Training Manual
Early Warning: Use & Practices

UNDP

ACKNOWLEDGEMENT

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Inevitably it is those who have least that, proportionally, lose most in a disaster.

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Introduction

Purpose and scope

This training module on Early Warning: Use & Practices is designed to introduce aspects of Early Warning and disaster management to an audience of professionals who form disaster management teams that may be government agencies, NGOs, and Community Members. This training is designed to increase the audience's awareness of the process of Early Warning System, leading to better performance in disaster preparedness and response. The major objective of this training manual is to increase awareness about early warning mechanisms for different hazards, their potential benefits, challenges in taking decisions during such early warning, and capacity building in interpreting and taking suggested protective measures. The content has been developed with inputs from experts in the field of disaster management and in general follows the ISDR Early Warning System principles, procedures, and terminology. However, terminology in this field is not standardized and different institutions may use the same terms in slightly different ways.

Overview of this module

The evidence shows that losses from natural and human-made disasters are increasing, causing death and injury to many millions, leading to the destruction of property, and continually setting back the efforts of the poorest countries to develop their economies. Enough is now known about the causes and frequencies of disasters and their likely effects for us to begin to estimate future losses, and plan to reduce them as a part of an overall development strategy. This module examines Early Warning System for various hazards such as Cyclone, Flood, Drought, Tsunami and Epidemics. It seeks to identify the various components of Early Warning System such as methods and process associated with detection/ monitoring, communication, interpretation, and standard operating procedures for response etc.

The first chapter gives an overview of the concept of Early Warning System, its components, and the linkages that are crucial. The succeeding chapters 2-6 discuss Early Warning System for various hazards (Cyclone, Epidemics, Tsunami, Flood, and Drought) applicable for coastal districts of Tamil Nadu. Each of these chapters looks at individual Early Warning Systems and Processes and makes an attempt to identify issues crucial from the perspective of those with responsibility for interpreting such warning. Each chapter in the module has a sample Early Warning case scenario

for exercise purposes. The actual Early Warning Situation at times can be quite complex and the case scenarios are thus only indicative of such a situation.

Training methods

This module is intended for two audiences: the self-study learner and the participant in a training workshop. The following training methods are planned for use in workshops and are simulated in the "training guide". For the self-study learner the text is as close to a tutor as can be managed in print.

Workshop training methods include:

- Presentation/Group discussions
- Simulations/role plays
- Supplementary handouts
- Videos
- Review sessions
- Self-assessment exercises

The self-study learner is invited to use this text as a workbook. In addition to note-taking in the margins, you will be given the opportunity to stop and examine your learning along the way through questions included in the text. Write down your answers to these questions before proceeding to ensure that you have captured key points in the text.

Chapter - I

Early Warning Systems (EWS)

The ultimate goal of hazard forecasting and early warning systems is to protect lives and property. They constitute one of the key elements of any disaster reduction strategy. To serve people effectively, systems must be integrated and link all actors in the early warning chain including the scientific and technical community, public authorities, and local communities. Accurate, timely, reliable, and comprehensible communications are essential. Effective early warning procedures should be part of the national institutional and legislative framework for disaster management. They equally need to have redundancy built into the system. Early warning must be complemented by professional services, training, and capacity-building activities and the allocation of resources to enable timely actions to be taken to avert loss.

System Approach :

A system is a set of interacting component parts that acts as a whole to produce an outcome. Systems thinking and methods have been very useful in improving the design and operation of many elements of modern society. Early warning systems can be likewise examined and improved from this perspective. The first step calls for the definition of the early warning system - of its desired outcomes, component parts, internal relationships, inputs and outputs - along with measures of its performance, preferably in relation to appropriate benchmarks or norms. The following four-element framework provides a good basis for defining early warning systems.

Four Elements of Early Warning System:

An effective Early Warning System comprises a chain of four elements, spanning the knowledge of risk faced through preparedness to act on early warning. Failure in any one part will be failure of the whole system.

a) Risk Knowledge	b) Monitoring and Warning Services	c) Dissemination and Communication	d) Response Capability
Prior Knowledge of Risk faced by the Communities	Technical Monitoring and Warning Services for all such risks	Dissemination of Understandable Warning to those at Risk	Knowledge and Preparedness to act
Risks arise from hazards and the vulnerabilities that are present: What are the patterns and trends in these factors?	Is there a sound scientific basis for predicting the risks faced? Are the right parameters being monitored?	Do the warnings get to those at risk? Do people understand them? Do they contain useful information that enables proper response?	Do communities understand their risk? Do they respect the warning services? Do they know how to react?

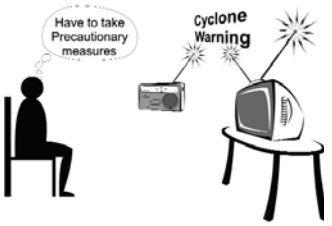
Question : What are the objectives of Early Warning?

Question : Name the four components of Early Warning System.

Good Early Warning Systems have strong linkages among all the above four elements. Risk scenarios are constructed and reviewed. Specific responsibilities throughout the chain are agreed and implemented. Past events are studied and improvement made to the Early Warning System. Manuals and procedures are agreed and published. Communities are consulted and information is disseminated. Operational Procedures such as Evacuations are practiced and tested.

An effective Early Warning System must recognize the differences in vulnerabilities that exist between different sections of societies and also the dynamic nature of such vulnerabilities. The risk due to hazards is not uniformly distributed and thus an effective Early Warning System need to be founded on appropriate Risk Assessment methodologies.

The monitoring and warning service is at the core of the EWS and it should integrate locally used methods while simultaneously making maximum use of the progresses in related Science and Technology fields. Local monitoring of hazards/risks and warning procedures such as Sirens, Drums, Bells etc. have often been found to be the most effective at the time of emergencies and such methods need to be recognized, supported, and integrated in the overall Framework.



There can be a range of technological solutions to communicate Early Warning to the vulnerable population and it is necessary to have such choices which are accessible and robust for Early Warning dissemination. Factors such as lead time, coverage, topography of the area, access to warning devices, cost, maintenance, reliability etc. need to be taken into account while designing the dissemination mechanism. To reach out to the last person and avoid failure, a combination of such dissemination technologies can be used.

The warning information that is communicated to the vulnerable population need to be user-friendly and at the same time the community should have the capacity to interpret it properly. Capacity building at the community level should ensure that systematic preparedness programs have been conducted, that disaster management plans are in place and have been tested, and that community members have been adequately trained to know how to act after receiving Early Warning.

Question : What are the measures Community needs to do as part of capacity building for Early Warning System?

Chapter - II

Cyclone Warning

The term Cyclones refers to all tropical storms that develop over tropical seas. These storms are also known as Hurricanes in the Atlantic / Eastern Pacific, as Typhoons in the Western Pacific, as the Willy-Willy in Australia and as Bagiuo in the Philippines. Cyclones are large revolving vortices in the atmosphere extending horizontally between 150-1000 kms and vertically from the surface between 12-14 kms. The actual powerhouse of a Cyclone is located within its core radius-eye of the storm. Cyclones generally move at the rate of 300-500 km/hr on sea and while moving on sea surface continue to pick up energy from warm water and the air by which some of them may grow into systems with devastating intensity.

Frequency of Cyclone :

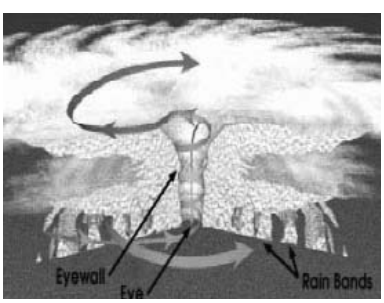
Approximately 80 cyclones are formed on an average in a year around the world out of which 5-6 are formed in the North Indian Ocean. Of these 5-6 only 2-3 may be severe; and historically, the Bay of Bengal breeds more cyclones than the Arabian Sea.

Cyclone Season :

There are two Cyclone Seasons observed in the North Indian Ocean a) May-June and b) Mid September-Mid December. Though Cyclones are formed during the Monsoon season in India; rarely do they become severe and are normally characterized by heavy rainfall.

Hazards Associated with Cyclones :

a) Storm Surge: The biggest threats from Cyclones are the storm surges which account for the bulk of the casualties. Storm surges refer to the sudden and rapid rise in sea-level that occurs as the Cyclone approaches the coast. The elevation of the sea-level is caused by various factors such as high offshore winds, low atmospheric pressures, and decreased water-depth close to the coast. Storm Surge heights (up to 7 meters have been recorded) depend on a range of factors such as tides, the rate of water run off from the land, onshore winds, coastal contours /configuration etc. High tides



at the time of landfall can worsen the situation as they lead to superimposing of the surge over the tides giving rise to peak surges. Surges cause the most havoc when they recede as receding sea water can wipe out everything that comes in its way.

b) **Strong Winds:** Cyclones can produce wind speeds up to 320-350 km/hr and such wind speeds can cause considerable structural damage and also pose risk to life from flying debris. After the Cyclone makes landfall, the increase in the pressure gradient of wind speed might reduce but sometimes, destructive winds can still occur far inland.

c) **Heavy Rainfall:** Torrential rain (to the order of 30-40 cm/day) accompanies cyclones and can result in rapid augmentation of flow in coastal stream catchments and water reservoirs leading to inland flooding. This heavy rainfall can cause breaching/damage to roads/bridges etc. affecting the evacuation of vulnerable people at the time of Early Warning. In Orissa, during a Super Cyclone (in 1999) 43 cms of rain was recorded at Bhubaneswar during a 24 hour period.

