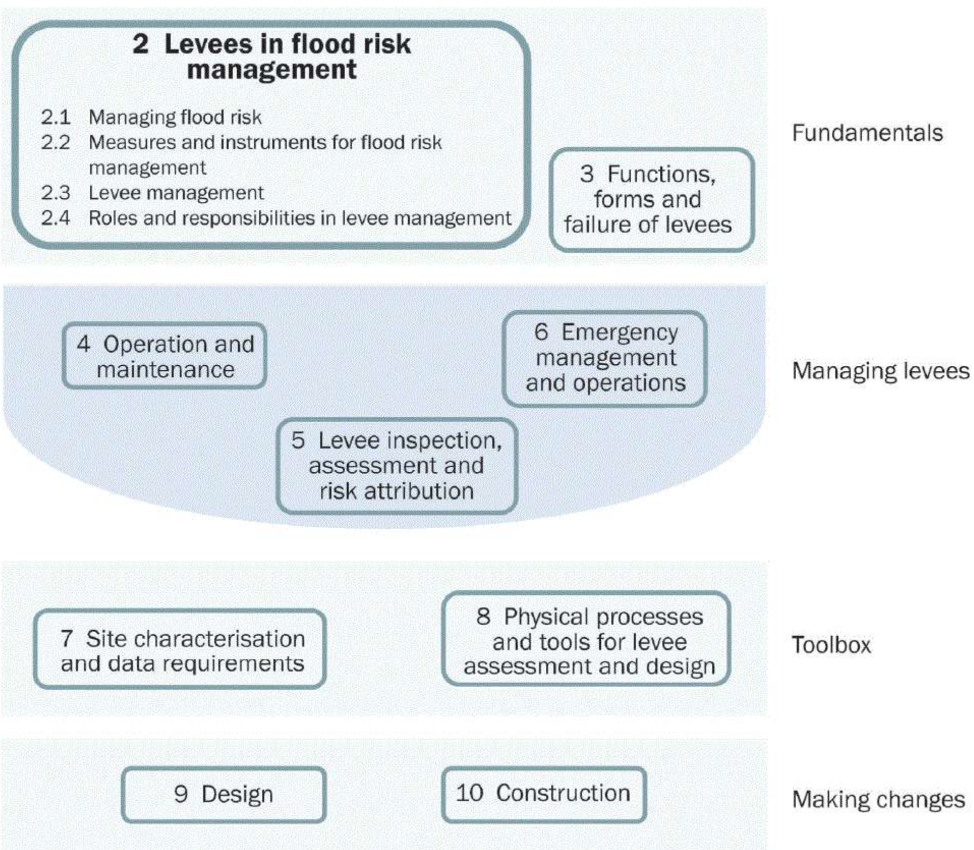
International Levee Handbook

# Overview of the handbook

Chapter 2: Levees in flood risk management

# Content and aims




**Chapter 2** sets levees in the wider context of flood risk management. General principles for levee management for use throughout the handbook are introduced.

Key outputs to other chapters

- starting point ⇨ **levee management**
- **conceptual and risk management frameworks** ⇨ all chapters

**Note:** The reader should revisit **Chapters 2 and 3** throughout the levee life cycle for a reminder of important issues.

