrastructure projects. However, if one would focus at a reduction of the risks/damages, there are a number of mainly non-structural measures available as shown on the risk side. In this respect there is a direct link with the No.1 Document, where it mentions non-engineering measures and early warning systems, etc. (Chapter 3, Articles 7, 9, 15, 19 and 30).

5.2 Vulnerability, exposure and resilience

If the Flood Risk Management approach is followed, non-structural and various other so-called soft measures become both relevant and important, such as early warning systems, flood proofing, awareness raising, and flood insurance. These are all issues that are mentioned in the No.1 Document, and therefore link quite well to the approach of reducing and managing the risks as well as hazards.

It should be mentioned that for words as Risk, Vulnerability, Exposure, Resilience etc. there are many different definitions. A good overview of such definitions is given in the UNDP handbooks on Disaster Reduction (UNDP, 2004 and UNISDR, 2009). However, for most of the words various definitions may exist and consequently there not always is a consistent understanding of for instance “Risk”. Sofar, we would promote to use the definition as given in the previous chapter.

For issues like the vulnerability of society to floods, or the exposure of people and buildings, as well as resilience in case of flooding, a good illustration is given in Figure 4.

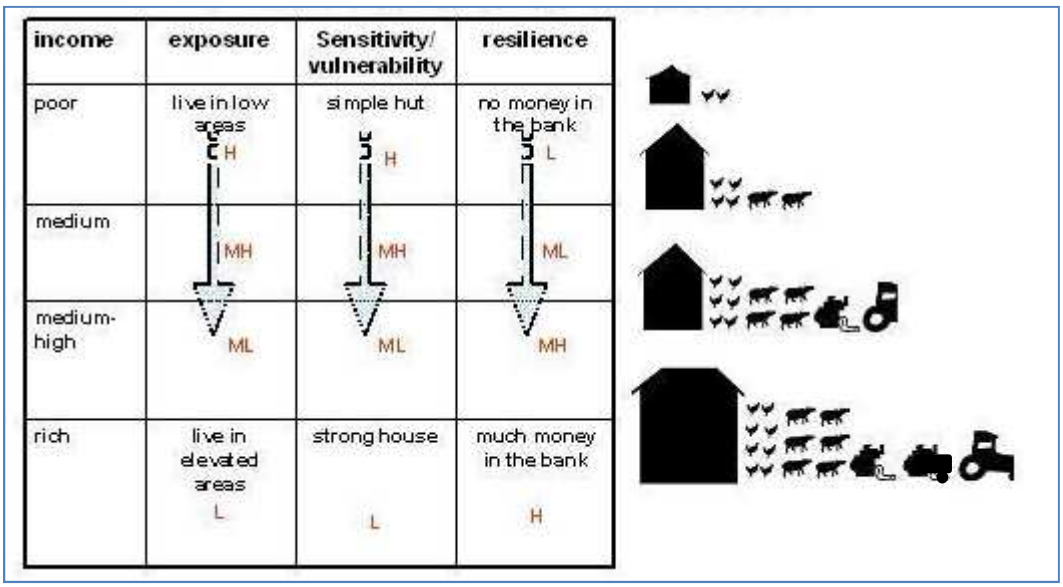


Figure 4 Exposure, vulnerability and resilience of different farming households

In some cases people use vulnerability as opposed to resilience, to be influenced by infrastructural works, and connect exposure with protection (spatial planning), but resilience can also be influenced by adaptation, fitting the concept of Living with Water. Presently many projects on adaptation are executed in the framework of climate change and sea-level rise studies, specifically in flood-prone countries all around the world.

5.3 Triple layer safety approach

The flood risk management concept also involves the so-called triple-layer safety approach of Prevention – Protection – Preparedness. Prevention mainly concerns the non-structural measures such as watershed rehabilitation, spatial planning and the strategy of “Keeping Water in the Landscape” including natural retention basins. Protection relates major infrastructure such as flood reservoir storage and artificial retention basins, as well to local infrastructure measures, while preparedness relates to crisis management, evacuation, temporary flood protection measures, etc.

The No.1 Document clearly shows the extensive and impressive experience in China with regard to the protection. The huge amount of infrastructure structures like dams, reservoirs, sluices, barriers, weirs, canal systems, diversions and dike systems have helped to reduce the hydrological hazard as well as the flood hazard.

In the field of prevention, however, the situation is less encouraging, as there is no good coordination yet between flood risk management, being the jurisdiction of mainly the Ministry of Water Resources, and spatial planning, land use etc. which is the mandate of other ministries. In that respect the importance of the institutional setting and the need for improved (horizontal) coordination and cooperation has to be emphasized again.

Another reason, however, is that land use control at the local level is the mandate of provincial, city, county and/or prefecture administration. The importance of spatial planning and proper land use as related to water management may for instance be clear for staff at the national level and/or in the River Basin Commissions, but certainly not for the lower administrative level. Moreover, one of the major problems mentioned during an interview with a senior Chinese water resources management expert, is the fact that the lower administrative levels, including the provincial level, do not really respond to instructions from the national level regarding issues like Room for Rivers or Living with Water concepts. As the pressure on land is large, particularly around cities and along rivers with good transportation potential, it is financially attractive to allow industrial and/or residential development in (also) floodplains or retention areas.

With regard to preparedness it should be mentioned that China has good systems in place with regard to evacuation, flood relief and crisis management. However, institutional issues also play a role here, since many different ministries are involved with issues related to flood preparedness and in case of actual floods. The State Flood Control and Drought Relief Headquarters play an important role in coordinating the inputs and efforts with regard to preparedness, specifically when floods are actually happening, and similar headquarters also exist at the level of River Basin Commissions, provinces and municipalities. In that respect the 3rd layer of “preparedness” is covered reasonably well.

5.4 Living with Water or Keeping Water in the Landscape

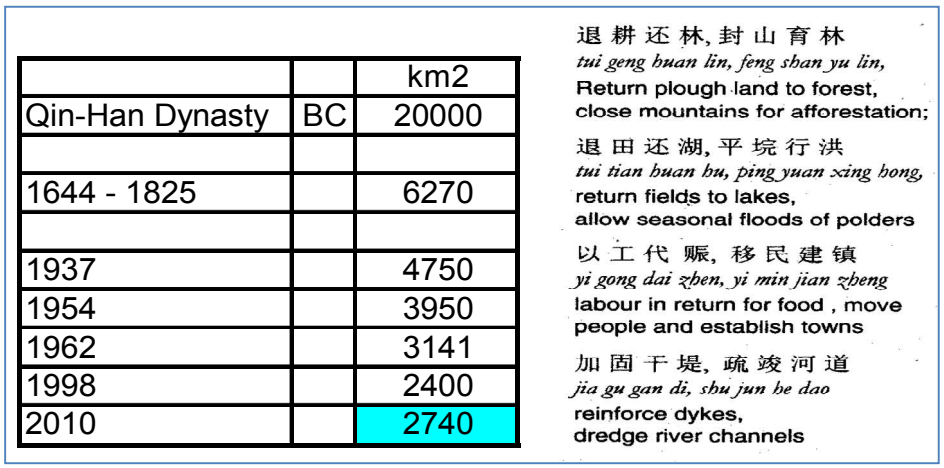
One major issue in flood risk management is the paradigm shift from flood control fighting against water to living with water or keeping water in the landscape. About 15 to 20 years ago people started to realize that a fight against nature never can be won, resulting in for instance the “Room for Rivers” programme in the Netherlands or more widely within the EU as “Keeping Water in the Landscape”. This policy shift has taken place after 800 years of fighting against the water, not just in the Netherlands, but also in several other countries in Europe, as well as in China. For instance, after the large floods of 1998 along the Yangtze River large areas of land were returned to the river, with the objective to restore the natural function of flood water storage in the floodplains and in the great lakes connected with the river.

These developments are encouraging, as they show that the concept and policy shift are well understood in China. In the No.1 Document this is presented as “to maintain harmony between water and people” (Chapter 2, Article 5). However, this level of understanding may exist at the national level and within the major River Basin Commissions, but not necessarily in the provinces and at the regional levels of administration. Consequently, much land is still being taken away from the water system for

agricultural, industrial or residential development, without sufficient compensation for flood conveyance. It may thus be concluded that the implementation of the policy shift needs more specific attention at the regional level.

Dongting Case Study

This refers specifically to Dongting and Poyang lakes, but also along the Yangtze River basin in wider perspective. These areas once belonged to the river system, but were gradually reclaimed for agricultural or other purposes over a period of several centuries (Figure 5). According to the latest figures in total over 5300 km^2 of land have been returned to the river system in Yangtze River basin and 3.8 million people have been resettled to create more space for water and accommodate the high floods. In Dongting Lake this is about 500 km^2 and 350,000 people respectively, while it is about 900 km^2 and 750,000 people for Poyang Lake.



		km2
Qin-Han Dynasty	BC	20000
1644 - 1825		6270
1937		4750
1954		3950
1962		3141
1998		2400
2010		2740

退 耕 还 林, 封 山 育 林
tui geng huan lin, feng shan yu lin,
Return plough land to forest,
close mountains for afforestation;

退 田 还 湖, 平 垸 行 洪
tui tian huan hu, ping yuan xing hong,
return fields to lakes,
allow seasonal floods of polders

以 工 代 赈, 移 民 建 镇
yi gong dai zhen, yi min jian zheng
labour in return for food , move
people and establish towns

加 固 干 堤, 疏 竣 河 道
jia gu gan di, shu jun he dao
reinforce dykes,
dredge river channels

Figure 5 Historical changes in surface area of Dongting Lake and remedial measures to return land to the rivers

5.5 Dike monitoring and maintenance

Flood Early Warning Systems can be quite useful in forecasts of meteorological conditions and related flood hazards. However, other types of early warning systems exist that can provide information on the status of protection systems like for instance dikes. This is done via real-time monitoring of a number of relevant parameters that give insight into the actual conditions of the dike (Figure 6), which in combination with for instance water level data may lead to early warnings of potential failure.

Firstly, it should be realized that dikes can collapse not just by floods, but drying out can also lead to loss of stability and sliding of the slopes. In 2003 in the Netherlands a major dike collapsed due to a long lasting drought, causing inconvenience and substantial damage. With increasing economic investments in flood prone areas, such events are not acceptable anymore. As a result this dike disaster triggered more research in the fields of flood risk management in general and dike monitoring and maintenance in particular, including inspection techniques for daily maintenance and during high water conditions.

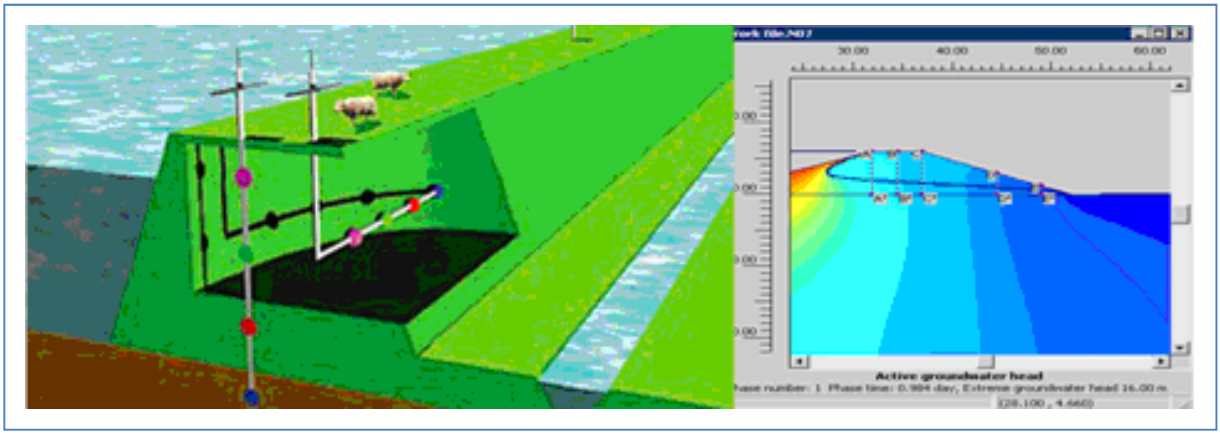


Figure 6 Dike monitoring and stability forecasting (Source: Netherlands 2015 Flood Control Program

Consequently, the technology for inspection and monitoring of dikes using multiple sensors has been spreading quickly in the Netherlands. Parameters measured are water pressure, temperature and movements within the dyke as well as the dyke itself. Such technology can be used for high water conditions, providing information on potential failure mechanisms and early warning about the hazard of dike collapse, but is also useful in the dry season.

A major research project in this field is the so-called Smart-Dike (or Smart-Levee) programme, combining sensor technology with geo-engineering expertise. In this project in-situ tests were done with a real stretch of dike, the so-called IJkdijk (calibration dike), with a length of 100 m and a height of 8 m. The dike was provided with 10 different monitoring systems, i.e. sensors to measure critical parameters during the real-time loading test. Loading on the dike was increased stepwise until failure occurred (Figure 7). Some of the sensor systems used in the 2008 experiment for the failure mode “sliding instability” detected the weak failure plane about one day before the actual failure took place.

Figure 7 IJdijk collapse experiment (2008)

Research further focuses on the failure mechanisms, with emphasis on understanding the mechanisms rather than their mathematical descriptions. Models and algorithms have been developed for assessment of potential loss of internal dike stability, for dike breaching, for piping, for overtopping, etc. Other research looks at techniques under development for remote sensing applications to measure anomalies and changes in the flood defence system, such as for instance the InSar radar technology for long-time monitoring of dike deformation.

Another system for remote sensing of dike profiles and levels is a laser altimetry type of surveying, specifically for the profiling of line elements like dikes or roads, using small helicopters (Figure 8), which It offers the following features:

- Flexible, fast and reliable data acquisition
- No access limitations - maximum safety for surveyors
- Low weather dependency
- Accurate and up-to-date information
- High level of detail
- Survey results “next day” available
- Data classification and information extraction
- Integration of laser data, video and still images
- Re-usable data for various applications
- Easy integration data into 3rd party software (GIS/CAD/database)
- Low investments data processing

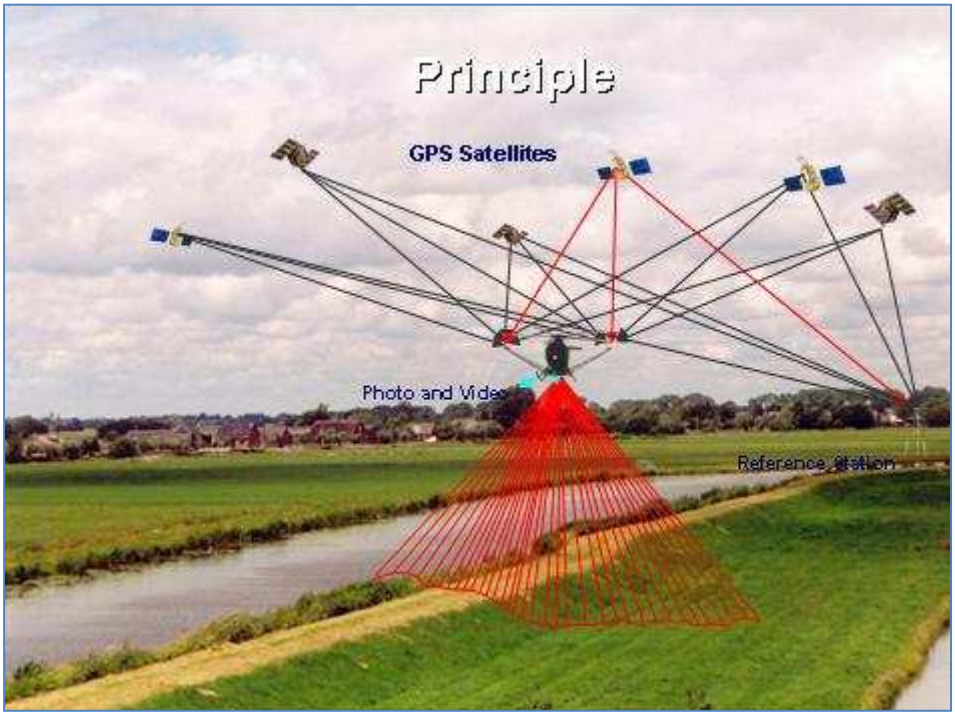


Figure 8 Principles of FLIMAP survey and monitoring technology

More information on the dike monitoring and survey techniques, the sensor technology, the Smart-dike concept, FLIMAP technology etc. is available on in the Dike Monitoring folder of the SKE harddisk.

5.6 Protection standards related to potential damage

One important component of flood control and flood risk management is the selection of measures for flood protection. The selection of measures should take place on basis of a proper Cost-Benefit Analysis for such measure(s), where the costs of the measures are balanced against the reduction of potential damages. In some countries other criteria may play a role in selection of measures, and particularly in the desired protection level related to such measures. For instance socio-economic criteria, health, or poverty reduction may play a role.

The height of a dike is often determined on basis of political choices for a certain level of protection. In China, for instance, the protection levels set in 1994 (Appendix 1) depend on a combination of the land use, agricultural versus urban, and on the size of population. It varies from 1 in 10 years for rural areas with low population and dominated by agriculture, via 1 in 50 or 100 years, to less than 1 in 200 years for big cities with a population of at least 1.5 million.

A better method to assess the optimum height of dikes has been presented in the RBMP Technical Report 072 - Efficient Safety Standards for Ring-Dike Areas prepared as part of the Strategic Knowledge Exchange. In this report it is shown how a proper cost-benefit analysis should be done for measures/projects related to dike improvement or dike heightening. The expenditure for such dike improvement projects in fact determines the level of protection, since the costs are directly related to the reduction of potential flood damage.

