3-3. Cases of Disaster Countermeasures

3-3-1. India Gujarat Earthquake

Tasks in Emergency Relief to Restoration: One Month from West India Earthquake

1) Introduction

On January 26 at 8:46 am (Indian Standard Time, time difference with Japan: 31/2 hours), the Indian Province of Gujarat, situated at the western edge of India, was hit by an earthquake measuring 6.9 on the Richter scale. The epicenter was 20 km northeast of the city of Bhuj in Gujarat. Damage was centered on the Kachcch district. High-rise apartments also collapsed in Ahmedabad, the largest city in Gujarat 300 km from the epicenter. The death toll stands at 20,717 as of March 7.

The director of the ADRC, Yujiro Ogawa, visited the site from January 26 (just one month from the earthquake) to March 6 as part of the Japanese government's "commission to investigate the reasons for specialists being requested to support restoration and rehabilitation for West India earthquake damage". Based on the findings of the survey, the state of Gujarat and future tasks as of one month after the earthquake is introduced below.

2) City of Bhuj One Month Later

We flew from Deli to Ahmedabad and entered the city of Bhuj by car. Bhuj has a population of about 70000, and markets along the roads bustled with activity. In the urban area, there was a mixture of completely destroyed buildings and semi-intact ones. There was not one building that escaped damage. Three tent villages for victims were set up around the city, in which many of the residents of Bhuj lived. Some lived on the streets, and there were also many shops that were open for business (Photo 1). We were also able to stay at one of the affected hotels in the city, though fearing after-tremors.

Photo 1

The central hospital which had 281 beds had collapsed from the earthquake. Of the 176 patients who had been staying at the hospital on the day of the earthquake, 160 had died. Currently, they have set up a temporary hospital to continue operations (Photos 2 and 3).

Photo 2

Photo 3

The Health Care Center had also been affected, though it was a smaller building. They had also built a temporary building to continue operations. There was a water supply to the city (Photo 4).

Photo 4

The whole province of Gujarat is frequently hit by cyclones, but at the same time, its dry season is severe. With the normal water supply system, water is supplied from a well to each household by a water supply vehicle. This water is then kept in a water storage tank and used. During the dry season, some wells dry out, and residents receive water from distant wells. Though the earthquake damaged the wells, because the water supply system for use in the dry season has been expanded, there has been no water shortage. Schools have also reopened. Though there are no school buildings, lessons are held on dirt floors using sheets as partitions. The same was seen in municipal offices. Work was done in partitioned spaces. (Photo 5)

Photo 5

3) Damage of Small Infrastructures.

As we traveled from Ahmedabad to Bhuj on road, the abutments of a bridge across the large river flowing out to the Sea of Arabia had broken, and those of several bridges were damaged (Photo 6). However there was no damage, etc. to road shoulders or top-heavy water towers (Photo 7).

Photo 6

Photo 7

4) Urgent Tasks

The current issue at the damaged sites is how to cope with the monsoon season, which starts in June. As mentioned earlier, this district is prone to dry weather and rain occurs mostly during the rainy season. As most of the victims live in tents, and most hospitals, schools, and administrative offices operate on dirt floor rooms separated by sheets or boards, it is evident that these will not be able to endure the monsoon rain. In damaged buildings that are barely livable, rain leaking in from damaged

portions cannot be avoided. This monsoon season is just a few months away. The homes partially or completely damaged by this earthquake totaled 900,000, and it is clearly difficult to supply temporary housings in a few months. Mornings and nights at the site in early March tend to get chilly enough to need a sweater. The weather becomes warmer from April to May with temperatures rising one degree every day. This will mean that victims will again lose homes. Aggravating hygiene conditions is another concern. In this sense, this disaster started with the earthquake and is still ongoing with the imminent arrival of a monsoon, though emergency relief seems to have come to an end.

5) Long Term Tasks

The provision of emergency temporary housing for victims to cope with the monsoon season is an urgent task. On the other hand, some of the long-term restoration and disaster management tasks in the future, which must be addressed are as follows:

6) Reinforcement of Earthquake-Resistance of Buildings

The conventional housing in the photographs evidently have poor resistance to earthquake. These buildings are by local masonry, and basically at low costs using local technology and materials. It is therefore unrealistic to expect high earthquake-resistance in these buildings. Instead, building reinforcement using techniques available in the area is required. Since Indian technology is said to be advanced, the solution to this problem lies in educating the masonry.

Regarding RC structures (Photo 8) or engineering structures, according to Professor Emeritus Arya of Roorkee University, buildings built according to construction standards suffer slight damage. The greatest problem in the current situation is that those standards are not observed. Local municipals are required to observe building standards when constructing, but construction regulations are not enforced by the central and provincial governments. The reform of laws and systems related to building standards-application of building standards to all buildings, punitive system for violations of building standards, clarification of the responsibilities of architects and construction supervisors, etc. is thus a long-term task.

