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The **Associated Programme on Flood Management** (APFM) is a joint initiative of the World Meteorological Organization (WMO) and the Global Water Partnership (GWP).

It promotes the concept of Integrated Flood Management (IFM) as a new approach to flood management. The programme is financially supported by the governments of Japan, Switzerland and Germany.

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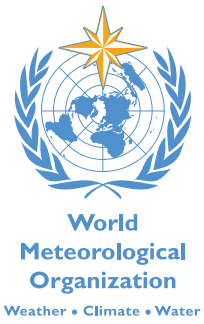

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To the reader

This publication is part of the *"Flood Management Tools Series"* being compiled by the Associated Programme on Flood Management. The *"Flood Emergency Planning"* Tool is based on available literature, and draws findings from relevant works wherever possible.

This Tool addresses the needs of practitioners and allows them to easily access relevant guidance materials. The Tool is considered as a resource guide/material for practitioners and not an academic paper. References used are mostly available on the Internet and hyperlinks are provided in the *References* section.

This Tool is a *"living document"* and will be updated based on sharing of experiences with its readers. The Associated Programme on Flood Management encourages disaster managers and related experts engaged in emergency planning around the globe to participate in the enrichment of the Tool. For this purpose, **comments and other inputs are cordially invited**. Authorship and contributions would be appropriately acknowledged. Please kindly submit your inputs to the following email address: apfm@wmo.int under Subject: *"Flood Emergency Planning"*.

Acknowledgements

This Tool has exploited the works of many organizations and experts, as listed in the references. Acknowledgement is due to the members of the Hydrology and Water Resources Department in WMO and the members of the Technical Support Unit of the APFM for their competent technical guidance and frank discussions on the issues and for bringing various perspectives into focus.

Disclaimer

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CONTENTS

FIGURES & BOXES

1 INTRODUCTION

1 Integrated Flood Management (IFM) calls for a combination of effective strategies in flood management that employ structural and non-structural measures and a pro-active and post-recovery approach to dealing with flood risk. Because absolute protection from flooding is a myth, flood emergency management is an integral part of flood risk reduction, which aims at managing and minimizing the damaging effects of flooding.

2 Flood risks are defined as the expected losses from actual flood events over a specified period, and consist of the magnitude of the flood hazard, the exposure of human activity to flooding and the vulnerability of the elements at risk (WMO, 2006c, pp8-9, 15) Flood emergency measures can reduce the exposure to flooding; for example, moving individuals away from flooded areas to prevent individuals from drowning or the spread of diseases. Similarly, flood emergency planning can contribute, when integrated into an early warning system, to the shutting down of facilities that, if flooded, are likely to have an adverse effect on the safety of the population and the environment (for example, chemical plants).

3 It is not easy, however, to perform flood emergency planning and management properly. Early warning without appropriate action is not sufficient to ensure reduction of risk to flooding. Inadequate management may even worsen the situation: risks owing to exposure to flooding may sometimes be higher when evacuation is unorganized rather than when it is nonexistent. Institutions and stakeholders need to make necessary flood emergency planning and management arrangements so that individuals can respond effectively to flooding.

4 For the public, governments provide, to the extent possible, flood defences in an effort to reduce risk up to a certain predefined 'design flood'.[1] Even if all adequate technical measures are taken, society has to deal with residual risk of a flood that exceeds the design flood. Flood management practitioners and policymakers should consider uncertainties from climate variability and change as well as the distribution cost of related flood risk reduction measures

[1] Flood hydrograph or instantaneous peak discharge adopted for the design of a hydraulic structure or river control taking into account economic and hydrological factors. (UNESCO/WMO International Glossary of Hydrology – def. 0319)

across populations at risk. This issue can be addressed through emergency preparedness and response measures that ease the financial burden from flooding, and ensure operational continuity in response to flooding.

5 This document serves as a tool to provide basic information on preparedness and implementation activities for flood emergency planning. It is written primarily for flood managers, and in particular for individuals with an engineering background, as they are involved in formulating flood management strategies and policies, and need immediate access to information to engage with emergency planning and response mechanisms as part of their overall flood management strategy.

2 INTEGRATED FLOOD MANAGEMENT AND EMERGENCY

6 Flood emergency management contributes to flood risk reduction. Flood risks can be reduced by decreasing the magnitude of hazards, preventing exposure of individuals and their activities to flooding and diminishing the vulnerability of flood-prone communities. Flood emergency measures can reduce exposure to flooding. This chapter outlines flood management policies underlying the flood emergency planning process.

2.1 Defining flood risks

7 IFM aims at reducing flood risk, resulting from a combination of flood hazards expressed in frequency and magnitude (depths of inundation, related velocities and duration of flooding); exposure of human activity to flooding; and vulnerability of the elements at risk **(Figure 1)** (WMO, 2006c, p. 9) The magnitude of the flood hazard itself cannot be controlled. Dams and reservoirs, however, can reduce the severity of downstream hazards by retaining floodwater during flood peaks. This means that the operation of storage and retention, including urban stormwater retention basins, needs to be considered in emergency planning. Exposure to flooding can be generally reduced through structural flood mitigation works, land-use planning and regulation, and flood emergency measures. Individuals' exposure to impending floods can be reduced through flood emergency measures that involve evacuation from flooded areas to avoid casualties or the spread of diseases. Economic activity that is likely to be adversely affected by flooding can also be halted through early warning (WMO, 2006c, p. 15). All measures must be taken with overall water resources management and development activities in the basin.

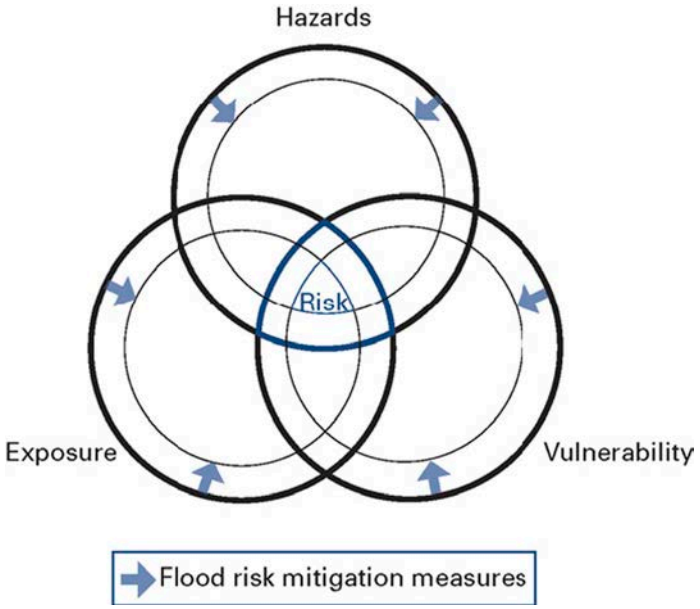

Figure 1 — Flood risk and its reduction

8 Risk management is an essential component in the development process for achieving sustainable development (APFM, 2004, p. 15). Measures of preparedness, response, recovery and rehabilitation are systematically applied in the risk management cycle **(Figure 2)** (Swiss Confederation, 2009).