5.7 Financing water management in the Netherlands

During the recent visit of Minister Chen Lei to the Netherlands in March 2012, it appeared that the minister amongst others was quite interested in the financing of water management in the Netherlands, and particularly the distribution of costs between the various stakeholders (Figure 9).

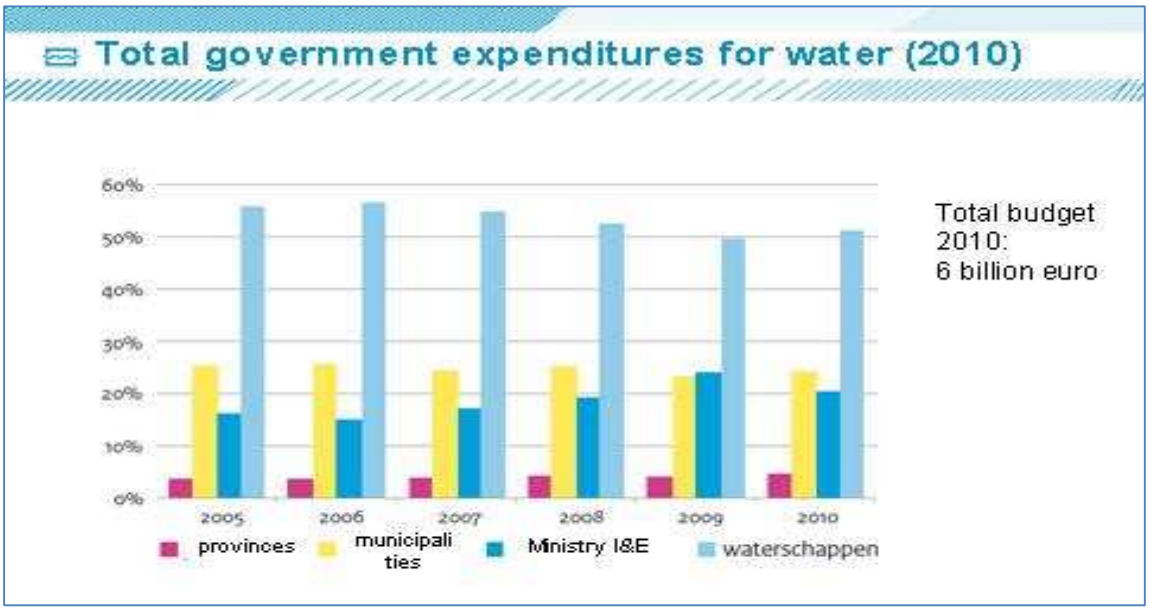


Figure 9 Distribution of costs of water management in the Netherlands 2005-2010 (waterschappen = water boards)

It is clear that the majority of the financial burden is placed on the water boards. As the water boards are mainly financed by direct fees and taxes from the users of the water systems, i.e. the farmers, industry and the public at large, it should be clear that water management in the Netherlands actually is financed directly by the population. The expenses for and by the municipalities mainly relate to drainage and wastewater collection, and are also paid by the population through municipal taxes.

The expenses for and by the Ministry of Infrastructure and Environment mainly relate to the costs of the major water system, and special programmes like Room for Rivers, design and construction of major infrastructure, and maintenance of the system.

The SKE hard disk contains various documents and presentations on water management in the Netherlands in general and the financing issues in general. These include the cost distribution per stakeholder, and the specific costs for tasks like safety/flood protection, wastewater collection and treatment, etc.

6 Flooding in China

6.1 The ADB approach

During the past 8 years China has cooperated with the Asian Development Bank (ADB) on studies of flood management practices in China. Reference in that respect is made to the National Flood Management Strategy project of 2006[3]. Recently also a publication was produced on Flood Risk Management in China[4], presenting a good overview of the actual situation as well as necessary steps to be taken with regard to the modernization of flood management in China. Salient statements and key elements of the approach are:

- There should be key roles for future integration of non-structural measures in Flood Management (ADB 2006)
- An outline is necessary of the shift "from flood control, relying on structural measures, to flood risk management with a more balanced and integrated approach, using both structural and non-structural measures (ADB 2006)
- The focus should be shifting further towards flood risk management: "it is important not only to manage the hydrological and/or flood hazard, but also to manage the consequences, i.e. the risk, being the product of probability and exposure, that could be expressed in potential damage.." (ADB, 2012)
- Integrated flood (risk) management should aim at optimum protection of the society against floods, without compromising other functions, users and uses of the system, and also taking into account trans-boundary effects
- A missing link / major problem is the lack of interaction/coordination between land use planning and flood (risk) management, as spatial planning is not in the jurisdiction of MWR …
- For full and effective integrated flood risk management it is essential that MWR forms partnerships with other administrative departments (ADB 2006)
- Key administrative parties to be involved are, in addition to MWR, the Ministries of Land and Resources and the Ministry of Housing, Urban and Rural Development, specifically to link land use, zoning and spatial planning to flood management

[3] ADB/GHD, 2006, National Flood Management Strategy Study, by GHD and IWHR for MWR and ADB, March 2006

[4] ADB 2012, 'Flood Risk Management in the People's Republic of China: Learning to Live with Floods', by Yoshiaki Kobayashi and John W. Porter, ADB, April 2012

- Other ministries with stakes in flood risk management may be Civil Affairs (flood warning, flood evacuation, etc.), Communication (transport infrastructure, use of the waterway systems, access during floods, etc.), Agriculture (field drainage, soil conservation), Environmental Protection (water pollution, harmful matter), Forestry Administration (watershed protection, erosion control), etc.

- This so-called horizontal cooperation, between ministries and departments at the national level, should trickle down to the other tiers of administration as, particularly at the levels of provinces, districts and towns it is important to recognize the interaction between flood (risk) management and spatial planning, land use, land/slope conservation, etc.

- It will be clear that such complex task will require strong guidance and/or directives from the upper echelons of government, such as for instance the National Development and Reform Committee (NDRC) or the State Council.

The approach reflected from these statements and reports very much corresponds with the EU Flood Directive as well as flood risk management practices in the Netherlands, UK and other EU countries. Many of the issues in the forthcoming chapters will consequently be recognized as being relevant for the modernization of flood management.

6.2 Influence of flood disasters on China

Flood disasters are recognised as one of the gravest natural disasters in China posing a great threat to some 67% of population, 35% of arable land, 90% of large and medium-sized cities and 80% of gross output value of industry and agriculture. Many severe flood disasters in history have caused serious losses and exerted influence on China's economic development, social stability and the ecological environment.

6.2.1 Social influence

The influences of flood disaster on human society primarily concerns the loss of lives during or after flooding. Prior to the 1950s floods in several river basins caused tens of thousands of deaths. According to statistics, the flood disaster in Yangtze River and Huai River in 1931 caused a death toll of 145,000, the flood disaster in Yangtze River in 1954 a death toll of more than 30,000 in the Dongting Lake area alone, and the Huai River flood in August 1975 caused a death toll of 26,400. Since the 1980s, with the extension of flood protected areas, increase of flood control standard and enhancement of economic strength, the death toll from flood disasters has steadily decreased. The total death toll in the country declined from an average of 9,000 per year in the 1950s to an average of 1,600 in the 2000s. However, the death rate due to flash floods and mudslides has shown a remarkably increasing tendency. Since 2003, the population death by flash floods has accounted for more than 70% of those who die from other flood disasters, and the flash flood in 2010 caused a death toll of more than 2,800 accounting for 90% of China’s total death toll from flood disaster that year, a record number since 2001 (Figure 10).

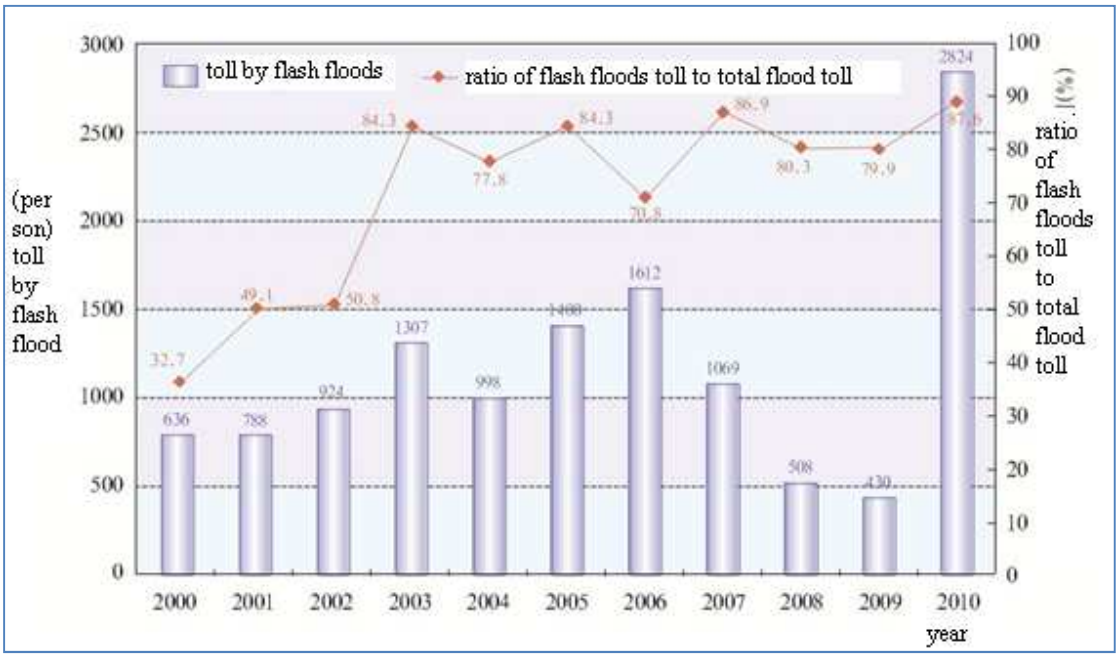


Figure 10 Number and proportion of death toll from flash flooding

Another influence of flood disaster on social life is revealed in migration of large numbers of population, which adds the factors of social unrest and instability. The resettlement of flood-stricken people, house rebuilding and production recovery placed heavy burden on society before 1949. For instance, the nationwide flood disaster in 1931 caused over 51 million flood victims in eight provinces of the Yangtze and Huai River basins; a large number of flood victims fled in groups suffering turbulence, homelessness and starvation, which created turmoil and could even jeopardise the stability of the country. Meanwhile, large casualties might cause huge trauma to the population and bring severe damage to the production force.

6.2.2 Economic Influence

Almost all great floods in China have caused severe economic losses. With China's rapid economic development, economic losses caused by flood are showing a rapidly increasing trend. Since the 1990s, China's average annual losses arising from floor disaster have reached RMB 125 billion (Figure 11). With the increase of asset value and population density, the economic losses per unit area are also increasing. According to statistical analysis, if the same magnitudes of floods occur, the loss er square kilometre flooded was RMB 220,000 in the 1950s, compared with RMB 1,400,000 in the 1990s, an increase of 7 times (Figure 11). In 2010 the direct economic losses from flood disaster amounted to RMB 375 billion, hitting a historical record.

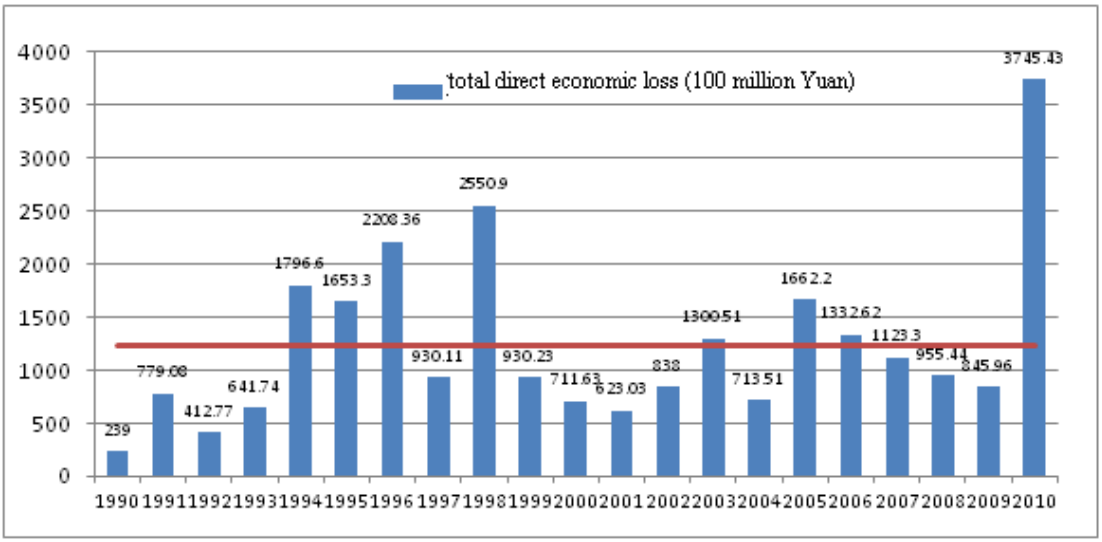


Figure 11 Direct economic losses from flood disasters in China 1990-2010

The structure of losses has also experienced striking changes, i.e. the proportion of agricultural losses declines, while there is a remarkable rise in the proportion of losses in industry, transportation, power, communication, etc. Among the total direct economic losses from flood disaster in 2010, the direct economic losses from farming, forestry, animal husbandry and fishery accounted for 35%, while the other 65% were attributed to the industry, transportation, industry, flood-damaged infrastructure and other categories. Cities are suffering from an ever-growing proportion of losses from flood disasters. According to the sampling data before 1998, it is estimated that the average annual direct economic losses of cities all over China from flood disaster amounted to RMB 30 billion, accounting for 15% of total costs of flood disasters in China. In 2007 disastrous rainstorms occurred in Chongqing and Jinan. The resulting flood disaster left 100 people dead and caused direct economic losses of RMB 4.5 billion for these two cities. This level of casualties and property losses from flood disaster for the major urban areas has been rarely seen in recent times.

In China several heavy flood disasters occurring in the last century, e.g. in 1931, 1954, 1956, 1963, 1964, 1985, 1991, 1993, 1994, 1995, 1996 and 1998 affecting more than 210 million mu (14 million ha) of farmland. The floods caused severe damage to roads and railways. The flood disaster in Yangtze and Huai River basin in 1954, for example, suspended the Beijing-Guangzhou Railway service for 100 day and the Yellow River flood in 1958 seriously jeopardised the Beijing-Guangzhou Railway Bridge over the Yellow River, which caused the interruption of train service for 14 days. The floods caused damage to hydraulic, communication, energy and other national infrastructure, e.g. the flood of Hai River in 1963 destroyed 5 medium-sized reservoirs, caused dam failure to 330 small-sized reservoirs, 2,400 breaches in levees, destroyed 62% of the irrigation area and 90% of drainage engineering infrastructure was destroyed or submerged. The flood of Hai River basin in 1996 caused 20,000 interruptions on the electricity grids and multiple national communication trunk lines, e.g. the Beijing-Wuhan-Guangzhou aerial cable, medium coaxial buried cables, etc. Such infrastructure often requires years of repair prior to full recovery.

In recent years, with rapid development of urbanisation, water supply, power supply, aviation, transportation, communication and other lifeline systems and human being's increasing reliance on them, lifeline systems may suffer a degree of damage, but the indirect influence arising from system

paralysis will be large. In addition, the relationship among industries becomes closer and closer, and damage to one industry may spread to other industries, exerting an overall influence.

Since the 1990s, the average economic losses in China caused directly by floods have accounted for 2.5% of the average annual GDP in the same period compared with 0.1% in USA and 0.2% in Japan. In the years experiencing the floods, such as 1991, 1994, 1996 and 1998, the losses caused by the floods accounted for 3%-4% of the GDP. Though the ratio of the economic losses caused directly by the floods to the total assets has decreased to some extent since the start of the 21st century the flood disasters still have a great influence on economic development and take a long time to recover.

6.2.3 Ecological and environmental Influence

Flooding does not only result in great economic losses, but also poses terrible damage to the environment, which is shown mainly in the following respects:

- Destroying farmland, causing arable land to be barren or to be unsuitable for farming
- Disturbing the water system and lowering the drainage capacity and flood discharge capacity of the water courses
- Polluting the water environment and endangering human health
- Disorganising the ecological system, etc.

In the flood-prone areas, with water erosion, sand and silt deposition, farmland is damaged and soil salinisation is exacerbated in low-lying areas. For example, 1.95 million mu (180,000 ha) of farmland was unsuitable for farming following the great flood in 1963. In 1938, when dikes of the Yellow River were breached by the Chinese army in order to stop the Japanese Army advancing southward, the human-made flood left some 10 billion ton of sand washed into Huai River basin, whose fertile land was vulnerable to the flood's destructive effects.

The bursting of river banks often upsets the water system resulting in lowering of the drainage and flood discharge capacity of the water courses. The previous diversions of the Yellow River have carried a large quantity of sand into the Huai River Basin and raised the land by several meters, thus choking the water system by the sand.

Floods often pollute the water environment, which thus becomes the source of water borne diseases and toxic substances, posing a direct threat to human health. In 1931, the Huai River basin saw the plague epidemic after the flood, and the acute infectious diseases spread from the urban area to the rural area. In Gaoyou County of Jiangsu Province, several hundred people died of the resulting epidemic. In July, 2010, over 7,000 barrels (1000 m^3) of toxic chemicals were washed from a chemical plant into the Songhua River and aroused widespread concern from the society and panic and terror of the people in the flood-stricken area, though various measures were taken to stop the pollution spreading.

