

# Flood Risk Management Approaches

As Being Practiced in Japan, Netherlands, United Kingdom, and United States

IWR Report No: 2011-R-08





# Flood Risk Management Approaches

As Being Practiced in Japan, Netherlands, United Kingdom,  
and United States

September 2011



## Table of Contents

Executive Summary .....	v
1 Introduction.....	1
1.1 Objective.....	1
1.2 Galvanizing Events.....	2
1.3 Flood Risk Management, A Conceptual Framework .....	3
2 Risk Assessment .....	5
2.1 National Level .....	5
2.1.1 National Risk Assessment (The Netherlands) .....	6
2.1.2 Flood Risk Assessment and the UK Flooding Foresight Study (United Kingdom) ..	10
2.1.3 Portfolio Approaches for Dam and Levee Safety (United States).....	13
2.1.4 Preparation of Charts and Index to Assist Examination of Flood Control-Related Climate Change Adaptation Strategies (Japan) .....	15
2.1.5 Nation-wide Evaluation of Safety Level of Flood Control of Small and Medium Rivers Using Airborne Laser Surveying Technology (Japan).....	16
2.2 Regional / Local Level .....	17
2.2.1 Regional Risk Assessment of Large-Scale Flood Disaster in the Tokyo Metropolitan Area (Japan).....	17
2.2.2 Risk Assessment Project VNK2 (The Netherlands) .....	20
2.2.3 Multi-Criteria Approaches to Address Coastal and Riverine Risk: Habitat Lessons from Louisiana (United States).....	22
2.2.4 Local Impact of Fast Flow on Houses Caused by Breach of Embankments (Japan).....	23
3 Policy Development.....	25
3.1 National Level .....	25
3.1.1 River System-Based Management and River Improvement Plan (Japan).....	25
3.1.2 Catchment Approach/Comprehensive Flood Control Measures (Japan).....	26
3.1.3 "Climate Change Adaptation Strategies to Cope with Water-Related Disasters Due to Global Warming": Policy Report by the Panel on Infrastructure Development, MLIT, June 2008 (Japan).....	28
3.1.4 Pitt Report, Recommendations, and Progress (United Kingdom) .....	28
3.1.5 Vision and Strategy for the UK (England, Scotland, Wales and Northern Ireland) Including Legislation and Strategies (United Kingdom) .....	29
3.1.6 Allowances for Climate Change (United Kingdom) .....	32
3.1.7 Adapting to Climate Change (United States).....	33
3.1.8 Proposed Principles and Guidelines (United States) .....	34
3.1.9 Development of Tolerable Risk Guidelines for Dams and Levees (United States) ..	36
3.1.10 Policy Development and Selection of Measures as a Result of 2010 Risk Assessment (The Netherlands) .....	37

3.2	Regional / Local Level .....	39
3.2.1	Considering Environmental/Social Benefits and Flexible Solutions (United States).....	39
3.2.2	Catchment-Based Regional Flood Management Planning, the Case of the Tsurumi River Basin (Japan).....	40
4	Executive Aspects .....	43
4.1	Land Use Policies .....	43
4.1.1	Opportunities for Buy-Outs, Mitigation, and Buying Down Risk (United States)...	43
4.1.2	Land Use Change and Flood Risk Management (United Kingdom).....	45
4.1.3	Flood Control Measures in Concert with Land Use (Japan).....	46
4.2	Protection.....	47
4.2.1	Super Levees (Japan) .....	47
4.2.2	Design, Maintenance and Improvement of Flood Defenses (The Netherlands).....	48
4.2.3	Efforts to Increase the Reliability of Embankments (Japan) .....	49
4.3	Maintenance.....	51
4.3.1	Aging Infrastructure (The Netherlands).....	51
4.3.2	Strategic Maintenance (Japan).....	52
4.3.3	River Channel Maintenance in Consideration of Response to Excavation of River Channel for River Improvement (Japan) .....	52
4.3.4	System Asset Management Plans and Creating Asset Management Capacity (United Kingdom).....	54
4.3.5	Water Course Maintenance – Conveyance and Dredging Trials Report Findings (United Kingdom).....	56
4.3.6	National Strategic Infrastructure Framework (United States) .....	57
4.3.7	‘Room for the River’ Programme (The Netherlands).....	58
4.4	Preparedness .....	60
4.4.1	Detection of “Guerrilla Downpours” by X-Band MP Radar (Japan) .....	60
4.4.2	Provision of River Information (Japan) .....	61
4.4.3	The Flood Forecasting Centre (United Kingdom).....	62
4.4.4	Exercise Watermark (United Kingdom) .....	63
4.4.5	Exercise, Preparedness and Response (United States) .....	64
4.5	Response and Recovery .....	65
4.5.1	TEC-FORCE (Technical Emergency Control Force for Disaster Assistance) (Japan).....	66
4.5.2	Flood Fighting Teams and Flood Fighting (Suibo) Act (Japan).....	67
4.5.3	Post-Disaster Restoration Schemes (Japan).....	69
4.5.4	Improving Capability to Recover from Disasters (United States).....	69
4.6	Governance, Public Participation and Communication.....	71
4.6.1	Roles, Strategy, and Legal Instruments (United Kingdom).....	72

4.6.2	Roles, Responsibilities and Legal Instruments (The Netherlands).....	73
4.6.3	Interagency Regional Flood Risk Management Team Partnership, Upper Mississippi River Basin (United States) .....	74
4.6.4	Shared Responsibility and Public Participation in Flood Risk Management (United States).....	75
4.6.5	Flood Hazard Map (Japan).....	77
4.6.6	Indication of Flood Hazard Using High Accuracy Elevation Data (Japan).....	79
4.6.7	Communication on Flood Risk (The Netherlands).....	80
4.6.8	Flood Risk Communication (United States) .....	80
4.6.9	Federal Interagency Floodplain Management Task Force (United States) .....	83
4.7	Financial Aspects.....	84
4.7.1	Watershed Investment Decision Tool (United States).....	84
4.7.2	Involving Cost-Sharing Partners (United States).....	85
4.7.3	Flood Insurance in the U.S. (United States) .....	85
4.7.4	Flood Insurance in the UK (United Kingdom) .....	86
4.8	Research and Education.....	87
4.8.1	Research and Development / Technology Transfer (United States).....	87
4.8.2	Expertise Network on Flood Protection (The Netherlands) .....	89
4.8.3	Education and Credentialing (United States).....	89
5	Topics for Collaborative Action and Research.....	91
5.1	2010 International Policy-Oriented Discussions .....	91
5.2	Learning from Other Countries .....	92
5.2.1	Learning from Floods That Happen in Other Countries (The Netherlands).....	92
5.2.2	Learning from Other Countries' Flood Exercises (The Netherlands) .....	93
5.3	International Levee Handbook .....	93
5.4	International Best Practice on Storm Surge Barriers.....	94
6	Conclusion .....	97
	Annex 1: Terms of Reference .....	99
	Annex 2: Characterization of Flood Risk in Each Country .....	103
	2A. Country Comparisons .....	103
	2B. Characteristics of Flood Control Measures in Japan.....	108
	2C. Flood Risk Management in the Netherlands, Main Characteristics.....	110
	2D. United Kingdom National Governance.....	113
	2E. Characterization of Flood Risks in the United States.....	118
	Annex 3: Authorship and Acknowledgements .....	121
	Annex 4: Flood Risk Related Terms.....	123





## Executive Summary

Flooding is a major natural hazard affecting some 520 million people every year, claiming the lives of about 25,000 worldwide and causing global economic losses between \$50 and \$60 billion annually. As a result, it is essential that we seek to manage the risk of flooding in an effective and appropriate way.

Flood risk is a product of the *probability* of occurrence of a flood hazard; the *vulnerability* of individuals, society, and the environment despite flood mitigation from a broad variety of measures implemented to dampen flood consequences through preparation, response, recovery and mitigation; and the *consequences* that result from the mitigated hazard event. Our understanding of flood risk is affected by our ability to identify and assess these hazards, vulnerabilities, and consequences; our ability to manage flood risk is enabled by our ability to coordinate our policies and actions with numerous partners across the risk management lifecycle to address these hazards, vulnerabilities and consequences. Flood risk management integrates and synchronizes programs designed to reduce flood risk, either in advance of or over a series of event cycles.

Many countries are reassessing their approaches in the face of improved understanding of flood risks. The Japanese Ministry of Land, Infrastructure, Transport and Tourism (MLIT), the Dutch Rijkswaterstaat, the United Kingdom Environment Agency, and the United States Army Corps of Engineers agreed in 2009 to develop a document to explore risk-informed approaches as being practiced and developed primarily in those four countries. Although very different in frequency and scale of flooding as well as cultural and governmental characteristics, each country had significant efforts underway to better orient its practices to flood risk realities, including those induced by altered land use and by climate change and variability. The quadric-lateral collaboration was envisioned as a continuing step in international collaboration and as one means for each country to learn from the other countries' experiences.

This document, the result of that collaboration, reflects contributions from agencies within the four participating nations but is not an official position of any government or international organization. The document is organized around a conceptual framework developed to encompass flood risk drivers, risk assessment, and the source-path-receptor concept; the flood risk management cycle with its overarching policies and supporting players and mechanisms; and the adaptive management cycle of maintenance, monitoring, evaluation, and adjustment over time. Differences in scale are addressed through consideration of national and regional/local levels. The document highlights the approaches in each country, the drivers for those approaches, and practices that are working or hold particular promise. Specific examples illustrate various approaches without trying to fully reflect the entirety of any one country's effort or to include an example from each country for any particular aspect.

National risk assessments (discussed in Chapter 2) can help put into perspective the relative risks faced in various parts of the country. Such assessments can yield surprises or confirm presumptions: for example, risk along rivers may be greater than previously understood, or may be greater than risk in coastal areas. One purpose of risk assessment on the national level is to help prioritize measures on a national scale, particularly when available funding is limited. Under ideal circumstances, a uniform method will be used to assess risks, on a general level, so that comparable information is available on which national policies and strategies can be determined. Because the implementation of strategies and the related infrastructure works often involves decades, it is important to consider the potential effects of climate and land use change. The

Netherlands is conducting a national risk assessment to consider desired levels of safety based on cost-benefit analyses and loss-of-life calculations. The United Kingdom has an ongoing program to develop understanding of the risks of flooding, the aim of which is to inform the organizations involved in flood risk management (including insurers) and the public as the levels of risk and also to support decision making in investment in risk management. In the United States, the U.S. Army Corps of Engineers implements a risk-informed dam and levee safety program and portfolio risk management process to protect life, property and the environment through a series of hierarchical activities that are used to assess, classify, and manage the risks associated with its inventory of dams and levees. Japan has been studying impacts of climate change on flood peak runoff and the safety level of flood control and developing a method to estimate the needed scale of flood control facilities to adapt to climate change. Regional-level efforts include Japan's assessment of emergency, preventive, and rehabilitation measures in consideration of the potential for large-scale flood disaster around Tokyo; the Netherlands' reliability analysis for each levee system considering all principal failure modes and correlations (VНК2); and the United States' coordination of coastal restoration and hurricane and flood damage risk reduction in Louisiana.

Policy development in a flood risk management context (discussed in Chapter 3) involves (high-level) decision-making on objectives and related levels of risk, and the selection of strategies and measures (prevention, protection, preparedness, response and recovery) and required budgets to achieve desired outcomes. The resulting mix depends on the characteristics and consequences of flooding, desired levels of risk, available budget, and cultural aspects. Notwithstanding political boundaries, decision-making will ideally occur within a watershed framework and consider lifecycle aspects. Some policy decisions involve setting an acceptable level of risk and then determining how to meet it over time, while others may be driven primarily by available budget and the expected level of risk reduction that can be achieved for the investment, with decisions focused on where best to spend precious funds. In all instances residual risk remains an important consideration. Examples include Japan's consideration of climate change adaptation strategies to cope with water-related disasters due to global warming; the United Kingdom's implementation of recommendations in the Pitt review that contained a detailed assessment of how the summer 2007 flooding in England was managed and what might be done differently; the United States' proposal to significantly change the principals and guidelines that govern its water resources planning; and the Netherlands' National Water Plan setting forth a comprehensive strategy based a time horizon running to 2100.

The success of the flood risk management policy (discussed in Chapter 4) is determined by its implementation, execution, and maintenance. Ideally risks and policies will be reassessed periodically so that implementation can be adjusted as warranted. Important aspects are related to the different parts of the safety chain, as well as the required governance, funds, legislation and skills of the involved employees. These executive aspects include land use policies, protection, maintenance, preparedness, response and recovery, governance, public participation and communication, financial aspects, and research and education. Many examples are highlighted, including Japan's efforts to increase the reliability of embankments through the upward spiral framework based on the steady accumulation of field data (i.e., monitoring, study and analysis, action and feedback); the Netherlands' addressing of flood defenses through periodic 6-year evaluation of the actual status of flood defences in relation to legal standards; the United Kingdom's conduct of "Exercise Watermark," a wide-ranging major national flood response exercise involving government agencies, communities, individuals, and the media; Japan's common and widespread use of locally-based volunteer flood fighting teams in municipalities through its Suibo Act; the United States' emphasis on public participation and communication in flood risk management; and flood insurance programs in the United Kingdom and United States.

Each country seeks the best approach to managing its own particular flood risks, taking into account its resources, governance, and culture. For countries in similar circumstances, partnerships (discussed in Chapter 5) can also provide opportunities for a mutually expanded base of experience and joint exploration of issues of concern. These include discussions to share information, such as 2010 policy-oriented discussions primarily among government officials from various countries responsible for developing policy and practicing flood risk management; learning from other countries' floods and flood exercises, such as lessons learned by Netherlands from floods in New Orleans and France; and exchange among professionals with similar interests or facing similar challenges, such as the development of an international levee handbook among a consortium of professionals from six countries or the international network to share experience and transfer knowledge on the operational and functional management of large movable storm surge barriers.

The commonalities encountered through coordination on this document are striking. Despite their varied histories and circumstances, the four countries face similar key challenges. These include adapting to new understandings of risk that take into account the impacts of climate change, bridging gaps between land-use decisions and flood risk management considerations, effectively communicating risk to the general public in a way that promotes individual as well as societal responsibility, and aligning planning and actions to identify and meet the most critical risks within a framework that is socially, environmentally, economically, and politically acceptable. Within the context of their particular flood risks, institutional structure and history, the four countries have taken many similar approaches to address these challenges. All are examining the implications of climate change on not only flood threats but also vulnerabilities and consequences. All have emphasized communications and outreach as a way to reduce consequences through better information and awareness. All are giving additional thought to the environmental impacts and opportunities in flood risk management approaches – although the tools for doing so are still developing. And although emphases may differ, all are focusing on the various aspects of the cycle of emergency management in order to better prepare for the future floods that will inevitably occur.

There are also some notable distinctions in approaches between the four countries. The Netherlands specifies a legislated level of protection, Japan sets long-term aspiration goals for levels of protection along its major rivers, while United Kingdom and United States use analyses of risk to inform decision-makers about the cost-effective options available to them. The United States and United Kingdom are unique in supporting separate flood insurance programs (although the provisions of the two programs differ). Japan has a widespread volunteer network for flood fighting and flood damage prevention stemming from its historical experience, while citizens in The Netherlands have less experience in responding to floods because of that country's history of high levels of structural protection.

No prescriptive “best practices” are promoted as appropriate in all circumstances. Rather, the approaches presented comprise a collective set of best practices among the four countries, with individual and approaches understandably tailored to meet specific country needs. Developing this document provided one means for those within the four countries to learn from the others, furthering the ability to bootstrap from others' efforts and incorporate aspects suitable to their own circumstances. The approaches documented provide a palette from which to choose, selecting what is useful and adjusting where needed. It is hoped that this document provides a vehicle for sharing the resulting information more broadly within the four participating countries and perhaps beyond.



# 1 Introduction

## 1.1 Objective

The Japanese Ministry of Land, Infrastructure, Transport and Tourism (MLIT), the Dutch Rijkswaterstaat, the United Kingdom Environment Agency, and the United States Army Corps of Engineers met in March 2009 to discuss to a proposal for developing a document to explore risk-informed approaches as being practiced and developed primarily in those four countries, and identify “best practices”. Although very different in frequency and scale of flooding as well as cultural and governmental characteristics, each country had significant efforts underway to better orient its practices to flood risk realities, including those induced by altered land use and by climate change and variability. Collaboration among these four countries seemed promising since all represent highly developed societies, with densely populated flood prone riverine and coastal areas. They differ, however, in the frequency of flooding, relative impact of floods on society, and governmental role in flood risk management:

- In the Netherlands flooding has become very rare, as a result of strong governmental responsibility and high protection standards, but the potential impact of a major flood may be disastrous to this relatively small country.
- In Japan, the U.S., and the U.K. floods occur more frequently, up to several times a year somewhere in these countries. The relative impact on society is more local, sometimes regional, enabling recovery support from unaffected areas.
- Japan has a long tradition in dealing with natural hazards (earthquakes, floods, volcanoes, tsunamis), resulting in policies covering the entire “safety chain” of prevention, protection, preparedness, response and recovery. In addition, there is high public awareness and much experience with early warning and disaster management.
- In the U.K. and U.S. the national governmental responsibilities regarding protection are less extensive than in the Netherlands and Japan. Hence, these latter countries have more experience with risk zoning and communication, spatial planning and disaster management. In addition the role of non-federal funding (by beneficiaries) and the management of insurance are important and differ among countries.
- The Netherlands and U.K., as European member states, have to comply with the European Directive on the Assessment and Management of Flood Risk (2007), the so-called “Floods Directive”. This Directive requires member states to prepare and implement flood risk management plans dealing with all aspects of the “safety chain”.

The flood risk management concept requires policies and measures in all aspects of the safety chain, although emphasis may differ. This quadri-lateral collaboration enables each country to learn from the experiences of the other countries.

The development of this document was envisioned as a continuing step in international collaboration, building upon events such as the May 2005 high-level meeting with thirteen countries in Nijmegen, Netherlands, held in conjunction with the 3rd International Symposium on Flood Defence; a second high-level meeting on Integrated Flood Management held in March 2006 in conjunction with the 4th World Water Forum in Mexico City, Mexico; and the May 2008 4th International Symposium on Flood Defence, held in Toronto, Canada. Results from the group’s efforts were anticipated to be included in the 5th International Symposium on Flood Management, to be held in Tokyo, Japan, in September 2011. Terms of Reference for the effort were adopted in May 2009 (see Annex 1.)

This document reflects contributions from agencies within the four participating nations, but is not an official position of any government or international organization. The document is intended to highlight the approaches in each country, the drivers for those approaches, and practices that are working or hold particular promise. Specific examples have been selected from the countries to illustrate various approaches, rather than trying either to fully reflect the entirety of any one country's effort or to include an example from each country for any particular aspect. The diversity of the information will permit each country to identify and incorporate those aspects suitable to their own circumstances. The resulting document provides a vehicle for sharing the resulting information more broadly within the four participating countries and perhaps beyond.

## **1.2 Galvanizing Events**

Flooding is a major natural hazard affecting some 520 million people every year, claiming the lives of about 25,000 worldwide and causing global economic losses between \$50 and \$60 billion annually.<sup>1</sup> As a result, it is essential that we seek to manage the risk of flooding in an effective and appropriate way.

In the United States, the 2005 Hurricane Katrina spawned a shocking human tragedy. More than 1,600 persons were killed or missing and presumed dead. The event was the costliest in U.S. history, causing an estimated \$75 billion in damages and the displacement of over 600,000 people. The catastrophic effects of Hurricane Katrina prompted re-examination of policies and practices, and a detailed look at what could – and should – be done differently in the U.S. It sparked discussions, not just in the United States but around the world, of the full spectrum of flood hazards, vulnerabilities, and consequences, and of governmental readiness with respect to flood risks. New programs and approaches focused on systematic consideration of risk are being developed, tested, and applied; these new directions are in their relatively early stages, and more work remains before they are in common use nationwide.

In the United Kingdom, floods struck across England in the summer of 2007 with South Yorkshire and Hull, Gloucestershire, Worcestershire and the Thames Valley being particularly badly affected. During June and July, some 55,000 homes, businesses, schools and other properties were flooded. Around 7,000 people were rescued by emergency services and 13 people died. Essential services and transport networks were lost, with almost half a million people without water or electricity. In addition to disruption and personal suffering, the event caused an estimated £3.2 billion in costs. The event served as a “wake-up call” and prompted re-evaluation of resiliency and risk.

In the Netherlands, catastrophic coastal flooding in 1953 prompted massive governmental investment in structural protection works known as the Delta Project. Catastrophic flooding of similar scale has not occurred in the country since, although high discharge volumes in rivers, such as the Rhine and Meuse in 1993 and 1995, led to reconsideration of policy. Nevertheless, the Netherlands has remained attuned to disasters in other countries, and its policy considerations include assessment of national implications from lessons learned abroad.

In the midst of collaboration on this document, the Great East Japan Earthquake struck. The March 2011 event prompted reconsideration by Japan of measures to manage disaster risks and

---

<sup>1</sup> UNU, Two Billion People Vulnerable to Floods by 2050; Number Expected to Double or More in Two Generations Due to Climate Change, Deforestation, Rising Seas, Population Growth, New Release, 2004, as cited in a February 2007 concept paper on The International Flood Initiative at [http://www.ifi-home.info/IFI\\_Concept\\_Paper.pdf](http://www.ifi-home.info/IFI_Concept_Paper.pdf).

provided Japanese society with an opportunity of seeing disaster risks in a new light. Japan is a country which has been stricken by earthquakes and tsunamis repeatedly over the past few hundred years. By assuming that it must deal with earthquakes expected in the near-term, Japan has been taking measures against earthquakes and tsunamis based mainly on structural measures. However, the 2011 disaster was of a magnitude far beyond prior assumptions, resulting in devastating damage including an enormous number of casualties and houses flooded away. From the viewpoint of human losses, it is necessary to verify whether the non-structural measures such as evacuation planning and actions were appropriate.

In Japan, discussions are now being made to broaden the view of tsunami risk management by considering the risks of possible phenomena however infrequent they may be. Discussions are oriented toward setting the assumed scale of tsunami in two levels. The first level is set for comparatively smaller-scale and frequent tsunamis. They are to be coped with mainly by structural protection to prevent tsunami waves from entering cities. The second level is set for greater-scale but less frequent tsunamis, for which a possibility could be confirmed from historic documents and geological surveys. For this level of tsunamis, structural protection has limitations and non-structural measures such as town development and evacuation to prevent human damage will be considered.

An important lesson learned from the disaster is that the earthquake and tsunami caused non-predictable situations that are geologically possible, but not known from history or projected by statistical extrapolation of measurements. Municipalities with the responsibility to take leadership in case of disasters were stricken themselves, and places of refuge were flooded. In disaster risk management, it is important to make necessary preparations by fully and deliberately imagining potential situations. This includes considering the potential for cascading impacts and secondary effects resulting from the failure of critical infrastructure systems (such as a nuclear power plant), with corresponding implications for design, mitigation, and response planning.

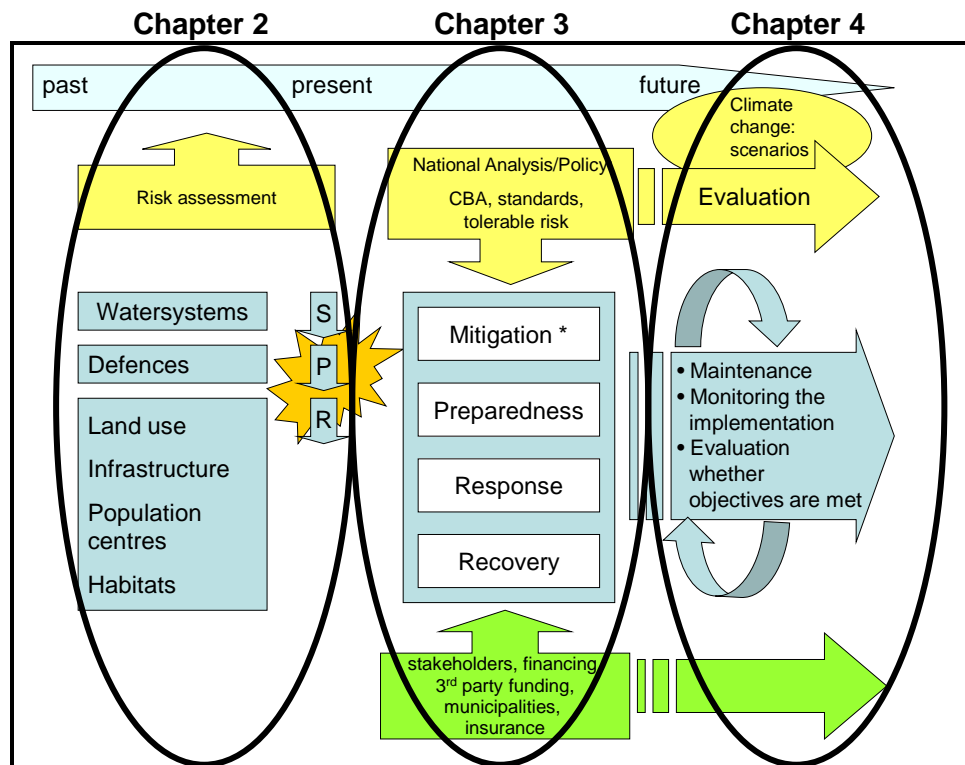
Another important point to consider is social support for disaster risk management. Risks must be conveyed correctly to residents for their social consent and support. Since natural phenomena have uncertainty, it is also necessary to make sure all people know that there are certain limits on prior assumptions.

For achieving this purpose, it is effective for not only Japan but also other countries to learn about risk-informed activities against disasters in respective countries. In this sense, multilateral efforts by countries to share experiences and knowledge are quite meaningful.

### ***1.3 Flood Risk Management, A Conceptual Framework***

The following conceptual framework (Figure 1) was developed to encompass flood risk drivers, risk assessment, and the source-path-receptor concept; the flood risk management cycle with its overarching policies and supporting players and mechanisms; and the adaptive management cycle of maintenance, monitoring, evaluation, and adjustment over time. The framework was developed by this document's primary authors to provide for the document's overall organization. Three major sections (chapters 2, 3 and 4) discuss Risk Assessment, Policy Development, and Executive Aspects. Differences in scale are addressed through consideration of national and regional/local levels. Specific items are drawn out where appropriate. Since the various approaches described occur within the context of a country's particular flood risks, institutional

structure, and culture, Annex 2 provides a brief overview of relevant characteristics for each country along with a chart of comparisons among the four countries.



\*project appraisal, prioritization, design standards  
 SPR = Source – Pathway – Receptor

**Figure 1: Conceptual Framework**



## 2 Risk Assessment

Flood risk is a product of the *probability* of occurrence of a flood hazard; the *vulnerability* of individuals, society, and the environment despite flood mitigation from a broad variety of measures implemented to dampen flood consequences through preparation, response, recovery and mitigation; and the *consequences* that result from the mitigated hazard event. Our understanding of flood risk is affected by our ability to identify and assess these hazards, vulnerabilities, and consequences; our ability to manage flood risk is enabled by our ability to coordinate our policies and actions with numerous partners across the risk management lifecycle to address these hazards, vulnerabilities and consequences. Flood risk management integrates and synchronizes programs designed to reduce flood risk, either in advance of or over a series of event cycles.

Because of large-scale consequences (damage, fatalities, and disruption), especially of more extreme or more widespread floods, national governments in all four countries have assumed key roles in flood risk management, especially regarding setting objectives, prioritization of budget and emergency operations. Although the structure differs among the four nations, in all cases regional and local authorities, private parties, and the public have complementary roles. Risk assessment may need to be performed at different scales. While acknowledging differences in scale among the four countries considered, Section 2.1 considers the national level and Section 2.2 considers the regional/local level.

### 2.1 National Level

National risk assessments can help put into perspective the relative risks faced in various parts of the country. Such assessments can yield surprises or confirm presumptions: for example, risk along rivers may be greater than previously understood, or may be greater than risk in coastal areas. One purpose of risk assessment on the national level is to help prioritize measures on a national scale, particularly when available funding is limited. Under ideal circumstances, a uniform method will be used to assess risks, on a general level, so that comparable information is available on which national policies and strategies can be determined. Because the implementation of strategies and the related infrastructure works often involves decades, it is important to consider the potential effects of climate and land use change. Risk assessment at the national level has been performed in Japan, the Netherlands and the U.K. and is in its early stages in the U.S. The U.S. example illustrates the move to a portfolio risk management approach for dam and levee safety programs. Japanese examples present promising uniform methods to obtain a rapid nationwide overview of changing rainfall patterns and the safety level of medium and small rivers.

- 2.1.1 The Netherlands: National Risk Assessment
- 2.1.2 UK: Flood Risk Assessment and the UK Flooding Foresight Study
- 2.1.3 USA: Portfolio approaches for dam and levee safety
- 2.1.4 Japan: Preparation of Charts and Index to Assist Examination of Flood Control-Related Climate Change Adaptation Strategies
- 2.1.5 Japan: Nation-wide Evaluation of Safety Level of Flood Control of Small and Medium Rivers Using Airborne Laser Surveying Technology

### 2.1.1 National Risk Assessment (The Netherlands)

The present flood protection standards in the Netherlands date from the 1960s. As a result of economic growth and climate change, the current flood protection standards are insufficient to achieve the desired level of safety. In 2008, a special group chartered by the national government to examine the challenges of the future, the Delta Committee II, proposed a new flood risk management approach, with protection standards that should not only be based on cost-benefit analyses but on loss-of-life calculations as well.

#### **Flood Protection 21<sup>st</sup> century<sup>2</sup>**

In this project a partly probabilistic risk assessment is performed from an economic point of view as well as a loss-of-life perspective for the presumed situation that all levee systems just comply with the current protection standards (while recognizing that the presumption is not necessarily valid.) Since 92 dike and dune improvement plans are being executed, this situation will not be achieved before 2015 – 2020. The project only considers overflow and wave overtopping as a failure mechanism. In this simplified approach compared to the VNK2 project (see Section 2.2.2), the other failure mechanisms are assumed negligible with regard to overflow (in compliance with the Netherlands' Water Act). For each levee system the consequences of several breach locations were calculated. Evacuation possibilities were taken into account. The likelihood of evacuation was based on the warning time (type of threat: coast vs. river), the population density in relation to the distance to a safe area and infrastructure capacity. High evacuation percentages (such as 75%) were assumed for levee systems along the upper rivers and low percentages along the coast (15%).

#### ***Cost benefit analysis<sup>3</sup>***

In a cost benefit analysis the, economic optimal flood probability per levee system has been calculated for the year 2050. The economic optimal flood probability is where additional investment in levee reinforcement is no longer cost-effective with respect to the avoided damage of flooding for that investment. In this analysis the investments necessary for levee reinforcements are compared with the avoided damage of flooding. Compared with the analysis from the 1960s (see text box below) that led to the current flood protection standards, the 2011 analysis takes climate change as well as economic growth (1.9% per year) into account: see Figure 2. Climate change will result in increased flood probabilities over time, while economic growth will make the optimal flood probability shift to lower values (by the increased amount of damage). Further fatalities (and casualties) are capitalized by using a value of a statistical life of \$ 10 million<sup>4</sup>. Finally, a discount rate of 5.5% has been applied for the investments as well as the damages.

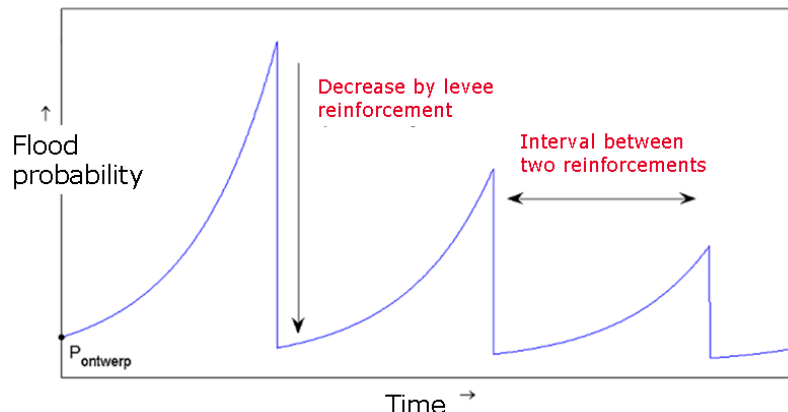
In March 2011 the cost benefit analysis suggested by the 2008 policy evaluation was completed, resulting in economic optimal flood probability for each levee system and the total investments (for levee reinforcements) necessary to realize these standards in 2050. These analyses will inform further policy discussions regarding desired national safety.

---

<sup>2</sup> [www.delta-programma.nl](http://www.delta-programma.nl) and [www.deltacommissaris.nl](http://www.deltacommissaris.nl)

<sup>3</sup> See paper prepared for the 5<sup>th</sup> International Conference on Flood Management, entitled "Efficient flood protection standards for the Netherlands"

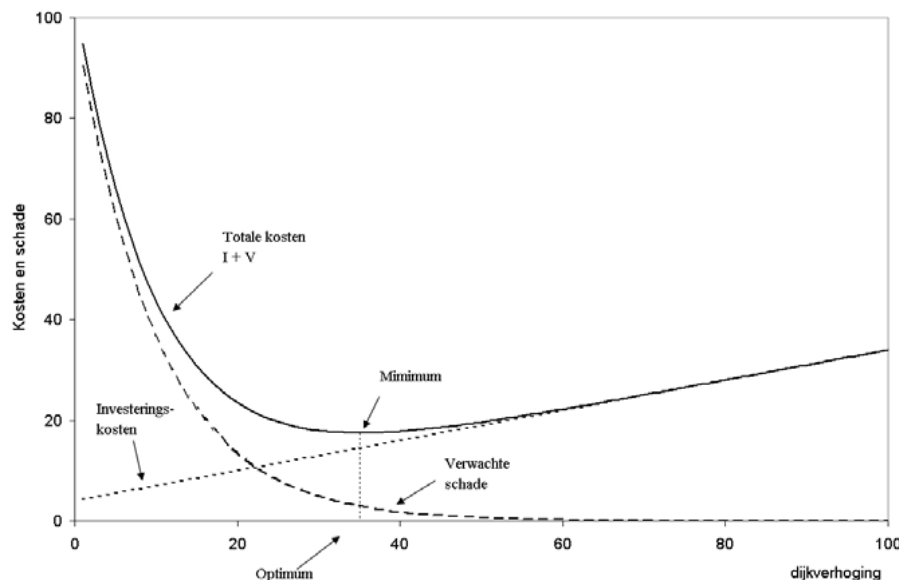
<sup>4</sup> The value of \$ 10 million (€6.7 million) includes costs for 5 persons being hospitalized, consistent with a study showing that, for floods, the ratio between fatalities and injuries requiring hospitalization is 1:5 on average.



**Figure 2: Diagram presenting the basics of the Cost Benefit Analysis performed in 2011**

### **“Cost benefit analysis” based level of protection (1960s)**

Presently the level of protection offered by dikes and dams is based on a semi-quantitative approach, developed by the first Delta Committee in the 1960s. For the area of Central Holland, covering the highly urbanized and floodprone area bounded by Amsterdam, The Hague and Rotterdam, a cost benefit analysis was performed. In this analysis the investments necessary to improve the level of protection were compared with the avoided damage of flooding (see Figure 3). Damage of flooding was calculated as direct and indirect economic damage, multiplied by a factor of 2, to account for fatalities and non-monetary damage to nature and cultural assets. It was concluded that a design level, equivalent to an annual 1/10,000 storm surge level, offered adequate protection against flooding. For less populated coastal areas south and north of Central Holland the Delta Committee proposed a protection level of 1/4,000 per year. In the 1980s, riverine areas, which have a better potential for evacuation, received a protection level of 1/1250 per year.



**Figure 3: Diagram presenting the basics of Cost Benefit Analysis performed by the 1<sup>st</sup> Delta Committee for Central Holland.** The horizontal axis relates to dike heightening (cm), the vertical axis relates to costs of dike heightening or damage by flooding. Total costs of dike heightening increase with height (continuously rising dotted line), while damage due to flooding decreases exponentially (hatched line). The economic optimum level of protection is where the sum of investments in dikes and residual damage (continuous line) shows a minimum, i.e., where further increase of dike height no longer outweighs the related avoided damage.

### ***Loss-of-life calculations<sup>5</sup>***

In addition to a cost-benefit analysis, loss-of-life calculations were performed for the situation presuming that all levee systems meet the current flood protection standard. For these calculations Individual Risk and Societal Risk were chosen as indicators:

- Individual Risk is the probability of being killed at a certain location as a result of a flood;
- The Societal Risk shows the probability of exceedance (in one year) of a certain number of fatalities due to one flood event.

These indicators had been used in the industrial safety policy in the Netherlands for many years.

In March 2011 the loss-of-life calculations were finished, resulting in an individual risk map for all levee systems and insight into the probability of a certain extent of ‘social disruption’ on the level of individual levee systems as well as on a national level.

### ***Individual Risk***

Individual Risk (IR) values ranges from  $10^{-4}$  to  $10^{-6}$  per year for deep polders (low-lying land reclaimed from the sea or other water body) along the upper and tidal rivers to  $10^{-6}$  to  $10^{-7}$  per year along the coast. IR values are calculated for each neighborhood, based on the local water depth and the rise rate. Figure 4 shows the IR map for an individual levee system, where the red areas represent the (relatively) high risk areas. Table 1 shows the number of people in the Netherlands living within a levee system with an IR risk limit higher than  $1 \times 10^{-5}$ ,  $1 \times 10^{-6}$  and  $1 \times 10^{-7}$  per year and the corresponding surface area.

**Table 1: Number of People in the Netherlands Living Within a Levee System with a Certain IR Level**

IR risk level (per year)	$IR > 1 \times 10^{-5}$	$IR > 1 \times 10^{-6}$	$IR > 1 \times 10^{-7}$
Inhabitants	120,000	3.3 million	6.8 million
Land area (% of flood prone area)	400 km <sup>2</sup> (2%)	7,400 km <sup>2</sup> (37%)	15,400 km <sup>2</sup> (77%)

### ***Societal Risk***

The societal risk (SR) is expressed in terms of a so-called FN curve, which gives, on a double-log scale, the probability of exceedance (1-F) as a function of the number of fatalities N during a single event. Figure 4 displays the FN curve for an individual levee system.

As determined by the societal risk calculations completed in 2011, the probability of a flood event causing 10, 100, 1000 and 10,000 fatalities in the Netherlands is 1/70, 1/100, 1/400 and 1/8,300 per year in 2040, respectively. Levee systems along tidal rivers have the highest. The SR will slightly increase between 2000 and 2040, mainly because new urbanization projects will result in an increase of people living in flood prone areas (not as a result of population growth).

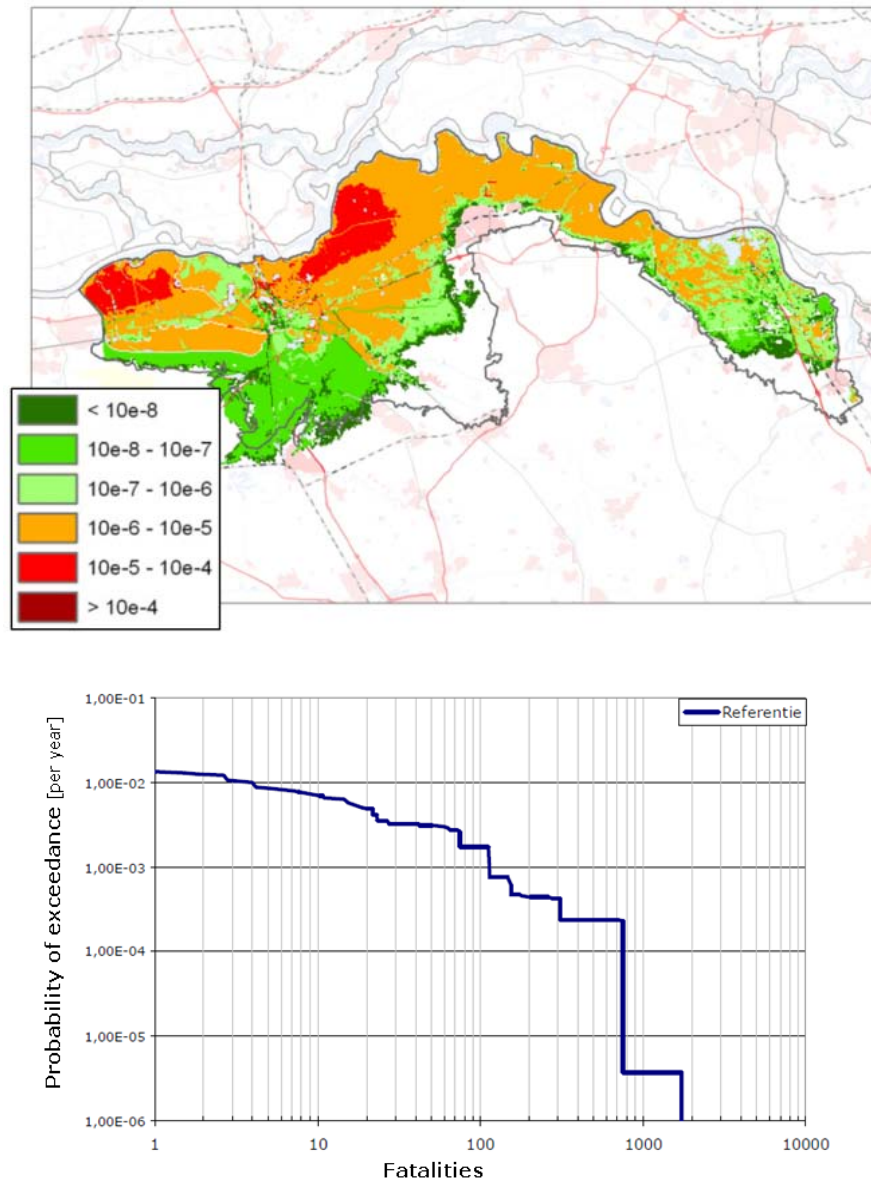
These calculations not only took the evacuation possibilities into account, but the probability that several levee systems can be flooded simultaneously during one event. For that reason societal risk is considered at a national level (and not for levee systems only).