Photo 8

7) Reconstruction of City

In the center of the city of Bhuj, there is an old town of about 2 km^2 surrounded by walls. This central area is concentrated with old buildings and 5 to 6 story buildings (Photo 9) and has narrow roads that look like a maze running through it. This town was particularly suffered damage from the earthquake. Though the rubble of most of the main roads has been cleared, the inside of the town remains untouched (Photo 10). Naturally, the debris of buildings themselves has yet to be cleared. The problem is that there seems to be no apparent reconstruction plan for this old town. The Gujarat Province Kachcch District government office in charge of this project is planning to move all the residents of the town outside, but the residents are apparently opposing this plan. Furthermore, though all the buildings in the town have been damaged in one form or another, people are still living and running barbershops and others in buildings that escaped collapse. There are even banks operating in these buildings. Because the reconstruction plan remains vague, plans to clear the rubble in the town and all other urban reconstruction plans have not shown much progress. Anjar, another town about 45 km southeast from Bhuj, was also severely damaged by the earthquake. It was equally damaged in the 1957 earthquake. During the 1957 earthquake, mass relocation of the residents had been planned, but apparently the residents ignored this plan and resumed living in their former homes. The government was unable to implement some kind of measure to rehabilitate the residents in a disaster-managed city due to their living there illegally, and at the same time, the residents were unable to receive any aid. The town thus

became frail and weak, and suffered the same consequence 44 years later in the Gujarat earthquake. Earthquakes are recurring phenomena. In this area, earthquakes occur approximately every 50 years. Efforts to apply disaster experience and prevent the same thing from repeating are vital. Though not a problem that can be resolved immediately, urban planning that takes into account disaster reduction must be undertaken urgently. This may be a task, which Japan can support from its own experience.

Photo 9

Photo 10

3-3-2. CYCLONE WARNING SYSTEM IN BANGLADESH

Bangladesh Meteorological Department (BMD) is entrusted with all sorts of weather forecasting. Weather warning system came into being historically through evolution in order to mitigate suffering of people. Cyclone warning system is the well-known warning system in Bangladesh. Besides there are other warnings such as heavy rainfall warnings, squall warning, hail warning, fog warning etc.

1) Tropical Cyclone season in Bangladesh

Mid March to May and mid September to mid December are cyclone season in Bangladesh.

2) Task of Issuing Tropical Cyclone Warning

Storm Warning Center (SWC) of Bangladesh Meteorological Department (BMD) is responsible for the issuance of warning for the tropical cyclone and all kinds of weather warning and forecast. During the cyclone season, SWC keeps a very watchful eye on such situations for issuing timely cyclone warning to minimize the loss of life and properties.

3) Work of Timely Detection and Warning

The general task of SWC is to detect of the cyclonic storm in the Bay of Bengal and issuance of timely warning. The cyclone information issued by the SWC requires meteorologist detect and monitor cyclones from the formation till its landfall and forecast the cyclone's future track. Modern technology has provided the means of early detection and constant tracking. Although more objective methods are under development, forecast and issuance of warning still depends upon the experience of the Meteorologists.

4) Standing Orders for Cyclone:

There are standing orders for cyclones to ensure that all concerned Ministries / Divisions / Department / Agencies are able to discharge their functions in a speedy and systematic manner, as time and speed of

action are vital to handle the situation efficiently.

There are four stages of actions:

(1) Alert Stage (Signal No.1, 2,3 and 4)
(2) Warning Stage (Signal No 4)
(3) Disaster Stage (Signal No.5, 6,7, 8,9,10)
(4) Post Disaster Stage (Signal Immediately after the cyclone till normalcy is attained)

(1) Alert Stage:

Besides normal function, Bangladesh Meteorological Department (BMD) ensures the following:

a) Shall issue early warning for cyclone as early as possible between 24 and 36 hours ahead as soon as depression forms in the Bay of Bengal.
b) Shall inform the Cyclone Preparedness Program (CPP) over the telephone/FAX about the depression so as to allow CPP to take appropriate actions including dissemination of information to concerned Senior Officials of Ministry Of Disaster Management and Relief.
c) Shall issue alert messages on Telephone/FAX to the concerned officials under the code address "Whirl Wind"
d) Shall issue suitable special weather bulletins to Bangladesh Betar (Radio) and the Bangladesh Television (BTV) to broadcast and telecast respectively from all stations and also to the national press for the public benefit. Adequate and constant coordination for broadcast and telecast beyond normal transmission hours will be established between the Meteorological Department and Bangladesh Betar(Radio) and Bangladesh Television(BTV) as soon as signal No.3 is hoisted.
e) Shall pass special Weather Bulletins to the control room of Ministry of Disaster Management & Relief, Disaster Management Bureau (DMB), Directorate of Relief and Rehabilitation, Cyclone Preparedness program(CPP) and Bangladesh Red Crescent Society(BRCS) for taking necessary action.