The flood may also damage the ecological system. For example, the surging and submerging may result in death of animals and plants or pose threats to their survival. The floods scour the banks and

destroy the vegetation along the river banks, which will result in a change of the living environment, while the sudden change of water quantity and quality and the restoration of the river banks have an impact on the propagation and growth of animals and plants. Therefore, the flood may damage the diversity of life and habitat and prevent the ecological system from functioning normally.

Being a natural phenomenon, floods will change the aquatic ecological environment, which may have negative impacts on the one hand and give more play to the ecological environment on the other hand. In recent years, the protection of the resource function and ecological function of flood has drawn concern during the flood management process, in particular, the planning and construction of the flood control projects.

6.3 Current situations and challenges of flood control

The flood control and disaster reduction system consists of a policy and legal system, an administrative system, structural system and social auxiliary system, of which the first three are the main parts.

6.3.1 Policy and legislation

The main and most effective representation of the policy and legal system is laws and regulations. The building of the current Chinese legal system on water management started in 1988 with the Water Law, which subsequently was revised in 2002. The clauses and provisions relevant to the flood control were perfected in Flood Control Law issued in 1997 (Appendix 3) that has become the fundamental law of flood control in China. In addition to the Flood Control Law, the national laws related to the flood control and disaster reduction include the Law on Water and Soil Conservation (2011), Law of Land Administration, City Planning Law, etc. (Figure 12)

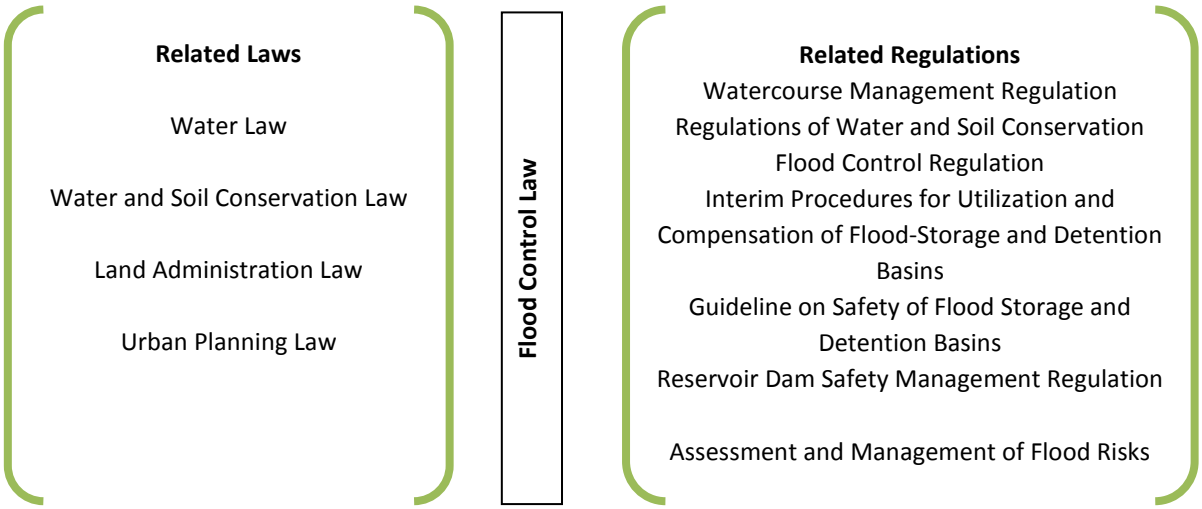


Figure 12 Legal system on flood control and disaster reduction in China

In order to better defend and mitigate flood disasters and strengthen the management of flood control, most provinces (municipalities and autonomous regions) observe not only the above-mentioned national laws and regulations, but also, formulate local regulations in light of their own actual situation, such as enforcement measures of the law of water and of flood control, management of flood control, flood prevention regulation, drainage regulation, etc.

6.3.2 Administrative management system

The administrative management system for flood control and disaster reduction in China can be divided into the daily management system (Figure 13) and the emergency management system (Figure 14).

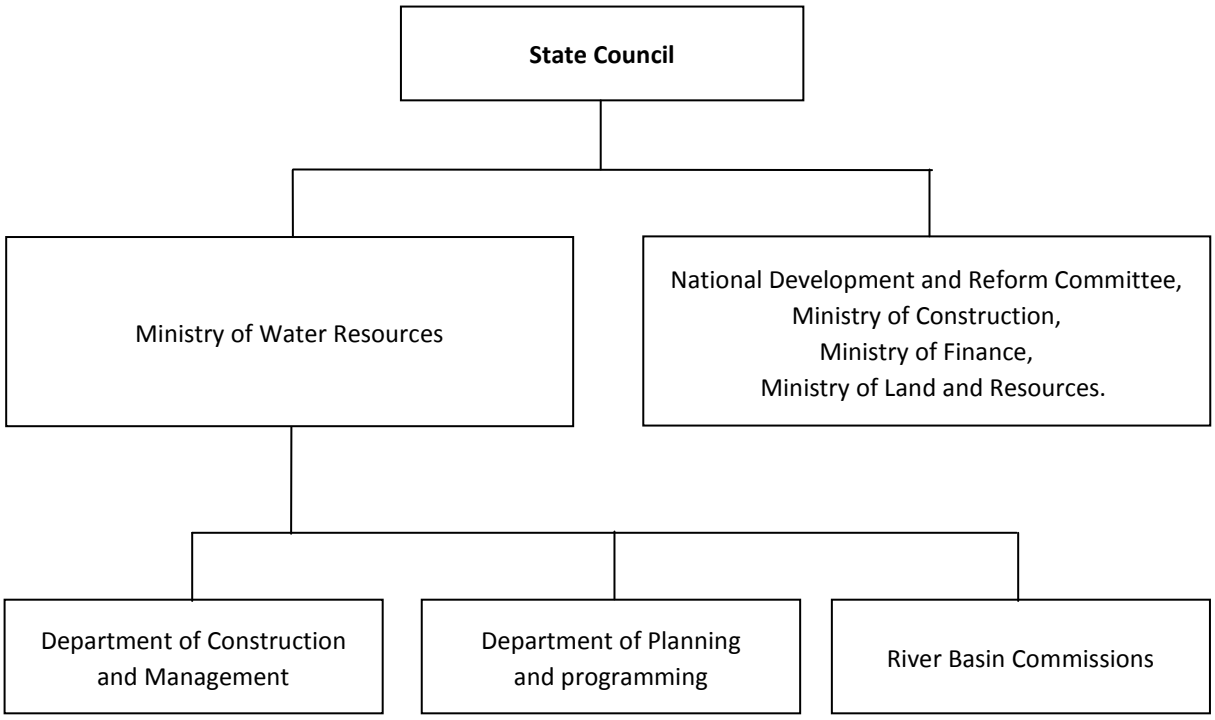


Figure 13 Daily flood control and disaster reduction management system in China

The routine management system on flood control and disaster reduction at all levels below the provincial level is similar to that at the national level.

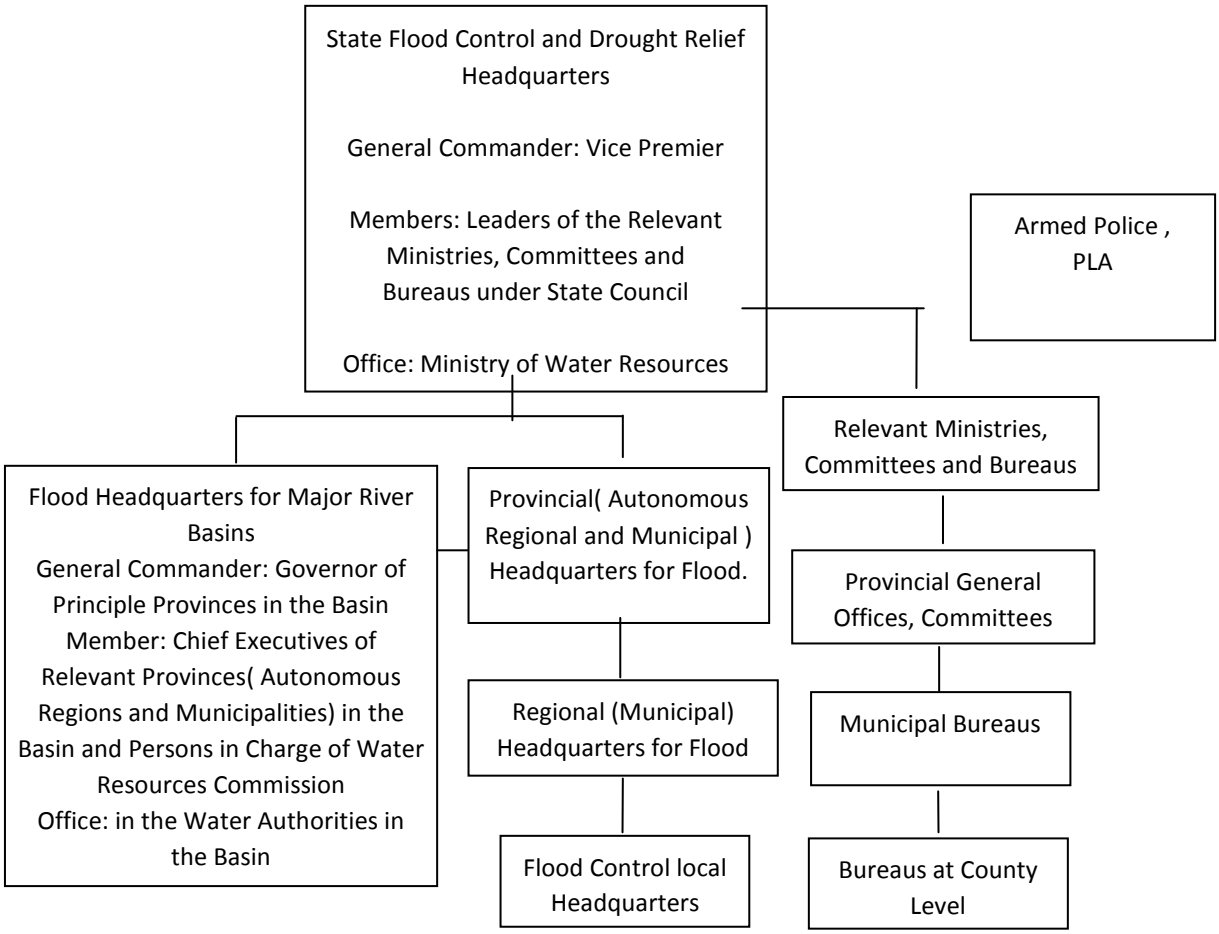


Figure 14 Emergency flood and disaster management system in China

6.3.3 Flood management measures

Structural measures

Flood control refers to structures on reducing flooding frequency of flood prone areas by changing the natural movement of rivers and floods.

After thousands of years of flood control, especially the large-scale infrastructure construction during the past 60 years, the system of flood control projects in China's main river basins has been developed composing of levees, reservoirs, the flood storage and detention area, and flood discharge channels. The main flood control areas in the middle and lower reaches of the big rivers were provided with the ability of controlling the maximum floods occurring in the 20th century. Flood control projects have been built in some medium and small river basins to protect towns, populated areas and extensive arable lands against medium and small scale floods. There are, however, few protective projects for flash floods and mudslides.

The drainage capability of most urban water-logging systems is designed to cope with floods arising from average rainfall intensities, which rapidly is proving inadequate. The drainage capacity of most farmlands have the standard 1 in 5 or 10 years, and in some important areas it is more than 1 in 10 years.

Non-structural measures

Non-structural measures refers to measures, which reduce the loss and effects of flood through managing and adjusting the actions of developments and flood control in flood risk areas or improving the recovery capability. The non-structural measures will almost not change the natural movement of floods.

Non-structural flood control measures taken by China include forecast warning, emergency responses (inspecting risks, dealing with risks, evacuation, relocation, etc.), aid after disasters, flood impact assessment, propaganda and education on flood control, among which China's emergency rescue organisation ability is ahead of most other countries.

Social support system

The social support system for the flood control and disaster alleviation refers to a system which offers support and services for the construction and operation of the above three systems (including scientific research, technology development, planning, design construction, etc.) , and also refers to the public spontaneous flood control and disaster alleviation behaviours.

In the long term, China has attached importance to the establishment of structural flood control systems. Therefore, support and service systems related to project constructions are comparatively sound and ahead of many other countries.

Public response to disaster preparedness has a long history in China, such as lifting the foundations of residences or building up DiaoJiao houses (i.e. suspended houses along rivers or ponds), spontaneous evacuation to avoid flood, constructing levees, planting of rice for flood season and wheat for dry season, assisting the disaster areas. Recently, inputs from NGOs and volunteers involved in flood control and disaster alleviation are growing, and becoming a new component of the social support system.

6.4 Problems in flood control

Although China's flood control and disaster reduction system currently can provide basic flood security for social stability and economic development as well as protection of people and property on the whole, it is accompanied by many imperfections and weakness as well as new challenges arising from the rapid development of the social economy. China's flood safety challenges mainly include flood control laws and regulations, flood control planning, construction and management of flood control system, flood emergency management, flood investment, socialisation management, high-tech flood application and scientific research.

6.4.1 Imperfect legislation and enforcement

Regulations provided by existing laws are flawed and imperfect affecting flood control and disaster reduction. Systems such as flood impact assessment, management of flood risk zoning, investment policies, insurance systems are not perfect or have not been established. A flood risk map would be one of the important supports for the flood risk management, but these do not yet have legal status.

The executive ineffectiveness of the existing laws and regulations also influences the improvement of flood control standards. For example, the Flood Control Act requires zoning the range of river management to ban the construction of buildings or structures that will impede flood discharge, dumping of garbage and waste, and other activities, which will affect the stability of river levee safety and impede flood discharge. As for local people, who live in river channels designated for discharge of floods, governments shall, in a planned and organised way, move those residents out. However, although the Flood Control Act has been in force for nearly fifteen years, the management ranges of a large number of river-lakes have not yet been designated. The phenomena of occupying the river channel and blocking the passage channels are very in common. The case of the great Zhouqu landslide disaster in 2010 is just the tip of the iceberg. The development of big and small "quasi-Zhouqu" events causes major risks for flood safety. The resettlement of residents living in the river channels has seen no substantial progress and the number of illegal river residents is increasing rather than falling.

Besides, there are few specific regulations for land use planning and management in areas with flood risk.

6.4.2 Lag in planning, and poor measures for extreme floods events

Urban flood control and water logging plans lag behind urban development. China is at the stage of the rapid urbanisation with an unprecedented expansion in the scale of urban construction and rapid expansion of city areas. But, the lack of urban flood control and drainage plans and their implementation due to long examination and approval times, have negative influence on avoiding and reducing flood and water-logging during the construction of cities.

Right now, the medium and small-sized river basin flood management has not yet been included in the unified planning of river basins and regions. If there is ignorance of the flood control safety of the whole river basin, blindly increasing of the flood control standards of small and medium-sized rivers and expanding the protection range, will bring extreme pressures and risks to the flood control of main streams and make the operation and management of flood control more difficult.

There are no clear counter-measures to deal with floods exceeding the normal flood standards. For 50 years, massive harnessing has been carried out on the big rivers improving the flood control ability to different extent. But, there are no efficient countermeasures to prevent catastrophic or extreme floods or flood events exceeding normal standards of flood control. At present the major rivers such as Yellow River, Yangtze River and the Huai River, Yongding River have their own plans to prevent catastrophic floods, which have been approved by the State Council. However, the prescribed measures have not been put into practice and the counter-measures mostly focus on the operation and management of the flood control, and rarely on other emergency counter-measures, which makes it difficult to deal with catastrophic flood.

6.4.3 Imperfect system of flood control and ineffective structural security

Among the approved flood control plans, there is some major or auxiliary infrastructure that still have not been built, thus it is hard to achieve the expected target of flood control. The standards of flood control and the social economic conditions in some areas are not taken into account, parts of the existing dykes and reservoirs need rehabilitation, and maintenance of the flood control infrastructure of many small and medium-sized rivers that should have been built long time ago is still neglected.

In a large number of the northern rivers, the flood discharge capacity has decreased substantially due to long-term drying-up, shrinking of river course, new physical barriers and the change of river regime, thus affecting the reservoir regulation and endangering the security of dykes. The security evaluation of flood control projects is lacking and the problems of aging, deterioration and disrepair have not been addressed for a long time, hence the security level of the infrastructure has decreased.

6.4.4 Low flood emergency management ability

The emergency management organisation system is still imperfect. Although the provinces, which have the task of flood control and drought relief, have set up flood control and drought relief institutions in provinces, cities, districts and counties, there are not special offices nor full-time staff in grassroots professional institutions. In addition, the flood control and drought relief institutions set up by towns and counties, villages or residential districts and communities are few. When the disaster occurs, the signal of early warning cannot be transmitted to the household and residents rapidly, and the information of disaster conditions cannot be reported easily, thus may have a side impact on the work of flood regulation and evacuation.

The coordination interaction mechanism of the departments of public works of the urban flood management has much room for improvement. Urban flood control works involve many departments, but the duties of the different departments are not divided definitely. There is overlap between the water conservancy bureau and the public utilities board in many cities in terms of the flood control and the flood drainage. The situation is that “feudal lords vying for the throne with the act of one’s free will”, thus severely wasting manpower and material resources on flood control and drainage. Meanwhile, there are conditions in which the different departments shuffle flood control duties, and this is unfavourable for the effective working of flood control in urban areas.