Question: What are the Cyclone Seasons in Tamil Nadu?

Question: What are the major hazards associated with Cyclones?

Question: What is the specific hazard associated with Cyclones for which we need to evacuate to safe areas?

Cyclone Classification : The most widely used classification of Cyclones is based on wind speed. In India the following classification is referred to :

Categories	Wind Speeds	
Low Pressure Area	Less than 17 Knots	Less than 31 km
Depression	17-27 Knots	31-49 Km
Deep Depression	28-33 Knots	50-61 Km
Cyclonic Storms	34-47 Knots	62-88 Km
Severe Cyclonic Storms	48-63 Knots	89-118 Km
Very Severe Cyclonic Storms	64-120 Knots	119-221 Km
Super Cyclone	Above 120 Knots	Above 221 Km

Cyclone Warning Services

Cyclone Warning Services in India are provided by the India Meteorological Department (IMD) through its Cyclone Warning Division (headquartered at New Delhi). Within the country, cyclone warning operations are carried out through Area Cyclone Warning Centers and Cyclone Warning Centers. The Chennai office of the India Meteorological Department is one of three Area Cyclone Warning Centre in the country (Kolkatta and Mumbai are the other Centers).

Cyclone Detection & Monitoring: IMD observational data input has a large network consisting of radars (one of which is located in Chennai), satellite data and data forms, and ships and other metrological observatories to detect the formation of cyclones on the surface of the sea. In the event of any cyclonic disturbance, the nearest Area Cyclonic Warning Centre/Cyclone Warning Centre assesses the situation and gives inputs about the system. After detection, the Cyclone Warning Division of the IMD monitors the movement of the storm through satellite and radar pictures. The Weather Centre, Pune plays a significant role in this process of monitoring and issuing cyclone advisories/warnings.

Issuing of Cyclone Advisories/Warnings (Four Stage Warning Systems):

Presently, the IMD uses a four tier strategy to issue warnings to Public and Government Officials. According to this system

- A pre-cyclone **"Watch"** is issued approximately 72 hrs before expected landfall and contains early information about development of the cyclonic disturbance
- An **"Alert"** is issued approximately 48 hours before the expected landfall
- A **"Warning"** is issued at least 24 hours before expected landfall
- A **"Post-landfall Scenario"** is issued mainly to cover the devastating impacts of the cyclone on the inland areas and is issued 12 hours before landfall and continues till such time as the cyclone's force wears down.

The IMD issues advisories/warnings for various user groups :

a) Port Warning b) Bulletins for ships in coastal water and for ships in high seas c) Fishermen Warning c) Bulletins for the Indian Navy d) Warning for Aviation.

Dissemination of Advisories/Warning:

The IMD H.Q. at Delhi and the Area Cyclone Warning Centre (ACWC) issues advisories/warnings to the All India Radio/Television News Channels for regular broadcastings.

Question: What will be approximate wind speed for a) Very severe cyclone and b) Super Cyclone?

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Question: What are the four stages of Cyclone Warning System in India?

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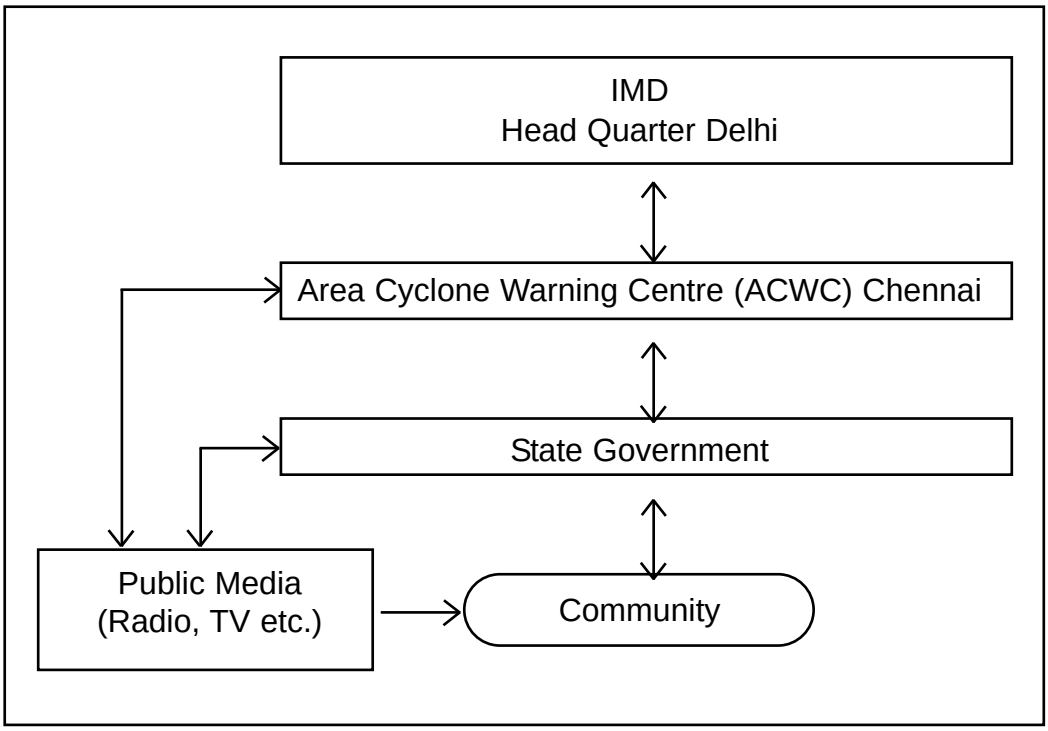


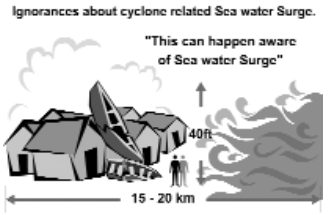
Normally warnings are to be broadcast at 3 hour intervals, but can be done more frequently if so needed. The Area Cyclone Warning Centre briefs newspapers in order to disseminate cyclone warnings. Ships on the high seas are warned through coastal radio stations and normally such bulletins are issued at 8 hours intervals.

Major Challenges in Cyclone Warning :

- **Landfall forecast :** The path prediction of a cyclone and the forecast about its landfall location is derived from a combination of techniques such as track extrapolation, numerical weather prediction etc. Given the current state of scientific understanding, land-fall location can be predicted with an error margin of 50 km. What this means, is that for a given a forecast about landfall location on a coastal area, evacuation for safety should occur 50 kms extending in both directions. The cyclone often changes track during the last few hours, and evacuating this zone is extremely crucial from the safety point of view.

- **Ignorance about Cyclone-related Sea Water Surge:**

The general understanding of cyclones as causing only heavy rainfall and wind obscures the severity of Sea Water Surge problems around cyclone landfall areas. There is generally a low level of awareness about cyclone related sea waves. For example, during the Orissa Super Cyclone in 1999, sea water surges measuring up to 30-40 ft high rushed inland to a distance of 15-20 km and killed 10,000 people. People in such areas had recived a cyclone warning but could not visualize the connection between the cyclone and a sea surge; and very few people evacuated to safe enough shelters. A major lesson here is to create greater awareness among all sections of people about Sea Water Surges at the time of Cyclone Landfall.



- **What is Safe Location/Shelter?**

At the time of Cyclone Warning, advisories suggest that vulnerable people should evacuate to safe location/shelters. It has been observed that people have problems in evaluating what exactly a safe area/location is. A single storied concrete building may be strong; but if it is in low-lying area and close to sea, then it will be vulnerable to sea surges and cannot be considered a safe shelter. This is why Cyclone Shelters should be two/multi storied buildings that take into account the dangers posed from possible sea surges. Additionally, the distance between the sea/villages to area(s) in which people need to evacuate, can be a major hindering factor in public response if such information is not part of Cyclone Advisories. You should contact administration officials if there is need for information on safe area(s) for evacuation.

- **Early Warning Dissemination:**

An early warning for Cyclone, when disseminated through radio/television and other public media, may not be location/district specific. Such dissemination can be

complemented with local level announcement for greater effectiveness. This can help vulnerable people relate the general warning to their location and take precautionary measures.