# Managing flood risk (Section 2.1)

- Flood management systems

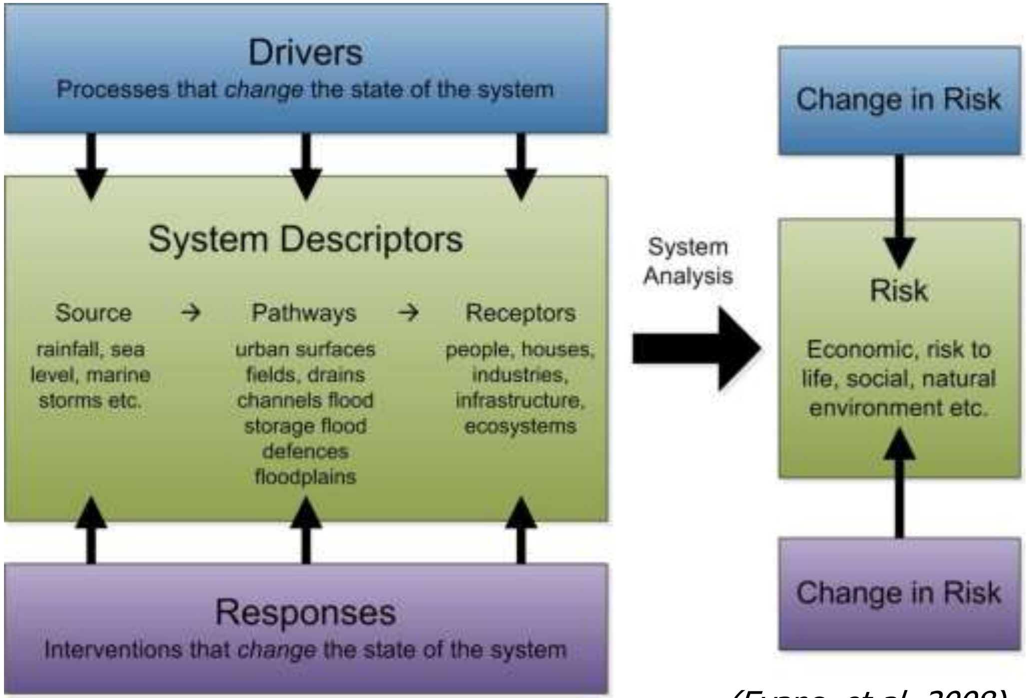
Although this handbook is primarily about the management of levees for flood risk reduction it is appropriate to place levees in the wider context of flood risk management. The management of levees must be seen alongside the broader range of activities such as land use planning and emergency preparedness that help to reduce flood risk.

- FRM process

The process of flood risk management is about a sequence of first identifying flood risk, then assessing the level of risk, and finally about creating policies and plans to control the risk and to reduce it to an 'acceptable' level.

# Causes of change in flood risk

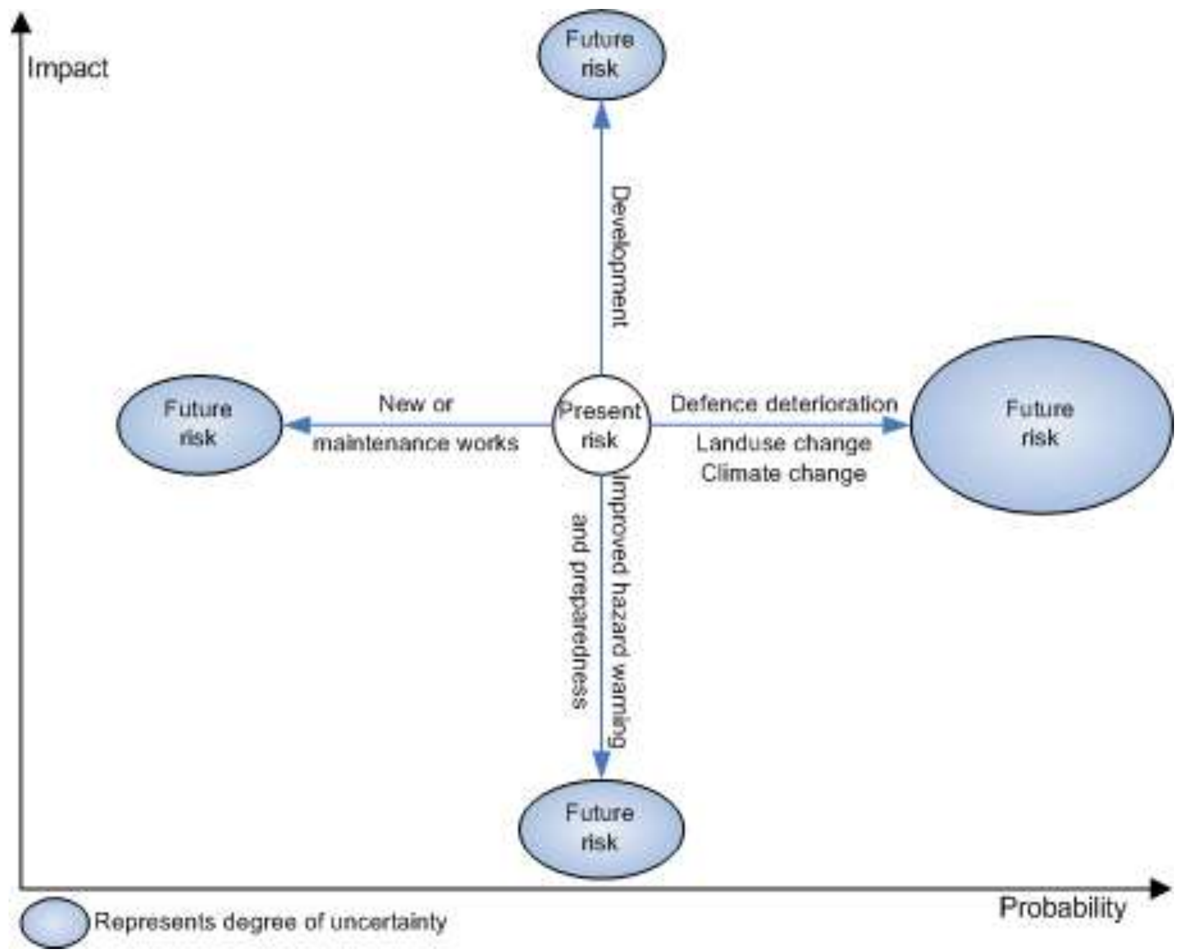
- Drivers (i.e. Natural processes)
- Responses (i.e. intervention measures &/or instruments)