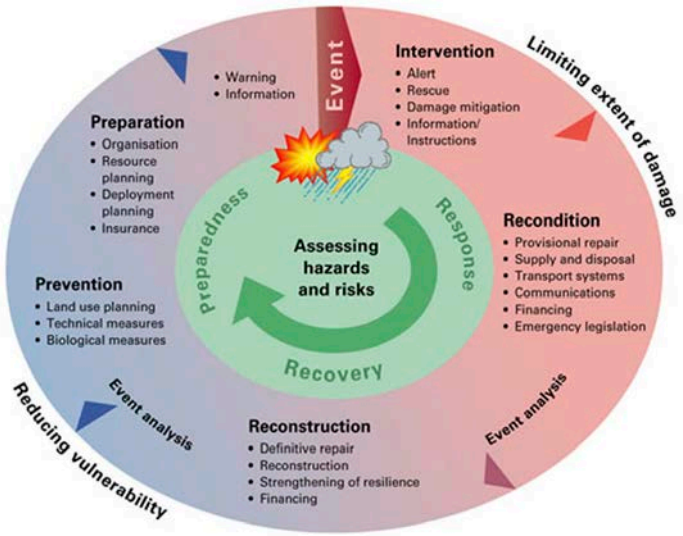

Figure 2 — Risk management stages *(Swiss Confederation, 2009)*

2.2 Integrated Flood Management and the risk management cycle

9 IFM aims at maximizing net benefits from floodplains and minimizing loss to life and livelihoods as a result of flooding. Flood risk increases with higher population density; increasing values of economic activity and infrastructure in flood-prone areas; and various needs for tourism and leisure that accompany development. Not only is it impossible to guarantee 100 per cent safety

from flood risk, but it is particularly important to develop the ability to cope with residual risks. A strategy to decrease risks from flooding through structural and non-structural measures can provide only partial safety for individuals inhabiting floodplains. When protection measures fail, damage is multiplied owing to increased investments made in flooplains by individuals who live behind protective structures (for example, dykes and embankments). For many societies throughout the world, the cost of reducing risk is too high or the effects of such measures are too damaging to the environment, or contradict the development goals of society. In such cases, a strategy to reduce vulnerability through disaster preparedness and flood emergency responses could be implemented (APFM, 2004, p. 21). Flood emergency management aims at managing and thus minimizing the damaging effects of flooding. The objective is to avoid exposure of critical infrastructure and economic activity and temporarily shift individuals and infrastructure (for example, mobile machinery) – wherever possible – from flood-prone areas, thereby reducing the negative impacts of flooding. Flood emergency plans should form part of a comprehensive multi-hazard strategy towards risk reduction in affected regions (Adapted from Oi, 2009, p. 47).

Box 1 — Cyclone emergency management experience in Bangladesh

To avoid exposure of critical activities and temporarily shift individuals from flood-prone areas, both early warning and evacuation shelters are fundamental. Once flooding overtops protection, flood emergency management depends on how easily individuals who inhabit floodplains can evacuate the flooding area. Early warning, with individuals' correct understanding of the warnings issued, can show how they can take action during flooding. When there is extreme flooding, individuals should know where to go to save their lives. The experience towards cyclone emergency management in Bangladesh shows that casualties have decreased in relation to an increased number of evacuation shelters and weather radars **(Figure 3)**. The disaster of 1970, when no weather radars and very few shelters were in place, provided an incentive for action towards cyclone emergency management.

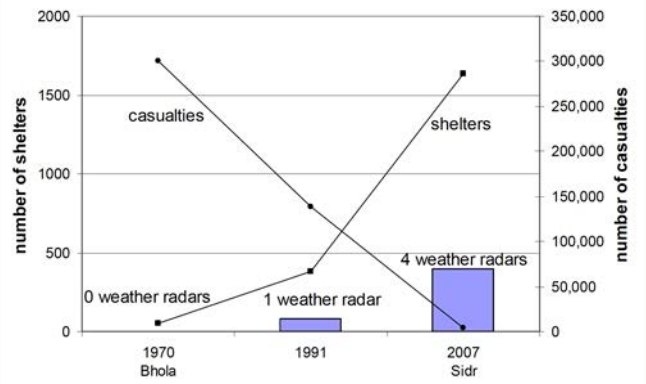

Figure 3 — Cyclone emergency management in Bangladesh

2.3 Emergency management and planning

10 The emergency plan, developed at the preparation stage in **Figure 2**, is known as the Emergency Preparedness Plan (WMO, 2006c, p. 42). Flood emergency planning is required at several levels: national, state, district, sub-district and community level. Although flood emergency plans are generally developed for emergencies at specific geographical locations, such plans should be developed in parallel with basin-wide flood management planning. One of the most important

interactions between the two planning processes takes place during the assessment of flood risks. While basin-level flood risks are a sum of all local flood risks, basin-level policies and development activities have a definite impact on the flood risk at the local level. It is therefore important to establish a mechanism that ensures constant interaction between the two processes. **Figure 4** illustrates the interaction between basin flood management and flood emergency management planning.

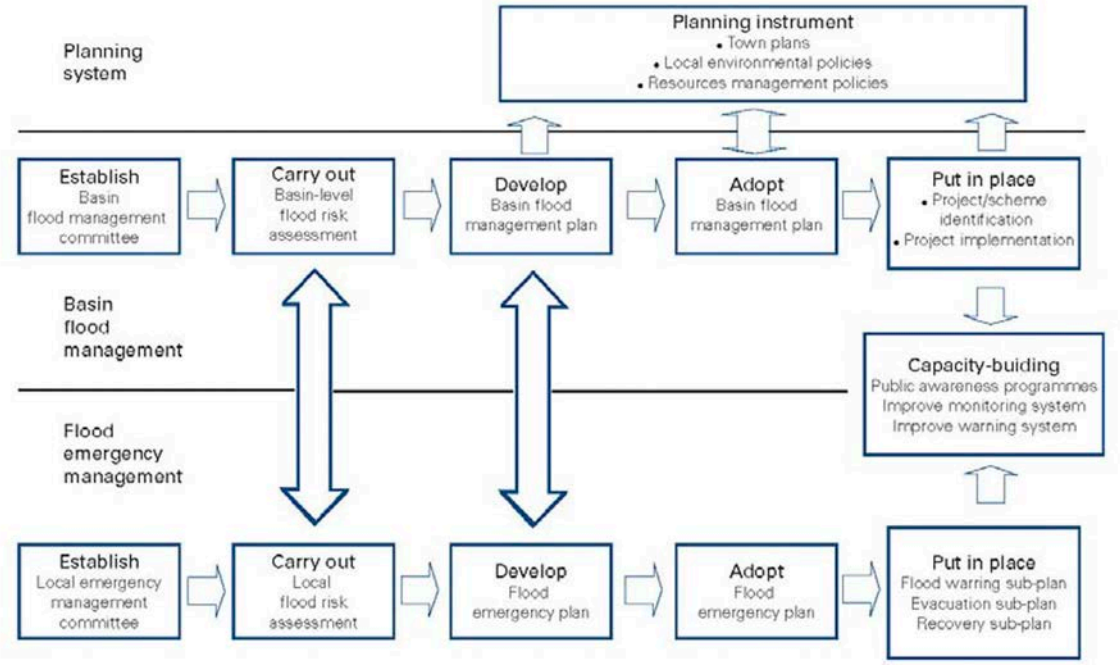

Figure 4 — Interaction between basin flood management planning and flood emergency planning (WMO, 2006c, p. 43; adapted from ARMCANZ, 2000, p.11)

11 Structural measures such as flood moderation reservoirs, floodwalls and bypass channels reduce the probability or degree of exposure of flooding through appropriate operation. Operational rules for such structural measures should be carefully planned in accordance with flood discharge into reservoirs, including discharge from extreme rainfall. In case these structural measures prove to be insufficient, flood-proofing methods should be adopted to minimize damages. Flood proofing is the provision of semi-structural measures to mitigate or minimize the damaging impact of flooding by avoiding exposure to floodwaters (WMO, 2006c, pp. 15–19). Emergency flood-proofing methods involve erecting temporary structures, building sandbag walls and protecting sensitive infrastructure and livelihoods. It is important to remember, however, that floods may also exceed the level of flood-proofing protection provided. In this case, emergency planning needs to include securing property and vacating premises during severe floods. For the entire process to be efficient, forecasts and flood warnings must be monitored and used in adaptive emergency flood management practices.

