# Early Warning System Plan

Municipal Corporation of Thiruvananthapuram, Kerala

**GoI-UNDP Project on Enhancing Institutional and Community Resilience to Disasters and Climate Change**

# Message

The Disaster Management Act 2005 defines disaster as “a catastrophe, mishap, calamity or grave occurrence in any area, arising from natural or man-made cause, or by accident or negligence which results in substantial loss of life or human suffering or damage to, and destruction of property, or damage to, or degradation of, environment, and is of such a nature or magnitude as to be beyond the coping capacity of the community of the affected area”. Nearly 80 per cent of the country’s geographical area is vulnerable to disasters of different kinds.

We are happy to publish ‘Early Warning Systems Plan’ document for the city of Thiruvananthapuram, with the support of ‘GoI-UNDP project on enhancing institutional & community resilience to disasters & climate change’. Early warning is an important aspect in preparing for hazards & in mitigating the risk.

Wish this document will help all the stakeholders to prepare for a safer tomorrow.

Prasanth 15/4.

**Adv. V. K. Prasanth**
**Mayor**

# Message

India is vulnerable, in varying degrees, to a large number of natural as well as human induced disasters. Heightened vulnerabilities to disaster risks can be related to expanding population, urbanization and industrialization, development within high-risk zones, environmental degradation and climate change. India has experienced exponential urban growth in the last few decades. As cities grow in an unregulated manner, and the number of people living in slums swell, urban risk exposure is likely to be significant. The city of Thiruvananthapuram is also growing on a faster rate with new development corridor coming up like; surface transport, infrastructure, IT hub, tourism and many more.

Disaster Risk Reduction comprises of components that include developing policy frameworks, capacity building programmes, and community-based mitigation/response plans, including Action Plan for Early Warning System.

Under USAID supported GoI-UNDP Project on Enhancing Institutional and Community Resilience to Disasters and Climate Change, the Municipal Corporation of Thiruvananthapuram has prepared an Action Plan on EWS – Early Warning Systems for the city of Thiruvananthapuram. I am happy to share this document with you.

**M. Nizarudheen**
**Secretary**

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# CHAPTER 1

## An Introduction to Early Warning System Framework

### Introduction

Natural hazards and their impacts can vary in time and space. Natural hazards can be either sudden or slow onset, with both having the potential to devastate a community, country or region. Sudden onset hazards are those that happen as the result of a single event with little to no warning, such as tsunamis and earthquakes, and they limit the ability of communities and institutions to react. A slow-onset hazard does not emerge from a single, distinct event but is one that emerges gradually over time, often based on a confluence of different events (OCHA, 2011), such as drought. In both cases, the ability to monitor the factors that turn a hazard (the actual event) into a disaster (the worst-case result of the event) can help save both lives and livelihoods that are at risk.

Early warning systems (EWS) are central to limiting the loss of lives and livelihoods as a result of hazards and disasters. It is a series of organized surveillance mechanisms or actions that collect information on potential hazards in a given location, in order to trigger timely, coordinated responses. Early warning systems build resilience to disasters and thus mitigate their impact. This is clearly recognized in the Sendai Framework for Disaster Risk Reduction 2015-2030, whose seventh global target is: "(g) substantially increase the availability of and access to multi-hazard early warning systems and disaster risk information and assessments to people by 2030." Member countries including India is thus committed to making early warning systems more people-centered, and also to improving access to risk information for end users. In disaster risk management, this will mean combining scientific information with practical approaches.

Early Warning Systems (EWS) are well recognized as a critical life-saving tool for floods, droughts, storms & cyclones, fires, and other hazards. As per the World Meteorological Organization report, the recorded economic losses linked to extreme hydro-meteorological events have increased nearly 50 times over the past five decades, but the global loss of life has decreased significantly, by a fraction of about 10, thus saving millions of lives over this period. This has been attributed to better monitoring and forecasting of hydro-meteorological hazards and more effective emergency preparedness.

One of the most fundamental and widely accepted roles of governments through the ages has been the protection of their people from external threats including those deriving from natural hazards. Over the past century, many countries have developed and integrated early warning capabilities, in particular for meteorological and hydrological events, as an important tool for averting disasters.

## Early Warning - An Evolving Agenda

Early warning systems have been increasingly in the global spotlight to address mitigation of and preparedness for natural hazards, since the mid-1980s. Through a series of coordinated efforts, spearheaded by the United Nations (OCHA, UNISDR) and many developing country governments, the ability to follow key indicators and the systems required to do so have become mainstreamed into the disaster risk reduction, climate change adaptation and humanitarian discourse.

Effective early warning systems for natural hazards are now increasingly perceived as an integral component of disaster risk reduction programmes - involving a broad spectrum of actors. The International Decade for Natural Disaster Reduction (IDNDR, 1990-1999) promoted this concept and worked to raise the profile of early warning accordingly, resulting in the acknowledgement of its crucial importance in the Yokohama Strategy for a Safer World, endorsed at the World Conference on Natural Disaster Reduction in 1994. The International Strategy for Disaster Reduction, the successor to the IDNDR, has introduced a stronger focus on vulnerabilities and has emphasized the need to integrate disaster risk reduction into sustainable development. The World Conference on Disaster Reduction adopted the Hyogo Framework for Action 2005-2015: Building the resilience of nations and communities to disasters in which risk assessment and early warning is one of the five themes of disaster reduction. Specific recommendations include the call for countries to develop people-centered early warning systems.

Other relevant development frameworks such as the Agenda 21, the multilateral environmental agreements, the Barbados Plan of Action for Small Island Developing States and the Johannesburg Plan of Implementation have called for actions to expand, deepen and strengthen local, national and international initiatives to develop early warning in particular and disaster reduction in general, as critical tools for promoting sustainable development and poverty reduction. The Sendai Framework, successor instrument to the Hyogo Framework for Action adopted at the Third UN World Conference in Sendai, Japan accentuate early warning as one of the seven global targets and intended to substantially increase the availability of and access to multi-hazard early warning systems and disaster risk information and assessments to the people by 2030.

Three international conferences on early warning, in 1998, 2003 and 2006 further produced a set of internationally agreed guiding principles for effective early warning systems as well as the outline of an international programme on early warning to reduce disasters. These conferences addressed technical considerations, strategic issues and institutional requirements and made specific recommendations for strengthening early warning systems, including the incorporation of early warning into policy and development frameworks, a greater emphasis on the social factors in early warning systems and mechanisms sustaining dialogue and collaborative action among key stakeholders.

# CHAPTER 2

# Early Warning System Framework

## Early Warning – Basic Concepts

The traditional framework of early warning systems is composed of three phases: monitoring of precursors, forecasting of a probable event, and the notification of a warning or an alert should an event of catastrophic proportions take place. An improved four-step framework being promoted by international emergency agencies and risk management institutions includes the additional fourth phase: the onset of emergency response activities once the warning has been issued. The purpose of this fourth element is to recognize the fact that there needs to be a response to the warning, where the initial responsibility relies on emergency response agencies.

Experience has shown that effective EWS need four components:

1. Detection, monitoring and forecasting the hazards;
2. Analyses of risks involved;
3. Dissemination of timely warnings - which should carry the authority of government;
4. Activation of emergency plans to prepare and respond.

An early warning system with all these elements is referred to as an ‘end-to-end’ system. These four components need to be coordinated across many agencies at national to local levels for the system to work. Failure in one component or lack of coordination across them could lead to the failure of the whole system. The issuance of warnings is the responsibility of the government; thus, roles and responsibilities of various public and private sector stakeholders for implementation of EWS should be clarified and reflected in the national to local regulatory frameworks, planning, budgetary, coordination, and operational mechanisms.

Given the need for inter-agency coordination, the early warning system requires standard operating procedures (SOPs) that spell out the main tasks, roles and responsibilities in the event of an emergency. These SOPs need to be tested and revised on a regular basis.

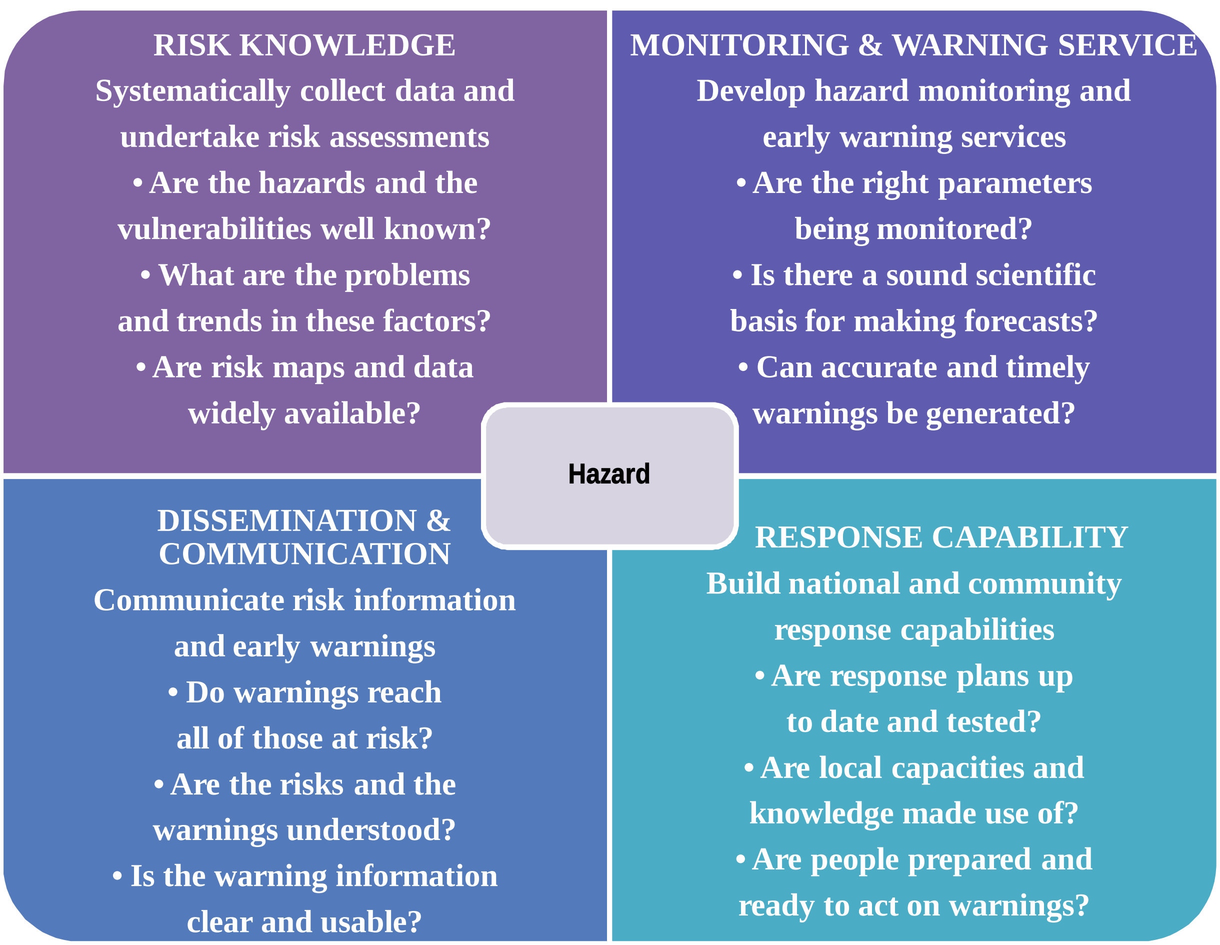
A key requirement is clear and unambiguous information. Unreliable or conflicting messages from official and non-official sources can allow rumours and disinformation to spread. The flow of information needs to be coordinated and shared among multiple actors − with a high degree of redundancy in the dissemination channels, since people are most likely to act on warnings corroborated from multiple sources.

The ultimate test of an early warning system is whether it provides timely and actionable information to all of the most vulnerable people – including children, pregnant and lactating women, older persons, the sick and people with disabilities. For persons with disabilities, information should be provided in accessible formats. If such vulnerable groups are not adequately informed and supported, the system as a whole must be judged to have failed.

An early warning system that covers multiple hazards should be sufficiently flexible to allow for the appropriate timeframes for each type of hazard. Rapid onset disasters such as near-field tsunamis and flash floods only allow between 15 minutes and a couple of hours from detection to impact (UNESCAP, The value of Early Warning) so the warning system should be able to respond to imminent danger. Other hazards, such as cyclones and seasonal floods, may be detected days or even weeks in advance – allowing people to protect assets and livelihoods.

