MANUAL ON FLOOD

Causes, Effects & Preparedness

UN HABITAT
UNITED NATIONS HUMAN SETTLEMENTS PROGRAMME

Scope of the Manual

This manual is developed with wider consultations and inputs from various relevant departments/ministries, UN Agencies, INGOs, Local NGOs, Professional organizations including some independent experts in specific hazards. This is intended to give basic information on WHY, HOW, WHAT of a disaster. It also has information on necessary measures to be taken in case of a particular disaster in pre, during and post disaster scenario, along with suggested mitigation measures. It is expected that this will be used by the school teachers, students, parents, NGOs, Civil Society Organizations, and practitioners in the field of Disaster Risk Reduction.

Excerpts from the speech of Ban Ki-moon, Secretary-General of the United Nations

Don't Wait for Disaster

No country can afford to ignore the lessons of the earthquakes in Chile and Haiti. We cannot stop such disasters from happening. But we can dramatically reduce their impact, if the right disaster risk reduction measures are taken in advance.

A week ago I visited Chile's earthquake zone and saw how countless lives were saved because Chile's leaders had learned the lessons of the past and heeded the warnings of crises to come. Because stringent earthquake building codes were enforced, much worse casualties were prevented. Training and equipping first responders ahead of time meant help was there within minutes of the tremor. Embracing the spirit that governments have a responsibility for future challenges as well as current ones did more to prevent human casualties than any relief effort could.

Deaths were in the hundreds in Chile, despite the magnitude of the earthquake, at 8.8 on the Richter Scale, the fifth largest since records began. In Haiti, a less intense earthquake caused hundreds of thousands of deaths. Haiti had non-existent or un-enforced building codes, and very poor preparedness.

The lessons are universally applicable. No country is immune from disaster, be it earthquakes or floods, storms or heatwaves. More and more intense natural disasters are affecting all five continents, we believe as a result of climate change. Many of the world's poorest people live in high-risk densely populated cities in flood or earthquake zones, or both.

The culture of disaster risk reduction must spread. I am encouraged that we already have a head start in this regard. The Hyogo Framework for Action, a 10-year plan to make the world safer from disasters triggered by natural hazards, was adopted by 168 governments in 2005. Hyogo gives national authorities a blueprint to assess and reduce risks through planning, training, and better public education. For example, making sure that schools, hospitals, and other key public infrastructure meet certain safety standards.

There has been progress. Bangladesh lost more than 500,000 people during Cyclone Bhola in 1970. It subsequently built 2,500 cyclone shelters on elevated concrete platforms and trained more than 32,000 volunteers to help in evacuations. When Cyclone Sidr struck in 2007 with an enormous sea surge, the death toll was less than 4,000. Cyclone Nargis, a similar event in unprepared Myanmar in May 2008, cost 140,000 lives. Cuba weathered four hurricanes in 2008. It sustained $9 billion of physical damage but very few lives were lost.

The evidence is overwhelming. Yet the lessons of these disasters are forgotten with depressing speed. We know prevention actually saves governments money in the long run. When China spent $3.15 billion on reducing the impact of floods between 1960 and 2000, it averted losses estimated at about $12 billion. Similar savings have been recorded in Brazil, India, Vietnam and elsewhere.

Everyone has a role to play.

Governments, central and local, have to do what it takes to make communities able to cope with both continuing challenges and sudden shocks.

The Chile and Haiti earthquakes showed us once again why action before disasters makes all the difference. To prevent natural hazards turning into disasters, we must all act sooner and act smarter.

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Chapter 1

Introduction to Flood

1.1 What are floods?

A flood is a high flow or overflow of water from a river or similar source of water occurring over a period of time. Heavy rain spell can result in an extra volume of water in the waterways, leading to a rise in the water level of streams and rivers. A flood happens when the carrying capacity of the waterways fails to hold the total volume of increased water at any given time.

Flood in Myit Nge, 2006

1.2 Causes of floods

The main causes of floods are:

- Continuous heavy rain
- Bad drainage facilities
- Blocking of river channels by landslides
- Narrowness of the river
- Change in the course of river
- Inefficient engineering design in the construction of embankments, dams and canals

- Failure of hydraulic and other control measures
- Destruction of mangroves and trees which do not grow back
- Deforestation and removal of root system
- Sediment deposit or silting of the river bed
- Rapid urbanisation with no proper drainage facility
- Storm surge
- Tsunami

1.3 Types of floods

Riverine flood (monsoon flood): It occurs when major rivers and their tributaries overflow, causing extensive inundation. The rivers rise slowly and with slow recession may remain above danger levels for many weeks. It can lead to extensive flooding. There are three types of river flooding: slow-onset, rapid-onset and flash floods.

Slow-onset flood – This type of flooding occurs slowly and can last weeks or even months. Causes may consist of snowmelt or steady ongoing rainfall. It can lead to major material losses and damage to crops as well as immense damage to infrastructure, services such as roads, rail links and power supply, etc. Rising flood levels can be forecasted, giving people the opportunity to evacuate from the areas at risk.

Rapid-onset flood - This type of flooding can occur more quickly in the mountain headwater areas of large rivers as well as in the rivers draining to the coast. It often lasts for a few days. These floods are potentially much more dangerous than slow-onset floods and can pose a greater risk to loss of life and property since there is generally much less time to take preventive action.

Flash flood - Flash flood results from relatively short but intense burst of rainfall, often from storms and cyclones. These are characterised by a sharp rise followed by relatively rapid recession soon after rainfall, causing high flow velocities. Early warnings for

timely evacuation may not always be possible. This type of flooding poses the greatest threat to loss of life and can result in damages to property and major social and economic disruption.

Coastal floods: Coastal floods occur when strong onshore winds push water from an ocean, bay or inlet onto land. This can take the form of storm surges associated with tropical storms, cyclones, tsunami and tidal waves. It can cover vast areas along the coast.

Urban floods: This type of flood takes place in urban areas because of lack of proper drainage facilities.

1.4 Flood impacts

Physical infrastructure – Structures damaged or collapsed by washing waters, landslide triggered on account of water becoming saturated. Boats and fishing equipments may be lost or damaged in coastal areas.

Damaged Yangon-Mandalay highway due to flood

Casualties and impact on public health – people and livestock deaths caused by drowning, very few serious injuries. Outbreak of epidemics, diarrohea, viral infections, malaria and other water related health hazards.

Water supplies – contamination of water (wells, ground water and, piped water supply).

Crops and food supplies – sudden food shortage may follow due to loss of entire harvest, standing crop damage, spoiling of grains when saturated in water along with loss of animal fodder. The crop storage facilities and godowns may get submerged resulting in immediate food shortage. Floods may also affect the soil characteristics and its fertility.

The land may be rendered infertile due to erosion of top layer or may turn saline if sea water inundates the area.

1.5 Destructive floods in Asia

- The Hwang-ho River flood in 1887 claimed 3,000,000 lives in China.
- The Yangtze (Chang Jiang) river floods of 1935 killed 145,000 people.
- Flooding in Hanoi, Vietnam in 1971 killed 100,000 people.
- The failure of Banqiao Dam in China claimed 232,000 lives in 1975.
- The Yellow River Flood of 1991 in China killed approximately 2,000,000 people.
- 1998 Yangtze River floods left 14 million people homeless.
- Bangladesh was flooded in 1998, with numerous victims.
- Jakarta's floods in January 2007 affected the whole city. 80 people died.