---

<sup>5</sup> See paper prepared for the 5<sup>th</sup> International Conference on Flood Management, entitled “Life safety criteria for flood protection standards”

### *Time schedule*

The desired level of flood protection in 2050 can be met by a combination of levee system improvements (prevention), sustainable spatial planning, and improved emergency response to floods (see Section 3.1.10). Initially there might be a focus on preventive measures only: for each



**Figure 4: Example of the Individual Risk (map) and Societal Risk (so-called FN-chart) Calculated for an Individual Levee System Along the River Meuse**

levee system an economic optimal flood probability can be calculated, as well as a flood probability that meets the tolerable risk guidelines to be proposed from an individual and societal risk point of view. These elements can be combined into new risk-based legal standards for flood protection for each levee system. Different policy options can be deduced from these calculations. In some options the new standards might be largely based on economic values, while others may be based on loss-of-life considerations. Each option will result in a map with classes of flood probabilities per levee system.

In late 2011 the vice-Minister of Water Management is expected to give his approval for the proposal on the new flood probabilities. This decision will have the status of a policy statement

and is expected to become legislation in the Water Act in 2017 (after a 6-year period of ‘exercising’ the impact on the safety assessment procedures (see Annex 2C). In 2011 governmental and non-governmental organizations and citizens will have the opportunity to enter the societal discussion about the flood protection proposed.

### **2.1.2 Flood Risk Assessment and the UK Flooding Foresight Study (United Kingdom)**

The Environment Agency has an ongoing program of work to develop understanding of the risks of flooding across England and Wales. This work examines the risks of flooding from rivers and the sea, surface water, reservoirs and groundwater and includes the development of maps that show the probability of flooding to areas of land. The aim to inform the organizations involved in flood risk management (including insurers) and the public about the risks and also to support decision making in investment in risk management. This work is explored in more detail below:

#### **Flooding from Rivers and Sea: the National Flood Risk Assessment (NaFRA)**

The national flood risk assessment produces a broad-brush assessment of the likelihood of flooding from rivers (with a catchment size 3 km<sup>2</sup> or larger) and the sea at a national scale. This is based on assessments undertaken for 85 river catchments and coastal cells, where a cell is an area of land measuring 50 metres<sup>2</sup>. It enables a comparison of the relative risks and their distribution within each of these catchments, rather than a detailed, local assessment of the risk at a specific location. It is based on a source-pathway-receptor conceptual model of risk and considers the probability that any defenses will overtop or breach. The calculations provide an indication of the likelihood of flooding at the center of each cell. These results are then placed into three risk categories as used by the UK insurance industry. These are:

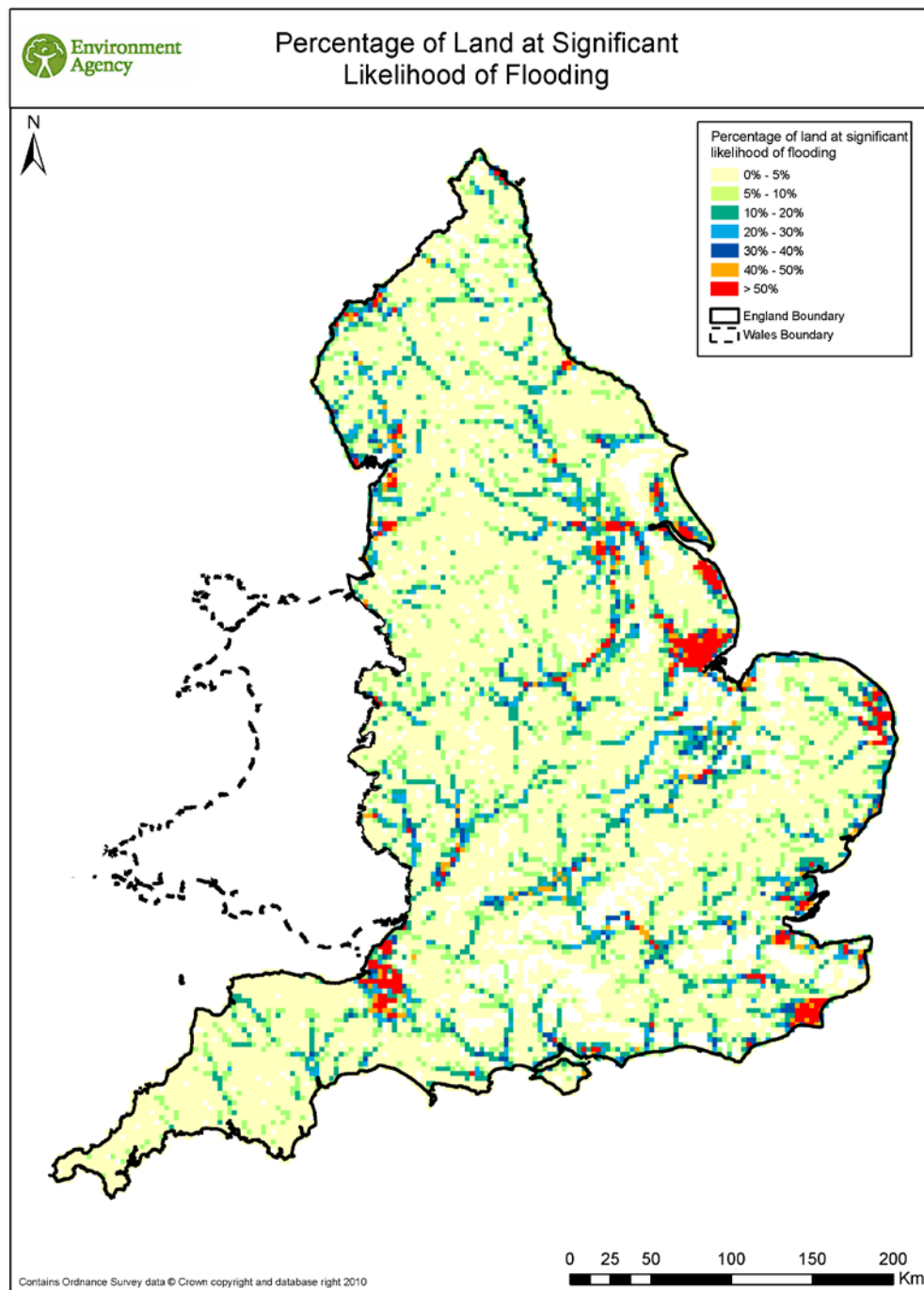
- low – the chance of flooding each year is 0.5 per cent (1 in 200) or less
- moderate – the chance of flooding in any year is 1.3 per cent (1 in 75) or less but greater than 0.5 per cent (1 in 200)
- significant – the chance of flooding in any year is greater than 1.3 per cent (1 in 75)

Figure 5 provides an example of the information provided by NaFRA and shows the percentage area of land at significant likelihood of river and sea flooding in England.

The results of the assessment are provided to the Association of British Insurers (ABI) under an agreement with Government to enable the industry to continue to offer their services to as many people as possible who live in flood risk areas.

The National Flood Risk Assessment has given a national picture of the total number of properties at risk in England and Wales and has been published through the Flooding in England and Flooding in Wales documents. Although the assessment is not accurate at a property level it gives vital information to help in decision making about resources and investment, and has been used with other data to develop the Long Term Investment Strategies for England and Wales. This report includes an assessment of the costs and benefits of flood risk management over the next 25 years under various scenarios including climate change. Results suggest that there is a need for a steady increase in investment to around £1040 million a year plus inflation in building, improving and maintaining defenses in England by 2035 just to maintain current levels of risk of flooding from rivers and the sea in the face of climate change and deteriorating assets.

NaFRA is updated every three months with new or improved data as this becomes available and the UK is considering how it can use the data more widely for purposes such as promoting flood awareness and preparation in the local community.



**Figure 5: Percentage Area of Land at Significant Likelihood of River and Sea Flooding (NaFRA 2010)**

The information developed through the NaFRA has also been made publicly available by the Environment Agency through its online Flood Map. This was first launched in 2004 and is updated every three months as new or improved data become available. The information is shared under licence with Local Authorities (LAs) and other partners for spatial planning and emergency planning purposes, can be accessed by the public via the Environment Agency website, and contains the following information:



- Flood Zones, which ignore the benefits provided by flood defenses, to support the application of land use planning policies in England and Wales, and show:
  - The extent of a flood from rivers with a 1 in 100 chance of occurring in any year;
  - The extent of a flood from the sea with a 1 in 200 chance of occurring in any year;
  - The extent of a flood from rivers or sea with a 1 in 1000 chance of occurring in any year. This is also known as the Extreme Flood Outline (EFO).
- the most significant flood defenses.
- the areas benefiting from defenses.

### ***Flooding from surface water***

The Environment Agency holds maps under licence (from JBA Consulting) that show Areas Susceptible to Surface Water Flooding and provide an indication of those locations which are likely to flood from surface water in a storm with a 1 in 200 chance of occurring in any year. The mapping is broad brush and is not suitable for use at a detailed local level. It does not take account of the effects of drainage systems or buildings. The Environment Agency have also developed improved data on surface water flooding which takes account of buildings, and some account of the effects of drainage systems. This uses improved ground level information over that used to derive information on the Areas Susceptible to surface water flooding, shows areas which are likely to flood from surface water in storms with a 1 in 30 and 1 in 200 chance of occurring in any year, and provides an indication of deeper and shallower areas of flooding.

These data have been shared under licence with Local Resilience Forums, Lead Local Flood Authorities and Local Planning Authorities to help support local risk management actions. The Environment Agency is currently considering how this data is best used alongside more site-specific information being produced by Lead Local Flood Authorities.

### ***Flooding from reservoirs***

The Environment Agency has also produced maps showing areas which could flood in the unlikely event of the failure of a reservoir with a volume of greater than 25,000m<sup>3</sup>. There is no specific probability associated with this information and the maps show a 'worst credible scenario'. Flood depth and velocity information have also been produced. Again these maps have been shared with Local Resilience Forums in England and Wales for Emergency Planning purposes and flood outline maps are available via the Environment Agency website following user testing and design to ensure that the data are easily understood.

### ***Flooding from groundwater***

The Environment Agency does not currently produce maps showing areas at risk of flooding from groundwater. However, it expects to produce data based on an analysis of a number of datasets including data from British Geological Society (BGS), showing an indication of the areas at greatest risk from groundwater flooding.

## **The Foresight – Future Flooding study**

The Foresight – Future Flooding study report<sup>6</sup> was published in 2004 and aimed to provide a long term (30-100 years) vision for future flood and coastal defense across the whole of the UK that took account of the many uncertainties, was robust, and could be used as a basis to inform policy and its delivery. In particular the study investigated:

---

<sup>6</sup> [www.bis.gov.uk/foresight/our-work/projects/published-projects/flood-and-coastal-defence](http://www.bis.gov.uk/foresight/our-work/projects/published-projects/flood-and-coastal-defence)



- How might the risks of flooding and coastal erosion change in the UK over the next 100 years?
- What are the best options for Government and the private sector for responding to the future challenges?

The project was structured into 3 phases:

1. identify the key factors likely to change flood risk on a 30-100 year timescale (the drivers) in terms of both the physical processes of, and human interventions in, the flooding system; provide a framework within which the following phases of the project can quantitatively assess changes in future flood risk; and set out work plans for the future phases of the project
2. deepen the analysis undertaken in phase 1 and quantify the impacts of future flood risk in the UK under four future scenarios that embodied different approaches to governance (national vs. localized), different societal values (consumerist vs. community), and different climate change scenarios.
3. identify and evaluate possible responses to the outputs of the analysis carried out under phases 1 and 2 and report.

The analysis carried out under the study suggested that risks could increase significantly over the 30 to 100 years following publication, but that there are significant variations in levels of risk between the different scenarios and considerable uncertainty inherent in looking so far into the future. It also quantified the potential scale of the challenges faced in managing flood risk in the UK and provided a broad assessment of the different measures available to manage that risk. The research has identified a range of difficult choices that could be made in managing risk, some of which have been highly influential in the development of flood management strategies. It has also identified areas where the potential benefits of investment are less well defined and would benefit from an improved understanding which can only be realised as the results from research and improved data become available.

### **2.1.3 Portfolio Approaches for Dam and Levee Safety (United States)**

Over 84,000 dams in the United States meet the criteria for inclusion in the National Inventory of Dams<sup>7</sup>. The Corps operates over 600 of these structures, mostly large dams; the remainder are owned or operated by other agencies or private organizations. The National Committee on Levee Safety<sup>8</sup> estimates there may be more than 100,000 miles of levees in the nation with tens of millions of people living behind them; approximately 15% of those levees are designed and constructed by the Corps and a similar number are operated by other federal agencies (U.S. Bureau of Reclamation, National Resources Conservation Service.)

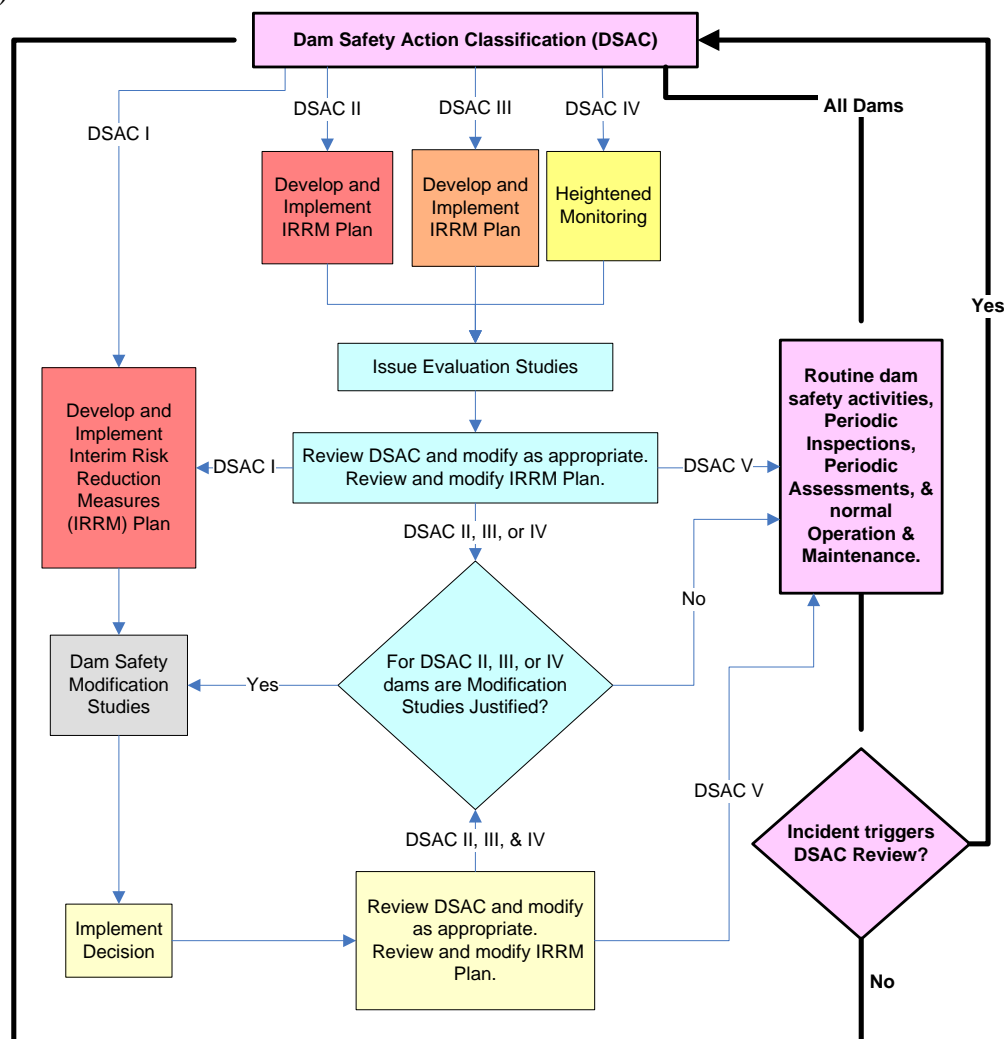
The U.S. Army Corps of Engineers is beginning to implement risk-informed dam and levee systems safety programs organized around a portfolio risk management process. The programs' purpose is to make life safety paramount, although protection of property and the environment is a consideration. The programs seek to ensure that all existing Corps dams and levee systems in the Corps inventory continue to function as intended, and are operated and maintained so no

<sup>7</sup> <http://www.usace.army.mil/Library/Maps/Pages/NationalInventoryofDams.aspx>

<sup>8</sup> [http://www.leveesafety.org/lv\\_nation.cfm](http://www.leveesafety.org/lv_nation.cfm) ; see [http://www.leveesafety.org/docs/NCLS-Recommendation-Report\\_012009\\_DRAFT.pdf](http://www.leveesafety.org/docs/NCLS-Recommendation-Report_012009_DRAFT.pdf) ) for the NCLS's report entitled *Recommendations for a National Levee Safety Program: A Report to Congress from the National Committee on Levee Safety (January 2009)* with recommendations for a comprehensive and effective National Levee Safety Program.

intolerable risk to life is present. Toward that end, the dam safety program has adopted tolerable risk guidelines for what it terms incremental risks; these are the risks to life that are the result of an unsatisfactory performance of the structure itself. This is distinct from the residual risk that remains from flood events for which the structures remain intact but are overwhelmed by the magnitude of the event. The Corps' process has moved away from an engineering standards-based approach for its structures to what it calls risk-informed decision making, organized around the three elements of risk analysis: assessment, communication, and management. These elements are to be applied continuously, in cooperation with those communities downstream of the dams and located behind the levee systems. The key concepts and supporting methods and tools that constitute the Corps' safety programs will be made available to other dam owners and operators, as well as state and local governments with responsibility for monitoring dams and levees.

The Corps' dam safety portfolio risk management process is now operational. The process is a series of hierarchical activities that are used to assess and classify, communicate, and then manage the risks to life associated with the Corps' national inventory of dams. Corps dams are given a Dam Safety Action Classification (DSAC) based on their probability of failure and the associated consequences. The DSAC governs the steps taken in the portfolio approach (see Figure 6.)



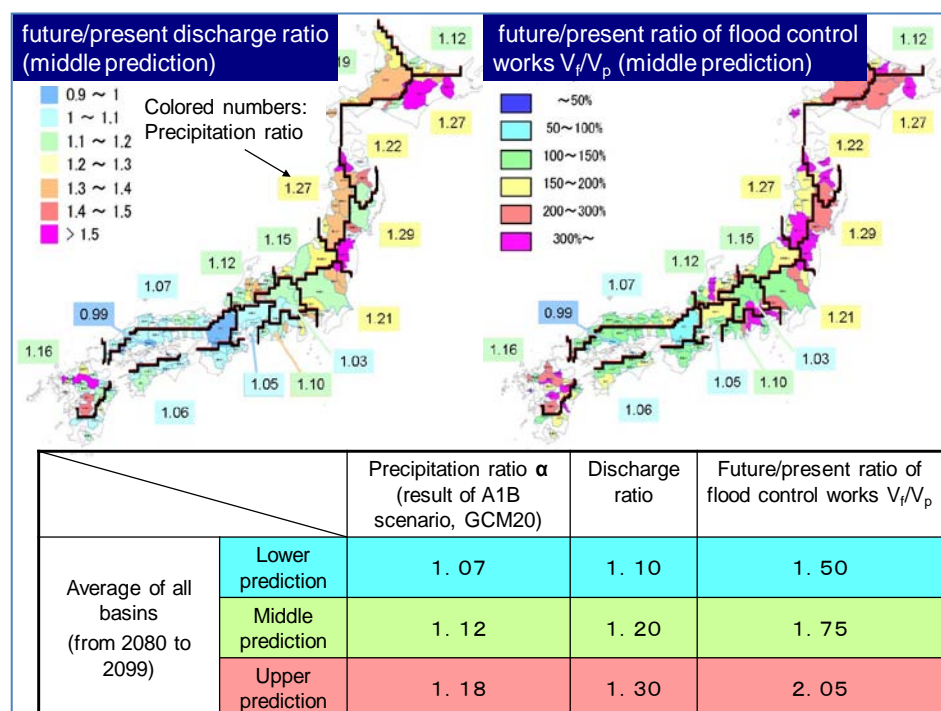
**Figure 6: Generalized Corps' Portfolio Risk Management Process**

## 2.1.4 Preparation of Charts and Index to Assist Examination of Flood Control-Related Climate Change Adaptation Strategies (Japan)

The increased intensity of torrential rain as a result of climate change has generated concern in regard to an increase of the flood peak runoff and the resulting decline of the safety level of flood control. To maintain the original target for the safety level (i.e., return period for the set precipitation), it is necessary to expand the scale of the originally envisaged flood control facilities to compensate for increased precipitation due to climate change. Given the absence of reliable methods at present to accurately assess the impacts of climate change and to manage the perceived risks, there is a strong need for a new index which can contribute to the debate on climate change adaptation strategies to cover the entirety of Japan. This is exactly the reason why the National Institute for Land and Infrastructure Management (NILIM) has been conducting studies on the impacts of climate change on the flood peak runoff and the safety level of flood control and also on a method to estimate the necessary scale of flood control facilities to adapt to climate change.

The concrete achievements of these studies so far include (i) charting of variations of the annual maximum daily precipitation based on the prediction results of the 20 km mesh global circulation model (GCM) of the Japan Meteorological Agency and (ii) charting of variations of the flood peak runoff in major rivers (sections which are directly managed by the central government) and of variations of the return period (which corresponds to the flood peak runoff in existing flood control plans) for each river system.

Moreover, "the increase rate of river channel improvement work" (= quantity of flood control works to adapt to climate change / quantity of flood control works in existing plans) has been proposed as a new index to indicate the increase rate of the scale of flood control measures to adapt to climate change. This index has then been estimated for several major rivers.



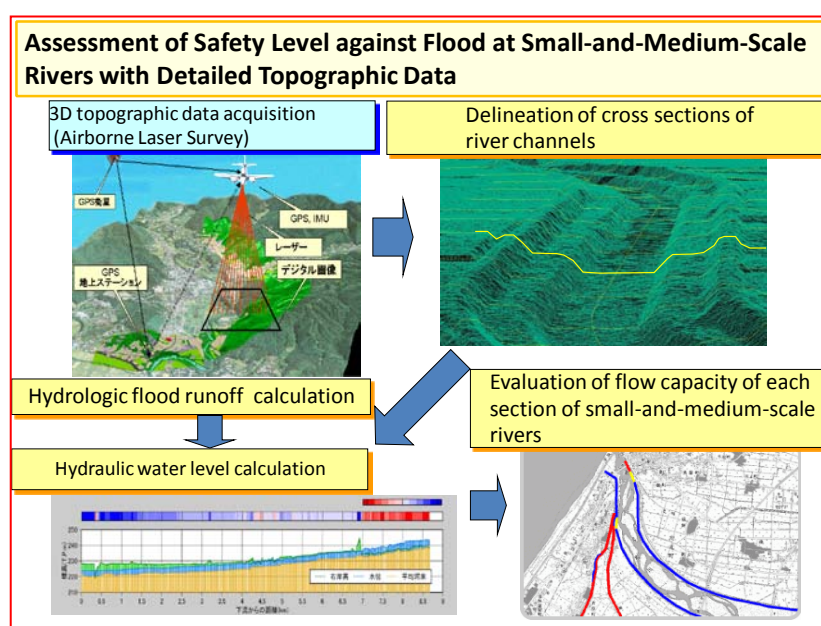
**Figure 7: Future/present ratio of precipitation, discharge and flood control works**

The charts and index described above are believed to be effective for general assessment of the impacts of climate change on major rivers. As they enable quantitative assessment of the likely increase of the scale of flood control measures to adapt to climate change in comparison to current flood control measures, they should prove to be very useful to progress debates on concrete adaptation strategies/measures and risk management further forward.

### 2.1.5 Nation-wide Evaluation of Safety Level of Flood Control of Small and Medium Rivers Using Airborne Laser Surveying Technology (Japan)

Large-scale rivers in Japan regularly undergo cross-sectional surveying and the hydraulic analysis with the cross-sectional data enables quantitative evaluation of the safety level of current flood control measures. In contrast, the much smaller budget size for small and medium rivers means a much lower surveying frequency, making it difficult to evaluate the safety level of current flood control measures for these rivers despite the fact that the total length of them is quite long. A new method using the airborne laser surveying technology has been developed for the inexpensive and speedy evaluation of the safety level of the flood control of numerous small and medium rivers to match the similar evaluation of major rivers. This method enables the evaluation of these rivers in terms of the safety level of flood control with the required level of accuracy from a nationally uniform viewpoint. It is hoped that the results of such evaluation will assist the implementation of more efficient and effective flood control measures.

The new method uses surveying data obtained by an airborne laser scanner to prepare three-dimensional TIN (triangulated irregular network) data and then creates a cross-sectional profile of a river channel. The safety level of flood control at a specific point is evaluated by means of comparing the computed water level based on the one-dimensional non-uniform flow model using the cross-sectional profile data and the rainfall data as an external force condition with the embankment height obtained from the cross-sectional profile.



**Figure 8: Assessment of Safety Level of Flood Control of Small-and-Medium-Scale Rivers with Detailed Topographic Data<sup>9</sup>**

<sup>9</sup> <http://www.nilim.go.jp/lab/rcg/newhp/seika.files/lp/eva.ntml> (Japanese)

It is correctly pointed out that the cross-sectional area produced by airborne laser surveying tends to be smaller than the actual cross-sectional area as an airborne laser scanner cannot obtain topographical data below the water surface and its readings are affected by herbaceous plants and so on. However, it is judged that the new method is capable of securing the required level of accuracy while functioning as an inexpensive and swift method of evaluation based on a nationally uniform viewpoint.

## **2.2 Regional / Local Level**

For the purpose of regional land use and water management planning, prioritization of improvement works, as well as the preparation of emergency operations, risk assessment on the regional and local level is required. Examples are presented from Japan, the Netherlands and the United States.

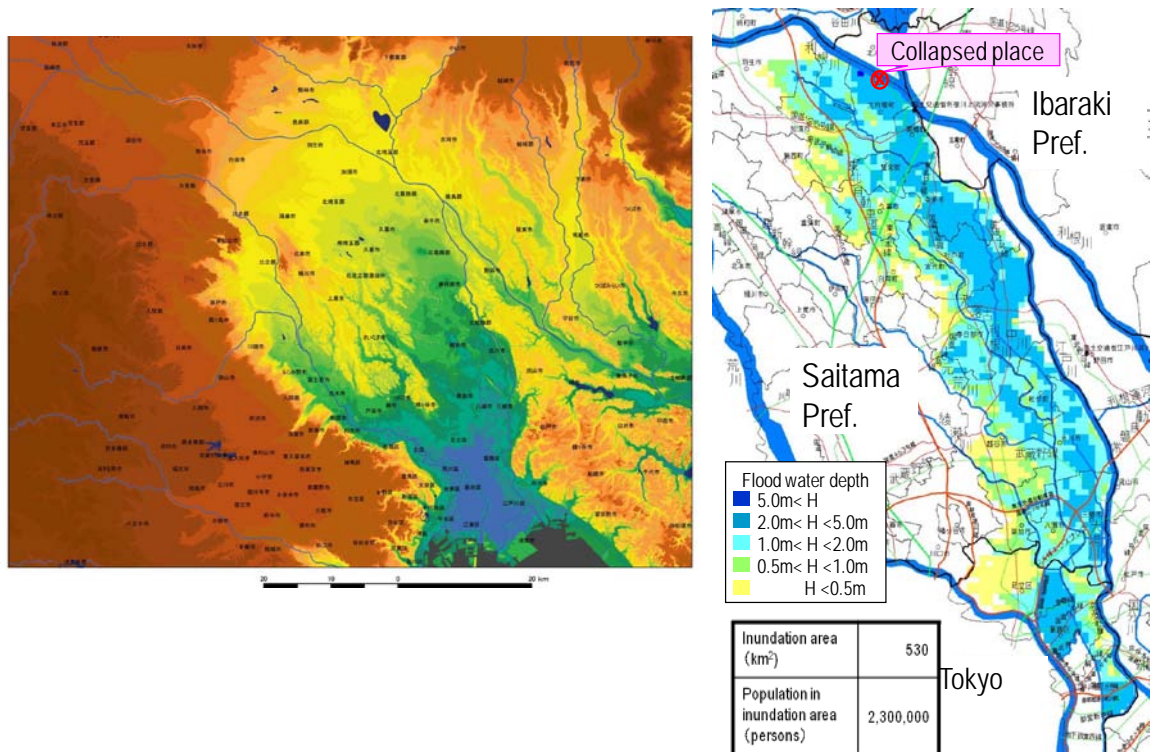
- 2.2.1 Japan: Regional Risk Assessment of Large-Scale Flood Disaster in the Tokyo Metropolitan Area
- 2.2.2 The Netherlands: Risk Assessment Project VNK2
- 2.2.3 USA: Multiple Scenario Approaches to Address Coastal and Riverine Risk: Habitat Lessons from Louisiana
- 2.2.4 Japan: Local Impact of Fast Flow on Houses Caused by Breach of Embankments

### **2.2.1 Regional Risk Assessment of Large-Scale Flood Disaster in the Tokyo Metropolitan Area (Japan)**

In recent years, the world has seen a series of large-scale flood disasters, including a storm surge disaster caused by Hurricane Katrina in the United States in 2005. The many deaths, evacuees and massive economic loss caused by these disasters pose many questions in regard to the regional and local preparedness and emergency response to counter such disasters.

Japan has suffered from large-scale flood disasters in the past. Typical examples are Typhoon Kathleen which badly hit the Tokyo Metropolitan Area (TMA) in 1947 and Typhoon Vera (Typhoon Ise Bay) in 1959 which caused devastation to areas near Nagoya. In more recent years, the steady construction of river embankments and other flood control facilities has improved the capability to effectively deal with floods and storm surge up to a certain level. However, the construction of flood control facilities is not yet complete although continuous efforts have been made. If a flood on the scale of Typhoon Kathleen in 1947, which is still the greatest flooding of Tone River and Ara River in the post-war period, occurs again, there is possibility of another massive flood disaster due to breaching of the embankments as was the case in 1947 when the embankments of Tone River were breached at Higashi Village (presently Kazo City, formerly Otone Town) in Saitama Prefecture with flooding of not only the neighborhood but also a huge urbanised area in TMA located downstream.



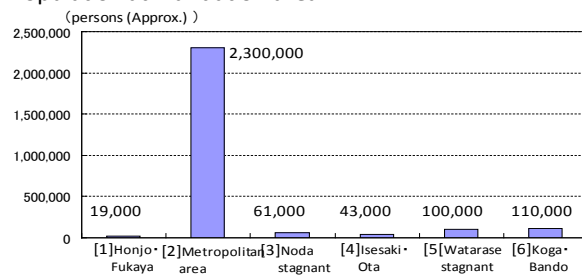


**Figure 9: Flooding simulation results (Study on large-scale flood damage mitigation in Tokyo metropolitan area)<sup>10</sup> (Provided by the Cabinet Office)**

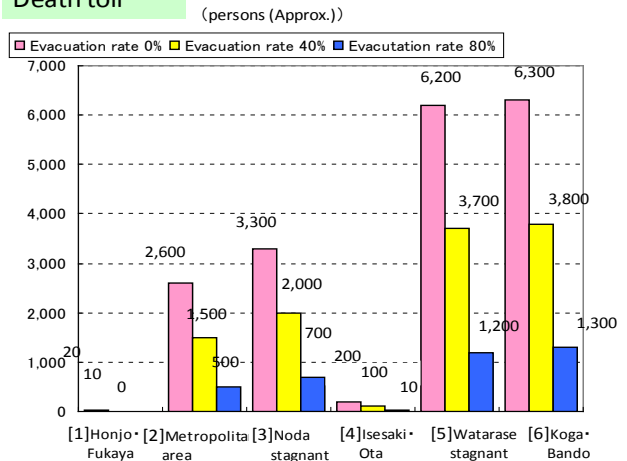
Through Japan's post-war economic growth, TMA in particular has built up a massive concentration of political and economic functions and the population has increased to some 43 million. This large population and numerous buildings have been massed on a small alluvial plain and even the underground space has been intensively utilized with complex structures. If flooding occurs in TMA due to a breach of the embankments along Tone River, Ara River and others, the resulting human casualties, property damage and economic loss are likely to surpass those caused

<sup>10</sup> [http://www.mlit.go.jp/river/basic\\_info/english/pdf/guigelines\\_eng.pdf](http://www.mlit.go.jp/river/basic_info/english/pdf/guigelines_eng.pdf), p. 23.

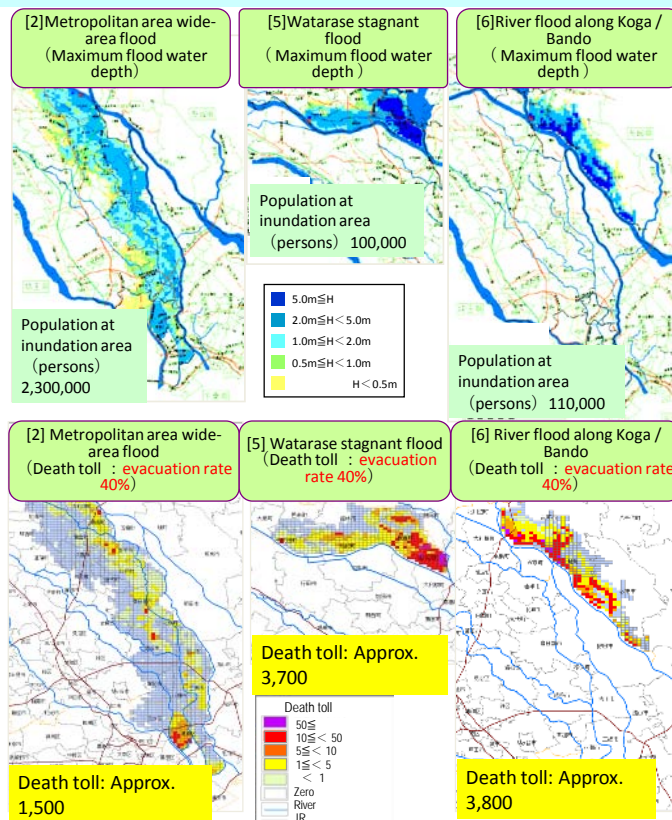
Population at inundation area



Death toll



No pump operation; no fuel supply; no floodgate operation; no pumper truck available



The number of deaths resulting from levee breach induced flooding of the Tone River caused by a 200-year flood was studied. As a result, it has been found that the number of deaths in an area with a large inundation area and a large population is not necessarily large ([2] Metropolitan area wide-area flood), and that the number of deaths in an area with a small inundation area and a small population may be large if the flood water stays long ([5] Watarase stagnant flood, [6] River flood along Koga/Bando). These results indicate that the number of deaths is greatly affected by the form of flooding.

**Figure 10: Effects of drainage operations on death toll (Study on large-scale flood damage mitigation in Tokyo metropolitan area)<sup>11</sup> (Provided by the Cabinet Office)**

<sup>11</sup> [http://www.mlit.go.jp/river/basic\\_info/english/pdf/guigelines\\_eng.pdf](http://www.mlit.go.jp/river/basic_info/english/pdf/guigelines_eng.pdf), p. 24.

by Typhoon Kathleen. The time and cost required for rehabilitation/restoration will be unimaginably long and high.

Moreover, the frequency of downpours is on the increase recently in Japan and there are worrying predictions from the viewpoint of disaster prevention such as an increasing frequency of downpours and rising sea level due to climate change.

In consideration of the real potential of a large-scale flood disaster associated with flooding of Tone River and/or Ara River or a storm surge in Tokyo Bay, thorough examination of emergency, preventive measures as well as rehabilitation/restoration measures to minimize the damage caused by a large-scale flood disaster is essential. Similar work has already been conducted for a large-scale earthquake and volcanic eruption.

Thus, the Expert Panel on Large-Scale Flood Disaster Countermeasures was established within the framework of the Central Disaster Prevention Council in June 2006 to examine such measures as the first such expert panel featuring large-scale flood disasters.

Based on the latest knowledge, the said panel has conducted several simulations of floods presumably caused by breaching of the embankments along Tone River, Ara River and others or by a massive storm surge in Tokyo Bay to clarify how the flooding may proceed. The panel analysed the likely mode of flooding and various risks in TMA by estimating various types of the likely damage such as the likely number of people killed and those stranded. Such estimation was done for the first time in Japanese studies. Based on the analysis findings and actual data on large-scale flood disasters in the past, the panel examined desirable measures to deal with a large-scale flood disaster in TMA and published a report in April 2010 after lengthy work for some three and a half years. The formulation of a policy outline for government efforts to deal with large-scale flood disasters based on this report is currently being planned.

### **2.2.2 Risk Assessment Project VNK2 (The Netherlands)**

In 2006 the VNK2 research project<sup>12</sup> (formerly known as FLOod RiSk in the Netherlands: FLORIS) was started to gain insight into the current level of flood protection. A quantitative risk analysis is performed for each levee system, considering all principal failure mechanisms and the consequences of levee failures. The effects of spatial correlations are explicitly taken into account. Weak links in the flood defense system can be identified, as well as the mechanisms and variables that contribute most to the probability of failure and the level of risk.

Failure mechanisms that are considered in the model are:

- Dikes: overflow and wave overtopping, piping, sliding of the inner slope and revetment erosion and subsequent internal erosion;
- Dunes: erosion by storms;
- Hydraulic structures: closing failure, structural failure, overflow and wave overtopping and piping.

---

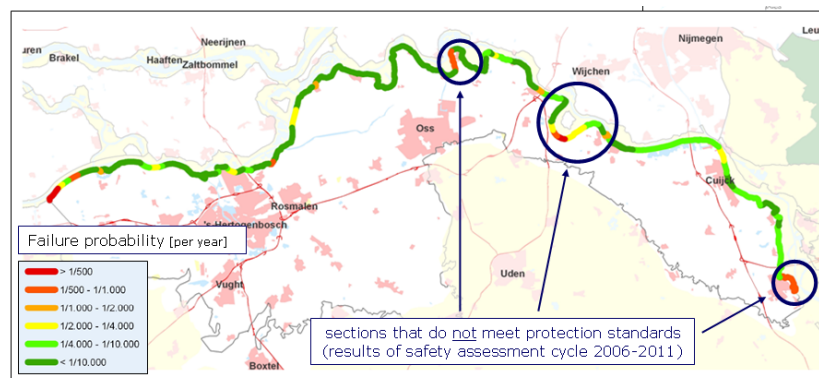
<sup>12</sup> See paper prepared for the 5<sup>th</sup> International Conference on Flood Management, entitled “The VNK2 project: a fully probabilistic risk analysis for all major levee systems in the Netherlands.” More information is also available at [vnk-2@rws.nl](mailto:vnk-2@rws.nl)



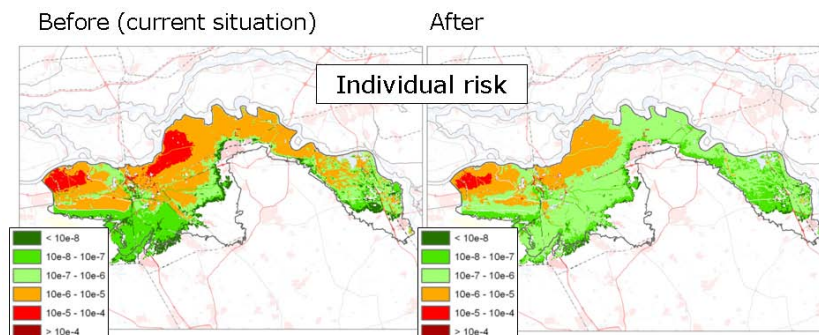
For the analysis, geometric data (slope, orientation, fetch, etc.), material properties (weight, sliding strength, etc.) and hydraulic boundary conditions (waves, water level, duration, etc.) are used.

### Results

In 2010, fully probabilistic risk analyses were completed for six levee systems. In a previous phase, three levee systems had already been analysed. The method turned out to be very useful for identifying weak sections (and the dominant failure mechanisms), prioritizing safety measures, and highlighting important sources of uncertainty. While in the previous phase the VNK2 analysis focused only on quantifying individual, societal risk and economic risks, later phases also analysed the impact on flood risks (and overall flood probabilities) of strengthening dikes, dunes and hydraulic structures, as shown in Figure 11 below.



**Figure 11: Failure probabilities for all sections in a levee system along the upper rivers. Marked sections do not meet current safety standards and should be strengthened. Strengthening these sections would reduce the level of flood risk (see figure 12).**



**Figure 12: Individual Risk map before and after reinforcement of three weak levee sections (see figure 11).**

The differences in risk levels among the nine levee systems are considerable. Flood probabilities range from more than 1/100 per year to less than 1/10,000 per year. While individual risk (IR) levels of less than  $1 \times 10^{-6}$ /year were calculated for Central Holland with its major cities of Amsterdam, Rotterdam and The Hague, 10 to 100 times higher IR levels of  $10^{-4}$  to  $10^{-5}$  per year were found for some levee systems along the rivers. Large variations in IR levels exist within levee systems as well, resulting from differences in consequences between breach locations and variations in the failure probability along a levee. Since the Netherlands is a flat country, flood patterns are influenced by the presence of former flood defenses ('secondary levees') and line elements such as roads and railways, which may block flood waters.

Piping turned out to be a dominant failure mechanism for almost all levee systems. This result implies that the probability of a levee failure below the water levels that the levees should be able to safely withstand (as defined by the Water Law) is significant. The high failure probabilities for piping initially led to disbelief. This gradually changed when a second opinion by the Expertise Network for Flood Protection concluded that the methods and results of VNK2 were scientifically correct, and that current design guidelines are overly optimistic. This is because the length-effect (see box below) has not been properly accounted for in these guidelines (which, at present, only focus on the safety of individual cross-sections).