The emergency planning system is imperfect and has poor flexibility. The system of flood control emergency preparedness is composed of the flood control emergency planning of the nation, river basins, provinces, cities, districts and counties, villages, towns and communities, the special flood control emergency planning of different industries, and the emergency planning for the key protection areas as well as the planning for the key reservoirs and river courses. The current emergency planning system is still not perfect, and it is hard to implement the measures stipulated in the planning at high and medium-level, thus affecting the flood control and disaster alleviation. The conditions triggering early warning systems are not defined and there are random choices regarding the time when the actual early warning is made. In the flood emergency plans, the information, such as the methods of early warning, distribution of risk, evacuation routes, location for resettlement and the measures of self-protection, which is closely related to the life and property of the people, is relatively coarse, and it lacks clear definition. The flood control emergency plans of the grassroots organisations are not always operational affecting the efficiency of the important first-time emergency response.

The level of flood monitoring, forecast and early warning has much room for improvement. Many of China's websites, which collect the flood and disaster information provide inadequate information, especially in the areas of the small and medium-sized rivers and flash flood gullies, where the density of the station network is low. The information relating to rain, water, works and disaster cannot be provided comprehensively and definitely, and the effectiveness of information transmission is bad, leading to interruption of communication in the period of severe flood and delay of the moment for giving an alarm and rushing to deal with the emergency. Affected by the limitation of the monitoring data and technological level, the flood forecast precision of the urban flood, the small and medium-sized rivers and the flash flood gullies is low and its forecast period is short. The advanced disaster monitoring technology, cloud cluster forecast technology and flood simulation technology, which are based on remote sensing are not widely used.

The emergency flood mitigation schemes and infrastructure under construction are lacking or the measures are not implemented completely. Due to the imperfection of the flood control emergency management plans and measures in the phase of infrastructure construction, accidents such as barrier collapse during flood discharge and casualties caused by roadbed and wall collapse at building sites, or occupied or filled drainage channels and blocking of drainage pipe network, frequently happen during infrastructure construction.

6.4.5 Inadequate investment

China often has a wide-range fluctuation in flood control investment, and the amount of investment has direct connection with the scale of the flood and drought disaster. If there are flood disasters for consecutive years or serious floods in a certain year, the flood control investment would increase substantially, and it would decrease during periods with less floods.

The central and regional right of budgets and responsibility do not match. With China's deep reform of its system of tax distribution, budget centralisation and responsibility decentralisation makes local fiscal revenue smaller. The investment in water conservancy construction decreases relatively, especially in the central and western regions, which have difficulties providing the funding for flood control construction. The central and provincial governments are financially sound, but they do not take the corresponding responsibility for flood control construction.

The direction of investment is out of balance, especially directing investment into construction of the large and medium-sized water conservancy infrastructure and the reservoir projects result in the maintenance of the facilities of the flood control project does not have stable capital sources. Due to the lack of capital for management and repair, many flood control projects cannot implement the necessary maintenance, repair and reinforcement. The infrastructure also lacks the mechanism for financing of operation and maintenance leading to aging and disrepair, decreased quality and standard. Thus, the function of flood control cannot be brought into play normally.

6.4.6 Weak socialisation

Flood control and disaster relief involves the whole country. The nation and the related government agencies still have shortage in terms of mechanisms to guide and mobilize the whole society to participate in the flood control and disaster relief. The notification on water, works and disaster

conditions, notification of flood risk, adopted actions and the process of decision-making cannot be disseminated promptly to the whole society. The deficiency and imperfection of the public participation in the mechanism always leads to public incomprehension of the government intentions and incompatibility with the flood control measures, thus seriously affecting the effectiveness of the flood control and even causing unnecessary loss.

Publicity concerning flood risk, information propaganda and common sense education on flood control and disaster relief are weak. There are no warning signs or cautions informing on the flood risk in flood prone areas, such as the perimeter of river courses, the lower reaches of reservoirs, low-lying areas, tourist spots in mountain areas, mouths of drainage wells, the lower parts of overpasses, and underground spaces. There is not much education or information of urban residents on flood risks and the counter measures, especially the disadvantaged groups, such as the old, students and migrant workers, on popularisation of through the written media, broadcast, TV and Internet.

6.4.7 Scientific research needs to be deepened

With global climate change, the process of China's urbanisation and the development of economic society, urban flood and drought disasters present some new features. The change of landscape and human activities have an increasingly unfavourable impact on the runoff and flow concentration. Problems such as traffic blocking and suspension, collapse of dangerous and old housing, suspension of electricity supply, flooding of underground facilities caused by ponding in urban areas are prevailing. Thus, the social economy is weaker in the face of flood threats. There is an urgent need to develop and improve the methods and technology of hydrology analysis, flood analysis, flood disaster and evaluation of effects.

In terms of flood forecast, Chinese flood forecast models and flood analysis software have been left behind compared with foreign software in terms of availability, universality, standardisation and generalisation. Therefore, flood management authorities lack suitable software tools, thus affecting the working process when preparing flood control and drainage plans, developing flood forecast and alarm systems, carrying out assessment of flood effects and making up the risk map.

China's flood control information management and policy support system is repeatedly constructed at low levels and the information resources are difficult to share. Each system is independent, which not only makes it difficult to share resources but also creates great waste. Besides, the applications of new technologies such as satellite remote sensing, radar rainfall estimation, flood simulation, geological information and policy support are still at a weak level.

6.5 Future challenges in flood control

6.5.1 China's flood risk distribution & proportion is changing remarkably

In the first decade of the new century, the proportion of annual average economic losses arising from floods has decreased from 2.4% of GDP in 1990s to 0.6% (Figure 15), and the annual average death toll has decreased from more than 4,000 in 1980s to 1,400 (Figure 16).The construction of flood control system in China has undoubtedly played a great role in supporting the rapid economic and social development.

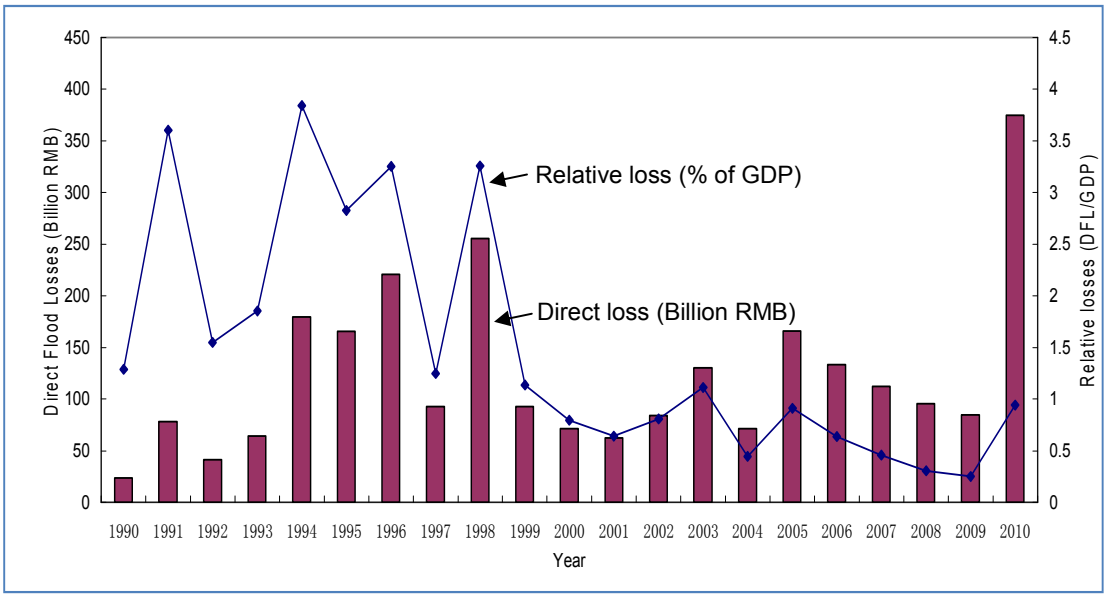


Figure 15 Changes in flood losses in China (1990-2010)

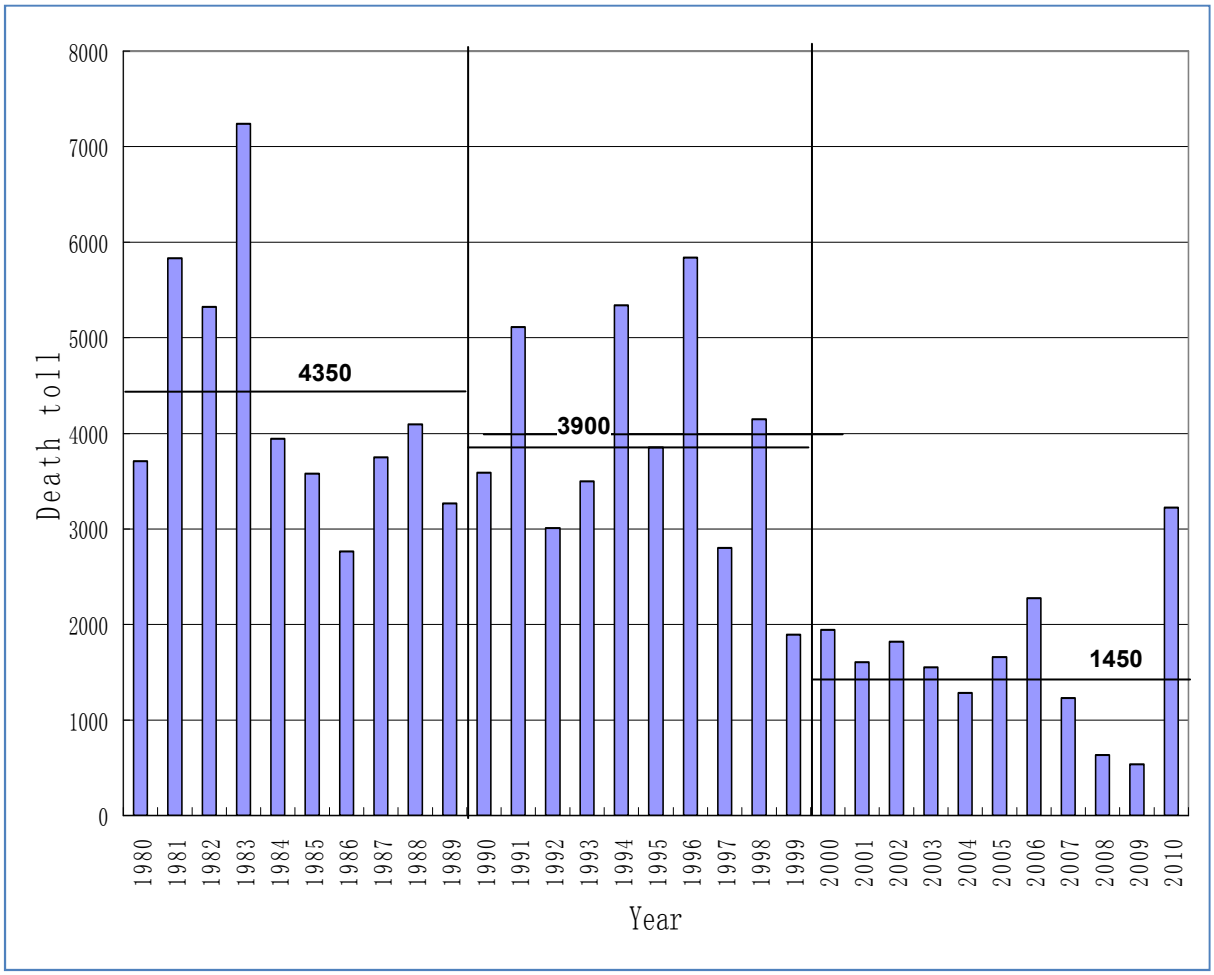


Figure 16 Death toll from floods in China 1990-2010

However, the floods occurring in recent years have sounded alarms once again. In 2010, the death toll and the assets losses resulting from floods in China have both exceeded those of great flood in 1998 (Figure 15 and Figure 16). However, the casualties were mainly caused in the medium and small rivers and by flash floods from mountain streams. In the flood season, 11 small-sized reservoirs collapsed and 8,800 embankments were breached. The death toll increased to 3,900 due to landslides and debris flows caused by flash flooding and unsecured construction projects, accounting for 92% of the total number of the dead and missing from floods in that year.

It's worth noticing that the direct economic losses from floods in 2010 reached RMB 375 billion, which was RMB 120 billion more than in 1998 (Figure 15). Only 35% of the direct economic losses were related to the sectors of agriculture, forestry, animal husbandry and fishery. The other 65% of the losses were in other sectors, such as the manufacturing, transportation, water works, etc. In 2010, there were over 250 cities at and above county level that experienced floods, most of which were caused by water-logging and inadequate water storage and drainage facilities. In 2011, there were 136 cities suffering from rainstorms and floods, including Beijing. Facts show that the distribution and type of flood risks in China is showing a remarkable change under the new circumstances of economic and social development, which has placed new demands and challenges on the flood control system.

6.5.2 Huge impact of rapid development and social transformation

China has entered a crucial stage in reform, opening up and modernisation. The location advantage of coastal areas resulted in rapid development. Opening up is now radiating inland and the urban population has exceeded 50% of the total population. Modernisation and industrialization, with rapid development and social transformation has brought about great impacts and pressures on flood control and security.

The drastic industrialisation and urbanisation process makes flood control even more complicated. But in order to enhance flood control suitable for the demands of economic and social development, the conflict of interest involved will become more acute, the restraining factors encountered will become rigorous and the cost spent will become higher.

The effect of urbanisation on the construction of flood control systems will not only be profound but also involve the overall situation. The urbanisation rate of China reached 36% by 2000 and 50% by 2012. At present urbanisation in China is at the peak of a rapid development with an annual growth rate of over 1%. Ten urban clusters or mega-cities are now emerging, such as Beijing-Tianjin, Shanghai-Nanjing, Chongqing-Chengdu and the Pearl River Delta. During this process, the current layout and management mechanism of flood control systems in urban areas will become more and more incompatible with the fast-expanding cities and the demand for a high level of water security. The relationship between the urban flood plans, urban development plans and the river basin flood control plans becomes more complex and important.

Meanwhile, as a great number of workers move from rural areas to urban areas, the previous workable and effective mechanism of farmers' volunteering on agricultural irrigation construction and river conservancy is difficult to maintain. The new flood control mode covering all aspects with successive inputs has not yet been formed. The probability of emergency discharge has increased after many reservoirs turn their main function from rural irrigation to urban water supply. However, faced with such

challenges generated or worsened under the new circumstances of economical and social development, they cannot be effectively coped with simply by strengthening the existing systems and measures.

Rapid urbanisation in China relies mainly on local budgets which depend mostly on land sales revenue. This urbanisation expansion mode of “the buildings above the ground come first and the underground infrastructures go second” makes the construction of flood control infrastructures in urban areas lag far behind. The short-term actions of the governments and the developers’ simple pursuit of benefits have left fatal risks on flood control in many cities. Moreover, the river and lake systems in urban areas have to provide for a greater demand in functions of resources, environment, landscape and ecology, which involves in many sectors such as water conservancy, urban construction, environmental protection, gardening, tourism and transportation. The independent management mode of each sector will inevitably hinder the flood control and drainage function of the urban rivers and lakes.

6.5.3 Limitations of the existing flood control system

As a rapidly developing country with a huge population, the fragile balance of water between different areas and between humans and nature will definitely be impacted greatly. Flood control will encounter many new issues. Restraining the increase of flood risks is a long-term arduous task.

1 The population of China is estimated to increase from 1.3 billion to 1.5 billion by the middle of this century. The demand on grains and land will become larger. The flood risk zone with relatively balanced water and land resources is unavoidable. The demand conflict on land between humans and water will be more prominent.

2 The proportion of urban population in China will increase from 37% at the beginning of this century to over 70% by the middle of this century. The remediation of urban rivers and urban flood control become more and more important. The control difficulty and the needed input will multiply. The enhanced demand of urban water supply security will make the reservoir functions more difficult to balance.

3 The natural flood regulation capacity of river courses will decrease. The peak discharge level during the flood season is likely to increase. The phenomenon of low flux rate with higher water level will become more frequent. The flood risk is increasing. How to get rid of vicious circle in flood control and create a new positive and interactive relationship between humans and the nature is urgently required.

4 Dependence on lifeline systems of water supply, electricity, gas supply, transportation, telecommunication and internet in the modern society becomes larger and larger. Once the flood occurs, the affected scope will be far beyond the actual flooded area. Due to the increase of population, assets density and vulnerability, the direct economic losses will be higher and higher. The indirect losses may greatly exceed the direct economic losses. A flood damage chain tends to come into being.

5 With the economic development and the improvement of people’s living standard, the public not only request the guarantee on life safety and minimisation of the loss, but also require basically

maintaining or rapidly recovering the normal production and living after disasters occur. The demand on flood control in the whole society is continuously increasing, thus the difficulty of flood control becomes larger.

6 It is difficult in a short term to reverse the trend of water crisis intensification with water disaster aggravation, water resource shortage and water environment deterioration as indicators. The relationship of flood risk between humans and the nature and between different areas becomes more acute. The difference in values make the conflicts in flood control become more difficult to coordinate.

7 The spatial and temporal distribution of rainfall will be more uneven due to the global climate change. Super typhoons and rainstorms will be more frequent, which makes it difficult for the existing water projects to reach the design standards. The rational scheduling of the hydropower systems will become more difficult.