With sufficient warning, businesses can move productive assets to safe ground, and households can shutter windows and reinforce rooftops. Given these varying needs, the warning authorities need to carefully judge how to release information − achieving the optimum balance between timeliness and accuracy.

**Elements for early warning components**



## People Centered Early Warning System

Early warning systems have limitations in terms of saving lives if they are not combined with “people-centered” networks. To be effective, early warning systems must be embedded in, understandable by and relevant to the communities which they serve. Warnings will have little value unless they reach the people most at risk, who need to be trained to respond appropriately to an approaching hazard.

A complete and effective, people-centered early warning system – EWS – comprises four inter-related elements, spanning knowledge of hazards and vulnerabilities through to preparedness and capacity to respond. A weakness or failure in any one of these elements could result in failure of the whole system. Best practice EWS also have strong inter-linkages between all elements in the chain.

**Risk Knowledge** Risks arise from the combination of hazards and vulnerabilities at a particular location. Assessments of risk require systematic collection and analysis of data and should consider the dynamic nature of hazards and vulnerabilities that arise from processes such as urbanization, rural land-use change, environmental degradation and climate change. Risk assessments and maps help to motivate people, prioritize early warning system needs and guide preparations for disaster prevention and responses.

**Warning Service** Warning services lies at the core of the system. There must be a sound scientific basis for predicting and forecasting hazards and a reliable forecasting and warning system that operate 24 hours a day. Continuous monitoring of hazard parameters and precursors is essential to generate accurate warnings in a timely fashion. Warning services for different hazards should be coordinated where possible to gain the benefit of shared institutional, procedural and communication networks

**Communication and Dissemination** Warnings must reach those at risk. Clear messages containing simple, useful information are critical to enable proper responses that will help safeguard lives and livelihoods. Regional, national and community level communication systems must be pre-identified and appropriate authoritative voices established. The use of multiple communication channels is necessary to ensure as many people as possible are warned, to avoid failure of any one channel, and to reinforce the warning message

**Response Capability** It is essential that communities understand their risks; respect the warning service and know how to react. Education and preparedness programmes play a key role. It is also essential that disaster management plans are in place, well practiced and tested. The community should be well informed on options for safe behaviour, available escape routes, and how best to avoid damage and loss to property

## Cross-cutting Issues in developing EWS Plan

There are a range of overarching issues that should be taken into account when designing and maintaining effective early warning systems.

## Effective Governance and Institutional Arrangements

Well-developed governance and institutional arrangements support the successful development and sustainability of sound early warning systems. They are the foundations upon which the previously outlined four elements of early warning are built, strengthened and maintained.

Good governance is encouraged by robust legal and regulatory frameworks and supported by long-term political commitment and effective institutional arrangements. Effective governance arrangements should encourage local decision-making and participation which are supported by broader administrative and resource capabilities at the national or regional level. Vertical and horizontal communication and coordination between early warning stakeholders should also be established

## A Multi-Hazard Approach

Where possible, early warning systems should link all hazard-based systems. Economies of scale, sustainability and efficiency can be enhanced if systems and operational activities are established and maintained within a multipurpose framework that considers all hazards and end user needs. Multi-hazard early warning systems will also be activated more often than a single-hazard warning system, and therefore should provide better functionality and reliability for dangerous high intensity events, such as tsunamis, that occur infrequently. Multi-hazard systems also help the public better understand the range of risks they face and reinforce desired preparedness actions and warning response behaviours.

## Involvement of Local Communities

People-centered early warning systems rely on the direct participation of those most likely to be exposed to hazards. Without the involvement of local authorities and communities at risk, government and institutional interventions and responses to hazard events are likely to be inadequate. A local, ‘bottom-up’ approach to early warning, with the active participation of local communities, enables a multi-dimensional response to problems and needs. In this way, local communities, civic groups and traditional structures can contribute to the reduction of vulnerability and to the strengthening of local capacities

## Consideration of Gender Perspectives and Cultural Diversity

In developing early warning systems it is essential to recognize that different groups have different vulnerabilities according to culture, gender or other characteristics that influence their capacity to effectively prepare for, prevent and respond to disasters. Women and men often play different roles in society and have different access to information in disaster situations. In addition, the children, elderly, disabled and other socio-economically disadvantaged communities are often more vulnerable and need handholding support to cope with disasters risks. Information, institutional arrangements and warning communication systems should be tailored to meet the needs of every group in every vulnerable community.

## Centralization and Decentralization of EWS

When analyzing who executes the two initial phases of the early warning systems, namely, monitoring and forecasting, one can see two trends, centralised systems where a national-type agency carries out these functions, and decentralised systems where these tasks are carried out by other agencies, municipal workers and volunteers at the more local level. For example, in Central America, the national meteorological agencies operate early warning systems for hurricanes and for floods, including the emission of the warning to the media. Such systems are set up and operated by these institutions. In contrast, national disaster reduction agencies, international organisations, and non-governmental organisations have been implementing decentralised systems in small basins, where communities carry out all phases, including the response. In such systems, city halls are coordinating most of the activities, and are connected to the national emergency agency via a radio network that is used to communicate all information within the system.

While decentralised systems operate using much simpler equipment and are thus less precise, such systems rely on a network of people-operated radios to transmit information regarding precursors to events or warnings. The trade off gained from losing precision to monitor and forecast events is gained by being able to transmit other very useful information, generally related to social issues, such as medical needs, information regarding relatives or processes, or the solution of such problems as the fixing of power lines when they fail, or acquiring heavy machinery to reopen a road which might be blocked by a landslide. So far, community-operated systems have been mostly applied in the case of floods, especially in small flood basins.

## Developing Multi Hazard Early Warning System

Each hazard has its own specific warning requirements and lead times. But where ever possible, early warnings for individual hazards should be integrated into a multi-hazard system. This brings benefits in terms of economies of scale, sustainability and efficiency. And since a multi-hazard system will be activated more regularly it is likely to be better maintained and more readily available for hazards such as tsunamis that occur infrequently. Such integrated systems may also help the public better understand the range of risks they face and the need to prepare and to respond to warnings.

## Ten principles common to development of Multi-Hazard Early Warning Systems

(1)There is a strong political recognition of the benefits of EWS reflected in harmonized national and local disaster risk management policies, planning, legislation and budgeting.

2. Effective EWS are built upon four components: (i) hazard detection, monitoring and forecasting; (ii) analyzing risks and incorporation of risk information in emergency planning and warnings: (iii) disseminating timely and “authoritative” warnings, and (iv) community planning and preparedness.

3. EWS stakeholders are identified and their roles and responsibilities and coordination mechanisms clearly defined and documented within national and local plans, legislation, directives, MOUs, etc.

4. EWS capacities are supported by adequate resources (e.g., human, financial, equipment, etc.) at the national and local levels and the system is designed and for long-term sustainability.

5. Hazard, exposure and vulnerability information are used to carry-out risk assessments at different levels, as critical input into emergency planning and development of warning messages.

6. Warning messages are; (i) clear, consistent and include risk information, (ii) designed with consideration for linking threat levels to emergency preparedness and response actions (e.g., using colour, flags, etc) and understood by authorities and the population, and (iii) issued by a single (or unified), recognized and “authoritative” source.

7. Warning dissemination mechanisms are able to reach the authorities, other EWS stakeholders and the population at risk in a timely and reliable fashion.

8. Emergency response plans are developed with consideration for hazard/risk levels, characteristics of the exposed communities.

9. Training on hazard/risk/emergency preparedness awareness integrated in various formal and informal educational programmes with regular drills to ensure operational readiness.

10. Effective feedback and improvement mechanisms are in place at all levels of EWS to provide systematic evaluation and ensure improvement over time.

## Checklist for Early Warning System

The checklist on developing early warning systems was developed as a contribution to the Third International Conference on Early Warning by ISDR (ISDR 2006b). They are;

### I) Risk Knowledge

#### 1. Organizational Arrangements Established

- Key national government agencies involved in hazard and vulnerability assessments identified and roles clarified (e.g. agencies responsible for economic data, demographic data, land-use planning, and social data).
- Responsibility for coordinating hazard identification, vulnerability and risk assessment assigned to one national organization.
- Legislation or government policy mandating the preparation of hazard and vulnerability maps for all communities in place.
- National standards for the systematic collection, sharing and assessment of hazard and vulnerability data developed, and standardized with neighboring or regional countries, where appropriate.
- Process for scientific and technical experts to assess and review the accuracy of risk data and information developed.

- Strategy to actively engage communities in local hazard and vulnerability analyses developed. • Process to review and update risk data each year, and include information on any new or emerging vulnerabilities and hazards established.

**2. Natural Hazards Identified**

- Characteristics of key natural hazards (e.g. intensity, frequency and probability) analyzed and historical data evaluated.
- Hazard maps developed to identify the geographical areas and communities that could be affected by natural hazards.
- An integrated hazard map developed (where possible) to assess the interaction of multiple natural hazards.

**3. Community Vulnerability Analyzed**

- Community vulnerability assessments conducted for all relevant natural hazards.
- Historical data sources and potential future hazard events considered in vulnerability assessments.
- Factors such as gender, disability, access to infrastructure, economic diversity and environmental sensitivities considered.
- Vulnerabilities documented and mapped (e.g. people or communities along coastlines identified and mapped)

**4. Risks Assessed**

- Interaction of hazards and vulnerabilities assessed to determine the risks faced by each region or community.
- Community and industry consultation conducted to ensure risk information is comprehensive and includes historical and indigenous knowledge, and local information and national level data. Activities that increase risks identified and evaluated.
- Results of risks assessment integrated into local risk management plans and warning messages.

**5. Information Stored and Accessible**

- Central 'library' or GIS database established to store all disaster and natural hazard risk information.
- Hazard and vulnerability data available to government, the public and the international community (where appropriate).
- Maintenance plan developed to keep data current and updated.

## II. Monitoring and Warning Service

### 1. Institutional Mechanisms Established

- Standardized process, and roles and responsibilities of all organizations generating and issuing warnings established and mandated by law.
- Agreements and interagency protocols established to ensure consistency of warning language and communication channels where different hazards are handled by different agencies.
- An all-hazard plan to obtain mutual efficiencies and effectiveness among different warning systems established.
- Warning system partners, including local authorities, aware of which organizations are responsible for warnings.
- Protocols in place to define communication responsibilities and channels for technical warning services.
- Communication arrangements with international and regional organizations agreed and operational.
- Regional agreements, coordination mechanisms and specialized centers in place for regional concerns such as tropical cyclones, floods in shared basins, data exchange, and technical capacity building.
- Warning system subjected to system-wide tests and exercises at least once each year.
- A national all-hazards committee on technical warning systems in place and linked to national disaster management and reduction authorities, including the national platform for disaster risk reduction.
- System established to verify that warnings have reached the intended recipients.
- Warning centers staffed at all times (24 hours per day, seven days per week).

### 2. Monitoring Systems Developed

- Measurement parameters and specifications documented for each relevant hazard.
- Plans and documents for monitoring networks available and agreed with experts and relevant authorities.
- Technical equipment, suited to local conditions and circumstances, in place and personnel trained in its use and maintenance.
- Applicable data and analysis from regional networks, adjacent territories and international sources accessible.
- Data received, processed and available in meaningful formats in real time, or near-real time.
- Strategy in place for obtaining, reviewing and disseminating data on vulnerabilities associated with relevant hazards.
- Data routinely archived and accessible for verification and research purposes.

### 3. Forecasting and Warning Systems Established

- Data analysis, prediction and warning generation based on accepted scientific and technical methodologies.
- Data and warning products issued within international standards and protocols.
- Warning analysts trained to appropriate international standards.
- Warning centers equipped with appropriate equipment needed to handle data and run prediction models.
- Fail-safe systems in place, such as power back-up, equipment redundancy and on-call personnel systems.
- Warnings generated and disseminated in an efficient and timely manner and in a format suited to user needs.
- Plan implemented to routinely monitor and evaluate operational processes, including data quality and warning performance.

## III. Dissemination and Communication

### 1. Organizational and Decision-making Processes Institutionalized

- Warning dissemination chain enforced through government policy or legislation (e.g. message passed from government to emergency managers and communities, etc.).
- Recognized authorities empowered to disseminate warning messages (e.g. meteorological authorities to provide weather messages, health authorities to provide health warnings).
- Functions, roles and responsibilities of each actor in the warning dissemination process specified in legislation or government policy (e.g. national meteorological and hydrological services, media, NGOs).
- Roles and responsibilities of regional or cross border early warning centers defined, including the dissemination of warnings to neighboring countries.
- Volunteer network trained and empowered to receive and widely disseminate hazard warnings to remote households and communities.