12 Community flood management committees **(CFMCs)** can be organized to serve as community representatives, focal points or community partners for basin-level planning. Flood emergency plans should be revisited as basin-wide flood management plans are implemented. Implementation of both plans are complementary and require capacity-building at the community level. Participatory planning for emergency situations can help build trust and confidence among stakeholders, enhance cooperation, facilitate information sharing and encourage regular communication.

3 THE ROLE OF EMERGENCY MANAGEMENT IN OVERALL FLOOD MANAGEMENT POLICY

13 Flood emergency management plays a vital role in overall flood management. It can be divided into three stages:

- Preparedness: pre-flood measures to ensure effective response;
- Response: measures to reduce adverse impacts during flooding;
- Recovery: measures to assist the affected community to rebuild itself.

Allocation of responsibilities needs to be considered carefully within each of the three stages: Government agencies from local to national levels should share flood emergency operation responsibilities for preparedness, response and recovery to flood Accordingly, various departments mandated for emergency response should form disaster response committees and meet regularly. Requirements relating to food, emergency shelters, evacuation of individuals, health services and emergency building materials should be assessed. Disaster response committees should also review experiences after previous flooding events and learn lessons for future adjustments and improvements to existing plans.

3.1 Flood emergency preparedness (WMO, 2006c, pp. 21–27)

14 Preparedness includes the issuance of timely and effective early warnings and the temporary evacuation of individuals and property from threatened locations. Education and public awareness; coordination among governmental and non-governmental agencies; effective stakeholder participation; and early warning systems are key components of preparedness planning.

15 **Raising public awareness:** Awareness can be raised through education and regular training – particularly in areas exposed to infrequent hazards or within new settlements. Flood hazard maps, depicting flood-prone areas, evacuation routes and safe shelters, can play a critical role in awareness building. Women and children should be included in education strategies, as they are disproportionately affected by natural disasters. Outreach efforts should be made to minorities and ethnic groups, as their mobility may be limited or affected owing to cultural, social or economic constraints.

16 **Emergency preparedness plan:** The emergency preparedness planning process and its relationship with the basin planning process is outlined in **Chapter 2**. Preparedness plans should be adequately linked to disaster management entities at the local, district, state and national levels. This method improves the ability of a community in a vulnerable area to respond to floods and to reduce the risk. Local inhabitants should be allowed to be active in developing and enacting flood emergency plans and to implement their own measures to reflect local conditions and real needs on the ground. Flood emergency preparedness activities vary from the individual to the national level, as shown in **Box 2**. At the community and municipality levels, mock evacuation and emergency exercises strenghten the preparedness coordination mechanism.

Box 2 — Flood emergency preparedness activities at various levels

1 Individual, family and household level

- Know the risks: drowning, waterborne diseases, electrocution, poisonous animals
- Install protective railings around house to protect children from falling into the water and to provide support for the elderly
- Scout for safe areas and know how to get there
- Know what to do when a warning is received
- Know whom to contact in case of emergency
- Keep life jackets or buoys or tires ready for use
- Keep first aid kits ready for use
- Store clean water and food in a safe place
- Listen to daily flood forecasts
- Move valuable items to higher ground
- Get ready for evacuation
- Protect livestock

2 Community or village level

- Identify and maintain safe havens, safe areas and temporary shelters
- Put up signs on routes or alternate routes leading to safe shelters
- Inform the public of the location of safe areas and the shortest routes leading to them
- Have all important contacts ready: district or provincial and national emergency lines; and have a focal point in the village
- Make arrangements for the set-up of teams in charge of health issues, damage and needs assessment
- Set up community volunteer teams for a 24-hour flood watch Improve or keep communication channels open to disseminate warnings
- Distribute information throughout the community

Box 2 — Flood emergency preparedness activities at various levels *(cont'd)*

3 Municipality, district, province and national levels

- Determine roles and responsibilities of each agency during response, relief and recovery phases
- Prepare maps (flood risk/inundation/vulnerability maps, resource maps) to provide essential information and data on current situation and to plan for assistance in those areas
- Make sure that critical roads are built up to a certain height – to create safe areas for flood-affected communities and to ensure continuous transportation critical for flood relief
- Identify new safe areas and maintain existing shelters, making sure they have sanitary and other basic necessities
- Implement public awareness activities to create a pro-active and prepared society, which can cope effectively with hazards and their aftermath
- Educate the public on what to do and what not to do to prevent harmful activities in the floodplain
- Educate the public on environmental management, water resource use and land-use planning
- Stockpile relief goods
- Prepare resource inventories – how much is available locally and how much is needed from the outside
- Plan resource mobilization
- Set up emergency teams (for example, health, search and rescue teams)
- Plan to assist in emergency response at the local level
- Conduct drills for search and rescue teams
- Make sure that communication channels to the community are functioning well
- Issue orders for various agencies and organizations to get prepared
- Inspect flood mitigation infrastructure (for example, dykes, levees and floodwalls)
- Disseminate public safety information through the establishment of early warning systems
- Specify the source and actions to be taken immediately after receiving warnings.

17 **Early warning systems:** Successful emergency operations depend greatly on the availability and reliability of flood forecasting information and the lead time provided by warning systems. Flood early warning is a message informing authorities of the impending danger of floods, that is, the water level rising above the warning level. Longer lead time will provide sufficient time to consider and effect a number of responses, whereas reliability of the warning and confidence with likely respondents determines its effectiveness. Warnings must be provided and conveyed in an unambiguous, easily understandable manner and in the local language through a legally designated single authority.

3.2 Flood emergency response

18 Flood emergency response can be defined as the implemention of pre-planned activities during flooding to reduce the adverse impacts to the population and material values and infrastrucutre at risk. It can be differentiated from post-flood recovery and rebuilding, which is explained in the following section. During this stage, the effectiveness of the preparatory work conducted during the pre-flood season is validated.

19 **Protection of critical infrastructure:** It is necessary to mobilize personnel and machinery – where available – to protect infrastructure, such as dikes, levees and retention basins; to remove individuals from facilities at risk, such as hospitals, schools, industrial sites, bridges, or individual houses; and to prevent landslides and disastrous river-bank erosions. This includes emergency strengthening and rehabilitation of existing structures and flood-proofing measures, such as sandbagging or establishing temporary earth, wooden or other flood barriers, including mobile flood barriers.

20 **Rapid needs assessment:** Local government agencies are expected to assess the immediate needs of affected communities, evacuate population in high-risk areas, activate local search and rescue teams, take immediate remedial measures to repair or restore damaged infrastructure, and seek help from state or national authorities when the scale of the disaster exceeds their capacity. In addition, to safeguard public order and security, as soon as the flood situation becomes critical, a rapid assessment should be made to confirm immediate needs, and updates should be provided as the situation unfolds. The most important feature of emergency response is the timely and efficient coordination between responsible government agencies, local communities and NGOs. Coordination and cooperation between institutions, humanitarian groups and individual volunteers needs to be addressed, particularly in major disasters.