- The floods in Peninsular Malaysia, Sabah and Sumatra in December 2006 and January 2007 are considered to be the worst in 100 years, resulting in the evacuation of over 100,000 people in the worst-hit state of Johor at its peak.
- Korea saw one of its worst floods in May 2006.
- Flooding in Mumbai (India) in July 2005 left over 700 dead. Some areas went under 5 m of water.

Flood in Myit Nge, 2006

Chapter 2

Floods in Myanmar

2.1 Geo-physical location of Myanmar

The topography of the country varies from hilly and mountainous areas in the west, north and east, a semi-arid dry zone in the central region, coastal areas in the west and alluvial plains in the southern delta. The major river systems follow the lie of the mountain ranges from the north of the country to the south. There are four main rivers crossing Myanmar: Ayeyarwady, Thanlwin, Chindwin and Sittaung.

The Ayeyarwady River, about 1,550 km (960 miles) long, flows from north to south. Its total drainage area is about 411,000 square km (158,700 square miles) and splits into many streams and drains into the Andaman Sea.

The Ayeyarwady Delta is a flat plain with the exception of low western hills, and the extension of the Rakhine mountain range. The Chindwin River is the biggest tributary of the Ayeyarwady River. The river flows 840 kilometres miles from north to south to join the Ayeyarwady at a tributary near Mandalay. Sittaung River lies in central-east Myanmar, rising northeast of Yamethin on the edge of the Shan Plateau and flowing south for 420 km (260 miles) to empty into the Gulf of Martaban of the Andaman Sea. The broad Sittaung River valley lies between the Bago mountains on the west and the steep Shan Plateau on the east. The Thanlwin River, which starts in Tibet flows through Yunnan, Myanmar and Thailand on its way to its mounth in the Andaman Sea, near Mawlamyaing.

Besides the main rivers, Myanmar has many small and medium rivers, streams and creeks flowing through every region of the country. Therefore, the topography of Myanmar comprises mountains, highlands, an intricate river system, vast river basins, lowlands and the delta region. During the monsoon season when

rainfall is rather heavy in the northern regions, the rivers fill to their capacity, often exceeding maximum levels; this sometimes causes flooding disasters in the towns and villages alongside of the rivers.

2.2 Flood seasons and flood prone areas in Myanmar

Flooding has always been one of the major hazards in Myanmar, accounting for 11% of all disasters, second only to fire.

Floods are most common during the rainy season. Myanmar usually receives all its rainfall between mid-May and October. The threat of flooding usually occurs in June, July, August and late September to October with the highest risk in August around the period of peak monsoon rains.

In general, the following parts of the country are prone to different types of flood:

The catchment areas of major rivers in the north and central zone are prone to riverine floods. The Ayeyarwady River basin and the catchment occupy 60% of the country area traversing Chin, Kachin and Shan States, Mandalay, Magwe, Bago, Yangon and Ayeyarwady Divisions. Floods, in consequence, can occur over a wide range of the region.

The Southern Delta faces riverine floods when there is a flood tide and high river water flow at the same time. In these areas, the lands are protected from floods by earthen dykes, but there have been times when floods have overpowered the dykes and caused the loss of life.

The mountainous and hilly Kachin, Shan, Mon and Chin State areas are threatened by the danger of flash floods. In Kachin State, at the confluences of the Ayeyarwady River, the snow melts at higher altitudes frequently and results in flash floods at the beginning of summer.

Along ***the coastal region in Rakhine State***, floods occur as a secondary hazard generated by cyclones.

Map 2.1 Flood prone areas of Myanmar

Source: Power-point presentation by the Health Care Service Committee at"National workshop on Communicating Risks", Yangon, Myanmar, 30-31 May 2006

2.3 Causes of flood in Myanmar

Riverine floods: These are the most common type of flood in Myanmar. They take place when the monsoon troughs or low pressure waves superimpose on the general monsoon pattern resulting in intense rainfall over significant strategic areas of the river catchments.

In *Ayeyarwady* and *Chindwin* rivers, the flooding occurs when intense rain persists for at least 3 days over the headwaters of the rivers in northern Myanmar. Most of the flooding in the lower Ayeyarwady and the delta is occured by Chindwin, when its flood coincides with upper Ayeyarwady floods.

Flood in Myitkyina, 2004

In *Sittaung* and *Thanlwin* rivers, floods are duly caused by rainfall associated with low pressure waves (the remnants of typhoons and tropical storms of South China Sea) moving from east to west across the country.

Flood in Pyay (1974)

Coastal floods: Tropical storms from the Bay of Bengal trigger storm surges and cause floods along the Rakhine coastline during the pre- and post- monsoon period.

Urban and localised floods: In the cities and towns, localised floods occur from time to time. This is due to a combination of cloudburst, saturated soil, poor infiltration rates and inadequate or poorly built infrastructure (such as blocked drains). In the rural areas, breakage of water resistance structures, such as dams, dykes and levees destroy valuable farm lands.

Flood in Yangon, Nargis 2008

Flash floods: Flash floods, frequent in the rivers, are caused by the heavy rainfall striking at the head water region for a sustained period of 1-3 days. In the central and delta regions in the southern part of the country, river bank erosions accidents are frequent incidents.

Flood in Shwesettaw Pagoda (12 April,

2.4 Major floods in Myanmar

(1) Flood Record in Myanmar (since 1966)

Stations	Danger Level (cm)	Max. WL (cm)	Flood Duration	Above DL (m)	Year
Ayeyarwady					
Hinthada	1342	1582	23 Days 12 Hrs	2.40	1966
Chauk	1450	1532	12 Days 12 Hrs	0.82	1974
Minbu	1700	1982	17 Days 12 Hrs	2.82	1974
Aunglan	2550	2737	15 Days	1.87	1974
Pyay	2900	3025	13 Days	1.25	1974
Myitkyina	1200	1411	4 Days 12 Hrs	2.11	1979
Katha	1040	1154	7 Days 6 Hrs	1.14	1979
Bhamo	1150	1338	8 Days 2 Hrs	2.38	2004
Mandalay	1260	1382	16 Days	1.22	2004
Sagaing	1150	1274	17 Days 6 hrs	1.24	2004
Nyaung Oo	2120	2263	16 Days 12 Hrs	1.43	2004
Chindwin					
Homalin	2900	3107	18 Days 6 Hrs	2.07	1968
Mawlaik	1230	1608	15 Days 12 Hrs	3.78	1976
Hkamti	1360	1771	18 Days 6 Hrs	4.11	1991
Kalewa	1550	1920	10 Days 12 Hrs	3.70	2002
Monywa	1000	1099	9 Days 6 Hrs	0.99	2002
Sittaung					
Toungoo	600	725	16 Days 18 Hrs	1.25	1973
Madauk	1070	1244	31 Days	1.74	1997
Dokhtawady					
Hsipaw	600	618	12 Hrs	0.18	1971
Myitnge	870	1048	8 Days 6 Hrs	1.78	2006
Shwegyin					
Shwegyin	700	927	4 Days 12 Hrs	2.27	1997
Bago					
Bago	910	950	2 Days 6 Hrs	0.4	1995
Thanlwin					
Hpaan	750	936	38 Days	1.86	2002

Source: DMH

(2) Floods in Myanmar with loss and damage data (1997-2007)