(2) Warning and Disaster Stage

1. Shall issue warning message for the following stages:
   a) Warning : 24 hours in advance
   b) Danger : Minimum 18 hours in Advance
   c) Great Danger : Minimum 10 hours in Advance

2. Shall include the following information in warning messages:
   a) Position of Storm
   b) Direction and rate of movement
   c) Area likely to be affected specifying Upazillas of the district if possible
   d) Approximate time of commencement of gale winds (speed more than 32 mph or 52 km/hr.
   e) Maximum wind speed expected
   f) Storm surge/tide of approximate height and the areas likely to be affected

3. In case of Danger, warning, messages shall be issued telegraphically to the Secretariats and officials of concerned ministries/divisions/departments under code address "Hurricane". In case of Great Danger, warning message shall have to be disseminated telegraphically to concerned officials of local administration under code address "Typhoon". Separate appropriate message shall also be issued telegraphically to the official concerned under code addresses "Water ways" and "Authority."

4. Shall issue warning message through FAX to Bangladesh Betar(Radio) and Bangladesh Television(BTV) to broadcast and telecast respectively from all stations as given below:

a) Early Warning Immediately on receipt, if the Radio station is operating and subsequently at 645,1210,1755 and 2325 hours BST.
b) Warning Immediately on receipt and every one-hour there after.
c) Danger/Great Danger: Frequently (Danger signal every 30 minutes and the great danger signals every 15 minutes without any break) or as advised by the Metrological Department.

5. Pass on warning messages to control rooms of the Ministry of Disaster Management and Relief, Directorate of Relief and Rehabilitation, Cyclone Preparedness Program (CPP) and Bangladesh Red Crescent Society (BRCS).

(3) Post Disaster Stage:

a) Evaluate the impact of the cyclone and its conformity with the warning given
b) Collect data from the devastating area for research purpose
c) Evaluate opinion of the people of the area about signals issued

Warning Signal for Maritime Ports

Signal	Meanings
1.Distant Cautionary Signal No.1	1.There is region of Squally weather in the distant sea where a storm may form
2.Distant Warning Signal No.2	2.A storm has formed in the Distant Area
3.Local Cautionary Signal No.3	3.The port is threatened by squally weather
4.Local warning Signal No.4	4.The port is threatened by a storm but it doesn't appear that the danger is as yet sufficiently
5.Danger Signal 5	5.The port will experience severe weather from a storm
6.Danger Signal No. 6	6.The port will experience severe weather from a storm of slight or moderate intensity that is expected to cross the coast to the north of the port of Chittagong or Cox Bazar and to the west of the port of Mongla.
7.Danger Signal 7	7.The port will experience severe weather from a storm of light or moderate intensity that is expected to cross over or near the port.
8.Great Danger Signal No.8	The port will experience severe weather from a storm of great intensity that is expected to cross the coast to the south of the port of Chittagong or Cox Bazar and to the east of the port of Mangla.
9.Great Danger Signal No.9	The port will experience severe weather from a storm of great intensity that is expected to cross the coast to the north of the port of Chittagong or Cox Bazar and to the west of the port of Mangla
10. Great Danger Signal No.10	The port will experience severe weather from a storm of great intensity that is expected to cross over or near the port.
11.Failure of Communication No.11	Communication with the Meteorological Warning Center have broken down

Signal for Inland River ports

Signal	Meaning
1.Cautionary Signal No. 1	1.The Area is threatened by squally winds of transient nature
2.Warning Signal No.2	2.A storm is likely to strike the area(Vessels of 65 feet and under in length are to seek shelter immediately)
3.Danger Signal No.3	3.A storm will strike the area (all vessel will seek shelter immediately)
4.Great Danger Signal No.4	4.A violent storm will soon strike the area (all vessels will take shelter immediately)

It is observed that death tolls and damage to properties have been reduced day by day and is now at minimum stage. It is mentioned that timely accurate forecast and its implementation is appreciated all over the world. An international award "Smith Tumsuroch" was given jointly to Bangladesh Meteorological Department (BMD) and Cyclone Preparedness Program(CPP) in 1998.The role played by CPP are highly appreciated and praise worthy. CPP will continue their efforts to minimize the loss of life and properties in the days to come in future.

Besides these signals/warnings, there are some warning also e.g Kalbaishakhi Squall warning, Aviation Warning, heavy rainfall warning, fog warning, cold and heat warning. A brief description is given below:

1.Kalbaishakhi Squall Warning:
Under certain synoptic situation when meteorologists expect wind speed preceded 60 kph or more , then BMD issues Kalbaishakhi squall warning over vulnerable regions.