8 China's investment on flood control will correspondingly increase with the economic and social development and the enhancement of comprehensive national strength. There is an urgent need to build a scientific flood control system on the basis of the characteristics of flood risks in order to guarantee the flood control safety and support the economic and social development.

Lake Tai Case Study

An analysis of the Tai Lake catchment shows the expected value of flood losses will increase by approximately 5 times from 2005 to 2050, when considering factors as the increase of rainfall and the rise of sea level (Figure 17). When solely considering the factors of urbanisation and economic development, the losses may also increase by about 5 times. But considering the combination of different development modes and climate change, the losses may increase by 15-30 times, while the economic growth is at a rate of 10 times. If flood control planning can be fully realised in Tai Lake area, the loss will decelerate, however, it will still increase by over 10 times.

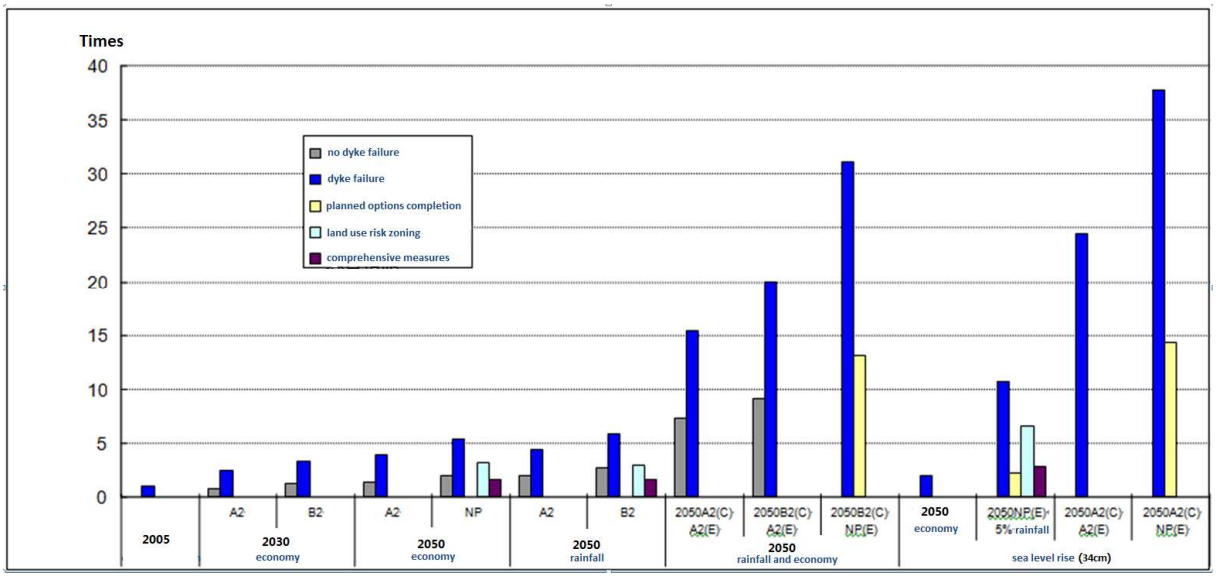


Figure 17 Modelling the costs of flood damage in the Tai Lake catchment for 2030 and 2050

Taking further measures on land use management and comprehensive flood control can effectively restrain the growth of flood risks. Under such circumstances, a 1 in 1000 year catastrophic flood would result in direct economic losses of RMB 120 billion, which is equal to that caused by Hurricane Katrina in the United States.

7 Reflections on flood strategy issues

7.1 Analysis and reflections

A broad number of issues relevant in this broad field of integrated flood management and flood control have already been identified. Firstly, we have referred to the concepts of “Room for Rivers”, “Living with Water” and “Keeping Water in the Landscape”. One thing that should be emphasised in this respect is that in many deltas in the world, particularly in the monsoon climates, the population has been “living with water” for thousands of years, working their rice fields and enjoying the benefits of the floods every year that rejuvenate their fields. This applies for instance to the Yangtze River Valley, the Mekong Delta, as well as the deltas of the major southern rivers in China. In that respect we should conclude that this concept of “Living with Water” is not new and certainly is not invented in Europe or the Netherlands. On the contrary, the principle of returning land to the river in order to make space and to accommodate large floods, as opposed to fighting against water or continuously raising the levels of embankments, is relatively new. This concept may have started in the Netherlands or elsewhere in Europe, but has also been well understood and applied in China.

Another recommendation is the advice to move from protection against floods to managing the consequences, i.e. the damages. In that respect the Flood Risk Management approach has been introduced. This implicitly encompasses a number of “soft measures”, i.e. non-structural measures that aim to reduce potential damages and casualties. They may include Flood Early Warning Systems, but also measures that connect flood management with spatial planning to reduce the risk. With the focus on risk, to protect assets and to reduce potential damages, there is a direct link to issues such as vulnerability, exposure and resilience.

Another important issue regarding the concept of flood risk is the relation between the selection of protection level (flood standard) and potential damage, i.e. expected losses. In fact, investments should be balanced with the reduction of expected damages, and therefore the value of existing assets basically should govern the protection level of specific areas as described in RBMP Technical Report 072 - Efficient Safety Standards for Ring-Dike Areas, which can be used by the Chinese government to (re)assess the optimum levels for protection of rural and urban areas. It is realized that so-far protection levels are often selected on basis of political or socio-economic reasons. However, with the cost-benefit approach described the RBMP report, it can be checked how realistic the existing protection levels/flood standards are in comparison with the value of assets to be protected.

Urban flood management differs substantially from overall integrated flood risk management due to the fact that in general the assets (protected value) are higher, but potential measures are quite different as in the urban environment there generally is a lack of space to implement large scale hydraulic infrastructure. Recently, in various parts of the world much attention has been paid to so-called

"Sustainable Urban Drainage Systems (SUDS)". That is a variety of (semi)structural and non-structural measures that will delay the runoff in the urban environment and thus reduce the pressure on the drainage system.

It should be realized that a broadening of integrated flood risk management or flood security in the way recommended above has serious consequences with regard to water governance. It is a fact that governance in the water sector in China is strongly fragmented, as many ministries have tasks and responsibilities in one of the water subsectors. In that respect reference is made to the document on the institutional setting for Water and Flood Management in the PRC on the SKE hard disk. Where about 10 years ago there was an expression on the "Seven dragons in the Water Sector", being the number of ministries involved in the water sector, recently one even speaks about 9 "dragons", as a result of restructuring of the ministries or more generally as a metaphor for the numerous conflicting interests.

It will be clear however, and is unavoidable, that a broadening of the approach for flood risk management will result in the need for better cooperation, both horizontally between ministries and provincial departments, and vertically between the various administrative layers: national, province, city, district, etc. In an interview for the research of this project, a senior staff member of MWR stated that one of the major problems presently is the lack of control mechanisms from the national government level to lower administrative layers. Due to the decentralization process of the last decades, local administration can more or less do what they want with regard to spatial planning and land use. Consequently, construction of industrial, business or residential complexes may be implemented in floodplains, lake areas and/or retention basins without much coordination. Even the existing River Basin Commissions have hardly any instruments to control such development.

It should also be clear that there will be a need for better and more open exchange of data and information in the water sector. Almost 10 years ago MWR issued a new regulation with a clear statement that all data and information in the water sector would be publicly available, starting as per the date of issue. This is supported by a regulation of the State Council, which by Law stated that all stakeholders should share the system and information on basic hydrology and hydraulic monitoring results[5]. However, it seems that the situation hardly has changed as other players apparently did not recognize the authority of MWR in this respect, and even institutions under MWR still see data and information as an asset/investment. Consequently a lot of information is not available for public use, for either security reasons, or for financial reasons. These aspects, the lack of coordination and (non)availability of data and information are considered serious constraints for a good functioning of integrated flood management.

As mentioned in the previous chapters already, even though the No.1 Document seems to focus mainly on infrastructure and water conservation, it is clear that there are sufficient links and statements that will support a broadening of flood management to the newer concepts of integrated flood risk management.

7.2 Informed decision making

It is recognized in the No.1 Document and the EU Floods Directive as well as in several other reports and papers that efficient flood control and flood risk management requires in-depth knowledge of the

[5] Regulation on Hydraulics and Hydrology, Chapter 4, Article 26. State Council 2007

natural system. In present times there are many tools and technologies that can assist us to achieve such knowledge (Figure 18). These tools and techniques can help to predict the behaviour of the natural system under various scenarios and strategies, and therefore can be very helpful in so-called “Informed Decision Making”, i.e. the selection of measures and strategies combined of hard (structural) and soft (non-structural, managerial) measures. In this respect the following tools/techniques can be mentioned:

- Decision Support Systems (models, pre- and post processors)
- Flood Early Warning Systems (FEWS)
- Digital Terrain Models, or Digital Elevation Models (DEM)
- Geographic Information Systems (GIS)
- Hydrological models (rainfall-runoff, rainstorm)
- Flood mapping techniques (2-D simulation of flooding depth and duration)
- Modelling the water system (hydraulic models)
- Flood forecasting models (combined Meteo + FEWS+ hydraulic models)
- Data bases and information networks
- Multi-Criteria Analysis techniques (MCA)
- Cost-Benefit Analysis tools (CBA)

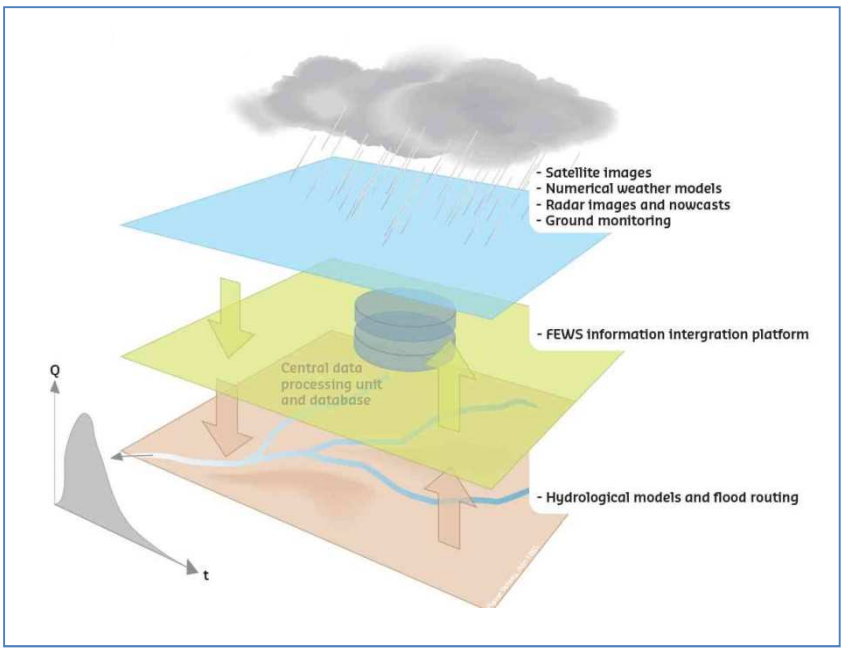


Figure 18 Informed decision making - from early warning to flood forecasting

7.3 Concluding remarks

It will be clear that flood control / flood management in China asks for reform and policy change. In this report many issues have been identified that could contribute to such reform and policy change.

It may be concluded that, in order to increase flood security, a broadening of flood management in China will be necessary. This broadening mainly relates to the shift from a structural approach to an integrated approach with a mix of structural, non-structural and managerial measures. Further it calls for a shift from hazard to risk management, and to include issues like vulnerability, exposure and resilience in the approach. It also will require a change in governance, as institutional issues presently hamper optimum flood management. This relates to horizontal and vertical coordination and cooperation, but also to a free exchange of data and information regarding the water system.

In the spirit of the so-called Three Red Lines strategy, which actually not really refers to flood security, all the observations, conclusions and recommendations regarding the desired reform and policy change can be summarized in eight “Blue Lines”. These Blue Lines can be considered focus areas for future flood risk management, i.e. statements that characterize the necessary changes to move to effective management of the flood risk:

- From structural to non-structural measures
- From reactive to pro-active measures
- From hazard to risk management
- From danger to safety management
- From single objective to integrated management
- From single ministry responsibility to partnerships
- From single stakeholders to society
- From poverty to wealth management

Implementation of these Blue Lines would greatly improve flood management in China, for the benefit of the country and the society.

8 Literature

8.1 The knowledge repository at DRC

During the study the Flood Risk Strategy Experts have collected a large number of documents, papers, reports, speeches and presentations. Some of these documents were updated or upgraded, while others more or less remain valid for the present situation in China. A list of all the material which was collected and stored in the SKE Knowledge Repository Hard Disk is included as Appendix 4.

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Appendix 1

Appendix 1 National Flood Protection Standards for China

On 02 June 1994, the General Administration of Quality Supervision, Inspection and Quarantine of the People's Republic of China and the Ministry of Housing and Urban-Rural Development jointly issued of the national Standard for Flood Control (GB50201-94), making regulations on protection of objects such as urban areas, rural areas, industrial and mining enterprises, communication and transportation facilities, water conservancy and hydroelectric power projects, power facilities, communication facilities, cultural relics and historic sites and tourist facilities, concerning the prevention and control of storm flood, snowmelt flood and rain-on-snow mixed flood.

According to Standard for Flood Control, cities shall be classified into four grades according to their importance of social and economic status and their non-agricultural population. T

Grades and Standard for Flood Control of the Cities

Grade	**Importance**	**Non-agricultural Population (wan = 10,000's)**	**Flood Control Standard (Recurrence Period) (years)**
Ⅰ	Very Important Cities	≥ 150	≥ 200
Ⅱ	Important Cities	150 ～ 50	200 ～ 100
Ⅲ	Medium-sized Cities	50 ～ 20	100 ～ 50
Ⅳ	Ordinary Cities and Towns	≤ 20	50 ～ 20

All the protection areas, which mainly consist of rural areas, counties and towns (Rural Protection Areas) shall be classified into four grades against their population and agricultural acreage and protected as follows.

Grades and Standard for Flood Control of Rural Protection Areas

Grade	**Population of the protection area (wan = 10,000's)**	**Agricultural land within the protection area (ten thousand mu)**	**Flood Control Standard (Recurrence Period) (years)**
Ⅰ	≥ 150	≥ 300	100 ～ 50
Ⅱ	150 ～ 50	300 ～ 100	50 ～ 30
Ⅲ	50 ～ 20	100 ～ 30	30 ～ 20
Ⅳ	≤ 20	≤ 30	20 ～ 10

All the industrial and mining enterprises such as metallurgical, coal, petroleum, chemical, forestry, building material, machinery, light manufacturing, textile and commercial businesses shall be classified into four grades according to their sizes and protected as follows.

Grades and Standard for Flood Control of **Industrial and Mining Enterprises**

Grade	**Industrial and Mining Enterprises (Size)**	**Flood Control Standard (Recurrence Interval) (years)**
Ⅰ	Very large	200 ～ 100
Ⅱ	Large	100 ～ 50
Ⅲ	Medium	50 ～ 20
Ⅳ	Small	20 ～ 10

Appendix 2

Appendix 2 Guiding Opinions for Strengthening Urban Flood Control Planning

(SGJ[2011] No. 649)

Translated by Dr. Furen JIANG

All Departments (Bureaus) of Water Resources (Water Affairs) of all provinces, autonomous regions and municipalities directly under the Central Government, and the Bureau of Water Resources of the Xinjiang Production and Construction Corps:

To implement the Decision on Accelerating Reform and Development in Water Conservancy by the Central Committee of the CPC and the State Council (ZF (2011) No.1) and relevant deployment of the Central Conference on Water Conservancy on accelerating the construction of infrastructure for urban flood control and water-logging drainage, to conscientiously strengthen urban flood control and water-logging drainage, improve urban ability to control flood, drain water-logging, reduce natural disasters, and ensure the safety of people and property, and the operation of the cities. Ministry of Water Resources conducts and proposes the Guiding Opinions for Strengthening Urban Flood Control Planning and hereby issue to you. Please seriously implement accordingly.

December 16, 2011

Guiding Opinions for Strengthening Urban Flood Control Planning

Ministry of Water Resources

To implement the Decision on Accelerating Reform and Development in Water Conservancy by the Central Committee of the CPC and the State Council (ZF (2011) No.1) and carry out the spirit of the Central Conference on Water Conservancy, to promulgate urban flood control plan in a scientific way, conscientiously strengthen urban flood control and waterlogging drainage work, improve urban ability to control flood and drain water-logging, reduce natural disasters, and ensure the safety of people and property and the operation of the cities. The following opinions are hereby proposed for strengthening urban flood control planning:

I. Attach great importance to urban flood control work and strengthen the organisation and leadership of flood control planning

1 New situations are faced by the urban flood control work:

Most cities in China are situated along the banks of rivers, lakes and seas and somehow threatened by floods, sea tides and water-logging. Along with the rapid economic and social development and the accelerating process of urbanisation as well as the increasing urban population and ever-expanded scales of cities, it has become more demanding on guaranteeing the flood security. However, the

construction of facilities for flood control and waterlogging drainage is still lagging in most cities, thus resulted from adopting lower standards for flood control and water-logging drainage, irrational project layout, imperfect institutional system, aged and poor repair facilities, and weak emergency tools and measures. Therefore the safety of people and property and the operation of the cities are prone to flood or storm attacks. Hence, it is very important and imperative to strengthen the construction of facilities for urban flood control and waterlogging drainage.