- **Past Experience of Cyclone Warning :**

  If communities have past experiences of responding to Cyclone Warnings for cyclones that eventually did not materialize, (the system may have weakened/track changed etc.) there will be a general reluctance/resistance to respond to subsequent cyclone warnings. A lot of awareness needs to be created among communities explaining cyclones as phenomena per se, and also why they need to take precautionary measures in response to cyclone warnings irrespective of a cyclone's eventual occurrence - in order to inculcate the desired level of preparedness.

- **Failure of Communication System :**

  Cyclones are invariably accompanied by strong winds and heavy rainfall. During the crucial hours of Early Warning, the communication system can fail and getting regular updates from the India Meteorological Department (IMD)/ other Government Departments may not be possible. It is thus strongly advised to build back up communication mechanisms to face any such eventualities.

Question: What are the major challenges in getting appropriate responses for Cyclone Warning?

Question: What measure you can suggest for making Cyclone Warning more effective?

Review Points

- There are 2 cyclone seasons for Tamilnadu out of which the Mid- September to Mid-December season witnesses the more severe cyclones

- The major hazards associated with Cyclone are a) Sea Water Surge b) Heavy Rainfall c) Very Strong Wind Speed

- If a cyclone makes a landfall (crossing the coast), it can cause sea water surges (large Sea Waves going long distance inland). Such surges are responsible for a majority of deaths in during a cyclone.

- Evacuation guidelines suggested at the time of a cyclone warning should keep in view the possibility of a sea water surge. A single storied house near the coast in a low lying are can get submerged if a sea water surge occurs and may not be safe to suggest as a possible evacuation site.

- The India Meteorological Department (IMD) issues a four tier Cyclone Warning strategy a) Pre-Cyclone-Watch b) Alert c) Warning d) Post Landfall Advisory

- Do not wait till the last moment after a Cyclone Warning for evacuation as heavy rainfall and strong wind speed may damage roads and make travel impossible.

- A cyclone warning may not be able to provide a pinpointed landfall location and thus it is essential to evacuate large stretches of probable areas.

- Cyclone shelters, if existing in your locality, need to be adequately provisioned with rations /drinking water/medicines at the start of cyclone seasons every year for the temporary shelter of villagers

- It is important to remember that every cyclone warning requires taking precautionary measures such as evacuating to safe areas. Even if such warnings do not materialize repeatedly; communities should not ignore them.

Case Study (Exercise)

Early Warning Scenario : Cyclone

It is 10 pm on 27th October and you are in the village. You have received communication that the cyclone monitored over the Bay of Bengal has intensified further and is moving towards the Tamil Nadu coast. The warning message you received is as follows:

Cyclone Warning Bulletin No. 3 issued by

Area Cyclone Warning Centre, Chennai at 21.30 hrs IST of 27th October

Warning for Chennai, Kanchipuram, Cuddalore, Villupuram, Nagapattinam, Thiruvarur, Pudukottai districts of North coastal Tamil Nadu, and Pondicherry. The severe cyclonic storm over southwest bay moved slightly northwards and lies centered at 1730 hours IST of 27th October about 150kms east-north east of Chennai. It is likely to intensify further and move in a west northwesterly direction and cross Tamil Nadu coast between Chennai and Nagapattinam by tonight or tomorrow early morning.

Rain or thundershowers are likely at most places over north coastal Tamil Nadu and Pondicherry and at many places over the rest of Tamil Nadu.

Heavy rain at a few places with isolated very heavy falls likely over Chennai, Thiruuvallur, Kanchipuram, Cuddalore, Villupuram, Nagapattinam, Thiruvarur, Pudukottai districts of north coastal Tamil Nadu and Pondicherry during next 36 hours. Isolated heavy rain also likely over remaining districts of north interior Tamil Nadu during the same period.

Gale warning: Gale force wind speed reaching 100 to 120 kmph causing extensive damage to thatched roofs and huts, minor damage to power and communication lines due to uprooting of large avenue trees likely along above north coastal districts of Tamil Nadu and Pondicherry during the same period. State of sea very rough to high off Cuddalore and Villupuram districts. Tidal wave reaching 4-6 meters above normal tide also likely affect low lying costal areas off above districts. Great danger signal number NINE hoisted at Chennai and Great danger signal number EIGHT at Nagapattinam port and great danger signal number TEN kept hoisted at Cuddalore and Pondicherry ports.

Fishermen advised not to venture into open seas

The above warning is for districts of Chennai, Kanchipuram, Tiruvallur, Cuddalore, Villupuram, Nagapattinam, Thiruvarur, Pudukottai, Thanjavur and Pondicherry.

Your village people have come to you to find out what they should do. You have talked to them about evacuation and some villagers have refused to evacuate. In some of the low lying coastal villages, people have moved into one concrete one storied building and believe that this building can be safe from the cyclone's impact. In some other neighboring hamlets, people who had evacuated during the last cyclone, point out that these forecasts may not be accurate and advise others in your Village not to evacuate. There is a cyclone shelter 2 km. from your village but the community is not agreeing to move into these shelters saying there may not be space for them and neither might there be provision of water/sanitation facilities.

Exercise I :

Work as a team and identify the major challenges you can face in guiding your community to take precautionary measures. You can draw a map (use chart paper/sketch) of your area identifying the evacuation route and safe areas that your panchayat/village people should move to take shelter. The group should make a presentation to other groups on these challenges and then plan identifying the route and safe areas for evacuation. (You can contact the instructors for clarification and guidance)

Chapter - III

Early Warning for Epidemics

Epidemics pose a significant disaster risk worldwide. Countries have been put on alert to prevent the spread of diseases such as cholera, measles, dengue, SARS, and HIV-AIDS. Early Warning for Epidemics is mostly dependant on prompt public health interventions based on timely surveillance systems that routinely collect information about epidemic-type diseases.

What are Epidemics?

An epidemic is the occurrence in a community or region, of cases of an illness (diseases) or other health events that is clearly in excess of what is normally expected. A recent example of such an epidemic is Chikungunya fever which spread in Tamil Nadu and other states such as Andhra Pradesh, Maharastra and Karnataka. When categorizing a disease as an epidemic, characteristics of the disease, the area of spread, and the season have to be taken into account. To judge whether there is an excess in occurrence of a disease or not knowledge is required about the previous incidence of the disease in an area; and such a matter of judgment can be done by health authorities.

What is a Disease Surveillance System:

Surveillance is the ongoing systematic, collection, collation, analysis and interpretation of data and information and its dissemination to those who need to know in order that action may be taken. The crucial information in surveillance is: who gets the disease? How many have been infected? What was the source of the infection(s)? When was the community infected? What needs to be done as Public Health Response? In a nutshell, a surveillance system collects data (on disease) with regards to time, place, and persons.

Integrated Disease Surveillance Project:

The Government of India has initiated an integrated disease surveillance system in 10 states of India. This system is now being implemented in a phased manner in Tamil Nadu. The System brings together various existing disease control programmes. The types of disease covered in this surveillance system include:

- Vector borne diseases (Malaria)
- Water borne diseases (Cholera, Typhoid)
- Vaccine preventable diseases (Measles)
- Disease under eradication (Polio)
- Respiratory diseases (Tuberculosis)
- HIV/AIDS, plague, blood pressure, blindness or any other unusual health condition.

Detection & How Epidemic Warnings are issued :

Disease surveillance systems at block/district/state level routinely collect data and if a specific pattern of illness is observed in a particular geographical region, samples will be collected for testing and confirmation. The Department of Public Health and Preventive Medicine at Chennai will then coordinate with district/block level agencies to analyze the disease pattern and if needed issue a warning. Such a warning is then communicated to various user groups through media, district administration etc. to take suggested control/preventive measures.

To give example of how epidemic diseases are monitored/warning issued, the incidence of disease (for example cholera) in the village is monitored and reported by community level health workers (for example, Village Health Nurses) to the block level monitoring unit (peripheral) which will analyze the reports and if needed collect/test the sample. Such reports are then collected from all the blocks in a district (District Surveillance Committee) and reports from districts get compiled/ analyzed at the State Surveillance Committee. In this system, Rapid Response Teams are made at the district and state level.

Question: When are specific types of illness designated as Epidemics?

Question: Give Example of a) vector borne epidemic b) water borne c) respiratory epidemic d) vaccine preventable epidemic diseases.

A surveillance committee will be involved in epidemic detection and control/prevention. The District Surveillance committee will be headed by the District Collector and members will be from various agencies such as Police, District Panchayat Chairperson, Water Board, District Program Manager etc. If a disease pattern is found to be epidemic, an early warning is issued and rapid response teams are constituted to take control/preventive measures.

Warning Signs of an impending Epidemic outbreak

- Clustering of cases or deaths in time and/or space
- Unusual increase in deaths
- Even a single case of measles, Cholera, Plague, Dengue
- Occurrence of two or more cases of epidemiologically linked cases such as meningitis, measles
- Natural Disasters (Tsunami, Flood, Cyclone etc.)
- High Vector density
- Shifting in age distribution of cases

What to do if you receive Early Warning for Epidemics?