#### Length-effect

*The longer a dike section, the higher the probability that there will be a weak spot somewhere within that section (due to spatial variability of properties, such as geotechnical properties.) The resulting phenomenon, that the failure probability increases with unit length, is called the “length effect”. The intensity of the length effect differs per failure mechanism (although the water level is always the driving force). The length effect is especially strong for geotechnical failure mechanisms such as piping and slope instability. This is because the dominant stochastic variables for these failure mechanisms are characterized by relatively high degrees of spatial variability.*

### **2.2.3 Multi-Criteria Approaches to Address Coastal and Riverine Risk: Habitat Lessons from Louisiana (United States)**

Following Hurricane Katrina, the U.S. Congress in 2006 directed the Secretary of the Army to conduct a comprehensive hurricane risk reduction design and analysis in close coordination with the State of Louisiana; develop a full range of hurricane risk reduction measures for South Louisiana, including coastal restoration; and consider risk reduction for surges equivalent to Category 5 hurricanes. The Corps of Engineers led the Louisiana Coastal Protection and Restoration (LACPR) planning and technical effort in collaboration with many others, including the Coastal Protection and Restoration Authority of Louisiana, other State and Federal agencies, scientists, academics, and stakeholders. In May 2007, the State of Louisiana officially adopted the State Master Plan<sup>13</sup> which provides the State's conceptual framework of a sustainable coast and is the overarching vision for LACPR. The LACPR Final Technical Report<sup>14</sup> complements the State Master Plan by presenting detailed technical evaluation for certain components.

Based upon lessons learned from historic water resources development projects and ecosystem restoration projects, the LACPR planning effort encompassed all of coastal Louisiana and integrated water resources objectives of hurricane protection, flood control, and coastal restoration. The LACPR technical report was offered as guidance for Congress and other decision makers in long-term decision making regarding hurricane protection, flood control and coastal restoration.

The LACPR developed a multi-criteria decision analysis (MCDA) tool to provide a “Risk Informed Decision Framework” that was proposed as a way to organize and present data in a format useful for decision making. This multi-criteria framework was developed to attempt to provide a transparent process for making and communicating planning decisions. The framework was offered to provide information to decision makers on a set of possible future conditions as

---

<sup>13</sup> <http://www.lacpra.org>

<sup>14</sup> <http://lacpr.usace.army.mil/default.aspx>

well as organizing evaluation information on multiple and diverse objectives and stakeholder values.

LACPR's Risk-Informed Decision Framework was proposed for:

- identification, assessment, communication and management of risks to life, health, the environment and economics associated with hurricane-induced flooding and residual risks associated with risk mitigation plans;
- accounting of the major uncertainties in the planning environment that could affect the performance of plans in the future;
- identification of data gaps that could influence decisions;
- a basis for ranking the performance of alternative plan formulations based on risk metrics correlated to planning objectives and stakeholder values; and
- establishment of confidence levels for planning decisions and recommendations.

There may be several very different effective solutions for very complex problems. The LACPR effort highlighted the fundamental issue of how to evaluate and compare various, often conflicting, alternatives. The primary lesson from the LACPR effort was that proponents and stakeholders for hurricane and flood risk reduction learned that in addition to typical quantifiable economic costs, there are also environmental functions and values, as well as individual or personal impacts, for which it is not possible to effectively determine the costs. Conversely, proponents and stakeholders for environmental restoration learned that environmental restoration efforts may also bear significant risk acceptance costs.

#### **2.2.4 Local Impact of Fast Flow on Houses Caused by Breach of Embankments (Japan)**

In urban areas located on flat lowlands, it is not unusual to observe residential areas extending right up to the river embankments. A breach of the embankments in these areas has a risk of the destruction or washing away of the nearby houses due to high speed flood water flow. Moreover, the rapid increase of the flood area and flood depth makes evacuation difficult, aggravating the prospect of possible human casualties.

Using the FDS (Flux Difference Splitting) method suitable for analysis of the mixed flow of streaming flow and jet flow where the water depth and flow velocity violently change, the National Institute for Land and Infrastructure Management (NILIM) has conducted a two-dimensional unsteady plane simulation for the flood water flow for actual cases in which the damage described above actually occurred. As this simulation adopted a 2 m mesh size to incorporate the shapes of individual houses and the roads in the computation model, it was possible to reproduce the situation where flood water surges due to the presence of houses and also runs on the roads like a river. These detailed simulation results were then used to identify areas where it would soon be impossible to walk (i.e., areas from which evacuation would be difficult) after the start of flooding and also high risk areas near the embankments for destruction and/or the washing away of houses. Work is currently in progress to develop a reliable risk evaluation method using these simulation results and other relevant data.

There are high expectations for the further use of flooding simulation results for the training of disaster prevention personnel and the education of the public on the risk of embankment breaches

in addition to the evaluation of possible human casualties due to flood water flow, as these results can assist visualisation of the situation of flooding due to the breaching of embankments in urban areas.

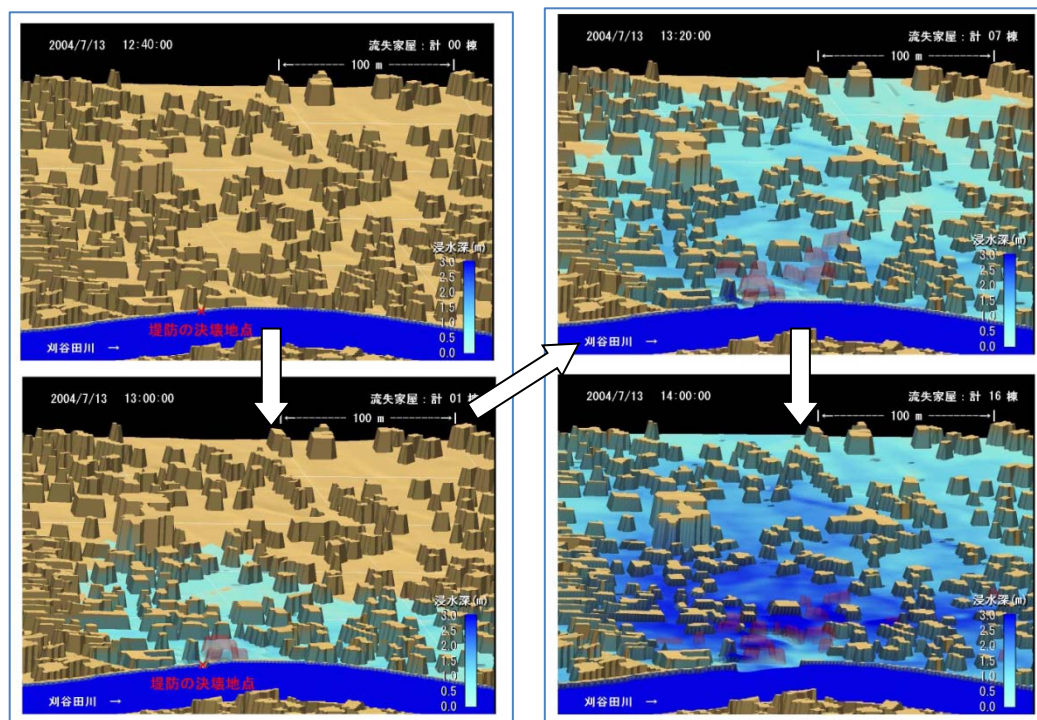


Figure 13: Simulation Results of Fast Flow Caused by Breach of Embankments<sup>15</sup>

<sup>15</sup> [http://www.mlit.go.jp/river/press\\_blog/past\\_press/press/200407\\_12/041224-2/pdf/20041224-2\\_1.pdf](http://www.mlit.go.jp/river/press_blog/past_press/press/200407_12/041224-2/pdf/20041224-2_1.pdf) (Japanese)

### 3 Policy Development

Policy development in a flood risk management context involves (high-level) decision-making on objectives and related levels of risk, and the selection of strategies and measures (prevention, protection, preparedness, response and recovery) and required budgets to achieve desired outcomes. The resulting mix depends on the characteristics and consequences of flooding, desired levels of risk, available budget, and cultural aspects. Notwithstanding political boundaries, decision-making will ideally occur within a watershed framework and consider lifecycle aspects.

Some policy decisions involve setting an acceptable level of risk, and then determining how to meet it over time. Setting an acceptable level of risk implies that design criteria are made explicit for measures to meet the acceptable level (e.g., the flood level corresponding to the 0.2% flood.) On the other hand, it also clarifies the conditions authorities, organizations and individuals have to be prepared for when the design level is surpassed, the so-called “residual risk”. The characteristics of those typical extreme events demand a probabilistic approach, since known historic events often don’t cover the entire scale of extreme events that are physically possible to address uncertainties inherent in flood risk analyses.

Other policy decisions may be driven primarily by available budget and the expected level of risk reduction that can be achieved for the investment, with decisions focused on where best to spend precious funds. In such instances, various levels of risk – among locations or implementation options – can help prioritize expenditures. Residual risk remains an important consideration and requires specific contingency plans, including the addition of possible resiliency features to a system.

Section 3.1 considers the national level; Section 3.2, the regional/local level.

#### 3.1 National Level

- 3.1.1 Japan: River System-Based Management and River Improvement Plan
- 3.1.2 Japan: Catchment Approach/Comprehensive Flood Control Measures
- 3.1.3 Japan: "Climate Change Adaptation Strategies to Cope with Water-Related Disasters Due to Global Warming": Policy Report by the Panel on Infrastructure Development, MLIT, June 2008
- 3.1.4 UK: Pitt Report, Recommendations, and Progress
- 3.1.5 UK: Vision and strategy for the UK (England, Scotland, Wales and Northern Ireland) including legislation and strategies
- 3.1.6 UK: Allowances for Climate Change
- 3.1.7 USA: Adapting to Climate Change
- 3.1.8 USA: Proposed Principles and Guidelines
- 3.1.9 USA: Development of Tolerable Risk Guidelines for dams and levees
- 3.1.10 The Netherlands: Policy Development and Selection of Measures as Result of 2010 Risk Assessment

##### 3.1.1 River System-Based Management and River Improvement Plan (Japan)

In Japan, the River Law prescribes basic matters about river management. In 1896, when the law was first established, its purpose was “flood control” only. Because of the rapid increase of water demand due to the economical development, the law acquired the new purpose of “beneficial use

of water resources” in 1964. Against the backdrop of the growing awareness of environmental importance, the purpose of “environment” was added to the law in 1997.

Since the revision in 1964, the basic idea of the River Law has been "river system-based management". The reason for adopting this idea is that river works in upstream sections or branches inevitably affects the safety of downstream sections or mainstream and may arouse conflicts. Based on the idea, river management has been implemented by adjusting the policy between the upstream and downstream, mainstream and branches of each water system.

The Law revised in 1997 prescribes that each river management authority shall determine a “basic policy for river improvement” for each river system. It contains matters related to basic policies for river works and maintenance, including design flood discharge and others. The basic policy should be determined to secure comprehensive river management for each river system by considering the occurrence of flood disasters, the current uses and the future development of water resources, and the river environment. The law also requires the basic policy to be coordinated with the national spatial plan and the basic environment plan. The basic policy for river improvement is a long-term plan for flood control and other river improvements.

Based on the basic policy for river improvement, each river management authority shall also determine a “river improvement plan” for each river section where river improvement works must be implemented in a well-planned manner. The river improvement plan prescribes specific measures to be taken in approximately two or three decades after its formulation. Where acknowledged necessary for working out the river improvement plan, river management authorities shall also take necessary measures to reflect opinions of the residents concerned.

The river system-based management with the formulation of the “basic policy for river improvement” and the “river improvement plan” contributes to the achievement of comprehensive flood risk management of each river system, balancing upstream and downstream, mainstream and branches for river improvement works and maintenance.

### **3.1.2 Catchment Approach/Comprehensive Flood Control Measures (Japan)**

During the period of high economic growth from the mid-1950s, there was a marked migration to three metropolitan areas in Japan. The progressive conversion of farmland and forest land to residential plots in vast areas adjacent to already urbanised areas led to the emergence of various problems from the viewpoint of flood risk management. The essential water retention and retarding functions of river basins declined, resulting in shortening of the time to reach the flood peak runoff as well as an increase of the flood peak discharge. Moreover, the development of residential plots increased the scale of the potential flood damage risk. As it became difficult to control flooding based on widening of the river channel and other conventional means of river improvement, there was growing recognition of the necessity to develop a new comprehensive scheme for flood control in which river improvement forms an integral part of regional development. Following a report by the River Council in FY 1977, it was decided to promote "comprehensive flood control measures".

Comprehensive flood control measures actually combine physical measures with non-physical measures to achieve the intended objective. These measures range from the construction of flood control facilities, such as embankments and sewerage systems, to basin management measures, including the construction of water storage and infiltration facilities at public parks, schools and temporary rainwater storage in newly developed residential areas. Other measures include those

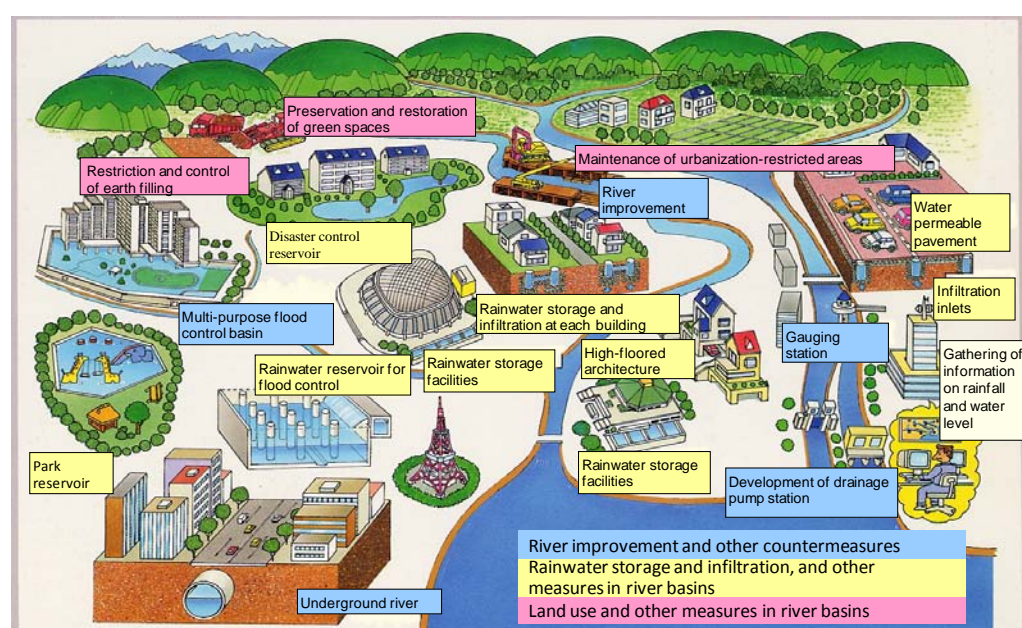


designed to alleviate flood damage by means of publicly identifying flood hazard areas to improve public awareness of the potential flood risk and those designed to promote appropriate land use.

Comprehensive flood control is currently adopted for 17 rivers nationwide where the basin has undergone the process of tremendous urbanization.

**Table 2: Systematic Chart of Comprehensive Flood Control Measures (Japan)**

Physical Measures	Construction of flood control facilities	Rivers	<ul style="list-style-type: none"> <li>• River improvement</li> <li>• Construction of reservoirs and diversion channels</li> </ul>
		Sewerage	<ul style="list-style-type: none"> <li>• Laying of sewer pipes</li> <li>• Construction of pumping stations</li> <li>• Construction of storm water reservoirs</li> </ul>
	Basin management	Storage	<ul style="list-style-type: none"> <li>• Introduction of storage tanks and regulating reservoirs for disaster prevention</li> </ul>
		Infiltration	<ul style="list-style-type: none"> <li>• Promotion of porous paving</li> <li>• Installation of infiltration inlets</li> </ul>
Non-Physical Measures	Appropriate land use, etc.		<ul style="list-style-type: none"> <li>• Retention of urbanization regulation areas</li> <li>• Preservation and restoration of green areas</li> <li>• Subsidy for flood resilient (e.g., high-floor) houses</li> </ul>
	Flood warning and fighting systems		<ul style="list-style-type: none"> <li>• Gathering and supply of precipitation and water level data</li> <li>• Establishment of a flood warning system</li> <li>• Strengthening of the flood fighting system</li> </ul>
	Public Relations activities, etc.		<ul style="list-style-type: none"> <li>• Public announcement of flood hazard area maps, etc.</li> <li>• Encouragement of river-related private sector activities, including river cleaning</li> <li>• Distribution of pamphlets, etc.</li> </ul>



**Figure 14: Comprehensive Flood Control Measures**

### **3.1.3 "Climate Change Adaptation Strategies to Cope with Water-Related Disasters Due to Global Warming": Policy Report by the Panel on Infrastructure Development, MLIT, June 2008 (Japan)**

Climate change due to global warming is causing concern for the aggravation of water-related disasters due to a rise of the sea level, increased frequency of torrential rain, further intensification of typhoons/hurricanes and worsening droughts. For example, one prediction suggests a conspicuous worsening of the safety level of flood control which corresponds to the precipitation in existing flood control plans. According to this prediction, the safety level is likely to drop in 100 years' time to the level capable of dealing with heavy rain with a return period of 90 to 145 years for river systems of which the current return period of target rain is 200 years.

In order to examine suitable policies and measures to deal with such a situation, the Panel on Infrastructure Development, a government panel of experts, held a series of deliberations on climate change adaptation strategies to cope with water-related disasters due to global warming and compiled a report in June 2008<sup>16</sup>.

The report recommends multiple implementation of "flood control policies to secure safety by river basin measures" to counteract the growing external forces in addition to "flood control policies to secure safety through river improvement" where the principal emphasis is placed on coping with a certain design discharge through river channel improvement and the construction of flood control facilities. Those policies in river basins involve (i) flood control facilities such as retarding basins, (ii) runoff control facilities such as regulating reservoirs and rainwater storage and infiltration facilities, and (iii) the use of setback (secondary) levees, ring dikes, roads and railroad embankments to prevent the spread of flood water, and should be applied with proper consideration of the mode of local land use.

For the smooth implementation of these policies, emphasis is placed on priority investment in preventive measures, clarification of priorities, preparation of a road map, adoption of an adaptive approach, collaboration of stakeholders, development of new technologies and promotion of international contribution, primarily focusing on the Asia-Pacific Region.

### **3.1.4 Pitt Report, Recommendations, and Progress (United Kingdom)**

Following the widespread and serious flooding in England during June and July 2007, Sir Michael Pitt conducted an independent review (the Pitt review) of the way the events were managed. The final report was published in June 2008<sup>17</sup> and contained a detailed assessment of what happened and what might be done differently. It put forward 92 recommendations covering prediction and warning of flooding, prevention, emergency management, resilience and recovery.

A government response to the Pitt review was published in December 2008. The Ministers at the time accepted all of the Report's recommendations and gave an undertaking to implement them in line with the delivery guide. Defra's Structural Reform Plan reinforced the current Government's commitment to ensure that the Pitt recommendations are implemented.

---

<sup>16</sup>[http://www.mlit.go.jp/river/basic\\_info/jigyو\\_keikaku/gaiyou/kikouhendou/pdf/draftpolicyreporttext.pdf](http://www.mlit.go.jp/river/basic_info/jigyو_keikaku/gaiyou/kikouhendou/pdf/draftpolicyreporttext.pdf)

<sup>17</sup> Learning lessons from the 2007 floods, 2008. Sir Michael Pitt, The Cabinet Office, London, United Kingdom.



The majority of the recommendations made in the Pitt review have now been implemented, though work on some is still in progress. The UK Government is not expected to pursue the recommendation on inclusion of flood risk information in Home Information Packs made available to potential purchasers of houses; and the recommendation on flood resilience and UK Building regulations is still being considered.

Key areas in which recent progress has been made include:

- The Flood and Water Management Act is starting to be implemented, with work underway to enable lead local flood authority roles to take effect from April 2011.
- The development and approval by UK Parliament of the first statutory national flood and coastal erosion risk management strategy for England (July 2011).
- The Government published the National Flood Emergency Framework in July 2010 to provides guidance and advice for councils and others on planning for and responding to floods.
- Defra is also working with key groups including local authorities, the Environment Agency and professional bodies to ensure that authorities have the capacity for their new role. Funding is being provided for local authority participants in a foundation degree and wider training developed. A draft strategy for skills and capacity building within local authorities was published in July.
- Local authority work on preliminary flood risk assessments was supported by £2 million UK central Government funding (announced July 2010) and to date 173 out of the 174 lead local flood authorities in England and Wales have submitted their assessments.
- Exercise Watermark took place successfully in March 2011 (see Section 4.4.4.)

### **3.1.5 Vision and Strategy for the UK (England, Scotland, Wales and Northern Ireland) Including Legislation and Strategies (United Kingdom)**

The vision and strategic approaches to flood risk management are broadly similar across the UK (i.e., within England, Scotland, Wales and Northern Ireland). However, the approach to delivery and the organizations involved differs in each country, to take into account different administrative, geographical and environmental circumstances. In all countries, the approaches adopted are risk-based and aim to promote sustainable approaches to flood management. These are explained in more detail below.

#### **England and Wales**

The Environment Agency has published a *National flood and coastal erosion risk management strategy for England*<sup>18</sup> to ensure that government, the Environment Agency, local authorities, water companies, internal drainage boards and other organizations that have a role in flood and coastal erosion risk management (FCERM) understand their role and co-ordinate how they manage these risks. This fulfils a requirement in the Flood and Water Management Act (2010)<sup>19</sup>,

---

<sup>18</sup>Understanding the risks, empowering communities, building resilience – the national flood and coastal erosion risk management strategy for England, 2011, The Environment Agency, England.

[www.environment-agency.gov.uk/research/policy/130073.aspx](http://www.environment-agency.gov.uk/research/policy/130073.aspx)

<sup>19</sup> The Flood and Water Management Act, 2010, The Stationery Office, London, England  
[www.legislation.gov.uk/ukpga/2010/29/pdfs/ukpga\\_20100029\\_en.pdf](http://www.legislation.gov.uk/ukpga/2010/29/pdfs/ukpga_20100029_en.pdf)

which gave the Environment Agency a ‘strategic overview’ of flood and coastal erosion risk management and in turn takes forward a recommendation from Sir Michael Pitt’s inquiry into the 2007 floods<sup>20</sup>. The Welsh Government has a similar obligation under the Act to produce a national FCERM strategy for Wales and carried out a consultation<sup>21</sup> on their developing strategy in the summer of 2010 and aim to publish the final strategy for Wales in 2011.

The national FCERM strategy in England provides a framework to enable the organizations involved in flood and coastal risk management to work together with communities to:

- manage the risk of flooding and coastal erosion to people and their property – over time, England will be able, where possible, to improve standards of protection.
- help householders, businesses and communities better understand and manage the flood and coastal erosion risks they face.
- respond better to future flood and coastal erosion. This includes during a flood incident and afterwards during the recovery phase, and the period before and after coastal erosion.
- move the focus from national government-funded activities towards a new approach that gives more power to local people, either at an individual, community or local authority level. Local innovations and solutions will be encouraged, too.
- invest in actions that benefit communities who face the greatest risk, but who are least able to afford to help themselves.
- put sustainability at the heart of the actions taken, to work with nature and benefit the environment, people and the economy.

The strategy stresses the need for risk to be managed in a co-ordinated way – both nationally and locally – whilst embracing the full range of practical options. It helps to bring together government and the authorities who are responsible for managing these risks with the organizations, communities, and people who are at risk. The strategy also sets out the main measures or actions that need to be undertaken to manage risk. These include:

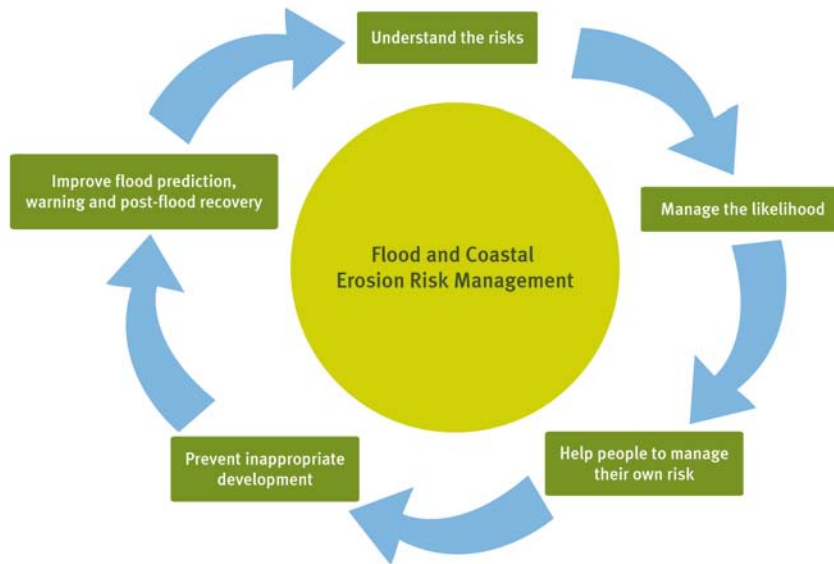
- improving understanding of the risks of flooding and coastal erosion, in particular of surface water and ground water flood risk, and making sure that any flood and coastal risk management plans use the most up-to-date information and raise awareness of these risks among affected communities.
- reducing the chance of harm to people and damage to the economy, environment and society by building, maintaining and improving flood and coastal erosion management infrastructure and systems, where it is affordable to do so.
- helping communities understand the risks and take action to manage them or reduce the consequences – for example, by making their properties more resilient or by adapting to coastal change.
- avoiding inappropriate development in areas of flood and coastal erosion risk.

---

<sup>20</sup> Learning lessons from the 2007 floods, 2008. Sir Michael Pitt, The Cabinet Office, London, England.  
<http://webarchive.nationalarchives.gov.uk/20080906001345/cabinetoffice.gov.uk/thepittreview.aspx>

<sup>21</sup> Flood and coastal erosion risk management: development of a national strategy for Wales, 2010, Welsh Government, Cardiff, Wales.  
<http://wales.gov.uk/topics/environmentcountryside/epq/waterflooding/flooding/strategy/?lang=en>

- improving the detection and forecasting of floods and the provision of flood warnings so that people, businesses and public services can take action, plan for, and co-ordinate a rapid response to flood emergencies and promote faster recovery from flooding.
- taking opportunities to work with and enhance communities, services, and the natural environment.



**Figure 15: Managing the risk of flood and coastal erosion**

## **Scotland**

In Scotland, the Scottish Environment Protection Agency (SEPA) has a strategic role in flood risk management, which includes the delivery of information and the co-ordination of flood risk management. To do this, SEPA is working closely with the Scottish Government, local authorities, Scottish Water (which is responsible for assessing the risk of flooding from surface water and combined sewers arising from higher-than-usual rainfall events), and others to assess flood risk and define the measures required to reduce these risks.

The Flood Risk Management (Scotland) Act (2009) initiated the development of new approaches to flood management in Scotland. The new approach<sup>22</sup> emphasizes the need to manage flood risk sustainably, considering all sources of floodwaters affecting an area, whether from rivers, groundwaters, coastal areas and where extreme weather events overwhelm the drainage and waste water networks in towns and cities. It aims to identify where such floods arise and take pro-active actions to reduce the impacts on those communities most at risk of flooding without moving the problems elsewhere. A key part of this process is the development of flood risk management plans to consider all forms of flood risk and will look at current issues as well as those likely to be faced in the future to help target investment in those areas most at risk. SEPA will produce a national flood management plan for Scotland, complemented by local flood risk management plans produced by the Scottish local authorities. These plans will identify and co-ordinate actions to tackle flooding, and will be released for public comment in 2014.

<sup>22</sup> *Introducing the new approach to flood risk management*, 2010, SEPA, Scotland. [www.sepa.org.uk/flooding.aspx](http://www.sepa.org.uk/flooding.aspx)

## **Northern Ireland**

In Northern Ireland, the Rivers Agency (an agency within the Department of Agriculture and Rural Development in Northern Ireland) has the lead role in flood risk management. The Rivers Agency published “Living with Rivers and the Sea” in 2008<sup>23</sup> to set out its strategic approach to managing flood risk. This document provides a 10 year, flexible policy framework for flood risk management in Northern Ireland and marked a change in the approach adopted by the Rivers Agency from flood defense to flood risk management, including the built and natural environment, surface water drainage and new development. The broad vision of the new approach is *to manage flood risk to facilitate the social, economic and environmental development of Northern Ireland* and includes the following aims:

- To reduce the risk to life and the damage to property from flooding from rivers and the sea.
- To undertake watercourse and coastal flood management in a sustainable manner.

The framework identifies five key risk management measures and summarizes key policies on: maintenance of the arterial drainage network, the regulation of river and coastal protection, and the sustainable management of the Northern Ireland coast. The five key risk management measures are:

- Identifying and planning for flood risk – identifying where flooding will take place and planning how to deal with it.
- Flood alleviation and development infrastructure – reducing the risk of flooding by providing infrastructure.
- Development advice – avoiding flood risk by building in the right place.
- Communication – reducing the impact by informing people about flooding.
- Emergency response – helping people prepare, cope and recover from flooding.

### **3.1.6 Allowances for Climate Change (United Kingdom)**

With the anticipated long term changes to the UK climate over the coming century and the threats this brings, it is important that flood and coastal erosion risks are managed to adapt to and reduce these impacts. With the long lifetime and high cost of the built environment and many flood and coastal erosion management measures, it is imperative that plans and investment in risk management projects are developed appropriately for the changing risks faced. This includes designing for adaptation where appropriate.

The Environment Agency has been working with the UK Department for the Environment, Food and Rural Affairs (Defra) to develop new advice on adaptation to climate change in flood and coastal erosion risk management<sup>24</sup>. This advice builds on the UK Government’s policy for

---

<sup>23</sup> *Living with rivers and the sea* (2008). Rivers Agency, Northern Ireland.  
[www.dardni.gov.uk/riversagency/index/rivers-agency-publications/rivers\\_agency\\_publications\\_policy\\_documents/about\\_us-living-with-rivers-and-the-sea/rivers\\_agency\\_publications-living-with-rivers-and-the-sea.htm](http://www.dardni.gov.uk/riversagency/index/rivers-agency-publications/rivers_agency_publications_policy_documents/about_us-living-with-rivers-and-the-sea/rivers_agency_publications-living-with-rivers-and-the-sea.htm)

<sup>24</sup> *Adapting to Climate Change: Advice for Flood and Coastal Erosion Risk Management Authorities*, 2011. The Environment Agency, United Kingdom.

climate change adaptation, and is mainly intended for risk management projects or strategies in England seeking central Government funding, but may also be useful where other sources of funding are being used.

The advice recommends a "managed adaptive approach" where possible, in line with Defra's flood and coastal erosion risk management appraisal policy statement. This provides flexibility to manage future uncertainties associated with climate change and sets out some broad principles that should be considered.

The managed adaptive approach contrasts with a precautionary approach, which may also be appropriate in some circumstances. For example, future adaptation may not be technically feasible or may be too complex to administer, or it may be economically more efficient to build in a precautionary element at the outset. In these cases, a precautionary approach, with a one-time only intervention, may be the only feasible or best option. However, considering only precautionary options would lead to greater levels of investment at fewer locations, whereas a managed adaptive approach would ensure a fairer and more flexible spread of public investment and therefore should be preferred where possible.

The new advice is based on the most recent climate change projections, in particular UKCIP09, and provides climate change factors anticipated over different time steps (2020s, 2050s, and 2080s) that can be taken account in scheme development and investment planning decisions. These include:

- projected changes to river flood flows by river basin district,
- changes to extreme rainfall,
- change to relative mean sea levels,
- change to storm surge, and
- change to wave climate.

### **3.1.7 Adapting to Climate Change (United States)**

There is growing awareness that Federal agencies must begin to plan for and adapt to climate change. Extensive records demonstrate the changing nature of climate, with changes occurring either gradually or abruptly and with effects differing regionally. There is an especially close tie between climate and water resources management, because the observed changes in temperature, precipitation, and snowmelt observed now and as projected for the future can cause changes in seasonal and spatial distribution of water, causing both floods and droughts.

Scientists and engineers from four federal agencies (U.S. Geological Survey, U.S. Army Corps of Engineers, Bureau of Reclamation, and National Oceanic and Atmospheric Administration) prepared an interagency report in 2009 to explore strategies for improving water management by tracking, anticipating, and responding to climate change<sup>25</sup>. The report describes the existing and needed underpinning science crucial to addressing the many impacts of climate change on water resources management. It includes a section specifically addressing the use of climate information in flood risk evaluations.

---

<sup>25</sup> USGS Circular 1331: Climate change and water resources management—A federal perspective.  
<http://pubs.usgs.gov/circ/1331/>

In 2010, the White House Council on Environmental Quality issued a set of Implementing Instructions for Federal Agency Climate Change Adaptation. The interagency report<sup>26</sup> outlined recommendations to President Obama for how Federal Agency policies and programs can better prepare the United States to respond to the impacts of climate change. The Progress Report of the Interagency Climate Change Adaptation Task Force recommends that the Federal Government implement actions to expand and strengthen the Nation's capacity to better understand, prepare for, and respond to climate change. These recommended actions include:

- *Make adaptation a standard part of Agency planning* to ensure that resources are invested wisely and services and operations remain effective in a changing climate.
- *Ensure scientific information about the impacts of climate change is easily accessible* so public and private sector decision-makers can build adaptive capacity into their plans and activities.
- *Align Federal efforts to respond to climate impacts that cut across jurisdictions and missions*, such as those that threaten water resources, public health, oceans and coasts, and communities.
- *Develop a U.S. strategy to support international adaptation* that leverages resources across the Federal Government to help developing countries reduce their vulnerability to climate change through programs that are consistent with the core principles and objectives of the President's new Global Development Policy.
- *Build strong partnerships to support local, state, and tribal decision makers* in improving management of places and infrastructure most likely to be affected by climate change.

The Corps of Engineers is responding to these recommended actions. The Corps plans to mainstream climate change adaptation by considering it at every step in the project life cycle for all existing and planned projects, collaborating with other federal agencies to take advantage of different perspectives and expertise. It is currently conducting a nationwide screening-level assessment of its vulnerability to climate change, working within a risk-informed framework. Priority plans include developing and implementing a framework for risk-informed decision-making for climate change, addressing the critical need for guidance in the case of nonstationary hydrology, developing best practice guidelines for how to select from the portfolio of approaches to develop climate information appropriate for different decisions, refining vulnerability assessments to include bottom-up approaches at the project level, and developing metrics and endpoints to measure adaptation effectiveness.

### **3.1.8 Proposed Principles and Guidelines (United States)**

The U.S. Federal Government is proposing to update the Principles and Guidelines for Water and Land Related Resources. The Principles and Guidelines for Water and Land Related Resources Implementation Studies (P&G) govern how Federal agencies evaluate proposed water resource development investments, including flood risk planning and risk reduction investment actions. The first set of "Principles and Standards" was issued in September 1973 to guide the preparation of river basin plans and to evaluate federal water projects. The current principles and guidelines went into effect in March 1983 and applied to the water resources development activities of the

---

<sup>26</sup> <http://www.whitehouse.gov/sites/default/files/microsites/ceq/Interagency-Climate-Change-Adaptation-Progress-Report.pdf>



U.S. Army Corps of Engineers, Bureau of Reclamation, Natural Resources Conservation Service and the Tennessee Valley Authority.

In the Water Resources Development Act of 2007, Congress instructed the Secretary of the Army to develop a new Principles and Guidelines for the U.S. Army Corps of Engineers (section 2031). In an effort to modernize the approach to all Federal water resources development, the Council on Environmental Quality has taken the lead on revising the Principles & Guidelines and is expanding its scope to include other relevant projects, programs and activities undertaken by other agencies such as the Environmental Protection Agency, and the Departments of Commerce, the Interior, Agriculture, and Homeland Security (Federal Emergency Management Agency).

The last publicly released draft was issued in December 2009<sup>27</sup>. Although there have been significant changes since that time, important concepts expected to remain consistent with those described in the 2009 draft include:

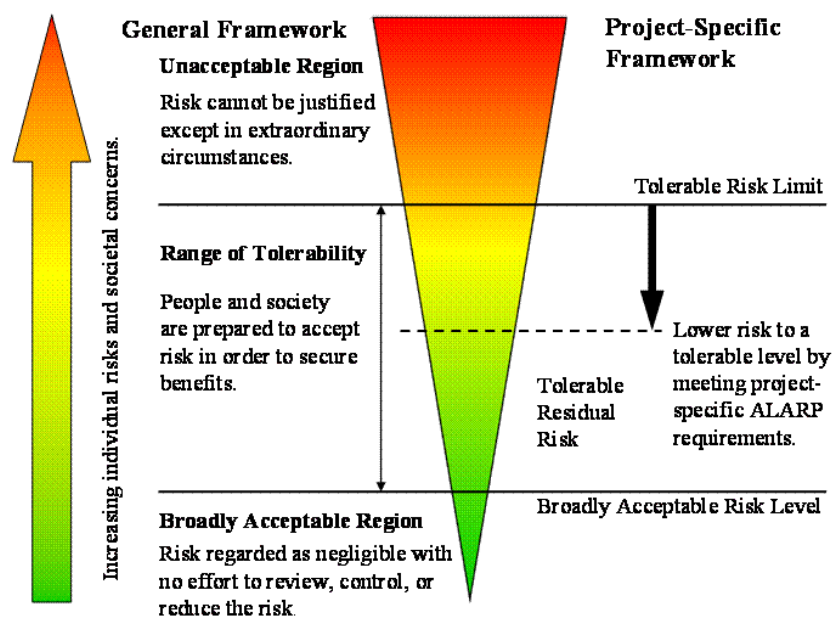
- **Achieving Co-equal Goals:** Federal water resources planning and development should both protect and restore the environment and improve the economic well-being of the nation for present and future generations. While the 1983 standards focused primarily on economic development, the new approach envisions that Federal investments in water resources as a whole should strive to maximize public benefits, including economic, environmental, and social goals, with appropriate consideration of costs.
- **Considering Monetary and Non-Monetary Effects:** Evaluation of investments should consider both monetary and non-monetary effects, and allow for the consideration of both quantified and unquantified effects, to justify and select a project. Tradeoffs among potential investments would need to be assessed and communicated.
- **Avoiding the Unwise Use of Floodplains:** Federal investments in water resources should avoid the unwise use of floodplains and flood-prone areas and minimize adverse impacts and vulnerabilities in any case in which a floodplain or flood-prone area must be used. Unwise use of floodplains is defined as any action or change that has an unreasonable adverse effect on public health and safety, or an action that is incompatible with or adversely affects one or more floodplain functions leading to a floodplain that is no longer self-sustaining.
- **Non-Structural Measures:** Water resources investment decisions must give non-structural measures full and equal consideration in the development of alternatives to address water resources problems and opportunities without adversely impacting floodplain functions. This re-emphasizes long-standing requirements for consideration of non-structural measures.
- **Increasing Transparency:** Through identifying and communicating tradeoffs among alternative investments and by providing a common framework for describing the effects of alternatives, Federal investments can be more easily viewed and compared within and among Federal programs, informing authorization and funding decisions.

---

<sup>27</sup> <http://whitehouse.gov/administration/eop/ceq/initiatives/PandG>

### 3.1.9 Development of Tolerable Risk Guidelines for Dams and Levees (United States)

The U.S. Army Corps of Engineers is implementing the tolerability of risk or tolerable risk guideline concepts for use in its dam safety program (see Figure 16). The Corps is adapting the U.S. Bureau of Reclamation's "Guidelines for Achieving Public Protection in Dam Safety Decision Making," and the Tolerable Risk Guidelines (TRG) concepts published in the Australian National Committee on Large Dams' 2003 Guidelines on Risk Assessment. The Corps will use the concept that a dam is considered adequately safe when residual risk is considered tolerable and it meets all essential Corps guidelines with no dam safety issues. Four risk measures are evaluated under the Corps tolerable risk guidelines: annual probability of failure, life safety risk (to include both individual and societal incremental life safety risk), economic risk, and environment and other non-monetary risk. However, according to the Corps and as reflected in the TRG, "life safety is paramount". In applying tolerable risk guidelines, the incremental risk (the added risk that may arise from poor performance of the dam over the risk that existed before the dam was built) is the basis for the TRG. New dams or major modifications have more stringent standards than existing dams. Dams with failure risks above a tolerable risk limit are considered to have an unacceptable level of risk; risks should be reduced to the tolerable risk limit regardless of cost considerations, except in exceptional circumstances, and then further until "As Low As Reasonably Practicable" considerations are satisfied (see Figure 16). Evaluation of the tolerability of risk for large incremental life loss estimates will be based on an official review of the benefits and risks of exceptional circumstances.



**Figure 16: Generalized and Project-Specific Tolerability of Risk Framework**  
(Adapted from Health and Safety Executive, United Kingdom, 2001)



The application of the TRG concept to levees remains under investigation and testing. In March 2010, the Corps sponsored a workshop exploring tolerable risk guidelines for its Levee Safety Program; the proceedings of this workshop are available online<sup>28</sup>.

### **3.1.10 Policy Development and Selection of Measures as a Result of 2010 Risk Assessment (The Netherlands)**

Even though existing policies already take future natural variability into account such as sea level rise, rainfall and river discharge, this may be insufficient to meet the long term challenges of climate change. Therefore, the government commissioned a special advisory group: the (2<sup>nd</sup>) Delta Commission. The Commission reported in 2008<sup>29</sup> and many of their recommendations have been implemented into the National Water Plan (2009<sup>30</sup>). With a time horizon running up to 2100, the new policy presents a comprehensive strategy consisting of (1) measures to protect against floods and droughts, (2) spatial development and water management, (3) a flexible approach starting with “no regret” measures (like spatial reservations), (4) long term funding and a legal basis to guarantee long term implementation.

Unlike the first Delta Program, which was almost exclusively run by the national government, the new program aims to join the interests of different layers of government. This raises issues concerning a new type of governance.

