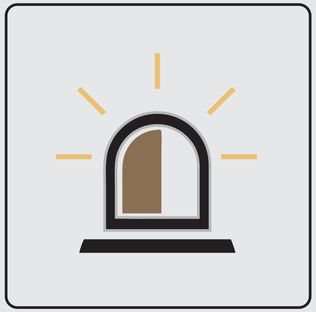
Review Of Early Warning System in Bhubaneshwar, Gangtok, Madurai, Navi Mumbai, Shimla, Thiruvananthapuram And Visakhapatnam



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ACKNOWLEDGEMENTS

This work was conducted under the programme titled 'GOI-UNDP Climate Risk Management in Urban Areas through Disaster Preparedness and Mitigation Project', funded by USAID.

TARU Leading Edge Pvt. Ltd (TARU) would like to extend its deepest appreciation to all key informants/stakeholders who participated in the review process. TARU is grateful for the significant contribution provided by the State Disaster Management Authority, District Disaster Management Authority, City Administration, Technical agencies – Indian Meteorological Department and their Regional Meteorological Centres, Central Water Commission, Geological Survey of India, Public Health Department, and experts from other technical agencies and disaster management agencies at the national, state, district and city levels.

The review process involved a number of consultation meetings and workshops in the cities. The support of the city government and State Government departments/ institutions is highly appreciated.

Specifically we would like to highlight the support and in-depth engagement of the City Project Coordinators from all the seven cities.

A word of special thanks to United Nations Development Programme (India) for their fruitful partnership throughout the implementation of the review process, for their valuable support in coordinating the activities as well as in organizing city missions, and for stakeholder consultations and city workshops.

The findings of the review have been shared and reviewed by the key stakeholders, including the Local Government and their valuable inputs have been incorporated in the final report.

The report takes into account the End-to-End Early Warning System approach of the Regional Integrated Multi-Hazard Early Warning System. This report has been prepared by a six member team with experience in areas of disaster risk management, the hazard risk assessment, early warning system design and climate risk management.

TARU

May 2014

Supported by: Ministry of Home Affairs, USAID and UNDP Partnership Project on Climate Risk Management in Urban Areas through Disaster Preparedness& Mitigation
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EXECUTIVE SUMMARY

Advancements in observation and monitoring, mathematical modelling, computing capabilities, communication technology and conduct of scientific risk assessment have allowed technical and disaster management agencies to disseminate timely and accurate warnings and move people and assets from the harm's way. One example of this is the case of Cyclone Phailin, where accurate forecast was made by the Indian Meteorological Department (Cyclone Warning Division) and timely dissemination of warnings to at-risk communities was done by the Orissa State and the District Agencies. Another example is the case of public health. Systemic collection of registered cases and observation of diseases in the city of Surat have led to the provision of timely information on potential outbreaks. Advance information on potential outbreaks leads to identification of additional measures to be stepped up by the local government to reduce the risk of diseases such as malaria, dengue, cholera, filariasis, among others.

India is highly diverse in terms of geography and climate and so are its cities. Cities are exposed to earthquakes, tsunamis, landslides, heavy precipitation, floods, heat waves, cyclone and severe winds, public health risks among others. Past disasters have shown significant impact on city economy and on key sectors (such as transport, energy, water and sanitation, trade and commerce). It is expected that due to climate variability and climate change, the frequency and intensity of the hydro-meteorological hazards will see an increase in future. This, combined with poor reservoir management practices, especially in cities located downstream the reservoirs, may put the lives of citizens and city assets at risk.

Adoption of the Hyogo Framework for Action (HFA) during the World Conference on Disaster Risk Reduction (2005, Japan) has led to a paradigm shift in disaster risk management from a post-disaster response to a comprehensive and strategic approach in disaster risk management encompassing preparedness and prevention strategies. The second high priority area of the HFA stresses the need for identifying, assessing and monitoring disaster risks and enhancing early warning.

This review is commissioned by UNDP under Contract (2013/067), and is an initiative under the programme titled, "GoI-UNDP Climate Risk Management in Urban Areas through Disaster Preparedness and Mitigation Project". The review investigates the condition of EWS governance, requirements of EWS users, core services provided by technical and disaster management agencies, coordination mechanism between technical and disaster management agencies and finally the issues centred on service delivery and feedback in seven cities (Bhubaneswar, Gangtok, Madurai, Navi Mumbai, Shimla, Trivandrum and Vishakapatnam). The report provides firsthand guidance as well as the steps for development of EWS from the city level to the urban local body (ULB), disaster management institutions, technical agencies involved in design and implementation of early warning systems for geological hazards, hydro-meteorological hazards and public health risks.

Methodology of Review

The assessment involved a systematic flow of understanding the EWS governance at the national, state, district and city levels; institutional mechanism and their roles within the elements of EWS; delivery of products and services by technical and disaster management agencies, as well as their coordination mechanism/operational cooperation; reviewing the existing EWS mechanism in cities; role of agencies in EWS and their integration in the disaster management institutional framework (City Disaster Management Plan); discussing with stakeholders the needs in EWS and gaps thereof, capacities of institutions (technical agencies) engaged in EWS, the operational cooperation of technical agencies with the emergency departments/functionaries at the district and city levels (emergency management structure and response capabilities), current status and future needs of observation and monitoring capabilities, data management systems; seeking information on pre-computed assessment of risks for various intensity of hazards (risk assessment), hazard analysis and prediction capabilities (threat assessment/potential impact assessment), warning formulation/issuing of guidance and potential outlook/provision of actionable early warning information/warning products, decision making, generation of tailored risk information and dissemination of risk information to at-risk communities or hot-spot locations (risk communication), information technology and telecommunication capabilities, preparation of response options, institution/emergency responders and community response.

The assessment was based on the information obtained through a set of processes.

- Design of the review framework by the Review Team

- A checklist and questionnaire prepared by the Review Team for obtaining information from technical and disaster management agencies
- Mission to select cities to understand the EWS environment
- Development of Criteria Development Matrix taking into consideration all the key elements of end-to-end EWS
- Information collected through stakeholder consultations/meetings, workshops in respective cities, discussions with programme focal point in cities, meeting with key experts
- Exchange and mid-term feedback from UNDP programme team
- Development of policy brief, where key recommendations cited are discussed for endorsement at the policy level
- Workshop with city stakeholders, sharing of results
- Final report and presentation

Key Observations and Recommendations

Based on the development stage indicators for all the six components (1. EWS governance – national, state and city level institutional framework, 2. User needs, 3. Operational components of EWS, 4. Products and services across the warning chain, 5. Coordination mechanism, 6. Service delivery and feedback loops), the report provides the summary for each city highlighting the current status. The Criteria Development Matrix also outlines the reason for selecting the development stage indicators. Specific recommendations are presented together and this will lead to the development of policy brief.

The overall analysis of this review revealed that in cities:

- EWS development is crucial for sustainable development and building resilience of the cities. It is therefore important to develop an EWS framework and strengthen strategies across all levels to ensure better coordination efforts for functional EWS at the city level. This must be seen as opportunity to strengthen network among institutions, foster partnerships and build the capacities of all keys stakeholders.
- EWS framework must be made as a functional component of the DM Plan process (national/state/district/city). The framework must foster areas of cooperation in data sharing and impact forecasting.
- It is widely realized that city institutions are being rather response-centric instead of being the ones that take preventive measures. The technical capacity in understanding DRR, risk assessment and EWS needs to be strengthened at the ULB level. City level hazard and vulnerability mapping capabilities need to be enhanced on priority basis. A long-term perspective on capacity development should be envisaged.
- There is a common challenge in the interpretation of the forecast products. Technical agencies involved in providing warning have to evolve in providing information that can either be used by a wide pool of users or create products based on user needs.
- Technical agencies/scientific institutions must also enhance the capability to deliver timely warnings with sufficient respite time so that they support DRR functions at the city level.
- The role of technical agencies in warning formulation is increasingly being recognized. It is therefore important to strengthen institutional coordination mechanism between technical and disaster management agencies at all levels.
- City government/ULB has to make significant investments towards development of EWS and associated mechanisms such as a functional EOC. The current level of preparedness and resource allocation is not sufficient to kick-start any activity around EWS.