2.Cold wave Warning:
When minimum temperature comes down below 8-10 degree Celsius, mild cold wave, 6-8 degree Celsius, moderate cold wave and 4-6 degree Celsius, severe cold wave occurs. In these cases, BMD issues cold wave warning depending upon its intensity and duration.

3.Fog Warning:
In presence of thin/thick fog and surface visibility reduces 3000m or less, then BMD issues fog warning for river basins and its adjoining land areas and also for the airports for smoth running of transports and aircraft.

4.Heavy Rainfall Warning:
During Cyclone, monsoon depression or strong monsoon if excessive rainfall is likely to occur within short period, heavy down pour may paralyze normal life. Under this situation, BMD issues heavy rainfall warning motioning its intensity with duration e.g moderately heavy 22-44mm,heavy 45-88 mm and heavy 89 mm or more.

5.Aviation Warning:
For smooth and safety landing and take off of aviation warning is issued over an airport for hazardous, e. g low cloud, thunder storm, heavy rainfall, poor surface visibility and squally wind.

BMD is going to be well equipped with modern technologies with the assistance of the Government of Japan under the project " Strengthening of weather warning services related to natural disaster in Bangladesh". It also provides radar in Rangpur and another one in Dhaka, which will help tp detect thunderstorms, tornadoes and other meteorological and hydrological events.

The signal system is based on the wind speeds. Signal number will increase with the increasing wind of the impending cyclone. Maritime and riverine signals are unified in the new system to avoid confusion. The new proposed signal is given below:

Proposed Signals for River and Maritime Ports

Signal	Wind speed(Kph)
1.Cautionary Signals No 2	20-40
2.Warning Signal 4	41-61
3. Damage Signal No 6	62-87
4.Great Signal Number 8	88-117
5.Great Signal No. 9	118-170
6.Great Danger Signal No.10	more than 171

With the inception of new equipment and modern technologies and new warning system in Bangladesh, the BMD in collaboration with CPP and other organizations related to disaster management will hopefully handle the natural disasters more efficiently and easily in near future.

3-3-3. REMEDIES FOR FLOODS IN SRI LANKA

1) INTRODUCTION

This article can be started with an event occurred in recent history in Sri Lanka. It was 5th June, 1992. (World Environment Day). The South West monsoon broke over the Island throughout the night ending the long period of drought. The rainfall was 494 mm (20 inches). Colombo city, the capital of Sri Lanka was invaded stealthily and silently by the floodwater. No human being could come out for even an emergency meeting because of the inclement weather. Many people woke up in the course of the night to find 2 to 3 feet of water standing in their bedrooms. People were dazed and unable to understand what had happened. The city and its environment were paralyzed the following day. Many of the roads were flooded and transport was not possible. The parliament building was visible in a sea of water like a stranded ship. It was unapproachable and its ground floor was under water. A large number of shanty dwellers occupying low-lying areas, often illegally, were completely destitute. The situation was same in some other districts like Matara, Kalutara, Rathnapura and Baticoloa. The people of these districts realized that their cities are no longer the safe heaven they had thought to be. Whenever, wherever there is a downpour in those districts the people of that area wonder whether their homes will get flooded or whether they will get back home without having a wade knee deep through flooded streets to catch the bus home. These experiences force us to find a quick and systematic solution for this problem.

Generally flood is considered to be a phenomenon associated with an unusually high stage or flow over land or coastal area, which results in severe detrimental effects. It means if a place is submerged in water it needs not to be called flood unless it causes damage and the process by which this damage is caused. In the Webster's new international dictionary, a 'flood' is defined as a "great flow of water, especially, a body of water, rising, swelling, and over-flowing land not usually thus covered; a deluge; a freshet"

Floods are more of a common occurrence in Sri Lanka than the other natural disasters. There are more reasons for that. Firstly we can see most Sri Lankans, being an agricultural Community, had naturally settled down in an environment suitable for that purpose. It means the location of a settlement has been determined by the availability of water resources, woods, a stream, etc. Therefore river-valley lands have always had a great attraction upon early settlers. On the other hand It was convenient to live close to the river bank because rivers were the main arteries of traffic those days. Moreover the flood plains of rivers are usually fertile and have relatively high moisture content, thus making them suitable for agricultural development.

Whatever the historic reasons have been for the occupation of river-valley lands, it must be accepted as a fact that many villages, cities and towns are situated in areas that are subject to flooding in Sri Lanka. The other reason that we can see is encroachments and unauthorized settlers in flood prone areas, especially near big coastal towns like Colombo, Kalutara, Galle, Matara. It is a continuing problem connected with flood problems.

Whatever the reasons for floods the present task should be to devise ways and means to protect those communities from flooding; and not to bewail the fact that people have elected to live where they are.