For a small flood prone country like the Netherlands, the consequences of flooding may be so large that the existence of the country is at stake. Therefore protection against flooding has the highest priority. However, 100% protection can never be guaranteed, requiring additional and appropriate measures to respond and avoid damage and fatalities when a flood does occur. The National Water Plan (2009) describes the Dutch policy regarding flood risk management. This policy is in line with the European Directive on the Assessment and Management of Flood Risk (“Floods Directive”).<sup>31</sup>

The flooding of New Orleans in 2005 illustrated the consequences of floods in large urban areas and the resulting large scale and long-lasting disruption of society. This triggered the development of policies to reduce flood damage to buildings and vital services (by developing a sustainable spatial planning) and to improve the emergency response to floods as well. Presently some provinces experiment with flood risk zoning, especially regarding new urban development (see Figure 17) and large scale reconstruction projects. The Taskforce Flood Management was established to improve the preparation on large-scale evacuations, resulting in a national exercise in the autumn of 2008.

#### ***Three layered approach***

The desired level of flood protection in 2050 (see Section 2.1.1) can be met by (1) levee system reinforcements or ‘room-for-river’-measures (prevention) (see Section 4.3.6), (2) sustainable spatial planning and (3) improved emergency response to floods. See Figure 17 (diagram on the right.) Until now attention has been paid to prevention only.

---

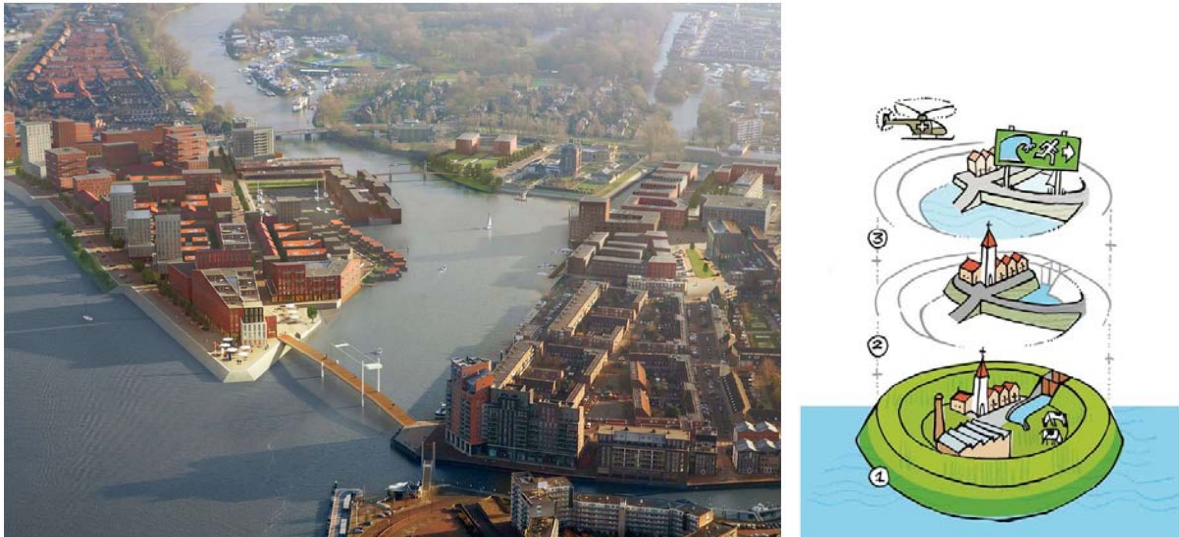
<sup>28</sup> <http://www.iwr.usace.army.mil/docs/iwrreports/10-R-8.pdf>

<sup>29</sup> [www.deltacommissie.com](http://www.deltacommissie.com)

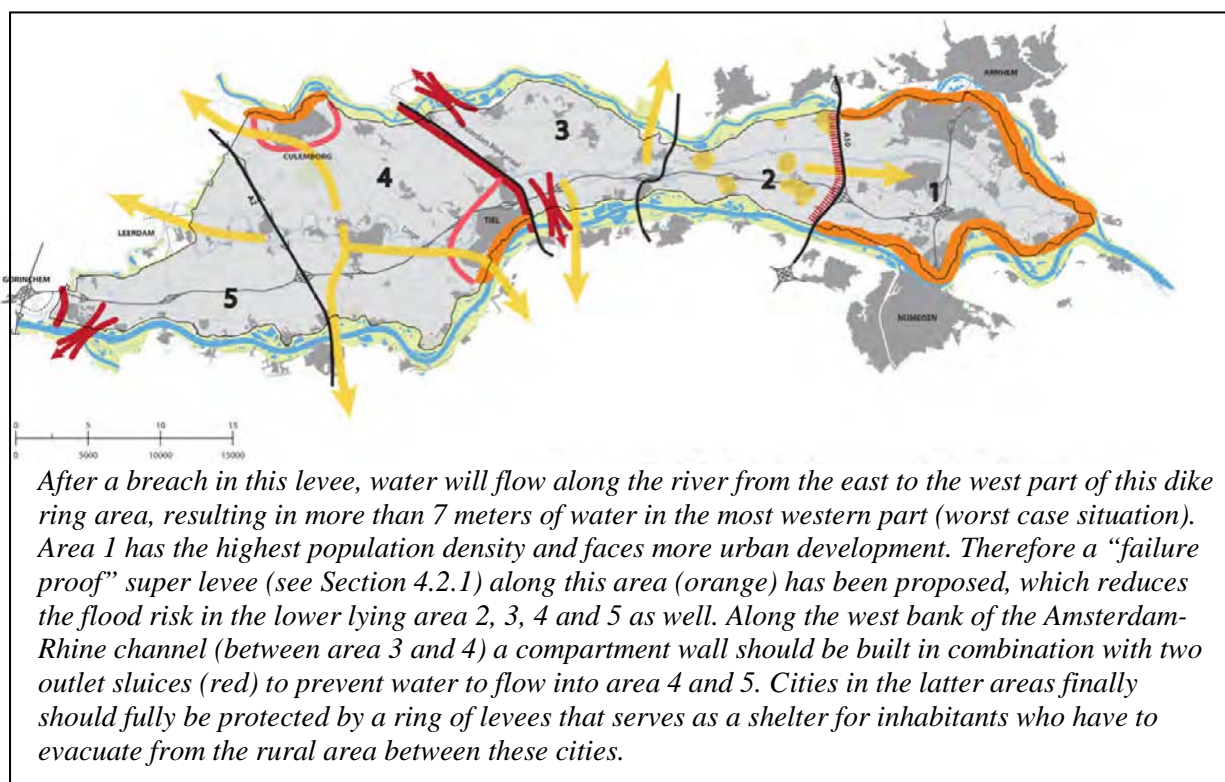
<sup>30</sup> [http://english.verkeerenwaterstaat.nl/english/topics/water/water\\_and\\_the\\_future/national\\_water\\_plan](http://english.verkeerenwaterstaat.nl/english/topics/water/water_and_the_future/national_water_plan)

<sup>31</sup> [http://ec.europa.eu/environment/water/flood\\_risk/index.htm](http://ec.europa.eu/environment/water/flood_risk/index.htm)

Six so-called ‘dike ring areas’ (areas protected by a levee system) have been assigned to develop new strategies in order to reduce flood risk according the above-mentioned three layered approach. One of the pilots is the *Betuwe*, a dike ring area along the upper rivers. Figure 18 below shows one of the most promising strategies developed by participants from the Province, several Municipalities, Water Boards and the Safety regions.



**Figure 17: An example of sustainable spatial planning.** The picture on the left shows new urban development in Dordrecht; the whole area will be elevated since it is not protected by a levee. The diagram on the right shows the three-layered approach.



**Figure 18: Possible measures in a relatively high risk area within a levee system along the upper rivers**

## **3.2 Regional / Local Level**

- 3.2.1 USA: Considering Environmental/Social Benefits and Flexible Solutions
- 3.2.2 Japan: Catchment-based Regional Flood Management Planning, the Case of the Tsurumi river basin

### **3.2.1 Considering Environmental/Social Benefits and Flexible Solutions (United States)**

The policies of the United States for repairing federal and federally-supported flood risk reduction projects damaged in flood events have typically been to “repair to pre-flood conditions.” For instance, Engineer Regulation 500-1-1, dated 30 September 2001<sup>32</sup>, requires that flood risk reduction systems be repaired to their pre-existing level of protection. Any repairs made that would create a level of protection beyond this pre-existing level would be considered a “betterment”, which must be completely financed by the non-Federal sponsor of the project. However, this policy is currently undergoing revision, and can be expected to allow for more flexibility in utilizing non-structural solutions in future repair work. The shift in policy towards allowance of these features has come about gradually in the United States, as the significant economic, environmental, and social benefits associated with them become evident, although implementation challenges remain. (For example, although environmental losses during Hurricane Katrina were an essential component to the overall assessment of consequences, they were difficult to characterize beyond the short term; not nearly enough information is available on long-term impacts of saltwater intrusion and flooding on freshwater marshes, or on the conditions and rates of recovery that can be expected.) Through the Sustainable Rivers Project, launched by The Nature Conservancy and the U.S. Army Corps of Engineers, state-of-the-art research on rivers’ unique flow requirements is being assembled and then dam operating plans created that achieve environmental flows in order to revive and sustain critical ecological functions and habitat for species. Using these flow prescriptions as a guide, the Conservancy has also begun acquiring flood-prone land to enhance flood protection for communities downstream, preserve wildlife habitat, and provide more flexibility to implement healthy flow patterns at dams.

The economic benefits of taking non-structural actions rather than making repairs to flood risk reduction project structures ought to be carefully evaluated before any repair action is taken. When a levee experiences an uncontrolled failure the results are often catastrophic, causing excessive damage to the levee system and the property behind the system, although loss of life is rare. Repairing the damaged system and the damaged property in these situations can be quite expensive, as can be the costs of land acquisition and removing structures from the floodplain that is now exposed to flooding through the breached levee. Similarly, a levee that experiences repetitive damages, failing in the same location repeatedly, requires intermittent repair at typically ever-increasing costs. Utilizing non-structural alternatives can allow for flooding in areas where the consequences of frequent flooding are low (e.g., agricultural use) and where the environmental benefits can be significant. Removing structures, and purchasing flood easements or purchasing land in fee simple, can allow for reconnecting the river hydrograph and the floodplain, restoring important natural habitat conditions, and providing sediment and nutrient trapping that can improve water quality. Recreational benefits may also be feasible. The newly opened floodplain may also reduce future flood damages upstream and downstream of the area by reducing flood peaks.

---

<sup>32</sup> <http://140.194.76.129/publications/eng-regs/er500-1-1/entire.pdf>

A recent example of the potential for such a post flood action took place after damage to a levee occurred in Louisa County, Iowa. After the Iowa River 2008 Midwest flood, a levee in Louisa County #11 Levee District sustained a total of seven breaches. Due to the high cost of repairing these breaches, a non-structural solution was proposed. Two of the upstream breaches were ultimately repaired, in order to protect vital local infrastructure, but the remaining five breaches were left open, allowing reconnection of the river and the floodplain. The land behind these breaches was agricultural, and may still be farmed when floods are not occurring. Therefore, the majority of the time, the land may still be used for its intended purpose. During flood events, however, the breaches allow flood waters into the agricultural areas, where the consequences of flooding are lower, reducing the amount of water available to flood the more heavily populated downstream areas. This alternative provides reconnection of nearly 1,295 ha (3,200 acres) of previously isolated floodplain with the Iowa River, improves environmental habitat, and increased flood storage benefits to downstream interests; construction is complete, with program costs estimated to be \$187,000 less than the full structural repair.

### **3.2.2 Catchment-Based Regional Flood Management Planning, the Case of the Tsurumi River Basin (Japan)**

The Tsurumi River, located between metropolitan Tokyo and Yokohama, is 43 km in total mainstream length and 235km<sup>2</sup> in catchment area. The downstream area is managed by the national government and the others by such local governments as Tokyo, Kanagawa prefecture and also Yokohama City. Since the river is located between the large cities of Tokyo and Yokohama, development along the river has progressed rapidly since 1960s. In the areas along the river, the rate of urbanized area and the population were about 10% and about 450,000 in 1958. Both numbers increased to about 85% and about 1,880,000 respectively until 2004. This rapid urbanization lowered the rainwater retention and retarding functions in the catchment area. Instead of permeating the soil, rainwater began to flow into the river. This increased the risks of flood damage.

Therefore, in 1981, the “Tsurumi River Area Improvement Project” was worked out as the first case to introduce comprehensive flood control measures in Japan. The project was to upgrade flood safety rapidly and to maintain and strengthen the retention and retarding functions along the river. In the project, assumed runoff discharge to the river is allocated to river channels and catchment areas and appropriate measures are applied to both of them. Measures to river channels were to be implemented by river management authorities and those to catchment areas were to be done by municipalities and private developers. To cope with changes of land use due to the unexpectedly fast progress of urbanization, the project was revised to the “New Tsunami River Area Improvement Project” in 1989.

However, new subjects surfaced: 1) insufficient river, sewage and catchment facilities to prevent flooding, 2) discrepancies between the predicted and the actual land use, 3) deterioration of retarding function, reclamation of existing flood control reservoirs because of the unclear legal position of runoff control facilities, and 4) occurrence of new type of flood damage such as flooding of basement spaces by localized torrential downpour.

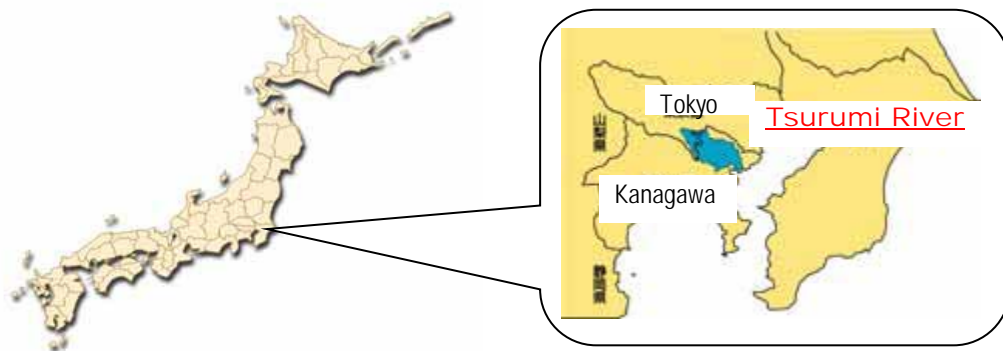
In 2004, the “Act on Countermeasures against Flood Damage of Specified Rivers Running across Cities” was put in force to take comprehensive measures against flood damage along urban rivers. The Act was intended for a new legal system for more viable implementation of comprehensive measures. It prescribes the development of catchment flood management plan, the construction of



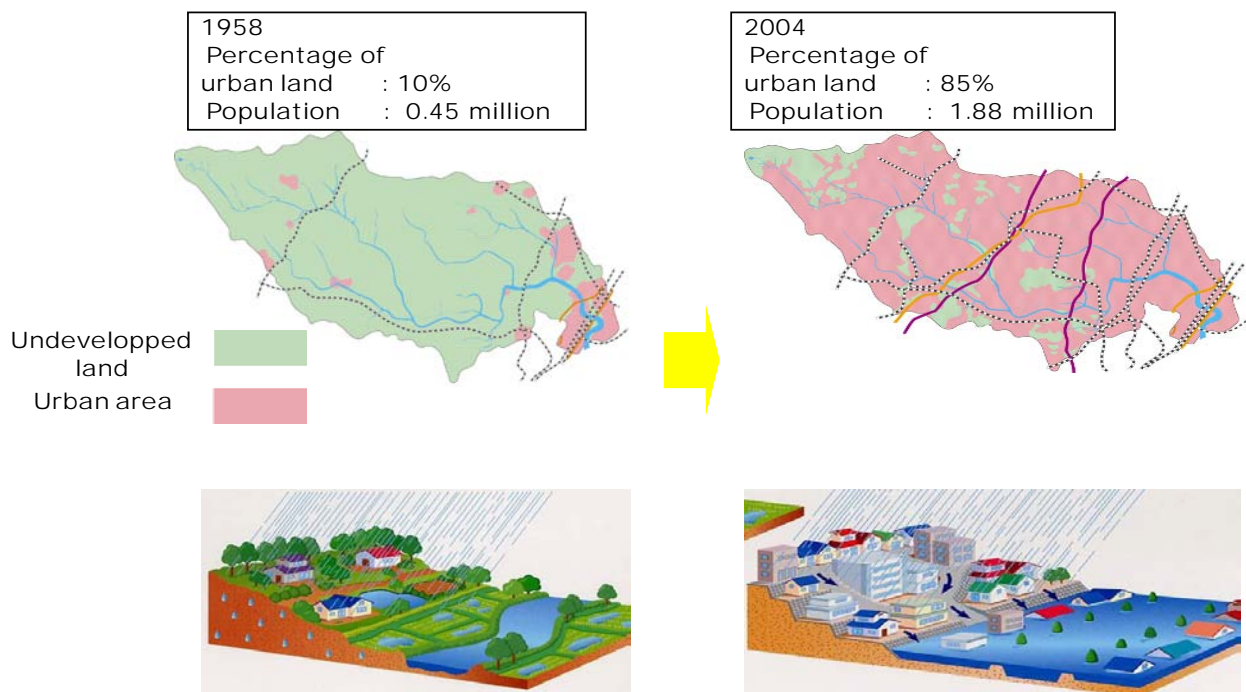
rainwater storage and infiltration facilities by river management authorities, the enforcement of regulation to catchment area to control runoff, designation of urban flood prone areas, etc.

Based on this Act, the Tsurumi River was designated as a specific urban river in 2005. This designation prompted river management authorities, sewage management authorities, and local public entities take concerted measures against flood damage.

In 2008, the “Tsurumi River Area Flood Control Plan” was worked out to promote flood control measures together by the above competent authorities and also local residents. Based on this plan, measures are being strongly promoted. Further information on Comprehensive Water Management in Japan, taking the Tsurumi River as an example, is provided in a paper (available in English.)<sup>33</sup>



**Figure 19: Tsurumi River Basin**



**Figure 20: Urbanization in the Tsurumi River Basin**

<sup>33</sup> [http://www.ktr.mlit.go.jp/keihin/tsurumi/project/masterplan/02\\_ritsuan/wwf3/forum/pdf/unno\\_e\\_w.pdf](http://www.ktr.mlit.go.jp/keihin/tsurumi/project/masterplan/02_ritsuan/wwf3/forum/pdf/unno_e_w.pdf)



## 4 Executive Aspects

The success of the flood risk management policy is determined by its implementation, execution, and maintenance. Ideally risks and policies will be reassessed periodically so that implementation can be adjusted as warranted. Important aspects are related to the different parts of the safety chain, as well as the required governance, funds, legislation and skills of the involved employees.

In this chapter the following topics will be considered: land use policies (Section 4.1), protection (Section 4.2), maintenance (Section 4.3), preparedness (Section 4.4), response and recovery (Section 4.5), governance, public participation and communication (Section 4.6), financial aspects (Section 4.7), and finally research and education (Section 4.8).

### 4.1 *Land Use Policies*

- 4.1.1 USA: Opportunities for Buy-Outs, Mitigation, and Buying Down Risk
- 4.1.2 UK: Land Use Change and Flood Risk Management
- 4.1.3 Japan: Flood Control Measures in Concert with Land Use

#### 4.1.1 Opportunities for Buy-Outs, Mitigation, and Buying Down Risk (United States)

U.S. Department of Homeland Security (DHS) Federal Emergency Management Agency (FEMA) hazard mitigation assistance programs present a critical opportunity to reduce the risk to individuals and property from natural hazards while simultaneously reducing reliance on Federal disaster funds. While the statutory origins of the programs differ, all share the common goal of reducing the risk of loss of life and property due to natural hazards.

Hazard mitigation assistance programs enable mitigation measures to be implemented before, during, and after the recovery from a disaster, although before-disaster budgets are limited. In general, hazard mitigation assistance programs provide up to 75 percent of the eligible activity costs, with the remaining 25 percent to be derived from non-Federal sources. States, Territories, and Indian Tribal governments are eligible applicants; local governments and, in some instances, private non-profit organizations may be sub-applicants. Funding depends on federal assistance provided for disaster recovery or annual appropriations by Congress. Eligible activities include property acquisition and structure demolition or relocation, structure elevation, dry floodproofing, and minor localized flood reduction projects. Some hazard mitigation planning and management costs are also eligible. All mitigation projects must be cost-effective, engineering and technically feasible, and meet Environmental Planning and Historic Preservation and other requirements. Eligibility is tied to location with respect to the 1% annual chance flood (termed the Special Flood Hazard Area), as well as to community participation and standing within the National Flood Insurance Program (including adoption and enforcement of minimum flood management ordinances.) All applicants and sub-applicants must have hazard mitigation plans meeting the requirements of federal regulations.

Examples range from individual to large-scale. In Rutherford County, Tennessee, a home subject to repeated flooding was acquired and demolished for a total cost of \$95,000 (including paying fair market value for the structure); short-term benefits have been calculated at approximately \$289,123. In Story County, Iowa, six properties were acquired for approximately \$732,884 after being flooded in 1990, 1993 and 1996; savings after one flood event are as high as \$541,900 not

including avoided costs of warning, rescue and evacuation. The community of Valmeyer, Illinois, (population 900 pre-flood and 1,200 today) relocated after being wiped out by floods in 1993. In Kinston-Lenoir County, North Carolina, more than 400 residential structures, three mobile home parks, and 68 vacant lots were acquired in a multi-year effort costing approximately \$31 million after Hurricane Fran caused major flood damages in 1996; losses avoided after Hurricane Floyd in 1999 were estimated to be over \$6 million, with repair and replacement cost of flooded homes accounting for almost half the avoided loss. And in Birmingham, Alabama, a cooperative effort by the city, State, and Federal governments spanning 20 years removed 735 structures from the floodplain at a cost of \$37.5 million, returning the floodplain to its natural state as a retention basin for floodwaters; there was an estimated 150 percent return on investment when severe storms hit in 2000, with almost no residential property damage, no displacement of residents and no need for assistance.

The Corps of Engineers, when developing its flood risk reduction projects, considers relocation of structures at risk to facilitate development of a comprehensive plan. For example, in the development of flood risk reduction along the frequently-inundated Red River between Grand Forks, North Dakota, and East Grand Forks, Minnesota, over 1,000 structures were removed from the floodplain.

The Corps has historically worked hand-in-hand with sponsors throughout the country to investigate flood risk management problems and opportunities and, if warranted, develop projects that would otherwise be beyond the capability of the sponsor itself. Corps flood risk management activities are initiated by sponsors or potential sponsors, authorized by Congress, funded by Federal and non-Federal sponsors, and constructed by private contractors supervised by the Corps under the civil works program.

The professional partnership between the Corps and project sponsors, as defined in a Project Partnership Agreement (PPA), is a multifaceted relationship in which the sponsors take an active role in all phases of project development, and work at the local level to mitigate risk to the extent practicable within their own authorities and capabilities (see Figure 21).



**Figure 21: Buying Down Risk**



As a condition for local sponsors accepting Federal funding for flood risk reduction projects, the PPAs routinely include provisions for local land use controls commensurate with the flood risk. These provisions include: 1) an agreement to participate in and comply with applicable Federal floodplain management and flood insurance programs; 2) compliance with Section 402 of the Water Resources Development Act of 1986, as amended (33 U.S.C. 701b-12), which requires a non-Federal interest to prepare a floodplain management plan within one year after the date of signing the PPA, and to implement that plan not later than one year after completion of construction of the proposed flood risk management project. The plan must be designed to reduce the impacts of future flood events in the project area, including but not limited to addressing those measures to be undertaken by non-Federal interests to preserve the level of flood protection provided by the project; and, 3) an agreement to publicize floodplain information in the area of concern and provide this information to zoning and other regulatory agencies for their use in adopting regulations, or taking other actions, to prevent unwise future development and to ensure compatibility with protection levels provided by the proposed project.

#### **4.1.2 Land Use Change and Flood Risk Management (United Kingdom)**

Sustainable planning and management of land use forms a key part of the strategic approach to flood risk management in the UK. The aims of this work are explored in more detail below and include:

- avoiding inappropriate development in areas of high risk,
- managing land use and development so that it does not increase risk in other areas without prior agreement, and
- managing land use activities in areas where the consequences of flooding may be low to reduce risk elsewhere.

The avoidance of inappropriate development in areas of high flood risk is an essential factor in containing future risk and avoiding the need to invest in additional flood defenses to protect new properties. To achieve this, the lead organizations involved in flood risk management in the UK liaise closely with national and local land use planning authorities to help develop understanding of areas at risk of flooding and ensure that these are taken account in development plans. National land-use planning policy also recognizes the importance of this work. For example, a recently launched consultation on a new draft national planning policy framework for England<sup>34</sup> emphasises the need to direct development away from areas at highest risk and to adapt to the potential impacts of climate change. This includes the development of strategic flood risk assessments to support local development plans and the use of a sequential, risk-based approach to the location of development to avoid flood risk to people and property where possible.

Where development does take place the aim is to use opportunities to avoid increases to risk, or if possible reduce the probability of flooding elsewhere, for example through the use of sustainable drainage systems to manage surface water run-off. Again, local planning authorities have a key role in this work by ensuring that development is informed by a site-specific flood risk assessment. In addition other land use management activities can also seek to reduce risk, for example by:

---

<sup>34</sup> <http://www.communities.gov.uk/documents/planningandbuilding/pdf/1951811.pdf>

- Adapting agricultural land management to reduce rainfall run-off rates through more sustainable approaches to drainage or by reducing the carrying capacity of field drainage systems.
- Changing the use of agricultural land to promote greater rainfall infiltration, for example by tree planting.
- Using land where the consequences of flooding are low to store flood water, thereby reducing flood risk elsewhere.

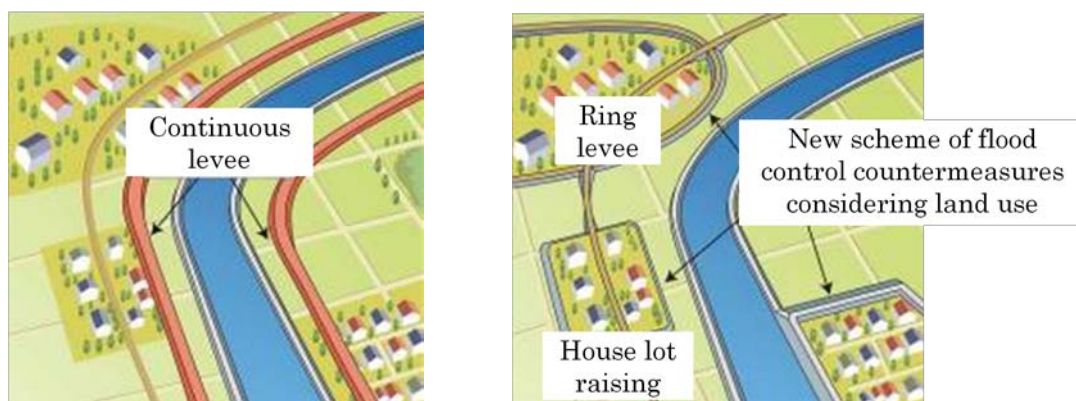
#### **4.1.3 Flood Control Measures in Concert with Land Use (Japan)**

When river improvement work by means of constructing embankments is opted for at mountain valleys, where land for levee construction is relatively large for the area to be protected or at places requiring long continual embankments, the completion of work tends to be delayed due to issues relating to insufficient land and prolongment of the construction work despite an urgent need for the quick implementation of flood control measures in view of the frequent occurrence of flooding.

From the viewpoint of facilitating quick but efficient as well as effective flood control work, the central and prefectural governments in Japan are implementing a type of flood control project called "flood disaster prevention project in concert with land use". With this type of project, while flooding must be tolerated in some areas, houses are limitedly protected from flooding through the construction of a ring levee, raising of the housing ground, introduction of small riverbank levees, flood protection facilities of houses, water storage facilities and other suitable measures.

With a view to alleviating flood damage, the municipality prepare and publicise a hazard map covering the areas where flooding must be tolerated and designates the areas as "disaster hazard zones" by enacting a bylaw based on the Building Standards Act to prevent the construction of new houses in these zones. The designation of "disaster hazard zones" must be included in the regional disaster prevention plan as stipulated by the Disaster Countermeasures Basic Act.

In addition to flood disaster prevention projects, there is a national government subsidy system to assist the construction of secondary embankments which are constructed by municipalities to prevent and alleviate flood damage. A new national government subsidy system launched in FY 2010 provides assistance for the cost of resettlement, including house removal cost, relocation cost and actual cost of a temporary dwelling, when a river administrator plans the construction of a ring levee under a flood disaster prevention project or a municipality plans the introduction of a disaster prevention facility such as a secondary embankment. However, this subsidy is only available when the relocation of existing houses (in addition to the construction of a ring levee, secondary embankment or other) in an area where flooding must tolerated will allow a reduction of the scale of the ring levee or secondary embankment in question, thereby making the project more efficient as well as economical.



**Figure 22: Flood control measures in concert with land use<sup>35</sup>**

## **4.2 Protection**

- 4.2.1 Japan: Super Levees (Japan)
- 4.2.2 The Netherlands: Design, Maintenance and Improvement of Flood Defenses
- 4.2.3 Japan: Efforts to Increase the Reliability of Embankments

### **4.2.1 Super Levees (Japan)**

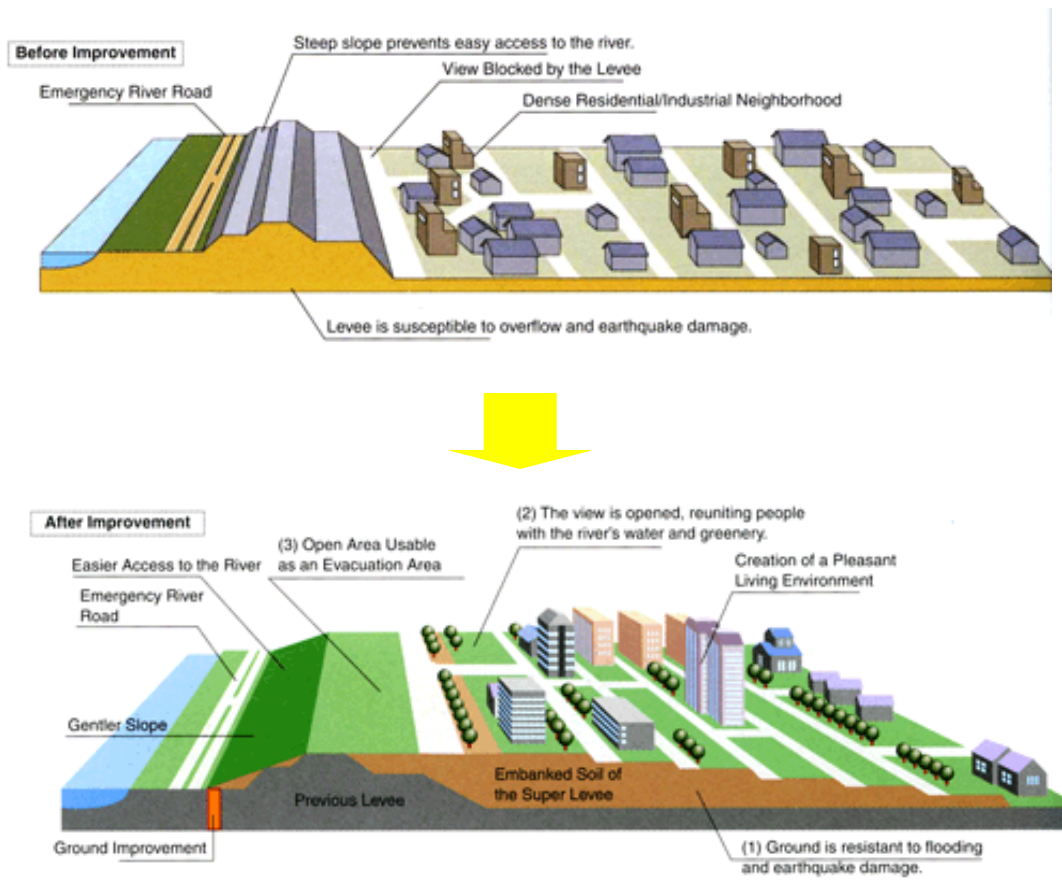
Metropolitan areas in Japan, such as Tokyo and Osaka, are largely situated on the flood plains of major rivers and, therefore, face an inherent flood risk. There is strong concern that if the embankments along a major river protecting these areas from flooding are breached, catastrophic damage could occur in these areas, possibly with a lethal impact on the socioeconomic activities of entire Japan.

In the face of such a prospect, a new scheme was created in FY 1987 following a report of the River Council issued in March 1987 to facilitate the construction of super levees (high standard levees) to avoid devastating damage due to the breaching of embankments caused by flooding exceeding the design scale at major rivers in metropolitan areas.

The scheme envisages the construction of very wide (the width of some 30 times of the height) and gently sloping embankments at designated sections along six rivers (Tone, Edo, Ara, Tama, Yamato and Yodo) in five river systems in the Tokyo Capital Region and Kinki (Osaka) Region. At the upper part of the embankment, conventional land use (for example, residential) is still possible and can also act as an emergency evacuation area at the time of an earthquake, fire or other disaster.

Super levees are extremely safe as the overflowing water caused by flooding exceeding the design scale still gently flows on the slopes of the embankment. The wide width better withstands seepage water to avoid destruction of the embankment. Moreover, soil stabilization work is conducted where necessary to ensure the ground resistance to soil liquefaction or landslides due to an earthquake.

<sup>35</sup> [http://www.mlit.go.jp/river/basic\\_info/english/pdf/guigelines\\_eng.pdf](http://www.mlit.go.jp/river/basic_info/english/pdf/guigelines_eng.pdf) page 39.



**Figure 23: Super Levees**<sup>36</sup>

As work under this scheme is integral to such urban development work as land readjustment work, it does not require the acquisition of land for itself while contributing to improvement of the housing conditions through the elimination of existing densely built up urban areas of wooden houses.

#### 4.2.2 Design, Maintenance and Improvement of Flood Defenses (The Netherlands)

The Dutch Water Act prescribes an assessment every six years of the status of the flood defenses in relation to (every 6 years actualised) hydraulic boundary conditions. This assessment is performed by the flood defense management authorities (mainly waterboards). The results and proposed measures are reported to the vice Minister of Water Management, who presents the assessment to the Parliament. The latest assessment (1 January 2006) revealed that 24 % of the flood defenses did not meet the standards, while for another 32% the status was unclear, e.g., due a lack of data.

The advantage of this system is a legal basis for (relatively high) flood protection standards, periodic evaluation and reporting of required improvement and maintenance works and political decision making on funding and prioritization. On the other hand, the high standards and lack of frequent flooding experiences creates a low flood risk awareness of the public, many administrations and politicians, often resulting in lower budgets than required. Waterboards have their own system of funding for ordinary maintenance. Land owners and inhabitants of each dike

<sup>36</sup> <http://www.ktr.mlit.go.jp/arage/english/outline/01.html>

ring pay taxes related to the value of their property. Dike reinforcements due to revised hydraulic boundary conditions or new knowledge on failure mechanisms are funded by the national government.

When improvement (or construction) of flood defenses is required, potential future hydraulic loads are considered, with a “design horizon” depending on the type of works:

- Small /dike improvement works: 10-50 years
- Capital works (sluices, locks): 100 years
- Major capital works (storm surge barriers): 200 years

Up till now for (relative) sea level rise the present value of 20 cm /century is adopted, but this may be increased to 60 – 85 cm per century according to recent climate change scenarios of the Royal Dutch Meteorological Institute. For the rivers Rhine and Meuse future design discharges (1/1,250 per year) are elaborated for the years 2050 and 2100, based on the most recent climate change and rainfall scenarios. For the river Rhine these estimates include upstream flooding in Germany, since this reduces the extreme flood discharge that may reach the Dutch border.

### **4.2.3 Efforts to Increase the Reliability of Embankments (Japan)**

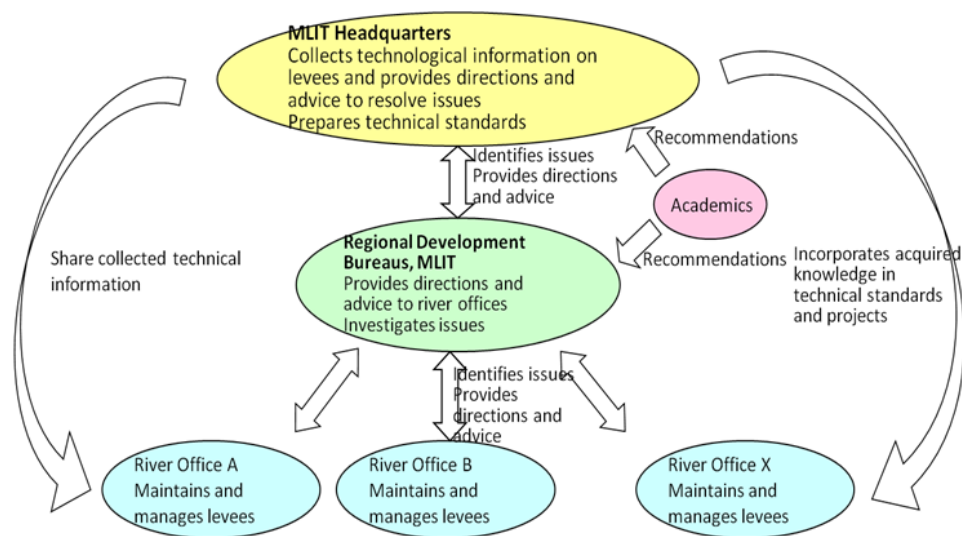
Many large cities in Japan are located on alluvial plains formed by sediment transported by rivers from upstream over a long period of time. As flooding on an alluvial plain tends to spread widely, embankments are traditionally constructed to protect human lives and assets on such a plain from flooding. Many embankments in Japan today have a complicated internal structure as a result of repetitive reinforcement works, including raising and widening. Together with the fact that many of them are constructed on fragile ground, such as a former river channel, embankments with a complicated structure offer less reliability of function compared to ordinary man-made structures.

The River Embankment Design Guidelines prepared by the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) in FY 2002 clearly indicate the functions required of an embankment, (1) seepage resistance function, (2) erosion resistance function and (3) earthquake resistance function and demand that new embankments are designed and constructed to meet the safety standards. For existing embankments, the MLIT has completed as of March, 2010 the seepage safety inspection of embankments directly managed by the central government throughout Japan based on the said guidelines. These inspections have discovered that some 40% of the existing embankments fail to meet the seepage safety standard and reinforcing work is currently in progress with priority given to sections with a noticeably low level of safety and sections with a high risk of being once breached. The typical reinforcing methods are the section area increase method and the drain method.

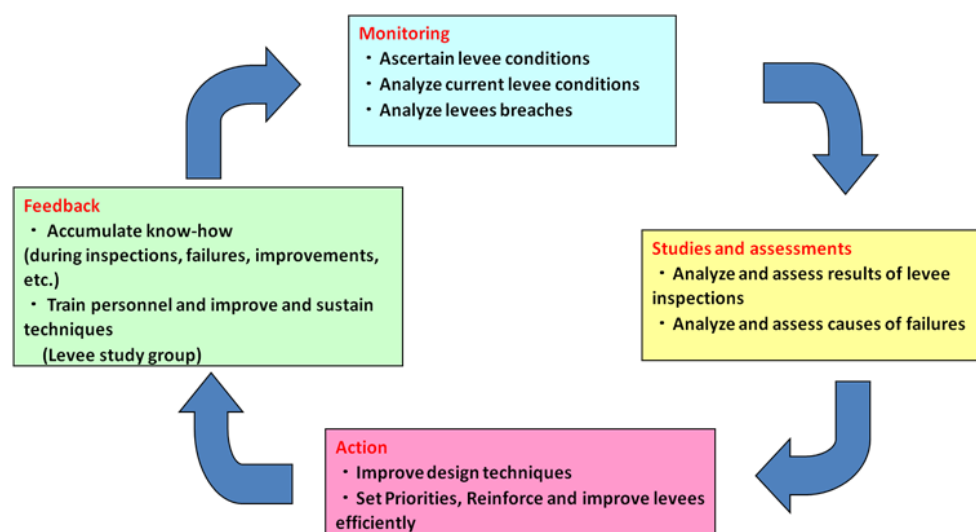
In FY 2008, the MLIT set up the Embankment Research Group and this group has since been actively working on improving the reliability of embankments in collaboration with regional development bureaus and offices. Given the special characteristic of embankments that they are partly natural structures developed over many years, posing extremely difficult engineering challenges, this work has adopted a mechanism of achieving its objectives in the manner of an upward spiral based on the steady accumulation of field data (see Figure 25). The intended upward spiral consists of the cycle of (1) monitoring of the present state of embankments and analysis of their damage at the time of a disaster, (2) study, analysis and evaluation of inspection results and causes of damage, (3) improvement of the design method and implementation of

embankment reinforcing measures and (4) accumulation of know-how, human resources development and inheritance of technical knowledge and skills. The main research themes of the Embankment Research Group are listed below.

- (1) Improved accuracy of the exact inspection technologies to detect seepage through embankments; improvement of the technical method to narrow down weak sections.
- (2) Examination of compaction control and other related engineering technologies while considering the qualitative safety of embankments.
- (3) Examination of the likely effects of different management conditions on embankment degradation.
- (4) Development of a system capable of formulating countermeasures through investigation of the causes of damage.