CONTENTS

GLOSSARY

Capacity
The combination of all the strengths, attributes and resources available within a community, society or organization that can be used to achieve agreed goals

Climate change
The Inter-governmental Panel on Climate Change (IPCC) defines climate change as: "a change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forcings, or to persistent anthropogenic changes in the composition of the atmosphere or in land use"

Disaster
A serious disruption of the functioning of a community or a society involving widespread human, material, economic or environmental losses and impacts, which exceeds the ability of the affected community or society to cope using its own resources

Disaster risk reduction
The concept and practice of reducing disaster risks through systematic efforts to analyse and manage the causal factors of disasters, including through reduced exposure to hazards, lessened vulnerability of people and property, wise management of land and the environment, and improved preparedness for adverse events

Early warning system
The set of capacities needed to generate and disseminate timely and meaningful warning information to enable individuals, communities and organizations threatened by a hazard to prepare and to act appropriately and in sufficient time to reduce the possibility of harm or loss

Forecast
Definite statement or statistical estimate of the likely occurrence of a future event or conditions for a specific area

Geological hazard
Geological process or phenomenon that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage

Hazard
A dangerous phenomenon, substance, human activity or condition that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage
Hydro-meteorological hazard
Process or phenomenon of atmospheric, hydrological or oceanographic nature that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage

Natural hazard
Natural process or phenomenon that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage

Preparedness
The knowledge and capacities developed by governments, professional response and recovery organizations, communities and individuals to effectively anticipate, respond to, and recover from, the impacts of likely, imminent or current hazard events or conditions

Prevention
The outright avoidance of adverse impacts of hazards and related disasters

Response
The provision of emergency services and public assistance during or immediately after a disaster in order to save lives, reduce health impacts, ensure public safety and meet the basic subsistence needs of the people affected

Risk
The combination of the probability of an event and its negative consequences

Risk assessment
A methodology to determine the nature and extent of risk by analysing potential hazards and evaluating existing conditions of vulnerability that together could potentially harm exposed people, property, services, livelihoods and the environment on which they depend

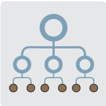
Risk management
The systematic approach and practice of managing uncertainty to minimize potential harm and loss

Vulnerability
The characteristics and circumstances of a community, system or asset that make it susceptible to the damaging effects of a hazard

Source: 2009, UNISDR Terminology on Disaster Risk Reduction

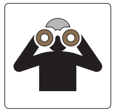
LIST OF ICONS

Background informartion on Review of EWS in 7 cities in India under the ongoing intitatve of Climate Risk Management in Urban Areas through Disaster Preparedness and Mitigation project by UNDP.

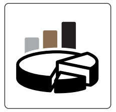


Methodology/Systematic approach adopted to assess the existing EWS and emergency communication netwrok in 7 cities across India.

Summary of all the criteria of all 6 components of study framework and discussed in brief.



Observation and Monitoring



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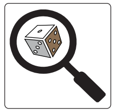
Prediction



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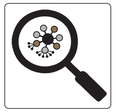

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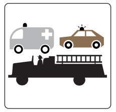
Dissemination to communities at risk



Preparation of Response

Community Response

1. INTRODUCTION

A systematic approach towards managing risk through an established early warning system (EWS) can minimize loss of lives and adverse economic impact. EWS backed with effective institutional arrangements can predict hazards in a timely and effective manner, thereby empowering decision makers and communities at risk.

Adoption of the Hyogo Framework for Action (HFA) during the World Conference on Disaster Risk Reduction (2005, Japan) has led to a paradigm shift in disaster risk management from a post-disaster response to a comprehensive and strategic approach in disaster risk management encompassing preparedness and prevention strategies. The second high priority area of the HFA stresses the need for identifying, assessing and monitoring disaster risks and enhancing early warning.

In recent years hazards of different origin have caused significant loss of lives and economic damages. The damages are showing a growing trend, and increase in climate variability and climate change can tip of many existing mechanisms of managing risk. A closer look into the nature of the hazard events clearly indicates the role of the technical agencies (national/regional/state/city) and the disaster management agencies (at the national/state/district/city/village) in early warning as critical. The increasing factor of risk in today's society underlines the need for enhanced cooperation from a wide spectrum of stakeholders in effective risk reduction and emergency response.

At a national level there is a growing reliance upon EWS as more people and assets are being exposed to the hazards. This calls for functional EWS (most effective for events that take time to normally develop, such as tropical cyclone) or Alert Systems (most effective for events that start immediately, such as earthquake) that have applicability for most hazards. In 2013, Government of Orissa agencies evacuated more than half million people in advance of tropical cyclone (Phailin, Category: Very Severe Cyclonic Storm) thereby reducing fatalities to a fraction (loss of human life - 21) when compared to the fatalities (loss of human life - 9887) from a tropical cyclone (Paradip Cyclone, Category: Super Cyclonic Storm) in the same region 14 years previously.

Advancements in observation and monitoring, mathematical modelling, computing capabilities, communication technology and conduct of scientific risk assessment have allowed technical and disaster management agencies to timely disseminate accurate warnings and move people and assets from the harm's way. In the case of Cyclone Phailin, accurate forecast by the Indian Meteorological Department (Cyclone Warning Division) and timely dissemination of warnings to at-risk communities by the Orissa State and the District Agencies made this possible.

The other example is in the case of Public Health. Systemic collection of registered cases and observations of diseases in the city of Surat has led to the provision of timely information regarding potential outbreaks. Advance information of potential outbreaks leads to identification of additional measures to be stepped up by the local government to reduce the risk of diseases such as malaria, dengue, cholera, filariasis, among others.

Warning dissemination and staging response actions are as important as accurate forecasting and determining potential impact. Any weak link in the elements of EWS (even in case of previous well performing system) will result in under-performance or its failure. Hence evaluation of EWS is important. The evaluation of the system effectiveness can be done during the event, post-event or during the lean period. This review of EWS for all the seven cities is done during the lean period. In most cases the cities haven't formally put in place a functional EWS. While it is important to have technical competence around a range of elements (forecasting, prediction, impact assessment), discussions with stakeholders emphasize that EWS is more organizational and institutional process which works to reduce loss. The methodology adopted in the study has roots to EWS elements defined by RIMES (2008) and the criteria-development concept by Parker (1999).

The review investigates into the condition of EWS governance, requirements of EWS users, core services provided by technical and disaster management agencies, coordination mechanism between technical and disaster management agencies and finally on issues centered around service delivery and feedback.

The purpose of this report is to provide guidance to the city government, disaster management institutions and technical agencies involved in design and implementation of early warning systems for geological hazards, hydro-meteorological hazards & public health risks. This study aims to assess the existing EWS in seven cities (Refer Figure 1) through:

- Review of the technical design/structure and efficacy of existing early warning system, assessment of early warning agencies, communications networks, protocols for issue of warning, and transmission to the people, assessment of how the residents of the city access the information and how they act upon it.

- Review of the technologies involved in the early warning system network design, technical specifications, up-time performance standards, connectivity and integration with all the important facilities and installations, emergency services, and the disaster management system in the city.
- Review of the mode of collecting information related to hazard events, monitoring, and transmitting it to other agencies, particularly the municipal government and district administration.
- Review of the mode and reach of the warning especially last mile connectivity and dissemination plan through mass media, print and audio-visual.
- Review the messages disseminated through the EWS: on timeliness, appropriateness, accuracy, and simplicity parameters.
- Review of the service support for maintaining the EWS on a regular basis and ensuring hundred percent uptime.

This report reviews the institutional mechanism and the decision making across the development model of EWS and its components. This report considers the use of Criteria Development Matrix (tool for review) to assess the level of development and present the findings for seven urban centres. Specifically, it focuses on the geological hazard, hydro-meteorological hazard and public health risk warning system, their current status, and capabilities and supporting disaster risk reduction.

Case studies of best practices and warning system for individual hazards are presented at the end of the city review sections for ready reference.

Figure 1**: Seven cities selected for review of EWS**

Background

Early warning in the usual context means some form of, either written or verbal indication of, an impending hazard. Early warning in the disaster context implies the means by which a potential danger is detected or forecast and an alert issued. In this report, the following definition has been taken into consideration: 'The provision of timely and effective information, through identifying institutions, that allows individuals exposed to the hazard to take action to avoid or reduce their risk and prepare for an effective response.' ISDR 2004

Over the last decade, India has incorporated disaster-reduction policies in its national, social and economic development plans to establish effective preparedness measures and improve the response capacities. The value of timely and effective warnings in averting losses and protecting resources/development assets becomes apparent. Urban centres are exposed to greater risk due to severe exposure of elements at risk (Mumbai Floods 2005, Surat Floods 2006). Some of the recent events show the rising trend in the number of people being affected by disasters, especially in the urban areas.