Location	Date	No. of Affected Village Tracts and Villages	No. of Affected House-holds	No. of Affected Families	Affected Popula-tion	Death Toll	Loss (x100,000 kyat)
Homalin, Sagaing Division	8/7/97	5 villages in 2 wards	9,916	9,950	59,594	-	99 (9,000 USD)
Homalin, Sagaing Division	25/9/97	63 villages	3,867	3,867	28,399	-	238 (21,636 USD)
Paungpyin, Sagaing Division	11/7/97	5 villages	6,652	6,652	44,143	2	-
Mawlaik, Sagaing Division	13/7/97	16 villages	3,622	3,622	21,897	-	-
Myikyina, Kachin State	9/7/97	10 villages	4,254	4,471	30,615	4	33 (3,000 USD)
Kayan, Yangon Division	7/6/97	-	1,189	1,189	5,878	-	-
Bago Division	7/7/97	All villages in 6 townships	6,629	6,629	33,768	50	-
Kayin State	1/8/97	All villages in 5 townships	18,804	18,855	109,840	-	-
Hpa-an, Kayin State	13/8/91	6 villages	2,669	2,669	14,488	-	-
Kyauktaw, Rakhine State	10/7/97	-	1,030	1,030	5,983	-	50 (4,545 USD)
Wundwin , Mandalay Division	2/6/01	Thètaw village	463	1,164	2,172	42	-
Monywa, Sagaing Division	18/8/02	-	9,178	9,460	48,746	-	2,535 (213,909 USD)
Salingyi, Sagaing Division	18/8/02	-	1,647	1,702	10,216	-	-

Location	Date	No. of Affected Village Tracts and Villages	No. of Affected House-holds	No. of Affected Families	Affected Popula-tion	Death Toll	Loss (x100,000 kyat)
Kani, Sagaing Division	19/8/02	-	2,042	2,207	12,048	-	2,447 (222,454 USD)
Kyaikmaraw, Mon State	19/8/02	-	829	829	4,686	-	414 (37,636 USD)
Shwepyithar, Yangon Division	8/9/02	-	886	886	4,541	-	-
Hkamti, Sagaing Division	3/7/03	-	1,230	1,536	8,131	-	-
Kyaukse District, Mandalay Division	9/10/06	All villages in 4 wards	1,443	1,763	7,045	-	351 (31,909 USD)
Sagaing Division	11/9/06	6 villages near Yaymyetgyi Lake	770	791	5,372	-	-
Kyaukpadaun, Mandalay Division	9/10/06	2 villages	14	18	97	16	-
Bhamo, Shwegu, Myitkyina, Kachin State	24/7/07	-	600	600	3,167	-	-

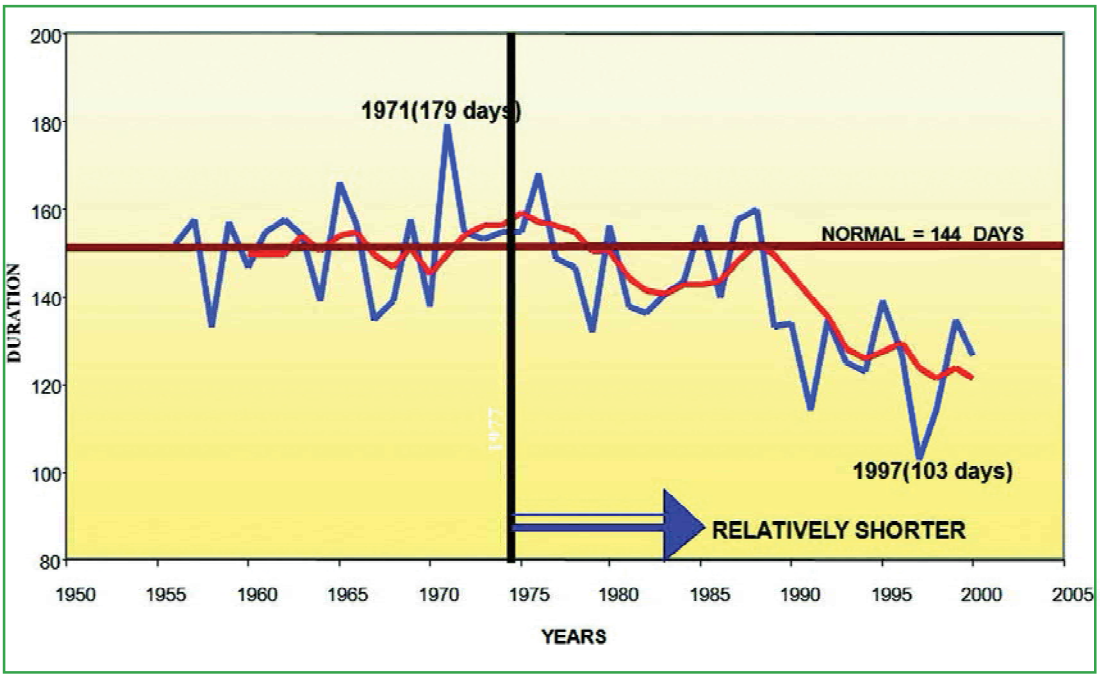
Source: Hazard Profile of Myanmar

Chapter 3

Flood Mitigation and Preparedness Measures

In the past two decades, the duration of monsoon in Myanmar is getting shorter but much more intense and the country has experienced heavier rainfall. For instance, in 2008, the annual rainfall surpassed yearly averages amount significantly in Kachin, upper Sagaing, Mon, Yangon, Ayeyarwady, Kayah, Kayin, Tanintharyi, Bago and Rakhine. Accordingly, the country is likely to suffer more severe floodings in the future. Unless effective mitigation and preparedness measures are adopted, floods will give serious negative repercussions, including loss of life and damage to property, critical infrastructure, crops and livestock. Thus, the potential harm to the economy and social fabric of the country as a whole could be catastrophic.

Figure 3.1 Annual durations of southwest monson season in Myanmar (1956-2000)



Source: DMH

3.1 Flood Mitigation

The term flood mitigation refers to long-term sustainable measures that can be taken up to reduce the impact of flood hazards. These measures can be structural and non-structural. The structural measures refer to construction and management of dykes, dams, reservoirs, irrigation system, raised settlements, housing design and other physical measures, etc. The non-structural measures include training, planning, awareness raising, change in the agricultural production patterns, flood resistant cropping, etc. These measures need government intervention and support with community participation. Some of the measures, especially legislation and policy frameworks, cannot be initiated by the community itself and it requires the government's initiative and intervention.

3.1.1 Structural flood mitigation measures

Structural flood mitigation measures include the following:

a) Flood protection

Flood protection is a major long-term structural system that physically prevents some (or all) flood water from entering a designated area. Flood protection does not necessarily mean complete protection from floods, but it can contribute to control flooding and drainage. Flood protection measures involve strengthening of embankments, construction and reinforcement of dykes and construction of by-pass channels to improve the flow of water in drainage channels. An essential component of flood protection is continuity of operation and maintenance of the facilities constructed.

b) Flood reduction

Projects such as reforestation, protection of vegetation, clearing of debris from streams and other water holding areas, and conservation of ponds and lakes may help to reduce flooding by decreasing the total water runoff. In some areas, absorption could be a valuable mitigation strategy.

Clearing drainage by the community

c) Flood diversion

Flood diversion includes levees, embankments, dams and channel augmentation. Embankments along the rivers, and sea walls along the coasts may keep water away from the flood plains. Dams can store water and can release water at a manageable rate. However, failure to manage water release in earthquakes may cause floods in the lower areas.

d) Flood proofing

Flood proofing reduces the risk of damage. Flood proofing measures can be applied to public structures such as schools, hospitals and health care centres, pagodas, temples, and other infrastructure including individual houses as they are often used as temporary shelter during floods. Flood proofing techniques can be undertaken by individual property owners without waiting for government action.