*(Evans, et al, 2008)*

# Causes of change in flood risk

Changes can be expressed in a probability consequence space




*(Adapted from Sayers et al, 2003)*

# Measures & Instruments (Section 2.2)

- Structural & non-structural measures
  - Source control, pathway modification & receptor resilience / vulnerability
- Financial & regulatory instruments
  - Influencing behaviour – 'carrot & stick'
  - Policies & standards – safety standards, land use reg's, design standards
  - Environmental considerations
- Portfolios of measures & instruments
  - Strategic alternatives
  - Choice factors
  - Individual and collective consideration
- Options appraisal
  - Advantages & Disadvantages
  - Do-something vs no-nothing
  - Techniques – MCA, CBA, SBCA, EIA
  - Social, economic & environmental pillars of sustainability
  - Impact on the environment & vice versa


Courtesy USACE

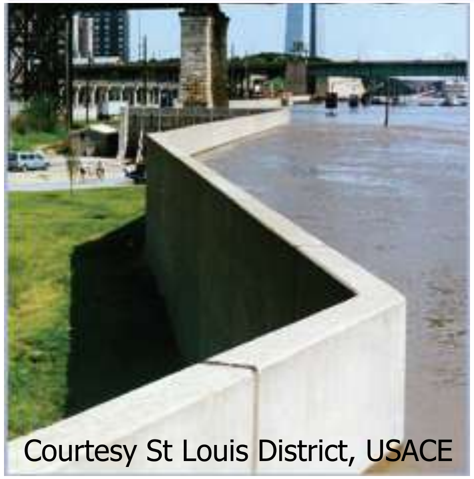
# Structural & non-structural measures

| ***Source control*** *- measures that reduce the likelihood of high flows/water levels occurring* |
| --- |
| • spatial planning and land use policies<br>• sustainable drainage:<br>○ detention basins<br>○ filter drains/strips<br>○ flow control systems<br>○ infiltration basins/trenches<br>○ permeable paving<br>○ retention ponds<br>○ soakaways<br>○ swales<br>○ wetlands<br>○ green roofs/walls<br>• oversized pipes/attenuation tanks within the drainage network<br>• rainwater harvesting<br>• attenuation reservoirs<br>• river regulation<br>– river restoration and floodplain rehabilitation. |

# Structural & non-structural measures

| ***Source control*** *- measures that reduce the likelihood of high flows/water levels occurring* | ***Pathway modifications*** *- measures that modify or block the pathways taken by floodwater to a site* |
|---|---|
| • spatial planning and land use policies<br>• sustainable drainage:<br>○ detention basins<br>○ filter drains/strips<br>○ flow control systems<br>○ infiltration basins/trenches<br>○ permeable paving<br>○ retention ponds<br>○ soakaways<br>○ swales<br>○ wetlands<br>○ green roofs/walls<br>• oversized pipes/attenuation tanks within the drainage network<br>• rainwater harvesting<br>• attenuation reservoirs<br>• river regulation<br>– river restoration and floodplain rehabilitation. | • ground raising<br>• construction of floodwalls and embankments/levees<br>• construction of diversion channels or tunnels<br>• tidal surge barriers, gates and sluices<br>• removal or modification of existing structures<br>• demountable flood defences<br>• temporary flood defences<br>• designing drainage networks for exceedance (eg overland flow routing)<br>• managed realignment to make space for water<br>• property or asset level flood resistance measures<br>• beach replenishment and heightening foreshores. |