Warning represents an added value and function in the overall disaster risk management/disaster risk reduction framework. There are three main abilities that constitute the basis of early warning.

- The first is technical capability to identify a potential risk or the likelihood of occurrence of a hazardous phenomenon, which threatens a vulnerable population.
- The second ability is that of identifying accurately the vulnerability of a population to whom a warning has to be directed,
- The third ability, which requires considerable social and cultural awareness, is the communication of information to specific recipients about the threat in sufficient time and with sufficient clarity so that they can take action to avert negative consequences.

Warning systems are only as good as their weakest link. They can, and frequently do, fail in both developing and developed countries for a range of reasons. There are significant decision points for the scientific/technical agencies and the disaster management agencies. These decision points coincide with the phases of the disaster management/emergency management decision stages as shown in Figure 2 (say, for hydro-meteorological event with sufficient lead time).

A range of factors influence the hazard event phase and the emergency phase. They include:

- Lack of standardized EWS framework, which is understood by both technical and disaster management agencies.
- Non-availability of warning information products and services at different temporal and spatial scales, and provision of same information content for various sectors/stakeholders.
- Warning message not being aligned in terms of societal impacts, risk assessment not being undertaken and potential impact assessment being based on either individual understanding or on past experience and being non-scientific.
- Lack of systemization steps for emergency response based on event severity.
- Warning content unable to facilitate appropriate

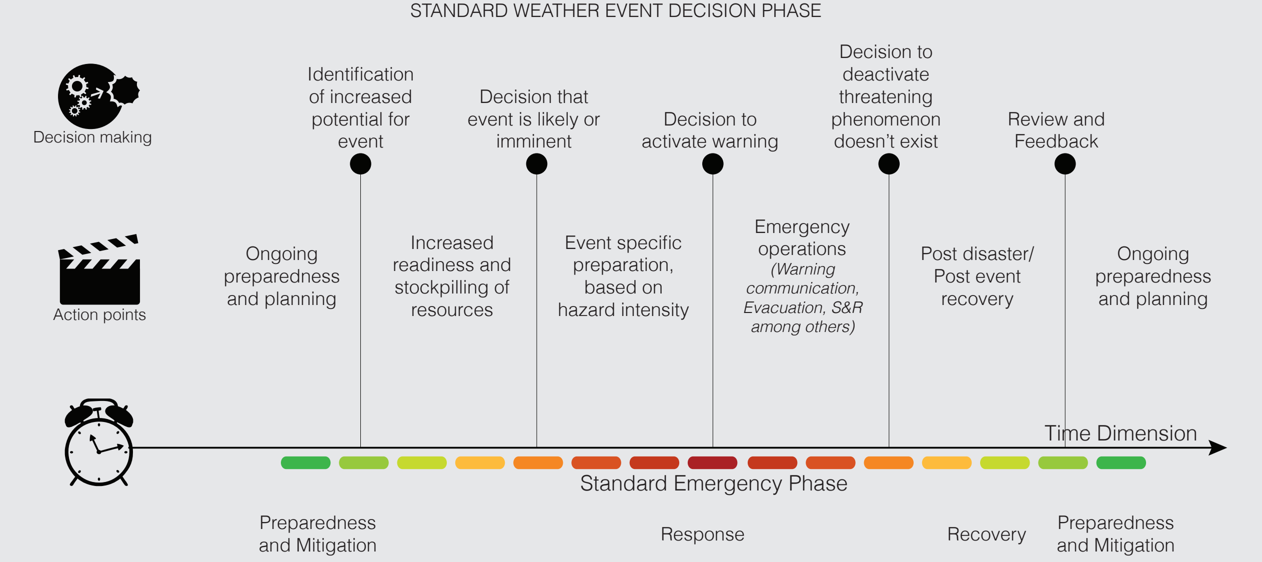


Figure 2: **Highlighting overlay of decision points over standard emergency phase and the weather event decision phase**

and timely decision actions at least to those people who are most immediately at risk or are under the influence of the hazard.

An effective early warning system links technical agencies that generate warning information with disaster management/emergency management institutions and finally with communities/people at risk. The end-to-end early warning system (RIMES, 2008) involves the following elements (Figure 3 shows the link between these elements):

1. Observation and monitoring
2. Data processing and analysis
3. Prediction and forecasting
4. Risk assessment
5. Potential impact assessment
6. Warning formulation
7. Dissemination to communities at risk (until the last mile)
8. Preparation of response options
9. Community response, which is shaped by:
   a. Resourced and practiced emergency response plans
   b. Risk awareness
   c.Mitigation programmes
10. Receiving user feedback
11. System adjustment/improvement

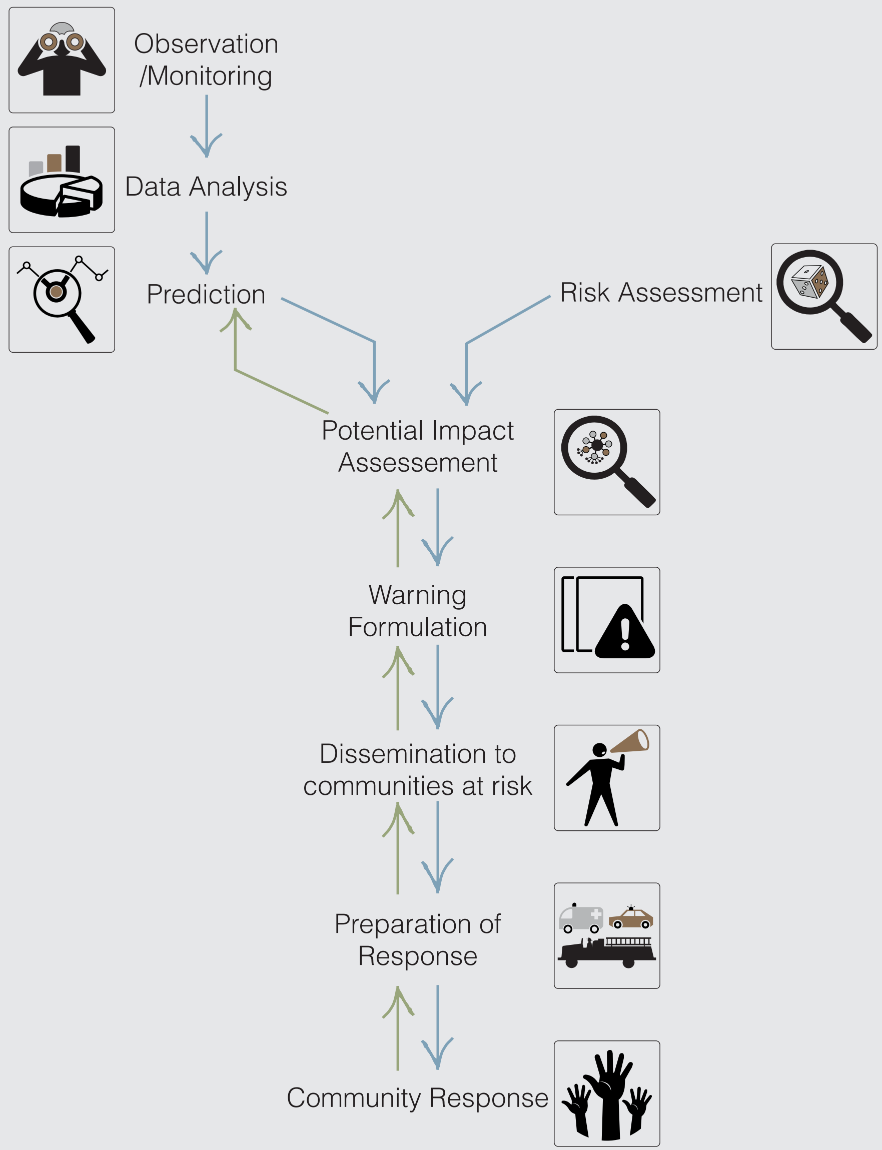


Figure 3**: Key elements in end-to-end EWS**

2. METHODOLOGY OF REVIEW

A systematic process was adopted by the Review Team to assess the EWS, particularly with respect to the systems for geological, hydro-meteorological and public health risks in all the seven cities.