Flood proofing can be undertaken through the following measures:

- Permanent measures are designated to provide long-lasting protection against flooding and do not depend upon any flood forecast or action to put them into effect.
- Contingent measures rely upon receipt of a warning or forecast: action is required to make the protection operational.
- Emergency measures may either be improvised in an emergency or carried out according to prior emergency plans of action.

At the community level, several approaches to flood proofing of buildings or individual units may be implemented, summarised as follows.

1. *Elevating the building:* valuable property is kept out of reach of floodwater levels and structural damage is avoided. The building or individual unit can be elevated on land fill, posts, piles or extended walls. Special attention must be given to the design of the foundations to avoid settlement or tilting of the building.

A monastry elevated on posts, piles above flood level so that the community can use it as a shelter during a flood.

2. *Constructing barriers* - between the building and floodwater. Some of the damage due to flooding can be minimised by appropriate measures to prevent flood water. Barriers (levee or reinforced flood walls) can be constructed around the entire building, or on the side of the building exposed to possible floods, in order to prevent flood water damage to the structure. Barriers can be made from earth, concrete masonry or steel. Care must be taken to ensure they are watertight. In this method, all areas below the flood protection level are made watertight. Walls are coated with a waterproofing compound or plastic sheeting and openings, such as doors, windows, sewer lines and vents, are closed temporarily, with sandbags or removable closures or shutters to secure the building against water flows. Such protection methods should be accompanied by adequate drainage to carry the water away from the building.

3. *Dry Flood proofing or sealing:* This method consists of making the building walls and floor watertight so that water cannot enter. The method can only be used in areas of shallow flooding to completely seal a building against water, i.e., in areas where flood levels do not exceed one metre and flood velocity is minimal. Sandbagging also represents temporary protection which can be utilised to close an opening or to protect a vulnerable part of the structure.

4. Protection of other facilities:

- Temporary removal of goods: In some areas, temporary removal of goods, equipment and supplies in the case of emergency can result in substantial reduction of damages.

- Watertight storage facilities: Storage tanks in flood-prone areas fitted with watertight caps can prevent goods and equipment from flood damage.

- Proper anchorage: During floods, some materials and buoyant structures (e.g., lumber) can be carried away by flood water, resulting not only in their loss but also in possible destruction

and debris accumulation downstream. Anchoring such structures could reduce damage.

- Utilities service: Utility systems like water supply and water distribution systems should be checked for leakages and repaired regularly to prevent contamination by seepage of flood water.

e) Engineered structures

Construction of engineered structures in the flood plains and strengthening of structures to withstand flood forces and seepage. The buildings should be constructed on an elevated area. If necessary, build on stilts or a platform. Engineered structures involve architects and engineers during the planning, designing and construction phases. They may include buildings ranging in scale, from simple dwellings to multi-storey office blocks, as well as infrastructure such as electricity pylons, dams, embankments, ports, roads, railways and bridges. While professionals are trained to plan, design and supervise the construction of buildings and infrastructure to achieve necessary structural safety standards, they may need additional training to incorporate mitigation practices that may withstand various disasters into their structural designs.

f) Non-engineered structures

Non-engineered structures are those constructed by their owners themselves or by local carpenters and masons who generally lack formal training. Such structures largely comprise simple dwellings and public buildings, built with local materials in the traditional manner. In some disasters, high casualties and economic losses can be attributed to the failure of non-engineered structures. Another important aspect of increasing the safety of non-engineered structures is to avoid building on hazardous sites such as steep slopes subject to landslides, floodplains subject to flash floods or river bank erosion, or coastal areas exposed to storm surges. However, people often do not want to leave their traditional homes and the area in which they have been living for generations, even

though the location may be hazard prone. Economic pressures may also force people to settle in hazardous areas. Wherever practical, incentives should be offered to attract people away from hazardous such locations. An alternative consideration, subject to affordability and practicality may be to enhance the safety of non-engineered constructions using appropriate structures or mitigation measures.

3.1.2 Non-structural flood mitigation measures

a) Flood hazard map

Mapping of the flood prone areas is the primary step for reducing the danger of floods in Myanmar. Historical records give an indication of the flood inundation areas, the frequency of occurrence and the extent of the coverage. A basic map should be combined with other maps and data to form a complete image of the floodplain. Flood hazard maps provide a useful starting point for making disaster preparedness plans. Flood hazard mapping should also give an accurate account of water flow during floods.

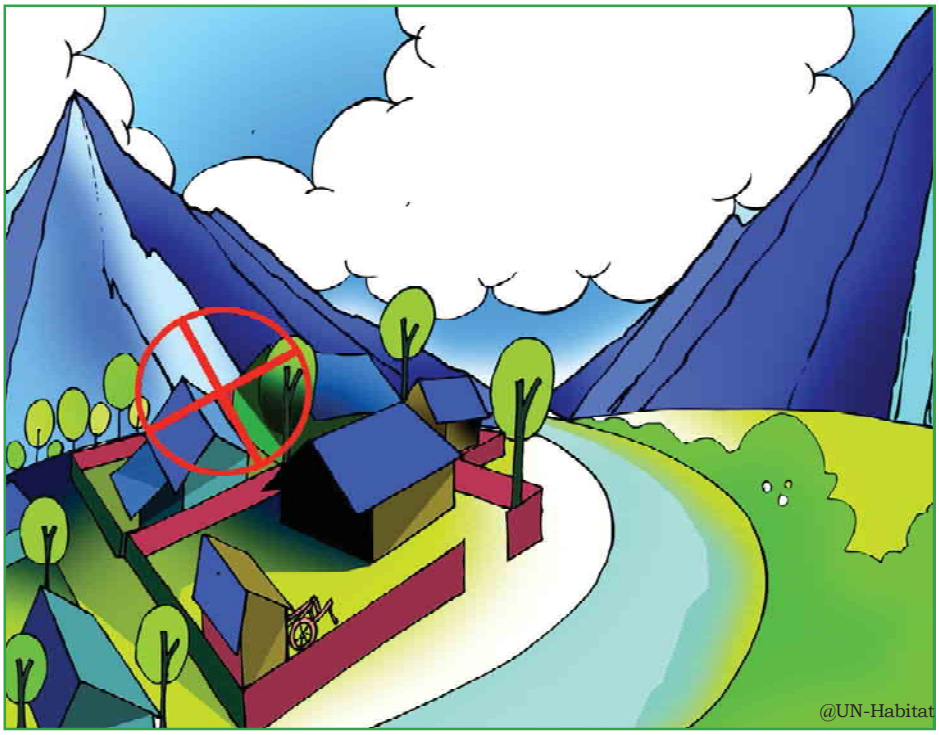
b) Land use planning

Land use control can help to reduce the threat to life and property when waters inundate floodplains and coastal areas. The number of casualties relates to the population in the area at risk. It is advisable to reduce population densities in areas where neighbourhoods are to be developed. In areas where people have already built their settlements, plans should be made to relocate to more appropriate sites so as to reduce vulnerability. No major development should be permitted in the areas which are subjected to high flooding. Essential facilities should be built in safe areas. In urban areas, water holding areas can be created in ponds, lakes or low-lying grounds.

Land use planning determines the location and design of development activities in a defined geographic area. The aim is to guide settlement expansion and redevelopment away from flood prone areas. Land use planning can be used to control human

development on the floodplain, which in turn, aims to reduce the vulnerability of its inhabitants to flooding.

However, these measures can only be successfully applied through the application of stringent land use planning rules and regulations to enforce effective implementation on the ground. Adequate law enforcement can help to significantly reduce unlawful activities such as illegal reclamation of lands on the river, which can drastically change the river path and pose greater threats to downstream communities. The inclusion of stakeholders is vital to the process of land use management planning since they are the ultimate beneficiaries and can be useful allies in implementing these regulations. The right blend of law enforcement, education and incentive schemes are, therefore, needed.