21 **Safe shelters:** Safe shelters should be identified in advance, and evacuation routes leading to designated shelters clearly marked. Organization of shelters and distribution of aid among the affected population should be mainly in the hands of local community organizations. Priorities should be established to prepare exclusive response programmes to meet the specific needs of infants, the elderly, pregnant women and the disabled. One area that requires attention, particularly in flood-prone locations, is the lack of an exit strategy in relief operations. Lack of a strategy that results in poor planning may force a community to become dependent on relief handouts for their survival rather than addressing their vulnerabilities pro-actively.

3.3 Post-flood recovery and rebuilding

22 The post-flood recovery and reconstruction phase creates opportunities as well as challenges for development projects in making sure that post-flood recovery and rebuilding do not contribute to future flood risks. It also provides the opportunity to move vulnerable activities away from risk areas and introduce flood-proof infrastructures during rebuilding.

23 Vital lifeline facilities, such as water and electricity supply, roads and telecommunications, hospitals and sewage systems, have to be repaired quickly, even if the repair is provisional. Restoring education and health systems, rebuilding damaged homes, restoring contaminated water sources and providing psychological care through counseling should be given top priority.

24 Once basic lifeline services are restored, long-term development goals and plans should be consulted. The recovery period shoud be viewed as an opportunity to explore ways to improve the flood risk situation and incorporate enhanced resilience of rebuilt assets. Reconstruction provides a great opportunity to reduce vulnerability at little or no expense by implementing methods for preventing future loss. Although authorities face great pressure for immediate and temporary solutions, they should grant building permits only after reassessment of the hazards. Assets and infrastructures should be rebuilt according to the latest standards ("no-regrets reconstruction").

25 In applying future risk reduction from flooding, authorities need to learn from previous disasters. Documenting the extent of the flooded area and the level of flooding by updating hazard maps is key to preparing for future flood events and for determining evacuation routes, shelter locations and future land-use planning. In addition to documenting disasters, it is necessary to document rescue operations to optimize future operations. Because local authorities are usually occupied with the most urgent work, external experts with inputs from local communities should carry out the documentation and analyses.

4 NECESSARY ARRANGEMENTS FOR EMERGENCY MANAGEMENT

26 This chapter draws on lessons from actual experiences for emergency management planning and preparedness at various levels, including the community level. Consideration should also be given to individual participation, which is essential in emergency flood management planning. Because absolute safety from floods is a myth, risk management needs to include activities and measures to reduce residual risks.

4.1 Flood emergency management planning

27 Decisions for flood emergency management must take into account not only flood risk reduction, but also humanitarian or civil protection within the context of IFM. There are two aspects: horizontal interactions and vertical interactions. First, planning must be integrated at the governmental level so that the government's strategy, implemented through different departments, is coherent and harmonized. Second, it must be applied at all levels of public planning, whether national, regional or local, and involve all relevant public agencies (WMO, 2006, p. 8).

4.1.1 Horizontal Interactions

28 Given the enormous influence of land use on flood risk, it is imperative that land-use planning and flood emergency planning are properly coordinated. For instance, the consequences of deforestation and especially uncontrolled logging on flood risk can be significant for flood peaks. The consequences of agricultural land-use practices may also have similar deleterious effects on downstream river regimes. Ministries that may be involved in the decision-making with the potential to affect flood emergency planning should not be limited to principal ministries for spatial and land-use planning, but include as well ministries of the environment, agriculture, civil/defence/security, nature conservation, transport, forestry, interior, construction, water resources and health (WMO, 2006, p. 9). To integrate flood emergency planning and land use,

planning authorities must identify and take into account those factors that increase or affect the risk of flooding when making decisions regarding new developments, changes of land use, construction of roads and new structural flood controls (WMO, 2006, p. 11).

29 Flood risk is also affected by the condition of watercourses, especially drainage conditions. Drainage congestion may cause or accelerate flooding in certain areas. To avoid alteration of watercourses by debris or other blockages, an organization should be identified and made responsible for their maintenance and enabled to fulfil its duties. As drainage capacity is an integral element of new developments – such as bridge construction – this organization should be consulted on respective developments. Where irrigation networks in the context of drainage are already in place, the needs and practices of farmers must be taken into consideration (WMO, 2006, p. 12).

30 In emergency situations, responsibility for the response often lies with interior ministries or specific ministries devoted to civil defence. Emergency management, however, requires cooperation across all sectors and administrative levels. Those sectors include but are not limited to the following: humanitarian; civil defence/security; infrastructure development of the public domain; and property owners with clarified relationships to each other. In particular, facilities for water resources management, such as hydropower or water storage or intake for drinking and industrial purposes, have direct impacts on flood conditions; therefore, their operation should be consistent with managing flood risk even though such facilities are operated primarily on the interest of facility owners.

31 Apart from involvement in decisions on planning particular activities or programmes that may potentially have an impact on flood risk, the participation of local communities that are closer to the event and are the first to react during a flooding emergency is vital. Local volunteers may be asked to contribute materials and equipment, and to take part in manual labour either individually or with other emergency response services in the area during flood crises. It may also be necessary to involve representative associations at the local level; for instance, Water Use Associations **(WUAs)**, Community Flood Management Committees **(CFMCs)** or forestry groups. WUAs are likely to be organized at the basin level and will have a far greater understanding and awareness of local watercourses than those in central administrations. Additionally, CFMCs improve the self-help capacity of individuals affected (WMO, 2006, pp. 23–24).

Box 3 — Typhoon Ketsana, 2009

The central region in Vietnam was severely affected by Typhoon Ketsana in September 2009. It is reported that 163 people died, 11 people were missing, and that economic loss was evaluated at US$ 785 million.

Response activities differed between communities. In the Binh Duong commune of Quảng Ngãi province, pre- disaster preparedness plans, workshops and meetings, periodic evaluation of their responses and individual preparedness proved effective, resulting in limited damages to individuals and their properties. The leadership of the flood committee played a strong role in the planning. On the other hand, in the Vu Gia-Thu Bon river basin, located in the Quảng Nam province, local residents were taken by surprise by the floods. They did not receive enough information on floods and storms as water levels rapidly increased. Their knowledge to cope with floods was insufficient, as flood levels this time were about 50 cm higher than the highest level they had experienced in the past. Although they were able to escape from the floods, livestock, harvested rice, and other valuables were lost. In most cases, usual communication systems did not work at the community level because of power failure. Individuals had to rely on conventional methods of communication, using megaphones or door-to-door visits for information, which made a difference for emergency response during flooding.

(**Box 3** excerpted from JICA, 2009, Project for Building Disaster Resilient Societies in Central Regions of Vietnam, Assessment Report on Response to Typhoon Ketsana in the Central Region.)

32 From an IFM standpoint, it may be instructive to examine the nature of legal liabilities and state obligations for pre-flood, during flood and post-flood scenarios. For a participative and integrated approach to become a reality, institutions and individuals must not only have the necessary rights to be able to enforce such a system, but also know their appropriate responsibilities so that they are accountable for their actions or inaction. Rights need to be associated with correlative powers and procedures for enforcement as well (WMO, 2006, p. 25).