If you are in your block/village and get early warning for any epidemics, you can inform/consult the Health Inspector (HI)/Village Health Nurse (VHN) for guidance on preventive/control measures. If you need additional guidance, you can contact the Medical Officer at the block level and the Surveillance Officer at the District level.

Major Challenges in Epidemics Early Warning :

- **Lack of reliable/accurate information on the nature of epidemics and the lack of control/preventive measures:** The process involved in early warning for epidemics such as testing/diagnosis of the disease, confirmation of the control measures/cause etc. are highly complicated and it may take a while in some cases, for an accurate diagnosis of the epidemic. People thus should continually be cooperating with the Early Warning issuing agencies in taking suggested control/preventive measures.

- **Controlling Rumors:** A major challenge during Epidemics Early Warning can be the spread of rumors about the disease and inaccurate information about its control/preventive measures.

- **Surveillance System:** Data from private health care systems is yet to be fully integrated into epidemic surveillance systems. The integrated Disease Surveillance Project is making an effort at addressing these issues. The birth and death registration process, causes of death, and extent of private sector participation are some of the challenges in early detection/issuing of early warning.

- **Constraints in taking suggested control/preventive measures:** It may also happen that the recommended control/preventive measures are not readily implementable.

Question: Give three warning signs for an epidemic outbreak.

Question: Who can you contact if you get a Warning for Epidemics?

Review Points

- Epidemics are diseases which spread and can be known illness such as cholera, malaria or unknown ones such as SARS
- Early Warning for Epidemics is based on disease surveillance systems which detect such events
- In Tamil Nadu, an integrated disease surveillance system is implemented for collection of data, analysis, and prompt public health intervention.
- Some warning signs for epidemic outbreak can be clustering/unusual increase in cases of deaths in time and/or space, any case of dengue, plague, measles, cholera, occurrence of natural disasters, new diseases spreading etc.
- If you get an early warning for an epidemic, you can contact Village Health Inspector/Nurse, Medical Officer at Block level and Surveillance Officer at the District level for guidance on control/preventive measures.
- Be vigilant against the spread of rumors about diseases and their respective control/preventive measures
- In some cases, it may take more time for diagnosis and getting advisory/information on control/preventive measures. One needs to cooperate with health officials and undertake the suggested precautionary measures for this period
- Early warnings for epidemics may sometimes be difficult to understand and comply with. It is crucial to consult the health authorities to understand and take suggested measures.

Exercise: Early Warning Scenario for Epidemics

Cuddalore district has 13 blocks. You are in one of the village panchayat union offices. You have received communication from the District Administration informing you that there is an outbreak of a disease in the district with symptoms of fever and joint pain. This disease has been confirmed by health authorities to be ***chikungunya*** and it has been sweeping Andhra Pradesh, Karnataka and Tamil Nadu. A mixed outbreak of ***chikungunya*** with dengue was reported from Andhra Pradesh between December 2005 and February 2006. In Tamil Nadu there have been 200 to 300 affected in some parts of Vellore, Thiruvullur, and Cuddalore districts. The virus was isolated by Pune's National Institute of Virology in March and the figures of its spread have been rising.

A meeting was conducted at 10.30 am in the gram panchayat office and you were given the overall responsibility to interpret/guide all vulnerable populations in your panchayat/villages against the ***chikungunya*** outbreak.

Mosquitoes play a major role in the spread of ***chikungunya.*** The Government has requested people to be cautious against stagnation of water in waste bottles, plastic buckets, and other containers.

Health department workers have started spraying insecticides on stagnant water. Three old women and one child have reported symptoms in the village and volunteers plan to clean the village area as a preventive measure.

Exercise: Work as a team and identify the main challenges in taking precautionary measures for this early warning and collect other information you need to guide others in community to take precautionary measures. The Group should present the challenges in taking preventive/control measures and plan how to overcome such issues.

Chapter - IV

Early Warning for Tsunami

What is Tsunami?

- A tsunami is a series of waves with a long wavelength and period (time between crests). The time period between two Tsunami waves can vary from a few minutes to over an hour.
- Tsunamis are often incorrectly called tidal waves; they have no relation to the daily ocean tides.
- Tsunami (soo-NAH-mee) is a Japanese word meaning harbour wave
- Tsunamis can occur at any time of day or night

Tsunami generation:

- Tsunamis are generated by any large, impulsive displacement of the Sea-bed level (Fig.1)
- Earthquakes of M > 6.5 are critical for tsunami generation
- Tsunamis are also triggered by landslides into or under the water surface, and can be generated by volcanic activity or meteorite impacts
- When tsunami waves reach the shallow water of coastlines, bays, or harbors, it forces the water into a giant wave. Some tsunamis reach heights of 100 ft. or more

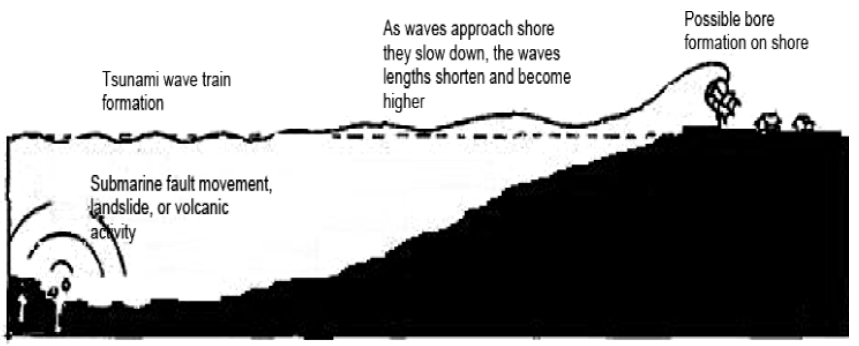


Fig.1 Wave train of Tsunami Wave train of Tsunami

SPEED OF TSUNAMI

- Tsunami velocity is dependent on the depth of water through which it travels. Tsunamis can travel approximately 700 kmph in 4000 m depth of sea water. For example, the tsunami from the Sumatra coast traveled to Tamil Nadu coast in about two hours.

- Even on shore tsunamis can move faster than a person can run.

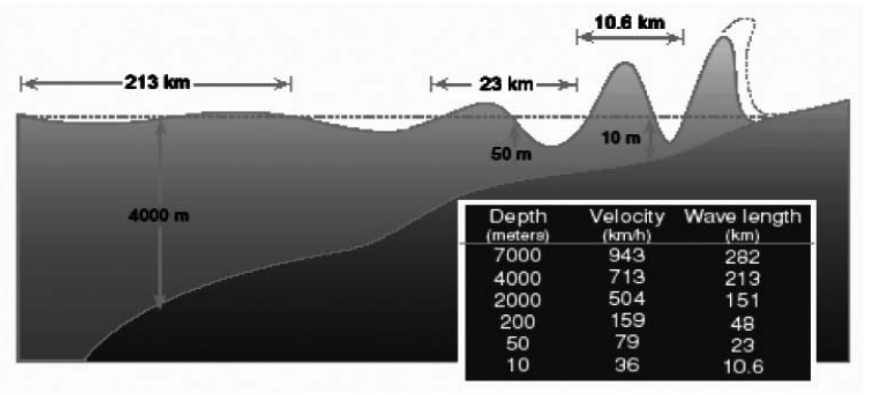


Fig.2 Tsunami Velocities

Size of Tsunami Waves:

- Tsunamis range in size from few centimeters to over 30 m height. Most tsunamis are less than 3 m in height.

- In deep water (greater than 200 m), tsunamis are rarely over 1m high and will not be noticed by ships due to their long period (time between crests)

- As tsunamis propagate into shallow water, wave height can increase by over 10 times

- Tsunami heights can vary greatly along a coast. The waves are amplified by certain shoreline and bathymetric (sea floor) features

- A large tsunami can flood land up to more than 1.5 - 2 km from the coast

- The force of some tsunamis can be enormous. Large rocks weighing several tons along with boats and other debris can be moved inland hundreds of feet by tsunami wave activity. Homes and other buildings are destroyed. All this material and water move with great force and can kill or injure people.

Appearance of Tsunami on the Shore:

- Normally, a tsunami appears as a rapidly advancing or receding tide
- In some cases a bore (wall of water) or series of breaking waves may form
- Sometimes a tsunami causes water near the shore to recede, exposing the ocean floor, and then the wave crest comes with a high speed
- Tsunamis can travel up rivers and streams that lead to the sea.

Question: When can a tsunami can be expected? What causes tsunami waves?

Question: a) How do tsunami waves appear on the sea and on the coast? b) Can one run faster than a tsunami wave?

How is a tsunami different from regular sea waves?

- Wind-generated waves usually have periods (time between crests) of 5 to 20 seconds. Tsunami periods are usually between 5 minutes and 1 hour.
- Wind-generated waves break as they shoal and lose energy offshore. Tsunamis act more like a flooding wave. A 6 m tsunami is a 6 m rise in sea level.