Courtesy USACE


Courtesy St Louis District, USACE

# Structural & non-structural measures

| ***Source control*** *- measures that reduce* | ***Pathway modifications*** *- measures* | ***Receptor resilience*** *- Measures that reduce the vulnerability of receptors to the impacts of a flood* |
|---|---|---|
| | | • flood risk identification and mapping<br>• planning policies and development control<br>• civil contingency planning<br>• awareness raising and enhanced preparedness<br>• flood forecasting and warning<br>• improved emergency response procedures<br>• desktop incident management exercises<br>• field incident exercises<br>• business continuity management<br>• risk transfer (eg flood insurance)<br>• feedback from lessons identified<br>• property or asset level flood resilience measures. |

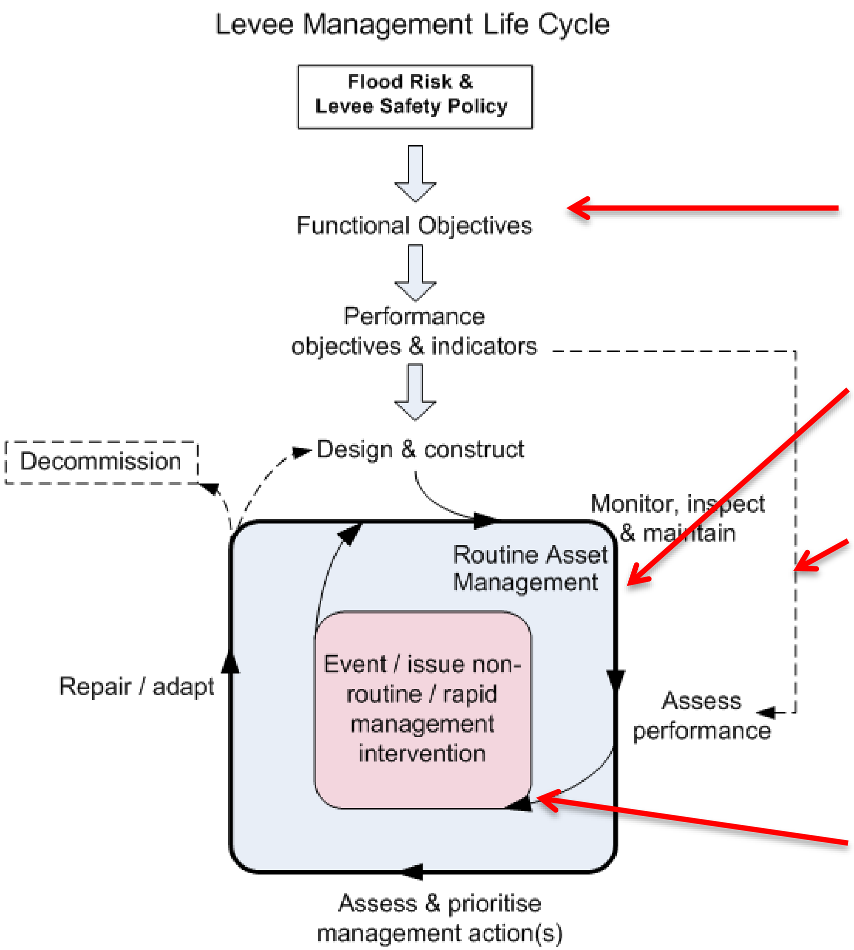
Courtesy City of Coquitlam, Canada

Courtesy USACE

# Levee Management (Section 2.3)

- Performance requirements
  - Clear definition of failure and common understanding of desired outcome
  - Hydraulic performance & structural integrity during critical loading
  - Risk-based (or risk informed) approach to levee design & management
  - Considerations during construction
- Functional objectives
  - Balancing of economic viability, environmental viability and social acceptability in the engineering solution
  - Multi-use benefits
- Levee management life cycle
  - Components of a generic asset management cycle
  - Components, principles and main issues of the levee management life cycle
  - Approaches / frameworks
- Managing performance and failure of levees
  - Required knowledgebase and information
  - Assessments & analysis – performance & reliability
  - Management reviews, residual risk and measures to reduce risk of failure

# Levee management life cycle




A generic levee management cycle has been constructed to be applicable whatever the national governance arrangements.

For a new levee, the normal entry point to the cycle would be from a definition of policy and functional objectives (i.e. from the top of the diagram).

For an existing levee, one would enter somewhere within the routine operational cycle.

Changes to existing policy and management objectives, or an event that changes the level of flood risk reduction, might take the manager outside this loop in order to consider alterations to an existing levee such as improving, rebuilding or even decommissioning.

Diversion to the inner emergency management loop is triggered by damage due to a severe flood event or an assessment, which indicates that the levee is not likely to perform as expected.