The assessment involved a systematic flow of understanding the EWS governance at the national, state, district and city levels; institutional mechanism and their roles within the elements of EWS, delivery of products and services by technical and disaster management agencies, as well as their coordination mechanism/operational cooperation; reviewing of existing mechanism of EWS in cities; role of agencies in EWS and their integration in the disaster management institutional framework (City Disaster Management Plan); discussing with stakeholders the gaps and needs in the EWS, capacities of institutions (technical agencies) engaged in EWS, operational cooperation of technical agencies with the emergency departments/functionaries at the district and city levels (emergency management structure and response capabilities), current status and future needs of observation and monitoring capabilities, data management systems; seeking information on pre-computed assessment of risks for various intensity of hazards (risk assessment), hazard analysis and prediction capabilities (threat assessment/potential impact assessment), warning formulation/issuing of guidance and potential outlook/provision of actionable early warning information/warning products, decision making, generation of tailored risk information and dissemination of risk information to at-risk communities or hot-spot locations (risk communication), information technology and telecommunication capabilities, preparation of response options, institution/emergency responders and community response.

The assessment was based on the information obtained through a set of processes. They are as follows:

- Design of the review framework by the Review Team
- A checklist and questionnaire prepared by the Review Team for obtaining information from technical and disaster management agencies
- Mission to select cities to understand the EWS environment
- Development of Criteria Development Matrix taking into consideration all the key elements of end-to-end EWS (Figure 3)
- Information collected through stakeholder consultations/meetings, workshops in respective cities, discussions with programme focal point in cities, meeting with key experts
- Exchange and mid-term feedback from UNDP programme team
- Development of Policy Brief, where key recommendations cited are discussed for endorsement at the policy level
- Workshop with city stakeholders, sharing of results
- Final report and presentation

The review includes key criteria as indicated in RFP for following key components:

1. TECHINCAL DESIGN / STRUCTURE AND EFFICACY OF EXISTING EWS: Assessment of early warning agencies, communication networks, protocols for issue of warning and transmission to the people. The review should also assess how the residents of the city access the information and how they act upon it.

2.TECHNOLOGIES INVOLVED IN EWS: Review the network design, technical specifications, up-time performance standards, connectivity and integration with all the important facilities and installations, emergency services, and the DM system in the city.

3. MODE OF COLLECTING HAZARD RELATED INFORMATION (Geological hazards, hydrometeorological hazards and disease risks): Review the mode of collecting information related to hazard events, monitoring, and transmitting it to other agencies, particularly the municipal government and district administration.

4. WARNING OUTREACH AND LAST MILE CONNECTIVITY: Review the mode and reach of the warning especially last mile connectivity and dissemination plan through mass media, print and audio-visual medium.

5. MESSAGE CONTENT AND APPROPRIATENESS: Review the messages disseminated through the EWS: on timeliness, appropriateness, accuracy, and simplicity parameters.

6. SERVICE SUPPORT AND SYSTEM MAINTENANCE: Review the service support for maintaining the EWS on a regular basis and ensuring 100 percent uptime.

The schematic diagram (Figure 4) is an illustration of institutional mechanism and decision making around the key warning chain elements. Numbers 1 to 6 in the schematic highlight the core components for evaluating the warning system provided by the technical agencies (national/state/city) to the DM agencies and other DRR stakeholders. The description of the core components and the evaluation principles are summarized below:

1. EWS GOVERNANCE: National, State and City Level Institutional Framework: EWS is underpinned by ministry/department/technical institutions providing operational nowcast/forecasts, products and services to a wide range of users/community. EWS in India is underpinned by legislation (DM Act 2005, State Disaster Management Act, State Disaster Management Policy) and institutional framework that clearly define the roles and responsibilities of various stakeholders among the key warning chain elements. Emphasis under this component was given towards understanding of the organizational coordination and cooperation mechanism (decision making and feedback across key warning elements), and allocation of resources at the city level (functional EOC, risk assessment, human resource capacity).

2. USER NEEDS: The users in the city are spread across government agencies (district DM authority, municipal corporation city DM authority/local authority, emergency services, first responders); communities at risk; general public; NGOs/CBOs; urban service providers (government and private: line departments such as water supply, storm water drainage, drainage, sanitation, health, transportation, energy, law and order); various sectors of the economy including business establishments, trade and commerce; and the media. The requirements and needs of EWS products and services vary among different users.

3. OPERATIONAL COMPONENTS OF EWS: The tasks of the technical agencies and disaster management agencies include developing products and offering a range of services across the warning chain elements. Observation, monitoring, prediction analysis and operational forecasting are core capacities to be exhibited by the technical agencies. The technical agencies rely on a range of supporting functions such as data gathering, data analysis, IT and telecommunication services and product development through qualified and trained staff. The prediction/operational forecast of hazard onset and hazard intensity are to be further translated into the potential impact assessment at the city level and the surrounding regions. In case of the city having a reservoir/dam located upstream, regional forecast needs to further take into account the opening of the reservoir gates and subsequent inundation scenarios for emergency release.

Risk assessment, risk communication and preparedness for emergency response/evacuation are the responsibilities of the local government/DM stakeholders (as identified in the City DM Plan). Guidelines and procedures typically follow the Standard Operating Procedure (SOP) as outlined in the City DM Plan. A sufficient number of qualified and trained staff undertakes the response functions through designated Emergency Support Functions (ESF). The nerve centre of operations during emergency is the City Emergency Operation Centre (EOC equipped with tools for decision support), which functions as the main hub for all emergency functions during the onset of hazard and during the impact, and shall remain operational until the threat phenomenon subsides. Organizational coordination and cooperation mechanism between ESFs are essential for effective delivery of early warning produced/generated by technical agencies.

City-level product development includes outputs derived from risk assessment studies, tailored risk information generated for the event, relevant information technology and telecommunication services for outreach and capability to handle emergency response.

4. PRODUCTS AND SERVICES ACROSS THE WARNING CHAIN: A wide range of products and services aid in decision making. While technical agencies undertake hazard monitoring, detection, analysis, prediction and forecasting (issue advisories to key stakeholders for initiating decisions), risk information will have to be tailored to the requirements of the city and communities at risk.

5. COORDINATION MECHANISM: A large number of institutions are involved in the warning chain elements. Each institution plays an essential role and there is a need for synergy and collaboration between forecasting (warning, data exchange through hydro-meteorological services, climate services, public health etc.) and DM agencies. It is important to analyse if there are any specific provisions of expertise by the technical agencies to the DM stakeholders that could support or enhance decision making.

6. SERVICE DELIVERY AND FEEDBACK LOOPS: While technical agencies issue the forecast and related warning, DM agencies have to understand the user needs and ensure effective and timely delivery of the services (overarching capacities in quality management system is essential for service delivery across functions). Feedback mechanism across the warning element chain helps in improving delivery/quality of product and services over time.

The elements of EWS and components have been integrated into the development of Criteria Development Matrix (CDM).