Tsunami Warning:

Present status of Tsunami Warnings in India: There are no codal provisions of tsunami warnings in India as yet. However, there is a good seismological network in India to record any earthquake within the country and its neighborhood. The need of a Tsunami Warning Centre (TWC) in India is now being conceptualized at the Government of India level.

The India Meteorological Department (IMD) is working on a proposal to set up a real time earthquake monitoring system in India. The Department of Ocean Development in collaboration with the Department of Space and the IMD under the Department of Science and Technology is evolving a plan of tsunami warning system in the Bay of Bengal and the Arabian Sea. Data from observation points to Warning Centre(s) will be sent through satellite links, specific systems called Deep Ocean Assessment and Reporting of Tsunamis (DART) using bottom pressure recorders, acoustic modems, acoustic release systems, and battery packs bolted to platform and float action and recovery aids will be deployed.

International Status of Tsunami Warning and Communication System: There are a number of initiatives at the international level for setting up Tsunami Warning Systems for the Indian Ocean region. Present techniques of tsunami prediction are severely limited. The only way to determine with certainty if an earthquake will lead to a tsunami is to note the occurrence and epicenter of the earthquake and then detect the arrival of the tsunami at a network of tide stations. While it is possible to predict when a tsunami will arrive at coastal locations, it is not yet possible to predict the wave height, number of waves, duration of the hazard, or the force to be expected from such waves at specific locations.

A tsunami warning system is based on the concept that tsunamis travel at much slower velocity (500 to 700 km per hour or 0.20 km/sec) as compared to seismic waves (6 to 8 km per second). Seismic waves therefore move 30 to 40 times faster than tsunami waves. Thus, after the occurrence of a damaging earthquake and quick determination of its epicenter, warning time of a few minutes to 2 to 3 hours is available depending upon the distance from the epicenter to the coast line. This time can be utilized for warning the coastal community if quick detection and rapid communication systems are established.

Guidelines to follow if you get Tsunami Warning :

Be aware of tsunami facts. This knowledge could save your life! Share this knowledge with your relatives and friends. It could save their lives!

If you are in an area at risk from tsunamis

- You should find out if your home, school, workplace, or other frequently visited locations are in tsunami hazard areas.

- Know the height of your street above sea level and the distance of your street from the coast or other high-risk waters. Evacuation orders may be based on these numbers.

- Find out the height above sea level and the distance from the coast of outbuildings that house animals, as well as pastures or corrals.

- Plan evacuation routes from your home, school, workplace, or any other place you could be where tsunamis present a risk.

- If possible, pick areas (30 meters) above sea level or go as far as 3 kilometers inland, away from the coastline. If you cannot get this high or far, go as high or far as you can. Every meter inland or upward may make a difference. You should be able to reach your safe location on foot within 15 minutes. After a disaster, roads may become impassable or blocked. Be prepared to evacuate by foot if necessary. Footpaths normally lead uphill and inland, while many roads parallel coastlines. Follow posted tsunami evacuation routes; these will lead to safety. Local emergency management officials can advise you on the best route to safety and likely shelter locations.

- If your children's school is in an identified inundation zone, find out what the school evacuation plan is. Find out if the plan requires you to pick your children up from school or from another location. Telephone lines during a tsunami watch or warning may be overloaded and routes to and from schools may be jammed.

- Practice your evacuation routes. Familiarity may save your life. Be able to follow your escape route at night and during inclement weather. Practicing your plan makes the appropriate response more of a reaction, requiring less thinking during an actual emergency situation.

- Use a Weather Radio or stay tuned to a local radio or television station to keep informed of local watches and warnings.

- Discuss tsunamis with your family. Everyone should know what to do in a tsunami situation. Discussing tsunamis ahead of time will help reduce fear and save precious time in an emergency.

- Expect aftershocks If the earthquake was very large (magnitude 8 to 9+ on the Richter scale) and located nearby. Some aftershocks could be as large as magnitude 7+ and capable of generating another tsunami. The number of aftershocks will decrease over the course of several days, weeks, or months depending on how large the main shock was.

- Watch your animals closely. Keep all your animals under your direct control. Hazardous materials abound in flooded areas. Your pets may be able to escape from your home or through a broken fence. Pets may become disoriented, particularly because flooding usually affects scent markers that normally allow them to find their homes. The behavior of pets may change dramatically after any disruption, becoming aggressive or defensive, so be aware of their well-being and take measures to protect them from hazards, including displaced wild animals, and to ensure the safety of other people and animals.

- Protect Your Property You should avoid building or living in buildings within 200 meters of the high tide coastline. These areas are more likely to experience damage from tsunamis, strong winds, or coastal storms.

- Make a list of items to bring inside in the event of a tsunami. A list will help you remember anything that can be swept away by tsunami water.

- Elevate coastal homes. Most tsunami waves are less than 3 meters. Elevating your house will help reduce damage to your property from most tsunamis.

Question: You are in Tsunami vulnerable area. What measures (Give minimum 4) you need to undertake in advance as preparation for Tsunami Warning?

Take precautions to prevent flooding.

- There may be ways to divert waves away from your property. Improperly built walls could make your situation worse. Consult with a professional for advice.

  When installing or changing fence lines, consider placing them in such a way that your animals are able to move to higher ground in the event of a tsunami.

What to Do if You Feel a Strong Coastal Earthquake

If you feel an earthquake that lasts 20 seconds or longer when you are in a coastal area, you should:

- Drop, cover, and hold on.
- You should first protect yourself from the earthquake damages.
- When the shaking stops gather members of your household and move quickly to higher ground away from the coast. A tsunami may be coming within minutes.
- Avoid downed power lines and stay away from buildings and bridges from which heavy objects might fall during an aftershock.

If you are on land:

- If you are in school and you hear there is a tsunami warning, you should follow the advice of teachers and other school personnel
- If you are at home and hear there is a tsunami warning, you should make sure your entire family is aware of the warning. Your family should evacuate if you live in a tsunami evacuation zone. Move in an orderly, calm, and safe manner to the evacuation site or to any safe place outside your evacuation zone. Follow the advice of local emergency and law enforcement authorities.
- If you are at the beach or near the ocean and you feel the earth shake, move immediately to higher ground, and DO NOT wait for a tsunami warning to be announced. Stay away from rivers and streams that lead to the ocean as you would stay away from the beach and ocean if there is a tsunami. A regional tsunami from a local earthquake could strike some areas before a tsunami warning could be announced.

- Tsunamis generated in distant locations will generally give people enough time to move to higher ground. For locally-generated tsunamis, where you might feel the ground shake, you may only have a few minutes to move to higher ground.

- High, multi-story, reinforced concrete hotels are located in many low-lying coastal areas. The upper floors of these hotels can provide a safe place to find refuge should there be a tsunami warning and you cannot move quickly inland to higher ground.

- Homes and small buildings located in low-lying coastal areas are not designed to withstand tsunami impacts. Do not stay in these structures should there be a tsunami warning.

- Offshore reefs and shallow areas may help break the force of tsunami waves, but large and dangerous wave can still be a threat to coastal residents in these areas.

Staying away from all low-lying areas is the safest advice when there is a tsunami warning.

If you are on a boat:

- Since tsunami wave activity is imperceptible in the open ocean, do not return to port if you are at sea and a tsunami warning has been issued for your area. Tsunamis can cause rapid changes in water level and unpredictable dangerous currents in harbors and ports.

" If there is time to move your boat or ship from port to deep water (after a tsunami warning has been issued), you should weigh the following considerations:

a) ost large harbors and ports are under the control of a harbor authority and/or a vessel traffic system. These authorities direct operations during periods of increased readiness (should a tsunami be expected), including the forced movement of vessels if deemed necessary. Keep in contact with the authorities should a forced movement of vessel be directed.

b) Smaller ports may not be under the control of a harbor authority. If you are aware there is a tsunami warning and you have time to move your vessel to deep water, then you may want to do so in an orderly manner, in consideration of other vessels.

c) Owners of small boats may find it safest to leave their boat at the pier and physically move to higher ground, particularly in the event of a locally-generated tsunami.

d) oncurrent severe weather conditions (rough seas outside of safe harbor) could present a greater hazardous situation to small boats, so physically moving yourself to higher ground may be the only option.

e) Damaging wave activity and unpredictable currents can affect harbors for a period of time following the initial tsunami impact on the coast. Contact the harbor authority before returning to port making sure to verify that conditions in the harbor are safe for navigation and berthing.

Question: What should you do if you are very near the sea and feel a strong earthquake?

Question: a) How far can tsunami waves travel inland? b) If you are on land, what should you do if you get a tsunami warning?

Question: What should you do if you are in a boat and get a tsunami warning?