**Figure 24: Action Framework to Improve Reliability of Levees**



**Figure 25: Spiral up system for improving reliability of levees**



## 4.3 Maintenance

- 4.3.1 The Netherlands: Aging Infrastructure
- 4.3.2 Japan: Strategic Maintenance
- 4.3.3 Japan: River Channel Maintenance in Consideration of Response to Excavation of River Channel for River Improvement
- 4.3.4 UK: System Asset Management Plans and Creating Asset Management Capacity
- 4.3.5 UK: Water Course Maintenance – Conveyance and Dredging Trials Report Findings
- 4.3.6 USA: National Strategic Infrastructure Framework
- 4.3.7 Netherlands: Room for the River Programme

### 4.3.1 Aging Infrastructure (The Netherlands)

In the Netherlands, decisions regarding the maintenance or improvement of flood defenses are based on the results of the periodic 6-year evaluation of the actual status of flood defenses in relation to the legal standards. Especially decisions on large-scale investments, like the renovation of a storm surge barrier, require a long-term perspective on potential hydraulic conditions and their potential probability. Important questions that may arise are:

- when is renovation inevitable because of the technical lifetime of the construction or because of functional conditions (e.g., sea level has become higher than the design conditions)?
- is renovation technically possible?
- is building another, new construction (at another location) more appropriate?
- how do you quantify future expenses and benefits, do we use a usual discount rate to translate these values to present costs, or another smaller one that is more adapted to a very long term horizon (>50 years)?
- uncertainty in climate change complicates decision making in a sense that it is more difficult to find a balance between over-expenditure by structures (as a consequence of systematically choosing to be prepared at any time for the worst scenario) and under-expenditure (with possibly disastrous consequences). Adaptive delta management tries to tackle this problem by:
  - embedding major, long-term interventions in the water system, in short-term interventions in the field of land use planning, such as spatial reservation for future dike improvement or flood storage. In this way part of the potential future problems are dealt with by short time scale actions, postponing major interventions until more confidence is gathered in the dynamics of climate change;
  - working with multiple investment paths, making explicit and transparent when, and under what conditions, decisions are necessary, which options remain open or become unavailable at that time.

In the Netherlands Rijkswaterstaat is exploring this field, within the context of the Delta-programme<sup>37</sup>. Methods are elaborated regarding an adaptive way of planning and a method to value flexibility (like "real options" method).

---

<sup>37</sup> [www.deltacommissaris.nl/english](http://www.deltacommissaris.nl/english)

### **4.3.2 Strategic Maintenance (Japan)**

In Japan, the central government manages an array of river structures, including embankments stretching some 13,400 km and some 10,000 flood gates, sluice ways, sluice pipes, drainage pump stations, weirs and others. The construction of these river structures accelerated in the second half of the 1960s, reaching a peak in the second half of the 1980s. This means that nearly 40% of them have passed the age of 40 years when the renewal of the main equipment is required. The ratio of such structures is expected to reach 60% in 10 years' time. It is estimated that the average annual renewal cost in the next 10 years will be almost double the current annual budget if the conventional management practices based on the design working life continue.

In the face of this daunting situation, increasing efforts have been made to introduce maintenance practices based on the monitored state where the timing of repair and renewal is determined based on the monitoring results for individual facilities, particularly in relation to the renewal of mechanical equipment. Moreover, there has been a shift to breakdown maintenance where repair or renewal is conducted after the breakdown or damage to equipment of which the breakdown or damage does not have a deadly impact on the functions of the entire facility. In FY 2008, a manual was prepared to explain this new maintenance approach for flood gates and pumping equipment. Meanwhile, data is being gathered to establish a reliable method of evaluating the actual level of deterioration.

With these measures, it is estimated that the increase of the average annual renewal cost in the next 10 years will be reduced to some 30% above the present level.

River management also involves river patrols, embankment inspection and repair, weeding, dredging of channels and tree cutting. Such non-structural river maintenance work is conducted according to precedent or the experience of damage to river management facilities due to flooding. The Plan-Do-Check-Act cycle has been adopted to systematically and efficiently conduct river management. To be more precise, a scheme to formulate river maintenance plans has been in place since FY 2007. Under this scheme, a plan covering a period of five years is formulated for individual rivers managed by the central government. Any shortcomings encountered in the process of river management based on the plan are fed back to improve the plan. The technical standards for river maintenance will be further revised in the coming years based on the results of trial river maintenance using the plan.

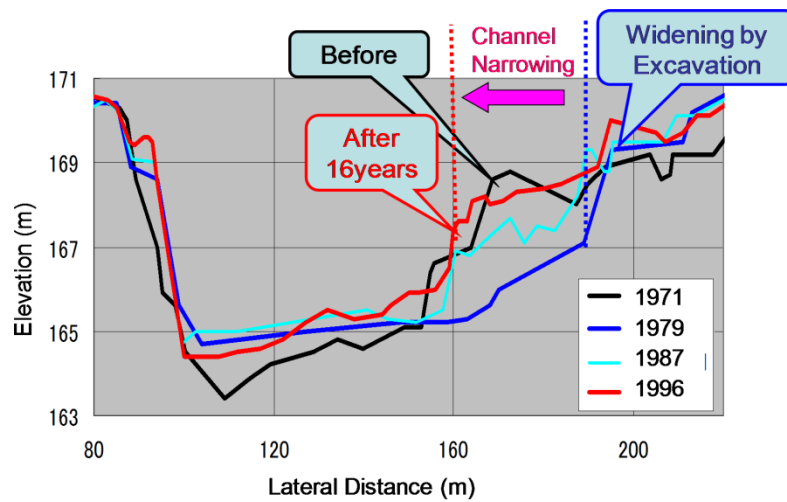
### **4.3.3 River Channel Maintenance in Consideration of Response to Excavation of River Channel for River Improvement (Japan)**

The excavation of a river channel is conducted to improve the discharge capacity of a river. This work must, however, be followed by regular dredging of the sediment deposited over subsequent years to secure the desirable cross-sectional area of the river. As the scale of this dredging work can become quite daunting at river sections where the speed of sediment deposition is fast, the examination of suitable measures to secure the said cross-sectional area at the earlier stage of planning is preferable. There has been growing attention on specific cases in recent years. In such cases, when a low water channel is widened where the river bed comprises sand and medium size gravel while the river banks and high water channel comprise smaller fine sand and silt which are hardly contained in the river bed, the high water channel is eventually reshaped by the deposition of fine sediment to narrow the width of the low water channel to its original width in 10 years or so. This reshaping of the high water channel is caused by the deposition of fine sediment flowing

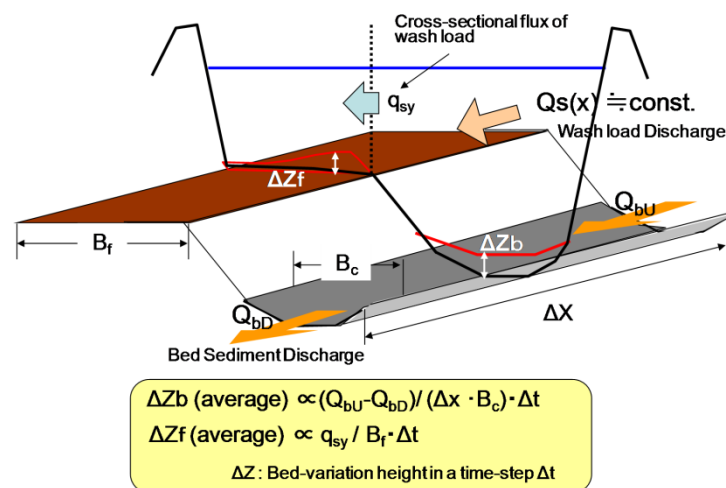


down the river as the wash load at the time of the flooding at places of herbaceous plant communities where the flow speed becomes very slow. Its mechanism is, therefore, quite different from the well-known mechanism of river bed fluctuation caused by the bed load.

A new river bed variation model has been developed for the purpose of predicting the amount of deposition, including the case mentioned above. This model combines the one-dimensional river bed variation prediction model with a simple model for wash load deposition at a plant community. Prediction of the amount of deposition based on this model can establish a desirable river channel profile to minimize the amount of deposition and the additionally required cross-sectional area to match the predicted amount of deposition. In addition to reducing the labor required for maintenance work, the new model allows the examination of realistic measures to maintain the discharge capacity of a river.



**Figure 26(1): Typical Example of Channel-narrowing (Sendai River)**



**Figure 26(2): Basic Framework of the one-dimensional riverbed variation model combined with a simple cross-sectional model for wash load deposition**

#### **4.3.4 System Asset Management Plans and Creating Asset Management Capacity (United Kingdom)**

The Environment Agency owns and/or manages a broad portfolio of infrastructure across England and Wales to manage river and coastal flooding. These include individual assets (i.e., specific risk management structures such as embankments, maintained river channels and flood walls) and/or asset systems (combinations of assets used to manage risk in a particular area). It also manages other assets related to the maintenance of navigation on major rivers and water resources. The estimated replacement cost of these assets is in excess of £20 billion. They are critical to flood risk management, waterways, navigation and water resources and it is essential that they are managed in an effective and sustainable way.

The Environment Agency is planning to spend over £2.5 billion on its infrastructure assets over the next five years and it is essential that this investment is efficiently managed and that these assets are maintained in the appropriate condition. As part of its work to achieve this, the Environment Agency is taking forward two initiatives, System Asset Management Plans and Creating Asset Management Capacity.

##### **System Asset Management Plans (SAMPs)**

The *System Asset Management Plans* project is designed to improve the Environment Agency's ability to process data on its flood risk management systems and provide:

- a greater understanding of the inventory of flood risk management assets and the work required to sustain those assets;
- information on the costs and benefits of maintenance, enabling the Environment Agency to assess maintenance regimes to decide where to target resources;
- the ability to provide consistent strategic and operational reporting of asset management information across all flood risk management systems and reporting on achievements in managing risk;
- additional support for the development of future funding bids and the evidence to demonstrate where asset replacement is best value;
- a forward investment profile highlighting where the Environment Agency should question the sustainability of current practices;
- assessment of failing assets (including both Environment Agency and third party assets);
- a prioritized plan of management actions or study work to improve understanding of the assets.

To do this the SAMP program has involved the collection of additional information on flood risk management assets and the development of a new information technology system to hold these data and facilitate its effective use. The SAMP system includes:

- descriptive information on flood risk management systems (including asset type, condition, physical characteristics, the protection they provide, the strategic influences affecting the system and future capital investment schemes that may affect the system);
- financial information on the system and any major assets within it to help determine the most efficient investment regime for the assets within the system to sustain the standard of

service over a whole life period of 100 years (this includes different levels of maintenance and investment scenarios);

- management action plans;
- the benefits provided by the system (including estimates for residential and non-residential property, agricultural production and designated nature conservation areas);
- supporting information (including historic flood history and strategic plans relevant to the area in question, for example Shoreline Management Plans and Catchment Flood Management Plans).

SAMPs were developed for all high consequence flood risk management systems by March 2010 and for all other systems (in excess of 3,100 systems across England and Wales in total) by March 2011.

### **Creating Asset Management Capacity**

The *Creating Asset Management Capability* project will provide improved tools to manage that investment effectively and efficiently. The project provides the essential supporting asset data and information systems need to manage these assets. It will replace the National Flood and Coastal Defence Database (NFCDD) currently used by the Environment Agency and responds to recommendations made by the National Audit Office, Public Accounts Committee which identified limitations in the Environment Agency's current systems in 2006/7 and the Sir Michael Pitt report on the floods in the summer of 2007.

As flood and coastal risk management assets age and environmental risks change, the challenges of maintaining an old and potentially obsolete systems will increase and eventually the system will fail. The Environment Agency would then be unable to report on flood risk, provide data to model flood risk and maintain records of asset condition.

To help manage these assets, the Environment Agency is developing a comprehensive asset data and information system supporting consistent business processes. The information system will hold information about asset location, importance, ownership, age, condition and regular maintenance requirements. This will enable the Environment Agency to focus investment on the right assets at the right time.

The project is split into several phases. Each phase is discrete and sequential so avoids issues to delivered phases should the decision be taken not to progress with further phases.

#### ***Phase 1 - Enabling (replacing NFCDD, restructuring asset data and improving data quality)***

The first phase will deliver a new asset inventory, populated with accurate, restructured data to meet current and future asset management needs. The new system will include an effective, map-based graphical interface allowing the spatial management and manipulation of information. This will offer significant efficiency over the current NFCDD system.

#### ***Phase 2 – Implementation and securing benefits***

The benefits from implementing the new system under phase 2 of the project are believed to be substantial and are expected to be in the range £8m to £12m per year. They are expected to be delivered through:

- Opportunities for cost reduction through organizational change.
- Increased ability to utilize field staff effectively.
- Reduced costs through improved resource utilization, work scheduling and data availability.
- Increased efficiency in the allocation of maintenance funding.
- Reduced dependency on external resources.

### ***Phase 3 – Further development and optimisation***

This phase will build upon earlier work. Areas for consideration are:

- Optimization of field operations by automated transfer of data to/from sites.
- Use of real-time data from telemetry and onsite data collection to improve flood event information.

## **4.3.5 Water Course Maintenance – Conveyance and Dredging Trials Report Findings (United Kingdom)**

The Environment Agency spends more than £20 million each year on removing silt and vegetation from watercourses. This maintenance work is carried out by the Environment Agency along with a number of organizations and individuals, including internal drainage boards, local authorities, and landowners. The aim of this work is to reduce the risk of properties being flooded and the impact on people.

Dredging is one of a number of activities classed as watercourse maintenance. Others include weed control, blockage removal and de-silting. Maintenance can improve the flow capacity of the river and reduce water levels as well as provide other potential benefits, such as land drainage, controlling invasive species and maintaining navigations. The Environment Agency also seeks to ensure that its work protects and, if possible, enhances the environment.

There are a number of steps taken to identify the need for dredging. This focuses on current and future maintenance needs rather than just work that has always been done. Some people and organizations have expressed concerns that not enough dredging and watercourse maintenance is done to manage risk properly. The Environment Agency recently completed studies in response to these concerns and to test the evidence used to develop the current approach to maintenance. The studies aimed to:

- Confirm to what extent watercourse maintenance or dredging would reduce the likelihood or severity of floods, focusing on six pilot study sites across England. Each site represented a typical type of watercourse managed by the Environment Agency, and demonstrated aspects of routine maintenance work<sup>38</sup>.
- Develop guidance on river channel maintenance and the management of conveyance to help Environment Agency staff assess the best approach to maintaining a river channel and whether this is the best flood risk management option – technically, environmentally and economically. The guidance is also designed to help staff as they involve the local

---

<sup>38</sup> Dredging pilot studies report, 2011, Environment Agency, United Kingdom.  
([www.environment-agency.gov.uk/research/policy/31740.aspx](http://www.environment-agency.gov.uk/research/policy/31740.aspx))

community in discussions about where and to what extent channel maintenance work is carried out<sup>39</sup>.

Work at the pilot sites showed that the maintenance work reduced flood risk locally. But in some areas the maintenance work was not cost effective – the flood risk benefit of the work did not justify the expenditure. The Environment Agency had to consider the whole catchment (that is, the whole river system) including the purpose of any watercourses in the catchment. Each pilot site was different and decisions have to be made on a case-by-case basis, using evidence and engineering knowledge to make judgements. Working with local communities to discuss the work and agree if it is the best flood risk management measure for them was beneficial.

#### **4.3.6 National Strategic Infrastructure Framework (United States)**

The US Army Corps of Engineers plans, constructs, operates, maintains and manages a significant portion of the US's water resources infrastructure. The agency's entire portfolio has approximately 1,600 projects across the US consisting of navigation (deep-draft port and harbor channels, shallow-draft ports, inland and intracoastal waterways), flood risk management and coastal storm damage reduction, and a wide range of multiple purpose projects. The estimated capital stock value of this portfolio is approximately \$230 billion. Its replacement value is in the multiple hundreds of billions.

The portfolio includes large dams planned, built and operated for water supply, hydropower, flood control, recreation, and various environmental purposes. In addition, the Corps also has oversight and inspection responsibilities for hundreds of local flood damage reduction projects (floodwalls, dams, levees) for which local governments agencies have assumed operation and maintenance responsibility. This water-based capital stock is critical to the US economy. The vast majority of this infrastructure was constructed in the early to mid twentieth century, and most has reached its original design life. As each year passes, the combination of age, extensive use, and natural effects of weather, wear and tear, and normal deterioration is taking a toll on condition and reliability.

In 2004/2005, the Corps established an integrated, collaborative and national process for condition assessment and risk-based asset management of the Corps' portfolio, under the authority and auspices of the President's Executive Order No. 13327 (Federal Real Property Asset Management). The effort is well underway in two of the Corps' larger portfolios, inland navigation structures and dams and levees (see Section 2.1.4). The foundation of the Corps' Asset Management program has been to inventory the portfolio, investigate the condition of the assets, determine where the risk of failure is most prominent, evaluate the consequences of failure, establish a relative risk index to support portfolio life-cycle investment decisions, and match that risk to the structure's value to the nation before supporting portfolio life-cycle investment decisions. National geo-spatial inventories and assessments of Corps dams and levees throughout the United States have been created and are being actively utilized to manage risk management activities within the dam and levee portfolio. These inventories are now being integrated and blended with similar portfolios for inland navigation, hydro-electric power, water supply, and recreation to facilitate the application of risk-informed performance and condition metrics across the full balance of the Corps Civil Works portfolio. The Civil Works' Watershed Investment Decision Tool (see Section 4.7.1) is integral to the risk-informed investment decision manifesting from this approach.

---

<sup>39</sup> River channel maintenance: a guide to how we manage conveyance, 2011. Environment Agency, United Kingdom.

Even with the diligent and aggressive process underway to apply risk-informed Asset Management across the portfolio, the capital stock value of the portfolio is continuing to decline. With that ominous fact in mind, the Assistant Secretary of the Army for Civil Works has directed the Corps to initiate a comprehensive assessment of the potential for recapitalization of the Corps' portfolio across all business lines. The combination of the Asset Management and Recapitalization initiatives into one unified program is underway towards establishing a National Strategic Infrastructure Framework across the Corps' Civil Works mission. The urgency of the combined effort cannot be understated. Failure of just one of the Corps key flood risk management systems or components within the U.S. would have a devastating impact for a given region and the nation, as sadly demonstrated when over one thousand lives were lost and economic losses totaled in the billions of dollars when Hurricanes Katrina and Rita struck New Orleans and the U.S. Gulf Coast in August and September 2005. Even planned short term events, such as scheduled shutdowns for "major maintenance," can cause disruptions to economic activity in the tens to hundreds of millions of dollars for 2-6 month closures. The effective life-cycle management and recapitalization of the nation's aging water resources infrastructure is of critical importance to the economy, security and national well-being of the United States.

#### **4.3.7 'Room for the River' Programme (The Netherlands)**

During the last centuries the area available for Dutch rivers has decreased continuously. Since about 200 years ago, dikes control river flows. At the same time, sedimentation is confined to the areas between the dikes, making the river gradually rise compared to the adjacent, subsiding polders. These developments are accompanied by increased population in the polders. Flooding under current conditions would put the safety of 4 million people at risk. And climate change may increase this risk, due to rising sea level and peak discharges.

##### ***Breaking the Trend***

In 1993 and 1995 river floods threatened the polders along the rivers Rhine and Meuse and a quarter of a million people had to be evacuated. The Dutch government, in agreement with other countries in the Rhine Basin, decided to break the trend of ever increasing the dikes. Instead, measures were developed to increase the discharge capacity of the river, resulting in lower extreme flood levels. The so-called "Room for the River" plan<sup>40</sup> has three objectives:

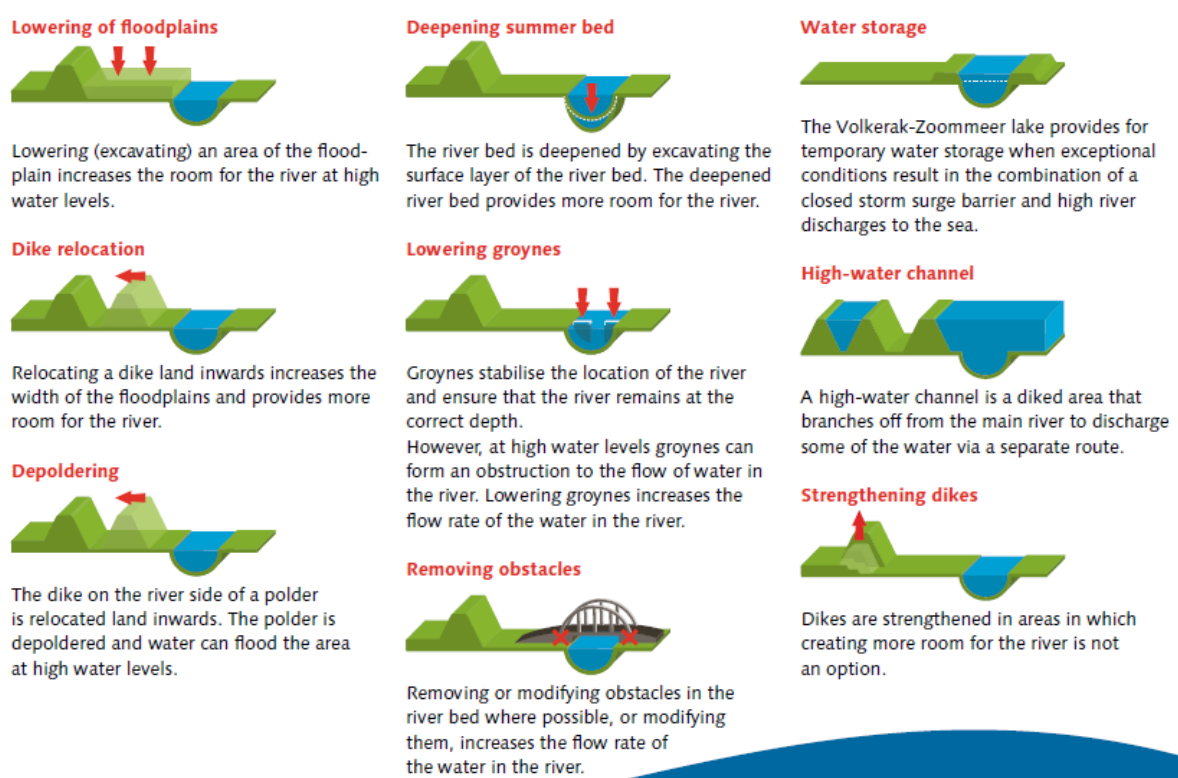
- by 2015 the branches of the Rhine will cope with a design discharge capacity of 16,000 m<sup>3</sup>/s without flooding;
- the measures implemented to increase safety will also improve the overall environmental quality of the river region;
- the extra room the rivers will need in the coming decades to cope with higher discharges due to the forecast climate changes, will remain permanently available.

A range of measures is being implemented to create more room for the river and reduce high water levels, such as lowering the floodplains, relocating dikes further inland, lowering groynes in the rivers and deepening the summer beds (see Figure 27 below). In 2007 the Dutch government approved the plan, and execution started.

---

<sup>40</sup> <http://www.ruimtevoorderivier.nl/meta-navigatie/english>

## How will the river be given more room?



**Figure 27: Overview measures how the river will be given more room**

### *Cooperation Among Authorities*

Various authorities at local, regional and national levels cooperate to carry out the Room for the River Programme. The Netherlands Ministry of Infrastructure and the Environment has overall responsibility for the Programme. The provinces, water boards and municipalities in the river region and Rijkswaterstaat (Directorate-General for Public Works and Water Management) elaborate the plans and implement the projects, since they are familiar with the exact situation in the region and can adjust the project to regional circumstances. The Programme Directorate Room for the River (PDR) is responsible for the implementation of the programme and acts as the link between the central government and the region. The Programme Directorate verifies that the plans are compatible with the Room for the River policy, monitors the cohesion between the measures being taken, facilitates the process, and promotes exchanges of expertise and experience among the 39 projects (see Table 3 below).

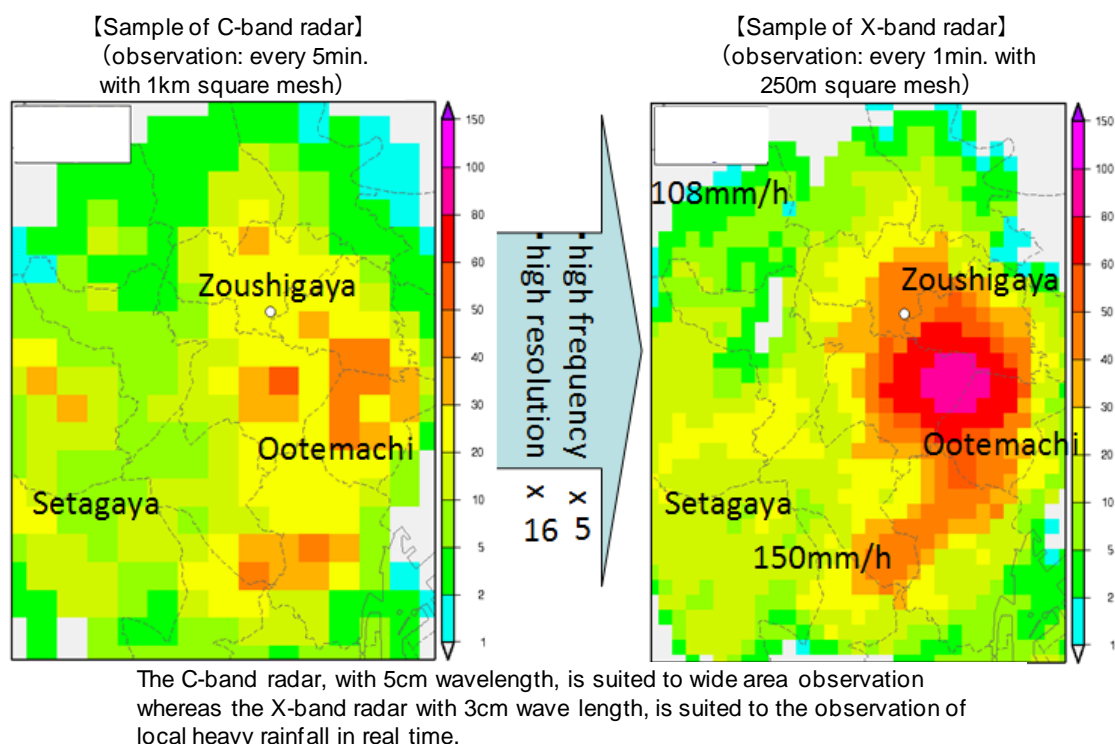
**Table 3: Facts and Figures – Room for the River Programme**

Budget	€3,2 billion
Planning	2007 – 2015
Maximum discharge capacity of the River Rhine	
- current	15,000 m <sup>3</sup> /s
- on completion	16,000 m <sup>3</sup> /s





of observing rainfall with a minimum observation unit of a 250 m mesh (compared to the 1 km mesh of the conventional C-band radars) and an observation interval of one minute (compared to five minutes of the conventional C-band radars), spatio-temporally an 80 times denser



**Figure 29: Rainfall distribution observed by X-Band MP Radar<sup>42</sup>**

observation. It is now possible to make detailed and real-time observation of localized and short bursts of rain which could not be detected by conventional C-band radars. It is hoped that the new radars will improve the accuracy of predicting rising river levels and flood risk due to guerrilla downpours.

Since 5 July 2010, rainfall observation data (web images) are being distributed to the general public on the Internet to assist evacuation and disaster prevention activities at the time of heavy rain (<http://www.river.go.jp/xbandrader/>).

#### 4.4.2 Provision of River Information (Japan)

Recent years have seen an increased frequency of downpours with hourly rainfall that exceeds 50-100 mm. One example is the downpour which hit Kobe City in July 2008. 24 mm of rain fell in 10 minutes and the resulting rise of the river level at a rate of 134 cm in 10 minutes claimed the lives of five people. The repeated occurrence of flood damage and water accidents during evacuation activities due to localized heavy rain or extremely intensified rain has made the reinforcement of measures against them an urgent task.

The importance of soft (non-physical) measures, such as the reliable operation of flood gates and other facilities, accurate flood forecasting and assistance for swift evacuation through the issue of evacuation instructions, has been growing to protect the lives and assets of people from the

<sup>42</sup> [http://www.mlit.go.jp/river/basic\\_info/english/pdf/guigelines\\_eng.pdf](http://www.mlit.go.jp/river/basic_info/english/pdf/guigelines_eng.pdf) (p. 43)

damage. The real-time observation and provision of rainfall, river level and other river information is required to meet these challenges.

The Ministry of Land, Infrastructure, Transport and Tourism (MLIT) gathers telemetric data on rainfall (radar detected rainfall and ground rainfall), river level and discharge and water inflow and discharge volumes at dams, all of which are observed nationwide, processes and edits such



Figure 30: River Information Provision<sup>43</sup>

data to produce tables, graphs, maps and charts for easy comprehension and releases these products to the general public through the Internet and mobile phone networks. Using this system, river administrators, municipal officials and residents can access real-time river information 24 hours a day, 365 days a year. The river information can be accessed on the MLIT's website called "Information Page for River Disaster Prevention" (<http://www.river.go.jp/>).

#### 4.4.3 The Flood Forecasting Centre (United Kingdom)

The Flood Forecasting Centre was created in response to the 2007 floods in England and Wales. Its aim is to help tackle the increased risks of flooding brought about through climate change by better forecasting and communicating the likelihood and probability of flood risk from all natural sources. It brings together staff from both the Environment Agency and the Met Office and aims to be a centre of expertise for hydrometeorology by combining operations, development, customer engagement, training and learning in one Centre. Launched on 1 April 2009, the Centre operates 24/7 with a small team of 24 staff, based at the Met Office Headquarters in Exeter in the south west of England.

The Centre provides a number of operational products and services, including:

- daily flood guidance statements for England and Wales which provide a 5-day forward look of developing situations to governments, local authorities and emergency services;

<sup>43</sup> [http://www.mlit.go.jp/river/basic\\_info/english/pdf/guigelines\\_eng.pdf](http://www.mlit.go.jp/river/basic_info/english/pdf/guigelines_eng.pdf) (p.42).

- primary alerts for heavy and extreme rainfall and for coastal water levels which are used to inform further warnings, including public;
- operating the national hydrological flood model which forecasts flows across the whole country and all river catchments; and
- communicating increasing flood risk; it also works with the wider forecasting units in both parent organizations (i.e., national weather warning service and local flood forecasting and warning services across the country.)

The Centre uses a number of different approaches to distributing these products, with an increasing use of telephone conferencing and web-based displays supplementing traditional email and text alerts.

The Centre also has an ongoing program of projects to improve its forecasting capability and enable new scientific techniques to be pulled through into an operational service and to improve the communication of flood risk. These include:

- developing the first operational national hydrological flood model;
- improving visualisation and access to real time rainguage information;
- improving the use of high resolution and ensemble weather and flood models;
- integrating guidance and alerts messages to reduce duplication and confusion in multiple messages;
- increasing the use of proactive briefings for government bodies with less reliance on paper based products;
- integrating services on web based applications;
- making information available to the wider public to improve early notification.

Other activities carried out by the Centre include the provision of training and learning (both formal and “on the job”) in hydrometeorology to improve the skills of forecasters. The Centre also works closely with local authorities, emergency services and other customers to support their preparations ahead of flooding. This work includes providing support to training exercises, input to planning activities, providing improved technical understanding and working across wider issues for the Centre’s parent organizations (e.g. managing droughts and other hazards).

#### **4.4.4 Exercise Watermark (United Kingdom)**

Exercise Watermark was a major flood response exercise lead by the UK Department for the Environment Food and Rural Affairs (Defra) that took place from 4-11 March 2011. It involved organizations from central government to local responders. Its aim was to be a wide ranging and publicly engaging exercise that tested the incident management arrangements across England and Wales to respond to all aspects of severe, wide-area flooding. The need for an exercise of this type was identified in the Pitt Review of the summer 2007 floods.

Managed by the Defra, supported by the Welsh Government and delivered through the Environment Agency, the exercise involved departments and agencies right across government and local resilience forums (LRFs) throughout England and Wales. The exercise successfully tested the whole range of flood response capability through from command and control, rescue

and evacuation capability, multi-agency cooperation and mutual aid. The flexible design architecture of Exercise Watermark also encouraged other LRFs to test their flood preparedness, including tactical response level at Sutton on Sea in Lincolnshire and Gwyniad at Bala Lake, Wales.

The exercise also included a wide range of community events and activities, with a significant level of support from the National Flood Forum. Individuals and community groups used the Exercise Watermark scenario and tools to produce, build and practice their flood response capability and readiness. This level of local self help and preparedness is vital in the face of flood risk.

The initial findings of the review of the exercise suggest that the targets for the exercise set out by Sir Michael Pitt and the many Pitt Review recommendations for improved flood preparedness have been successfully met across England and Wales. However, a number of lessons were identified in the following key areas:

- Communications, including the development, management and exchange of information and the effective use of information
- Liaison within the Environment Agency and with our external partners in incident management
- Incident management procedures and plans and the provision and analysis of information
- Resources, including manpower and equipment
- Operational responses
- Media and public relations management
- Staff welfare and training.

A conference occurred in July 2011 to share and discuss the lessons from the exercise and the Environment Agency is aiming to issue a final report on the exercise in September 2011.

#### **4.4.5 Exercise, Preparedness and Response (United States)**

As part of the National Flood Risk Management Program, the U.S. Army Corps of Engineers, under the authority of Public Law (PL) 84-99, is authorized to undertake activities including disaster preparedness, advance measures, emergency operations (flood response and post-flood response), rehabilitation of flood control works threatened or destroyed by flood, and protection or repair of federally authorized shore protective works threatened or damaged by coastal storms. Under the law, it conducts an aggressive exercise, preparedness and response program. This program which is carried out throughout the United States provides for collaboration with federal, state, local and tribal partners at the regional, watershed, and state levels. While the authority of PL 84-99 provides for supplementing the state and local governments during actual disasters, the Corps' authority permits the flexibility to conduct exercises and workshops with state and local governments as well as tribal partners in order to better understand potential flood scenarios and enhance inter-governmental preparedness and response capabilities. These exercises and workshops further the importance of state participation in planning efforts to improve collaborative risk management planning processes. The resultant outcomes strengthen the trust between federal, state and tribal partners while raising expectations for interagency success in future responses on both a regional and national basis.

The Corps has developed a comprehensive data acquisition and hydrologic modeling system for real time decision support of water control operations. This system, known as the “Corps Water Management System”, or CWMS, is currently being implemented at Corps offices throughout the United States. CWMS supports the informational needs for Corps water control decisions in its operations of over 700 reservoir and lock-and-dam projects. CWMS retrieves precipitation, river stage, gate settings and other data from field sensors, and validates, transforms and stores those measurements in a database. The measurements are used for calibration and adjustment of hydrologic and hydraulic models to reflect current conditions. The gauged precipitation, combined with Quantitative Precipitation Forecasts or other future precipitation scenarios, are used by the HEC-HMS hydrology model to forecast possible future river flows into and downstream of reservoirs. The reservoir operations model, HEC-ResSim, uses these flow scenarios to provide operational decision information for the engineer. The river hydraulics program, HEC-RAS, computes river stages and water surface profiles for these scenarios. An inundation boundary and depth map of water in the flood plain can be calculated from the HEC-RAS results using ArcInfo, and viewed with CorpsView, a geo-spatial data viewer based on ArcView. The economic impacts of the different flows are computed by HEC-FIA. This sequence of modeling software allows engineers to evaluate operational decisions for reservoirs and other control structures, and view and compare hydraulic and economic impacts for various “what if?” scenarios.

From an interagency perspective, the Corps initiated a “Silver Jackets” program<sup>44</sup>. The intent of the program is to bring state, federal, and sometimes local and Tribal agencies together to manage a state’s flood risk throughout the lifecycle. The program has grown from a single Silver Jackets team in 2005 to approximately 20 active teams in 2011. The Silver Jackets program<sup>45</sup> will address those preparedness and planning activities that then transition into response and recovery efforts. Teams also help assure that the impacted watershed is more resilient to future flooding by implementing pre-planned mitigation strategies/measures when funding is made available for recovery. State Silver Jackets teams can also be brought together in a Regional team framework to address common challenges and watershed level objectives. This has been demonstrated as a successful strategy following the 2008 flood events in the upper Mississippi River watershed. The Silver Jackets program contributes to flood risk management by: 1) integrating flood damage and flood hazard reduction programs across local, state and federal agencies, 2) improving public awareness and comprehension of flood hazards and risk, and 3) providing current and accurate floodplain information to the public and decision makers. Further, through a corrective action process, the Corps is able to make changes to policy and doctrine that will assist decision makers in approaches to future flood fight activities and other response operations to reduce the threat to life and property.

## **4.5 Response and Recovery**

- 4.5.1 Japan: TEC-FORCE (Technical Emergency Control Force for Disaster Assistance)
- 4.5.2 Japan: Flood Fighting Teams and Flood Fighting (Suibo) Act
- 4.5.3 Japan: Post-Disaster Restoration Schemes
- 4.5.4 USA: Improving Capability to Recover from Disasters

<sup>44</sup> During emergency operations, participants frequently wear colored jackets indicating their organization. Silver jackets represents the concept of bringing all of the participants together under one color for one purpose.

<sup>45</sup> <http://www.nfrmp.us/state/index.cfm>

#### **4.5.1 TEC-FORCE (Technical Emergency Control Force for Disaster Assistance) (Japan)**

In Japan, local public bodies have the primary responsibility for disaster prevention. However, when a large-scale disaster occurs, it is difficult for local public bodies alone to organize an adequate response because of their insufficient experience and resources, including experts and equipment. This situation makes it necessary for the central government to order the precise dispatch and deployment of highly capable equipment and experts of regional development bureaus (of the Ministry of Land, Infrastructure, Transport and Tourism: MLIT) and/or other bodies. In fact, the MLIT is in charge of the overall command and adjustment of these resources.

Emergency assistance of the central government has been conventionally organized to respond to each occasion but it has been felt that a suitable system should be permanently in place to ensure smooth and swift assistance. For this reason, the TEC-FORCE was created within the MLIT in May, 2008. Its principal task is to establish a system capable of smoothly and swiftly providing technical assistance for local public bodies for the purpose of the quick establishment of an accurate picture of the damage caused by a large-scale natural disaster and the facilitation of the speedy restoration of disaster-hit areas.

National government employees are assigned to the TEC-FORCE in advance as part of a system designed to achieve the swift dispatch of personnel and equipment. Members regularly undergo simulations and training sessions in peace time to improve their skills. The main activities of the TEC-FORCE are listed below.

- Swift assessment of the disaster damage situation
- Speedy restoration of social infrastructure facilities
  - Quick initial response
  - Highly focused response by a team of experts
  - Upgrading and strengthening of technical guidance on restoration measures
- Prevention of secondary disasters
  - Highly sophisticated technical guidance for disaster-hit areas
  - Emergency measures (planning and execution)
  - Disaster risk prediction (judgement on the necessity for evacuation)
- Other emergency measures to deal with disasters
  - Coordination of emergency transportation operation

As of 1 April 2010, the TEC-FORCE has 2,605 members nominated by the MLIT headquarters, regional development bureaus, district transport bureaus and the National Institute for Land and Infrastructure Management (NILIM).

The TEC-FORCE provided assistance totalling 17,980 man-days for disaster-hit area by the Great East Japan Earthquake since the occurrence of the disaster on 11 March (as of 18 July 2011).





**Figure 31: TEC-FORCE Disaster Assistance in the Great East Japan Earthquake**

#### 4.5.2 Flood Fighting Teams and Flood Fighting (Suibo) Act (Japan)

In Japan, people have long worked on flood-prone alluvial plains and carried on various types of productive activities to sustain their lives. The historical experience of the Japanese has developed two principal components of flood risk management: (i) "flood control" (*Chisui*) by means of river improvement and (ii) "flood fighting" or "flood damage prevention" (*Suibo*) as a human activity to protect human lives and property from ongoing and approaching flooding to minimise the damage.

Flood fighting activities are conducted by volunteer-based flood fighting teams which are commonly established in each municipality. A flood fighting team is developed and managed by the traditional self-governing body of a village, etc. Its members are normally engaged in different jobs but are also involved in patrolling, watching out and levee protection work. During peace time, they still conduct patrols and the inspection of levees, provisions for flood fighting warehouse and for communication facilities, drills and other activities in preparation for a flood.

At present, there are some 900,000 flood fighting team members in Japan and a total of 265,000 members were mobilized nationwide in 2004 when the number of typhoons which direct hit Japan was the largest in observatory history at 10.





**Figure 32: Flood Protection Works by Flood Fighting Teams**<sup>46</sup>

The Flood Fighting Act stipulates all of the necessary issues, including the authority of flood fighting teams, to ensure the smooth implementation of flood fighting activities. The Act also has provisions governing the following matters to alleviate flood damage.

- Flood forecast to guide evacuation, etc. (jointly issued by a river administrator and the Japan Meteorological Agency)
- Flood fighting warning to guide flood fighting activities (issued by a river administrator)
- Public announcement by a river administrator of flood prone areas along each major river and preparation of a hazard map by each municipality based on the assumed flood prone areas.

Japan is now facing rapid social changes, namely the aging population combined with the diminishing number of children. The rate of aged population is over 20% and is still increasing at unprecedented rate. The series of disasters in 2004 showed changes of flood damage characteristics due to the social changes as well as the changes of meteorological tendencies: frequent localized torrential downpour, many floods and landslides at small and medium-sized rivers, many casualties among the aged and other people requiring help in times of disaster because of the aging society with fewer children, and weak local mutual-aid system because of local communities on the decline and decrease and aging of flood fighting team members. Under such circumstances, the following revisions of the Flood Fighting Act were made in FY2005 to enhance the ability of local communities and local public bodies to competently deal with flood risks.