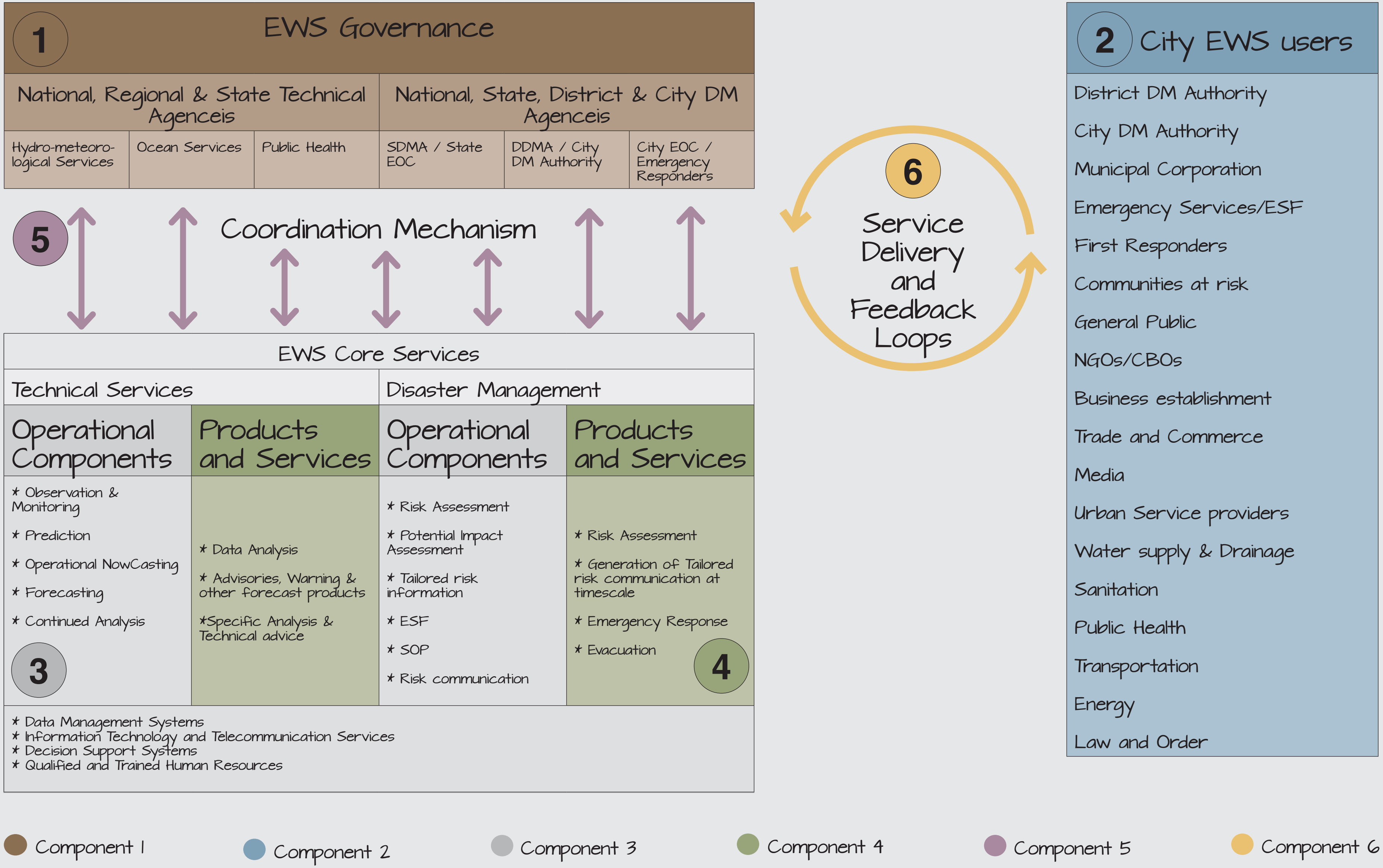


Figure 4: **Study framework schematic showing the links of stakeholders across the development model of EWS**