Review Points

- Undersea earthquakes (of size higher than 6.5 in the Richter Scale), landslides, volcanic activities, meteorite impact and any other such events causing large displacement of water can trigger a tsunami
- Series of tsunami waves can have intervals of few minutes to few hours between two waves
- Tsunami waves can travel up to 1.5-2.5 km inland
- In deep sea, the height of a tsunami may not be observable for its height. When this reaches the shallow coast, the height of the wave increases up to 10 times and causes destruction.
- The size of tsunami waves at the coast can be as little as few centimeters to as much as 3 meters
- Tsunami waves can appear to be regular advancing/receding sea tides. Sometimes such waves are preceded by receding of sea water, exposing the sea floor and then the waves come crashing with great speed
- Tsunami Waves at the coast can still travel at great speed. Never assume that you can run quicker than tsunami waves
- If you are in a coastal area and feel a strong earthquake, protect yourself first from impact of the earthquake (go to an open space if you can do so quickly otherwise protect yourself from building collapse). After the earthquake, get up quickly and run to safe areas as a precautionary measure. This is needed because if the earthquake has occurred very near and has triggered tsunami, the waves will come without warning.
- If you get a tsunami warning in your village/city, find out if you are in this hazard zone. To make an assessment about your vulnerability, you need to know how far you are from the sea and at what altitude (height) from sea level.
- The safest advice for tsunami warning is to stay away from all low lying areas. You should not take shelter in ground floor of concrete building close to coast as they can be flooded.
- Tsunami waves have great power and can carry large rocks, buildings etc, with its force.
- If you are in a boat and deep inside the sea and get a tsunami warning, you should remain there until the warning is over.
- Plan the evacuation route from your house, school and work place and practice it regularly to respond to tsunami warnings
- The safest advice for tsunami warning is to stay away from all low lying areas. You should not take shelter in ground floor of concrete building close to coast as they can be flooded.
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Exercise

Case Study: Early Warning for Tsunami

Cuddalore district has a coast line of 87 km. It is 5am on 27th December. You are in one of the coastal village and received a communication from Sate Relief Commissioner informing that a very high intensity earthquake measuring 8.2 in the Richter scale has occurred 300 km. north of Sumatra and this can trigger tsunami waves. The Ministry of Home Affairs (Government of India) after consulting with India Meteorological Department (IMD) has sounded a Tsunami Alert and as a precautionary measure and has advised evacuation of coastal areas of Tamil Nadu, Kerala, Pondichery and Andhra Pradesh within the next two hours.

The Natural Disaster Management Division (MHA) has communicated the same warning to the public media. Radio/television stations have started sending warning messages in their routine broadcasts. Maps are shown on television showing area in three states and asking people to take safety measures.

There are reports on some TV channels about confusion among people with regards to the warning message and how far they need to evacuate for safety. In your village which is very near the sea, people have assembled to know what they should do. The fishermen in your community are wondering if they should go to sea or remain in the village.

In some other neighboring areas, people have moved to one of the coastal villages as it was not much affected in the last tsunami. There have been reports of people going to rooftops to watch for signs of tsunami waves. Some of your village members are not taking this warning seriously as last time they had evacuated after getting such warning nothing that was anticipated had occurred. Others come to you for guidance.

Exercise:

Work as a team and a) Identify major challenges involved for the community in taking precautionary measures for this warning. Groups will make individual presentations on b) How to overcome these challenges and ensure that people take safety measures.

Chapter - V

Early Warning for Floods

Floods are among the most common and widespread of all natural disasters. Most Communities in India experience some kind of flooding after or during monsoon rains, heavy thunderstorms, or winter snow thaws. Cuddalore receives more rain fall during the North East monsoon. The major rivers in Cuddalore district are Gadilam; Pennar & Vellar and the major lakes are Veeranam, Perumal eri & Wellington Lake. Several factors contribute to flooding. Two key elements are rainfall intensity and duration. Intensity is the rate of rainfall and duration is how long the rain lasts. Topography, soil conditions, and ground cover also play important roles. Floods can be slow or fast-rising but generally develop over a period of days. Flash floods can occur in a quick time. Flooding occurs in known floodplains when prolonged rainfall takes place over several days. Intense rainfall takes place over a short time, or when jammed debris causes a river or stream to overflow and flood the surrounding area. Melting snow can combine with rain in the season; severe thunderstorms can bring heavy rain in the spring and summer.

Anything that is stored outside, and not securely anchored to the ground, can be carried away by floodwaters, i.e. weak houses, firewood, fuel tanks, structures, utensils, tools or vehicles. Floods become much more forceful as they accumulate debris. Debris can batter or impale people, and can affect building structures as well. Many of the bodies recovered from the November 2005 Cuddalore flood were severely battered. Floodwaters can conduct electrical currents and hide debris. Be sure to look for potential electrical sources and stay away from any water in contact with them. Sometimes animals and snakes seek refuge in flooded homes or debris deposits, and may become hidden dangers. More people are killed trying to drive on flooded streets/roads or bridges than in any other single flood situation. Cars can float in as little as 18 inches of water, and flooding may hide a washed out road with what appears to be only a few inches of water.

Early Warning for Flood :

Flood warning in Tamilnadu is a coordinated process in which many institutions participate to issue warning. The organizations involved in issuing of flood warning are

1. Public Works Department (PWD)
2. Ground/Surface Water Board
3. Revenue Department (RD)
4. District Administration
5. Police, Fire Department
6. Agriculture Department

The stages of warning process is as follows, PWD (Public Works Department) monitors the water reservoir with the support of Ground/Surface Water Board, and if the water crosses the permissible limit it issues the warning to the revenue department/district administration. The PWD also gets data on depth of river water at strategic locations and if a flood is anticipated, issues warning to these departments. The Revenue Department in coordination with District Administration/Collector develops the warning message and gives it to the specific block/villages. From the district HQ the information is given to police, rural development, and Agriculture Department for issuing warning and taking measures. The nodal center for dissemination of Flood Early Warning information is the district administration. From the district administration, the information goes to various disseminating agencies such as newsprint, television, radio and other sources.

River Gauges

This is a warning device which monitors river water levels and sends out warning signals to the prescribed address, if the level of water in the river crosses the danger limit. In India, these types of gauges were employed in monitoring of water level in big reservoirs. This system can be utilized for river banks also. This instrument can send out warning signals through sirens. The signals can also be transmitted to other locations for future processing of signals. There are also very advanced versions of river gauges available which can give accurate details of breaches in rivers and can monitor water levels in real time format. This warning system is an automatic process it can send out warning signals without any manual handling. River gauge can work by solar power to make operations more reliable.

Question: Which factors play a role in flooding?

Which government agencies are involved in Flood warning for Tamil Nadu?

Question: Who is/are the authorized persons for issuing flood warning in the district?

Flood Forecasting Network in India: Flood forecasting has been recognized as one of the most important, reliable and cost-effective non-structural measures for flood management. Recognizing the crucial role it can play, the Central Water Commission, Ministry of Water Resources has set up a network of forecasting stations covering all important flood prone interstate rivers. The forecasts issued by these stations are used to alert the Public and to enable the administrative and engineering agencies of the States/UT's to take appropriate measures. Central Water Commission started flood-forecasting services in 1958 with the setting up of its first forecasting station on Yamuna at Delhi Railway Bridge. At present Central Water Commission has network of 159 floods forecasting stations. It has office in Andhra Pradesh.

Types of Floods :

River Flood: Flooding along rivers is a natural and inevitable part of nature. Some floods occur seasonally during winter or spring rains; coupled with melting snows, they fill river basins with too much water, too quickly. Torrential rains from tropical cyclones systems can also produce river flooding. In fact cyclones bring lot of rain fall in a short time and are a key factor in many instances of flooding.

River flood

Coastal Flood: Winds generated from tropical storms and hurricanes or intense offshore low pressure systems can drive ocean water inland and cause significant flooding. Routes can be cut off and blocked by high water. Coastal flooding can also be produced by sea waves called tsunamis (tsoo-n" -m z). These waves are produced by undersea earthquakes or volcanic activity/landslides. These types of floods were seen in during the Tsunami in 2004 on the coast of Cuddalore district.

Urban Flood: As land is converted from fields or forests to roads and parking lots, it loses its ability to absorb rainfall. Urbanization increases runoff 2 to 6 times over what would occur on natural

terrain. During periods of urban flooding, streets can become swift moving rivers, while basements can become death traps as they fill with water.

Flash Floods: Flash floods can result from

a) intense cyclonic storms dropping large amounts of rain within a brief period depending on local terrain, ground cover, degree of urbanization, degree of man-made changes to river banks, and initial ground or river conditions.

b) River streams blocked due to land slides/ debris blocked in bridges.

c) Dam bursts.

d) Unregulated release of water from reservoirs

Flash floods occur with little or no warning and can reach full peak in only a few minutes. Cuddalore is vulnerable to this type of flooding.

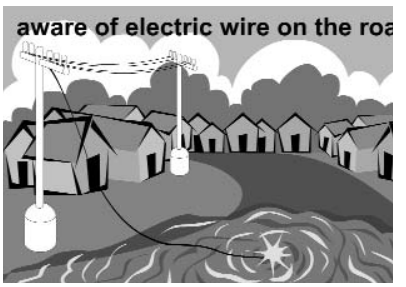
Question: How are river floods and flash floods different?