- Expansion of the scope of the subject rivers for announcement of flood prone areas and also for the issue of flood warnings to include small and medium sized rivers
- Provision of real time information on flooded areas and flood water depth after the commencement of flooding of a major river
- Improved communication of disaster information at underground facilities such as shopping complexes and facilities primarily used by the elderly and other vulnerable people
- Improved communication of disaster information at facilities primarily used by the elderly and other vulnerable people (In local disaster prevention plans, specifying methods of conveying flood forecasts to facilities in flood-prone area, mainly used by the aged and infant)

<sup>46</sup> [http://www.mlit.go.jp/river/basic\\_info/english/pdf/guigelines\\_eng.pdf](http://www.mlit.go.jp/river/basic_info/english/pdf/guigelines_eng.pdf) (p.44)

- Establishment of a system to incorporate public-interest corporations to flood fighting activities, in cooperation with flood fighting teams
- Establishment of a rule of supplying retirement allowance to flood fighting team members

#### **4.5.3 Post-Disaster Restoration Schemes (Japan)**

Japan is prone to disasters because of its meteorological and topographical conditions and damage occurs every year to such civil engineering facilities as river embankments and roads. Damage to river embankments and other river protection facilities means a high flood risk and the absence of quick restoration could lead to a repetition of flood damage. Local public bodies must urgently restore damaged facilities to ensure the stability of civilian life and economic activities. The huge financial burden of this can cause a funding crisis for local public bodies. Moreover, large-scale spending for restoration projects can make the systematic implementation of flood control projects difficult, further increasing the risk of flooding in other areas.

The post-disaster restoration project schemes listed below are in place to assist the speedy restoration efforts of local public bodies when public civil engineering facilities are damaged by a natural disaster.

- Post-disaster restoration project scheme: restoration of the previous usage of public civil engineering facilities damaged by a natural disaster with a high level of treasury funding (two-thirds of the cost or higher).
- Post-disaster restoration-related project scheme: additional project scheme for prevention of repeat disasters with treasury funding (approximately half of the cost) when a post-disaster restoration project alone is judged to be incapable of preventing repeat disasters.

One special feature of the post-disaster restoration project scheme is the speedy and assured budgetary arrangements in addition to high level treasury funding. The necessary funding on each occasion has so far been approved through a supplementary budget without the need to wait for the formalization of the following year's budget. The exact funding has been made available based on the results of the post-disaster restoration cost assessment which is conducted as soon as local public bodies have completed their preparations. Even prior to this assessment, local public bodies can start work immediately after a disaster based on their own judgement as treasury funding is available for a restoration project which meets the criteria regardless of the timing of its commencement. In this manner, the swift commencement of suitable projects is assured.

The introduction of these schemes in Japan has positively contributed to preventing repeat disasters and to the steady improvement of the flood safety level.

#### **4.5.4 Improving Capability to Recover from Disasters (United States)**

Immediately following Hurricane Katrina in 2005, there was considerable emphasis placed on issues related to life-saving and life sustaining response. Congress passed the Post-Katrina Emergency Management Reform Act to address various response shortcomings and the National Response Framework (described further below) was developed to improve intergovernmental and private sector response. When recovery efforts from Katrina lagged, the administration saw a need to review and improve the Nation's capabilities to recover from disasters.

At the President's request, the Secretaries of Homeland Security and Housing and Urban Development chaired a Long-Term Disaster Recovery Working Group<sup>47</sup> composed of the Secretaries and Administrators of more than 20 departments, agencies, and offices. This strategic initiative was initiated to provide operational guidance for recovery organizations as well as make suggestions for future improvement.

### **National Disaster Recovery Framework (NDRF)**

One of the products being developed as a part of the Working Group is a National Disaster Recovery Framework to provide direction for the delivery of recovery assistance using current resources and authorities. The NDRF will provide operational guidance for federal, state, tribal, and local authorities to provide for unified and effective disaster recovery. The NDRF defines:

- key recovery principles;
- roles and responsibilities of the recovery coordinators and other stakeholders;
- a coordinating structure that facilitates communication and collaboration among all stakeholders;
- guidance for pre- and post disaster recovery planning; and
- the overall process by which, together as a nation, the country can capitalize on opportunities to rebuild stronger, smarter, and safer communities.

These elements improve recovery support and expedite recovery of disaster impacted individuals, families, businesses and communities. While the NDRF speaks to all who are impacted or otherwise involved in disaster recovery, it concentrates more fully on governmental actions. A draft of the NDRF was released for public comment on 5 February 2010<sup>48</sup>.

The U.S. Army Corps of Engineers and Department of Homeland Security (DHS) Office of Infrastructure Protection are the co-leaders for working with other agencies to develop the Infrastructure Systems Recovery portion of the NDRF. The group is charged with developing an Annex to the NDRF that will provide the guidance for coordinating agencies and programs that are available to repair and reconstruct the physical infrastructure following a disaster, including identification of an implementation strategy and overall coordination strategy.

### **National Response Framework**

The NDRF builds on and aligns with the *National Response Framework* (NRF)<sup>49</sup> which, although it anticipates the need for long-term recovery, addresses primarily actions during disaster response. The *National Response Framework* (NRF) is a guide to how the Nation conducts all-hazards response. It is built upon scalable, flexible, and adaptable coordinating structures to align key roles and responsibilities across the Nation, linking all levels of government, nongovernmental organizations, and the private sector. It is intended to capture specific authorities and best practices for managing incidents that range from the serious but purely local, to large-scale terrorist attacks or catastrophic natural disasters.

---

<sup>47</sup> <http://www.disasterrecoveryworkinggroup.gov/>

<sup>48</sup> <http://disasterrecoveryworkinggroup.gov/ndrf.pdf>

<sup>49</sup> <http://www.fema.gov/pdf/emergency/nrf/nrf-core.pdf>

The NRF is composed of two integrated parts: a printed component and an on-line component. The printed core document, reviewed every four years, describes response doctrine and guidance, roles and responsibilities, primary preparedness and response actions, and core organizational structures and processes. The on-line component<sup>50</sup> contains supplemental materials including annexes, partner guides, and other supporting documents and learning resources. This information is more dynamic and will change and adapt more frequently to respond to lessons from real world events, new technologies, and changes within organizations.

The NRF articulates the five key principles of response doctrine:

- *Engaged Partnership.* Leaders at all levels must communicate and actively support engaged partnerships by developing shared goals and aligning capabilities so that no one is overwhelmed in times of crisis
- *Tiered Response.* Incidents must be managed at the lowest possible jurisdictional level and supported by additional capabilities when needed
- *Scalable, Flexible, and Adaptable Operational Capabilities.* As incidents change in size, scope and complexity, the response must adapt to meet requirements
- *Unity of Effort through Unified Command.* Effective unified command is indispensable to response activities and requires a clear understanding of the roles and responsibilities of each participating organization
- *Readiness to Act.* Effective response requires readiness to act balanced with an understanding of risk. From individuals, households, and communities to local, tribal, State, and Federal governments, national response depends on the instinct and ability to act.

A key concept is that the NRF is always in effect. It provides a national rather than a Federal plan. In most cases, incidents are managed locally with existing resources. Where a gap in local capability develops, State capacity comes into play. When a State anticipates a gap, it may request Federal assistance. The NRF provides the coordinating mechanism for sharing information, ensuring rapid assessment, and seamlessly integrating Federal support.

### **Floodplain Management: Regional Teams and System Performance Evaluation**

During the Midwest Floods of 2008, the Corps of Engineers took on the role as the “lead federal agency” to initiate a Regional Interagency Levee Task Force to address flood risk management that spanned five states (Iowa, Illinois, Indiana, Missouri and Wisconsin) impacted by the flooding. This was the first time a regional task force was established to look at a collaborative, holistic regional approach to the long-term restoration of floodplain management systems damaged by the Midwest Floods of June 2008. The initial task force transitioned to a Regional Flood Risk Management Task Force in 2009. While the initial emphasis of the task force was very much on non-structural alternatives, the transition is significant because it allowed for a broader vision of total flood risk management within the region to include flood protection and natural resource management strategies.

The Corps activated "Operation Watershed" to review the performance and management of the Mississippi River and Tributaries (MR&T) project during historic 2011 floods, identify and prioritize recapitalization requirements to prepare for future events, and identify opportunities to improve system performance and reliability. A regional Interagency Task Force has been

---

<sup>50</sup> [www.fema.gov/nrf](http://www.fema.gov/nrf)

established to coordinate review and implementation efforts. The MR&T project owes its origins to major 1927 Mississippi River flooding that galvanized the nation's support for comprehensive and unified system of public works patterned after the Jadwin Plan, which proposed levees in combination with setbacks and floodways to provide floodwater "escape valves", thus allowing strategic reconnection to floodplains during very high flood stages. The project protects 4.5 million people and to date has yielded a 34 to 1 return on investment. During the 2011 flood, the Corps operated three separate floodways simultaneously for the first time in the project's history to ease pressure on levees and divert floodwaters away from densely populated areas downstream.

## **4.6 Governance, Public Participation and Communication**

- 4.6.1 UK: Roles, Strategy, and Legal Instruments
- 4.6.2 The Netherlands: Roles, Responsibilities and Legal Instruments
- 4.6.2 USA: Interagency Regional Flood Risk Management Team Partnership, Upper Mississippi River Basin
- 4.6.3 USA: Public Participation in Flood Risk Management
- 4.6.4 Japan: Flood Hazard Map
- 4.6.5 Japan: Indication of Flood Hazard Using High Accuracy Elevation Data
- 4.6.6 The Netherlands: Communication on Flood Risk
- 4.6.7 USA: Flood Risk Communication
- 4.6.8 USA: Federal Interagency Floodplain Management Task Force

### **4.6.1 Roles, Strategy, and Legal Instruments (United Kingdom)**

The Government's framework for managing environmental risk emphasises the establishment of risk assessment, risk management and risk communication as essential elements of structured decision-making processes across government, and provides an over-arching framework for the development of functional risk assessment guidance.

The Flood and Water Management Act 2010 provides clarity on roles and responsibilities for the Environment Agency, local authorities and others who manage flood and coastal risks in England and Wales. The Flood Risk Regulations 2009 transposed the European Floods Directive (see text box below) into law for England and Wales, setting out requirements to manage flood risk from all sources in order to reduce the consequence of flooding on human health, economic activity and the environment. The Regulations embed a risk-based approach, by requiring the identification of Flood Risk Areas (where there is a significant flood risk). Flood Hazard Maps, Flood Risk Maps, and Flood Risk Management Plans are then required for these areas.

A new national strategy for flood and coastal erosion risk management in England<sup>51</sup> was approved by the UK Parliament in July 2011 and meets a key requirement of the Flood and Water Management Act 2010. The strategy describes how all flood risk operators will use a risk informed approach in how they manage the risk of flooding from rivers, the sea, surface water and groundwater. The Welsh Government are currently developing a similar strategy for application in Wales.

---

<sup>51</sup> <http://www.official-documents.gov.uk/document/other/9780108510366/9780108510366.pdf>



#### The European Floods Directive

*The European Commission adopted in 2007 a Directive on the assessment and management of flood risks, requiring its member states (including the U.K. and The Netherlands) to assess if all water courses and coast lines are at risk from flooding, to map the flood extent and assets and humans at risk in the areas, and to take adequate and coordinated measures to reduce this flood risk; it contains specific target dates for action, requires coordination in the development of basin plans, prompts long-range planning and consideration of sustainable land use practices, and provides for public information. (See the European Commission's website at [http://ec.europa.eu/environment/water/flood\\_risk/index.htm](http://ec.europa.eu/environment/water/flood_risk/index.htm) for further information.)*

### **4.6.2 Roles, Responsibilities and Legal Instruments (The Netherlands)**

Currently the formulation of flood risk management objectives and measures takes place by different authorities, at different geographical levels with dedicated plans, under the realm of different legislative regimes and with different schedules for planning and public consultation. On the national level the most important legal instruments are:

- Spatial Planning Act: defines roles, responsibilities and procedures regarding spatial planning. Water management authorities should be informed of planned activities that might affect water management.
- Water Act: defines roles, responsibilities and procedures regarding water and flood risk management. It presents the legal standards of protection for each dike ring (levee system) and the procedure for 6-year assessment of the flood defenses.
- Safety Regions Act: defines roles, responsibilities and procedures of disaster management. It stipulates that every region performs a risk analysis, including potential flooding, and establishes plans and performs exercises to be prepared.

Table 4 presents an overview of the authorities involved in flood risk management in the Netherlands, their legislation and type of plans:

- Ministry of Infrastructure and Environment (I&E): development of water policy and policy on spatial planning on national level; within this ministry, the Directorate-General Rijkswaterstaat is responsible for the maintenance of the coastline, river bed and major flood defenses;
- Ministry of the Interior and Kingdom Relations (IKR): planning, preparation and execution of disaster management on national level;
- Provinces: spatial planning, water management planning on regional level;
- Municipalities: spatial planning and disaster management on local level
- Waterboards: water management, maintenance of flood defenses and disaster management related to flood defenses, all on regional level, funded by taxes paid by land owners and inhabitants of each dike ring;
- Safety regions: joint organizations of municipalities for coordinated disaster management and preparation on (sub-) provincial level.

**Table 4: Overview of the Authorities Involved in Flood Risk Management (Netherlands)**

	Prevention	Protection	Preparation	Response	Recovery
National Legislation	Spatial Planning Act (SPA)	Water Act (WA)	Safety Regions Act (SRA)		
Plans and Policy documents					
State	National Water Plan 2009-2015, I&E – <i>accent on protection</i> (WA), <i>also zoning scheme</i> (SPA)				
	National Spatial Strategy, I&E (SPA)				
		National Water Plan 2009-2015 National Flood protection programme, I&E (WA)			
			National floods crisis plan and large-scale evacuations, IKR (SRA)		
Province (12)	Provincial Water Plan (WA), <i>also zoning scheme</i> (SPA)				
Waterboard (26)	Water Management Plan (WA)		Flood Disaster Management Plan (WA)		
Safety region (25)			Crisis Coordination Plan (SRA), Disaster Management plan (SRA)		
Municipality (450)	Land use plan (SPA)				

#### 4.6.3 Interagency Regional Flood Risk Management Team Partnership, Upper Mississippi River Basin (United States)

The Interagency Regional Flood Risk Management Team (RFRMT) is the first interagency initiative to approach flood risk reduction from a holistic perspective, applied to a large regional watershed that is encompassed predominantly within five Midwestern states. The RFRMT was born out of successful application of the Interagency Levee Task Force (ILTF) that was formed under the leadership of the Corps of Engineers following the Upper Mississippi River Basin flood of June 2008, under authority previously provided by Congress, the Council on Environmental Quality, and the Office of Management and Budget in the Executive Office of the President. The historic approach by the Corps and other federal agencies has been to take the flood risk reduction lead through plans for construction of federal levees to protect flood-prone areas, contained within a specific state. The mandate of the ILTF was to ensure rapid collaborated flood recovery assistance bringing to bear the capability of all state and federal agencies, and to provide a quick analysis of potential non-structural measures that could be implemented in lieu of repair and rehabilitation of levees that have historic damage and repair trends.

The RFRMT continues to provide regional awareness for flood recovery, but has with greater emphasis integrated preparedness, response, and long-term mitigation to form its complete mission. By approaching flood risk reduction with this four-part, full-cycle philosophy, adoption of non-structural measures has become the primary focus for reducing flood risks, with shifting of leadership from the federal agencies to the state and local agencies. The true success of the RFRMT lies in the reversed leadership and responsibility paradigm that the states have responsibility to lead, and the federal agencies support.

The RFRMT carries no authorities for implementation of preparedness, response, recovery and long-term mitigation programs or projects, but rather acts as a tool to assist the states and federal agencies in applying their missions and programs to maximize flood risk reduction benefits. All



RFRMT members are afforded the opportunity to bring alternative flood risk reduction solutions before the full RFRMT. Through a risk identification, communication and analysis process issues are identified that pose challenges to implementation of solutions, and recommended revisions to regulations, policies, and practices are made by the RFRMT to appropriate national-level agencies for implementation to resolve the challenges.

Recommendations from the RFRMT have been instrumental in helping to re-shape the emphasis of flood risk management at the national level. A few key recommendations have been adopted to enable optimum leveraging of federal resources and programs, and several other recommendations are under review. The primary lesson learned from the Interagency Regional Flood Risk Management Team model is that fully-partnered flood risk reduction is achievable in a regional context if the local, state, and federal stakeholders are committed to shifting their leadership and flood risk reduction measures paradigms.

#### **4.6.4 Shared Responsibility and Public Participation in Flood Risk Management (United States)**

U.S. Federal agencies offer programs to assist states and communities in managing flood risks and promoting sound flood risk management, while the authority to regulate how land is used in floodplains and to enforce flood-wise requirements lies in the hands of state and local government. Table 5 shows the division of responsibilities in the United States and key authorities related to flood risk management.

Given the inherent shared nature of responsibilities and authorities, there is a growing understanding among Federal agencies that early and continuous public participation is key for Federal flood risk management-related programs and initiatives. Public participation allows Federal flood risk managers to incorporate the range of other factors, in addition to flood risk, that influence individual and community land use choices, such as fiscal security, public safety, and environmental quality considerations.

Both the U.S. Army Corps of Engineers and the Department of Homeland Security, Federal Emergency Management Agency (FEMA) have worked to incorporate public participation within their agency programs. In 2008, the Corps established its Conflict Resolution and Public Participation Center to support improved public participation in addressing water resource management issues. A key technique promoted by the Corps is Shared Vision Planning<sup>52</sup>, a collaborative modeling approach to water resources decision making. FEMA is likewise seeking to foster public participation through its RiskMAP program to update a nationwide portfolio of floodplain maps and develop related tools utilizing the mapping results to support local mitigation planning (see Section 4.6.7.)

Some of the challenges Federal agencies face in their efforts to expand public involvement in agency programs include:

- identifying opportunities to engage the public early in the decision making process and at each step in the decision making process,
- ensuring that the important, decision-relevant information enters the process and that residual risks are explicitly communicated,

---

<sup>52</sup> <http://www.sharedvisionplanning.us/>

**Table 5: Division of Responsibilities in the United States**

National – Legislation	Flood Control and Planning	<p>Flood Control Act (1936) (PL 74-738) <a href="http://www.corpsnedmanuals.us/FloodDamageReduction/FDRID008NatFldDamage.asp">http://www.corpsnedmanuals.us/FloodDamageReduction/FDRID008NatFldDamage.asp</a></p> <p>Watershed Protection and Flood Control Act (1954) (PL 84-566) <a href="http://www.fws.gov/laws/lawsdigest/WATRSHD.HTML">http://www.fws.gov/laws/lawsdigest/WATRSHD.HTML</a></p> <p>Water Resources Planning Act (1965) (PL 89-80) <a href="http://www.fws.gov/laws/lawsdigest/WATRES.HTML">http://www.fws.gov/laws/lawsdigest/WATRES.HTML</a></p> <p>Flood Control and Coastal Emergency Act (PL 84-99) <a href="http://www.nwk.usace.army.mil/Flood/FactSheets/PL84-99FactSheet.pdf">www.nwk.usace.army.mil/Flood/FactSheets/PL84-99FactSheet.pdf</a></p> <p>Water Resources Development Act of 2007 <a href="http://www.gpo.gov/fdsys/pkg/PLAW-110publ114/content-detail.html">http://www.gpo.gov/fdsys/pkg/PLAW-110publ114/content-detail.html</a></p>
	Flood Insurance	<p>National Flood Insurance Act of 1968 and Flood Disaster Protection Act of 1973 <a href="http://www.fema.gov/about/programs/nfip/index.shtml">http://www.fema.gov/about/programs/nfip/index.shtml</a></p>
	Disaster Assistance	<p>Robert T. Stafford Disaster Relief and Emergency Assistance Act (PL 93-288) (1988) <a href="http://www.fema.gov/library/viewRecord.do?id=3564">http://www.fema.gov/library/viewRecord.do?id=3564</a></p>
	Risk Management	<p>National Dam Safety Act (2002) <a href="http://www.fema.gov/plan/prevent/damfailure/ndsp.shtml">http://www.fema.gov/plan/prevent/damfailure/ndsp.shtml</a></p> <p>National Levee Safety Act (2007) <a href="http://uscode.house.gov/download/pls/33C46.txt">http://uscode.house.gov/download/pls/33C46.txt</a></p> <p>Disaster Mitigation Act (2000) <a href="http://www.fema.gov/library/viewRecord.do?id=1935">http://www.fema.gov/library/viewRecord.do?id=1935</a></p> <p>Post Katrina Emergency Management Reform Act (2006) <a href="http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=109_cong_bills&amp;docid=f:s3721is.txt.pdf">http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=109_cong_bills&amp;docid=f:s3721is.txt.pdf</a></p>
National – Plans and Policy Documents		<p>Presidential Executive order 11988, Floodplain Management (Federal actions) <a href="http://www.fema.gov/plan/ehp/ehplaws/eo11988.shtml">http://www.fema.gov/plan/ehp/ehplaws/eo11988.shtml</a></p> <p><i>Principles and Guidelines</i> for Water and Land Related Resources Implementation Studies <a href="http://www.usace.army.mil/CECW/Documents/pgr/pg_1983.pdf">http://www.usace.army.mil/CECW/Documents/pgr/pg_1983.pdf</a></p> <p>National Response Framework <a href="http://www.fema.gov/emergency/nrf/">http://www.fema.gov/emergency/nrf/</a></p> <p>National Disaster Recovery Framework <a href="http://www.fema.gov/recoveryframework/">http://www.fema.gov/recoveryframework/</a></p>
States		<p><i>Varies significantly by State, but includes:</i></p> <p>Dam Safety Plans (emergency action plans) (e.g., Wisconsin) <a href="http://dnr.wi.gov/org/water/wm/dsfm/dams/eap.html">http://dnr.wi.gov/org/water/wm/dsfm/dams/eap.html</a></p> <p>State Hazard Mitigation Plans (e.g., North Carolina) <a href="http://nccrimecontrol.org/Index2.cfm?a=000003,000010,001623,000177,001563">http://nccrimecontrol.org/Index2.cfm?a=000003,000010,001623,000177,001563</a></p> <p>State Flood Risk Management Plans (e.g., California FloodSafe Plan) <a href="http://www.water.ca.gov/floodsafe/">www.water.ca.gov/floodsafe/</a></p>
Local		<p><i>Varies significantly by locality</i></p> <p>Primary Responsibility for Land Use Regulation: Zoning Ordinances, Comprehensive Plans Municipality (e.g., City of Tulsa, OK <a href="http://www.cityoftulsa.org/city-services/flood-control.aspx">http://www.cityoftulsa.org/city-services/flood-control.aspx</a> )</p> <p>County/Regional (e.g., Denver area Urban Drainage and Flood Control District <a href="http://www.udfcd.org/">http://www.udfcd.org/</a>)</p>

- using participatory techniques that provide for interaction and deliberation, not just an opportunity to comment,
- collaborating closely with other Federal, state, and local entities to maximize what each agency can contribute to the public involvement effort,
- ensuring that all interested and potentially impacted groups and individuals – including minority, low income and tribal communities – have both the capacity and opportunity to offer meaningful and informed participation in all aspects of decision-making that could affect their community.

#### **4.6.5 Flood Hazard Map (Japan)**

The Ministry of Land, Infrastructure, Transport and Tourism (MLIT) and prefectural governments throughout Japan are constantly improving flood control facilities to reduce flood damage which occurs almost every year in many parts of the country. The target level of flood control, however, is not necessarily high and the work often requires a long period to complete. This situation makes it important to provide advance information on the possible flooding of rivers to local residents so that flood damage can be minimised even if flooding actually occurs.

Since FY 2001, the MLIT and prefectural governments regularly released their respective flood prone area maps indicating areas which are likely to experience inundation when a major river is breached and the likely flood depth as required by the Flood Fighting Act. The head of a municipality of which the administrative area includes a flood prone area prepared a flood hazard map and distributes a printed version to local residents. The principal purpose of this map is to prevent human casualties by means of providing information on possible breaches of embankments, flooding and evacuation. The map shows flood prone areas and the expected flood depth with additional information on how flood warnings are conveyed and evacuation sites and other matters which are necessary to ensure smooth and swift evacuation at the time of flooding. The responsibility for the preparation and distribution of a flood hazard map now falls on each municipality following revision of the Flood Fighting Act in FY 2005.

Other efforts of administrations to enhance public understanding of the danger of flooding and the importance of appropriate evacuation include the preservation and signage of evidence of past flooding and the real-time provision of river level information in the street. Another tool currently being promoted is the introduction of a "neighborhood hazard map" which indicates the expected flood depth in the "neighborhood" which forms a space for everyday life. This tool treats an entire local residential area as a hazard map so that residents can really understand the danger of flooding in the place in which they live.

The preparation of a flood hazard map by each municipality has clarified the problems to secure evacuation sites. The work is contributing to the improvement of disaster prevention plans as it has led to agreements with neighbouring municipalities to secure evacuation sites and also to the designation of privately-owned buildings as vertical evacuation sites.





#### 4.6.6 Indication of Flood Hazard Using High Accuracy Elevation Data (Japan)

The frequent localized heavy rain and extremely intensified rain in recent years have caused a series of flood damage and water accidents. Flood damage has been particularly frequent with small and medium rivers, lowland, underpasses, underground spaces and irrigation channels, making flood prevention measures at these places an urgent necessity.

The improvement of flood prediction is essential to cope with the localized but quickly emerging flooding. For this purpose, a new prediction model has been developed through the application of the distribution model analysis and detailed rainfall data provided by high accuracy radars. What is also important for the effective use of such high accuracy model is the availability of accurate elevation data for the target area.

Airborne laser surveying can obtain 5 m mesh high accuracy elevation data which can clearly indicate lowland and other micro-topographical features in a river basin. At present such high accuracy elevation data has been mainly established for Class A (large scale) rivers and is used to improve the accuracy of flood prediction. Moreover, the same data is publicly provided in the form of high accuracy elevation maps to assist river management, flood fighting activities and the preparedness of residents. High Accuracy elevation maps incorporate many innovative features, including the use of different colours to indicate different elevation ranges so that ordinary people can understand the micro-topography of their own areas.

High accuracy elevation maps for selected areas in Japan can be accessed through <http://disapotal.gsi.go.jp/seimitsu/index.html> (Japanese).

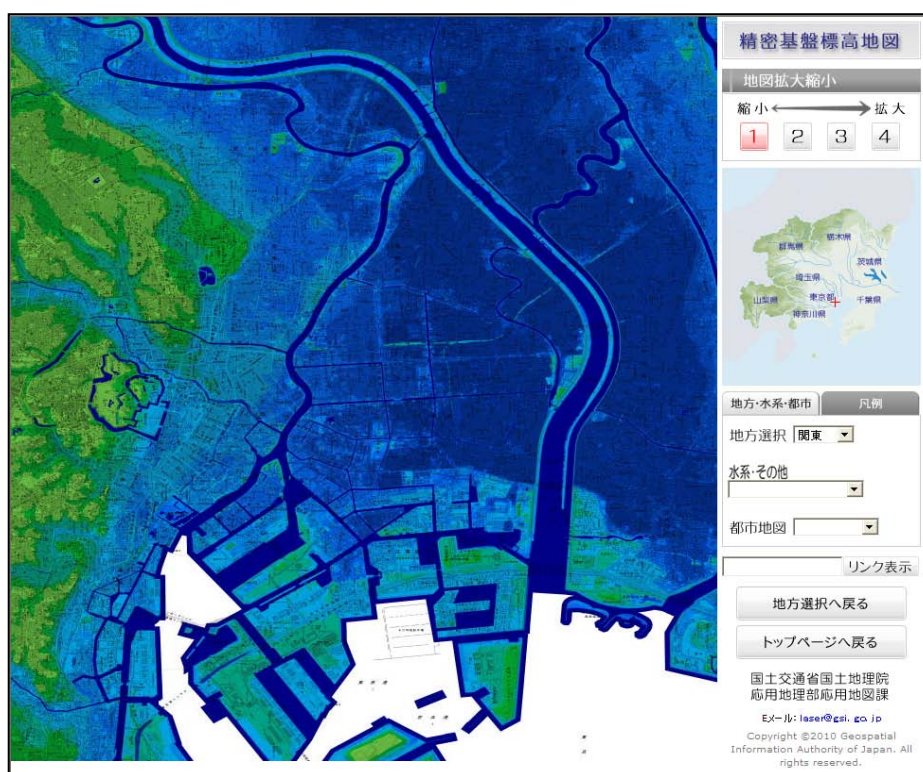
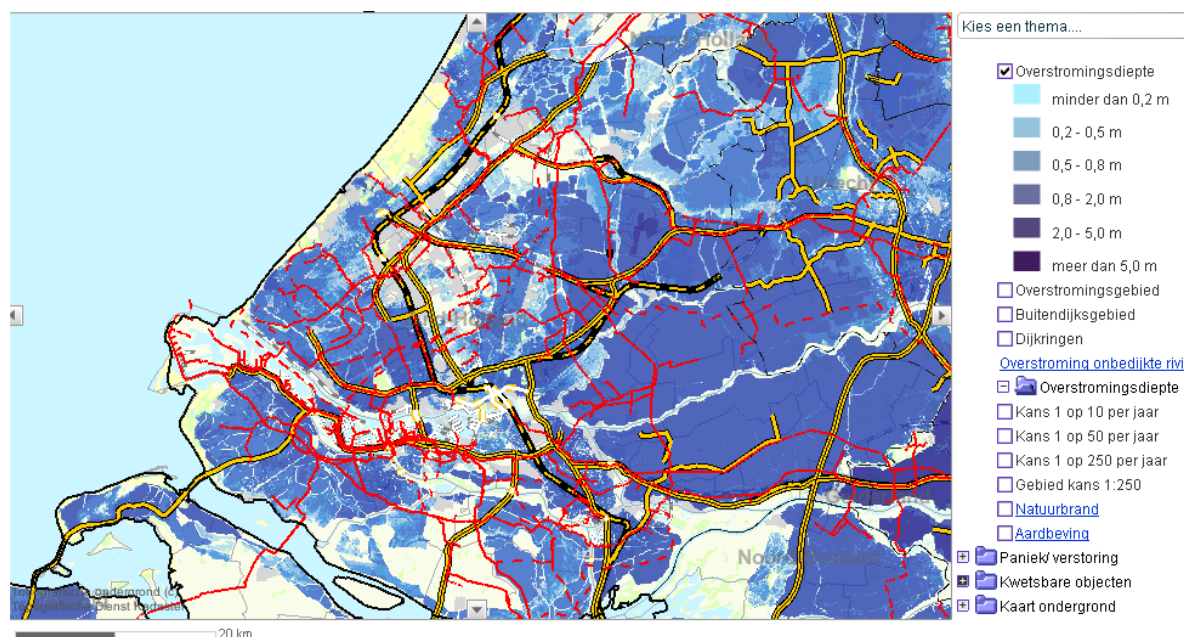


Figure 34: High Accuracy Elevation Data Map (Tokyo)

#### 4.6.7 Communication on Flood Risk (The Netherlands)

The Netherlands has a high level of protection against floods. As a result the actual occurrence of floods is very rare: in 1953 the south western coastal area became flooded, drowning about 1,800 people, whereas in 1995 peak discharges on the rivers Rhine and Meuse triggered the evacuation of 250,000 people, but actual dike failures and resulting flooding did not occur.

Related to the low frequency of flooding, flood awareness is relatively low. The government tries to increase flood awareness, especially for people living outside the protected areas. Since 2008 flood hazard (= extent and depth) maps are available on Internet, in combination with information on industrial risks (major accidents on industrial sites where hazardous materials are being handled and stored, transport routes of hazardous materials) and vulnerable objects.<sup>54</sup> The maps are combined with information on how to prepare and respond on floods.



**Figure 35: example of flood risk map of Rotterdam region on Internet. Maximum depth of flooding (blue) combined with highways (yellow), secondary roads (red) and railways (black-yellow)**

For professionals working in spatial planning and disaster management additional maps will become available in 2011 and 2012, presenting information on progress, rise rate of the water, duration of flooding, vulnerable public services, nature reserves, and potential sources of pollution by floods.

The preparation and distribution of flood hazard and flood risk maps occurs within the framework of the European Floods Directive.

#### 4.6.8 Flood Risk Communication (United States)

Communicating risk is a difficult task that can be achieved only through a spectrum of coordinated efforts. Since “risk” is a broadly-used general term, developing a common

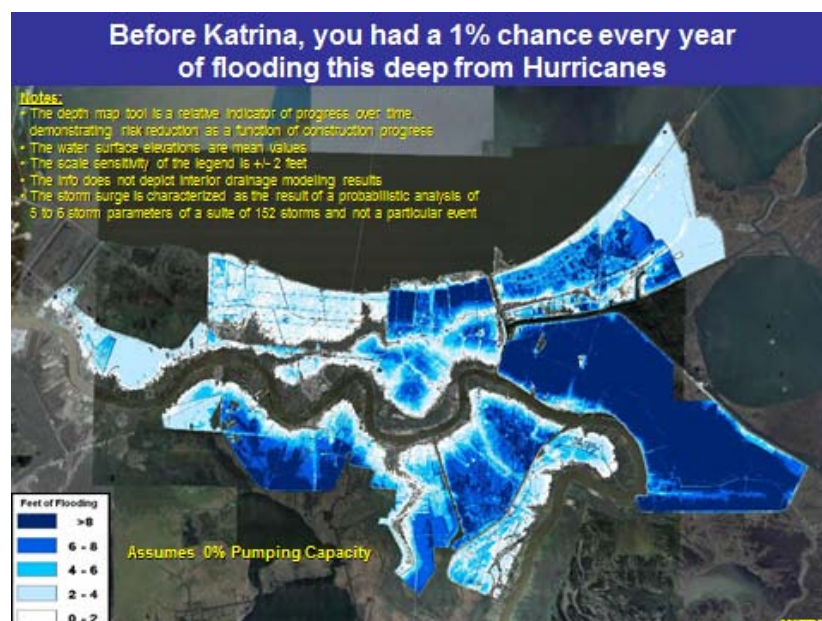
<sup>54</sup> <http://nederland.risicokaart.nl/risicokaart.html> (select: “overstroming”)

understanding of the content and context of the information available, and its appropriate (and inappropriate) uses, are essential. Local and national media and the internet are essential components for making information available to the broadest possible audience.

The U.S. government does not have a single, unified Federal risk communication plan; however, a variety of different Federal agencies engage in flood risk communication. For example, both the U.S. Geological Survey (USGS) and the National Oceanic and Atmospheric Administration (NOAA) administer programs communicating risk to support local flood emergency preparedness and response, including stream gauging, media-broadcast flood warnings, flood maps and monitoring sites. A key target for Federal risk communication efforts in the U.S. are the citizens and the state and local agencies that ultimately drive floodplain use choices and regulation. Communication of flood risk with this vast and highly diverse audience requires expanding the examination of flood risk beyond the traditional focus on hydrologic and hydraulic analyses, engineering studies and structure inventories, to explore the range of economic, social, cultural and behavioral factors that influence the individual and community choices that play a central role in determining flood risk.

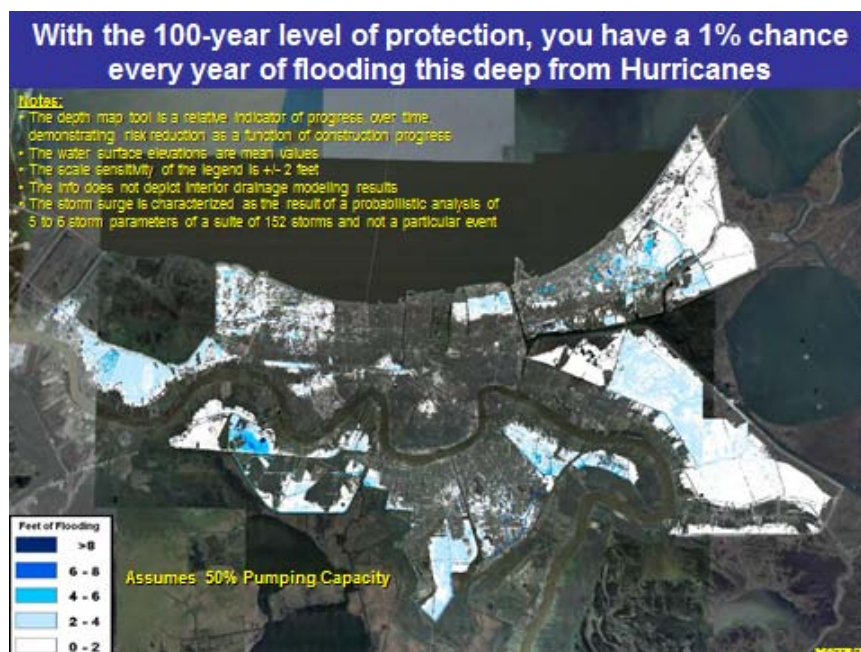
Quantitative estimates of vulnerability to flooding and potential losses (risk) are a powerful tool for creating a common understanding of the situation and the relative benefits of alternative approaches to manage or reduce risk. It allows the public to make individual decisions within their purview, provides more knowledgeable input for dialogue with public officials, and facilitates more focused discussions and collaboration among government agencies at all levels.

New Orleans is the first city in the U.S. to have risk and reliability maps that provide a comprehensive system assessment of the area's flooding risk. As part of the Corps' goal of communicating risk and assisting the public with risk-informed decision making, in 2007 the Corps of Engineers released risk maps showing the depth of flooding that could be experienced after it completed improvements bringing the Hurricane Protection System in New Orleans to a 1% chance of overtopping from surge and waves produced by a variety of hurricanes. The risk assessment that went into making these maps (see Figure 36 below) was fairly complex. The resulting product provided a critical piece of information for citizens in the New Orleans area to use in making informed decisions regarding their own particular set of conditions.



**Figure 36a: Risk Map Showing 1% Chance of Flooding With Pre-Katrina Conditions**





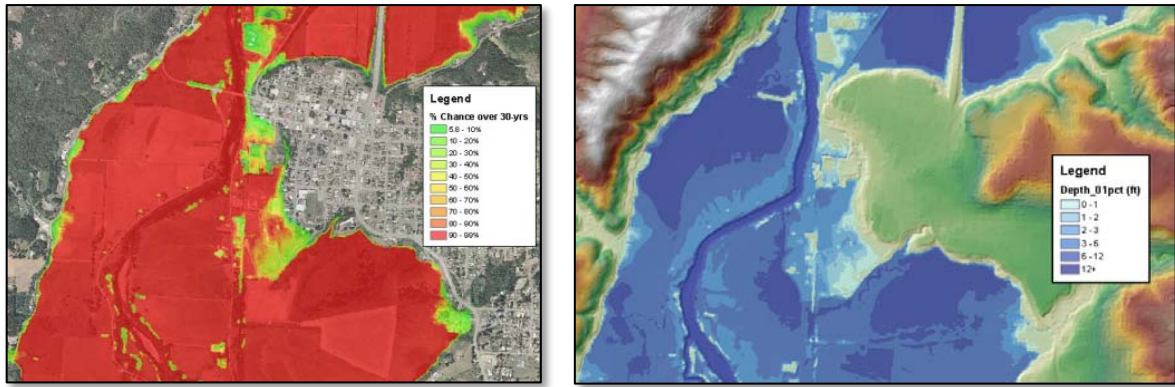
**Figure 36b: Risk Map Showing 1% Chance of Flooding With HSDRRS in Place and 50% Pumping Capacity**

On a national scale, the Federal Emergency Management Agency's flood insurance rate maps showing the 1% annual chance flood in approximately 20,000 communities have been available for decades, increasing awareness of flood hazards as part of the National Flood Insurance Program (see Section 4.7.2). Building on flood hazard data and maps, the U.S. Federal Emergency Management Agency (FEMA) recently initiated Risk Mapping, Assessment, and Planning (Risk MAP). The Risk MAP program<sup>55</sup> provides communities with flood information and tools they can use to enhance their risk mitigation plans and take action to better protect their citizens. Through more precise flood mapping products, risk assessment tools, and planning and outreach support, Risk MAP strengthens local ability to make informed decisions about reducing risk.

As part of the Risk MAP Program, FEMA has developed a set of strategies, products, and services to address mapping, assessment, and planning needs related to flood risk study prioritization, elevation data acquisition, a watershed-based study approach, engineering and mapping methods, flood risk assessment, mitigation planning support, and risk communications. Two key products in this suite are the Flood Depth and Analysis Grids and the Flood Risk Assessment.

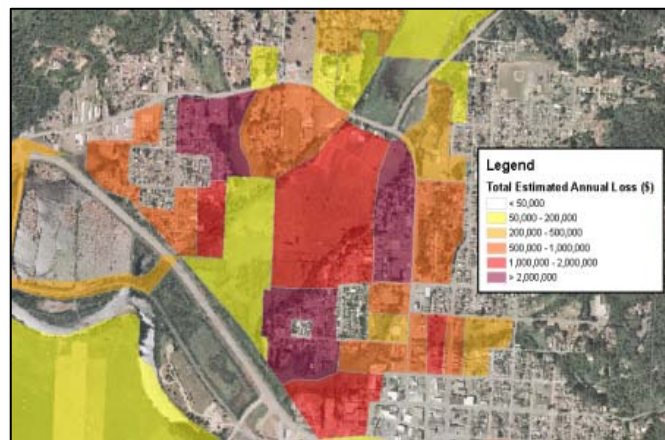
Flood Depth and Analysis Grids (see Figure 37 below) help communities better understand their flood hazard and risk in the mapped floodplain by mapping water depths for flooding events of varying severity. Depth Grids are produced for the 10%, 4%, 2%, 1%, and 0.2% annual chance flood events. The analysis grids can be used to create additional analyses that depict the percent annual chance of flooding and the percent chance of flooding over a 30-year time period in the floodplain.

<sup>55</sup> [http://www.fema.gov/plan/prevent/fhm/rm\\_main.shtm](http://www.fema.gov/plan/prevent/fhm/rm_main.shtm)



**Figure 37: Example Flood Depth and Analysis Grid**

Flood Risk Assessments (see Figure 38 below) are developed using HAZUS, a nationally applicable, standardized methodology containing models for estimating potential losses from earthquakes, floods, and hurricanes. Flood risk assessments help guide community mitigation efforts by highlighting areas where risk reduction actions may produce the highest return on investment. Building on the foundation of the 2010 nationwide HAZUS Level 1 Average Annualized Flood Loss Study, basic refined HAZUS loss estimation analyses can be performed for flooding sources with default HAZUS building stock information. Where additional local building data is available, enhanced HAZUS or other risk assessment analyses are possible. The results of both the basic refined and enhanced HAZUS analysis can be incorporated into community or state hazard mitigation plans.