4.1.2 Vertical Interactions

33 A clear and unambiguous institutional framework is required to manage the interfaces between different layers of government during flood emergency situations to minimize the response time at the appropriate level. The subsidiarity principle is applied to induce action at different levels of government, depending on the impact of the flood. In addition, in any emergency situation, the success of operations is also determined by the type of political leadership provided (WMO, 2006, p. 11). Coordination is required between national, state, district and local levels of the different ministries cited above. Equally important is where a national disaster management body acts as key coordination facilitator during the planning stage and where the respective district or commune disaster management entities act as key implementers of emergency measures (WMO, 2006c, pp. 42–43). Coordination is required also among all emergency response agencies – such as government agencies, CFMCs and other humanitarian NGOs, where national and local flood emergency plans are shared.

34 Participatory planning is a prerequisite for emergency planning. At each level, all stakeholder groups concerned must unite to develop an emergency plan. Risk and vulnerability assessments, distribution of specific roles and responsibilities, resource analysis and mobilization are critical components of emergency planning, which call for the participatory process. Risk assessment conducted at the local level in the form of flood hazard maps provides basic information on the likely extent of flooding, identifying flood-prone areas and the population residing in such areas. Results are then shared with all stakeholders. Basin communities residing in flood-prone areas should be informed of local risks to motivate them to take action to develop their own resilience.

35 Local authorities play a key role in flood emergency management with respect to flood warning, provision of labour and equipment, evacuation, management of safe havens and assessing and addressing relief camp needs. Involvement of key response agencies in determining and assigning responsibilities for flood emergency management confirms their commitment, clarifies their roles and responsibilities and reduces duplication of tasks among stakeholders, thereby enhancing coordination and effectiveness.

36 Effectiveness of flood and emergency warning is determined by how many individuals can reach the area that is expected to be affected. It is dependent on their coverage and reliability, as well as the ability of the population at risk to receive and adequately react on a warning, in addition to the effectiveness of the action taken. Responsibility of issuing flood warnings should be clearly defined in the body or bodies where the resources and technology commensurate with carrying

these out (WMO, 2006, pp. 17–18). In addition to the question of "which emergency agency should provide the public with flood warnings", there are the questions of "which agencies should receive what information, and when". National practice around the world varies with respect to authorities who are responsible for the practicalities of flood emergency response coordination. As far as possible, it is desirable that the nature of the meteorological and hydrological data collected at a national or basin level and the tools used to collect these data are consistent. Basin-wide organizations responsible for collecting data may be formed or, if in existence, charged with such responsibility. In addition to resource mobilization, continuous, timely and precise information flows are vital for handling emergency situations (WMO, 2006c, p. 21). Because flood forecasts are based on knowledge of progressive flood behaviour to date, either in terms of catchment rainfalls or upstream water levels, forecast flood levels contain uncertainties in their origin and should be interpreted as likely rather than absolute flood levels. Undue reliance on the accuracy of forecast flood levels can exacerbate damage if actual levels are higher than predicted. A flood warning by itself does not alleviate hazard and flood damage – accompanying flood defence and evacuation arrangements are also required (ARMCANZ, 2000, p. 17).

4.1.3 Flood Emergency Management Plan

37 The flood emergency management plan is a detailed document containing sub-plans that address, among other things, preparedness for and implementation of responsive activities to be taken depending on the severity of a flood. Its primary aim is to clearly identify the responsibilities and appropriate activities to be taken by stakeholders during an actual flood.

Coordination is required between government agencies, including disaster management committees at different levels, line departments, public works, health, armed forces and police, economic and finance, planning, education, rural development, transport, communication, environmental and natural resources, where disaster management committees can take the lead and coordinate the planning process. Active NGOs may play an important role in interacting with government agencies and in undertaking emergency measures at the local level within an overall flood emergency plan. The importance of horizontal and vertical interactions requires that the emergency plan clearly identifies responsibilities of various players during an actual flood (WMO, 2006c, p. 42). The plan should clearly spell out responsibilities involved in disseminating flood forecasts and warnings, and identify the authority that will order and organize evacuations under various scenarios along with the necessary actions – these functions need to be worked out during the development of the flood emergency plan. Local authorities have a key role in flood emergency management with respect to flood warning, provision of labour and equipment, evacuation, management of safe havens and assessing and addressing relief camp needs – these functions need to be worked out during the development of the flood emergency plan. The involvement of key response agencies in determining and assigning responsibilities for flood emergency management confirms their commitment, clarifies their roles and responsibilities, and reduces duplication of tasks among stakeholders, thereby enhancing process coordination and effectiveness. Again, structured communication and ensuring adequate means of communication between stakeholders at all levels during an emergency are key to success.

38 Flood emergency plans can be developed for different levels of jurisdiction – states, regions and local areas or a combination of these. The emergency plan should clearly define responsibilities and necessary actions, depending on the severity and range of flooding, to assure security in

suffered areas and to distribute basic necessities (water, food, and so forth). Plans at different administrative levels will have differing contents, partly reflecting responsibilities of the principal participants at these different levels (ARMCANZ, 2000, pp. 59–60).

39 State flood emergency plans may detail:

- Responsibilities of key agencies (for example, emergency service and department of planning and water resources management) with respect to prevention, preparedness, response and recovery measures;
- Requirements for flood emergency planning at the regional and local levels – these plans would define the appropriate scope and content of such plans and any special flood emergency plans that may be needed (for example, to cater for potential dam failures);
- Requirements for specific flood emergency activities (for example, warning and information provision);
- Emergency management structures that support flood operations;
- Control mechanisms and responsibilities of key staff (for example, emergency service controllers or managers).

Regional flood emergency plans may detail:

- Arrangements for coordinating flood responses occurring simultaneously in several council areas within the region;
- Arrangements for coordinating the provision of extra resources required at the local level;
- Activities at the regional level on behalf of agencies involved in operations at the local level (for example, the transmission of flood forecasts and the provision of information to the media)
- Control arrangements.

Local flood emergency plans may detail:

- Nature of the flood threat;
- Areas that could be affected by flooding;
- Sources of flood intelligence (for example, fundamental data through constant monitoring of floods);
- Roles and responsibilities of listed agencies before, during and after flood episodes;
- Control arrangements;
- Trigger conditions for plan activation;
- Liaison and communication arrangements;
- Arrangements for public education, warning, the passage of information to flood-affected communities, road control, sandbagging, evacuation, re-supply, rescue, registration and welfare of evacuees, initial recovery and post-flood debriefing.

4.2 From plan to action for emergency management

4.2.1 Hazard Mapping

40 Effective use of hazard information is important. Flood hazard maps contain basic information on the magnitude of flood hazards within a basin. Such maps should not only demarcate the extent and magnitude of flooding but also the sensitivity of such demarcations to various land uses and drainage conditions (WMO, 2006, p. 11). Mapping should also be connected to training and local capacity-building for response and evacuation.

41 Sustaining individuals' awareness is critical for making mapping on flood management effective and for enhancing communication with stakeholders, including local inhabitants. It is not easy to maintain awareness because it diminishes with time although individuals are aware of flood risks just after major floods. Rapid changes in local communities, such as migration and urbanization, have led to a decrease in the number of residents that have experienced flood disasters. Most community residents lack information on previous major regional flood damage as well as knowledge of projected floodwater depths in the area where they live and other facts pertaining to flood risk. To sustain individuals' awareness, efforts in dissemination and communication with stakeholders are required. One example of this effort is through the updating of flood mapping.