Do not construct houses in area of river-turns flood plain and mud flow.

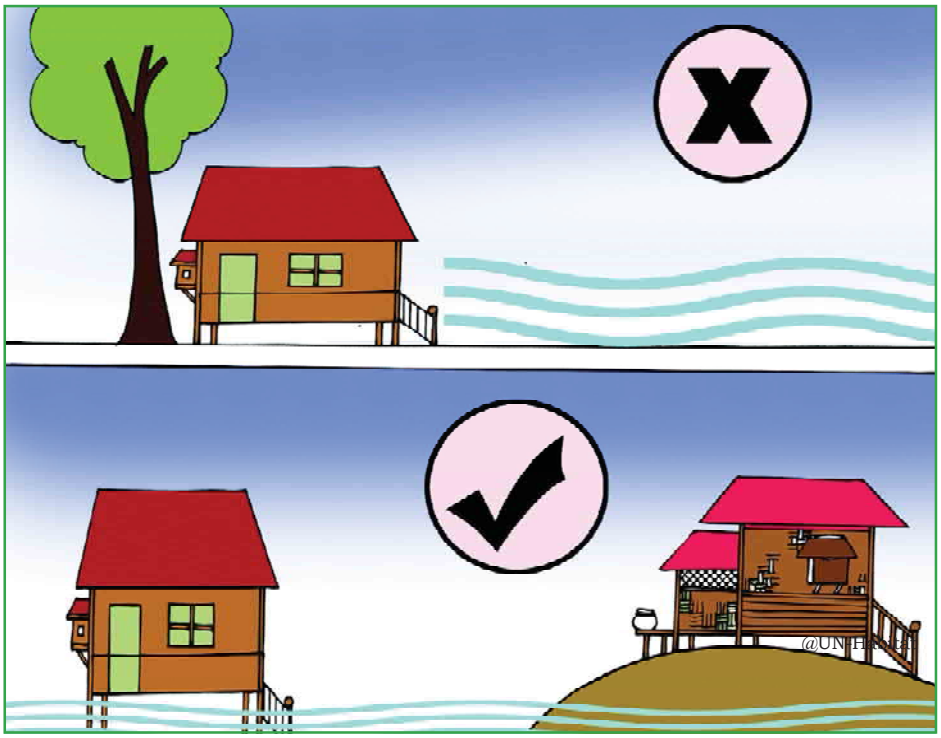
c) Building regulations and codes

Building regulations and codes provide general guidelines for appropriate design methodologies and construction techniques. Building codes which specify design and construction requirements for disaster-resistant structures should be formulated and enforced.

Some suggestions for flood resistant building designs are provided below.

Location

- Avoid natural drainage paths, water courses, water detention areas and restricted reservation areas.
- Construct the buildings on the best bearing soil on ground higher than the Probable Maximum Flood (PMF) level.
- If locating the building on high ground is not possible, construct the building on individual high mounds with thoroughly compacted soil surrounded by trees to maintain stability.



House construction above the High Flood Level (HFL)

Foundations and Plinths

- Foundations should be deep enough (should be at least between 1 to 2 metres) to prevent undermining The plinth should be above the level of the HFL or PMF.
- Buildings may be raised on strong columns (stilts or piles).
- When it is not possible to raise the whole building, raise the floor of at least one room to use as a flood shelter.

Configuration (building shape)

- The building shape that will be reducing the impact of the water is circular.
- The V shape facing the oncoming water is advisable. It is best to have as little surface as possible facing the oncoming water.

Structure

- Use strong corner posts fixed into deep foundations (reinforced concrete where possible).
- If using timber pillars, the free height should not be more than 2250mm and they should be anchored in the ground at least 600mm deep.
- Houses raised on stilts should have a rigid frame and be braced against overturning.
- All joints should be tied with metal or wire strips. They should be braced diagonally using fixed wires or wooden strips.

Walls and openings

- If thatch is used as wall cladding, they should be in two parts, upper and lower so the bottom part can be removed to allow the free flow of water through the building.
- If fixed materials are used such as bricks or mud blocks, then doors and windows should be positioned to allow the water to flow through.

Roof

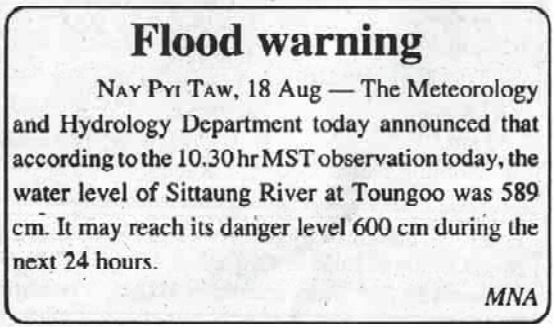
- The height of the roof should be well above the height of the flood.
- The roof should have a flat section and should be strong enough to hold the weight of the occupants of the house during a flood emergency.

d) Flood forecasting and warning

With exception of flash floods, most floods allow for a reasonable warning period. Heavy precipitation will give sufficient warning of the possibility of river flooding. High tides with high winds may indicate flooding in the coastal areas. Evacuation is possible with suitable monitoring and warning.

In Myanmar, at the national level, the Department of Meteorology and Hydrology (DMH) is largely responsible for flood monitoring, weather forecasting and issuance of early warning. The Hydrology Division of the Department of Meteorology and Hydrology has river water monitoring stations located along the major rivers of Myanmar: Ayeyarwady, Chindwin, Duhtawady, Sittaung, Bago, Thanlwin and Shwe Kyin. A river flood warning is issued when the river waters reach about 1 meter below the danger level. River flood warnings give at least 24 to 72 hours of advance notice. The warnings are also disseminated through different channels of communication such as radio, television, newspaper, telegraph and telephone to the administrative authorities of the flood prone areas. If the expected flood is a severe one, the warnings are broadcast very frequently (every 3 hours) through the Myanmar Broadcasting Services.

In case of flash floods, warnings for timely evacuation is not possible.