Note:Various components analysed are numbered (as in the text) in the schematic

3. Review of EWS in Bhubaneshwar

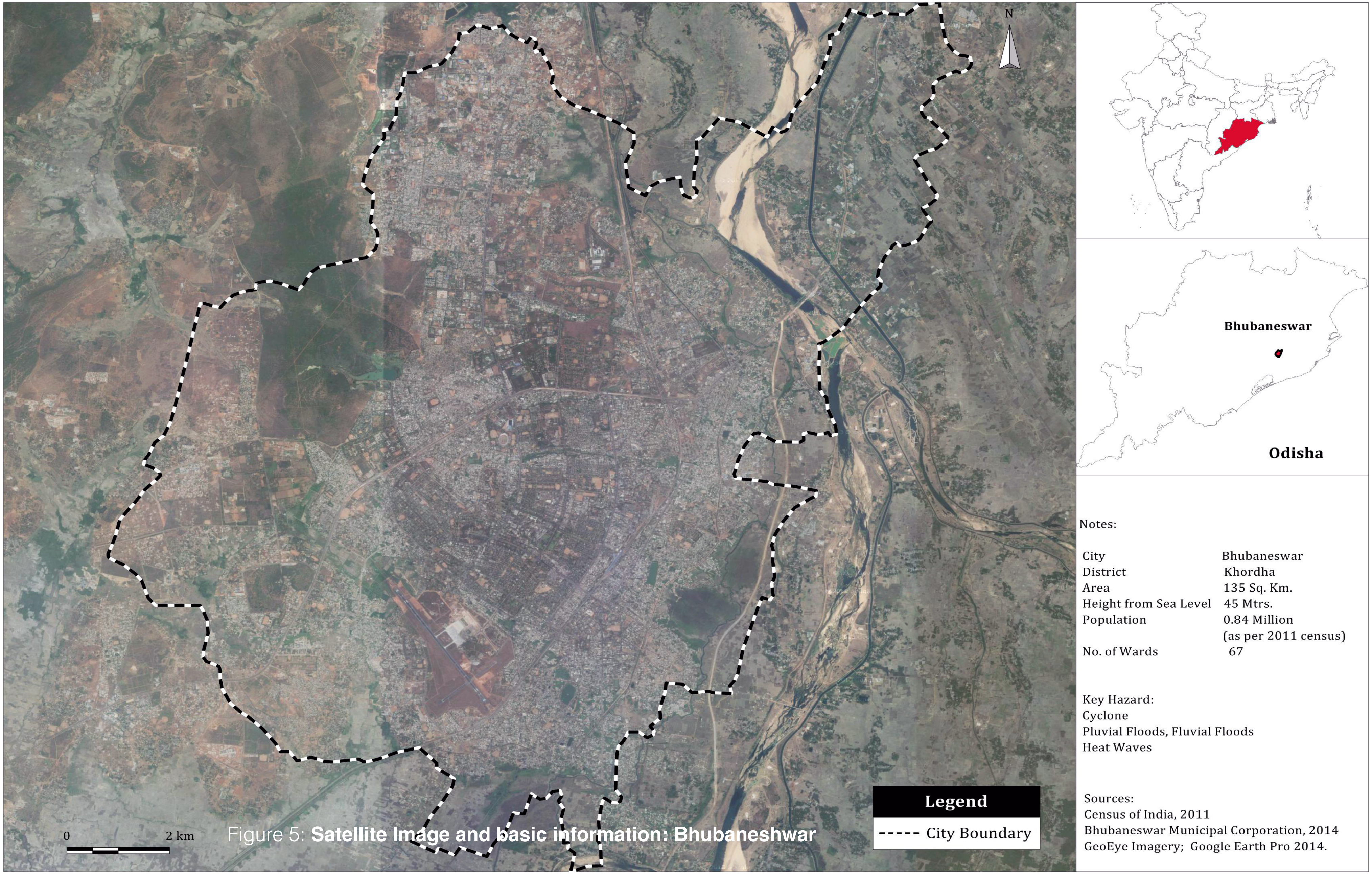


Figure 5: **Satellite Image and basic information: Bhubaneshwar**

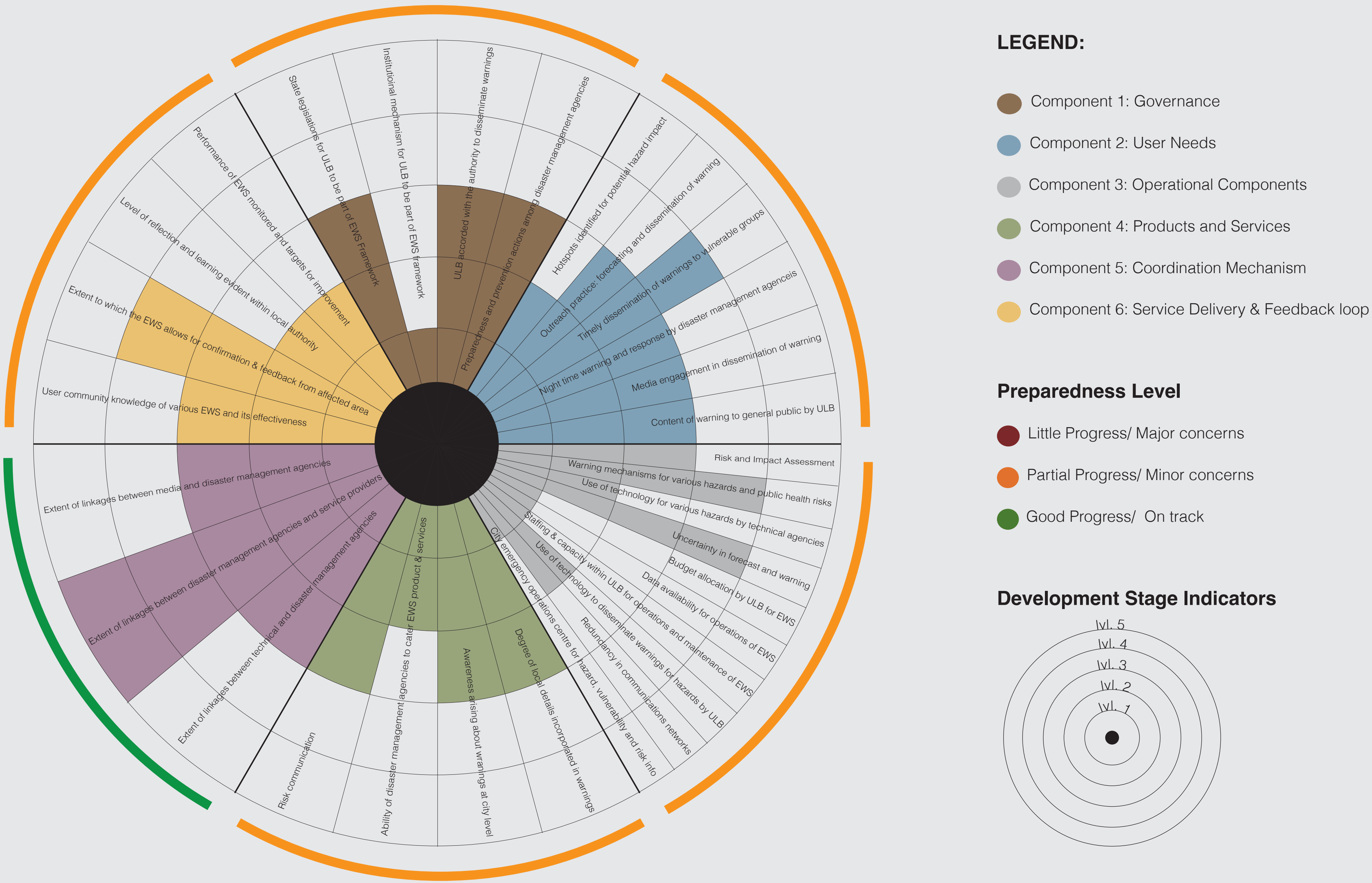


Figure 6**: Preparedness of EWS indicators for Bhubaneshwar**

3.1 SUMMARY

Bhubaneswar, being the capital city of Odisha, has the advantage of being the headquarters for all key State Government and regional institutions. The presence of Odisha State Disaster Management Authority (OSDMA), the State Emergency Operation Centre (SEOC), Department of Water Resources (DoWR), emergency management cell, Indian Meteorological Department's (IMD) regional centre for cyclone warning and State Surveillance Unit (SSU) of Integrated Disease Surveillance System (IDSP) has led to spurious perception within urban local bodies to not have an early warning system for the city.

The city municipality released its first city disaster management plan in 2012. This comprehensive document has indication of local authority being the nodal agency for incident command, information collection, preparedness and generating awareness. However, it does not mention the need of early warning system or possible coordination required for collection and dissemination of early warning information, which is currently being issued by various authorities within the city.

Post major disaster events in Odisha, notably the super cyclone and heat wave of 1999, have resulted in increased awareness of the need for warning within the state. The events have led key technical agencies to focus on the development of state wide warning system. Bhubaneswar, being around 55 km from the coast of Bay of Bengal, and the distributaries of Mahanadi flowing near peri-urban areas, has attracted less attention from technical agencies for developing a city-specific early warning system. Nevertheless, there was evidence of forecast being developed for weather events and warnings being provided for all key hazards (excluding earthquake and landslide) by IMD, Water Resource Department and Health Department to other government institutions and media.

The review of key agencies brought to the forefront realization of need for early warning system for all hazards. Success of any EWS will depend on the detailed understanding of city risks. In case of Bhubaneswar, city-level risk assessment has been undertaken and the qualitative ward-level hazard indication has been mapped. This information is rudimentary and cannot be used for potential impact assessment or warning to vulnerable population in the city. The need of targeting the warning to the intended users is currently realized based on the experience and outcome of past disaster events. Technical institutions realize the gap in data collection for arriving at informed forecast for disseminating timely warning. For example, IMD indicated its requirement for high resolution city-specific radar information to track extreme rainfall events, while Water Resource Department indicated its requirement of high resolution satellite-based rainfall information to derive runoff within sub-basin and forecast water levels in the reservoirs. While individual technical and disaster management agencies realize their needs and share their forecast information through mail, phone and fax, no immediate plans exists within these agencies to develop forecast that could address the specific needs of other users.

IMD, Bhubaneswar, is the regional centre for cyclone monitoring in India. They currently forecast regional weather and also provide warning for cyclones. Based on their weather forecast, while some of the hazards, especially heat wave and their impacts, are being appreciated by the general public who are able to take action, events such as strong winds and heavy rainfall remain vague and no actions are being taken at the local level (ward-level flooding). The event of heavy rainfall provided at regional level is also less used by the Water Resource Department to incorporate into its functioning, especially reservoir management, due to high uncertainty and generalization of such forecasts. Similarly, Water Resource Department, being a state department, does issue flood warning at catchment level which is more relevant for district-level actions and irrigation, but does not convey city-level warning or impact.

Health advisories and warnings are currently provided by health department and IDSP, upon the realization of disease break out. Similar to hydro-met events, technology used to monitor, nowcast and disseminate warning lacks required information to address city-specific needs.

The current method of dissemination of warning by all the above agencies is through formal mail/ fax being sent to government departments. The same information is also disseminated to general public and local media, both print and television. In spite of the uncertainty in information, some of the government departments and technical agencies are able to interpret the information to suit their functioning requirements, while the general public is unable to translate the forecast into warning or actionable points. Addressing the last mile connectivity is still an issue.

Similar to IMD, Water Resource Department and IDSP, the state EOC is also located within the city. The strong presence of regional and state institutions has led to non-realization of needs to establish and operate a city disaster management centre with a functional city EOC. This has led to state institutions, including EOC, to function for the state and the city. Also, OSDMA, in spite of being a state authority, due to its presence in the city, has made attempts to collate data. ULB is currently not involved in the process of collection or collation.

Evidence of warning mechanism exists for hydro-met and public health risks. The key stakeholders, based on their previous experience, do tend to translate the hazard information to possible risk (including vulnerability) to take action. The agencies which are currently providing these warnings realize the need for development of customized products/services. The lack of user need assessment across all stakeholders may be the reason for isolated technology incorporation, product development and service delivery plans. While the awareness programmes are currently being conducted by state and national agencies (OSDMA, UNDP and IDSP) with a wide reach, the realization and move towards city-specific risk and warning issues are yet to evolve.

Due to the absence of city disaster management cell and city EOC, the state agencies (OSDMA and EOC) wear more than one hat. While their mandate limits their extent of involvement in city affairs, being a state agency provides them with an advantage to link/communicate with all agencies. Formal links between agencies is evident through mail, fax and phone communications and in the reflection of warning information in media products (daily).

Post-event reflections leading to increased communication and response mechanism over the past one decade is evident from the emergence of new state institutions, decrease in the number of deaths and in timely transfer of information between departments (IMD sends a daily forecast at 12:30 p.m., while Water Resource Department sends a revised bulletin based on IMD forecasts at 05:30 p.m.). These warning messages are sent to all key government departments, including the media. But this system caters to only hydro-met hazards, especially those that are of importance to the state. City-specific forecast and warning is limited for events such as pluvial floods and disease incidents which occur every year. The need for development of a system is realized by all institutions.