42 According to the European Union **(EU)** Flood Directives, for instance, all member nations should assess by 2011 all water courses and coast lines that are at risk from flooding, and draw up flood risk maps by 2013 showing flood extent as well as assets and individuals at risk in these areas (EU, 2007). Flood mapping activities are common in EU countries.[2]

43 **Community activities and mapping:** Describing the hazards of flooding without giving advice on what to do is insufficient, as it confuses individuals on what appropriate actions to take in case of disastrous floods. Flood mapping exercises need to be combined with on-the-ground training, which demonstrates that the possibility of an event is recognized and improves actions, maintaining continuous planning and updating of action plans as a part of flood emergency planning. In many vulnerable communities, experience shows that flood issues are not always given a high priority compared with daily survival issues, such as livelihood, lack of water and sanitation facilities, law and order, and so forth This often makes communities behave passively towards flood risks, as they are seen as a remote occurrence without a perceived chance to control events (otherwise described as a fatalistic behaviour). This renders communities more vulnerable and sometimes more exposed to floods. To avoid this situation, motivation for initiating community participation, such as socio-economic incentives and systematic training, are indispensable. Better understanding results in higher aspirations and assertiveness among individuals, which are essential for motivating and sustaining these activities. Along with regular messages, organizing community participation increases community awareness of the risks and enhances their interest and motivation in mitigating risks (APFM, 2008). Every stakeholder and local individual should share a common vision, which leads to a sense of shared ownership and motivates community action. For example, raising yards or homesteads through earth fills

2 For instance, a mapping framework for flood risk management in Germany, the Netherlands, Norway, Sweden and the United Kingdom of Great Britain and Northern Ireland can be seen in (Flows, 2006).

in the framework of a United Nations Centre for Regional Development (UNCRD) case study in Bangladesh not only safeguards the local population against flooding but also results in long-term livelihood benefits (UNCRD, 2004). As a result of the 2008 Tsunami in Thailand, risk reduction measures have included emergency and evacuation plans, and land-use planning along with tsunami signs (CCOP, 2006) **(Figure 5)**.

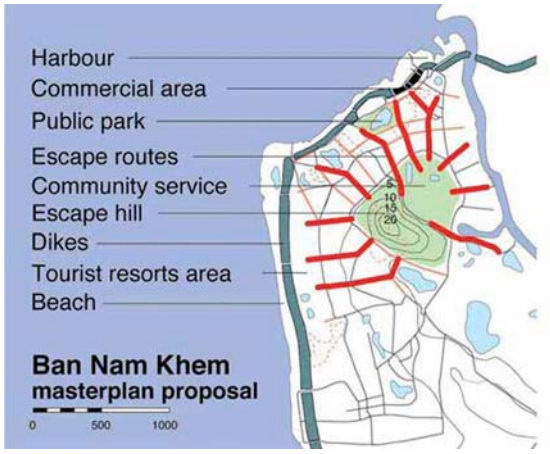

Figure 5 — Map showing a possible protection dike around Ban Nam Khem, in Thailand, with escape routes to safe high areas (CCOP, 2006b)

44 Flood signs: Flood signs that are the direct equivalent to traffic signs are effective means of communicating the contents of flood maps. Sustaining individuals' awareness for flood risks, flood signs provide vital indications for individuals to realize the degree of exposure and their relative vulnerability to flood hazards. Risk awareness means recognizing the hazard, understanding the mechanisms of an impending flood and its impact, and taking flood map information into account when taking action in accordance with the flood emergency plan. Flood signs serve to create a heightened sense of risks and better awareness of the location of escape routes, protective shelters and safe high areas for evacuation, among others. In combination with flood maps, flood signs are highly useful to promote the use of maps and facilitate community participation in flood risk assessment as well as in planning and implementing risk management measures.

45 As mentioned in **Section 4.2.1**, flood maps contain flood hazard information, thus flood signs on the ground reflect information provided in flood maps. In Japan, for example, this has resulted in efforts to standardize pictoral designs for flood signs, called "Ubiquitous Flood Hazard Maps (Comprehensive Town-Wide Hazard Maps)". Japan enhances the signs of flooding in downtown areas for individuals' understanding about flooding, such as flooding and evacuation routes during a flood. The "Manual for Making Flood Hazard Maps Ubiquitous" (MLIT, 2006) aims at providing directives on orderly evacuation of flood-affected areas and at helping to minimize flood damage by providing facts and encouraging the dissemination of knowledge of possible floodwater depths and shelters. The Manual also aims at raising awareness of risks by displaying information on floodwater depths and shelters in the form of flood-related signs around towns **(Box 4)**. These marks are registered in the Japan Industrial Standards **(JIS)** and are being sought registration under the International Standard Organization **(ISO)**. The philosophy behind this approach is that the more standardized signs are spread, the more individuals can recognize and interpret flood risks, just as the general population obeys traffic signals. Some signs have already been displayed outside Japan **(Figure 6)**. Although flood signs may be effective, they alone are

not sufficient. They should be combined with updated plans of action to be taken during flood events, and on-the-ground practical training to improve action for possible events.

Figure 6 — Flood signs, Kasiru Village, Kenya *(Picture taken by APFM staff; 2008)*

Box 4 — Standardized signs for flooding in Japan *(MLIT, 2006)*

The Manual establishes three categories of information to be provided by flood-related signs: Flood (placed at floodwater expected depths), Shelters, and Levees. The symbols indicated in this box are specified for nationwide use in providing each kind of information under the principles of

- Eye-catching symbols that should be used nationwide for intuitive understanding by everyone and that urge evacuation towards safe places,
- Colors and shapes of each symbol that are in accordance with the conditions for using symbols, and
- Symbols that are used for flood-related signs should also be used in paper hazard maps and other media related to flood response.

The sign for "Flood" (left) indicates overbank flow of a river to clearly mark areas likely to be affected by flooding. The sign "Shelter building" (right) indicates a safe shelter (building) and marks the direction to a safe building that can be used as shelter in the event of a severe flood.

4.2.2 Emergency Drills and Exercises

46 Emergency drills and exercises aim at facilitating the recognition of roles and responsibilities for each player during an emergency response, and at identifying means of communication and sequences of actions to be performed. Different skill sets are needed at different levels for stakeholder groups, depending on the roles they are expected to play. The variety of stakeholders, their respective interests, needs and gaps with regard to skills, knowledge and ability to adequately take part in emergency response should be analysed.

47 Drills and exercises comparable to fire drills at the institutional level aim not only at accustoming each institution to its respective function, but also at building up capacity to manage the organizational aspects of stakeholder participation and to form partnerships with other experienced groups in the participatory processes. Methods for drills and exercises include formal training, learning through implementation, thereby developing skills as part of the institution-building process and organizational reforms or both. Drills and exercises at the community or individual level start with identifying an existing level of knowledge and behavioral pattern, including risk awareness and attitudes towards different levels of risk perception and acceptance. It focuses on building awareness of flood risks in a community to help it respond with activities that mitigate flood hazards; and keeping the population informed on local environmental issues aimed at improving natural resources. In addition, such promotional activities provide an opportunity to update emergency stockpile, check evacuation routes and shelters, and raise public awareness (Osti and others, 2009). With mapping activities, this approach supports effective management of probable flood emergency situations by different users of flood maps.