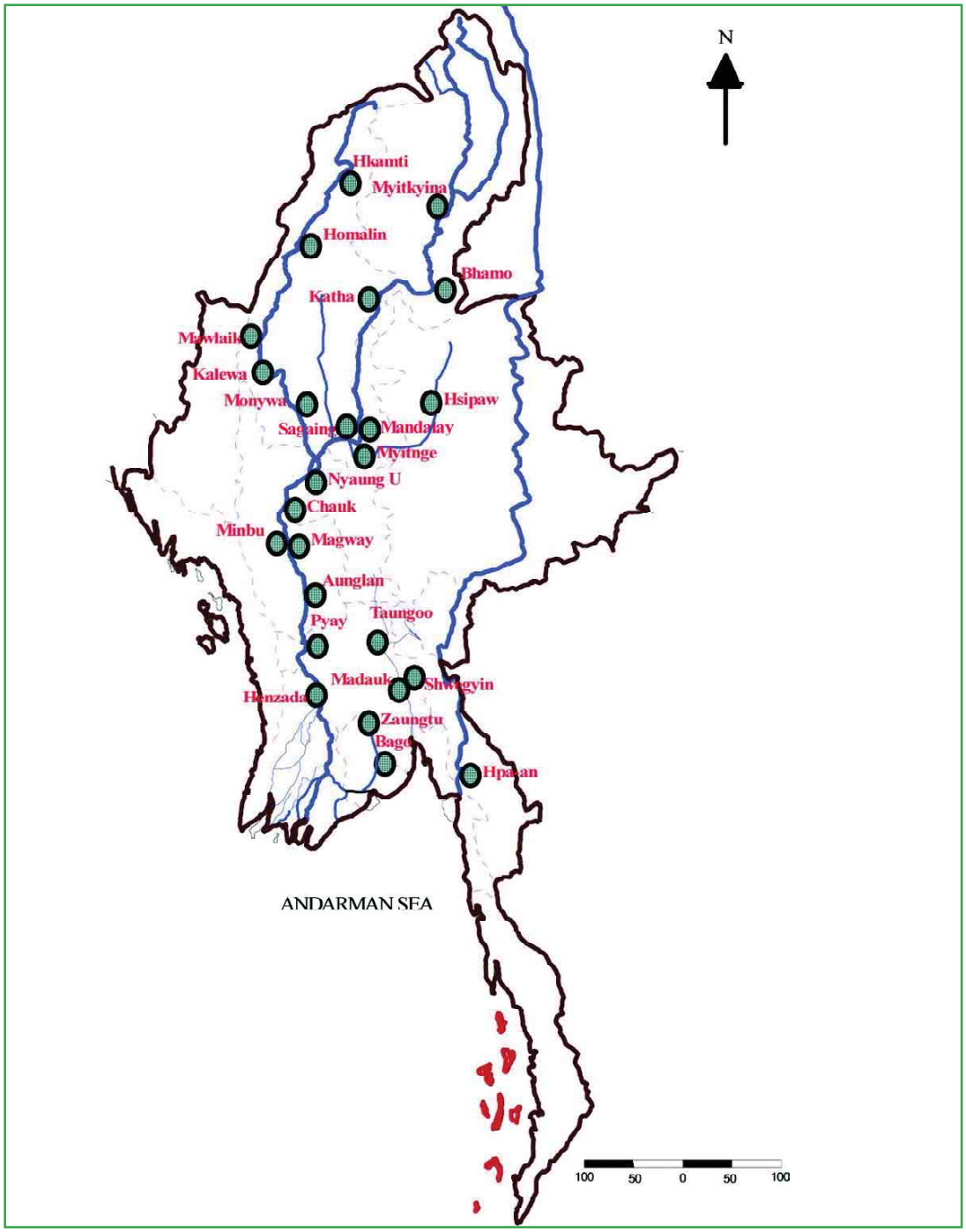
Flood warning

NAY PYI TAW, 18 Aug — The Meteorology and Hydrology Department today announced that according to the 10.30 hr MST observation today, the water level of Sittaung River at Toungoo was 589 cm. It may reach its danger level 600 cm during the next 24 hours.

MNA

A flood warning in the daily newspaper

Map 3.1: The location of river water monitoring stations under the Department of Meteorology and Hydrology



Source: DMH

e) Training and education

Training programs and public education are necessary to ensure that mitigation programs would be supported and properly implemented. Specialised trainings should be organised for local leaders, volunteers, youths etc. who are likely to play an important role in search and rescue operations. Such trainings should be an annual feature and should take place about two months in advance of the flood season. In the training courses, specific subjects like health, sanitation and management of relief camps should be included.

f) Public awareness generation

Public awareness generation is a process through which people living in flood-prone areas are sensitised regarding specific dangers of flooding. It includes educating, informing and warning the community about floods and helping them to be better prepared for response to flood emergency situations, with less minimum dependence on outside assistance or external intervention.

Through appropriate actions, this increased resilience can help prevent loss of human life and property. The objectives of public awareness generation on floods are to:

- Increase public knowledge on floods, their nature and possible consequences and impacts.
- Improve public knowledge on practical preparedness measures at the household level that the communities can implement on their own.
- Inform the public about flood early warning systems and various means of communication to receive warning signals and flood information.
- Disseminate information on flood preparedness programs and mobilise support for coordinated flood response activities within local authorities or township disaster management committees and community-based disaster management organisations.

The following are some of the mediums that can be used for conducting awareness raising campaigns:

- Electronic media - radio, TV, video spots, photo packages, audio tapes or cassettes.
- Print media - newspapers, leaflets, brochures, booklets, posters and billboards.
- Community activities - meetings, community discussions and consultations.
- Community oriented programs such as street plays, distribution of pamphlets, door-to-door campaigns and school programs.

g) Community-based mitigation

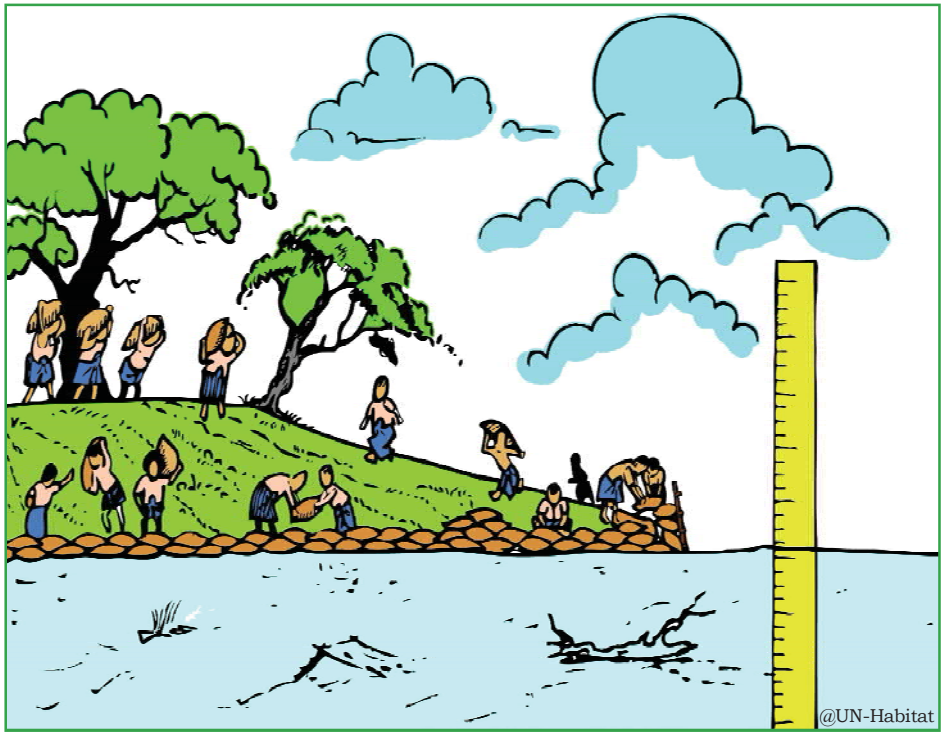
The following activities are suggested for effective flood mitigation measures which can be implemented through the community's strength and capacity.

- Sedimentation clearance
- Reforestation programme
- Dike and flood wall construction
- Flood fighting: organising teams to repair embankments, pile sandbags and stockpile needed materials
- Applying flood compatible farming practices. Special varieties of seeds are available which can be harvested during the flood season.
- Retrofitting: houses need to be made flood resistant
- Construction of multipurpose shelters
- Raising embankments can give shelter to the community as well as the livestock during the time of floods.

3.2 Flood Preparedness at the Community Level

Disaster preparedness covers activities to enhance the ability to predict, respond and cope with the effect of a disaster. It includes pre-cautionary activities by households, communities and organisations to react appropriately during and following the event.

Community-based disaster preparedness activities at community level include designing warning dissemination system, planning for evacuation and relocation, storing of food and water, building temporary shelter, devising management strategies, and conducting mock drills and simulation exercises.