### 2. Effective Communication Systems and Equipment Installed

- Communication and dissemination systems tailored to the needs of individual communities (e.g. radio or television for those with access; and sirens, warning flags or messenger runners for remote communities).
- Warning communication technology reaches the entire population, including seasonal populations and remote locations.
- International organizations or experts consulted to assist with identification and procurement of appropriate equipment.

- Multiple communication mediums used for warning dissemination (e.g. mass media and informal communication).
- Agreements developed to utilize private sector resources where appropriate (e.g. amateur radios, safety shelters).
- Consistent warning dissemination and communication systems used for all hazards. Communication system is two-way and interactive to allow for verification that warnings have been received.
- Equipment maintenance and upgrade program implemented and redundancies enforced so back-up systems are in place in the event of a failure.

### 3. Warning Messages Recognized and Understood

- Warning alerts and messages tailored to the specific needs of those at risk (e.g. for diverse cultural, social, gender, linguistic and educational backgrounds).
- Warning alerts and messages are geographically-specific to ensure warnings are targeted to those at risk only.
- Messages incorporate the understanding of the values, concerns and interests of those who will need to take action (e.g. instructions for safeguarding livestock and pets).
- Warning alerts clearly recognizable and consistent over time and include follow-up actions when required.
- Warnings specific about the nature of the threat and its impacts.
- Mechanisms in place to inform the community when the threat has ended.
- Study into how people access and interpret early warning messages undertaken and lessons learnt incorporated into message formats and dissemination processes

## IV. Response Capacity

### 1. Warnings Respected

- Warnings generated and distributed to those at risk by credible sources (e.g. government, community leaders, respected community organizations).
- Public perception of natural hazard risks and the warning service analyzed to predict community responses.
- Strategies to build credibility and trust in warnings developed (e.g. understanding difference between forecasts and warnings).
- False alarms minimized and improvements communicated to maintain trust in the warning system.

**2. Disaster Preparedness and Response Plans Established**

- Disaster preparedness and response plans empowered by law.
- Disaster preparedness and response plans targeted to the individual needs of vulnerable communities (Increasingly it is possible to target vulnerable individuals).
- Hazard and vulnerability maps utilized to develop emergency preparedness and response plans.
- Up-to-date emergency preparedness and response plans developed, disseminated to the community, and practiced.
- Previous disaster events and responses analyzed, and lessons learnt incorporated into disaster management plans.
- Strategies implemented to maintain preparedness for recurrent hazard events. • Regular tests and drills undertaken to test the effectiveness of the early warning dissemination processes and responses.

**3. Community Response Capacity Assessed and Strengthened**

- Community ability to respond effectively to early warnings assessed.
- Response to previous disasters analyzed and lessons learnt incorporated into future capacity building strategies.
- Community-focused organizations engaged to assist with capacity building.
- Community and volunteer education and training programs developed and implemented.

**4. Public Awareness and Education Enhanced**

- Simple information on hazards, vulnerabilities, risks, and how to reduce disaster impacts disseminated to vulnerable people, communities and decision-makers.
- Community educated on how warnings will be disseminated and which sources are reliable and how to respond to different types of hazards after an early warning message is received.
- Community trained to recognize simple hydro-meteorological and geophysical hazard signals to allow immediate response.
- On-going public awareness and education built in to school curricula from primary schools to university.
- Mass media and folk or alternative media utilized to improve public awareness.
- Public awareness and education campaigns tailored to the specific need of each audience (e.g. children, vulnerable people, emergency managers, and media).
- Public awareness strategies and programs evaluated at least once per year and updated where required.

# CHAPTER 3

## Early Warning System framework – Thiruvananthapuram Municipal Corporation: Capacities and gaps

### Vulnerability profile of Trivandrum Corporation

Thiruvananthapuram city is situated on seven small hills and is home to nearly 8 lakh people inhabiting in 215 $km^2$ of land. With the current rate of urbanization and development, the city and the adjoining urban outgrowth is expected to witness a massive growth in its population. Thiruvananthapuram city is historically vulnerable to various natural disasters. The city is prone to naturally triggered hazards like flood, drought, coastal erosion, lightning and earthquakes and human induced hazards like petro-chemical accidents, transportation accidents and epidemics.

Thiruvananthapuram is exposed to a multitude of hazards and is categorized as a multi-hazard prone city due to its location. The city experiences various kinds of disasters of recurrent nature, which result in loss of life, livelihood and property, and disruption of economic activity, besides causing immense misery and hardship to the affected population.

The physical vulnerability of the city is high due its growth pattern. The city is expanding along the major transportation corridors, with concentration of urban development in a few major nodal points. Thiruvananthapuram city experienced urban floods problem due to blocked or inadequate storm sewer and increased urbanization. Further, wrong land-use practices and mismanagement of water resources in and around the city have increased the vulnerability of the city's population. Human interventions contributing to flood problems include reclamation of wetlands and water bodies, change in land-use pattern and construction of dense networks of roads. Increased floodplain occupancy has also increased the flood impacts in the city.

### Institutional framework

List of key agencies currently involved in the process of issuing early warning and coordinating response before and during the events, their roles and current functioning based on the available plans are described below.

**Indian Meteorological Department (IMD)**

Meteorological Centre, Thiruvananthapuram, caters to the requirements of Kerala state and Lakshadweep Islands by supervising and coordinating the weather services in the state. Weather forecast (both aviation and non-aviation) for optimum operation of weather sensitive activities like agriculture, irrigation, aviation etc. and warnings against severe weather phenomenon (over the state and nearby sea area) like heavy rains, thunderstorm, strong winds etc., which cause destruction to life and property are rendered by this centre under the technical advice of area Cyclone Warning Centre of Regional Meteorological Centre (ACWC) at Chennai.

ACWC issues four stage warnings on cyclone alert and cyclone warning, in case a weather system is detected near the coast. After receipt of pre-cyclone watch bulletin issued by HQ, ACWC/CWC monitor issues of warnings under two stages warning system – cyclone alert and cyclone warning. Cyclone alert is issued 48 hours in advance of the Collector of coastal districts and the Chief Secretary of the concerned maritime state. After alert message is issued for broadcast the subsequent numbered bulletins are released by ACWC (NDMA, Guidelines for Cyclones) Cyclone warning is issued 24 hours before the commencement of adverse weather. Subsequent to this warning is sent more frequently to all the concerned recipients (Collectors and Chief Secretaries), if the storm is tracked by radar with a high degree of confidence. These recipients will be informed that subsequent warning on the storm will be broadcast by the AIR stations. The final stage of the warning, i.e., Post Landfall Outlook (PLO) meant for interior districts is issued 12 hours before the estimated landfall of the storm for the notice of the Collectors.

Dissemination of warnings, other than AIR (All India Radio), is through satellite-based Cyclone Warning Dissemination System (CWDS) installed at maritime district HQ, so that district authorities can initiate appropriate precautionary measures on receipt of such warnings. This scheme makes use of the S-band broadcast capability of INSAT satellite. At present there are five CWDS stations located in Kerala, which are at Thiruvananthapuram, Alappuzha, Ernakulam, Thrissur and Kozhikode.

Heavy rainfall warnings are issued to District Collectors when rainfall amount is expected to exceed by 7 cm per hour. The warning is also issued to various agencies, such as public services, PWD, irrigation, hydro-electric, and port, telegraphs, railway and community project officials, so that the disaster management machinery can be kept in readiness.

Continuous monitoring of earthquake is done by state-of-art instruments installed at Thiruvananthapuram centre of IMD and SEOC (State Emergency Operation Centre), functioning at Institute of Land and Disaster Management. Continuous monitoring of surface ozone, measurement of solar and terrestrial radiation and recording of atmospheric electricity are some routine activities of this office. Climatology section undertakes the scrutiny and archival of meteorological data and use such data over a number of years for answering various weather-related enquiries from different users for research and planning purposes.

When wind speed over sea area is expected to exceed 45 kmph up to 75 Nautical miles from the coast, wind warnings are issued and communicated to the Director of Fisheries, all Deputy Directors of Fisheries and Director of Ports through fax/SMS through VPN connection, advising fisherman to be cautious while venturing into the sea. Meteorological Centre, Thiruvananthapuram, also provides weather information at toll free number 1800 180 17 17.

**Indian National Centre for Ocean Information Services (INCOIS)**

The Indian National Centre for Ocean Information Services (INCOIS) has a mission to provide the best possible ocean information and advisory services to the society, industry, government and scientific community through sustained ocean observations and constant improvement through systematic and focused research.

The Indian Tsunami Early Warning System established at INCOIS has the responsibility of providing tsunami advisories to Indian mainland and the island regions. The Warning Centre is capable of issuing tsunami bulletins in less than 10 min after any major earthquake in the Indian Ocean, thus leaving us with a response/lead time of about 10 to 20 minutes for near source regions and a few hours in the case of mainland. Currently, the warning centre disseminates tsunami bulletins to various stakeholders through multiple dissemination modes simultaneously (fax, phone, emails, GTS, SMS etc).

**Geological Survey of India (Thiruvananthapuram Office)**

Geological Survey of India office at Thiruvananthapuram is responsible for conducting/coordinating geological studies for landslide hazard mitigation. They are also the key agency for preparing and updating landslide hazard zonation, monitoring and suggesting precautionary and preventive measures. However, there currently is no forecast or warning mechanism for landslides.

**Centre for Earth Science Studies (CESS)**

Centre for Earth Science Studies (CESS) is a premier institute established to conduct researches and studies related to the Earth System. CESS along with INCOIS have recently installed (2011) two tsunami buoys and two stations scheduled off coastal waters of Kerala at 30 m depth off Thiruvananthapuram.

The coastal stations provide real time data on coastal weather conditions, which includes tide, current and wave parameters. This information is vital to the local community, especially the fishermen during extreme weather conditions for sale planning of their activities and also in identification of potential fishing zone. The real time data will also be disseminated to the various scientific institutions to carry out research on coastal hydrodynamics and applications of sea-state forecasting.

The wave rider buoy data is currently extensively used for the calibration of observations made by the satellite sensors and for various applications in fisheries, coastal zone management, oil exploration, and offshore/coastal engineering works and for field of calibration and validation of sea-state forecasting model.

CESS issues voice messages daily (mobile collaboration with Reliance network for the registered users) in the local languages through radio.

### Kerala State Disaster Management Authority (KSDMA)

Kerala State Disaster Management Authority (KSDMA) was established as an apex decision making body to facilitate, co-ordinate, review and monitor all disaster-related activities in the state, including capacity building. The KSDMA is responsible for the preparation and implementation of State Disaster Management policy, guidelines, State Disaster Management Plan and departmental plans.

Kerala State Disaster Management Rule was passed in March 2007, Kerala State DM Authority was formed in May 2007, District DMA in September 2009, KSDM Policy was released in 2009 and DM plan in 2011.

### Institute Land and Disaster Management (ILDM)

Institute of Land and Disaster Management (ILDM) is an autonomous body constituted under the Revenue Department, Government of Kerala, to impact professional training, including induction training, in-service training and refresher training to personnel of the Land Revenue and Survey Department of Kerala State.

### State Emergency Operation Centre (SEOC)

State Emergency Operation Centre (Previously known as Hazard Vulnerability and Risk Assessment (HVRA) Cell, the research and technical unit of Kerala State Disaster Management Authority.

### IDSP and Health Department

Under IDSP, data is collected on a weekly (Monday-Sunday) basis. The information is collected on three specified reporting formats, namely ‘S’ (suspected cases), ‘P’ (presumptive cases) and ‘L’ (laboratory confirmed cases) filled by health workers, clinicians and clinical laboratory staff respectively. State health department and district IDSP cell provide health advisories using IEC material.

The Municipal Corporation’s Health Department is headed by Health Officer CHO). The Health Department is responsible for conservancy services, sanitation facilities, solid waste management and other public health duties. The HO is assisted by an Assistant Health Officer, 19 Health Inspectors and 45 junior Health Inspectors (JHI).

Coordination meetings are held in March-April. Information is disseminated through local newspaper, radio, television and pamphlets. Information on heat wave vector-borne and water-borne diseases is disseminated (advisory, dos and don’ts). Disease seasonality mapping is done every year through ward level health centers.