48 A variety of measures for drills and exercises is available, including the dissemination of awareness materials, meetings and sharing information on advanced tools. Advancements in information science and communication technology have facilitated communication and networking among interest groups. Facilitating information exchange and networking can build the capacities of local stakeholder groups. The UK Environment Agency, for example, provides free flood warning services directly to registered individuals by telephone, mobile, e-mail, SMS text message and fax (UK, 2009).

49 Along with traditional drills and exercises, training that includes role-playing exercises may be useful **(Box 5)**. This method has proven more effective with informed participants, but is also an enlightening and interesting way to help individuals see a problem from another perspective (WMO, 2006b, p. 57). It allows participation from representatives of community groups, interest groups or key stakeholders, and sometimes decision-makers in local governments. Disaster response exercise systems for role playing have been developed by local government personnel of disaster prevention divisions (Hada and others, 2004), as well as a disaster management training support system based on scenarios of flooding in river basins (FRICS, 2009).

Box 5 — Role-playing drill for practitioners ***(MLIT, 2009)***

In traditional drills, participants are informed before the drill begins about the scenario in which they will be acting; therefore, participants know in advance what actions they need to take. Once an unexpected event occurs in a play scenario, however, flexible decisions or actions are required to manage such situations. Such role-playing drills are developed for situational decision-making training. In other words, the traditional drill is suitable for training of repeated necessary actions by many stakeholders under standard expected situations (scenarios), while role playing is for training of flexible and adaptive decision-making by practitioners of a disaster response (FDMA, 2006, p. 63).

...

Box 5 — Role-playing drill for practitioners *(cont'd)*

What is a role-playing drill?

The drill is not based on a scenario in which participants have been informed in advance. Trainees are divided into two groups: *"controller"* and *"player"*. Although controllers provide a situation in accordance with the scenario, players should think about their appropriate actions based only on the provided situation without knowing the scenario. To assume an environment similar to actual disasters, controllers play several roles, such as other government agencies, mass media and local inhabitants, and act as stakeholders in such a drama through various communication tools (face-to-face, telephone, cards, and so forth). All decisions and actions are reviewed by all participants after all sessions are over.

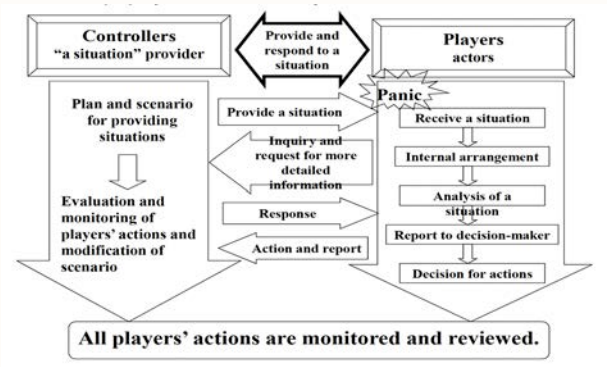

Figure 7 — Basic flow chart of a role-playing drill

4.3 Residual risks

50 As has been previously mentioned, absolute protection from flooding is neither technically feasible nor economically or environmentally viable. There is always the possibility that a flood may be greater in magnitude than predicted for a specific level of protection. The potential for such a flood event presents a residual risk. There is practically no zero-risk condition achievable through actions and plans that form part of managing flood risks. Damages and losses that occur as a result of exceeding the design risk should be transferred, shared, or examined for alternative solutions.

4.3.1 Residual Risk Sharing

51 Efforts should be made to reduce residual risks that involve flood emergency management. Examples include early warning, evacuation and preparation for disaster relief and flood proofing, along with land-use and spatial planning (APFM, 2009, p. 7). For instance, levees only reduce the risk to individuals and structures. They do not eliminate the risk and, in many cases, can create significant and potentially catastrophic residual risk that may increase as conditions in the region change (for example, land-use change) (FEMA, 2006, p. 24). The population and public officials often do not understand the residual risk to individuals living behind levees (FEMA, 2006, p. 13). Examples in the United States show that, even if a levee system has been restored to provide 100 years of protection, and if the area around the levee was eventually fully developed, then that area would be at risk if the levee system were overtopped or failed.

52 Even with all efforts in place, flooding may result in losses and damage to properties and interruption of economic activity. Such losses have the potential to increase vulnerability of

the population affected; therefore, cost-sharing should be considered. The perception of flood risks vary among individuals in their respective geographical location. Even the planners and individuals living in the floodplains perceive risks quite differently. Past flood incidents can either reduce or accentuate vulnerability, depending on the frequency of such events and the capacity of the affected individuals to recover (WMO, 2007, p. 5). Such issues should be considered when risks are shared among governments (such as central governments, regional governments and local governments), interested parties (such as private companies), and communities and residents charged to take flood management measures aiming at reducing risks. Flood insurance has often been advocated as a long-term non-structural measure for building resilience among flood victims. The unsatisfactory status of flood insurance in developing countries, however, shows that financial support mechanisms (subsidies, funds and loans for spreading the financial burden in terms of equity and fairness) should be combined in flood management to incorporate equity with economic effectiveness (WMO, 2007, p. 38).

53 Climate change and variability also increase the uncertainty of risks, which affect the bandwidth of residual risks. Climate change is generally perceived as an increase in frequency or intensity of extreme weather events, such as in tropical storms. The relationship between averages and extremes is not well understood. A shift in average rainfall increase is likely to be associated with a more significant change in floods. A projected increase in total rainfall could be not only affecting the frequency in distribution of floods but also related to the intensity/severity of flood events. Uncertainty in climate predictions, however, are still high, and there are also major uncertainties in quantitative projections of changes in hydrological characteristics of rivers in addition to dynamics associated with land-use changes and demographic developments. Methodologies in risk sharing need to be continuously developed and refined.

4.3.2 Retained Risk Management

54 Because of the consequences of residual risks, retained risks need to be managed adequately by each community at different levels, as outlined in previous chapters. In this context, business continuity is a holistic concept that ensures integrity of operations in case of unforeseen events (BCI, 2008, pp. 1–5). Business continuity was originally devised mainly for "business" entities, but is now also applied for public entities in disaster management. In the public sector, business continuity is also known as Continuity Of Operations **(COOP)** or continuity of government (NFPA, 2007, A.3.3.1).

55 COOP has been recently re-emphasized as an example for "good business practice" to be incorporated into day-to-day planning to reduce vulnerability and ensure continuity (DHS, 2008). An organization's resiliency (in flood management: a community or larger administrative unit) is directly related to the effectiveness of its continuity capability, which rests on key components and pillars: individuals; communications and technology; and facilities. In the United States, for example, for national continuity policy, the elements of a viable continuity capability are delineated within the following essential functions **(Figure 8)**.

- National Essential Functions **(NEFs)** represent the overarching responsibilities of the federal government to lead and sustain the nation and will be the primary focus of the federal government's leadership during and after an emergency.
- Primary Mission Essential Functions **(PMEFs)** are mission essential functions **(MEFs)** that need to be stated in the Mission Statement of government agencies, and that must be performed to support or implement NEFs before, during and after an emergency. PMEFs

are defined as functions that need to be continuously performed during an event or resumed within 12 hours of an event, and that need to be maintained for up to 30 days after an event or until normal operations can be resumed.

– Mission Essential Functions **(MEFs)** are a broader set of essential functions. These functions include not only an agency's PMEFs but all other agency functions that must be continued throughout or resumed quickly after disruption of normal activities, and that do not qualify as PMEFs. MEFs are functions that enable an organization to provide vital services, exercise civil authority, maintain the safety of the public and sustain the industrial/economic base during disruption of normal operations.