**Figure 38: Example Flood Risk Assessment Information**

#### **4.6.9 Federal Interagency Floodplain Management Task Force (United States)**

The large geographic extent of the country’s flood risks, and the large number of federal agencies with a role in water management, make inter-agency coordination critical. The Federal Interagency Floodplain Management Task Force, established in 1975 to develop a unified national program for floodplain management, reconvened in 2009 to align the efforts of a dozen U.S. member agencies. The task force has been exploring the most significant benefits associated with floodplain management, and obtaining the perspectives of stakeholders on how these challenges can be addressed, in order to more effectively protect resources and reduce hazards to people and property. Its vision is that “the economic, environmental, and societal values of

floodplains are protected and flood-prone communities are resilient and sustainable.” To meet this vision, the Task Force established three overarching goals:

- **Public Safety:** Protect lives, property, and cultural assets through effective implementation of sound floodplain management programs and policies by all federal agencies.
- **Sustainment of the Nation’s Floodplain Resources, Functions, and Services:** Protect and restore the natural resources and beneficial functions of floodplains, and the services they provide.
- **Economic Vitality:** promote and sustain economic benefits of floodplains with minimal degradation to the natural environment while limiting flood risk.

Further information about the Task Force, including a link to work plan, is available on its website<sup>56</sup>.

## **4.7 Financial Aspects**

- 4.7.1 USA: Watershed Investment Decision Tool
- 4.7.2 USA: Involving Cost-Sharing Partners
- 4.7.3 USA: Flood Insurance in the U.S.
- 4.7.4 UK: Flood Insurance in the UK

### **4.7.1 Watershed Investment Decision Tool (United States)**

The U.S. Army Corps of Engineers’ Institute for Water Resources is investigating an alternative approach to evaluating flood risk based on combining disparate geospatial data layers, at the national level, to provide decision makers with a broad scale view illustrating the potential risk of flooding based on environmental, economic, and social factors. These spatial data layers are uploaded from various on-line locations and then combined using statistical techniques and decision support logic that allows these independent layers to be linked to show previously unknown areas of concern. These layers are also being combined with climate change scenarios to identify future areas of risk, and regions where strategic improvements in flood protection can provide important benefits. The system is scalable between national and regional areas of interest. The system under development is designed to assist decision makers with strategic deployment of resources to improve program performance. This program will support decision making, in part, because it is designed to be operated by the decision maker rather than Geographic Information System support staff. It is intuitive, and decision makers can easily conduct analysis of complex data and distil these layers down to a single summary, or a set of results based on multiple alternative scenarios. Although development is in its early stages, the Institute is consulting with other federal agencies to share information, identify possible enhancements, and create awareness for potential multiple agency use. The benefits of this system are twofold: 1) to allow decision makers to evaluate for themselves multiple scenarios for determining flood risk at a watershed scale and 2) to present areas for future investment of federal and local resources.

---

<sup>56</sup> [http://www.fema.gov/business/nfip/fifm\\_task\\_force.shtm](http://www.fema.gov/business/nfip/fifm_task_force.shtm)

#### **4.7.2 Involving Cost-Sharing Partners (United States)**

A realistic look at the future U.S. federal budget shows it will be increasingly consumed by healthcare costs, social security, and interest payments on the national debt. State and local government funds are being similarly squeezed. Clearly, prospects for Federal aid are diminishing, and states cannot run deficits. For example, the U.S. Army Corps of Engineers' Civil Works Construction Appropriation has decreased in real terms over time; operations and maintenance funding has remained constant, but it is usually allocated to aging and newly completed projects.

Outside government, both philanthropic and corporate entities are looking for good investments. Additionally, other organizations could provide further relief. This has led to considering Public-Private Partnerships (PPPs) as a potential solution to financial constraints and a means to improve overall efficiency and effectiveness. PPPs can be generally defined as a contractual agreement between a public agency (federal, state or local) and a private sector entity. The skills and assets of each sector (public and private) are shared in delivering a service or facility for the use of the general public, and each party shares in the risks and rewards potential in the delivery of the service and/or facility (after National Council for Public-Private Partnerships, 2008). For governments, PPPs are a mechanism for accomplishing missions through leveraging private resources and expertise. Healthy competition, full-cost pricing, the right balance along with the appropriate activities are essential. Increasing use of PPPs is occurring by U.S. federal agencies, states, and sponsors in areas such as utility and highway construction and operation, with primary motivation including shifting the cost burden from government to private and achieving increased efficiency.

Particularly with its inherent nature of shared responsibility in the United States, flood risk management offers potential for PPPs. PPPs could substitute for the Federal role from studies to construction, operations, maintenance, and financing. Sharing risks is an important consideration. Some experts believe PPPs must be engaged to assist in national levee protection because the needs are too great for just the government to meet, although any continuing governmental liability must be considered. However, PPPs must be appropriate to the circumstances, and potential negative aspects must be taken into account. For example, smaller and/or poorer communities may have more difficulty in making cost-sharing arrangements, and this must also be taken into consideration. In addition, certain aspects are inherently governmental.

#### **4.7.3 Flood Insurance in the U.S. (United States)**

In 1968, the U.S. Congress created the National Flood Insurance Program (NFIP) to help provide a means for property owners to financially protect themselves. The NFIP offers flood insurance to home-owners, renters, and business owners if their community participates in the NFIP. Participating communities agree to adopt and enforce ordinances that meet or exceed U.S. Federal Emergency Management (FEMA) requirements and to reduce the risk of flooding.

The NFIP is administered by FEMA, which works closely with nearly 90 private insurance companies to offer flood insurance at set rates. Flood insurance rates depend on many factors, including the date and type of construction and the structure's level of risk. Flood insurance protects two types of insurable property: building and contents. Land is not covered. A lender can require flood insurance, even if it is not federally required.

FEMA has published almost 100,000 individual Flood Insurance Rate Maps to show the locations of high-risk, moderate-to-low risk, and undetermined-risk areas. High-risk areas, known as Special Flood Hazard Areas, have at least a 1% annual chance of flooding, equivalent to a 26% chance of flooding during a 30-year mortgage. All homeowners in high-risk areas with mortgages from federally regulated or insured lenders are required to buy flood insurance. Flood insurance is recommended but not required in other areas. The average cost of a \$100,000 flood insurance policy is approximately \$500 annually, but can vary from hundreds to thousands of dollars. Rates depend on several factors including the date and type of construction as well as the area's level of risk.

FEMA has engaged in a comprehensive effort to address the concerns of a wide array of stakeholders about the National Flood Insurance Program. A multi-phase process considered the largest breadth of public policy options in order to ensure that the program can efficiently and effectively meet the needs of the public. Listening sessions captured stakeholder concerns and recommendations. A working group conducted analyses, developed evaluation criteria, and created policy alternatives. The U.S. Congress is currently considering the National Flood Insurance Reform Act (passed by the House of Representatives July 15, 2011). Key provisions of the act include (1) a five-year reauthorization of the National Flood Insurance Program, (2) a three-year delay in the mandatory purchase requirement for certain properties in newly designated Special Flood Hazard Areas, the officially-designated area of the 1% chance flood, (3) a phase-in of full-risk, actuarial rates for areas newly designated as Special Flood Hazard, (4) a reinstatement of the Technical Mapping Advisory Council previously established by Congress to provide recommendations to FEMA on how to improve the accuracy, quality, distribution, and use of its flood insurance rate maps, and (5) an emphasis on greater private sector participation in providing flood insurance coverage.

#### **4.7.4 Flood Insurance in the UK (United Kingdom)**

In the UK, flood insurance is currently provided through the private market, as a standard component home and contents insurance policies. The vast majority of properties in the UK are therefore covered by flood insurance, including properties in areas which are considered to have a significant risk of flooding.

Members of the Association of British Insurers (ABI), accounting for over 90% of the insurance market in the UK have an agreement in place with the Government known as the *Statement of Principles*. This agreement commits:

1. ABI member companies to:

- Continue to make flood insurance available for domestic properties and small businesses where the risk of flooding is not significant (1.3% or 1 in 75 annual probability);
- Continue to offer flood cover to existing domestic property and small business customers at significant flood risk providing the Environment Agency has announced plans and notified the ABI of its intention to reduce the risk for those customers to below 'significant' within five years;
- Continue to offer cover to the new owner of any applicable property subject to satisfactory information about the new owner.

2. The Government to:

- Put in place a long-term investment strategy setting out flood prevention aims and assessing future policy options and funding requirements;
- Ensure that the planning system prevents inappropriate development in flood risk areas;
- Improve the understanding of flood risk by making publicly available better flood risk information.

The Statement of Principles was originally put in place in 2000 and was only intended as a temporary measure to secure cover for properties at flood risk until that risk could be mitigated. However as understanding of flood risk has improved it has become clear that significant flood risk in the UK cannot be completely removed, even if the Government invests heavily. This is particularly relevant because of the likely increase in the frequency and magnitude of flood events due to climate change.

It is not appropriate for the Statement of Principles to continue in the long-term. The agreement distorts the market for insurance because new entrants to the market have no obligations to continue cover and can avoid offering insurance in areas which they know are at higher risk of flooding. In addition, existing insurers are committed to continuing to offer cover in high-risk areas, putting them at a commercial disadvantage. The agreement also restricts the opportunity for a specialist insurance market to develop in high flood risk areas, and reduces the incentive for property owners and local communities to invest in managing their flood risk.

Therefore, although insurers will continue to honour their Statement of Principles commitments until 2013, the Statement of Principles will not be renewed beyond that point.

Nevertheless, the ABI wants to ensure that flood risk is managed effectively and that as many people and businesses as possible can continue to obtain competitively priced home and business flood insurance to protect themselves from the financial cost of flooding. To this end they are working closely with the UK Government to lay the foundations for a long-term solution to managing flood risk in the UK to develop a shared approach to flood risk management that shares responsibility between Government, consumers and insurers.

Investment in flood defenses is a key aspect of managing flood risk in the long term. A major part of the ABI's work with the Government is seeking to provide certainty to insurers that they will continue to provide adequate funds to manage flood risk effectively. The new National flood risk management strategy for England provides a very positive step forward. The ABI is also concerned about building on flood plains and is keen to ensure that the planning system is rigorous enough to prevent unsuitable developments being built in flood risk areas.

## **4.8 Research and Education**

- 4.8.1 USA: Research and Development / Technology Transfer
- 4.8.2 The Netherlands: Expertise Network on Flood Protection
- 4.8.3 USA: Education and Credentialing

### **4.8.1 Research and Development / Technology Transfer (United States)**

The U.S. Army Corps of Engineers supports flood risk management activities of communities in both urban and rural areas throughout the United States, including by operating projects that



reduce flood risk, conducting emergency management activities, and studying and implementing flood risk management measures at the direction of Congress. Over the years the Corps has significantly reduced the impacts of floods by implementing measures such as dams, levees and floodplain management activities.

One way the Corps advances these techniques and programs is through its Civil Works Research and Development (CW R&D) program. The CW R&D program allows the Corps to develop new products, procedures and programs that meet the changing needs of the country by utilizing new science and technology. For example, over 15 years ago, the Corps created a piece of software, HEC-FDA (Hydrologic Engineering Center - Flood Damage Reduction Analysis), that is used to perform a risk analysis of its projects looking at uncertainties in hydrology, hydraulics and economics. This tool has been used extensively to evaluate flood risk management alternatives and to evaluate project performance. Understanding the need to create an even more comprehensive flood risk management tool, the CW R&D program began investing into HEC-WAT/FRM (Watershed Analysis Tool with the Flood Risk Management Option), which includes a systems approach to risk analysis, event-based sampling, the ability to do scenario analysis, and structure-by-structure, cost, non-structural, loss-of-life, and agricultural damage analysis. HEC-WAT/FRM includes sampling and solution techniques, uncertainty definitions, and system-wide component fragility and performance interactions/relationships for complex riverine systems. The new tool can be used nationwide for levee certification, levee assessment, planning and design studies and advances the Corps' modeling approach for risk analysis. The tool will accommodate many recommendations from the National Research Council report (2000) on the Corps' implementation of risk analysis for flood damage reduction. It will also aid in helping to set a new direction within the Corps that includes a fresh look at how it implements risk analysis. Similar risk analysis software, Beach-FX, has been created for the coastal environment.

In addition to creating software, many physical products have been developed and enhanced over the years. The I-wall studies performed at the Engineer Research and Development Center after Hurricane Katrina is an example of the type of research and development the Corps conducts to help reduce the flood risk to communities. There are many other examples of this type of research but one other of note is the vegetation on levees research. The idea is to see if trees have a detrimental effect on the structural integrity of a levee. It is important to determine if the trees strengthen or weaken the levee itself and determine if they pose risk during a flood for flood fighting. The Corps' National Flood Risk Management Program helps to integrate and synchronize the Corps flood risk management activities, both internally and with counterpart activities of the Department of Homeland Security, Federal Emergency Management Agency (FEMA), other Federal agencies, State organizations and regional and local agencies. One such collaborative effort between FEMA and the Corps is the development of new floodplain mapping capabilities for the efficient production of floodplain maps that can be used for Emergency Action Planning which will improve public awareness and comprehension of flood hazards and risk.



### 4.8.2 Expertise Network on Flood Protection (The Netherlands)

The Expertise Network for Flood Protection (ENW)<sup>57</sup> is a platform bringing together specialists in the area of flood protection provides an address for guidelines and technical reports in this field. The ENW pays particular attention to the development of the expertise necessary for keeping the Netherlands safe from flooding both now and for many years in the future.

The objective of the ENW is to combine and develop knowledge on the subject of flood protection. The activities of the ENW are a continuation of the work done by the Technical Advisory committee for Flood Defence (TAW).

The ENW focuses on expertise for flood protection in its widest sense. Its activities cover both physical water management and social aspects, both for primary and regional flood defense systems. To meet its objectives, ENW has the following functions:

- Keeping guidelines and technical reports up-to-date;
- Drawing up a research agenda for flood protection;
- Quality assurance for research, knowledge development and policy development;
- Providing advice on flood protection on request;
- Identifying possibilities for the improvement of policy development or delivery.

#### **Organization**

The ENW consists of a core group and four workgroups. In addition, temporary workgroups and feedback groups can be set up, usually in relation to a particular project. The core group is the external contact point for the ENW, specifies ENW products and sets priorities as necessary for the activities of the ENW. The core group also correlates the activities of the four workgroups.

The workgroups concentrate on four themes: Safety and Flood Risk approach, Technology, Rivers and Coast. Each workgroup fulfils the functions of the ENW in relation to its own theme. Examples of activities are: supervising research, keeping abreast of new developments, providing quality assurance and contributing ideas to projects within their field of attention. Workgroup chairmen are members of the core group.

On the ENW website several publications can be downloaded<sup>58</sup>.

### 4.8.3 Education and Credentialing (United States)

Risk management incorporates the reduction of an array of initial risks related to critical infrastructure. The Flood Risk Management Program focuses on integration and synchronization of the ongoing, diverse flood risk management projects, programs and authorities of the Corps with projects, programs and authorities of FEMA and other federal and state and local agencies. It combines disciplines to adequately address the numerous issues and challenges related to buying down the risk within the construct of flood risk management. To this end, the Corps is committed to developing and sustaining its work force by engaging emerging talent through University

---

<sup>57</sup> <http://www.enwinfo.nl/asp/uk.asp?documentID=110>

<sup>58</sup> <http://www.enwinfo.nl/asp/uk.asp?DocumentID=112&niveau=1>

outreach programs. This commitment to education fosters an environment that cultivates and sustains an energetic and motivated work force of expertise. The Student Career Employment Program (SCEP) is one such program that offers opportunities for aspiring talent to work in career fields targeting their own expertise while leveraging existing government programs. Student-Corps work collaborations target key positions while students complete their degree course work. The opportunity then exists to non-competitively place them in permanent Government Service jobs. Additionally, the credentialing of this work force provides a consistent and reliable process for preparing and utilizing personnel with specific skill sets and experiences for the jobs required. The process of credentialing provides current and prospective team members and supervisory personnel with a clear understanding of position-specific requirements and the knowledge, skills, and abilities needed to advance in their positions. It is the intent of the Corps to provide accessible and concise guidelines for each position across the Corps' Risk Management Directorate. As a result, the Corps has clear visibility as to the qualifications required for recruiting the right people for the right jobs.

A non-governmental example is The Association of State Floodplain Managers' (ASFPM's) national program for professional certification of floodplain managers<sup>59</sup>. The Certified Floodplain Managers program recognizes continuing education and professional development that enhance the knowledge and performance of local, state, federal, and private-sector floodplain managers. The formation of a professional certification program is recognized as an effective means to:

- Formalize a procedure to recognize and provide an incentive for individuals to improve their knowledge of floodplain management concepts;
- Enhance individual professional development goals;
- Promote an understanding of relevant subject matter that is consistent nationwide;
- Convey new concepts and practices; and
- Build partnerships among organizations and agencies that share the goal of advancing sound floodplain management.

ASFPM has recognized over 7,000 individuals as Certified Floodplain Managers (CFM) eligible to use the CFM title in their professional work.

---

<sup>59</sup> <http://www.floods.org/index.asp?menuid=426&firstlevelmenuid=180&siteid=1>

## 5 Topics for Collaborative Action and Research

Each country seeks the best approach to managing its own particular flood risks, taking into account its resources, governance, and culture. For countries in similar circumstances, however, partnerships can provide opportunities for a mutually expanded base of experience and joint exploration of issues of concern.

This chapter highlights a few such partnerships, including recent policy-oriented discussion (Section 5.1), opportunities taken to learn from flood exercises and flood disasters in other countries (Section 5.2), international development of a levee manual (Section 5.3), and international sharing of best practices on storm surge barriers (Section 5.4).

### 5.1 *2010 International Policy-Oriented Discussions*

Approximately 100 people from nearly 20 countries participated in international policy-oriented discussions on flood risk management approaches November 30 and December 1 in Washington, D.C. The two days of discussion, hosted by the U.S. Army Corps of Engineers in conjunction with the Federal Emergency Management Agency and international steering committee partners, focused on flood risk management approaches internationally and emphasized the movement from theory to practice. Most participants were government officials responsible for developing policy and practicing flood risk management. Participants shared their progress in developing and implementing flood risk management approaches, learned what others have accomplished internationally and identified the strengths of those achievements, and highlighted areas where partnerships can provide mutual advantage. A synthesis of discussions, as well as presentations made during those discussions, is available at <http://www.nfrmp.us/ifrma/index.cfm>.

During the discussions, participants identified specific actions that would be useful to undertake through international partnerships. These included:

- Comparing means of prioritize investments in flood risk reduction (tools, case studies)
- Extending invitations to other nations to participate in flood exercises, development/assessment of flood exercises
- Determining non-intrusive means of observing and learning from other nations' floods
- Building common terminology
- Examining different attitudes/expectations in build concepts of self-reliance
- Revisiting definitions of resilience to address not just structural, but also social aspects
- Turning to land use planners to build personal disinclination to live in hazardous areas
- Bringing climate change research from global to regional levels in order to develop interim measures for addressing impacts
- Developing ways to value environmental functions and benefits
- Furthering visualization tools to better communicate risk, bridge the technical/public divide
- Bolstering political fortitude to take a long-term view
- Clarifying objectives for flood risk management programs
- Clarifying and communicating relationship between who benefits and who pays, particularly to inform public policy-making

## 5.2 Learning from Other Countries

5.2.1 The Netherlands: Learning from Floods That Happen in Other Countries

5.2.2 The Netherlands: Learning from Other Countries' Flood Exercises

### 5.2.1 Learning from Floods That Happen in Other Countries (The Netherlands)

Although flood management approaches in other countries are different from the one in the Netherlands, important lessons can be learned. The flood in New Orleans caused by hurricane Katrina, for example, served as a wake-up call for the Netherlands. Questions were asked whether we are we prepared if such a catastrophic disaster happens in our country? Should we not give more attention to disaster management than primarily to flood protection? Should we evaluate our current flood protections standards which date from the 60s? In general: lessons can be learned from floods abroad.

Two examples are given how information after a flood was gathered, analyzed and conclusions (lessons learned) were drawn and made available in the Netherlands:

- New Orleans (2005);
- Atlantic Coast, France (2010)<sup>60</sup>

New Orleans in 2005 and France in 2010 are examples of events which can help the Netherlands to stay alert. The Delta Programme will give our flood protection an additional boost. This is unique: for the first time in Dutch history this kind of boost is given without a prior (near) flood disaster.

#### New Orleans (2005)

Two years after hurricane Katrina flooded large areas of New Orleans, a team of five consultants of HKV and one employee of the Delft University visited the city (for 6 days). The six were driven by a professional curiosity, since the trip was not sponsored by a governmental agency in the Netherlands(!). They interviewed professionals as well as residents. Although some contacts were already made before the trip (U.S. Army Corps of Engineers and an insurance company), most appointments were made during their visit (with some help from the employees of the welcome center). The appointments with residents were arranged by friends, neighbors, etc., of one of the consultants who worked in New Orleans at that time.

Two years after the flood many documents, articles and information on websites were available, the flood was still on the people's minds and they were willing to share information. The latter would possibly be harder when more time would have passed since the tragedy.

The information gathered and conclusions drawn were published in the book *Twee jaar na Katrina – de catastrofale overstroming van New Orleans* (in Dutch). The knowledge gathered and contacts made resulted in improved preparation on floods culminating in a nationwide exercise in 2008 (see Section 5.2.2).

---

<sup>60</sup> On the 28th of February 2010 at 2 a.m. the storm Xynthia hit the French Atlantic coast. The storm surge combined with the high tide and large waves caused flood defences to fail along the coastline from the Gironde (Bordeaux) to the Loire Estuary. A significant amount of land (>50 000 ha) was consequently flooded and 47 people died as a result of the storm.

## **France (2010)**

The Netherlands can learn from this flood in a neighboring country with a common history and legal system. In combination with the fact that coastal flooding is rarer than riverine flooding and large parts of the Netherlands are also prone to coastal flooding, this flood received a more than average interest among professionals in the Netherlands.

An employee of Rijkswaterstaat, being personally involved since family lived in the flooded area, gathered information from the French television and internet (from day one) during one month. He travelled twice to the flooded area: after three and five months. The second time a levee expert from Rijkswaterstaat accompanied him. Pictures were taken and experts (not managers!) from several governmental agencies were interviewed. The conclusions drawn from what he read, saw and heard were reviewed by two of the experts he interviewed. Without such a review, conclusions drawn from a flood abroad are less useful<sup>61</sup>.

The information gathered and conclusions drawn are written down in a book, which had been translated into English (and French): *Learning from French experiences with storm Xynthia - Damages after a flood*<sup>62</sup>.

### **5.2.2 Learning from Other Countries' Flood Exercises (The Netherlands)**

One of the lessons the Netherlands learned from Hurricane Katrina was not to focus only on flood protection but on emergency management as well. In September 2008 the (large scale) flood exercise *Waterproef* took place. As a result of the cooperation between the United States and the Netherlands<sup>63</sup> (since Katrina) observers were invited. They were consulted during the preparation of the flood exercise as well. The delegation from the United States observed the decision-making in Rotterdam-Rijnmond area, the evacuation in Zwijndrecht and levee reinforcement in Vianen. Their findings were reported and discussed with our Ministry of Internal Affairs and the Ministry of Public Works and Water Management and other involved stakeholders.

## **5.3 International Levee Handbook**

A consortium of professionals from six participating countries including the United Kingdom, Ireland, Germany, the Netherlands, France and the United States are coordinating development of an International Levee Handbook. Levees to defend against flooding remain a critical part of flood risk management. The effects of ongoing climate and socio-economic change have been exemplified by the serious disasters in recent years in the United States (Hurricanes Katrina and Rita) and France (Tempête Xynthia), where extensive loss of life and property damage occurred following levee failures or overflows. The team has identified the need for a new comprehensive guidance handbook, written by experts and practitioners, to enable mutual lesson-learning among the participating countries in the project consortium. Work is currently ongoing and is expected

---

<sup>61</sup> The Pakistan 2010 flood for example, was not studied since no contacts with local experts could be made.

<sup>62</sup> <http://www.rijksoverheid.nl/documenten-en-publicaties/rapporten/2010/09/01/learning-from-french-experiences-with-storm-xynthia-damages-after-a-flood.html>

<sup>63</sup> A Memorandum of Agreement between US Army Corps of Engineers and Rijkswaterstaat was signed, but there has been also cooperation between universities about disaster management.

to be completed in 2013. The primary intent of the development of an International Levee Handbook is to learn from one another's experiences and share in the effort of producing good practice guidance resource. A website is available at <http://leveehandbook.net/>.

## **5.4 *International Best Practice on Storm Surge Barriers***

In 2006 organizations in the UK, the Netherlands, Italy and Russia established an international network to share experience and transfer knowledge on the operational and functional management of large movable storm surge barriers. The main aims of the network are to optimize and foster innovation in their management of barriers, support the exchange of information, and work together on common issues for example responses to climate change, sea level rise and the development of flood warning systems. This aim is being achieved through a network which functions as a meeting place for storm surge barrier managers. Participating organizations in the network include: the Environment Agency (United Kingdom), Rijkswaterstaat (Netherlands), Groot Salland Water Board (the Netherlands), Magistrato alle Acque di Venezia (Italy), Consorzio Venezia Nuova (Italy), Rosstroy (Russian Federation), Saint Petersburg City Administration (Russian Federation).

The network fosters the sharing of knowledge and experience on many themes, but in particular this focuses on four main areas:

- general management,
- asset management,
- operational management and maintenance, and
- policy issues.

Since the network was formed in 2006, a wide range of activities have taken place and are ongoing. These include:

- Annual conferences, enabling barrier managers and employees of relevant organizations to meet and discuss topics of common interest
- Bilateral activities, including exchange visits between countries involved in the network to share information and knowledge
- Workshops (often held in conjunction with the annual conference) to discuss key topics such as probabilistic assessment and management and the role of private and public parties in barrier management.
- Field trips to learn about the functioning of barriers. These have included visits to see maintenance works on the Ramspol Barrier (The Netherlands) and a field trip to the St. Petersburg barrier.
- Joint studies, for example work carried out by the UK and the Netherlands on joint reliability studies to establish a more common standard in reliability analyses of the storm-surge barriers and to obtain more effective exchange of expertise. Other work carried out in 2008/2009 compared purchasing strategies for storm surge barriers.



- Exchanges, such as two employees coming from the City Administration of St. Petersburg in 2006 to the Netherlands for a coastal zone management course at IHE, and a traineeship at Rijkswaterstaat. The Environment Agency and Rijkswaterstaat are now working on an exchange program between employees from different organizations.

The development of the network has also fostered the exchange of knowledge and practical information between members on a daily basis, for example by phone or email. The network has also established a website<sup>64</sup> which provides access to a wide range of information on surge barrier management.

---

<sup>64</sup> [www.networkbarriermanagers.com](http://www.networkbarriermanagers.com)



## 6 Conclusion

Countries around the world are working to better orient flood management approaches and practices to flood risk realities. Recent catastrophic events such as 2005's Hurricane Katrina in the United States, 2010's flood disaster in Pakistan, and 2011's Great East Japan Earthquake in Japan provide painful reminders of the size and scope of possible disasters and the suffering they cause, while the anticipated effects of climate change underscore the potential for future catastrophes. The four countries collaborating on this document have significant risk-oriented efforts underway, and believed they could gain by building on previous collaborative efforts and by sharing information.

Commonalities are striking. Despite their varied histories and circumstances, the four countries face similar key challenges. These include adapting to new understandings of risk that take into account the impacts of climate change, bridging gaps between land-use decisions and flood risk management considerations, effectively communicating risk to the general public in a way that promotes individual as well as societal responsibility, and aligning planning and actions to identify and meet the most critical risks within a framework that is socially, environmentally, economically, and politically acceptable.

Within the context of their particular flood risks, institutional structure and history, the four countries have taken many similar approaches to address these challenges. All are examining the implications of climate change on not only flood threats but also vulnerabilities and consequences. The Netherlands and the United Kingdom have analyzed anticipated national flood risks decades into the future to inform policy and decision-makers. All have emphasized communications and outreach as a way to reduce consequences through better information and awareness. All are giving additional thought to the environmental impacts and opportunities in flood risk management approaches – although the tools for doing so are still developing. And although emphases may differ, all are focusing on the various aspects of the cycle of emergency management in order to better prepare for the future floods that will inevitably occur.

There are also some notable distinctions in approaches between the four countries. For example, The Netherlands is unique in specifying a legislated level of protection. Japan sets long-term aspiration goals for levels of protection along its major rivers. The United Kingdom and United States instead use analysis of risk to inform decision-makers about the options available to them. The United States and United Kingdom are unique in supporting separate flood insurance programs (although the provisions of the two programs differ); Japan, in contrast, includes floods in its household comprehensive insurance, while The Netherlands government does not offer flood insurance. Japan has a widespread volunteer network for flood fighting and flood damage prevention stemming from its historical experience (although cultural changes are posing some challenges), while citizens in The Netherlands have less experience in responding to floods because of that country's history of high levels of structural protection.

No prescriptive “best practices” are promoted as appropriate in all circumstances. Rather, the approaches presented comprise a collective set of best practices among the four countries. With varying flood risks and differing country size, history, and culture, lessons to be learned are individual and approaches will understandably be tailored to meet specific country needs. The document reflects contributions from agencies within the four participating nations, but is not an official position of any government or international organization. Nevertheless, the effort provided one means for those within the four countries to learn from the others, furthering the ability to bootstrap from others' efforts and incorporate aspects suitable to their own

circumstances. The approaches documented provide a palette from which to choose, selecting what is useful and adjusting where needed. The collaboration leading to this document has helped those within the four countries better understand the approaches taken in other places, the reasons for them, and the challenges faced. It is hoped that this document provides a vehicle for sharing the resulting information more broadly within the four participating countries and perhaps beyond.

## Annex 1: Terms of Reference

The following Terms of Reference were considered during a meeting on March 20, 2009, subsequently adjusted, and finalized on May 19, 2009.

### Proposed Terms of Reference

**International Flood Risk Management Group, March 20, 2009**

### *Objective*

To explore risk-based flood management approaches, as being practiced and developed primarily in the Netherlands, Japan, the United States, and the United Kingdom, and jointly develop a “best practices” document.

### Participants

Netherlands:	Dutch Ministry of Transport and Public Works and Water (DG Water)
Japan:	Japanese Ministry of Land, Infrastructure, Transport and Tourism (MLIT)
United States:	U.S. Army Corps of Engineers (USACE)
United Kingdom:	Environment Agency (EA)

### *Discussion*

The above participants have expressed interest in working together to explore risk-based flood management approaches that:

- Encompass a broad spectrum of flood risks (including coastal and riverine flooding) on project and system/ catchment level, and measures to address them (including structural and non-structural),
- Address a comprehensive array of consequences, including economic (properties, industry, direct and indirect,..) and non-economic considerations such as loss of life, large numbers of casualties, loss of cultural heritage, social disruption and associated public works and services damage, environmental degradation,
- Anticipate changing risks over time, including climate change, social change, economic, land use and environmental<sup>65</sup> change, including related uncertainties (and how to deal with that),
- Include construction as well as management and maintenance aspects (“life cycle approach” and “cradle to grave”),
- Are easy to operate, assess, and explain,
- Are appropriate for a variety of governance structures (local, regional and national level), and developments in this, and
- Are suitable for political discussion and decision-making in each participating country, aimed at better managing flood risks.

Each participant has experience in developing and implementing risk-based approaches for flood risk management. Participants have also cooperated on flood risk issues previously, through both informal and formal mechanisms.

---

<sup>65</sup> Environmental changes due to climate change as well as the environmental effects of FRM measures and vice versa the benefits of the environment on flood risk management (like wetlands).

## ***Approach***

- Overview each participant's approaches, practices, and future ideas, and main driving mechanisms behind, drawing from two case studies from each country (one riverine and one coastal)
- Overview other possible sources (e.g. SAFECOAST) and determine whether or not to further explore
- Prepare inventory of approaches, practices, case studies (coastal and riverine) and ideas by each participant and, if appropriate, from other sources
- Identify and define "long list" of best practices, if necessary select and refine into "short list" of best practices for further development
- Jointly determine which participants will apply and evaluate which best practices, drawing on participants' unique strengths and experience
- Jointly review and adjust best practices as needed
- Develop introduction and summary
- Present results

## ***Milestones***

1. March 20, 2009. Initial meeting (Istanbul, Turkey.) Introductions; overviews of each participant's approaches, practices, and ideas; discussion and agreement regarding terms of reference. Present group's anticipated efforts at Dutch/CPWC side event to the 5<sup>th</sup> World Water Forum.
2. September 2009 (Japan?) principles of flood risk management approaches (quantitative and qualitative) and related measures (illustrated by some cases) leading to "Long list" of best practices. Meet to exchange experiences and knowledge in Participants' workshop, if necessary select and refine into "short list".
3. If necessary spring 2010?
4. Autumn 2010. Selected practices developed. Review and Meet to exchange intermediate results, possibly in conjunction with proposed flood risk management conference in United States.
5. Winter 2010 / Spring 2011 (UK). Best practices document complete.
6. October 2011. Present results at 5<sup>th</sup> International Conference on Flood Management (Tsukuba Science City, Japan.)

## ***Roles***

- DG Water is organizing and hosting the initial meeting in Istanbul, Turkey, in conjunction with the Co-operative Programme on Water and Climate. Each participant is determining and funding appropriate persons to attend.
- USACE will organize and host a meeting in 2010 in the United States.
- MLIT will organize and host a meeting in 2009 and 2011 in Japan and liaise with the 5<sup>th</sup> International Conference on Flood Management.
- EA will organize and host a meeting in Winter 2010 /Spring 2011 as needed.
- Participants will work primarily through email exchanges, but may establish conference calls as needed in addition to anticipated meetings.
- Each participant will work within its country to bring relevant information to the group.



### ***Time and Cost***

- Each participant will bear the cost of its participation, including time to review and present case studies, inventory and develop best practices, and travel to meetings.
- Four meetings are anticipated.
- Six conference calls are anticipated.
- The entire effort is expected to span two and a half years, with the great majority of the effort occurring in 2009-2010.
- This effort is intended to conclude with the presentation of results in 2011. Any further collaboration that participants may determine to be desirable shall be considered at a later date.



## Annex 2: Characterization of Flood Risk in Each Country

### 2A. Country Comparisons

	Japan	Netherlands	United Kingdom	United States
<b>Population</b>	127,970,000 (April 2011 est.)	16,847,007 (July 2011 est.)	62,261,545 <sup>66</sup>	313,232,044 (July 2011 est.)
<b>Land Area</b>	377,945 km <sup>2</sup>	33,893 km <sup>2</sup>	241,930 km <sup>2</sup> <sup>67</sup>	9,161,966 km <sup>2</sup>
<b>Population Density</b>	343 per km <sup>2</sup>	497 per km <sup>2</sup>	257 per km <sup>2</sup> <sup>68</sup>	34 per km <sup>2</sup> (varies widely)
<b>Coastline</b>	35,126 km	451 km	12,429 km	19,924 km
<b>Flood prone Area (Percentage of Total Land Area)</b>	35,080 km <sup>2</sup> (9%)	20,000 km <sup>2</sup> (59%)	(Approximately 12%)	About 7 percent, or 178 million acres, of all U.S. land is floodplain; percentages are much higher along the coasts and major rivers, where most of the larger cities are located. <sup>69</sup>
<b>Population in Flood prone Area (Percentage of Total Population)</b>	51,660,000 (41%)	9 million (55%)	(Approximately 9%)	n/a

<sup>66</sup> Combined statistics: England & Wales = 55,240,445 (ONS mid-2010 estimates); Scotland = 5,222,100 (General Register Office for Scotland, mid-2010 estimates); Northern Ireland = 1,799,000 (Press Notice, 2010).

<sup>67</sup> Combined statistics: England & Wales = 149,558 km<sup>2</sup>, Scotland = 78,772 km<sup>2</sup>, Northern Ireland = 13,600 km<sup>2</sup>.

<sup>68</sup> Combined statistics: England & Wales = 383 people/km<sup>2</sup>, Wales = 142 people/km<sup>2</sup>, Scotland = 67 people/km<sup>2</sup>, Northern Ireland = 132 people/km<sup>2</sup>.

<sup>69</sup> Kusler, Jon, and Larson, Larry. "Beyond the ark: a new approach to U.S. floodplain management." *Environment*. June 1, 1993. Note that, as cited, "Floodplains are lands subject to periodic inundation by hurricanes, storm tides, heavy rains, and spring snow melt. They are the lowlands adjoining the channels of rivers, streams, and other watercourses and the shorelines of oceans, lakes, and other bodies of water."

	Japan	Netherlands	United Kingdom	United States
<b>Asset in Flood plain Area (Percentage of Total Asset)</b>	11.1 trillion US\$ (889 trillion yen) (66%)	2,700 billion US\$ (€1,800 billion) (65%)	5,694,000 properties <sup>70</sup>	<p>About 50% of the 3.6 million single-family homes (non-condominiums) in Special Flood Hazard Areas have flood insurance (percentage varies greatly by region)<sup>71</sup></p> <p>3.5 -7 million structures estimated within the area outside the one percent floodplain but within the 0.2 percent floodplain<sup>72</sup></p> <p>Of insurable single-family homes outside of designated Special Flood Hazard Areas (but within NFIP communities), about 1 percent have flood insurance<sup>73</sup></p> <p>Modeling shows uncompensated losses to individuals (flood costs not recovered by insurance or federal assistance) are about \$771 million annually<sup>74</sup></p>

<sup>70</sup> Combined statistics: 5.5 million properties in England & Wales; 131,000 properties in Scotland; 63,000 properties in Northern Ireland.

<sup>71</sup> Dixon, Lloyd, et. al. The National Flood Insurance Program's Market Penetration Rate: Estimates and Policy Implications. Rand Corporation, Santa Monica, California. February 2006, page xiii.

<sup>72</sup> Galloway, G.E., et. al. Assessing the Adequacy of the National Flood Insurance Program's 1 Percent Flood Standard. Water Policy Collaborative, University of Maryland. October 2006.

<sup>73</sup> Dixon, Lloyd, et. al. The National Flood Insurance Program's Market Penetration Rate: Estimates and Policy Implications. Rand Corporation, Santa Monica, CA. February 2006, page xiii.

<sup>74</sup> Sarmiento, Camilo, and Miller, Ted. Costs and Consequences of Flooding and the Impact of the National Flood Insurance Program. October 2006, page 1.

	Japan	Netherlands	United Kingdom	United States
<b>Annual Precipitation</b>	1,467 mm/year (Tokyo)	800 mm/year	600-3000 mm (1971-2000) <sup>75</sup>	Varies widely: <ul style="list-style-type: none"> <li>• Less than 250 mm/year (Las Vegas, NV; Phoenix, AZ)</li> <li>• Over 1,600 mm/year (Baton Rouge and New Orleans, LA; Mobile, AL; Tallhassee, and Pensacola, FL; Astoria OR)</li> <li>• Over 2,583 mm/year (Mt. Washington, NH; Quillayute, WA)</li> <li>• Higher average annual values recorded in AK and HI</li> </ul>
<b>Flood Frequency</b>	Floods occur each year	Rare (last major flood 1953), evacuation of 250.000 people in 1995	Statistics above are based on areas which are estimated to have a 0.5% or greater chance (1 in 200) of fluvial, coastal or surface water flooding each year	Major floods occur each year
<b>Nature of Flood Hazards</b>	Riverine and coastal. Includes flash floods, typhoons, tsunamis	Riverine, coastal and from lakes	River, coastal, surface water, sewer and groundwater flooding	Riverine and coastal. Includes flash floods, long-term river floods, hurricanes
<b>Outline of Flood Risk Management Policy</b>	Since Japan has various types of natural hazards (earthquakes, floods, volcanos, landslides, tsunamis), it has long tradition of dealing with them. Flood disasters occur frequently every year. Japan is a mountainous county and most of its population and assets concentrates in flood prone area. Large cities such as Tokyo, Osaka, Nagoya are situated in low-lying coastal area where risks	Existing flood protection standards are based on semi-quantitative risk based approach from 1960s, being improved and actualized presently	Sustainable management of flooding using a risk-based approach	Responsibility for flood risk management is shared among federal, state, and local levels of government, the private sector, and floodplain inhabitants. Numerous federal agencies have programs to support national flood risk management through planning support, a National Flood Insurance Program, flood risk mitigation investments, emergency management, and post-disaster assistance. The primary responsibility and

<sup>75</sup> Met Office, <http://www.metoffice.gov.uk/climate/uk/averages/ukmapavge.html> .