### Thiruvananthapuram Corporation

The Mayor, who is elected members, is responsible for overall functions of TMC. Every year, before monsoon, meetings with all the departments are held to review the situation and take up activities to reduce risk of flooding and health-related issues.

### Fisheries Department

There are 23,000 vessels and 2.5 lakh active fishermen in Kerala. Marine enforcement wing of the Fisheries Department enforces KMRF act of 1980 (The Kerala Marine Fishing Regulation Act). Fishing in the sea is banned from 15 June to 31 August (47 days). Fisheries Department receives weather-related information from the Irrigation Department. INCOIS, AIS (Automatic Identification System) transponder from 600 deep sea vessels. About 700 radio beacons are in place. Warning received by the Fisheries Department is disseminated through PAS, SMS and radio.

### Port Authority

Thiruvananthapuram port office disseminates warning to medium-and small-sized vessels in the sea. They receive warning messages from IMD, especially on tsunami, cyclone and heavy wind.

### Department of Environment and Climate Change

The Department of Environment and Climate Change is the Environmental Impact Assessment (EIA) authority and is mainly responsible for issuing environmental clearances. Climate change activities are currently restricted to preparation on state action plan on climate change. Implementation of SAPCC in a phased manner will be taken up by the same department.

### Irrigation Department

Irrigation Department has carried out flood mitigation studies for Killi amd Karamana Rivers of Thiruvananthapuram city. They have also carried out studies for pollution abatement.

### Geology Department and GSI

Geology Department is mainly responsible for mining-related activities and does not have much role to play in disaster-related matters. GSI, which is a national agency, is actively involved in mapping landslide prone areas, road corridor mapping, geotechnical changes and stability analysis in general. These studies are not city-specific.

## Review of early warning components

### Risk Knowledge

The development of effective warnings depends on the generation of accurate risk scenarios showing the potential impacts of hazards on vulnerable groups. Authorities of Warning Centres need to define acceptable levels of risk to communities ditto determine whether and when to warn. Making this determination requires capabilities to analyse not only the hazards, but also the vulnerabilities to the hazards and the consequential risks. At present hazard vulnerability maps have been prepared for the city corporation and incorporated into the city DM Plan under UNDP Climate Risk Management project, however the characteristics of risks such as risk mapping, frequency distribution are absent due to the non availability of qualitative data, lack of micro level observation network and limited institutional support.

In addition to this, inadequate emphasis on social, economic, environmental vulnerability, lack of monitoring mechanisms to identify, how the vulnerability is changing and influenced by policy and practices such as environmental degradation or urbanization, poor community inclusiveness in vulnerability assessment, data gaps, societal memory loss about hazards and lack of early warning indicators are some of the major gaps in risk knowledge.

**Monitoring and warning services**

There have been marked improvements in the quality, timeliness and lead time of hazard warnings by national/state level agencies, largely driven by scientific and technological advances, particularly in computer systems and information and communications technology. There have been continuous improvements in the accuracy and reliability of monitoring instrumentation and in integrated observation networks particularly through the use of remote sensing techniques. In turn these have supported research on hazard phenomena, modeling and forecasting methods and warning systems at national level. However, capacities in monitoring and prediction of hazards at local / city level are less due to;

1) Inadequate level of technical capabilities (resources, expertise and operational warning services)
2) Lack of systems for monitoring hazards
3) Lack of interdepartmental level negotiated data-exchange policies and procedures to share essential data in a timely fashion
4) Inadequate access to information (forecasts and interpreted data)
5) Insufficient multi-disciplinary, multi-agency coordination and collaboration for improving forecasting tools such as for storm surge and flood forecasting and for integrating warnings into the disaster risk reduction decision processes in a more effective and proactive fashion;
6) Inadequate communication systems to provide timely, accurate and meaningful forecasting and early warning information down to the level of communities.

Overall, a major need across the board is the integration of risk information into hazard warning messages. This would require close collaboration between technical operational agencies and state level agencies responsible for vulnerability and risk assessment. Capacities for risk assessment need to be developed at local levels, on methodologies, hazard and various socioeconomic data. There is a widespread need for closer collaboration among the meteorological and hydrological agencies and communities at the national, state, local levels to ensure enhancement of flood forecasting, modeling and warnings.

**Dissemination and Communication**

A typical warning dissemination chain involves channeling warnings from technical and scientific sources through government decision makers and the media to multiple receivers who may also function as onward disseminators. Such users include emergency services, security agencies, operators of utilities, information and communication services, other economic service providers and vulnerable communities. Though remarkable progress is made in this sector by the state & district authority in last few years, there are hardly any such dissemination chain structure exists with the City emergency operation cell to the community. Following are the major gaps in dissemination and communication

1) No formal institutional structures with requisite political authority to issue warnings exist in the City. Warning communication often fails as a result of weak inter-personal and inter-agency relationships, including between early warning services and response units and other sectors.
2) Lack of clarity and completeness in warnings issued -Often warnings are incomplete because they do not meet essential requirements for effectiveness including: brevity, clear and uncluttered presentation, use of non-technical language, identification of areas affected, explanation of potential losses and of the chance of the loss occurring within a certain timeframe, as well as instructions to reduce losses through response actions. This is partly because of lack of common standards for developing warning messages. It may also be unclear to the public whether the information is a forecast or a warning, as the inherent uncertainty of warnings may not have been appropriately conveyed. Lack of clarity of warning messages is often due to unclear responsibilities about who provides forecasts (of hazards) and who provides warnings (of risks).
3) Perhaps the most important reason for people failing to heed warnings is that the warnings do not address their values, interests and needs. Messages are often not sufficiently targeted to the users and do not reflect an understanding of the decisions stakeholders need to make to respond to the warning. Individuals may perceive the warning as irrelevant or find it impossible to heed, for example because they are reluctant to abandon the assets upon which livelihoods depend, such as livestock, or that have personal importance, such as pets. Furthermore, most warnings are delivered to the whole population through the media and are not tailored to the needs of individual groups.

**Response Capability**

The failure to adequately respond to warnings often stems from lack of planning and coordination at the national, state and local levels, as well as a lack of understanding by people about their risks. Some major gaps and needs include:

1) Lack of multi- agency collaboration and clarity of roles and responsibilities at local levels.
2) Lack of public awareness and education for early warning response
3) Lack of simulation exercises and evacuation drills
4) Limited understanding of vulnerability by the community

**Cross- Cutting Issues and Gaps**

Though a number of issues have emerged and cut across the four elements of early warning, most important among them are;

1) Inadequate political commitment for developing integrated early warning systems, lack of legal frameworks for early warning systems, and inadequate recognition of the links between disaster risk reduction and development.
2) Insufficient investment in early warning capacities
3) Insufficient coordination among actors responsible for early warning
4) Lack of participatory approaches, with over-reliance on centralised government direction and limited engagement of civil society, NGOs and the private sector; and
5) Inadequate identification and sharing of methodologies and good practices, as well as cross-discipline collaboration to enhance warning capacities both within and between the different hazard fields.

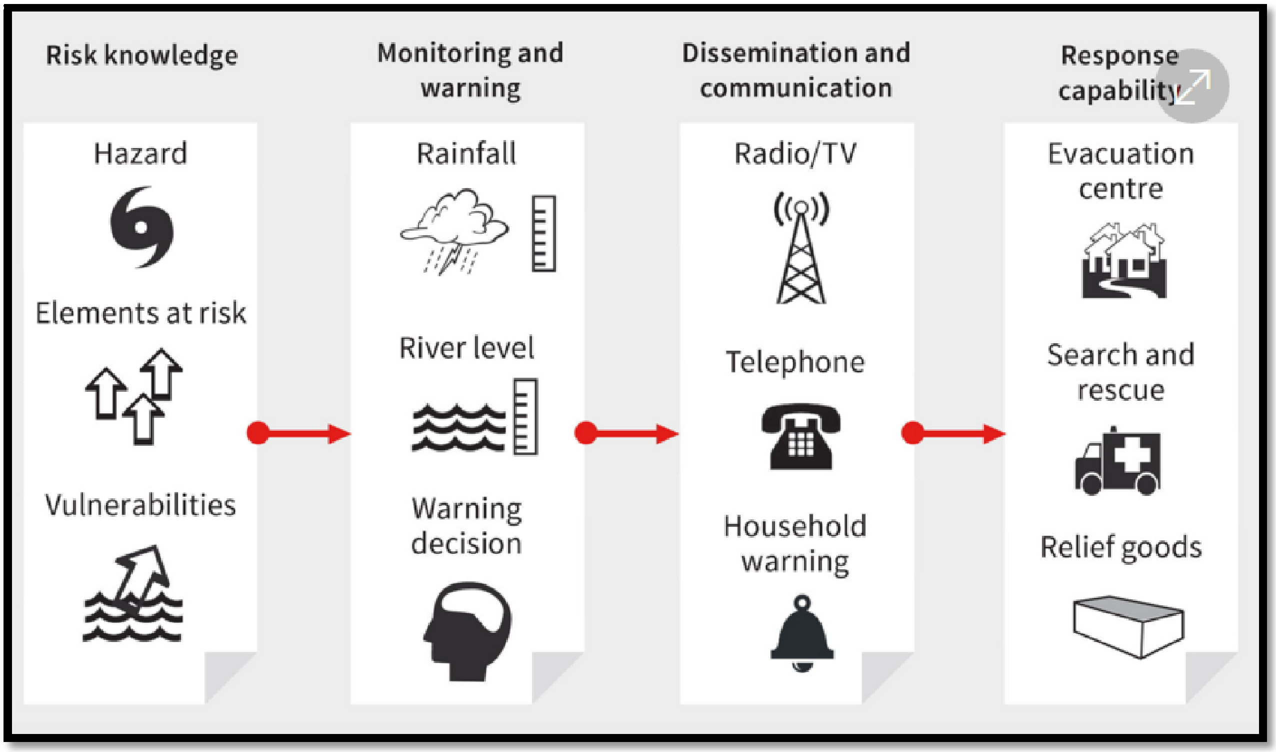
# CHAPTER 4

## Early Warning System Plan for Flood hazard

Floods are an increasingly acute problem in the city of Thiruvananthapuram. Intense precipitation has become more frequent and more intense, growing manmade pressure has increased the magnitude of floods that result from any level of precipitation, and flawed decisions about the location of human infrastructure have increased the flood loss potential. Though the natural topography of the city has adequate slope to drain storm water, poor maintenance of major drainage outlets and frequent blockages of primary drains cause local flooding and water logging. Normally, water logging takes place during the period of high intensity and/or for extended duration of rains. Though the Government of Kerala and the City Corporation had undertaken several initiatives to solve the issue, the problem remains unresolved, causing severe flooding, inundating the low lying areas.

Flooding cannot be wholly prevented. The occurrence of a flood need not be considered a 'failure' and, conversely, minimisation of losses may constitute a 'success'. There are lessons to be learned from every flood and it is important to use them in preparing for the next flood. Once we accept that no flood protection measures can guarantee complete safety, a general change of paradigm is needed to reduce human vulnerability to floods. The attitude of 'living with floods' and accommodating them in planning seems more sustainable than hopelessly striving to eradicate them. Flood forecasting and warning systems fail because links in the chain perform poorly or fail completely. A single weak point in a system that otherwise contains excellent components may render the overall system performance unsatisfactory. A successful system requires sufficient integration of components and collaboration and coordination between multiple institutions.

Here comes the significance of Local Flood Early Warning System (LFEWS), which can be successfully implemented in Trivandrum City Corporation. LFEWS means a watershed-based system managed by local government units and affected communities. LFEWS has an integrated system of communication. Its Operation Center works 24/7 to monitor data on rainfall and river water level and issues the official appropriate alert signals to the communities. It is a tool for empowering communities in partnership with their local governments. Affected communities co-own and participate in managing the system. LFEWS empowers local governments to make informed decisions where and when needed and under conditions when higher level guidance or advisory is not available. It also integrates indigenous knowledge systems and practices, traditional local coping mechanisms such as this homemade bating-ting (bell) and modern technology in monitoring and forewarning. LFEWS has four core components that coincide with the International standards for MHEWS. They are;




**Risk knowledge**

A risk is the combination of the probability of an event and its negative consequences. Risk takes into account both the impacts on a community when or should a hazard occur, and the capacity of individuals and communities to prepare or cope. Assessing risks includes a multitude of data concerning people and where they are situated. By conducting a Participatory Disaster Risk Assessment, data such as these are gathered: estimates of how many people live and work in the flood prone area(s) and the moveable materials the households or businesses in the flood prone area have; how many of the population are the most poor, how many have shelter that can withstand a flood, have children, elderly, handicapped; availability of gadgets like boats, vests, ropes, etc. Coupled with these are the data related to frequency of floods, and developing maps showing where the flooded areas are exactly and what the depth and current of floodwater is.