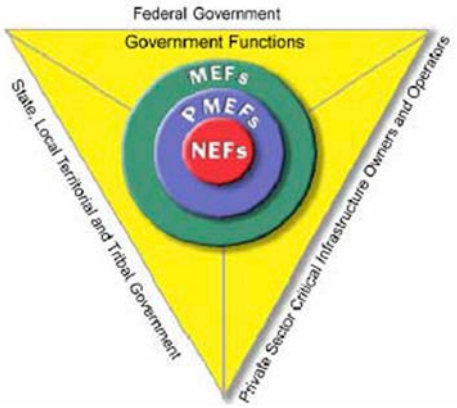

Figure 8 — Government organizational levels and essential functions *(DHS, 2008, FCD-D-6)*

56 Along with the continuity of government functions, the "Ready" campaign was designed in 2003 to educate and empower individuals to prepare for and respond to emergencies, including natural and man-made disasters (Ready America).

57 Another example of business continuity is the United Kingdom Civil Contingencies Act, enacted in 2004. The Act is a framework that instructs all emergency services and local authorities to actively prepare and plan for emergencies (UK, 2009) (UK, 2004). It is separated into two substantive parts: a clear set of roles and responsibilities for those involved in emergency preparation and response at the local level, and emergency powers for making temporary special legislation to help deal with the most serious emergencies. The local responders are divided into two categories, imposing different sets of duties on each.

– Category 1: the organization at the core of the response to most emergencies (for example, emergency services, local authorities, national hydrological service entities), subject to the full set of civil protection duties;

– Category 2: the "cooperating bodies" (for example, health and safety executives, transport and utility companies) likely to be involved in the heart of planning work but would be heavily involved in incidents that affect their sector.

58 Likewise, in Japan, the Central Disaster Management Council, chaired by the Prime Minister of Japan, formulated in 2005 a policy for business operational continuity of fundamental government functions towards major earthquakes in the Tokyo area. All central government agencies have formulated their own business continuity plans based on guidelines of the Cabinet Office of the Japanese Government (CAO, 2010) (MLIT, 2007). With regard to flood risks, the Council formed a special committee for discussing extreme flooding in the Tokyo area and for drafting measures for large-scale flooding, such as cooperative response, rescue of stranded individuals, and providing estimates on the impact on lives and social and economic conditions **(Box 6)** (CAO, 2008).

Box 6 — Simulation of extreme floods in Japan

The Central Disaster Management Council *"Special investigation committee on large-scale flood"* in Japan is officially in charge of estimating damages, such as death toll, number of homeless individuals and flooding duration in case of floods beyond the 1947 largest ever recorded flood from the Tone River causing severe inundation.

1 Flooding duration

Flooding duration is estimated in some cases, depending on scenarios. Because the discharge pumping station installed for drainage behind the levee (mainly for inner flooding) might stop when large-scale flooding occurs, scenarios depend on the drainage system, such as discharge of the pump station, drain pump car and sluice. For example, if the embankment breaches in Otone-cho, Saitama Prefecture, owing to 200-year flooding (almost the same as a recorded typhoon in 1947), one of the following may apply:

a If drainage facilities are completely out of operation, about 1.6 million people (about 310 km^2) are affected in one week after breach of the embankment. The flooding continues afterwards for a yet undetermined period amount of time.

b If drainage facilities operate perfectly, about 0.2 million people (about 120 km^2) are affected in one week after breach of the embankment. It will take about three weeks to completely pump out 95 per cent of the floodwaters.

2 Death toll, Comparison of breach points

A maximum death toll occurs when the embankment collapses in Koga city, Ibaraki Prefecture, owing to 200-year flooding. In this case, assuming a 40 per cent evacuation rate, one of the following may apply:

c If drainage facilities are completely out of operation, the death toll would be about 3,800.

d If all the drainage facilities operate perfectly, the death toll would be about 3,500.

This assumed that the evacuation rate (40 per cent) does not mean typical value; therefore, it can change greatly depending on the degree of imminence and temporal adequacy of flood information, timing of evacuation orders and the way they are disseminated to residents, prevalence of flood hazard maps, drilling, and so forth.

3 Death toll, Flood scale influence

The death toll is estimated under the condition of embankment breach in Otone-cho, Saitama Prefecture, in case 1.2 times larger amount of 200-year flooding occurs (equivalent to 1,000-year flooding), and assuming a 40 per cent evacuation rate. This is with precipitation of 320 mm per three days, about 22,000 m^3/s volume of Tone River flow.

e In case drainage facilities are completely out of operation, the death toll amounts to about 2,700 (1.8 times increase).

f In case drainage facilities operate perfectly, the death toll amounts to about 1,700 (2.0 times increase).

4 Number of affected individuals

The number is estimated under the condition of embankment breach in Otone-cho, Saitama Prefecture, owing to 200-year flooding and assuming a 40 per cent evacuation rate when executing rescue with all police boats, fire fighters and the Self Defense Forces of the Kanto region (estimated at about 1,900 boats, 12 hours of operation per day).

g In case drainage facilities are completely out of operation, rescue operations for affected individuals (about 480,000) would take about 14 days.

h In case all drainage facilities operate perfectly, rescue operations for affected individuals (about 120,000) would take four days.

5 CONCLUSIONS AND RECOMMENDATIONS

Key Messages:

- By reducing exposure to flooding, flood emergency management contributes to flood risk reduction, which is an important objective of Integrated Flood Management.
- Flood emergency management plays a vital role in each stage of the flood management cycle: preparedness for, response to and recovery from flood disasters.
- The emergency plan should clearly spell out the responsibilities involved in disseminating flood forecasts and warnings, and identify necessary implementation activities that mandated and responsible authorities will carry out and organize under various emergency flood scenarios. Flood emergency planning is required at several levels: national, state, district, sub-district and commune, depending on the severity and range of floods.
- Emergency management requires cooperation across sectors and administrative levels horizontally and vertically. Individuals' participation is essential in all steps undertaken as part of a comprehensive and integrative approach to emergency flood management.
- Flood hazard mapping contributes to making effective use of hazard information through planning, preparing and responding to flooding.
- Emergency management requires understanding different flood scenarios that may require adaptive situational management actions. Likewise, flood hazard mapping is useful for local capacity-building, including the planning and execution of drill exercises.
- To reduce residual risks, losses owing to damage to properties and interruption of economic activities from flooding should be transferred, shared, or examined for alternative solutions.
- It is essential to define risk sharing mechanisms in allocating responsibility and financial burden for flood management and explaining shared responsibilities for each stakeholder in managing flood risks in the context of physical, technical, economic and political background.
- Continuity planning is required for retained risk management for floods.

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For more information, please contact:

Associated Programme on Flood Management
c/o Climate and Water Department
World Meteorological Organization

tel +41 (0) 22 730 83 58
fax +41 (0) 22 730 80 43 apfm@wmo.int
email www.floodmanagement.info

World Meteorological Organization
Communications and Public Affairs Office
7 bis, Avenue de la Paix – P.O. Box 2300
CH-1211 Geneva 2 – Switzerland

tel +41 (0) 22 730 83 14/15
fax 41 (0) 22 730 80 27
email cpa@wmo.int
www.wmo.int

GWP Global Secretariat
Linnégatan 87D - PO Box 24177
SE-104 51 Stockholm – Sweden

tél +46 8 1213 86 00
fax +46 8 1213 86 04
email gwp@gwp.org
www.gwp.org