	Japan	Netherlands	United Kingdom	United States
	<p>of inundation caused by levee break are quite high.</p> <p>In Japan frequently occur torrential rains caused by typhoons and seasonal fronts. In addition, most of the rivers are short and steep, making it difficult to prevent the flood damage from occurring. Although structural measures have been strongly and consistently promoted, the present safety level is still far below its planned targets. Given this situation, Japan is seeking policies covering the entire “safety chain” (prevention, protection, preparedness, response and recovery). For instance, in rivers where their basins have been rapidly urbanized, “Comprehensive flood control measures” are promoted. The measures combines various components including construction and appropriate maintenance of facilities such as levees, flood fighting activities, runoff control in catchment areas, preparation of hazard maps and provision of river information, etc.. Since consequences of levee breaks in large cities caused by flooding over the present safety level of facilities are expected to be catastrophic, risk assessment and implementation of measures are urgent issues.</p>			<p>authority for floodplain management and regulation lies at the state and local levels of government through zoning and land use regulation. Local governments may request state assistance in responding to larger events, and similarly a state may request federal assistance. A National Response Framework provides guidance on Federal coordinating structures and processes for domestic incident management.</p> <p>Given the large geographic extent of the country, with its consequent extreme variation in flood risks and large numbers of governmental structures, partnerships are critical. Size and scope make more detailed national assessments a greater challenge. Great emphasis is placed on sharing responsibilities among all partners (governmental and non-governmental) to “buy down” flood risk.</p>

	<b>Japan</b>	<b>Netherlands</b>	<b>United Kingdom</b>	<b>United States</b>
<b>Level of Safety and Percentage of Completion</b>	Long-term goal of 100 to 200-year protection along major rivers About 40% (Ara river in Tokyo Metropolitan Area)	Legislated level of protection of 1:250 to 1:10,000	Determined by risk/circumstances	Level of protection determined by circumstances. 100-year flood prompts insurance requirements and rates; federal policy suggests locating critical structures outside 500-year floodplain.
<b>Flood Budget (Central Government)</b>	7,623 million US\$ (FY 2010) (609,828 million yen) including sediment disaster prevention, river environment protection and coastal protection	1,350 million US\$ (€900 million) per year (2010, maintenance and capital works of national government and Waterboards), 0.2% of GDP	£2.1bn 2011-15 (England and Wales)	Federal: as much as \$10bn annually <sup>76</sup> States: in excess of \$57 million <sup>77</sup>
<b>Risk Approach (Use of Tolerable Risk Guidelines)</b>	N/A	In a semi-quantitative way included in present flood protection standards, under consideration in revised flood protection standards and additional measures regarding land use planning and disaster management	Risk-based approach – source-pathway-receptor model	Moving from standards approach to risk approaches, including dam safety portfolio risk management approach, development of risk-informed guidance for levee safety. (Currently considering tolerable risk guidelines for dams and levees.)
<b>Flood Insurance</b>	Special contract to private fire insurance “households’ comprehensive insurance” covers floods as well as other conceivable risks. The premium of the above contract is uniform to all areas.	None	As offered by insurance companies	Federal program

<sup>76</sup>The President’s FY 2012 Proposed Budget contains a placeholder for major disasters requiring Federal assistance for relief and reconstruction.

<sup>77</sup> Total amount reported by 39 states/territories (out of 53) for the floodplain management budget, including federal funds provided for state use, in response to a survey conducted by the Association of State Flood Plain Managers and leading to its 2010 Final Report “Floodplain Management 2010: State and Local Programs,” available at <http://www.floods.org/index.asp?menuID=730&firstlevelmenuID=186&siteID=1>



## ***2B. Characteristics of Flood Control Measures in Japan***

The topography of Japan is generally characterised by a chain of spinal mountains running through the central part of the country and by a number of alluvial plains situated between the mountain ranges branching out from these spinal mountains to the coastline. Although the total area of flood plains consisting of these plains only accounts for some 10% of the national land, some 75% of the total assets and 51% of the total population of Japan are amassed on these flood plains. Each of the three largest metropolitan areas, i.e. Tokyo, Osaka and Nagoya, in particular spread over an extensive plain formed by major rivers. A large-scale flood disaster in any of these areas could result in the paralysis of not only the urban functions of the disaster-hit areas but also the general socioeconomic activities of entire Japan. Moreover, because Japanese rivers in the generally mountainous land tend to be short and steep, the short time from the initial rain to the occurrence of flood flow makes the preparation of an adequate response, including the evacuation of residents, difficult. The implementation of physical flood control measures in Japan has not yet been completed. For example, flood control facilities are still a long way from the target level (ability to withstand heavy rain with a return period of 100 - 200 years) for most Class A rivers which are directly managed by the central government. This situation makes flood fighting activities such as an emergency response to flooding and others truly important. The present state is best described as a combination of flood fighting and river improvement functioning as two wheels of a cart.

The two principal flood control measures are an increase of the river discharge capacity through channel improvement and the construction of such flood control facilities as dams and retarding basins. In river basins where local cities are located, farmland and other areas with a relatively low population density may still exist. In this case, a ring levee is constructed to encircle a residential area to protect it from flooding and the development of new residential areas outside the said levee is regulated. For some small and medium rivers, rapid urbanisation throughout the basin have weakened the water retention and retarding functions of the basin, raising the level of the flood peak runoff. In these rapidly urbanised areas, work is in progress to construct water retention and retarding facilities. To compensate for the still insufficient development level of physical flood control facilities, intensive efforts are being made to implement non-physical measures, including the preparation and distribution of flood hazard maps and the supply of river information at the time of flooding. One emerging problem in recent years is the frequent occurrence of flood damage and water accidents due to the flooding of small and medium rivers caused by localised heavy rain or extremely intensified rain in mountainous areas as well as on the plains.

As outlined above, multiple flood control measures of a physical and non-physical nature are being implemented in Japan. However, further improvement and implementation of these multiple measures is essential in view of the continuing situation where the development level of flood control facilities falls short of the target, under the prediction of an increased intensity of heavy rain due to climate change.

About 50% of population  
and about 75% of property  
exist on about 10% of national land  
lower than river water levels during flooding.

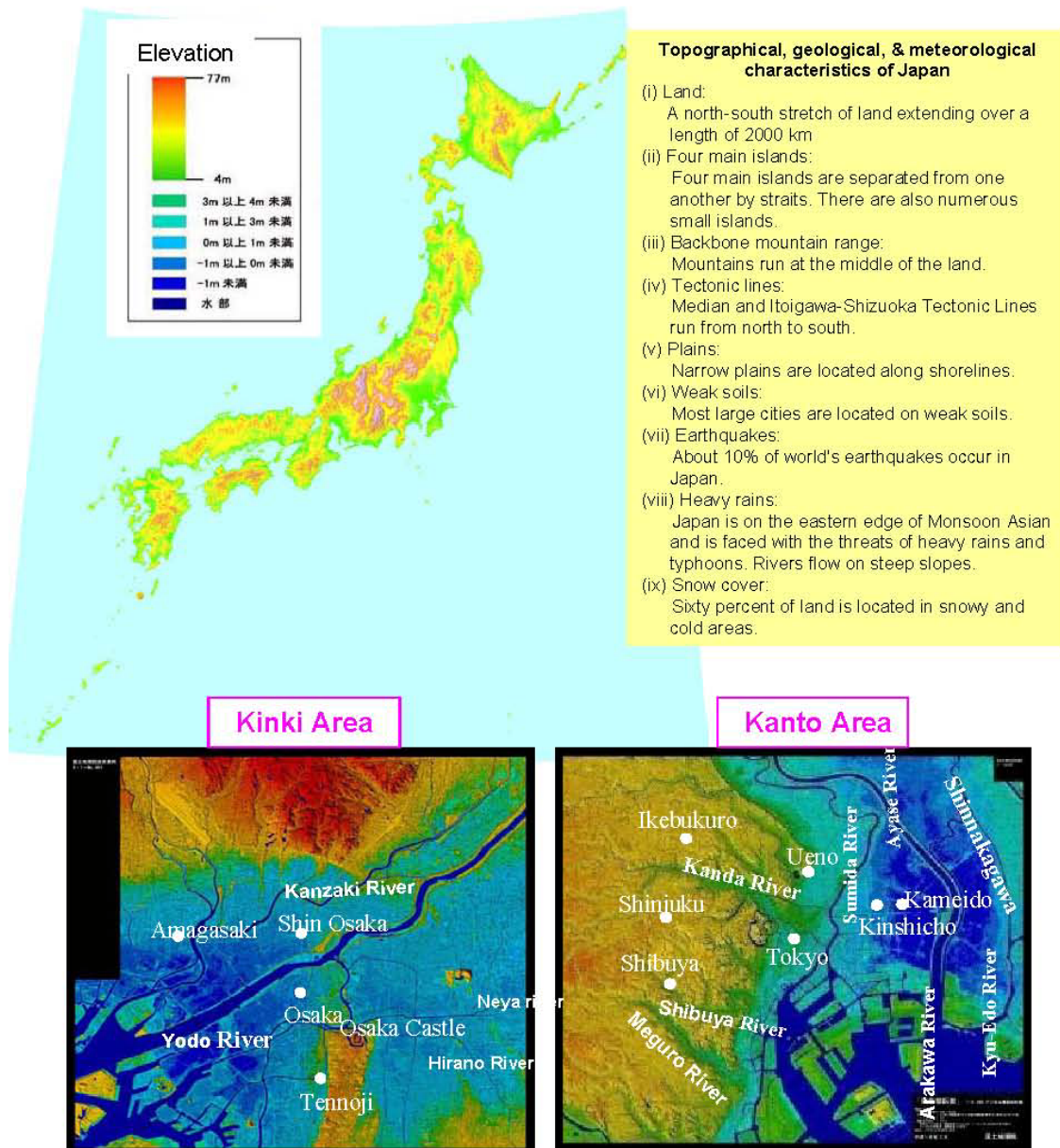


Figure 1: Characteristics of Japan

## 2C. Flood Risk Management in the Netherlands, Main Characteristics

### Major part of the country is flood prone

The Netherlands is situated in a delta area in which the transboundary rivers Rhine, Meuse, Scheldt and Ems flow into the North Sea. Floods threaten the country from these rivers, as well as from the North Sea and from large freshwater lakes. All in all, two-thirds of the country is prone to floods from these large water systems. Figure 1 presents the maximum depth of flooding that may occur under those conditions. This may vary from 0.5 to 6 m. In addition, part of the dense network of inland regional waters, in particular in the western regions, has water levels above land surface, resulting in additional flood risks. Finally, there are floodplains and other areas without flood protection nearby rivers or the seas that occasionally flood. All in all, almost the entire country is either obviously exposed to flood risk or locally liable to flood incidents.

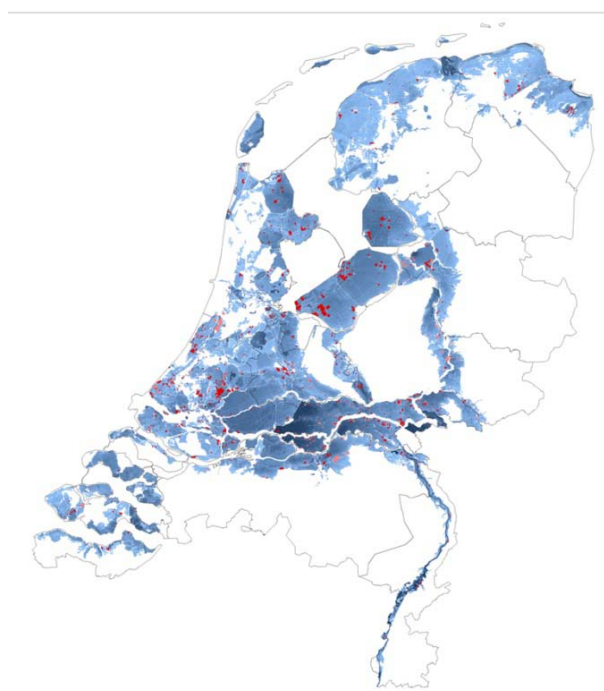


Figure 1: Flood hazard map, presenting maximum depth of flooding of dike rings. Planned urban developments are indicated red

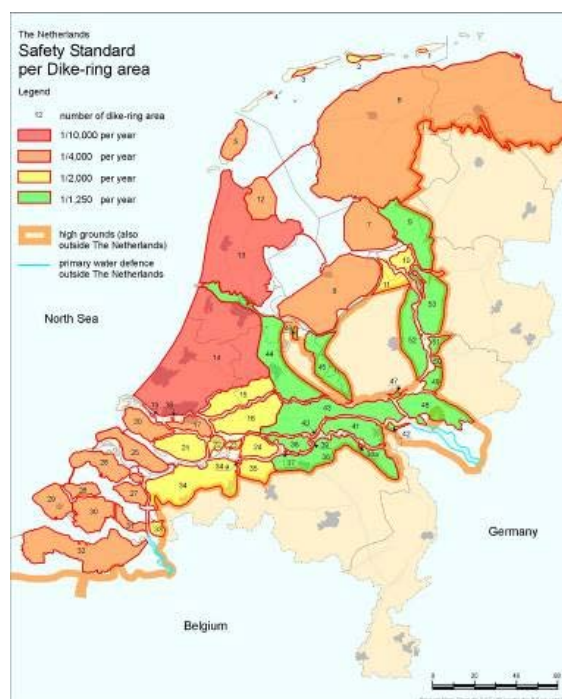


Figure 2: Legal level of flood protection. (Flood Defence Act, 1996; Water Act, 2009).

### The protection of flood prone areas

Whereas the management of flood risks from main water systems consists of an array of measures in the areas of spatial planning, disaster management and protection, the latter acts as the “corner stone” in the Netherlands.

Protective measures are geographically organized in about 100 so-called “dike rings”: a closed system of natural and manmade flood defenses, like dikes, dunes, storm surge barriers and high grounds, maintained mainly by waterboards. According to the Water Act (2009) all defenses for a given dike ring need to comply with a specified legal standard, expressed as an “exceedance frequency” of flood level. The level of this standard is semi-quantitatively related to the potential damage and number of casualties, as well as options for early warning and evacuation (see Figure 2). The central coastal area, densely populated and including the capital of Amsterdam, the

government seat at The Hague, and the harbors of Rotterdam, has the highest level of protection: 1/10.000 per year. More rural areas along the rivers, which also have better evacuation potential, have a protection level of 1/1250 and 1/250 per year.

The Water Act prescribes a 6-yearly assessment of the status of the flood defenses in relation to periodically actualised hydraulic boundary conditions. This assessment is performed by the flood defense management authorities (mainly waterboards). The results and proposed measures are reported to the vice Minister of Water Management, who presents the audit to the Parliament. The latest audit (1 January 2011), revealed that about 25 % of the flood defenses don't meet the standards and requires improvements works, like dike reinforcements or beach nourishments.

The advantage of this system is a legal basis for (relatively high) flood protection standards, periodic evaluation and reporting of required improvement and maintenance works and political decision making on funding and prioritization. On the other hand, the high standards and lack of frequent flooding experiences creates a low flood risk awareness of the public, administrations and politicians, often resulting in lower budgets than required. Waterboards have their own system of funding of maintenance. Landowners and inhabitants of each dike ring pay taxes related to the value of their property.

In the Netherlands flood risk management (FRM) policy includes prevention, protection, preparation, response and recovery, i.e. the whole so-called "safety chain". This implies that objectives, measures and prioritization in all these fields should occur in an integrated Flood Risk Management Plan (FRMP). Currently the formulation of such objectives and measures takes place by different authorities, at different geographical levels with dedicated plans, under the realm of different legislative regimes and with different schedules for planning and public consultation. The implementation of this policy has just started with the National Water Plan in 2009. As prescribed in the EU Directive on the Assessment and Management of Flood Risk (2007) <sup>78</sup> this will result in first generation FRMPs in 2015.

### **International river basins**

Flood management of the main rivers in the Netherlands is also coordinated within international river commissions. The commissions of the rivers Rhine and Meuse, ICPR and ICM respectively, have developed flood action or flood risk management plans for the entire international river basin. These plans contain joint objectives and an overview of measures to retain and temporarily store floodwaters in up-and midstream areas, and measures to increase the discharge capacity on downstream stretches. In addition measures are promoted to decrease potential damage by improved early warning, spatial planning and increased flood risk awareness.

### **Preparing for the future and climate change: 2nd Delta program**

Even though existing policies already take future natural variability into account such as sea level rise, rain fall and river discharge, this may be insufficient to meet the long term challenges of climate change. With a time horizon running up to 2100, the (2nd) Delta Commission, advised the government on a comprehensive strategy consisting of (1) measures to protect from floods and from droughts, (2) spatial development and water management, (3) a flexible approach starting with "no regret" measures (like spatial reservations), (4) long term funding and a legal basis to guarantee long term implementation <sup>79</sup>. Most recommendations have been implemented into the

---

<sup>78</sup> [http://ec.europa.eu/environment/water/flood\\_risk/index.htm](http://ec.europa.eu/environment/water/flood_risk/index.htm)

<sup>79</sup> [www.deltacommissie.com](http://www.deltacommissie.com)

National Water Plan (2009)<sup>80</sup>. In 2010 the elaboration and implementation of 2<sup>nd</sup> Delta Program has started<sup>81</sup>, in close cooperation with regional and local authorities and stakeholders.

---

<sup>80</sup> [http://english.verkeerenwaterstaat.nl/english/topics/water/water\\_and\\_the\\_future/national\\_water\\_plan](http://english.verkeerenwaterstaat.nl/english/topics/water/water_and_the_future/national_water_plan)

<sup>81</sup> [www.deltacommissaris.nl/english](http://www.deltacommissaris.nl/english)



## ***2D. United Kingdom National Governance***

### **Background**

This annex focuses on flood risk management policy and practice within England. Welsh, Scottish and Northern Irish governments are responsible for flood risk management in their areas of UK and, whilst approaches are generally similar, this enables geographical, administrative and other differences to be taken into account. In general terms there has been a move from reacting to flood events to a strategic approach during the 1990s. This involved the development of risk assessments and long term plans for coastal cells and river catchments, together with awareness of the wider impact of interventions.

More recently there has been a transition from flood defense to flood and coastal erosion risk management, which incorporates measures to address consequences as well as probabilities, and increased use of more holistic approaches to deliver multiple benefits. These changes have been reflected in governance arrangements.

### **Flood Risk in England and Wales**

Over 5.5 million properties in England and Wales are at risk of flooding (1 in 6 properties). Some 14% of agricultural land is in the floodplain in England including 58% of the most fertile land.

Significant public infrastructure assets are located within flood risk areas. These include over 950 pumping stations in England with 595 at significant risk and 7100 electricity sites and 10% of all roads and 20% of railways.

### **Legislation**

Flood risk management within the UK is undertaken on the basis of permissive powers – that is the authorities do not have a legal duty to maintain any particular standard of protection. However, recent legislation including the Flood and Water Management Act<sup>82</sup> (the Act) and the Flood Risk Regulations<sup>83</sup> which transpose the European Floods Directive requires authorities to assess risk and develop strategies and plans.

The Flood and Water Management Act amends existing legislation (including the Land Drainage Act and Coast Protection Act, both of which originated in the first half of the last century) to provide for wider risk management activities, further clarify responsibilities and ensure that these can be delivered effectively. The Act received Royal Assent in April 2010 and will need to be commenced before it comes into effect. Some sections are already in force and it is expected that the remaining sections will be brought into effect during 2011 and 2012.

---

<sup>82</sup> [http://www.opsi.gov.uk/acts/acts2010/pdf/ukpga\\_20100029\\_en.pdf](http://www.opsi.gov.uk/acts/acts2010/pdf/ukpga_20100029_en.pdf)

<sup>83</sup> [http://www.opsi.gov.uk/si/si2009/pdf/uksi\\_20093042\\_en.pdf](http://www.opsi.gov.uk/si/si2009/pdf/uksi_20093042_en.pdf) and  
[http://www.opsi.gov.uk/si/si2010/pdf/uksi\\_20101102\\_en.pdf](http://www.opsi.gov.uk/si/si2010/pdf/uksi_20101102_en.pdf)

## National Governance Structure in England

Policy responsibility rests with Defra – the central government department for Environment Food and Rural Affairs – but the Environment Agency has a strategic overview of all forms of flood and coastal erosion risk. This is encapsulated through the national strategy for flood and coastal erosion risk which the Act requires the Environment Agency to prepare, prior to Ministers approving and laying it before parliament. The Environment Agency is also required to monitor and report on the implementation of the national strategy.

The National Strategy will bring together relevant aspects of documents such as the government response to the *Making Space for Water* consultation in 2005<sup>84</sup> and the Pitt review of the summer 2007 flooding<sup>85</sup>. It is also likely to provide a clear policy direction from the new Government. It is expected that the national strategy will be published in summer 2011.

## Regional Governance

The Environment Agency has a duty to establish Regional Flood Defence Committees (which will be given a wider remit and renamed Regional Flood and Coastal Committees by the Act). The chairs of these committees are appointed by ministers, but Local Authorities have a bare majority, the Environment Agency appoint 2 members and ministers appoint the balance. The new committees are likely to retain the local authority majority but a wider membership, including from communities at risk may be sought and boundaries may be revised.

The committees are able to raise funding to supplement the national programme and provide an oversight of activities in their areas which will be increasingly important with the new responsibilities. Current committee boundaries are shown with the Environment Agency regions in Figure 1 on the following page.

## Responsibilities

In addition to the strategic overview role the Environment Agency has operational responsibility for managing flood risk from main rivers and the sea, and works with the Meteorological Office through the Flood Forecasting Centre to provide flood forecasts and warnings. Defra and the Environment Agency collaborate on national level stakeholder engagement, working with partners such as the insurance industry (with whom a formal agreement – the ‘Statement of Principles’ is in place to ensure that most people can get flood insurance on normal terms), professional bodies, non-governmental organizations (including environmental charities etc) and groups such the National Flood Forum (a charity which provides support and advice to communities and individuals that have been flooded or are at risk of flooding).

The upper tier local authorities are responsible for leading local flood risk in their area and required to produce a local flood risk management strategy as well as having powers to manage flooding from surface runoff and ground water. Lower tier authorities have powers to address flooding from ordinary watercourses and internal drainage boards have responsibility for flooding from ordinary watercourses in their areas. These arrangements mirror administrative arrangements for local government. The Act enables authorities to enter into agreements to

---

<sup>84</sup> <http://www.defra.gov.uk/environment/flooding/documents/policy/strategy/strategy-response1.pdf>

<sup>85</sup> <http://www.defra.gov.uk/environment/flooding/documents/risk/govtresptopitt.pdf> ,  
<http://www.defra.gov.uk/environment/flooding/documents/risk/pitt-progress091215.pdf> and  
<http://archive.cabinetoffice.gov.uk/pittreview/thepittreview.html>



deliver flood risk management responsibilities, allowing best use to be made of existing skills and experience within the different organizations.



**Figure 1: Current Regional Flood and Coastal Defence Committees and EA Regions**

Local authorities will be required to consult publicly on the local flood risk management strategies and are expected to work in partnership with other risk management authorities (the Act provides a duty to cooperate). It is expected that they will form groups that will reflect the nature of the risk and activity needed in their areas; coastal groups formed to produce and oversee shoreline management plans that set out the strategic approach to managing a coastal sediment cell may provide a model.

Local authority scrutiny committees will be able to consider the flood risk management in their area and compel risk management authorities to attend committee hearings and explain their actions.

## **Funding**

Defra grant aid is provided for capital improvement projects and the allocation of this to Regional Flood and Coastal Committees, Local Authorities and Internal Drainage Boards is largely devolved to the Environment Agency with overall targets for the programme set by Ministers<sup>86</sup>. However, the new Regional Flood and Coastal Committees will need to provide their consent to Environment Agency regional programmes of works. Central government funding is also being provided to local authorities to support them in fulfilling their new responsibilities, developing local strategies and implementing measures to manage local flood risk.

## **Monitoring**

As well as developing the national strategy the EA will be required to monitor implementation and report on to ministers on flood and coastal erosion risk management.

## **Advantages and challenges**

The key advantages of the UK approach to Flood and Coastal Erosion Risk Management is that it distributes responsibility between a range of different parties. Different levels of government take responsibility for long term planning and fund activities (including warning etc as well as defenses) for relevant sources of risk. However, there is no requirement to provide protection and much of the residual risk is borne by individuals and transferred through private sector insurance. Premia and other policy terms are increasingly risk based and incentivise individuals to take action.

Funding does however represent a key challenge – whilst flood and coastal erosion risk management provides a good return on investment, funding has been effectively rationed so that only a limited number of communities benefit. Climate and other changes will increase pressure and in addition where works do take place there can be considerable benefits to individuals who are not currently required to contribute. New approaches to funding are currently being consulted on by the Government and are expected to be introduced over the next two years.

---

<sup>86</sup> [www.defra.gov.uk/environment/flooding/funding/targets.htm](http://www.defra.gov.uk/environment/flooding/funding/targets.htm)

## FCRM FACTS AND FIGURES – February 2011

<p><b>Flood risk / awareness / preparedness</b></p> <ul style="list-style-type: none"> <li>Over 5.5 million properties in England and Wales are at risk of flooding (1 in 6 properties)</li> <li>Over <b>5 million</b> people and <b>2.6million</b> properties are located in areas at risk from flooding from rivers and sea in England and Wales (<i>almost 5 million people and 2.4 million properties in England</i>)</li> <li>Summer 2007 - <b>55,000</b> properties flooded with insurance industry claims over <b>£3 billion</b>.</li> <li>Potential increase of <b>1.5 million to 3.5 million</b> people at high flood risk in England and Wales by <b>2080</b></li> <li>Over <b>44 per cent</b> of people in England and Wales are unaware that they are at risk of river and sea flooding</li> <li><b>1.23 million</b> high-risk properties in England and Wales have access to our flood warning service.</li> <li>Signed up a further <b>640,000</b> people to FWD since June 2007</li> <li>Currently over <b>900,000</b> customers registered on FWD.</li> <li>To registered call <b>0845 988 1188</b> or log on to our website.</li> </ul>	<p><b>Coastal erosion / flooding</b></p> <ul style="list-style-type: none"> <li><b>3500 km</b> - risk from flooding (<i>England 2750 km, Wales 750 km</i>) <b>(90%)</b></li> <li><b>3200 km</b> – is defended</li> <li><b>2500 km</b> - high ground, may be subject to erosion <b>550km defended (23%)</b></li> <li><b>22 - SMP2s</b> in place by 2011 including coastal erosion maps (18 in England, 2 in Wales and 2 over Wales/England border)</li> <li><b>1500ha</b> – habitat created since 2000 (430ha is intertidal habitat).</li> <li>The EA maintained defences for <u>England and Wales</u> are fluvial 5,988km <b>(80%)</b> &amp; coastal 1,505km <b>(20%)</b></li> <li>The EA maintained defences <u>England only</u> are fluvial 5,574km <b>(79%)</b> &amp; coastal 1,441km <b>(21%)</b></li> </ul> <p><b>Building on flood plains (2007/08 data) [waiting for development in floodplain report for new figures]</b></p> <ul style="list-style-type: none"> <li>2007/08 <b>96%</b> of decisions in line with our advice where we objected on flood risk grounds</li> <li>Responded to over <b>38,000</b> planning consultations</li> <li>Objected to 6232 planning applications on flood risk grounds in 2007/08</li> <li><b>16</b> Major developments permitted against our advice</li> <li><b>9</b> major developments referred to Government Offices for consideration for call-in. <b>6</b> permitted against our advice.</li> </ul>
<p><b>Surface water flooding</b></p> <ul style="list-style-type: none"> <li><b>£16m</b> for surface water management plans and related activities (from Pitt £34.5m)</li> <li><b>MAPS:</b> overview of <u>areas susceptible to surface water flooding</u> for emergency planning and spatial planning purposes – excludes drains and buildings</li> <li>Committed to provide the public and businesses with accurate information about surface water flood risk.</li> </ul> <p>Majority of flooding in 2007 was caused by flooding from surface water.</p>	<p><b>Flood defences</b></p> <ul style="list-style-type: none"> <li>Completed <b>225 flood defences</b> in England and Wales (<i>159 in England</i>) since June 2007, increasing protection to <b>over 198,000 properties</b> [these are Defra FDGiA and WAG funded]</li> <li>Between April 07 and March 08 we undertook <b>167,000</b> risk-based visual asset inspections</li> <li>Responsible for <b>11,600km of flood defences (52,000 defences)</b> and <b>36,000 flood defence structures</b> and estimate replacing all defences that we maintain would cost over £20billion</li> <li>The Thames Barrier alone protects £200 billion of assets in London and the surrounding areas.</li> </ul>
<p><b>National Infrastructure</b></p> <ul style="list-style-type: none"> <li>Over <b>950 pumping stations</b> in England 55% are in flood risk areas, with 595 at significant risk</li> <li>Over <b>7100 electricity sites</b>, of which 14% in England are at risk.</li> <li>10% of all roads and 20% of railways are within flood zones</li> </ul>	<p><b>Allocation and Investment</b></p> <ul style="list-style-type: none"> <li>The Flood Defence Grant in Aid (FDGiA) allocation from Defra for 2010/11 is <b>£259m</b> for capital and £262m for revenue.</li> <li>In <b>2007/08 £427m</b> spent on building, improving and keeping flood defences in good condition.</li> <li>New schemes on average reduce expected damage by <b>£8 for every £1 spent</b>.</li> </ul>
<p><b>Reservoirs</b></p> <ul style="list-style-type: none"> <li><b>2,111</b> large raised reservoirs in England and Wales (can hold more than 25,000m<sup>3</sup> above natural ground level)</li> <li>In Dec 2010 we published reservoir flood maps on our website, which fulfilled the Pitt Review recommendation.</li> <li>Members of the public can request a copy of the public register of reservoirs by contacting the national reservoir safety team based in Exeter</li> </ul>	<p><b>Agriculture</b></p> <ul style="list-style-type: none"> <li>In England <b>1.3 Million ha</b> (14% of total agricultural resource) in areas of flood risk, 550,000ha is grades 1 or 2</li> <li>Produces &lt;1% of the UK GVA</li> <li>England received <b>£1450 million per annum</b> in direct payments through single farm payment</li> <li>Value of environmental services provided by agriculture estimated at <b>£1.5bn per annum</b></li> <li>External costs of agricultural impacts on environment estimated <b>at £1-3bn a year</b></li> <li><b>42,000ha (approx 0.4%) of agricultural land flooded</b> in England in 2007 summer floods – with land loss and total crop loss amounting to £24.2 million</li> <li>12,000ha flood storage areas created in 180 locations</li> <li>Approx 1000ha of agricultural land converted to intertidal habitat since 1991: less than 0.01% of total agricultural land</li> </ul>

## ***2E. Characterization of Flood Risks in the United States***

The United States of America encompasses approximately 3.79 million square miles<sup>87</sup> within its boundaries. It supports a population of nearly 309 million people<sup>88</sup> with an estimated 2009 GDP of \$14.3 trillion. Terrain and climate varies considerably. Two major mountain ranges, the Appalachian Mountains in the east and the Rocky Mountains in the west, separate the contiguous United States into different geographic regions. The Great Lakes act as inland freshwater seas. The climate is mostly temperate. It varies from tropical to humid subtropical and humid continental in eastern regions; to desert, semi-arid, and alpine in western regions; to arctic in Alaska<sup>89</sup>. Precipitation varies widely, from deserts in the southwest receiving less than 15 inches (38 cm) annual precipitation, to temperate rainforests receiving 137 inches (348 cm) of annual precipitation. Mountainous areas and those subject to lake-effect snow can see considerable snowfall (up to 600 inches annually in isolated upper elevations in the northwest.) The 12,380-mile (19,924 km<sup>90</sup>) coastline varies from highly erodible soil to rock ledges. In varying areas, the U.S. is subject to hurricanes (typically Gulf and east coasts), severe thunderstorms and tornados (typically in the Midwest and Southeast), tsunamis (Pacific basin), mudslides (California), long-term river flooding along major rivers, flash flooding, and alluvial fan flooding with debris loads.

The most intense period of settlement occurred over the past two centuries. It brought considerable changes to the landscape: major canals, dredged channels, and harbors for transportation, levees for protection from more frequent floods, dams for hydropower and flood control, and (particularly in the more arid west) major water-supply reservoirs (Lake Mead, the largest, stores more than 28 million acre-feet.) Approximately 223,850 sq km of land are irrigated<sup>91</sup>. There are over 75,000 dams in the National Inventory of Dams, of which more than 95% are owned by states, local governments, industry, and individuals<sup>92</sup>. More than 85% of the estimated 100,000 miles of levees in the United States are locally owned and maintained<sup>93</sup>. The early era of single-purpose projects gave way to multi-projects and, by the mid 1900s, to a multi-objective focus in water resources planning and management<sup>94</sup>. Greater emphasis was placed on environmental issues in the later 1900s, first with more of a protection emphasis and later with restoration goals.

Flood control efforts were usually undertaken by levee districts, other quasi-public groups and individual landowners prior to the Flood Control Act of 1936. Issued after major flood disasters in various regions in the country, the 1936 Act recognized floods as a “menace to national welfare”, flood control as an “appropriate activity of the Federal Government in cooperation with States, their political subdivisions, and localities,” and a policy that the Federal Government should make flood control improvements when benefits outweighed costs.

---

<sup>87</sup> The World Factbook. Central Intelligence Agency. Accessed at <https://www.cia.gov/library/publications/the-world-factbook/geos/us.html> on February 11, 2011.

<sup>88</sup> “Resident Population Data.” United States Census 2010. Accessed at <http://2010.census.gov/2010census/data/apportionment-dens-text.php> on February 11, 2011.

<sup>89</sup> The World Factbook.

<sup>90</sup> Ibid.

<sup>91</sup> Ibid.

<sup>92</sup> Office of Emergency Preparedness. “Frequently Asked Questions... On Dams and Dam Safety.” <http://www.gohsep.la.gov/factsheets/FAQsDamsandDamSafety.htm>. Last modified April 16, 2008. Accessed on February 11, 2011.

<sup>93</sup> American Society of Civil Engineers. Report Card for America’s Infrastructure. Accessed at <http://www.infrastructurereportcard.org/fact-sheet/levees> on February

<sup>94</sup> Russell, Clifford S. and Duane D. Baumann, Editors. *The Evolution of Water Resource Planning and Decision Making*. IWR Maas-White Series. Edward Elgar Publishing, Inc. Northampton, Massachusetts. 2009.

Responsibility for managing flood risks in the United States remains shared across Federal, State and local levels of government, the private sector and inhabitants of the floodplains, themselves. At the Federal level of government, the United States Army Corps of Engineers, the Department of Homeland Security, Federal Emergency Management Agency, and nearly a dozen other Federal agencies have programs to support national flood risk management through planning support, a National Flood Insurance program, flood risk mitigation investments, emergency management and post flood disaster assistance.

One distinctive feature is a National Flood Insurance Program, which makes Federally-backed flood insurance available for structures within the approximately 20,000 communities opting to participate; participating communities must adopt floodplain management ordinances meeting or exceeding minimum national requirements. (See main body of report for additional information.) Through this mechanism, individual homeowners and building owners shoulder a considerable portion of flood recovery costs, although the Federal government has still contributed significant funding after catastrophic events such as Hurricane Katrina.

In the five years since Hurricane Katrina devastated the Gulf Coast of the United States, the United States has done a lot of work to shift risk-informed, system-wide approaches to flood risk management. Coordination among the many federal, state and local partners is critical to this system-wide approach.

At the Federal level, Principles and Guidelines that direct water resources studies are being modernized to place equal treatment of national economic, environmental and social benefits. An Interagency Floodplain Management Task Force works to align efforts of a dozen U.S. federal agencies and has drafted a 5-year work plan to develop strategic direction and provide leadership for federal efforts that promote, encourage and support sound floodplain management. The National Flood Insurance program is being examined to address concerns of a wide array of stakeholders to ensure that the program can efficiently and effectively meet the needs of the public.

Since much of the responsibility and authority for managing flood risk in the United States is tied to local land use decisions, work has also progressed with non-federal partners. A National Committee on Levee Safety developed recommendations for a National levee Safety Program, including a strategic implementation plan; in response to the Committee's recognition of the need to address aging infrastructure and the need for a broader national flood risk management approach, risk management approaches are being developed for dams and levee systems. A Regional Flood Risk Management Team helps coordinate federal, tribal, state and local governments' flood risk management initiatives. A "Silver Jackets" program helps forge strong federal-state partnerships focused on flood mitigation, with state officials serving as the lead.



## **Annex 3: Authorship and Acknowledgements**

The primary authors of this document are Jos Van Alphen (Staff of the Delta Commission; the Netherlands), Lisa Bourget (U.S. Army Corps of Engineers' Institute for Water Resources; United States), Craig Elliott (Environment Agency; United Kingdom), Koh-ichi Fujita (National Institute for Land and Infrastructure Management; Japan), Durk Riedstra (Rijkswaterstaat; the Netherlands), David Rooke (Environment Agency; United Kingdom), Kenichiro Tachi (Ministry of Land, Infrastructure, Transport, and Tourism; Japan.) Lisa Bourget also served as editor. This document reflects contributions from agencies within the four participation nations, but is not an official position of any agency, government or international organization.

The leadership provided by Steven Stockton and Robert Pietrowski (U.S. Army Corps of Engineers), Koji Ikeuchi and Toshio Okazumi (Ministry of Land, Infrastructure, Transport, and Tourism) in initiating and supporting the effort is sincerely appreciated. Leadership of Mr. Hillen (Rijkswaterstaat), Mr. Balfoort (DG Water), Mr. Boessenkool (Rijkswaterstaat), Mr. Van de Berg (Rijkswaterstaat) and Mr. Parmet (Staff Delta Commissioner) in support of work on the document, participation at international meetings, and acting as host for a meeting in the Netherlands is also appreciated. Significant thanks are due to Edward Hecker (U.S. Army Corps of Engineers) for ongoing guidance and personal involvement as the document progressed, and to Alex Dornstauder, Pete Rabbon, and Jeff Jensen (all from the U.S. Army Corps of Engineers) and Eiji Otsuki (Ministry of Land, Infrastructure, Transport, and Tourism: Japan) for their interest and championship.

Thanks is also due to individuals who contributed or reviewed specific text, including: Matthew Cullen (Association of British Insurers), Mike Grim (U.S. Federal Emergency Management Agency), Ruben Jongejan (project bureau VNK2), Leonard Shabman (Resources for the Future), Robert Slomp (Rijkswaterstaat), and numerous persons at the U.S. Army Corps of Engineers. Thanks are also due to Gerald Galloway (University of Maryland) for compiling an initial list of flood risk related terms, on which the primary authors drew in preparing this document.

This document reflects contributions from agencies within the four participating nations, but is not an official position of any government or international organization.





## Annex 4: Flood Risk Related Terms

TERM	DEFINITION	SOURCE
Acceptable Risk	The level of loss a society or community considers acceptable given existing social, economic, political, cultural, technical and environmental conditions. In engineering terms, acceptable risk is also used to assess structural and non-structural measures undertaken to reduce possible damage at a level which does not harm people and property, according to codes or 'accepted practice' based, among other issues, on a known probability of hazard.	UN-ISDR (UNU)
Consequence	In relation to risk analysis, the outcome or result of a risk being realised. This includes impacts in the downstream, as well as other areas resulting from failure of the dam or its appurtenances.	ICOLD 2005
Disaster	A serious disruption of the functioning of a community or society causing widespread human, material, economic or environmental losses which exceed the ability of the affected community to cope using its own resources. A disaster is a function of the risk process: hazards + vulnerability.	UNESCO-IHE
Flood	A general and temporary condition of partial or complete inundation of normally dry land areas from the overflow, the unusual and rapid accumulation, or the runoff of surface waters from any source. An overflow of water onto lands that are used or usable by man and not normally covered by water. Floods have two essential characteristics: The inundation of land is temporary; and the land is adjacent to and inundated by overflow from a river, stream, lake, or ocean. (From USGS Water Science.)	US Army Corps of Engineers
Flood Risk Management	Continuous and holistic societal analysis, assessment and mitigation of flood risk.	FLOODsite
Floodplain	The generally flat areas adjacent to a watercourse or the sea where water flows in time of flood or would flow but for the presence of flood defences. The limits of floodplain are defined by the peak water level of an appropriate return period event.	Northern Ireland
Hazard	A potentially damaging physical event, phenomenon or human activity that may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation. Hazards can include latent conditions that may represent future threats and can have different origins: natural (geological, hydrometeorological and biological) or induced by human processes (environmental degradation and technological hazards). Hazards can be single, sequential or combined in their origin and effects. Each hazard is characterised by its location, intensity, frequency and probability.	UN-ISDR
Recurrence Interval	(Return period). The average interval of time within which the given flood will be equaled or exceeded once.	UNESCO-IHE
Residual Risk	The risk that remains after risk management and mitigation.	Defra-HR Wallingford

Resilience	Ability to resist, absorb, recover from or successfully adapt to adversity or a change in conditions.	US Department of Homeland Security
Risk	The probability of harmful consequences, or expected loss of lives, people injured, property, livelihoods, economic activity disrupted (or environment damaged) resulting from interactions between natural or human induced hazards and vulnerable conditions. Risk is conventionally expressed by the equation: Risk = Hazard x Vulnerability	UN ISDR
Risk Assessment	The process of identifying hazards and consequences, estimating the magnitude and probability of consequences and assessing the significance of the risk(s).	Defra-HR Wallingford
Risk Communication	Exchange of information with the goal of improving risk understanding, affecting risk perception and/or equipping people or groups to act appropriately in response to an identified risk.	UNESCO-IHE
Risk Management (Disaster)	The systematic management of administrative decisions, organisation, operational skills and abilities to implement policies, strategies and coping capacities of the society or individuals to lessen the impacts of natural and related environmental and technological hazards.	UN ISDR
Risk-Informed Decision Making	Determination of a course of action predicated on the assessment of risk, the expected impact of that course of action on that risk, as well as other relevant factors	US Department of Homeland Security
Tolerable Risk	A risk within a range that society can live with so as to secure certain net benefits. It is a range of risk that we do not regard as negligible or as something we might ignore, but rather as something we need to keep under review and reduce it still further if and as we can.	ICOLD
Unacceptable Risk	A level of risk that cannot be justified except in extraordinary circumstances (typically where the continuation of the risk has been authorised by government or a Enforcement Authority in the wider interests of society).	ICOLD
Vulnerability	Resilience of a particular group, people, property and the environment, and their ability to respond to a hazardous condition. For example, elderly people may be less able to evacuate in the event of a rapid flood than young people.	UNESCO-IHE

<u>Acronym</u>	<u>Organization Referenced</u>
DEFRA	Department for Food, Environment and Rural Affairs (United Kingdom)
FLOODsite	Integrated Project in the Global Change and Ecosystems priority of the Sixth Framework Programme of the European Commission
ICOLD	International Commission of Large Dams
UNESCO-IHE	United Nations Educational, Scientific and Cultural Organization-Institute for Water Education
UN ISDR	United Nations International Strategy for Disaster Reduction





Levee along the Ara River (Japan)



Eastern Scheldt Storm Surge Barrier (Netherlands)



Thames Barrier (United Kingdom)



Levees along the Sacramento River (United States)

## Flood Risk Management Approaches

As Being Practiced in Japan, Netherlands, United Kingdom, and United States