Piling sandbags by the community at their own strength to prevent flood.

a) Community-based Organisation on Disaster Risk Reduction

It is best if the community has already formed a Community-based Organisation (CBO) on Disaster Risk Reduction (DRR). If not, leaders should coordinate such organisation comprising of the stakeholders of the community. Under the CBO on DRR, a

number of sub-groups or teams should also be organised to address different disaster management activities such as early warning dissemination, evacuation, search and rescue, first aid, relief operation etc.

b) Community-based Disaster Management Plan (CBDMP)

The CBO should prepare a CBDMP with the help of local authorities, NGOs, community leaders and the inclusion of community members. The plan should list activities which the community members are required to perform for flood preparedness. It should also detail out the delegation of duties so that each individual is aware of his/her specific responsibilities when an emergency warning is received. Once the plan is prepared, it should be shared with the community through various means, such as announcements in the community assembly and postings on the notice board of village or ward's Peace and Development Council, monasteries/churches, markets, etc. Everyone in the community should well understand the contents of the plan. Development and refinement of the plan should be ongoing; it should be rehearsed through the use of drills and evaluated for its effectiveness when disaster strikes the community. It should be updated periodically or regularly at predetermined intervals so that it will reflect and adapt the changing conditions of the community, climate, and natural environment.

c) Community-based flood risk assessment

The community-based flood risk assessment is needed to ensure that all community members living in flood prone areas understand the dangers properly. They should know the flood history of the area and understand the flood warning messages, the impacts of flooding, and the areas vulnerable to different degrees of flooding. The CBO on DRR should also prepare and discuss the details of local flood hazard map, with the involvement of other community members. The map should also indicate the flood path and possible sequences of flooding in the area in advance.

The community working together to develop a community-based disaster management plan

d) Flood forecasts and early warning dissemination

Flood forecasts and warning are essential for relocation of people to safer areas and deployment of resources for flood response activities. A flood early warning system can facilitate the dissemination of vital information in a flood event, including when and where the flood will occur, so that the decisions to take protective action are made on time and in accordance with the level of risk the warning conveys. A simple and effective early warning system is made of four main components, as follows:

- Flood hazard detection and forecasting
- Formulation of warning messages
- Dissemination of warning messages
- Community response.

People living in flood-prone areas should have a clear and sufficient knowledge of the risks they face and the existing early warning system.

It is also important to ensure that the relayed flood forecasts originate from a reliable and authorised source, for validation purposes. The warning information, generated from the forecasts, should be despatched to the relevant local disaster management agencies, which can then make decisions and initiate necessary actions.

If a community is subject to flash floods, preparedness activities such as organising volunteer groups, planning for flood level monitoring, discussion on information dissemination should be undertaken in advance.

e) Flood referencing

Flood referencing is an activity that can be carried out at the community level, to forecast flooding by community members. It is most useful for communities living along canals, tributaries, or small rivers, connected to major flood-prone rivers, but not covered under the national forecasting network. It involves the following activities:

- Installation of water level marker (or level gauge) along the river or tributaries next to the village/community.
- Putting up of billboards placed at strategic points such as the market place, junctions of main streets (where many people can view them).
- Training of selected focal persons within the community on maintenance of the equipment being installed.
- Establishment of a proper communication system which can receive flood information (forecasts and warnings) from the national level and send real time information from the local level to assist the weather stations of the Department of Meteorology and Hydrology to produce flood forecast for the locality.

f) Community safe shelter

The community should identify flood shelters based on their accessibility, location, facility and capacity, etc. The safest evacuation routes and road-plans for relocation/evacuation should include designated flood shelters. All community members should be well aware of the shelter. The following activities are recommended to be included in the preparation of a safe shelter.

(a) cleaning/clearing the premises in and around the shelter,

(b) preparation of large-size cooking stoves,

(c) sinking a fresh or elevating the existing tube-well above flood danger level,

(d) provision of smaller rooms/chambers for health care check-ups, lactating mothers and their children, privacy of adolescent girls, and storage of medicine, food items, fuel-wood/ biomass/ kerosene, and lanterns for lighting,

(e) identification of alternative shelters, and

(f) expansion of the capacity of shelters to prepare for the worst.

g) Evacuation arrangements

Evacuation plans should be prepared well in advance by the relevant local government agencies and NGOs, together with the community volunteer groups. Each member/team of the community must be given specific instructions and responsibilities in case of evacuation. In order to facilitate evacuation planning, the vulnerable areas should be clearly identified by using flood risk mapping. Again, an evacuation centre (shelter) should be prepared and maintained. The community members should also be familiar with which routes they have to follow to reach their destination. In preparation of evacuation plans, more than one alternative evacuation route to a safe shelter should be identified so that lead time during evacuation can be minimized.

The following considerations will be useful in planning evacuation routes to safe areas:

- Identification of the safest and shortest possible route to safe area (including alternate routes in case of unforeseen route blockages) avoiding possible high current or water logged areas of unknown depth.
- Installation of signs or markings along the route for easy recognition.
- Informing the public about the location of safe areas and their access routes.
- Preparation of boats and other means of transport. It is crucial to periodically check the working conditions of such equipment.
- As and when appropriate, it is advisable to relocate the most vulnerable households closer to safe areas in advance.

h) Trainings and capacity building

Training is important to enhance the capability of the community-based organisation and its members to reduce disaster risks. The aim of training is to enable the community-based organisation and other community members to understand the DRR activities on their own.

The training should be provided to: i) the members of the community organisation, ii) members of the community at large, iii) special technical experts; e.g. masons, paramedics, teachers, farmers, and staff of the local authorities.

The training can cover following range of broad topics.

1. Disaster Risk Reduction Training
2. Emergency Response Training including Search and Rescue, Medical first aid, Relief coordination, distribution, Emergency shelter management, evacuation management, etc.

3. Technical training for specific target groups to promote community-based hazard mitigation such as Training of carpenters, masons, artisans, households to teach flood resistant construction and retrofitting. Training of households and mothers on water purification techniques, Training on swimming for men, women and kids to save themselves in flooding.

A search and rescue traning

A training for carpenters o enhance community-based disaster mitigation

i) Drill

Drills or simulation exercises are an important part of the community preparedness. Some of the skills can only be taught and strengthened through drills. The effectiveness of CBDMP can be evaluated through drills. The Two kinds of drills can be organised with the community; i) table-top exercises, ii) functional drills. The functional drills could include a range of areas as following.

- Early warning and follow-up action by concerned people
- Evacuation drills
- Search and Rescue drills
- Medical first aid drills.

A search and rescue drill participated by community members

3.3 Preparedness at household level

People who are living in flood prone areas should follow the following preparedness activities.

- Use flood resistant construction design and materials during the construction of your house.
- Elevate, where possible, the plinth of the homestead.
- Replace, if possible, the weakened pillars/stilts.
- Raise, where possible, the level of plinth of the cattle-sheds.
- Collect pipes for tubewell and raise its level upon receipt of flood forecast.
- Prepare elevated stages to: (a) store food (preferably dry food such as dry-rice, seeds), fuel (biomass), (b) keep fodder, (c) store family assets and valuables.