2 Urban flood control planning system needs to improve.

The urban flood control planning is an important basis to guide urban flood control and strengthen urban flood control management according to law, and lays the foundation for the construction of flood control and water-logging drainage facilities. In the 1990s, the Ministry has organised and guided the compiling urban flood control plans in different cities across the country, which played an important part in the orderly construction arrangement of urban flood control projects for the improvement of the cities' abilities of flood control and disaster reduction. With the revision or modification of the overall planning in different cities in recent years, the flood control protected areas in most cities have been expanded. More targets need to be expanded, and the standards of flood control have been improved as well. Therefore, the urban flood control plans need to be recompiled or revised to keep a balance between urban flood control and water-logging drainage, urban development, land use and environmental protection. Efforts shall also be made to rationally arrange the rooms for floods, work scientifically out a layout for flood control, water-logging drainage and disaster reduction system, and specify the overall objectives, main tasks and countermeasures of urban flood control, water-logging drainage and disaster reduction in the coming future.

3 Establish new mechanism on urban flood control planning.

As stated in the Flood Control Law of the Peoples Republic of China, local governments at all levels shall be responsible for the urban flood control work. Urban flood control plans shall be compiled by local governments through organising water, construction and other relevant administrative authorities. The duties and responsibilities of water administrative authorities and relevant authorities and units shall be defined, efforts shall be made to establish a planning mechanism with tiered responsibility and inter-sectoral collaboration for promoting the compilation and implementation of urban flood control plans. The compiling of urban flood control plans shall be financed by the local urban governments.

II. Consider overall and define rationally layout of urban flood control and water-logging drainage system

4 Define the guiding ideologies for urban flood control planning.

The urban flood control planning shall follow the guidance of scientific outlook on development, put the safety of people and property first, uphold the people-oriented philosophy and strive for the harmonious coexistence between mankind and water, take overall consideration of the needs of between flood defence, urban water-logging drainage, municipal engineering construction, environmental control, water-related ecological protection and rehabilitation, and urban water landscape, define rational standards for urban flood control and water-logging drainage, take

scientifically structural and non-structural measures for flood control and water-logging drainage for improving urban overall capability of flood control and waterlogging drainage.

5 Establish the basic principles for urban flood control planning.

First, adhere to people-first principle. Improve the overall capacity of urban flood control and water-logging drainage for ensuring the safety of people and property. Second, adhere to overall consideration. Take overall consideration of urban flood control security, the use of water resources, the control of water environment, protection of water ecology, water culture building. Coordinate flood control requirements between basins and regions, and in new and old parts in same city. Combine external flood and internal water-logging, and municipal and flood control construction. Promote the coordination of urban development and flood control and waterlogging drainage. Third, adhere to the combination of structural and non-structural measures. Not only to formulate fundamental solutions, but also work hard to establish flood control and waterlogging drainage system and monitoring, forecasting, early warning and other non-structural measures, and strengthen the management of flood control and waterlogging drainage. Fourth, adhere to the convergence between the short-term and long-term construction. Keep both the status quo and future in mind in accordance with the needs of the development of the cities and coordinate the construction of short-term and long-term urban flood control and waterlogging drainage projects. Fifth, adhere to the combination of regular and emergency measures. Not only to focus on the management of the construction of urban flood control and waterlogging drainage projects, but also to pay attention to the improvement of the cities' capability of urban flood control and emergency management.

6 Zoning scopes of urban flood control protection and flood risk management.

It is necessary to take into account the short-term and long-term development of the cities in accordance with the overall plan of their social and economic development and their relations with adjacent rivers and water systems to zone the scope of urban flood control protection, which shall not only cover the existing urban areas but also leave space for the future development of the cities. Carry out overall evaluation of the cities' ability of flood control and waterlogging drainage and rationally zone areas for urban flood risk management, chart flood risk maps, determine the risk levels and identify the scope of flood control and waterlogging drainage management. During urban construction, none occupy the river courses and lakes. Evaluation of flood impact must be conducted and approved competent water administrative authorities for the lands and construction facilities in natural detention basins, temporal detention basins for flood exceeding the designed level or other flood detention and storage places.

7 Define standards for urban flood control and water-logging drainage.

The standards for urban flood control and water-logging drainage should be defined based on the requirements of the flood control planning in the river basin or region, while the regional flood control planning shall conform to basin flood control planning in accordance with the population, economic and social factors in the cities and relevant rules and regulations of the state. Characteristics of flood and waterlogging, existing engineering conditions and urban development shall be taken into full account for defining specific standards for the flood control in different areas such as the central part of the city, urban-rural fringe areas, suburbs and emerging economic development zones. For those

protected targets that are extremely important or special demands on flood control and waterlogging drainage, the standards shall be raised as appropriate but the necessity and feasibility of the raising of standards shall be proved and reported to competent water administrative authorities for approval.

8 Demonstrate overall layout of the urban flood control and water-logging drainage.

The overall layout of urban flood control of the cities shall be in harmony with that of its river basins and regions. The upstream reservoirs, urban embankment, river training, near flood storage and detention areas, and flood diversion ways shall be taken into considerations to select the best proposals and establish urban flood structural system to prevent external floods based on flood control plans the basin or region. Arrange rationally system of water-logging reduction including the drainage courses, inland lakes, lower lands, sewer networks, and pump stations in accordance with the overall plan of urban development. The impact of urban flood structural system on the basin, region, and neighbouring cities should be demonstrated based on the requirements of flood control in the whole basin, local region, and the city with well-established flood control and water-logging drainage systems. If any impact, take necessary remedial measures to address the influence. In addition to strengthening of the structural system, efforts shall also be made to establish non-structural systems for urban flood control organs with command and dispatch, operation management, emergency response and rescue, and set up a complete information release platform including forecast, prediction, early warning and so on.

III. Highlight priorities and develop major measures for Urban Flood Control and water-logging drainage

9 Arrange scientifically structural measures for urban flood control.

Propose engineering measures to prevent external flood, water-logging, flash flood, and rainstorm for the flood hazards prone to cities.

10 Plan structural measures in detail for urban water-logging drainage.

Take overall consideration of urban flood control and waterlogging drainage, strengthen the research and evaluation of rainstorms in urban areas. Formulate scientific standards for urban water-logging drainage. Propose engineering layout for water-logging drainage facilities including drainage channels, pipeline network, and pump stations and for rainfall infiltration and collection and storage. Make use of detention spaces including lakes and lower lands.

11 Establish and improve warning system for urban flood control and water-logging drainage.

Further improve the layout of urban rain and water gauge station network. Establish sound urban flood modelling and hydrological monitoring system based on urban geographical information system. Enhance the monitoring and emergency monitoring ability, and improve the monitoring and forecast schemes. Enhance prediction and forecast ability of storm and flood disasters. Establish sound warning system of urban flood control and water-logging drainage. Ensure the timely release of information.

12 Enhance emergency management ability of urban flood control.

Based on the actual situations of the cities, plan competent organs, search and rescue teams, supplies and equipment, and communications support and so on. Establish emergency response and rescue working mechanism with unified command, rapid response, close collaboration, and effective interaction. Devise social mobilisation schemes, carry out publicity and education, and improve the awareness and ability of the general public to participate in the fight against and prevention of disasters.

13 Strengthen emergency project construction of flood control and waterlogging drainage.

According to urban characteristics and actual situations, define construction procedures and fund raising schemes of emergency response projects for urban flood control and waterlogging drainage in the plan, Clear the formulation, review, approval, fund raising, organisation and implementation of construction schemes for emergency response projects under different circumstances.

IV. Make considerate arrangement and devise management measures for urban flood control and water-logging drainage

14 Strengthen urban preparedness scheme system for flood control and water-logging drainage.

According to the current situation, tasks and responsibility of urban flood control and water-logging drainage, define the urban preparedness scheme system frameworks, covering the overall preparedness scheme of urban flood control and water-logging drainage, specific preparedness schemes for built districts, suburbs, inner rivers, lake, external rivers, reservoirs, flash flood, and typhoon and so on, special preparedness schemes for overpasses, flooded streets, pipe drainage, pump station and water gate and so on, key region preparedness scheme for enterprises and public institutions, schools, residential quarters, underground space and key facilities and so son, and temporal preparedness schemes of flexible working hours or leave against flood and water-logging for government offices, enterprises, public institutions and schools. Promulgate emergency response plans for high risk inundated areas based on flood risk zoning.

15 Strengthen regulation of urban flood control projects needs.

The urban flood control regulation involves many departments such as water, transportation, electricity, meteorology, urban construction, gardens, municipal engineering and urban management. The planning shall make clear regulation schemes and responsibilities of flood control and waterlogging drainage projects under the overall framework of the urban flood command authority, and specify the responsibilities, scope and other coordination needed of different departments in regulation and management to avoid confusion such as duties and responsibilities and the absence of management.

16 Strengthen social management of urban flood control and waterlogging drainage.

Formulate social management measures of urban flood control according to the risk levels of flood control and waterlogging drainage in different regions. Strictly demonstrate the influence of flood so as to strengthen the protection and management of exiting and planned flood detention areas and guide

the urban construction to keep away from risk areas. Raise requirements on the management of flood control and waterlogging in underground space and low-lying areas to promote the coordination between urban development and flood control and waterlogging drainage.

17 Propose implementation plans for urban flood control.

According to the local economic power and importance of the projects, propose suggestions of the phased implementation opinions on urban flood control items in urban flood control plan, and implement the plan in accordance with the procedure of construction. The construction funds for structural and non-structural measures proposed in the urban flood control plan are mainly raised from the financial budget, basic infrastructure investment, urban construction maintenance tax, and river regulation funds by the local governments. If conditions permit, the construction could attract the participation of social funds.

5. Standardise procedures and speed up the review and approval progress of urban flood control plan

18 Compile (revise) urban flood control plan.

Compile urban flood control plans based on the selection of best selected water conservancy planning, survey and design units with corresponding qualification. The flood control plan of flood control in national key and important cities (see the attachment) shall be compiled by those with A-class qualification, and that of other cities could be compiled by units with B-class or above qualification. The compilation of urban flood control plan shall draw on advanced experience both at home and abroad, make innovations of guidelines and tools based on flood control plans in the basin and the region of local government at the next higher level. Strengthen the plan and policy coordination, and improve the quality of plan compilation, and ensure that the plan could meet the overall demands of the urban development and fit in with the flood control requirements in the river basin and the region.

19 Review technically urban flood control plan.

The compiled urban flood control plan shall be submitted to the water administrative authority under local government at the same level to apply for review. The flood control plan of flood control in national key cities shall be reviewed by the water administrative authority of State Council, and that of flood control in national important cities shall be initially reviewed by the water administrative authority of local government at the next higher level and then submitted to the basin authorities for review. The plans of other cities shall be submitted to water administrative authority at the provincial level for review and related basin management authorities for appraisal.

20 Approve urban flood control plan.

The flood control plan of flood control in national key cities, after passing the review, shall be submitted by local urban government to the government at provincial level for approval, while that of other cities shall be submitted by the water administrative authority to local government at the same level for approval. The approved plans shall be incorporated into the urban overall plan.

21 Time limit of the compilation of urban flood control plan.

Cities (including counties) responsible for flood control shall lose no time to compile or revise their urban flood control plans. The compilation, revision and approval of flood control plans in all cities responsible for flood control are supposed to be completed within two years, while those that have completed the compilation of plans shall revise and improve the plans as appropriate in pace with urban development.

Attachment:

31 National Key Cities Responsible for Flood Control:

Beijing, Tianjin, Panjin, Shenyang, Changchun, Jilin, Harbin, Jiamusi, Qiqihaer, Shanghai, Nanjing, Anqing, Bengbu, Hefei, Huainan, Wuhu, Jiujiang, Nanchang, Jinan, Kaifeng, Zhengzhou, Huangshi, Jingzhou, Wuhan, Changsha, Yueyang, Guangzhou, Liuzhou, Nanning, Wuzhou, Chengdu

54 National Important Cities Responsible for Flood Control:

Handan, Shijiazhuang, Taiyuan, Baotou, Hohhot, Anshan, Dalian, Dandong, Fushun, Daqing, Mudanjiang, Changzhou, Suzhou, Wuxi, Xuzhou, Yangzhou, Hangzhou, Ningbo, Quzhou, Wenzhou, Fuyang, Huangshan, Ma'anshan, Tongling, Fuzhou, Quanzhou, Xiamen, Zhangzhou, Ganzhou, Jingdezhen, Shangrao, Qingdao, Zibo, Xinyang, Changde, Yiyang, Shantou, Shenzhen, Zhanjiang, Zhuhai, Beihai, Guilin, Haikou, Mianyang, Yibin, Chongqing, Guiyang, Kunming, Lhasa, Xi'an, Lanzhou, Xining, Yinchuan, Urumqi.

Appendix 3

Appendix 3 Flood Control Law of the PRC

FLOOD CONTROL LAW OF THE PEOPLE'S REPUBLIC OF CHINA

(Adopted at the 27th Meeting of the Standing Committee of the Eighth National People's Congress on August 29, 1997, and promulgated by Order No. 88 of the President of the People's Republic of China on August 29, 1997)

Contents

Chapter I General Provisions

Article 1 This Law is enacted with a view to preventing and controlling flood, taking precautions against and alleviating calamities by flood and waterlogging, maintaining the safety of people's lives and property, and safeguarding the smooth progress of the socialist modernization construction.

Article 2 The work for flood control shall observe the principles of unified planning, overall consideration, focusing on prevention, integrated measures for treatment and subordinating local interests to general interests.

Article 3 The construction of flood control works should be incorporated into the national economic and social development plan.

Flood control funds shall be raised according to the principle of combining government input with rational payment by beneficiaries.

Article 4 The exploration and protection of water resources should be subject to the overall arrangements for flood control and observe the principle of combining the promotion of advantages with the elimination of disadvantages.

The control of rivers and lakes and the construction of flood control works should conform to the comprehensive plans for river basins and be integrated with the comprehensive exploration of water resources in river basins.

The comprehensive plans referred to in this Law mean those for the exploration of water resources and the prevention and control of water disasters.

Article 5 The work for flood control shall be carried out in the light of river basins or administrative areas and according to a system by which unified planning shall be implemented at different levels and consideration given to the administration of river basins as well as the administration of administrative areas.

Article 6 All units and individuals shall have the obligations to protect flood control works and to take part in flood control and flood fighting according to law.

Article 7 People's governments at all levels should intensify the unified leadership over the work for flood control, organize departments and units concerned, mobilize social forces, depend on scientific and technological progress, harness rivers and lakes in a planned way and take measures to enforce the construction of flood control works in order to consolidate and enhance flood control capacity.

People's governments at all levels should organize departments and units concerned and mobilize social forces to ensure flood control and flood fighting and reconstruction and relief work after flood or waterlogging calamities.

People's governments at all levels should lend support to flood storage and detention areas and provide compensations and aids according to the state provisions after flood storing and detaining.

Article 8 The water conservancy administrative department under the State Council shall, under the leadership of the State Council, be responsible for routine duties of organization, coordination, supervision and guidance for flood control nationwide. River basins administrative agencies set up by the water conservancy administrative department under the State Council for major rivers and lakes as designated by the state shall perform duties of coordination, supervision and administration of flood control within their jurisdiction as provided for by laws and administrative regulations and authorized by the water conservancy administrative department under the State Council.

The construction administrative department and other relevant departments under the State Council shall, under the leadership of the State Council, be responsible for relevant work of flood control within their scope of powers and duties. Water conservancy administrative department s under local people's governments at or above the county level shall, under the leadership of the people's governments at the same level, be responsible for routine duties of organization, coordination, supervision and guidance for flood control within their respective administrative areas. Construct ion administrative departments and other relevant administrative departments under local people's governments at or above the

county level shall, under the leadership of the people's governments at the same level, be responsible for relevant work of flood control within their scope of powers and duties.

Chapter II Flood Control Planning

Article 9 Flood control planning refers to the overall arrangement for the prevention and control of flood and waterlogging calamities in a certain river basin, river course or region, including river basin flood control planning for major rivers and lakes designated by the state, flood control planning of other rivers, river courses and lakes as well as regional flood control planning.

Flood control planning should be subject to the comprehensive planning of a certain river basin or region. Regional flood control planning should be subject to the flood control planning for a certain river basin.

Flood control planning constitutes the bas is for the control of rivers and lakes and the construction of flood control works.

Article 10 Flood control planning for major rivers and lakes designated by the state shall, in accordance with comprehensive river basin planning for these rivers and lakes, be formulated by the water conservancy administrative department under the State Council in conjunction with other relevant departments and the people's government (s) of the province (s), autonomous region (s) and municipality (s) concerned directly under the Central Government, and submitted to the State Council for approval.

Flood control planning for other rivers, river courses and lakes or regional flood control planning shall, separately in accordance with comprehensive river bas in planning and comprehensive regional planning, be formulated by water conservancy administrative department s under local people's governments at or above the county level in conjunction with other relevant departments or regions, submitted to the people's governments at the same level for approval and then submitted to the water conservancy administrative departments under the people's governments at the next higher level for the record. Flood control planning for rivers, river courses or lakes involving two or more provinces , autonomous regions and municipalities directly under the Central Government shall be drafted by the administrative agency for the relevant river basin in conjunction with the water conservancy administrative departments and other relevant departments under the people's government (s) of the province (s), autonomous region (s) and municipality (s) directly under the Central Government wherein the river, river course or lake drains water and, after the people's government (s) of the province (s), autonomous region (s) and municipality (s) involved directly under the Central Government examines it and comes up with comments, be submitted to the water conservancy administrative department under the State Council for approval.