**Monitoring and warning**

Warning lies at the core of LFEWS. The best data for predicting a flood is measuring the water level of the river. The second best way is predicting a flood from rainfall data. LFEWS uses both and the system operates 24 hours a day. The variability of rainfall and river water levels are processed and converted into warning signals to inform courses of action in the form of warning signals. Detection of a flood condition upstream and the arrival of the warning at the inhabitants of the flood-prone area take time. This time depends on how frequent the data is gathered, the communication of the data to an operation center, the decision to issue a warning and the communication of the warning to the households (possibly via a chain).

**Communication and dissemination**

This mainly consists of an effective communication network that serves as platform for risk monitoring data and alert signals using radio, mobile telephony and indigenous and traditional communication media such as bells (bamboo and iron), megaphones, LED Display boards and human communicators on foot, or motorbike who and which can communicate warning levels to the communities.

**Response capability**

Forming part of the system but usually coordinated with City Disaster Management Cell and other emergency support functionaries response capability pertains to humanitarian actions during worst-case scenarios such as search and rescue, evacuation and emergency assistance.

## Proposed Implementation Process – LFEWS for Trivandrum City Corporation

**1) Secure political consent of local governments and social acceptance at community level**

LFEWS should be demand-driven. Although its relevance and use value to local governments and communities are self-revealing, political consent and community acceptance need to be secured and reaffirmed at the onset.

**2) Conduct Participatory Disaster Risk Assessment (PDRA)**

Disaster risk assessment is best done with the involvement of local government units together with the communities. The participatory aspect enables the development of clear objectives and transparent information for making decisions that can reduce disaster risks. This step involves identifying, analyzing and determining how the community will manage disaster risks. A review of disaster history is done as well as the conduct of several assessments. The assessments are on: hazards, risk perception, vulnerability and capacity. Step 2 enables them to: Establish the disaster risk context Identify the disaster risks Analyze the disaster risks Prioritize the disaster risks Determine means of monitoring and communication also taken into account are the existing traditional or local coping mechanisms. Using traditional systems recognizes the importance of well established roles and responsibilities of different members of the community and the existing knowledge, methods (such as utilizing the use of church bells for setting off warning alerts), skills and capacities of community members. Flood scenarios could be created by utilizing the community-based flood maps and also by making use of existing hazard maps from the State Emergency Operation Centre. By adding the socio-economic data, such as that from Community-Based Monitoring System, allows for a more detailed understanding of the elements at risk, such as the number and kind of infrastructure, services, agriculture and population, in a given area.

**3) Planning and integration of LFEWS to existing disaster plans and structures**

In Trivandrum Municipal Corporation, there is a pre-existing Disaster Preparedness Plan that should be integrated into the Comprehensive Development Plans of the municipal corporation. LFEWS needs an anchor – either a Disaster Preparedness Plan or a Disaster Risk Management Plan. It also needs an over-arching steering structure that could already be present such as city emergency operation centre.

**4) Hardware installation and calibration**

An operational LFEWS require the following equipment and preparations: Installation and calibration of monitors and communication equipment, Dry run and drills Post-event validation and calibration of monitors and equipment Continuing refinement of protocols Basic FEWS hardware set-up require only three major hardwares: one rain gauge, one river-level gauge and one data receiver for the Operations Center. These devices collect data and provide readings which are transmitted to the Operations Center via an automatic or manual radio. Hardware installation should be tailored fit to a flood prone area to ensure more precision and reliability in forecasting the expected arrival time and height of a flood.

**5) Implementation**

This step is the final phase of LFEWS installation and the first phase of an ideally sustained LFEWS operation and maintenance. Effective implementation requires the following;

**6) Operation Centre**

The Operation Center or a command center processes monitoring data and is the designated and authorized office that sends out warnings to affected communities through a pre-established communications network. What is important is that for any type of Operation Center, there should be a dedicated staff for LFEWS.

**7) 24/7 disaster monitoring**

LFEWS establishes water level and rainfall devices which provide data that are observed, recorded and transmitted to the Operation Center. After the Operation Center has decided to issue the warning, it is essential that the communications network is followed so that there is a clear flow of information.

**8) Systems maintenance**

Wear and tear afflicts not only equipment but also the human resources dedicated to monitor the gauges or operate the system. Organizational maintenance should come alongside hardware maintenance.

**9) Coordination with ESF's**

The local disaster risk reduction and management office or Operations Center can touch base with the state/national agencies such as the IMD, INCOIS, GSI, NCESS and its services and research institutes to be part of a growing network of disaster risk management practitioners that tap and contribute to each others' learning and resources.

**10) Political, Policy and Administrative Support**

Political turnovers may have negative effects to LFEWS implementation and deciding to sustain it or not may emerge both at the level of the command center and at the community level. It would be best to institutionalize LFEWS with adequate policy coverage such as executive orders, budgetary allocation or integration in local development plans.

**11) Legal & Administrative Processes**

LFEWS development came alongside the evolution of the legal and policy frameworks in disaster risk reduction and management. It is expected that the roll out of national policies and guidelines will have varying applications at the local government level. In whatever way LFEWS comes into being, there should be clear lines of accountability in order for LFEWS to be sustained. Policy and political environment needs to be favourable and communities who adopt it must have a sense of ownership over the system. To see is to believe, thus if LFEWS continues to save lives and properties, the community support and ownership of the product will also continue.

**12) Social Processes**

LFEWS is also a tool for community empowerment. Community ownership and participation is important from inception, system installation and implementation. There is ample room for affected communities to participate in all of the steps and transform themselves from pure victims of disasters to active participants in risk reduction and management. Some community members can play critical tasks such as disaster awareness campaigners, gauge readers and monitors, communicators or evacuation drill facilitators. They can also provide security to the rain and water level gauges. LFEWS tends to reinforce community coping mechanisms and household strategies for responding to calamities.

**13) LFEWS Operations**

At the heart of LFEWS is the Operations Center that contains the data center and communications hub. It is operated by at least two specialists other than a nodal officer and should function under the city emergency operation centre/cell.

### LFEWS Flood alert and warning system

Three colors can be used to communicate warning and alert levels, they are;

- Yellow for Flood Level 1 and Standby
- Orange for Flood Level 2 and Preparation
- Red for Flood Level 3 and Evacuation

**Flood Level 1**

**Alert Stand By**
**High Probability of Flood**

**Warnall Municipal Corporation DM Staffs/councils/ward members in flood-prone area.**

**Inform district authroities/EOC**

**Alert community task force members.**

**Ask the search & rescue team to go on stand by**

**inform local media to broadcast status report**

**Flood Level 2**

**Preparation**

**Flood is inevitable within hours**

**Warnall Municipal Corporation DM Staffs/councils/ward members in flood-prone area.**

**Inform district authroities/EOC and community task force members.**

**Inform local media to broadcast status report**

**Flood Level 3**

**Evacuation**

**Flood coming anytime**

Orderall ward members to evacuate residents at risk.

**Inform district authroities/EOC and community task force members.**

**Inform local media to broadcast status report**

**Communication**

City Emergency Operation Centre shall be the communication hub for receiving data on water level and rainfall and for sending alert signals. It shall be a two-way communication channel where the Local Volunteer Observers and telemeters will send rainfall and water level data to the operation centre 24/7 and where the city EOC sends back corresponding alert signals through mobile phones, sirens, mega phones and electronic display board. The most common medium that can be used is amateur radio on the VHF channels, complemented by mobile phone and SMS. At the ward level, support personnel can use motorbikes to disseminate information in cases where mobile telephony and radio fail to reach out to the intended targets. At the community level, communities can activate indigenous media such as bells (acoustic signal) or word of mouth communications. –

# CHAPTER 5

## Early Warning System Plan for Coastal Hazards

Coastal communities are increasingly at risk from tsunamis and many other coastal hazards. Coastal hazards are those natural and manmade hazards that occur at the interface between the ocean and the shoreline. These chronic and episodic hazards include human-caused actions and natural events that threaten the health and stability of coastal ecosystems and communities.

The risk from coastal hazards is characterized by the frequency of occurrence and severity of the hazard. Tsunamis are typically infrequent events with moderate to severe consequences. Mild flooding may occur frequently, while severe flooding may be an infrequent event. Coastal erosion may be a chronic event with mild consequences or, coupled with other hazards, may result in severe impacts on the shoreline. Infrequent events with limited predictability pose the greatest risk of disaster and the longest time needed for disaster recovery. Frequent or ongoing hazards such as resource or environmental degradation processes can be monitored to reduce risk.

Coastal communities are experiencing unprecedented rates of changes due to population growth, human induced vulnerability, and global climate change. The effects of this change are placing communities at increasing risk of inundation from coastal hazards including tsunamis, storm surges and shoreline erosion. Vulnerability in the coastal zone is increasing as more people move to the coast and natural buffers such as wetlands and dunes are lost to development and erosion. There is an obvious relationship between the consequences of flooding events (loss of lives, economic damage) and the extent of coastal spatial and infrastructural developments in terms of land use, buildings, infrastructural facilities and related values, driven by population and economic growth. It also has become evident that, even without a major catastrophic inundation, these coastal communities are poorly resilient to normally recurring hazards. Indeed, high coastal population density coupled with projected increases in storm frequency and severity may exacerbate the impacts of coastal disasters and slow subsequent recovery and community rebuilding efforts, raising the question of how to increase community resilience.

Based on systematic field survey conducted by National Centre for Earth Science Studies, 6.5 km of the 27.4 km of Thiruvananthapuram City's coastline is prone to high rates of coastal erosion. In the worst case scenario, sea level may rise by 15 to 38 cm by mid-21$^{st}$ century. Considering the tsunami inundation level this anticipated increase is negligible and thus, tsunami inundation level is also considered as the worst case scenario inundation level in the event of major storm surges. Thus an early warning system is very much essential to mitigate the loss of life and property from coastal flooding in Thiruvananthapuram City Corporation.

## Early warning System for Coastal Hazards - Present status

Currently, coastal hazards including cyclones and storm surges are monitored with the help of land-based, ocean-based and space-based observational systems which include conventional meteorological observations, reports from ships, observations from ocean data buoys, coastal radars (conventional and Doppler) and national and international satellites (geo-stationary and polar orbiting). These operations are generally carried out by IMD in association with multiple stake holders including INCOIS, National remote Sensing Centre, IAF, Indian Navy etc.

The Ministry of Home Affairs (MHA) being the focal point at the national level coordinates appropriate dissemination of warnings received from IMD, CWC, etc. This Information is further disseminated to State and District Disaster Management authorities for initiating appropriate response mechanisms.

IMD is the nodal agency for providing cyclone warning services. IMD‘s INSAT satellite based CWDS is one of the fail-proof systems (satellite-based) currently in use in India to communicate cyclone warnings from IMD to communities and important officials in affected areas directly and quickly. The cyclone warnings are uplinked to the INSAT satellite in C-band. The satellite audio broadcasts in regional languages are continuously sent at fixed time intervals to the coastal CWDS receiving stations. These warnings are selective and received only by the likely affected receiving stations in S-band. IMD has installed specially designed receivers in the vulnerable coastal areas for direct transmission of warnings to officials and people in general.