2) TYPE OF FLOODS IN SRI LANKA

(1) Flash floods: -

A flood that its peak flows in a short length of time after the storm or other event causing it. Often characterized by high velocity flows. As I mentioned at the beginning Colombo and suburban cities are more vulnerable for flash floods.

(2) Rain floods due to high intensity rainfalls: -

The very high rainfall and duration in the monsoon season often generate water volumes in excess of the local drainage capacity, casing local floods. In Sri Lanka this is the main reason for flooding. The country has experienced very intense rain very often. To make this clearer some exceptional rainfalls, which occurred throughout the day in different parts of Sri Lanka, can be given as follows.

(3) Monsoon floods from major rivers: -

The major rivers generally rise slowly and the period of rise and fall may extend over 10-20 days, or more. Spilling through distributaries and over the banks of the major rivers causes the most extensive flood damage, particularly when several major rivers rise simultaneously. In Sri Lanka 103 river basins were identified in 1959 an among them 10 rivers are considered as major. There are five rivers among these major rivers, which are more vulnerable for floods. (Kalu, Keleni, Gin, Nilwala, and Mahawali).

(4) Flood caused by human activities: -

This is one of the biggest reasons for floods in Sri Lanka. There is a rapid increase of converting forests, grasslands and marshy lands to urban uses or agriculture purposes.

Although floods are a natural occurrence, most flood problems exit because of improper floodplain development during some times long periods between floods. As there is no proper maintenance of law and regulations by the relevant authorities improper land use pattern can be seen all over the country. Some of the examples are given below.

(A) Erecting structures that deflect flows or increase downstream areas.
(B) Urbanizing watersheds and covering large areas with pavements and rooftops which increase the amount and speed of runoff.
(C) Building drainage systems that accelerate flood flows to downstream erosion.
(D) Construction bridges, culverts, landfills, buildings and other encroachments that reduce the size of the stream channel and natural storage areas, thus raising flood heights.

3) COST DUE TO FLOODS: -

Floods to the Sri Lanka economy as well as people have done more often heavy damages. In 1978 floods were followed by the cyclone and caused serious damages to the 28% of the country. In the very recent history; November 2000, the flood in Baticoloa district caused heavy damage to the community. 4,000,000 people were rendered homeless. Over 3,000 acres of paddy fields were destroyed. Many roads were impassable with the water rising 3.5 feet at certain point. Two people were reported lost.

In Sri Lanka there is not an accurate method to assess both tangible and intangible damages due to natural disasters. But in general it is understood that the cost for replacing damaged properties, cost for evacuation, relief and rehabilitation of victims, cost due to disruption to commercial, industrial, activities and damage to crops and livestock take a considerable portion of government expenditure.

4) FLOOD MITIGATION IN SRI LANKA

In Sri Lanka various kind of attempts, can be seen which the ancient people and rulers on flood control have taken. One of the greatest king in the history once declared that not a single drop of rainwater should flow to the sea without profiting the people. The ancient kings built number a of reservoirs. They constructed large mounds, in order to have a place of escape. It proves that the attempts of man to protect himself from flooding are as old as the history of civilization. But comparing to the ancient time now the damages are much more. Although the nature of the flood is same its intensity is accounted to the extent of the damage it causes. Today the population has gone up. People inhabit the areas, which is flood prone. Flood plain occupancy has increased. The increasing population occupies lowlands. Therefore more developed and effective measures are needed to mitigate the sufferings of people from floods.

According to the proposed national disaster management plan and the measures, which have been taken already, the present flood mitigation measures consist of two approaches. One is take water away from the people and the and the other one is to take people away from water, or We can identify them as flood control and flood damage mitigation measures. These measures can be put into three strategies.

- Flood protection measures
- Flood proofing
- Flood preparedness

(1) FLOOD PROTECTION MEASURES: -

This is the major and long-term structural measure that can be taken to prevent a designated area from entering into floodwater. Safeguarding the day-to-day economic and social activities from the flood is the main objective of this approach.

Many steps have been used and proposed according to this. Namely,

(a) Storing flood water in reservoirs: -

In Sri Lanka most of ancient kings used to use this method. In this method a portion of flood flow will be stored to minimize the flood peak at the point to be protected. Flood mitigation reservoir has it maximum potential for flood reduction when it is empty. After a flood has occurred a portion of the flood mitigation storage is occupied by the collected floodwater and is not available for use until this water can be released. A second storm may occur before the draw down is completed. Consequently it is often necessary to reserve a portion of the storage capacity as protection against a second flood.

The full capacity of the reservoir cannot be assumed to be available for the control of any single flood. If a second flood occurred while the reservoir is full the effect of the reservoir might be make flood worse.

The other thing is if we want to get more successful results from this an accurate flood forecasting system is needed.

(b) Constructing dikes: -

This is accepted as the most economical, common and old flood protection method.