4. Review of EWS in Gangtok

Notes:

City	Gangtok
District	West Sikkim
Area	35 Sq. Km.
Height from Sea Level	1600 Mtrs.
Population	0.10 Million (as per 2011 census)
No. of Wards	15

Key Hazard:
Earthquake, Landslide
Floods, Flash Flood, Lightning, Hailstorm, Cloud Burst, Cold Waves

Sources:
Census of India, 2011
Gangtok Municipal Corporation, 2014
GeoEye Imagery; Google Earth Pro 2014,

Figure 7: **Satellite Image and basic information: Gangtok**

LEGEND:

- Component 1: Governance
- Component 2: User Needs
- Component 3: Operational Components
- Component 4: Products and Services
- Component 5: Coordination Mechanism
- Component 6: Service Delivery & Feedback loop

Preparedness Level

- Little Progress/ Major concerns
- Partial Progress/ Minor concerns
- Good Progress/ On track

Development Stage Indicators

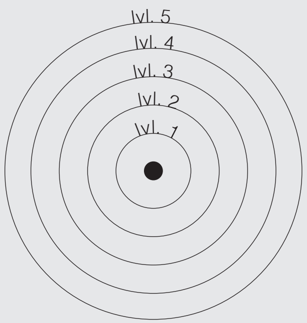


Figure 8**: Preparedness of EWS indicators for Gangtok**

4.1 SUMMARY

Gangtok, being the state capital of Sikkim, has SSDMA, Land Revenue and Disaster Management Department, Irrigation and Flood Control Department. However, ULBs has limited interaction with national-level technical agencies.

GMC, which was very recently formed by State Urban Development Department, is only looking after Solid Waste Management (SWM) in the city. Early warning and disaster management activities are managed by SSDMA through District Collector of East District (headquarters in Gangtok).

IMD has established a meteorological centre in the city of Gangtok. This centre provides early warning on heavy rain and thunderstorm to the District Collector's Office and state departments such as agriculture, revenue etc. The District Collector's Office passes on this information to the general public using PAS. The city also has 24X7 Emergency Operation Centre at MG Road, which is run by the District Collector Office. State Health Department and IDSP give recommendations to the general public on vector- and water-borne diseases.

GMC came into being recently and its mandate for operations is currently limited to solid waste management. State Disaster Management Plan indicates roles and responsibilities of local governments. Select state departments have DM Plan but these plans are yet to be implemented. While the role of ULB is realized, the mandate for implementation does not exist and dissemination of early warning information is not formalized. Much of the state departments have disaster management plan. Implementation is limited to adaptation and short-term measures. Resource constraint was quoted as a main barrier in realizing implementation.

The SSDMA has a range of products, which indicate their efforts towards sound disaster management practice, including preparation of Multi Hazard Risk and Vulnerability Assessment of Gangtok Municipal Corporation Area and Multi Hazard Risk and Vulnerability Assessment of North, East, West and South Sikkim. Hotspots are identified and mapped across them, but are not updated at regular intervals.

Dissemination of warning exists for hydro-meteorological and public health hazards by IMD and health department respectively with limited respite time. Due to the nature of the terrain, media has limited coverage. Currently warning information is collected by media from the respective technical and administrative agencies for dissemination. Shortcomings in communication were evident. City stakeholders recognize the need for warning, especially night time warning, but are yet to prepare an action plan for implementation.

There exists high dependency on national agencies (Met Centre, IMD Regional Centre) for observation, monitoring and forecasting. Efforts are underway by IMD to improve the consistency and reliability of the warning message. For public health, general advisory currently exists with no indication of areas and vulnerable groups. The city does not have nowcast/forecast mechanisms for geophysical hazards risk monitoring or forecasting. State health department has established a mechanism under IDSP to observe, monitor and nowcast disease outbreaks at regional/district levels. Surveillance exists at city level within government hospitals (using paper-based forms) and analysis is undertaken at city level.

Warning system reflects the arrangement partially developed, and scope for considerable improvement exists. State EOC has been established post recent disaster events, especially earthquake. The EOC lacks technical and human resource support and is activated only on a need basis. Use of modern technology (mobile SMS) to disseminate hydro-meteorological and public health hazards was evident. In addition, presence of PAS, siren, digital display, satellite phones and ham radios was evident. But, their use is currently limited. With no dedicated budget for the owning and operating of EWS, both the state and city are limited from deploying dedicated staff to manage the system on a day-to-day basis.

User needs, while realized, have not been assessed. Initiatives for the development of training materials and awareness building were evident. Local risk assessment has been undertaken (MHRVA) and communicated (threat and associated safety measures) to limited stakeholders. Efforts are also being made to sensitize citizens on frequent hazards such as landslide, maintenance of natural drainage (jhoras). A comprehensive dissemination plan is required to support the ongoing efforts.

The current communication, including SMS on risk events, is limited to select agencies. In most cases, these systems are active post event and do not provide action points for pre-event preparedness or coordination. Due to the nature of the terrain and connectivity problems, the role of media is limited in providing warning information.

Post-event reflection is done and change is evident in the mode of communication. Only key staffs in

ULB are aware of select early warnings and the impact, but are not clear on initiating action. Formal procedures to monitor the performance, including the roles of respective departments for initiating the warning and translating it to on-ground action will help strengthen the existing mechanisms.

5. Review of EWS in Madurai

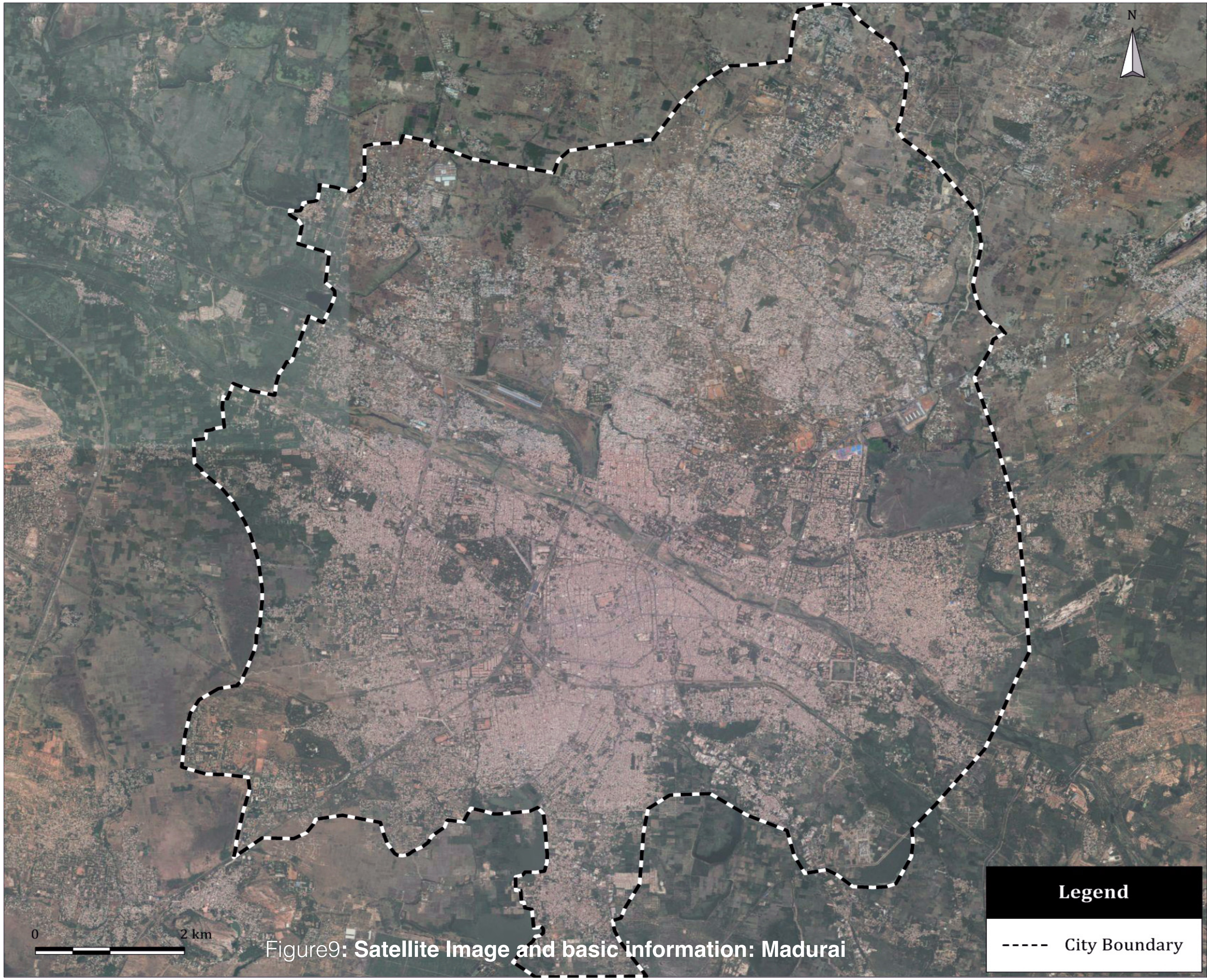
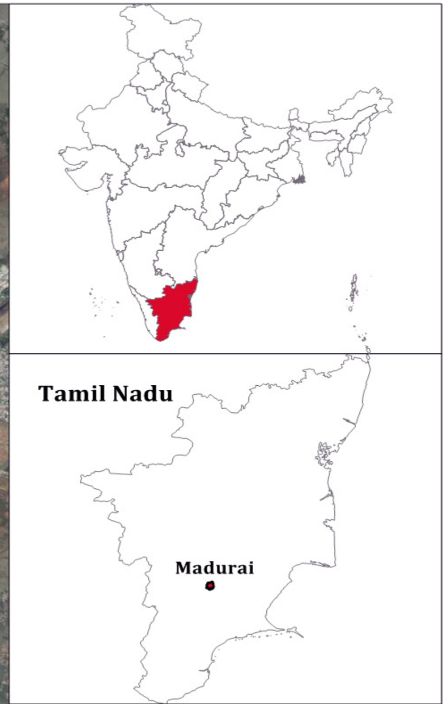