Question: Which types of floods have affected Cuddalore district?

What should you do if you get a Flood Warning?

- Follow radio announcements, television, or emergency instructions given by the administration. Take the warning seriously and try to understand what measures are suggested for protection

- If a Flood Warning was issued and you are in a low lying area:

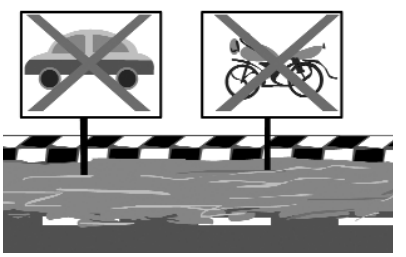


  - Climb to high ground as fast as possible
  - Do not try to take all your things with you - your life is more important!
  - Do not try to run or drive in low lying areas to outrace a flash flood.

- If warning suggests evacuating, discuss with family and friends about such plan and take measures. Keep your valuables and other such articles packed for quick evacuation

- Make plan for your pet animals for emergency evacuation

- If a Flood Warning was issued and you are in the mapped floodplain:



  - Turn off the electricity and gas if necessary.
  - Lock your doors and evacuate to higher ground/cyclone prevention shelter.
  - If you don't have a safe place to stay on high ground, listen to the radio or TV for information on public shelter locations. Contact Administration Officials for clarification on Warning and updates on such warning

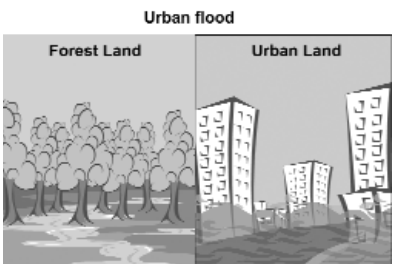
- If you are not in the mapped floodplain, it is unlikely that you will be flooded deeply. If the streets are flooding, you may be safer staying in your house. Fill utensils, buckets, and plastic bottles with clean water. Move your furniture and valuables to higher floors of your home. If you are instructed by local authorities, turn off all utilities at the main power switch and close the main gas valve. Fill your two wheeler/four wheeler fuel tank in case an evacuation notice is issued.

- Flood is mostly followed by epidemics - take appropriate measures to protect yourself from epidemics

- Make sure that place you are evacuating to is safe from flooding. Also make provisions for food and drinking water

Flood Warning: What it should be?
1) The Early Warning for flood should be in understandable form - *The warning message should be as simple to understand and with less technical words.*
2) It should be specific - *The warning message should be specific about the areas under threat.*
3) It must be authentic - *Warning should be given from only duly authorized person only, this minimizes the false warning / rumors.*

What to do mitigate the effects of flooding



Preventive floodplain management approaches usually consist of land use controls, such as floodplain regulations which are applied to the 100-year floodplain. Briefly, the procedure is to define the 100-year water surface elevations, flood outlines, and floodways. The floodway is the channel required to pass the 100-year flood without significantly increasing the water surface. Once the floodplain and floodway are defined, potential development agencies have the option, which are subject to regulation, of leaving the floodplain in open space (perhaps as public or private park and recreation areas), developing the fringe area, or modifying the floodplain or floodway (using options such as channelization) to remove areas from the floodplain. Development that occurs under any of these options will essentially be free from major flood damage up to and including the 100-year flood event.

Other preventive/preparedness approaches include:

1. Flood proofing mechanisms during house construction (such as raised areas) or buildings specified as refuge areas if evacuation is impossible.

2. Diversification of agricultural production; identification and planting of flood-resistant crops or adjustment of planting season, if possible, to avoid coinciding with the flood season; establishment of cash and food reserves;

3. Reforestation, range management, and animal grazing controls to increase absorption and reduce rapid runoff;

Question: What should you do (give a minimum of six) as soon as you get a Flood Warning?

Question: How can we mitigate the effects of /prepare for a flood? Suggest minimum of three measures.

Review Points

- Floods can be a slow onset event or flash floods giving little time for early warning.
- The District Administration in coordination with Public Works Department (PWD) issues flood warning. The warning is issued through the Revenue Department.
- The evacuation suggested at the time of flood warning is done keeping in view the possible flooding and safety of houses and is dependant on structure and location of the house.
- Heavy rainfall and leaching of roads make evacuations very challenging at the time of flood warning. Do not wait till the last moment at the time of flood warning for evacuation as heavy floods may damage road and make travel impossible.
- If you are in low lying area and get a flood warning, climb to safe ground as quickly as possible. Make sure that the house/area/ground you are evacuating to is safe from flooding.
- If you have time when evacuating, turn off all electricity and cooking gas connections and lock your house.
- The other hazard associated with floods is the possibility of epidemics. Make provision for food and drinking water.
- Improper drainage in urban areas is the major reason for urban flooding.
- A flood warning may not be able to provide a pinpointed location and thus it is essential to evacuate large stretches of probable areas.
- It is important to remember that every flood warning requires following precautionary measures such as evacuating to safe areas. Even if such warnings do not materialize for a long time, we should not ignore it.

Exercise

Early Warning Scenario: Flood

Cuddalore district has geographical area of 3,678 Sq Km and comprises of 13 blocks. The district is experiencing heavy rainfall for the last six days and most of the river systems in the district are close to danger level.

It is 9.30 pm in the night and you are in an isolated village which is 30 Km form the Cuddalore town. You have received communication that heavy rainfall is likely to occur in the district in the next 48hrs. There has been release of water from the Kallanai reservoir and also information that flood water has crossed danger limit in several rivers. Three blocks including yours are most vulnerable and flood warning has been issued advising people in low lying areas to evacuate.

The block administration has started alerting the communities by siren/ megaphones which are in the village panchayat office. You are the one who attended the training program on Early Warning Systems and have been given the overall responsibility to interpret the warning message to all in the vulnerable areas.

One of the embankments protecting the southern parts of the block is vulnerable and there are reports that flood water has crossed the danger limit. The warning message has created a great panic in the village and many people are beginning to spread false rumors. There are people in the village saying that the warning message is not true, saying that previous flood warnings never worked.

The panchayat presidents of neighboring areas have gathered in your village to discuss about immediate preventive/precautionary measures.

Exercise-I: The Groups should discuss the various issues in this flood warning. Make a list of measures you can plan to guide community members for taking protective measures and make a presentation of the same.

Chapter - VI

Early Warning for Drought & Management

Tamil Nadu Scenario:

Tamil Nadu has a total geographical area of 13 million hectares of land out of which seven million hectares are under cultivation. In the total cultivable area, only 45 per cent is under irrigation and the balance 55 per cent is dry land. Considering the irrigated area percentage, the State (Tamil Nadu) can manage drought successfully without affecting economy only for one to two years of continuous drought occurrence. This was witnessed from 2000 to 2003, wherein Tamil Nadu experience failures of both the South West Monsoon (SWM) and North East Monsoon (NEM).

Though the total water availability in Tamil Nadu, based on geographical area and annual rainfall is 12.285 mhaM, the annual availability is only 4.74 mhaM and the balance goes as run-off with out any use. Out of 384 blocks in Tamil Nadu 287 blocks have been listed as 'dark' - based on ground water availability indicating the need for focusing on water management.

In 60 per cent of cultivable area, red soil is dominant; while in the remaining area black soil and alluvial soils can be seen. Since the water holding capacity of red soils is less (< 100 mm) as compared to black soils (200-300 mm) drought occurs very early in red soil under the same rainfall situation.

1) What is Drought: There is no universal definition for drought. It is a period of extreme water deficiency and is associated with prolonged and abnormal deficiency in rainfall over a place. As per the India Meteorological Department (IMD), if a meteorological sub-division receives seasonal rainfall of less than 75 per cent of normal rainfall, that area is considered to be affected by drought. If the seasonal rainfall deficiency is between 25 and 50 per cent of the normal rainfall, then it is labeled as moderate drought. When deficiency is more than 50 per cent of the normal rainfall, then it is called as severe drought. A year is considered to be a drought year when the area is affected by one of the criteria for drought - either individually or collectively - and is more than 20 per cent of the total area of country.

Types of drought:

1. **Meteorological drought -** It is a situation when rainfall deviates appreciably below normal for an extended period of time.

2. **Hydrological drought -** This drought follows meteorological drought in chain wherein below normal water level is seen in lakes, streams, and reservoirs including in the ground water level.

3. **Agricultural drought -** It occurs when available soil moisture is inadequate to meet the crop water requirement and leads to moisture stress and wilting.

4. **Socio-economic drought** - A situation where water shortage ultimately affects the established economy of the region adversely.

In the case of agricultural drought, under ground situation the following droughts are common:

Early season drought - This is due to late onset of seasonal rain (sowing rain) from the normal onset. Crop establishment would be the biggest problem.