In Sri Lanka during 1930 to 1935 dikes were constructed on the both banks of Kalani river. Like wise Gin river and Nilwala river were also tried to protect by constructing dikes. Although the Gin river project is quite successful, Nilwala project is not, owing to various reasons. The main problem that has been identified in the dike system is that it provides protection only up to a certain level of flood. On the other hand a long period of absence of flood. This will create a feeling of security for inhabitants of dike-protected areas leaving them unprepared for an eventual failure of the dike.

(**c) Floodways and flood diversions: -**

Floodways play two roles in flood mitigation. First, they create large, reservoirs, which store a large portion of floodwater and hence decrease the flow in the main channel below the diversion. Second, they provide an additional outlet for water from upstream, increasing velocity and decreasing stage for some distance above the point of diversion.

Floodways is originally used only during major floods, and the land in the floodway may be used for agriculture, although usually no fixed improvements of any value are permitted in the floodway area.

The other method that is suggested to cope up with flood in Sri Lanka is taking water away from the river channel. The ancient people used this method by breaching a dike purposely in an area where the resultant damage is relatively small. In order to save dikes that protects another area where the damage would be relatively large. Now it is realized that according to this method the better way is to have a spillway that sluices with gates and dissipaters energy.

Actually this method is quite effective and inexpensive means of flood. But to get more results some requirements there. First one is the area where into which the floodwater are diverted should be free from habitation.

(d**) Channel improvement: -**

This method will improve the hydraulic capacity of the channel. Removal of brush and snags, dredging of bars, straightening of bends, and other devices can be used to achieve this target. But the attention should be taken not to make the channel susceptible to bank erosion. The other thing that we have to consider is some time the lining of channels may eliminate the natural recharge of the ground water.

(e) **Discharging drainage water by pumping:-**

Pumping is usually used for the disposal of interior drainage water whenever adequate discharge by

gravity flow cannot be achieved because of limited outlets, insufficient storage capacity or because of backwater caused by flooding.

(f) **Vegetal covers: -**
In some of the areas deforestation is the main reason for flooding. Vegetal cover is identified as a better solution for these area. The vegetal cover can remove moisture from the soil and by transpiration and that it also promotes loose organic soil, which is favorable for the infiltration of rainfall. On the other hand a heavy vegetal cover means a high interception loss during storms. In Sri Lanka these techniques are most commonly used in agricultural areas. They include maintaining trees, shrubbery and vegetal cover, terracing, slope stabilization, using grass waterways, contour planning, and strip framing.

(g**) Flood plain management:-**
The purpose of the flood plain management is to balance between the values obtainable from the use of floodplain and the potential losses to individuals and society arising from such use. This approach is designed to combat flood problems more effectively and to reconcile the objective of reduction of damage with benefit of preserving and enhancing natural floodplain values. Floodplain management is based on:

- Controlling development of floodplains through regulatory measures and withholding financial assistance from government for new developments and improvements to existing development areas subject to flooding.
- Using wider range of tools to reduce flood losses to both existing and new structures and emphasizing use of those tools causing less severe environment impacts.
- Assumption by state and provincial governments and private property owners of a greater share of responsibility for the consequences of the floodplain development incorporating concern for natural values into decisions about floodplain development and projects for flood loss reduction.

But Specific recommendation for flood-plain management should be developed very carefully. Because the best solution will vary from stream to stream.

(2) FLOOD PROOFING: -

This method is consists of two strategies.
- Flood proofing of specific properties
- Flood adaptation

Flood proofing of specific properties:-
This measure are included with the provision of shutters to secure the building against the entry of flood water, construction of building on elevated piers or earth mounds, construction of retaining walls around the properties, or use of flood water resistant materials.
In areas where the floodwater is shallow and slow moving, sand bags can make temporary walls. Furthermore elevating buildings above flood level is also another method for this.

(b) Flood adaptation
This is done through informing the people about the possibility of floods where they work or live. According to this the height of flood level that can be reached, how to structure the home or shop or farm, will be thought. Then the people themselves will take flood protection measures on their own initiatives.
As an example in the rural areas farmers can take action to reduce susceptibility to flooding by modifying their land management practices. They can remove the unwarranted obstructions done by them selves.

Actually specific recommendation for flood mitigation should be developed from a deep study. The best solution will be differing from place to place. It depends on various kinds of facts. However to

implement above strategies laws and regulations should be enacted.
According to the national disaster management plan those regulations are as follows:

- Not permitting unrestricted new development in the hazard prone area.
- Anchoring and flood proofing structures to be built in known flood prone areas.
- Built-in safeguards for new water and sewage system and utility lines from flooding
- Enforcing risk zone, base flood elevation, and floodway requirements.
- Prohibiting of development in wetlands.
- Prescribing standard for different flood zones on flood maps.