- Stop cutting trees. Plant bamboo or appropriate trees around the houses to prevent erosion.
- Do not throw trash in rivers or canals.
- Do not throw anything like cigarette butts or wrappers especially those made of plastic or non-biodegradable objects - around the compound. Throw them away in identified designated places. These articles may clog or block the drainage system thereby impeding the flow of water.
- Grow crops that can withstand flood or would suffer less damage.
- Prepare a flood emergency kit

Contents of a flood emergency kit

- A portable radio and torch
- Several fresh batteries
- Candles and water-proof matches
- Reasonable stocks of drinking water, canned food and food items such as instant noodles
- A medical first aid kit (with topical antibiotic, bandages, etc.)
- Oral rehydration solution (ORS)
- A supply of essential medicine for cold, cough, diarrhea, headache, fever and other common illnesses etc.
- Sanitary napkins
- Strong shoes and if possible, a pair of rubber gloves
- A water proof bag for clothing, documents and valuables
- A plastic bucket to collect fresh water until you get water supplies
- Your emergency contact numbers and addresses (whom should be informed in case of emergency)

- Know the flood warning system in your community and be sure your family knows it.
- Understand the flood warning messages, the impacts of flooding to house and family.
- Evacuation plans should be made in advance. Each member of the family must be given specific instructions and responsibilities in case of evacuation.

- Designate an evacuation area for the family and livestock.
- If a family has boats, make sure that they are well maintained and securely tied to a tree or other permanent structure.
- Store essential food supplies and documents in a safer place.
- Raise the level of sanitary latrine. If possible, connect the latrine to the raised house by a bridge.
- Keep a few sachets/packets of ORS, sugar & salt, water purifying tablets, emergency first aid material etc. in a basket hanging from the ceiling/roof.
- Collect several stems of banana plant and build raft(s).
- Inspect escape routes, houses, etc. for weaknesses before floods. If any weaknesses are found, reinforce the escape route by building wall of sand bags to block the floodwaters.
- In times of adverse weather conditions, always listen to the official warnings issued by local authorities and news reports on the local radio or television.

Chapter 4

Flood Safety Tips

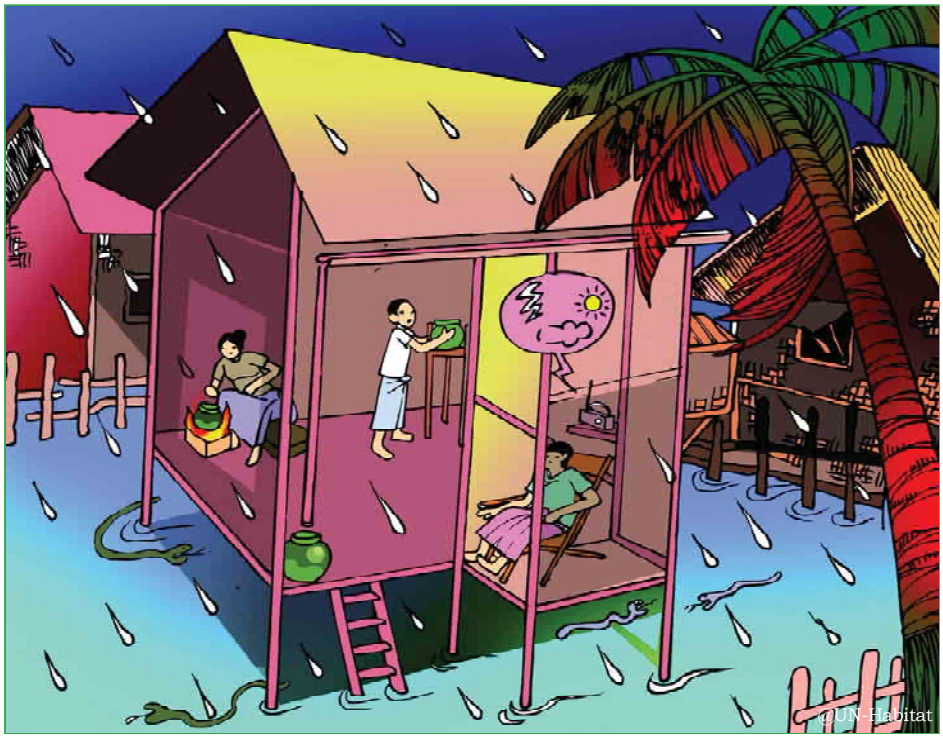
4.1 When warned of flood

- Watch for rapid rising flood water.
- Listen to your radio for emergency instructions.
- Store drinking water in containers.
- Move household belongings to upper levels.
- Keep a stock of food which requires little cooking.
- Get livestock to a higher ground.
- If you find it is necessary to evacuate, move to a safe area before access is cut off by flood waters.

4.2 During a flood

- Keep the emergency kit safe and dry.
- Do not eat food which has been in contact with flood water. Do not eat spoiled food supplied by outsiders. Such food may contain bacteria and could cause infection or illness. Do not eat dead animals; they may have died due to diseases.
- Collect rain water until fresh water supplies are available. Boil all water before drinking it.
- Do not use water from dug wells during flooding.
- Do not use gas, electricity or other electrical appliances until they have been checked for safety.
- Do not allow children to play or swim in flood water.
- Beware of poisonous animals such as snakes, spiders which may move to drier areas in your premises.

- Wear appropriate shoes while walking through water (including shallow) as it may be contaminated. Contaminated water and soil can be harmful and can cause skin diseases.
- Do not enter or drive through flood water without checking the depth, current, etc.
- Keep away from river banks in the flooded area as these may be unstable and subject to collapse.
- Listen to radio and follow all advice and warnings.



Household preparedness during a flood

4.3 If evacuation is advised

When advised to evacuate by local authorities or CBO on DRR or if you decide to leave the area, the following actions should be taken:

- Inform the responsible persons and neighbours and provide them all the details of the place you are going to.
- Collect all valuables, important certificates and documents etc.
- Stack furniture, electrical appliances and possessions away from the potential flood level.
- Turn off electricity, gas supply and water and close the windows and doors of the house.
- Take the emergency kit.
- Lock the doors of the house before leaving.
- Be sure to follow the recommended evacuation routes.

Evacuation to safe places

4.4 After a flood

Although the floodwater levels may be decreased, many dangers may still exist in the house and compound. The following actions are suggested for safety:

- Inform the responsible person in the community and neighbours about your return to home and seek advice before making a decision to enter.
- On way back home, if you find roads with stop signs, please avoid that road and find alternate route.
- Continue listening to the radio for news. Additional flooding or flash floods may occur.
- Avoid walking through the flooded area. Flooded water often erodes roads and walkways. Flooding may have caused changes to your familiar roads and paths. Flood debris may hide poisonous animals (like snake and spiders) broken bottles and sharp steel ends.

Do not walk through flooded water. Standing water may be electrically charged from underground or downed power lines.

- If you need to walk through a flooded area, use the firm ground to walk on. Standing water may be electrically charged from underground or downed power lines.
- Use mosquito-nets when you sleep.
- Do not go near river banks or where there are signs of landslides or to areas where people have been evacuated.
- Do not allow children to enter the houses/buildings which have been flooded unless they are checked by adults.
- Do not touch any damp electrical sockets or turn on the electricity if the house has been subject to floodings until it has been checked and dried out for some time.

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The List of Organizations Contributed to the Development of this Manual

- Action Aid
- Arche Nova
- Asian Disaster Preparedness Center
- Care Myanmar
- Department of Educational Planning and Training
- Department of Meteorology and Hydrology
- Fire Services Department
- French Red Cross
- Information and Public Relation Department
- Maltesa International
- Metta Foundation
- Myanmar Engineering Society
- Myanmar Geosciences Society
- Myanmar Information Management Unit
- Myanmar Red Cross Society
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- United Nations Development Programme (UNDP)
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- United Nations Office for the Coordination of Humanitarian Affairs (UNOCHA)
- United Nations Office for Project Services (UNOPS)
- United Nations Population Fund (UNFPA)
- World Vision

MANUAL ON FLOOD

Causes, Effects & Preparedness

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