# Roles & responsibilities (Section 2.4)

Participants in levee management

- Different internal & external 'actors'
- Stakeholder categories of Responsible / Affected / Interested parties
- Levels of engagement
- Institutional arrangements of formal actors
- Towards working partnerships and public participation

**National legislation on floodplain management in the USA**

The US Congress established the National Flood Insurance Program (NFIP) on 1 August 1968 with the passage of the National Flood Insurance Act of 1968. This was modified by the Flood Disaster Protection Act of 1973, the National Flood Insurance Reform Act of 1994 and the Flood Insurance Reform Act of 2004. The NFIP is administered by the Federal Emergency Management Agency (FEMA). As a participant in the NFIP, a community is responsible for making sure that its floodplain management regulations meet or exceed the minimum requirements of the NFIP. By law, DHS FEMA cannot offer flood insurance in communities that do not have regulations that meet or exceed these minimum requirements. The basis of the community's floodplain management regulations is the flood hazard data provided to the community by FEMA (FEMA, 2011).

**National legislation on flood management in France**

The Grenelle 2 law transposes the EC Floods Directive (2007) into French Law, which encourages the:

- sharing of a new and homogeneous knowledge of risks through the preliminary assessments of flood risk (EPRI) at the level of each district
- definition of a national strategy for risk management (SNGRI) defining nationally important risk criteria
- identification of priorities for action in each district of the territories
- definition in each district of a plan for flood risk management
- variation and adoption of these plans at the local level by local strategies driven by local actors based on the current tools of risk management: flood risks prevention plans (PPRi) action programmes for flood prevention (PAPI) etc.

Chapter 2 also includes examples of national policy and regulatory instruments which define flood risk management in different countries, and devolve roles and responsibilities to the relevant and responsible authorities

# Communication

## Why & how

- Influencing factors
- Communication pathways & governance hierarchies
- Communicating risk
- Disseminating information – key aspects
- Forms of communicating information

It is important to communicate risk and residual risk effectively to at risk communities. Risk can often be communicated through the variety of probabilistic risk and performance metrics. However, the use of specialist risk terminology can often cause problems.

The use of flood risk terms such as 'a 100-year event' can often lead the public to believe that this means they are free from flood risk within their lifetime. This is a common misunderstanding of probability and of risk.

As a general rule the messages should be kept simple and straightforward.

The use of flood risk terms such as 'a 1 in 100 year event' can often lead the public to believe that this means that they are free from risk within their lifetime, which is a common misunderstanding of probability and of risk. A 1:100 year event is one that has a one per cent chance or probability of occurring in any year. The resulting likelihood of exceedance or 'encounter probability' $P_e$ can be calculated using the equation (Kamphius, 2000):

$$P_e = 1 - [1 - (1/T)]_n \quad (2.1)$$

where T is the flood return period (eg a 1 in 100 year event), and n is the lifetime (eg design life of levee, or period of construction) in years. This results in the following percentage encounter probabilities for the given flood events and lifetimes.

| Lifetime, n: years | Annual flood return period, T | | | | |
|---|---|---|---|---|---|
| | *1 in 10* | *1 in 50* | *1 in 100* | *1 in 200* | *1 in 1000* |
| 1 | 10 | 2 | 1 | <1 | <1 |
| 2 | 19 | 4 | 2 | 1 | <1 |
| 5 | 41 | 10 | 5 | 3 | <1 |
| 10 | 64 | 18 | 10 | 5 | 1 |
| 20 | 88 | 33 | 18 | 10 | 2 |
| 50 | >99 | 64 | 39 | 22 | 4 |
| 100 | >99 | 87 | 64 | 39 | 10 |

This shows that if people are living in a 1 in 100 year flood area (an area that will only be inundated by events of return periods greater than 1 in 100 years), the probability of being inundated in 100 years is 64 per cent.

This can still be confusing, but further steps can be taken to place the terms into contexts that may be more familiar or easier to understand. For example, considering the same probability, but placing it in the context of an average lifetime of 70 years, then the likelihood of experiencing a flood during that lifetime is 51 per cent – or about a 50/50 chance. Other well-understood time period contexts could be used such as over the life of an average mortgage, or the expected design life of a building.

Placing such terminology into real life contexts does not reduce the quality of the information but does provide a means of communicating a complex concept in a more readily comprehendible way, both for decision makers and the public.

*(after Porter, 2012, and CIRIA; CUR; CETMEF, 2007)*

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# Thank you

## Chapter 2 Team Lead:

Michael Wallis

HR Wallingford

E: m.wallis@hrwallingford.com

T: +44 (0)1491 822373

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