(3) FLOOD PREPAREDNESS: -

Flood preparedness describes the wide rang of pre-emergency activities designed to reduce flood impacts. This method is included the following strategies.

- Forecasting and warning
- Evacuation and sheltering
- Relief work

(a) Forecasting and warning: -

Objective of flood forecasting and warning system is to provide prediction for water level during floods and inform appropriate authorities with a view of warning local officials and the community as soon as possible. There are three essential stages in f & w.

- Collecting rainfall data from upstream stations and catchments
- Translate the data into expected water levels and their timing at key downstream locations.
- Transmit the results to appropriate agencies, which may provide warning for floods to vulnerable community.

(b) Emergency evacuation: -

Evacuation is regarded as a short-term measure and can be divided into three phases, such as pre-flood, during flood and post flood. The greatest potential for reducing the number of casualties and flood damage is during the pre-flood phase and as mentioned previously the degree of success is depend on the effective flood forecasting and warning system.
If the flood becomes larger evacuation should be done during the flood. The post flood phase includes relief and rehabilitation of the flood affected area.

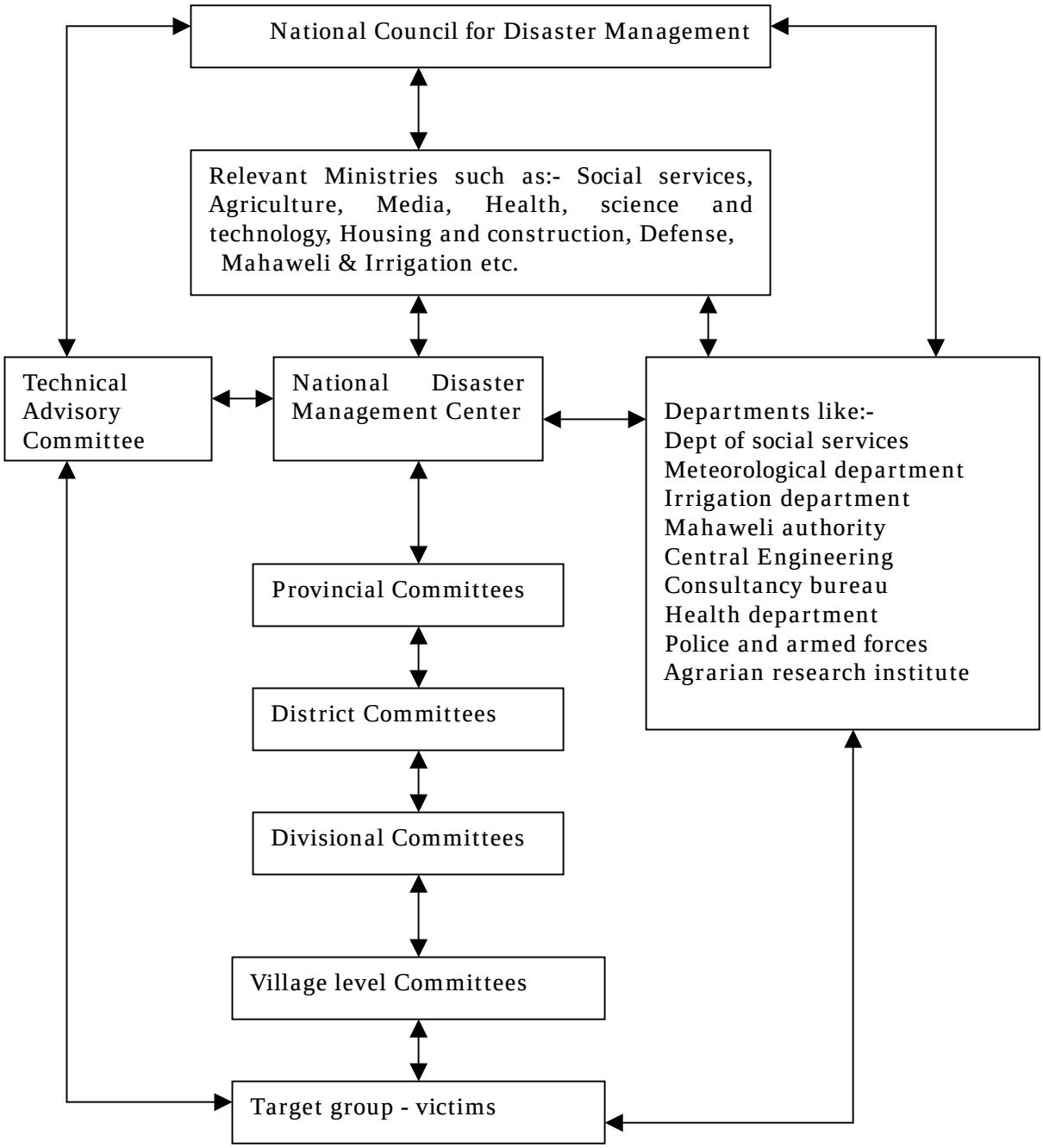
(c) Flood relief

These arrangements provide the financial assistant to help the local authorities to meet the relief requirement. In Sri Lanka, every year government efforts to regulate relief and rehabilitation, with respect to various disasters have resulted in a number of policy guidelines and government circulars including some gazette notification. It is therefore necessary to take stock of these existing instruments and bring them under the purview of disaster management legislation and relief and rehabilitation policy. The existing ad-hoc measures will have to be replaced to the extent possible with more definite arrangements.
This would help in communicating the expectations of the administration.
Furthermore flood relief can be looked upon as zero premium insurance and does little to reduce the impact of flood losses. Under a policy, which provides generous flood relief, there is a potential for flood relief payments to increase.
Past experience has shown that great deal of damage caused by flood is due to unprepared ness, inefficient warning system, lack of accurate information,