Urban flood control planning shall, in accordance with the river basin flood control planning and the regional flood control planning of the people's government at the next higher level, be formulated by the water conservancy administrative department, the construct ion administrative department and other relevant administrative departments under the people's government of a city which shall organize those administrative departments in the formulation of the planning, and be included into the overall urban planning subject to approval through the examination and approval procedures stipulated by the State Council. Amendment to flood control planning should be subject to the approval from the original approval organ.

Article 11 The formulation of flood control planning should, following the principle of ensuring key projects and considering others at the same time, and integrating flood control with drought fighting, engineering measures with non--engineering measures, take full account of the flood--drought law, the relation of the upper and lower reaches and of both banks of a river, and the requirements for flood control in the national economy, and be coordinated with the national land planning and the overall land use planning as well.

Flood control planning should include the protected objects, aims and tasks of flood control, flood control measures and act ion plans, delimit the flooded area, the flood storage and detention area and the flood control protected area, and determine the principle for use of the flood storage and detention area.

Article 12 Local people's governments at or above the county level in coastal areas which are threatened by storm tides should include the prevention of storm tides into the flood control planning within their respective areas , strengthen the construct ion of systems of anti--storm tides works including seawalls (sea dykes), tidewater gates and coastal shelter--forest, and supervise the design and construct ion of buildings and constructions that should meet the requirements for the prevention of storm tides.

Article 13 Local people's governments at or above the county level in areas where flash floods may trigger landslides, collapses and mud--rock flows and in other area where flash floods frequently occur should organize the departments in charge of geological and mineral administration, water conservancy administrative department s and other relevant department s to conduct a general investigation on hidden dangers of landslides, collapses and mud--rock flows, to delimit zones for focal control, and to take prevention and control measures.

Distribution of cities, towns and other inhabited areas as well as factories , mines and trunk lines of railways and highways should avert the threat of flash floods; for those having been built in places threatened by flash floods, precautions should be taken.

Article 14 Local people's governments concerned in areas liable to waterlogging such as plains, depressions, river networks and embankment areas, valleys and basins should formulate planning for elimination and control of waterlogging, organize relevant departments and units to take corresponding control measures, ,improve drainage systems, develop types

and varieties of waterlogging--enduring crops and take integrated measures for controlling flood and water logging, drought, saline and alkaline land.

People's governments of cities and towns should strengthen the administration and construction of waterlogging drainage piping systems and pumping stations in urban areas.

Article 15 The water conservancy administrative department under the State Council should, in conjunction with the relevant departments and the people's governments concerned of provinces, autonomous regions and municipalities directly under the Central Government, formulate the planning for controlling estuaries in the Yangtze River, Yellow River, Pearl River, Liao River, Huai River and Hai River.

Reclaiming land from seawaters in estuaries mentioned in the preceding paragraph should conform to the planning for controlling estuaries.

Article 16 Land to be used for realignment of river courses as planned in flood control planning and land to be used for dykes in planned construction projects may be delimited as planned reserve zones upon verification by the land administrative department and the water conservancy administrative department in conjunction with the involved areas, and submitted for approval of the people's government at or above the county level within the scope of powers authorized by the State Council. If land within the planned reserve zones involves that to be used in other projects, the land administrative department and the water conservancy administrative department should consul t with departments concerned for verification of land.

The planned reserve zones should be announced upon delimitation according to the provisions of the preceding paragraph.

No industrial or mining facilities not related to flood control may be constructed within the planned reserve zones. If special circumstances exist under which it is really necessary for state industrial and mining projects to occupy land within the planned reserve zones mentioned in the preceding paragraph, approval should be obtained according to the procedures set by the state for capital construct ion and consultations should be made with the relevant water conservancy administrative department.

Land to be used for expanding or exploring man--made floodwater drainage channels as determined in flood control planning may be delimited as planned reserve zones to which the provisions in the preceding paragraph shall apply upon verification by the land administrative department and the water conservancy administrative department of the people's government at or above the provincial level in conjunction with other relevant departments and regions and submitted for approval of the people's government at or above the provincial level within the scope of powers authorized by the State Council.

Article 17 Construction of flood control works or other hydraulic works and hydropower s tat ions in rivers and lakes should conform to the requirements of flood control planning. Reservoirs

should keep adequate storage capacity for flood control according to the requirements of flood control planning.

When the feasibility study report for flood control works or other hydraulic works and hydropower stat ions stipulated in the preceding paragraph is submitted for approval pursuant to the procedures set by the state for capital construction, a consent document for planning issued by the relevant water conservancy administrative department which conforms to the requirements of flood control planning should be enclosed as an appendix.

Chapter III Control and Prevention

Article I8 For the prevention and control of flood in rivers, attention should be paid to flood storage as well as to flood discharge. The smooth drainage of floodwater should be ensured by giving full play to flood drainage capacity of river courses and flood redistribution and storage functions of reservoirs, depressions and lakes, intensifying the protect ion of river courses and taking measures to remove and dredge silt at regular intervals in line with local conditions.

For the prevent ion and control of flood in rivers, measures should be taken to protect and expand the coverage of forest, grass and other vegetation in river basins, conserve water resources and intensify the comprehensive control of water and soil conservation in river basins.

Article 19 In the realigning of river courses and building up construction projects for leading the river direction or protecting embankments, full consideration should be given to the relations between the lower and upper reaches and between both sides of a river and the planned realigning and leading line be followed.

The direction of a river shall not be changed at will.

Planned realigning and leading lines for major rivers designated by the state shall be worked out by river basin administrative agencies and submitted to the water conservancy administrative department under the State Council for approval.

Planned realigning and leading lines for other rivers or river courses shall be worked out by water conservancy administrative departments under local people's governments at or above the county level and submitted to the people's governments at the same level for approval. Planned realigning and leading lines of rivers or river courses involving two or more provinces, autonomous, regions and municipalities directly under the Central Government and of boundary river courses of provinces, autonomous regions and municipalities directly under the Central Government shall, under the leadership of river basin administrative agencies concerned, be worked out by water conservancy administrative departments under the people's governments of provinces, autonomous regions and municipalities directly under the Central Government of involved rivers or river courses and, after the people's governments concerned examine the proposed lines and

come up with comments, submitted to the water conservancy administrative department under the State Council for approval.

Article 20 Where the realignment of river courses or lakes involves navigable waterways, full consideration should be given to the requirements for navigation and views solicited in advance from the administrative departments for transportation.

The realignment of navigable waterways should conform to the safety requirements for flood control in rivers and lakes and views solicited in advance from the water conservancy administrative departments.

The realignment of river courses in rivers which are suitable for bamboo and log rafting or in fishery water areas should take into account the needs for bamboo and log water transportation and fishery development and views should be sought in advance from the administrative departments for forestry and fishery. The bamboo and log rafting in river courses should not affect the safety of flood passage and flood control works.

Article 21 The control of rivers and lakes shall follow the principle of unified control in line with water systems combined with control at different levels in order to strength the protect ion and ensure the smooth passage.

Main courses of major rivers and lakes designated by the state, major river courses and lakes involving two or more provinces, autonomous regions or municipalities directly under the Central Government, boundary rivers and lakes of provinces, ,autonomous regions or municipalities directly under the Central Government as well as river courses and lakes which serve as national boundaries (borderlines) shall, according to the designation of the water conservancy administrative department under the State Council, be under the control of river bas in administrative agencies and water conservancy administrative departments under the people's government s of provinces, autonomous regions and municipalities directly under the Central Government in the place where rivers and lakes are drained. Other river courses and lakes shall, according to the designation of the water conservancy administrative department under the State Council or its authorized agencies , be under the control of water conservancy administrative departments under local people's governments at or above the county level.

The scope of control for any river course or lake with embankments shall include the water area, sandbanks, beaches, the flood passage area, the embankments and dyke protect ions between the embankments on both s ides. The scope of control for any river course or lake without embankments shall include the water area, ,sandbanks, beaches and the flood passage area between the all-time high flood levels or the designed flood levels.

The scope of river courses and lakes under direct control of river basin administrative agencies shall be delimited by river bas in administrative agencies in conjunction with local people's governments concerned at or above the county level in accordance with the provisions of the preceding paragraph. The scope of control for other river courses and lakes

shall be delimited by local people's governments concerned at or above the county level in accordance with the provisions of the preceding paragraph.

Article 22 The use of land and shore lines within the scope of control for any river course or lake should conform to the requirements for flood discharge and water flow.

Within the scope of control for any river course or lake it is prohibited to construct buildings or structures impeding flood discharge, dump garbage and waste residues or engage in activities affecting the stability of river flows, harming the safety of banks and embankments or other activities impeding flood discharge in river courses.

It is prohibited to plant trees or long-stalk crops impeding flood discharge in river courses used for flood discharge.

Restrictions of speed should be imposed in river courses where navigation of ships may endanger the safety of embankments. Marks for speed restrictions shall be set up upon the consultation between administrative departments for transportation and water conservancy.

Article 23 Enclosing a lake for cultivation is prohibited. Those reclaimed lakes should be put in order according to the standards set by the state for flood control and restored from farmland in a planned way.

Enclosing river courses for cultivation is prohibited. If enclosure is really necessary, scientific authentication should be carried out and on confirmation by the water conservancy administrative department that there is no impediment of flood discharge and water flow, submitted to the people's government at or above the provincial level for approval.

Article 24 Local people's governments should in a planned way organize residents to move out of river courses for passage of floodwater.

Article 25 Administrative agencies for rivers and lakes shall organize the planting and maintenance of protective trees along banks and embankments. Protective trees along banks and embankments shall not be felled without authorization. If anyone intends to fell them, he must obtain the consent from administrative agencies for river courses and lakes, go through the formalities for a felling licence and complete the task of regeneration and planting of trees as required.

Article 26 For those bridges, approaches, wharves and other engineering structures across a river which seriously intercept or block water, the water conservancy administrative department concerned may, according to the flood control standards, report to the people's government at or above the county level that will, within the scope of powers provided by the State Council, order the construction unit to rebuild or dismantle them within a time limit .

Article 27 The construction of bridges, wharves, roads, ferries, pipelines, cables and engineering structures for tapping or draining water which need to cut across rivers, through rivers or embankments, or to stand on rivers should conform to flood control standards, shore lines planning, navigation requirements and other technical requirements, and shall not endanger

the safety of embankments, affect the stability of river conditions or impede the smooth passage of floodwater. Before the feasibility study report of the involved project is to be submitted for approval according to the procedures set by the state for capital construction, the engineering construction scheme included in the report should be subjected to the examination and approval of the relevant water conservancy administrative department in accordance with the requirements for flood control as mentioned above.

If engineering structures mentioned in the preceding paragraph need to occupy land within the scope of control for any river course or lake, or to cut across the space over any river course or lake, or to go through riverbeds, ,the construction unit should subject the pos it ion and border of the engineering structures to the examination and approval of the relevant water conservancy administrative department before completing the formalities for starting the projects according to law. In the arrangement for the construct ion project, the position and border should be followed as approved by the water conservancy administrative department.

Article 28 The water conservancy administrative department shall have the right to inspect engineering structures constructed according to the provisions of this Law within the scope of control for river courses or lakes. When the water conservancy administrative department exercises inspect ion, the inspected should truthfully provide the information and materials concerned.

The acceptance of engineering structures mentioned in the preceding paragraph upon completion should be taken part in by the water conservancy administrative department.

Chapter IV Administration of Flood Control Areas and Flood Control Works

Article 29 A flood control area means an area where floodwater is likely to inundate, which is classified as a flooded area, a flood storage and detention area or a flood control protected area.

A flooded area means an area to which floodwater reaches without the protect ion of works.

A flood storage and detention area means a depression or a lake from outside embankments including flood--diversion mouths for temporarily storing floodwater

A flood control protected area means an area protected by flood control works according to flood control standards.

The scope of a flooded area, a flood storage and detention area or a flood control protected area shall be delimited in the flood control planning or the flood prevent ion scheme, reported to the people's government at or above the provincial level according to the scope of powers provided for by the State Council and if approved, announced to the public.

Article 30 People's governments at all levels should, according to flood control planning, exercise administration of the use of land within different flood control areas.

Article 31 Local people's governments at all levels should strengthen leadership over the safety and construct ion work within flood control areas and organize relevant departments and units to conduct flood control education among units and residents within flood control areas, to popularize flood control know-how and to enhance their awareness of flood control.

They should, according to flood control planning and flood prevent ion schemes, establish and perfect the flood control system as well as systems for hydrology, meteorology, communications, early warning and monitoring of flood and waterlogging in order to improve the capability for flood control. They should organize units and residents within flood control areas to actively take part in flood control work and take measures for flood control and flood evasion in the light of local conditions.

Article 32 People's government s of provinces, autonomous regions and municipalities directly under the Central Government in places where flooded areas or flood storage and detention areas are located should, as required by flood control planning, organize relevant departments and units to formulate safety and construction work plans for flooded areas and flood storage and detention areas, to bring under control population growth within flood storage and detention areas, to move residents in a planned way out of flood storage and detent ion areas which are frequently in use, and to take other necessary safety and protective measures.

Regions and units directly benefiting from flood storage and detention areas should bear obligations of compensation and aid to flood storage and detent ion areas as required by the state. The State Council and relevant people's government s of provinces, autonomous regions and municipalities directly under the Central Government should establish a system to support and give compensations and aids to flood storage and detent ion areas.

The State Council and relevant people's government s of provinces, autonomous regions and municipalities directly under the Central Government may formulate measures for control of safety and construction within flooded areas and flood storage and detention areas and measures for giving support, compensations and aids to flood storage and detention areas.

Article 33 Where a construct ion project not intended for flood control is to be carried out within a flooded area or a flood storage and detention area, the possible impact of floodwater on the construct ion project and the possible impact of the construction project on flood control should be assessed, a flood impact assessment report be provided and precautions be put forward.

When submitted for approval according to the procedures set by the state for capital construction, the feasibility study report of the construction project should include the flood impact assessment report having been examined and approved by the relevant water conservancy administrative department.

Flood impact assessment reports for oilfields, railways, highways, mines, power plants, telecommunications installations and pipelines to be built within flood storage and detent ion

areas should include flood control and flood evasion plans arranged by construction units themselves. When the construction project is to be put into operation or use, their flood control works should pass the acceptance by the water conservancy administrative department. Houses built within flood storage and detention areas shall have flat roofs.

Article 34 Flood control work should focus on large and medium--sized cities, trunk lines of major railways and highways as well as large--sized key enterprises and their safety be guaranteed.

Cities, economic development zones, industrial and mining areas and important state agricultural production bases under the threat of floodwater should be protected as key areas and necessary flood control works constructed. 1n urban construction, no one may, without authorization, stuff or block up originally existing river courses, ditches, branching streams and waterlogging lakes, pools or depressions, or demolish originally existing embankments used for flood control. If it is really necessary to stuff or block up or demolish them, consent should be obtained from the water conservancy administrative department and the case be reported to the people's government of the city for approval.

Article 35 The scope of administration and protection of state--owned flood control works should be determined by people's governments at or above the county level according to the state provisions before the completion and acceptance of the projects according to the approved design.

The scope of protect ion of collective--owned flood control works should be determined according to the provisions of people's governments of provinces, autonomous regions and municipalities directly under the Central Government Within the scope of protection of flood control works, exploding, drilling wells, quarrying stones, collecting earth or other operations endangering the safety of flood control works are prohibited.

Article 36 People's governments at all levels should organize the relevant departments to intensify the regular inspection, supervision and administration over dams of reservoirs. For those dams in danger which fail to conform to the designed flood standards and anti-earthquake defence requirements, or have serious quality defects, the department in charge of the dams should organize the relevant units to take measures to eliminate dangers and reinforce dams, set a time limit to get rid of dangers or rebuild dams, and the relevant people's governments should give priority to funds needed. For reservoirs whose dams are likely to collapse, emergency measures for rush repair and schemes for temporarily evacuating residents should be worked out in advance.

People's governments at all levels and the relevant administrative departments should strengthen the supervision and management of tailings dams and take measures to avoid the collapse of dams in floodwater.

Article 37 No unit and individual may damage, occupy or destroy flood control works such as dams, embankments, sluices, bank revetments, pumping stations and drainage systems,

hydrological and communications facilities and stand--by apparatuses and materials for flood control.

Chapter V Flood Control and Flood Fighting

Article 38 The administrative heads of people's governments at all levels shall assume overall responsibility for the work of flood control, with different levels and different departments responsible for part of work under a centralized command.

Article 39 The State Council establishes the state flood control headquarters responsible for leading and organizing the flood control and flood fighting work nationwide, with its agency in the water conservancy administrative department under the State Council.

The flood control headquarters for major rivers and lakes designated by the state may be established and formed by persons in charge of the relevant people's governments of provinces, autonomous regions and municipalities directly under the Central Government and persons in charge of the administrative agencies for these rivers and lakes, which shall take control of the flood control and flood fighting work within their jurisdiction and have their agencies in the administrative agencies for rivers and lakes.

Local people's governments at or above the county level responsible for flood control and flood fighting shall establish flood control headquarters formed by persons in charge of the relevant departments, local garrisons and the people's armed forces departments. Under the leadership of the flood control headquarters at the next higher level and the people's governments at the same level, the flood control headquarters shall take control of the work of flood control and flood fighting and have their agencies in the water conservancy administrative departments at the same level. When necessary, the flood control headquarters may, subject to the decision of people's governments of cities , establish city district agencies under the construction departments with responsibility for handling routine duties of flood control and flood fighting in urban districts under the unified leadership of the flood control headquarters.