**Real time Observational Data for Cyclone Early Warning**

| S. No. | Type of Observation | Nodal Ministry | Nodal Agency | Agencies to be Involved |
|---|---|---|---|---|
| 1 | Land-based Observations | Ministry of Earth Sciences | IMD | IAF, Indian Navy, DoS, CWC, State Irrigation Departments, Agricultural Universities, River Authorities, etc. |
| 2 | Ocean-based Observations | Ministry of Earth Sciences | INCOIS | National Institute of Ocean Technology (NIOT), Indian Navy, Coast Guard, Ships of opportunity, International Floating Platforms, etc. |
| 3 | Space-based Observations | Department of Space | ISRO | IMD, International satellite agencies from polar orbital and geostationary platforms |
| 4 | Special Observations | Ministry of Earth Sciences/ Department of Space | IMD/NRSA | IAF, CWC and other user agencies |

## Establishing Coastal Hazards Early Warning System

The coastal hazard early warning system components can be categorized into four;

1) Monitoring & Detection System
2) Risk Knowledge
3) Warning Dissemination and Evacuation
4) Emergency Response Capability

### Monitoring & Detection System

The coastal hazards monitoring & detection at national level is primarily done by Indian National Center for Ocean Information Services (INCOIS), Hyderabad and Indian Meteorological Department, IMD along with multiple research organizations. There are multiple observation networks currently in operation throughout the Indian Ocean, Arabian Sea and Bay of Bengal region to monitor and receive real time data, which enables to send accurate and précised warnings to all coastal states & Districts through FAX, Phone, Email, SMS, Video conference, Hotline, GTS, Electronic Display Boards, VPN-DMS, Web, FTP and VOIP. Under this system Trivandrum District along with State Emergency Operation Centre is receiving the warning alerts disseminated by INCOIS & IMD. Considering the non viability of installing an early warning monitoring system for any of the coastal hazards that include cyclones, Tsunami and storm surge, it is better to have a proper dissemination mechanism from District

### Risk knowledge

Risk knowledge, is the awareness a community has about its potential hazards and its susceptibility to experiencing the negative impacts of those hazards. It requires an understanding of all of the chronic and episodic hazards that threaten the community, including the potential geographic extent of impact and the potential frequency of impact. It also involves knowing how each of these hazards threatens various components of the community, such as the local economy, the built environment, terrestrial and marine natural resources, all segments of the population, critical facilities, utilities, infrastructure, etc. It is essential that access to information pertaining to risk knowledge be open and freely shared among the entire community. A bench mark for risk knowledge related to coastal communities is given below.

## Risk Knowledge Benchmark on Policy and Planning Capacity

| **Coastal hazard risk assessments are completed at a scale appropriate to the community and routinely updated.** | |
|---|---|
| **Benchmark Description**<br>The type, frequency, and magnitude of chronic and episodic hazards needs to be routinely assessed and mapped in order to determine the risk to coastal communities.<br>The scale of the assessment should be appropriate for the community. Resilient coastal communities have an understanding of the hazard threats they face and utilize this information to reduce risk.<br>Sources of information may come from historical data, local experience, traditional knowledge, or model predictions | **Potential Assessment Questions**<br>Has an assessment of coastal hazards been completed?<br>Did the assessment consider historical events, existing hazards, and potential future coastal hazards?<br>Did the assessment cover chronic and episodic hazards?<br>Was there any community participation in the assessment?<br>Are results of the assessment shared with local and national stakeholders? |

## Risk Knowledge Benchmark on Physical and Natural Resource Capacity

| **Coastal hazard risk assessments are comprehensive and incorporate risks to all elements of resilience (e.g. livelihoods, coastal resources, land use, etc.).** | |
|---|---|
| **Benchmark Description**<br>A community should have an understanding of its potential for experiencing negative impacts from coastal hazards. This understanding of vulnerability needs to include the impacts on social and cultural resources, economies and livelihoods, natural resources, and critical facilities of the community. Resilient coastal communities have an understanding of the potential negative impacts of hazard threats they face and utilize this information to reduce risk. | **Potential Assessment Questions**<br>Does the community have an understanding of how coastal hazards could impact its economic and livelihood assets?<br>Has an assessment of social and cultural vulnerability been conducted that identified areas where individual resources for disaster preparation and recovery tend to be minimal (i.e. areas with high concentrations of poverty, elderly, illiteracy, gender issues, etc.)?<br>Has the community identified areas where cultural differences may bring about special needs to build resilience, such as areas with high concentrations of persons who speak a foreign language?<br>Has the vulnerability of natural resources been assessed?<br>Has the community identified all facilities, infrastructure, and utilities that are deemed critical?<br>Has an assessment of the vulnerability of the critical facilities, infrastructure, and utilities is conducted? |

**Risk Knowledge Benchmark on Social and Cultural Capacity**

| Community participates in the hazard risk assessment process. | |
|---|---|
| **Benchmark Description**<br>Risk information is one of the keys to early warning system. The risk information must be accessible and understood by all members of the community. It is critical that all risk information be shared among all those who make decisions related to community development, coastal resources, and disaster management. The sharing of risk knowledge helps coastal communities make wiser decisions, thereby helping to reduce risk. | **Potential Assessment Questions**<br>Was the community involved when hazards risks were assessed?<br>Is risk information made accessible to the community?<br>Is risk information shared and used among institutions to better inform policy and action?<br>Do formal or informal education programs exist to promote risk knowledge? |

**Risk Knowledge Benchmark on Technical and Financial Capacity**

| Information from risk assessment is accessible and utilized by the community and government. | |
|---|---|
| **Benchmark Description**<br>Hazard risk knowledge should be utilized to guide all community planning efforts, both short term and long term. The utilization of risk knowledge helps to ensure that the plans are sustainable and the goals are attainable. Risk knowledge should also be utilized to identify mechanisms to lessen the risk through mitigation measures. Over time, risk can change due to numerous factors, such as population growth, climate change, deforestation, etc. communities should periodically reassess their risks to account for these changes | **Potential Assessment Questions**<br>Do community development goals and the plans to achieve them take into account hazard risk?<br>Are hazard risks considered by institutions when making planning and development decisions?<br>Are hazard risks considered when making coastal management decisions?<br>Are risks utilized to prioritize and guide planning and mitigation actions consistent with community development goals?<br>Is risk periodically assessed to address changes in physical, social, cultural, environmental, and climate conditions? |

**Warning Dissemination & Evacuation**

On receiving an alert from IMD/INCOIS or from The Ministry of Home Affairs, the State Emergency Operation Centre and District Disaster Management Authority, Thiruvananthapuram district should communicate the warning alert either through FAX, Phone, Email, SMS, Video conference, Hotline or VOIP to the City Disaster Management Cell and Secretary, Thiruvananthapuram Municipal Corporation. The City Disaster Management Cell on receiving alert must get into touch with all municipal ward councilors, community task force members and city level response force for disseminating the information at community level and further evacuation from coastal areas. The City EOC must go in tandem with the district administration in whole communication /Dissemination processes and further help the district administration in this phase. The warning can be disseminated through the community via location based short message services, loudspeakers in religious places, broadcast on radio and television, Public service loudspeakers in traffic islands, markets and LED Display boards. A bench mark for Warning & Evacuation is given below.

**Warning and Evacuation Benchmark on Policy and Planning Capacity**

| **Community warning and evacuation systems, policies, plans, and procedures are in place and capable of alerting vulnerable populations in a timely manner** | |
|---|---|
| **Benchmark Description**<br>Coastal communities should possess adequate mechanisms for receiving emergency information from external sources and are able to disseminate messages to the farthest reaches of the community in an appropriate amount of time. They should also have evacuation plans in place well in advance of receiving any hazard warning. These plans incorporate knowledge of vulnerable populations and input from the community in identifying evacuation routes and developing procedures. Lastly, they must practice responding to hazard events through training exercises and drills. These activities are evaluated for their effectiveness, and mechanisms exist to modify procedures and plans for improvement. | **Potential Assessment Questions**<br>Does the community have a way to receive emergency information from administration? Does the community have a way to disseminate emergency information?<br>Does the community have an evacuation plan in place that is comprehensive and addresses individuals with special needs?<br>Do evacuation procedures address transient populations (tourists or migrants) and local businesses?<br>Is there redundancy in both human and technical components of the warning and evacuation system?<br>Are warning system and evacuation procedures tested regularly and evaluated after exercises or hazard events to improve effectiveness? |

**Warning and Evacuation Benchmark on Physical and Natural Resource Capacity**

| **Community warning and evacuation infrastructure is in place and maintained.** | |
|---|---|
| **Benchmark Description**<br>Coastal communities should maintain the infrastructure that is used to warn and evacuate vulnerable populations. This infrastructure may include warning sirens, warning flags, warning towers, evacuation route signs, tsunami zone signs, tsunami shelters, and safe areas. In addition, they must maintain their information technology and communications hardware and ensure critical system components have backups and alternative power supplies. | **Potential Assessment Questions**<br>Are warning system components in place and maintained?<br>Are hazard zones, evacuation routes, shelters, and safe areas clearly marked throughout the community with signs and/or maps?<br>Is there redundancy in the technical and human components required for effective warning and evacuation? |

**Warning and Evacuation Benchmark on Social and Cultural Capacity**

| Community is prepared to respond to hazard warnings with appropriate actions. | |
|---|---|
| **Benchmark Description**<br>Coastal communities must actively educate about coastal hazard risks and warnings. Prepare individuals and institutions to respond appropriately to warning information through awareness campaigns and outreach activities. When emergency information is provided, individuals and institutions act accordingly. | **Potential Assessment Questions**<br>Have outreach programs been established to ensure that community members are aware of hazard risks, warning procedures, and evacuation plans?<br>Do outreach efforts reach transient populations such as tourists and migrants?<br>Do schools teach students about hazard risks, emergency preparedness, hazard warnings, and evacuation plans?<br>Are there trained community volunteers and/or organizations that provide awareness information?<br>Do popular culture and news media outlets participate in raising community awareness? |

**Warning and Evacuation Benchmark on Technical and Financial Capacity**

| Technical and financial resources are available to maintain and improve warning and evacuation systems. | |
|---|---|
| **Benchmark Description**<br>Identify and allocate the technical and financial resources to maintain and improve warning systems and evacuation plans and procedures. Coastal communities must seek out the weakest link in warning systems and evacuation procedures and actively work to address them through fundraising, partnerships, and agreements. | **Potential Assessment Questions**<br>Are warning systems and evacuation procedures supported by government programs?<br>Does the community have the appropriate amount of resources to maintain warning systems?<br>Are evacuation procedures routinely updated to incorporate changes in the community?<br>Has the community established partnerships or agreements with external governments or organizations for funding or technical assistance? |

**Emergency Response Capability**

The emergency response function incorporates a wide range of measures to manage risks to communities and the environment. Effective emergency response enables coastal community to better absorb the shock associated with disaster events. Emergency response plans and mechanisms also provide the basis for the community to bounce back quickly from the impacts of disasters. In the event of a disaster, effective emergency response procedures can reduce the loss of life and help to lessen the time and investment needed for a community to recovery. The benchmark for emergency response is given below.

**Emergency Response Benchmark on Policy and Planning Capacity**

| Predefined roles and responsibilities are established for immediate action at all levels. | |
|---|---|
| **Benchmark Description**<br>Emergency response to disaster events usually requires the involvement of multiple institutions. For the response activities to be effective there must be a clearly defined system for leading and coordinating the activities of all of the institutions involved. For a community to be resilient, it should have an emergency response plan that includes information detailing how numerous institutions and various levels of government will interact and coordinate during disasters. In addition, communities should take steps to ensure that vital response supplies and resources are identified, stored in safe locations, and can be mobilized in a timely manner. | **Potential Assessment Questions**<br>Have disaster-specific emergency response plans been developed?<br>Do emergency response plans clearly define leadership roles and coordination mechanisms (e.g. incident command system)?<br>Have response teams (e.g., damage assessment teams, search and rescue, etc.) or other relevant committees been formed and trained for action?<br>Does the Emergency Operations Center have the capacity to mobilize and implement the emergency response plan?<br>Have protocols and linkages between all response institutions been established for coordination?<br>Have materials and supplies for short-term disaster management and emergency response been identified?<br>Are materials and supplies for short-term disaster management and emergency response stored in locations outside of high risk areas? |

**Emergency Response Benchmark on Physical and Natural Resource Capacity**

| Basic emergency and relief services are available. | |
|---|---|
| **Benchmark Description**<br>During emergency response, some of the most immediate needs relate to the wellbeing of the community members. Disasters can be very traumatic, and emergency response measures are needed to help save lives, reduce losses, and attend to those in need of assistance. Communities should take measures to ensure that community members have access to medical care, food, water, and temporary shelter in the immediate aftermath of disaster events. | **Potential Assessment Questions**<br>Have facilities vital to emergency response activities been identified?<br>Have assessments been done to determine if these vital facilities will withstand the impacts of disasters?<br>Have measures been taken to ensure that these vital facilities will be functional during a disaster?<br>Have measures been taken to ensure that emergency healthcare and life support systems for the community will be functional during a disaster?<br>Are essential emergency food supply systems accessible during disaster events?<br>Have plans been implemented to ensure that psychological and social support is incorporated into healthcare and life support systems during disaster events? |