Mid season drought - It occurs in association with long gaps between two successive rain events in the mid of crop season and the stored soil moisture falls below the crop water requirement. Sometimes this drought may be associated with inadequate rainfall in the growing season. The crop's vegetative growth will be affected.

Late season drought - Early withdrawal of seasonal rain from normal date would bring this drought. Crop's productivity will be affected.

Apparent drought - Rainfall in a given season would be adequate for one crop and may not be for other crops grown under same soil condition.

Permanent drought -This drought is associated with inadequacy of soil moisture to meet the crop water requirement during most of the years in a region.

There are two other terminologies to indicate the relationship between area and drought and they are as follows:

Drought prone area - This is like permanent drought, wherein drought is inherited in the area and drought could be seen in all the years of life.

Drought affected area - Droughts occur once in a way with a periodicity of four years of normal rainfall with one-year drought in a cycle of five years.

Causes for drought:

As discussed in the previous section, the main cause for drought is inadequate seasonal rainfall below the level of requirement, irrespective of crop, dam stream etc.

The causes for low rainfall are as follows:

1. Variation in atmospheric general circulation affects the development of the local rain producing disturbances. The causes of such circulation variations are not well understood, but links with sea surface temperature and snow cover have been established.

2. Higher surface albedo would affect the radiation balance and hence drought occurs.

3. The injections of large amounts of ash into the atmosphere by violent volcanic activity alter the Earth's radiation balance and thereby create compensating circulation adjustments which include climatic fluctuations.

4. ENSO (El Nino and southern oscillation)

5. Geographical position of a region

6. Global warming

7. Deforestation

8. Atmospheric pollution

9. Early withdrawal of seasonal rain

10. Late onset of seasonal first rain

11. Mid seasonal dry spell

Further improper management of rainfall and other water resources would bring drought very early to a region. Drought follows quickly under following rainfall and soil situations.

a. When the run-off is relatively lesser

b. When the rainfall intensity is lesser than the rate of infiltration

c. When volume of infiltrated water is lesser than soil moisture deficiency

The causes for drought are still under debate and further research is still under progress to investigate this complex phenomenon.

Question: When do droughts occur? What are the different types of drought seen in Tamil Nadu?

3) Drought prediction and forecasting and present status

It is possible to reduce the adverse effects of drought by providing advanced or real time information on the possible occurrence of drought though it may not be possible to give accurate forecast when drought will occur. The existing ways are discussed to understand drought occurrence in advance with little precision.

a. Long range forecast

IMD has been giving out this forecast from 1988 for operational purposes for the SWM of India. The forecast contains information on the rainfall quantity to be obtained in general for the four divisions of India viz, north India, south India, western India and eastern India. This forecast is given before the start of the SWM season. The deficiency of the forecast maybe attributed to the lack of regional level rainfall information and also data on monthly distribution of rainfall within the season. From this forecast it is possible to understand the possible occurrence of drought in general.

b. Seasonal climate forecast

This is given by Department of Agricultural Meteorology, TN Agriculture University both for South West Monsoon (SWM) and North East Monsoon (NEM) for whole of Tamil Nadu with district wise information. This forecast provides real time rainfall information for total season and also for the months of each season. Accordingly drought can be monitored.

c. Drought probability analysis

By taking long time rainfall data, (may be 30, 60, 90,120 years of seasonal rainfall) analysis can be done to identify the probability occurrence of below normal events. And from this, the periodicity can be assessed for the occurrence of drought.

d. ELNino signal

If the information on ELNino is available for a particular year, there would be every probability of getting below normal rainfall during SWM and excess rainfall during NEM season for Tamil Nadu.

e. Satellite derived chart

From the satellite data, vegetation index (ratio between reflected radiation between visible band and near infrared band). These charts are available from National Remote Sensing Centre, Hyderabad. This chart gives real time information on when the drought initiates, where it starts, its nature of spread, its intensity, and its magnitude.

f. IMD charts, Bulletins, and others

Agricultural Rainfall Index (ARI): This is one among the tools to be used to identify agricultural drought.

a. IMD Weekly aridity anomaly index: This index provides information on drought hazard over a sizable area and a periodic assessment of the current extent and severity of the drought over a region.

   The departure of real time --- from its long-term mean is expressed in percentage and this is called as aridity anomaly. From the computed aridity anomaly, drought intensity can be measured as follows:

Aridity anomaly	Drought intensity
Lesser than 25%	Mild drought
26 to 50%	Moderate drought
Greater than 50%	Severe drought

This is computed for 194 stations and an anomaly chart is prepared on a weekly basis to the meteorological sub-division of India and communicated to users.

b. IMD agro advisory bulletin: Weekly rainfall, its progressive total, departure from normal along with other weather information is given along with agro advisories. This bulletin will be useful to find out the onset of drought, its progress, etc.

g. NCMRWF agro advisory bulletin

This is given from different field units in India including six field units from Tamil Nadu. Anticipated weather information will be known to users on every Tuesday and Friday. This information may be used to monitor drought occurrence.

Challenges in Early Warning for drought occurrence

The main challenge is that we do not have any standard methods for fore-warning drought presently. World Meteorological Organization (WMO) and its member countries have been actively engaged in searching a satisfactory method for drought prediction. In India, based on the post-ante study made since 1875, there were 25 drought years; the worst of which was in 1918.

Question: What are the different Early Warning tools (Give a minimum of three) used for drought prediction and forecasting?

The last drought occurred in 1987 and affected 47 per cent of the country. This drought was not predicted. Hence IMD initiated issuing long range forecasts from 1988. This forecast gives seasonal rainfall forecast for SWM season only and did not cover spatial and temporal dimensions of India. The focus is the deviation of rainfall from the Long Period Average (LPA) and is communicated as the seasonal forecast. From this, it is possible to interpret whether the ensuing seasonal rainfall is normal or below normal or excess and accordingly plans may be prepared. Normally, in the case of below-normal long-range forecast, the region with >1000mm annual rainfall will be affected relatively lesser as compared to a region with annual rainfall lesser than 1000mm rainfall. Up to 2006 there was no forecast/forewarning given from the long-range forecast of IMD because of certain limitations. However, during the 2006 SWM long range forecast, there was an indication for below normal rainfall and based on that it is our duty to prepare contingency planning.

Though 1997, 2001, and 2002 were ELNino years and thus drought anticipated; no early warning was given by the Government. These were our learning periods. Since drought prediction is still under study, the present available information from long range forecast, SCF, ELNino signal and remote sensing imageries could be used to forewarn for drought occurrence if enough skill is developed.

The community might know drought occurrence earlier still since they have strong local knowledge.

5) Impact of drought

In defining drought, it is necessary to consider both rainfall quantity and soil moisture storage together. Moderate rainfall in black soil may not bring drought, but even with higher rainfall, there is greater possibility of occurrence of drought in red soils. Hence the impact would differ between these two soils. In general, the following impact would be seen in the drought-affected area:

1. Crop's failure and productivity loss
2. Change in land use pattern and resource degradation
3. Depletion in water resources
4. Fodder non-availability

5. Distress sale of animals
6. Imbalance in rural economy
7. Migration
8. Discomfort environment
9. Social disharmony
10. Political instability
11. Spread of poverty
12. Ecological imbalance
13. Resource conflicts

Question: What are the major challenges in drought forecasting?

Drought impact has to be monitored from the start of the season and has to be assessed critically. In this context, drought intensity and its magnitude must be measured. Drought starts from one point and proceeds to nearby places. Under normal situations, the Revenue Department is given the responsibility of assessing drought. However, in order to assess drought impact precisely, a multi disciplinary team can be formed by the Revenue Department. The impact assessment must be made first at micro level followed by regional, national, and global levels.

Drought Management:

Prevention is better than cure. In drought management, the following approaches may be adopted:

1. Analyze the historical rainfall data and understand the occurrence probability of drought in that region.

2. Monitor the long-range and seasonal climate forecast on real time basis and prepare a contingency plan for the concerned region covering all the activities of the existing

population This can be done through group discussion with community, experts from different fields, government officials etc. The coping practices that were adopted in the earlier drought years may be documented and reviewed again for adoption during present drought year, with enough validation.

3. Prepare separate plans for sustaining agriculture, live stock, social networks, and develop plans for local village cottage industries to maintain cash flows through employment generation against migration, which is common during drought years. The plan must properly mix local indigenous practices with new cost effective scientific technologies.

4. Establish Village Knowledge Centers and Village Resource Centers at the appropriate places of the region with due support from concerned organizations and the community may be empowered to acquire updated knowledge.

5. The community may be made aware of natural disasters and should be prepared to meet with challenge at any time of their life.

Question: Identify (minimum of four) major impacts of drought.

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Question: What is contingency planning? Can a contingency plan be prepared for drought?

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(This module on Early Warning for Drought and management is developed by Prof. T.N. Balsubramanian, Founder Head of Department of Agricultural Meteorology, Tamil Nadu Agricultural University)

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