Inefficient administrative machinery, inadequate coordination between various departments, unplanned actions and delay in mobilizing resources.
Therefore flood mitigation measures of Sri Lanka should be totally based on community needs and they should be planned from the perspective of the affected community and preparedness measures are based

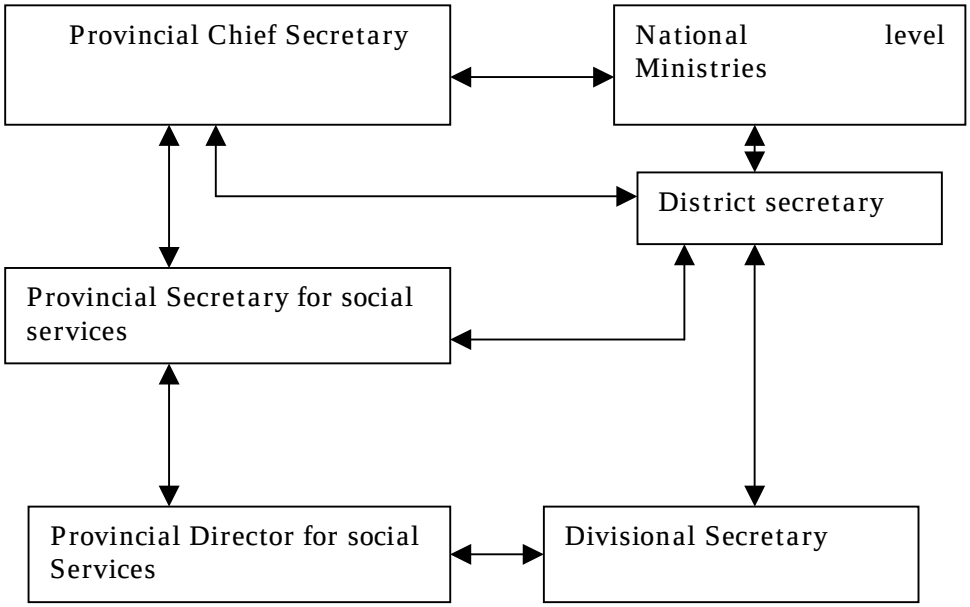
on following set of policies.

- First priority in use of available resources shall be placed on protection of life.
- The program shall be conservatively designed to ensure that personnel, organizations and equipments readily available within the community can effectively carry it out effectively.
- Every practical precaution shall be taken to eliminate the need for unnecessary evacuation and protective actions.
- Arrangements shall be included for at least a minimum “stand along” capability to detect impending floods and predict their magnitude and timing.
- Individuals, business and others shall be given the opportunity to receive warning of potential flooding in advance of those issued to the public, continent upon their recognition of potential unreliability of such warnings.

Proposed Institutional framework for flood mitigation in Sri Lanka: -



Provincial level flood mitigation structure



Functions of each organization on flood mitigation (briefly)

Organization	Function
Meteorological department	Observation, collection and analyzing the data. Issuing weather forecasting. Translate forecast in to warnings. Flood prediction
Irrigation department	Flood simulation studies and prediction of floods. Observation, collection and analyzing hydrological data. Recording and maintenance of flood levels in river basins. Issue flood warnings.
Department of Media	Broadcasting all relevant information to the Public and organization.
Dept.of Social services	Relief and rehabilitation works.
NDMC	Overall coordination. Conducting Training and awareness programs. Coordination with foreign disaster related organizations. Preparing national action plan for flood mitigation.
District level committees	Divide flood vulnerable areas into smaller areas for flood preparedness. Evacuation, relief and rehabilitation activities. Preparing district action plan for flood mitigation.
Police and arm forces	Evacuation and other emergency activities.
Department of Health	Providing all the health care facilities.
Village level committees	preparing detail action plan for the village. Maintaining an inventory of available resources and the history of disasters in the village. Assisting rescue and relief operation at the village level.