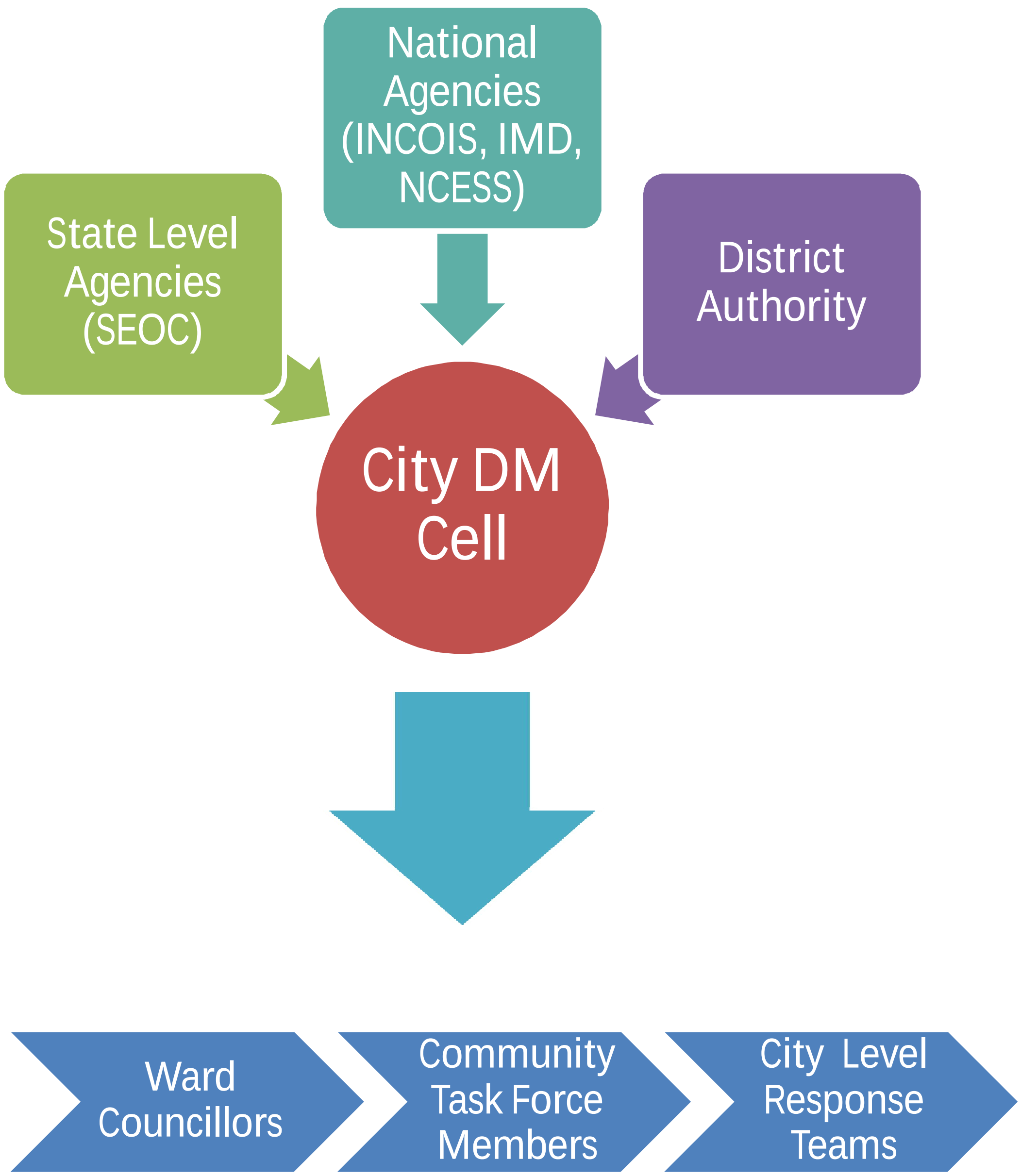
**Emergency Response Benchmark Social and Cultural Capacity**

| **Preparedness activities (drills and simulations) are ongoing to train and educate responders.** | |
|---|---|
| **Benchmark Description** | **Potential Assessment Questions** |
| It is important to periodically train members of emergency response institutions to ensure that they are ready when their services are needed. It is just as important to ensure that community members are aware of the types of emergency response services available and how to utilize them. This requires an effective education and awareness program. In addition, it is important to conduct drills and exercises on a periodic basis to ensure that the community is ready to respond, they can also help to identify gaps and deficiencies in the response plan. Communities must ensure that response institutions and community members are ready to respond to hazard events through training, education, and drills. | Does the community conduct regular training programs for institutions responsible for emergency response activities?<br>Do public awareness and education programs exist to inform all sectors of the community of the emergency response plans?<br>Have volunteers been identified and trained properly prior to disaster events?<br>Does the community conduct periodic “end-to-end” emergency response drills and exercises?<br>Are the results of emergency response drills and exercises utilized to identify gaps or deficiencies in existing response plans?<br>Are emergency response plans updated based on assessments of response drills and exercises? |

**Emergency Response Benchmark on Technical and Financial Capacity**

| **Organizations and volunteers are in place with technical and financial resources to support emergency response activities.** | |
|---|---|
| **Benchmark Description** | **Potential Assessment Questions** |
| During the immediate response phase of hazard events, communities often must respond with limited or no resources from outside of the community. For response to be effective at limiting the loss of life and property, a community must have a pre-established network in place to utilize community organizations, volunteers, and resources in a well thought-out manner. These organizations and volunteers will need to be trained periodically to ensure that they are ready to respond when necessary. In addition, mechanisms must be in place to ensure that all resources identified for use during an emergency are readily available and properly maintained. | Have community resources been identified that can be utilized during emergency response activity?<br>Have community volunteers willing to assist during emergencies been identified?<br>Have community organizations willing to assist during emergencies been identified?<br>Have community organizations and volunteers been trained on emergency response activities?<br>Have agreements been established to utilize community resources during emergency response?<br>Are there mechanisms in place to ensure proper maintenance of community resources identified for use during emergency response? |

**Early Warning System Framework for Coastal Hazard**



# CHAPTER 6

## Early Warning Plan for Public Health Risk

Thiruvananthapuram City due to its spatial attribute is one of the vulnerable locations with regard to epidemic outbreak. Every year thousands of people are affected with various kinds of epidemics and the frequency of which is increasing in year after year. The City has become the focal point for a mosquito-borne plague that is sweeping the whole state. Out of the six diseases included under NVBDCP viz, Malaria, Dengue fever, Filariasis, Chikungunya, Kala azar and Japanese encephalitis, the first 5 are being reported in the City. A few cases of cutaneous leishmaniasis (a disease) were also reported in the city in 2009 and in 2015.

Since 1994, indigenous Malaria was a problem at Valiyathura and neighboring areas in the coastal Thiruvananthapuram. During 2011, 13 indigenous cases were reported from Mukkola and in 2014 this was increased to 360 cases, in 2015 it became a serious threat to the coastal areas and numbers of cases are further increasing.

Dengue fever was first reported in the district in the year 2001.Maximum number of cases were reported in year 2013. Dengue fever still continues as one of the most threatening outbreak prone communicable diseases in the city.

Very recently another vector-borne disease seems to have surfaced, with the reporting of an indigenous case of Kala Azar or visceral Leishmaniasis at the Medical College Hospital. An infectious disease usually seen only in Bihar, West Bengal and Uttar Pradesh, this is a rare instance of Kala Azar being reported here. The disease, which had been eradicated in India in the late 1950s, resurfaced after 20 years and by the late 80s manifested again as a major public health problem.

Therefore an effective community based surveillance system is required that enables integration of Information Communication technology and the conventional methods. This can be done effectively using mobile phone technology and the internet to track disease activity in different communities. It successfully enables real-time estimation of disease activity and can also aid in the prevention and control of disease outbreaks. Here a mobile based application called Mo-Buzz is developed in Srilanka for dengue Surveillance, like wise an application based system can also be developed for Thiruvananthapuram City Corporation for epidemic surveillance. The more we understand about disease spread, the faster we can intervene and limit the impact of disease outbreaks.

**EWS Plan for Public health risks using Participatory Surveillance Mechanism: Digital Disease Detection**

Participatory epidemiology is the application of inclusive approaches to epidemiology through the empowerment of stakeholders to identify and solve their own problems. True participation goes beyond consultation to give stakeholders a role in decision-making, so that they share in the control of the process. Participatory approaches involve a shift in the delivery of health services, from a 'top-down' centralised approach to a 'bottom-up' approach of understanding the needs and priorities of diverse livestock producers. The participation of community members and other stakeholders in surveillance systems ensures that the systems are responsive to stakeholders' needs and increases their sense of ownership of and commitment towards sustaining the system.

**Related Literature**

On the predictive surveillance front, various efforts to develop early warning systems for epidemics have been reported. The mandate of these initiatives is to develop robust associations between environmental and vector variables that can help to predict an outbreak in advance so as to inform in advance the efforts of public health and vector control personnel (Ebi, 2009). The Malaria Atlas Project (MAP) is one of the foremost exemplars that attempts to make malaria early warning systems accessible to the general public through an interactive website (http://www.map.ox.ac.uk/). Predictive modeling efforts for infectious diseases such as dengue and West Nile virus have been extensively chronicled in public health literature (Degallier et al., 2010; Estallo et al., 2008; Rochlin et al., 2011) but efforts to make these early warning devices available to the general public remain scant.

ICT-based civic engagement in public health has been driven mainly on the premise of a virgin concept called participatory epidemiology (PE). PE denotes the use of local, on-ground intelligence to gather information and track the spread, causes, and effects of diseases. The PE concept was popularized by Catley and Mariner's work in East Africa where qualitative community-based approaches were deployed to derive animal health status from local farmers (Catley, 2006). However, the rapid proliferation of the Internet and mobile phones has transformed the PE landscape in recent years.As shown by initiatives such as Frontline SMS and Ushahidi (Freifeld et al., 2010), disease surveillance, health monitoring, and information sharing can now be digitally integrated and used to link disparate stakeholders such as health authorities, health providers and the general public. Chunara et al. (2012) tested an online initiative where respondents reported their experiences with malaria, and concluded that "micro-monitoring and online reporting are a rapid way to solicit malaria, and potentially other public health, information". The Program for Monitoring Emerging Diseases (http://www.promedmail.org) provides an online reporting system and rapid information dissemination related to infectious disease outbreaks. In this sense, participatory epidemiology also denotes employing participatory methods – those nestled in, and involving communities – to collect epidemiological data. The other key principle includes the use of participatory mapping techniques in order to inform prevention activities. In terms of shaping healthy behaviors through communication, mobile phone-based short messaging service (SMS) has been used to promote smoking cessation behaviors (Rodgers et al., 2005), create awareness about sexually transmitted diseases (Lim et al., 2008) and encourage adherence to antiretroviral treatment (Lester et al., 2010) in both developed and developing countries. At the health systems level, mobile phones have empowered community health workers in developing countries through cost-effective and time effective techniques that facilitate data collection, surveillance and mobile-based telemedicine (Chib et al., 2008; Mechael, 2009). The advantage of such technologies to the general public is that they bring accessible and affordable healthcare to the remotest and impoverished of communities.

The use of information and communication technologies (ICTs) in public health has thus rapidly proliferated over the last two decades given the deep penetration of the Internet and mobile phones in both developed and developing countries. In addition, we argue that the capabilities of social media that allow users to participate and share information have thus far been underutilized in the global health space. There is a need to optimize social media affordances with an eye on the future, given that smart phones are becoming an increasingly ubiquitous commodity in developing countries because of decreasing costs and increasing availability.

**Methodology – Based on Srilankan experience in Dengue Surveillance**

All over the globe there are many efforts to monitor diseases such as dengue, by asking people in the community to submit information on infections and mosquitoes. These systems are usually referred to as participatory surveillance systems (which basically involves the use of participatory methods to collect data on the presence or absence of a particular disease in a region) and have been developed for several countries including the Philippines, Pakistan, Sri Lanka and Puerto Rico.