Article 40 Local people's governments at or above the county level responsible for flood control and flood fighting shall, in accordance with the comprehensive plans for river basins, in the light of the actual conditions of flood control works and based on the flood control standards set by the state, formulate the flood prevention schemes (including the measures for dealing with catastrophic floods).

Flood prevention schemes for the Yangtze River, Yellow River, Huai River and Hai River shall be formulated by the state flood control headquarters and submitted to the State Council for approval. Flood prevention schemes for other rivers involving two or more provinces, autonomous regions and municipalities directly under the Central Government shall be formulated by the relevant river basins administrative agencies in conjunct ion with the relevant people's government s of provinces, autonomous regions and municipalities

directly under the Central Government and submitted to the State Council or its authorized agency for approval. 0n approval, the flood prevention schemes shall be carried out by the local people's governments concerned.

Flood control headquarters at all levels and departments or units responsible for flood control and flood fighting must make preparations for flood control and flood fighting according to the flood prevent ion schemes.

Article 41 Flood control headquarters under people's government s of provinces, autonomous regions and municipalities directly under the Central Government shall, according to the law of floods in their localities, fix the starting and ending date for flood seasons.

When the water situation of any river or lake approaches the guaranteed water level or the safety flow capacity, or when the water level of any reservoir approaches the level of design flood, or when a great danger occurs to flood control works, the flood control headquarters under the relevant people's government at or above the county level may declare an emergency flood season.

Article 42 Obstacles in river courses or lakes which impede flood passage shall, according to the principle of whoever places the obstacles will remove them, be removed within a time limit by order of the flood control headquarters.

If obstacles have not yet been removed within the time limit, the flood control headquarters shall organize a forcible removal at the expense of the person who placed the obstacles.

During the emergency flood reason, the state flood control headquarters or its authorized flood control headquarters in provinces, autonomous regions and municipalities directly under the Central Government shall have the right to take emergency measures against bridges, approaches, wharves and other engineering structures across a river which seriously intercept or block water .

Article 43 During the flood reason, departments concerned of meteorology, hydrology and oceanology should provide real--time information on weather and hydrology as well as forecasts of storm t ides for the relevant flood control headquarters within their respective functions and duties, the telecommunications departments should give priority to providing services for communications for flood control and flood fighting, and departments concerned of transportation, electricity and supply of materials should give priority to providing services for flood control and flood fighting.

The People's Liberation Army, the People's Armed Police Forces and the militia should perform duties of flood fighting and emergency operations entrusted by the state.

Article 44 During the flood reason, the use of reservoirs, sluices, dams and other water engineering structures must be subjected to the command, control and supervision of the relevant flood control headquarters.

During the flood season, no reservoir may store water above the flood season restricted level without authorization and the use of flood control capacity beyond the flood season restricted level of any reservoir must be subjected to the command, control and supervision of the relevant flood control headquarters During the melting ice flood season, any reservoir upstream a river or lake responsible for the control of melting ice flood must obtain the consent of the relevant flood control headquarters and be subject to its supervision when discharging its flow down stream.

Article 45 During the emergency flood season, the flood control headquarters shall, according to the requirements for flood control and flood fighting, have the right to al locate material s, equipment, means of transport and manpower within their jurisdiction and to make decisions for collecting earth, occupying land, felling trees, removing obstacles blocking water and taking other necessary emergency measures. When necessary, departments for public security and traffic control shall, according to the decision of the flood control headquarters, execute traffic control on land and in water areas.

Materials, equipment and means of transport allocated according to the provisions of the preceding paragraph should be returned promptly after the flood season. If they have been damaged or are unable to be returned, proper compensations should be given or other measures be taken according to the relevant state provisions. Those who collected earth, occupied land or felled trees shall apply to the competent department for completing required formalities according to law after the flood season. The local People's government concerned shall organize the reclamation of land on which earth was collected and organize the planting of trees In the place where trees were felled.

Article 46 Where the water level or the flow of any river or lake attains the flood divers on standards of the state which needs to put a flood storage and detention area in use, the State Council, the state flood control headquarters the flood control headquarters of the river basin, the people's government and the flood control headquarters of the province, autonomous region or municipality directly under the Central Government shall, according to the conditions for starting the use of a flood storage and detention area and approval procedures stipulated in the approved flood prevention scheme, make a decision on starting the use of the flood storage and detention area. No unit or individual may obstruct or delay the use of a flood storage and detention area. In the event of someone's obstruction or delay, the relevant local people's government at or above the county level shall execute the use forcibly.

Article 47 After the occurrence of flood and waterlogging, the relevant people's government should organize the relevant departments and units to ensure the relief work in the disaster area in respect of supply of necessities health care and immunity, supply of relief materials, public security, resumption of classes, resumption of production and rebuilding of homes as well as repairing of various engineering structures destroyed in floodwater within its jurisdiction.

The renovation of flood control works should take precedence in the annual construction plans of the relevant departments.

The state encourages and supports the flood insurance.

Chapter VI Guarantee Measures

Article 48 People's governments at all levels should take measures to improve the overall level of flood control allocations.

Article 49 Realignment of rivers and lakes and construction and maintenance of flood control works shall, according to the principle of consistency of business power and financial power, and with responsibility divided at different levels, be financed by the Central authorities and local authorities respectively. The construction and maintenance of flood control works in cities shall be financed by the people's governments of cities.

Enterprises and institutions in charge of oilfields, pipelines, railways mines, electric power and telecommunications in flood-threatened areas shall raise funds by themselves to build up necessary self-securing flood control works.

Article 50 The Central finance should allocate funds for flood fighting and emergency operations when embankments and dams of major rivers and lakes designated by the state suffer catastrophic floods and waterlogging and for renovation of flood control works destroyed by floodwater. People's governments of provinces, autonomous regions and municipalities directly under the Central Government should allocate funds from financial budgets at their level for flood fighting and emergency operations In areas afflicted by catastrophic floods and waterlogging within their administrative regions and for renovation of flood control works destroyed by floodwater.

Article 51 The state establishes a fund for water conservancy projects for the purpose of the maintenance and construction of flood control works and water conservancy works. The State Council shall stipulate the specific measures for this fund.

The provinces, autonomous regions and municipalities directly under the Central Government threatened by floodwater may, for the purpose of strengthening the construction of flood control works and improving the capacity for flood control within their administrative regions and according to the relevant provisions of the State Council, stipulate the levying of a fee for construction, maintenance and administration of river course projects within flood control protected areas.

Article 52 Local people's governments at all levels responsible for flood control should, according to the relevant provisions of the State Council, assign village compulsory labour and accumulative labour at a proper ratio for the construction and maintenance of flood control works.

Article 53 No unit or individual may intercept or appropriate funds and materials for flood control and disaster relief.

Auditing organs of people's governments at all levels should strengthen the supervision through auditing of the use of funds for flood control and disaster relief.

Chapter VII Legal Liability

Article 54 Any violator of the provisions of Article I7 of this Law who, without his consent document for planning approved by the water conservancy administrative department, builds flood control works or other hydraulic works and hydropower stat ions on rivers and lakes shall be ordered to stop the illegal act and complete the formalities for the consent document for planning.

In case where violation of requirements in the consent document for planning seriously affects flood control, the violator shall be ordered to dismantle his works within a time limit. In case where violation of requirements in the consent document for planning affects flood control but remedies can be taken, the violator shall be ordered to take remedies within a time limit and may be concurrently fined not less than RMB 10,000 yuan and not more than RMB 100,000 yuan.

Article 55 Any violator of the provisions of Article 19 of this Law who fails to follow the planned realigning and leading line to realign river courses and build up construct ion projects for leading the river direction or protecting embankments shall, if the flood control work is affected, be ordered to stop the illegal act, restore to the original state or take other remedies and may be concurrently fined not less than RMB 10,000 yuan and not more than RMB 100,000 yuan.

Article 56 Any violator of the provisions of the second and third paragraphs of Article 22 of this Law who commits one of the following acts shall be ordered to stop the illegal act, remove the obstacles or take other remedies and may be concurrently fined not more than RMB 50,000 yuan.

(1) constructing buildings or structures impeding flood discharge within the scope of control for river courses and lakes;

(2) dumping garbage and waste residues or engaging in activities affecting the stability of river flows, harming the safety of banks and embankments or other activities impeding flood discharge in river courses within the scope of control for river courses and lakes; or

(3) planting trees or long--stalk crops impeding flood discharge in river courses used for flood discharge.

Article 57 Any violator of the provisions of the second paragraph of Article 15 and Article 23 of this Law who reclaims land from seawaters or encloses a lake or river course for cultivation shall be ordered to stop the illegal act, restore land to the original state or take other remedies and may be concurrently fined not more than RMB 50,000 yuan. If the violator neither restores

land to the original state nor takes other remedies, the competent department shall do so at his expense.

Article 58 Any violator of the provisions of Article 27 of this Law who fails to obtain approval for its engineering construction scheme from the relevant water conservancy administrative department, or fails to follow the posit ion and border as approved by the water conservancy administrative department in engaging in the construct ion of engineering structures within the scope of control for river courses and lakes shall be ordered to stop the illegal act and to complete the formalities for examination and approval. If the construction of engineering structures seriously affects the flood control work, the violator shall be ordered to dismantle them within a time limit. If he fails to do so within the time limit, the competent department shall dismantle them forcibly at the construct ion unit's expense. If remedies can be taken for impact on the discharge of flood, the violator shall be ordered to take remedies within a time limit and may be concurrently fined not less than RMB 10,000 yuan and not more than RMB 100,000 yuan.

Article 59 Any violator of the provisions of the first paragraph of Article 33 of this Law who fails to provide a flood impact assessment report for a construction project not intended for flood control within a flooded area or a flood storage and detention area shall be ordered to make corrections within a time limit. If he fails to do so within the time limit, the violator shall be fined not more than RMB 50,000 yuan.

Any violator of the provisions of the second paragraph of Article 33 of this Law who puts the construction project in operation or use while the flood control works have not yet passed the acceptance by the water conservancy administrative department shall be ordered to stop the product ion or use, pass the acceptance of the flood control works within a time limi t and may be concurrently fined not more than RMB 50,000 yuan.

Article 60 Any violator of the provisions of Article 34 of this Law who, without authorization, stuffs or blocks up originally existing river courses , ditches, branching streams and waterlogging lakes, pools or depressions, or demolishes originally exiting embankments used for flood control in urban construction shall be ordered by the people's government of the city to stop the illegal act, restore to the original state or take other remedies.

Article 61 Any violator of this Law who damages, occupies or destroys embankments, sluices, bank revetments, pumping stations, drainage systems or other flood control works, or hydrological or communications facilities, or stand--by apparatuses or materials for flood control shall be ordered to stop the illegal act, take remedies and may be concurrently fined not more than RMB 50, 000 yuan. If damage has been caused, the violator shall bear civil liability according to law. Should an administrative penalty be given, the Regulations on Administrative Penalties for Public Security shall apply. If a crime has been constituted, criminal liability shall be investigated according to law.

Article 62 Whoever obstructs or threatens any functionary of the flood control headquarters, water conservancy administrative departments or river basin administrative agencies who performs duties according to law shall, If a crime has been constituted, be investigated for

criminal liability acording to law. If a crime has not been constituted and administrative penalty for public security should be given, the Regulations on Administrative Penalties for Public Security shall apply.

Article 63 Whoever intercepts or appropriates funds and materials for flood control and disaster relief shall, If a crime has been constituted, be investigated for criminal liability according to law. If a crime has not been constituted, administrative sanctions shall be given.

Article 64 Administrative penalties and administrative measures stipulated in this Chapter with exception of the provisions in Article 60 of this Law shall be decided by water conservancy administrative departments of people's governments at or above the county level, or by river basin administrative agencies within the scope of powers provided for by the water conservancy administrative department under the State Council. However, administrative penalties for public security stipulated in Articles 61 and 62 of this Law shall be decided by organs as provided for in the Regulations on the Administrative Penalty for Public Security.

Article 65 Any state functionary who commits one of the following acts shall, if the act has constituted a crime, be investigated for criminal liability according to law. If a crime has not been constituted, administrative sanctions shall be given.

（1）in violation of the provisions of Article 17, Article 19, the second or third paragraph of Article 22, Article 27 or Article 34, affecting flood control seriously;

（2）abusing power, neglecting duties or engaging in malpractices for personal gains resulting in heavy losses to the flood control and flood fighting work

（3）refusing to implement the flood prevention schemes, flood control and emergency operational instructions or flood control operational plans such as flood storage and detention plans or measures, or dispatching and operation plans in flood seasons; or

（4）in violation of the provisions of this Law, causing or aggravating flood losses to contiguous regions or other units.

Chapter VIII Supplementary Provision

Article 66 This Law shall come into force as of January, 1998.

Appendix 4

Appendix 4 Content of Flood Risk Management Folder in DRC Knowledge Repository Hard Disk

Folder: 01 ADB Flood Management Strategy 2006

- National Flood Management Strategy Study, Final Report March 2006

Folder: 02 Chinese documents and presentations

- Chinese Documents
  - 2011-01 No.1 Document
  - 2011-01 No.1 Document US Translation
  - 1998 Flood Control Law of the PRC
  - 111227 CN Standards for Flood Control
  - Guiding Opinions for Strengthening Urban Flood Control Planning
  - Current Situations and Challenges of the System on Flood Control in China (English and Chinese version)

- Chinese Presentations
  - 121214 Brussel No.1 Document EN PPT
  - Flood Mapping PPT Cheng XiaoTao
  - DWHR Flood and Drought Disaster Reduction PPT
  - Yangtze-DongTing lake basin changes

Folder: 03 Dike Monitoring

- Brochure Diverse Dike
- Brochure DAM
- Brochure Smart Levees
- FLIMAP Generic Presentation

Folder: 04 Dutch documents and presentations

- Dutch Documents
  - Research Achievements Flood Management & Regulation Technology
  - Institutional Structure in the Netherlands
  - Resilience strategies for flood risk management in the Netherlands

- Dutch Presentations
  - Room for Rivers PPT
  - 6 Basic Room for River measures

- Deltares Approach to Flood Risk Management PPT
- Presentation Water Governance in NL
- Presentation Financing Water management in NL

Folder:05 EU Documents and Presentations

- EU Documents
  - EU Blueprint Leaflet

- EU Presentations
  - EU Water Framework Directive, Principles and Implementation PTT
  - Expert Briefing DRC – 8 March 2012

Folder: 06 Flood Early Warning Systems

- Demo-Simulations-Movies
  - Demo-movie World Rainfall patterns
  - Demo-movie Nargis typhoon simulation
  - Demo-movie world1Azie
  - Demo-movie tsunami-Japan2
  - Demo-movie Bangkok flooding

- Introduction to Delft-FEWS and Global Flood Model
  - Presentation Introduction FEWS and GFM

- Introduction to Delft-FEWS
  - Presentation Introduction Delft-FEWS
  - FEWS Deltares pdf-file

Folder: 07 Flood Probability Analysis Storm Surge Barrier HuangPu-Shanghai

- Phase 2 Final Report Shanghai Barrier
- Paper Copula Approach Shanghai Barrier
- Thesis Joe Nai-Flood Probability Analysis Shanghai Barrier
- Phase 1 Summary Shanghai Barrier report
- Phase 1 Full Report Shanghai Barrier

Folder: 08 Flood Security Economist

- Memo213 pdf.file
- Discussion62 pdf file
- Presentation kind_Xynthia 20111215

Folder: 09 HaiHe Flood Management project

- Report HaiHe Flood Management Project
- Presentation HaiHe IFRM final workshop, PPT

- Paper IAHR Conference Hai Flood Management

Folder: 10 HongKong Drainage Masterplan Project

- Flood Management Paper WP9
- Annex to the Flood Management Paper WP9
- Sustainable Urban Drainage Systems (SUDS, 3 parts) WSP5

Folder: 11 Institutional Setting Water&Flood Management

- Institutional setting in the PRC
- Institutional structure in the Netherlands

Folder: 12 Lower Mekong Basin – Flood Vulnerability Indices

- Presentation LMB Vulnerability study PPT

Folder: 13 Miscellaneous (Folder)

- Flood Management PPT-Real Time Safety Regulation Technology

Folder: 14 SAMA Flood Management Game

- SAMA General Introduction PPT 2012
- Notes for Presentation
- SAMA Flood Simulation description document

Folder: 15 UK Flood Papers

- Long Term Investment Strategy – EA
- Foresight Future Flooding – executive summary
- 120303 Flood Risk Management Strategy Note LSA

Folder: 16 UNDP Reports

- UNDP Report Reducing Disaster Risk
- UNISDR Terminology on Disaster Risk Reduction 2009

Folder: 17 Urban Flood Management

- Presentation IFRM & Inundation management HoChiMinh City PPT
- Presentation Urban Flood Management ICCUF PK 2009 PPT

Folder: 18 Water Strategy – World Bank

- Agenda for Water Sector Strategy for North China, Volume 1, Summary Report (3-H basins)
- Short Executive Summary of 3H report

Folder: 19 Yangtze Dikes Strengthening Project/Flood Disaster Prevention Center

- FDPC01_setup
- FDPC04_setup
- FDPC05_setup
- FDPC06_setup
- FDPC07_setup & summary
- Report Flood Risk Analysis for construction and management of detention basins, Delft Hydraulics 2002
- Report The Technology of Flood Risk Models, Delft Hydraulics 2005