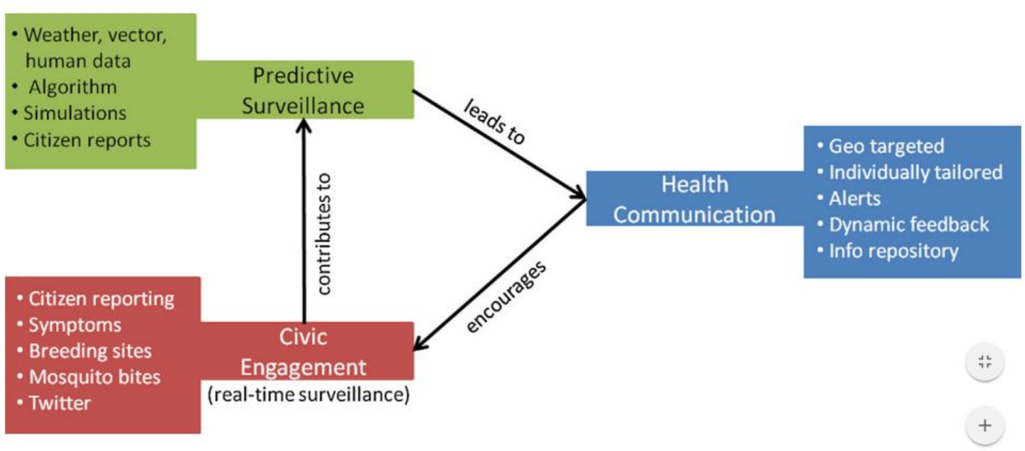
Dengue, like influenza, is a great candidate for participatory surveillance. Dengue is often underreported because of mild infections or the similarities between dengue symptoms and other disease symptoms. So, infections that may be missed by health professionals could be picked up by participatory surveillance. For example the places that have dengue also have influenza. Because those symptoms are shared, failing to monitor both diseases will actually inflate your estimated case counts for the disease you are tracking.

Dengue is typically transmitted to humans through the bite of infected Aedes aegypti mosquitoes. Although dengue is rare in the continental United States, it is endemic in many tropical countries. According to the U.S. Centers for Disease Control and Prevention, there are approximately 390 million cases of dengue infection worldwide each year. In Sri Lanka, there were over 137,000 cases reported in 2009-2013. Individuals infected with dengue usually experience symptoms that include high fever, severe headache, pain behind the eye, nausea, vomiting, rash and severe muscle, bone and joint pains.

Traditional dengue tracking methods rely on reports from medical providers. If you are bitten by an infected mosquito and later begin to experience any of the dengue-related symptoms, you would likely visit a clinician who would examine you, ask about your symptoms, and collect a blood sample to test whether you have dengue or not. Once the diagnosis of dengue is confirmed, the healthcare worker can report the data (your positive diagnosis) to local officials who then report the information to the next appropriate unit and so on. This health information tends to travel through a hierarchical structure. Thus, transmission of data to the ministry of health or dissemination to the public might be delayed by weeks or even several months.

Although there might be delays in the transmission of case information, the data collected through traditional monitoring of dengue is usually reliable since cases are confirmed in the lab. However, not everyone who gets infected has access to a medical provider. Also, the lack of financial resources and a weak public health infrastructure might hinder the effective monitoring of dengue cases in some countries. So, to supplement traditional systems, and reduce the delay in data transmission and dissemination, some public health and government officials have developed participatory and mobile phone surveillance systems, which take advantage of the global uptake of social media and mobile phone technology. These systems rely on public participation and/or reports from field workers to collect data on who is sick (including individuals who have been medically diagnosed and those who have dengue symptoms but have not yet had an official diagnosis) and where. Some of these systems also collect information on mosquitoes and mosquito control. Examples include the submission of reports through text, pictures or video on mosquito larvae clusters, and elimination of standing water in containers in the house and patio where mosquitoes can lay eggs.

An example of a participatory dengue surveillance system is Mo-Buzz, launched in Sri Lanka in 2013. The program was created by scientists at Singapore’s Center of Social Media Innovations with the goal of encouraging and improving communications between health officials and the public about dengue prevention and control. The system is made up of 3 parts: a predictive surveillance component, civic engagement component and health communication component.




Integration of three dengue prevention components in MO-Buzz

**(1) Predictive surveillance component**

The aim of the predictive surveillance component is to warn the public and health authorities of the likelihood of a dengue outbreak. The developers of Mo-Buzz use a computer simulation model that combines information on current spread of dengue cases, weather, and mosquito data to simulate what the spread of cases could look like several weeks into the future. This information is presented in hotspot maps, which are available to public health workers and the public. There are several advantages to this predictive component. First, healthcare workers can use the patterns predicted by the model to prepare for an outbreak by deciding what epidemic control measures to use and how to allocate resources. Second, simulations can be used to assess "what-if" scenarios to help researchers estimate the potential cost of different interventions.

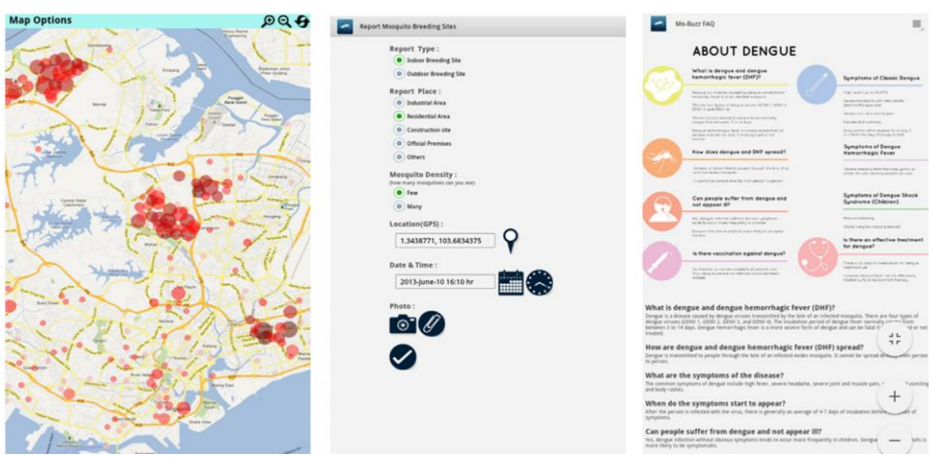
**(2) Civic engagement component**

The civic engagement component aims to collect near real-time data on dengue risk by encouraging the public to report information on disease symptoms, mosquito bites and breeding sites. Individuals who choose to participate can select from a list of symptoms, which include fever, body aches, joint pains, loss of appetite, etc. Users have the option of adding symptoms not already listed and specifying whether they have been diagnosed with dengue. For mosquito bites, users can report information regarding whether they experienced the bite indoor or outdoor, any visible symptoms such a rashes or bumps, mosquito density (few or many) and location of breeding sites. This information can be submitted through mobile phones by filling out interactive reporting forms, which automatically capture the user's geo-location. In addition, users can choose the type of reports they wish to see. The map is available to both registered users and healthcare authorities.

**(3) Health communication component**

The health communication component is made up of three subcomponents: health alerts, tailored health communication, and an information repository. The system sends health alerts to users based on their location. Users are also prompted to seek further information on prevention based on the reports submitted. According to the scientists working on Mo-Buzz, the information repository covers topics such as "dengue serotypes, risk factors, symptoms, statistics and preventive steps." This information is available to both registered and non-registered users and can be shared on social networks (such as Twitter and Facebook) and through SMS.

By combing these three components, the creators of the system aim to encourage active participation of the public to improve surveillance, prevention and control of dengue in Sri Lanka."



## Action Plan for Early Warning System

| Hazard Type | What needs to be done | Who Does it | When will it be done | How will it be done |
|---|---|---|---|---|
| Flood | | | | |
| Risk Knowledge Assessment | Participatory Disaster Risk Assessment | MC in consultation with SEOC and DDMA | PDRA needs to be updated once in 2 years | Initially MC to hire technical agency on contract, in long run MC may build in-house capacity for PDRA |
| Monitoring & Warning | Hardware Installation & Calibration | MC to spearhead | 2015-16 | MC to call EOI, Supplying agency on EMC |
| | Establishment of 24 X 7 City EOC | MC to spearhead | 2015-16 | Using existing staffs of health and engineering department |
| | Formation of Local Volunteer Observers for monitoring water level data | MC to spearhead | 2016-17 | Linking volunteers of CBDRM |
| | Establishment of alert-warning- de warning systems | MC networking with INCOIS, DDMA, NCESS, SEOC, DHS & IMD | 2016-17 | Based on Memorandum of Understanding |
| Communication & Dissemination | Establishment of communication network – sirens, area based SMS Service, LED Display Board | MC in network with public – private telecom companies | 2016-17 | Entering into MoU and AMC to firms |
| | Assign persons to provide warnings to local volunteers | MC staffs coordinating City EOC | 2016-17 | MC staff on rotation basis |
| Response Capability | Task force formation - Search & Rescue/ Evacuation team etc. | MC to spearhead | Continuing since 2013, completion in 2016 | Resource support from MC, Community mobilization support from NGO & Technical support from UNDP |
| | Identification of emergency shelters | MC in collaboration with DDMA | 2016-17 | With Technical support from UNDP & SEOC |

| | | | | |
|---|---|---|---|---|
| **Response Capability** | Resource Inventory | Wholly by MC | Data available in City DM Plan, Updating every year | City EOC Team |
| | Mock drills & training programs | MC with support of other agencies / departments | 2015-16 & 2016-17 | Technical support from Kerala Fire & Rescue Services, SEOC, DDMA & NGO |
| | Community based Evacuation / Response plan preparation | MC with support of NGO involved in CBDRM | 2016-17 | Resource support from MC, Community mobilization support from NGO & Technical support from UNDP |
| **Coastal Hazards** | | | | |
| **Monitoring & Detection System** | No hardware Installation required | | | |
| | Liaisoning with state & District stake holders | MC to network with technical NCESS, Fisheries Dept, SEOC and DDMA | Years to come | Conduct consultation meetings with key stakeholders |
| **Risk Knowledge** | Participatory Disaster Risk Assessment | MC in consultation with SEOC and DDMA | PDRA needs to be updated once in 2 years | Initially MC to hire technical agency on contract, in long run MC may build in-house capacity for PDRA |
| **Warning Dissemination and Evacuation** | Installation of fail proof communication system b/n city & stake/District stakeholders | MC to discuss with technical experts, District Authority and State Emergency Operation Centre in establishing alternative communication system including VSAT based DMS- VPN connectivity, BTS terminal, INSAT MSS type D terminal, Portable multimedia terminal etc. | 2016-17 | Technical Support from Government organizations including NRSC/ISRO can be availed. |
| | Installation of fail proof communication channel b/n city EOC and Community members | MC to discuss with technical experts and invite proposals to establish fail proof last mile connectivity. | 2016-17 | Invite proposals from technical agencies. |

| | | | | |
|---|---|---|---|---|
| **Warning Dissemination and Evacuation** | Identification of temporary shelters, evacuation plan, critical infrastructures | MC to spearhead | 2016-17 | Technical support from SEOC and DDMMA |
| **Emergency Response Capability** | Community based Emergency response plan | MC to spearhead | Continuing since 2013, completion in 2016 | |
| | Formation of task force members | MC to spearhead | Continuing since 2013, completion in 2016 | Resource support from MC, Community mobilization support from NGO & Technical support from UNDP |
| | Community training & mock drill | MC to spearhead | Continuing since 2013, completion in 2016 | Resource support from MC, Community mobilization support from NGO, Technical support from UNDP and Technical support from Kerala Fire and Rescue Services for fire mock drill |
| | Resource inventory preparation | MC to spearhead | Data available in City DM Plan, Updating every year | City EOC Team |
| | Pre - Identification of response agencies | MC to spearhead | 2016-17 | City EOC Team |
| **Public Health Risks** | | | | |
| **Predictive surveillance component** | Computer Simulation Model | MC to spearhead | 2016-17 & 2017-18 | Technical support from DHS, DMO and other Govt./Private computer modeling agencies |
| **Civic engagement component** | Developing mobile based application for surveillance | MC to spearhead | 2016-17 & 2017-18 | Technical support from DHS, DMO, KELTRON & C-DAC |
| **Health communication component** | Web based User Interface for the Health Workers | MC to spearhead | 2016-17 & 2017-18 | Linking with open end software, technical support from DHS, DMO, KELTRON & C-DAC |

## Conclusion

It is important at this stage to note that EWS in Thiruvananthapuram City Corporation needs to be expand significantly to meet the larger objective of reducing fatalities and protecting infrastructure/assets from future events. It is recognized globally that an operational EWS has the potential of minimizing loss and contributing to sustainable development and building resilience. While technology is available for establishing the robust communication system for EWS, it is the institutional foundation and the networking arrangements which have to be deep rooted for meeting the desired objectives of the system. All the key elements of the system have to be functional and it is important to review them annually by targeting for different scenarios and measuring performance.

This plan provides in detail the technical components needed for establishing an early warning system for each hazards along with a workable action plan. The results of this study can be used for the design and implementation of hazard specific EWS in consultation with various stakeholders. As EWS systems develop in the city, robust EWS audit mechanism can be rolled in the future to measure system efficiency.

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