Figure9: **Satellite Image and basic information: Madurai**



Notes:

City	Madurai
District	Madurai
Area	59.96 Sq. Km.
Height from Sea Level	101 Mtrs.
Population	1.01 Million (as per 2011 census)
No. of Wards	72

Key Hazard:
Cyclone, Pluvial Floods, Fluvial Floods
Dengue

Sources:
Census of India, 2011
Madurai Municipal Corporation, 2014
GeoEye Imagery; Google Earth Pro 2014,

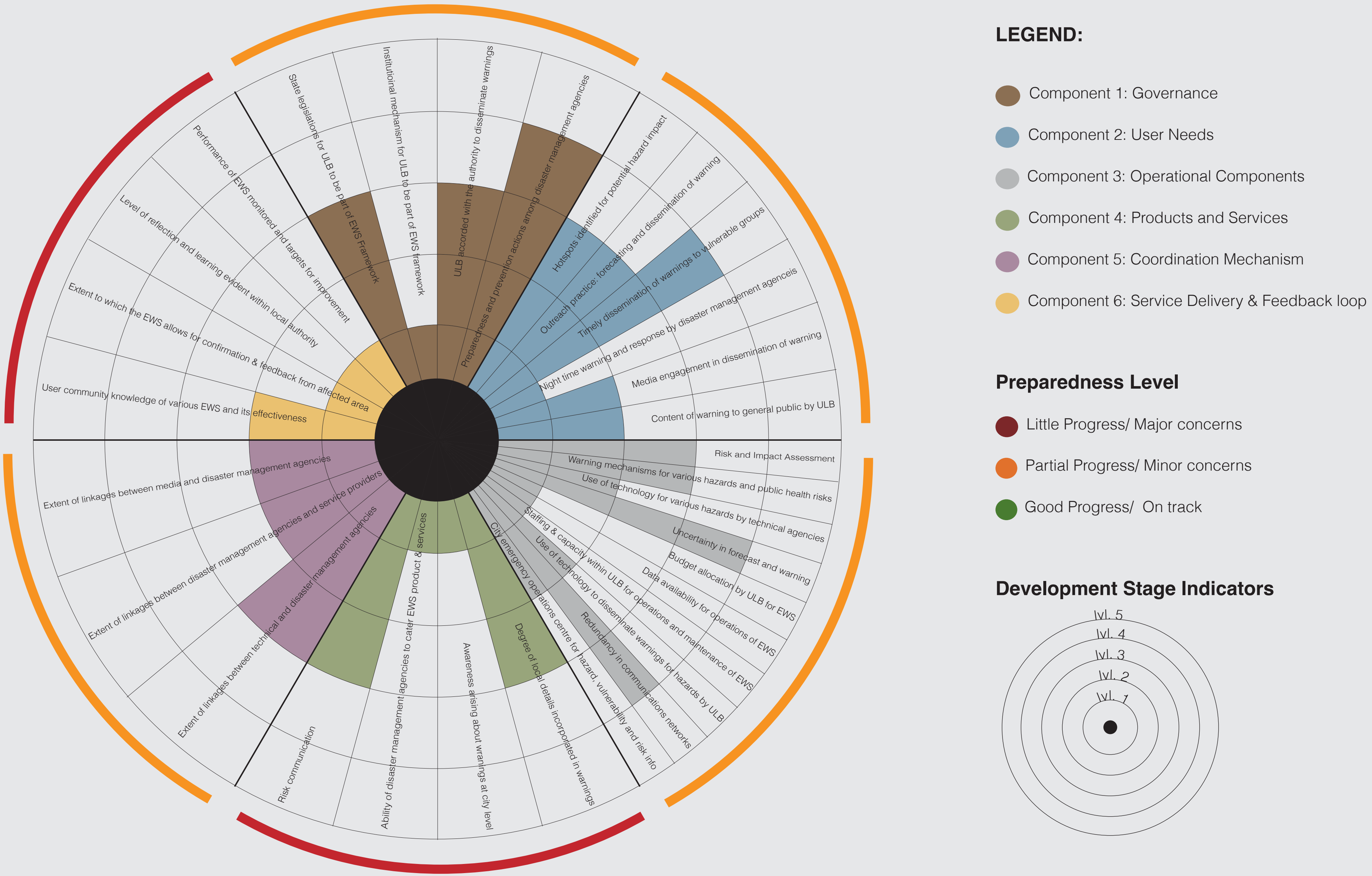


Figure 10**: Preparedness of EWS indicators for Madurai**

5.1 SUMMARY

Madurai is tier two city in Tamil Nadu, which has very limited link with state and national level early warning and disaster management agencies. The city of Madurai has limited exposure to hydro-met and geological hazards. Flood is considered to be a threat to the city. The last recorded major flood in Madurai city was in the year 1993. Forecast for hydro-met hazards (heavy rainfall) is currently provided by IMD Regional Met Office, Chennai, to State Relief Commissioner. District Collector receives warning from State Relief Commissioner. Madurai is highly vulnerable to vector-borne diseases such as dengue, malaria and chikungunya. In recent years, dengue has emerged as one of the major diseases in the city and the surrounding regions.

Vulnerability is very high due to floating population. Madurai is a city of tourist importance; both domestic and foreign tourists visit the city. The economy is mainly dependent on tourism business.

Madurai district and city have their respective Disaster Management Plans. As per District DM Plan, Madurai Corporation is a member of District Disaster Management Committee (DDMC). Roles and responsibilities are clearly mentioned in the city disaster management plan. Department of Madurai Corporation has been assigned the task related to early warning.

Public Relation Officer (PRO) of Madurai Corporation is responsible for informing the public in low lying areas for evacuation and providing shelter in the corporation in areas identified as safe. PRO is also responsible for issuing flood warning through newspapers, television and other media. PRO makes arrangement to broadcast public address through the Mayor and/or Commissioner.

As per City DM Plan, Health Department of MMC is assigned to issue warning to people residing in low lying areas by the Vaigai river side and also advise them to move to safer locations (towards high rise area); communicate flood warning to people with the help of public address system (PAS); broadcast flood warning information through radio and television.

MMC also receives three levels of warning from PWD (Irrigation Department) through Collector Office. This warning is related to water level in Vaigai reservoir and water release from the reservoir. After issuing the third warning, water is released from Vaigai dam. City Hotline between Indian Meteorological Department and the State Emergency Operation Centre (EOC) is established (in Chennai). Dissemination to the districts is done through telephone and fax. IP phones are also available; they connect the State with the district headquarters, taluks and blocks. Wireless radio network – both high frequency and very high frequency – is available for communication across the state.

MMC is fully dependent on District Collector's Office for hazard based early warning. At the city level, Madurai Corporation has established a wireless communication network. Each officer at the ward level (up to sanitary inspector) is equipped with wireless sets, which helps in a close coordination between implementing agencies.

Local level details are not incorporated in hydro-met forecast/warning, which is currently given by district level disaster management agency to ULB. However, low lying areas have been marked and mapped by MMC. Health Department of Madurai Corporation actively observes the existing situation of public health in the city and also collects relevant data. This information is also provided to state level research institution. Awareness programmes are limited to public health only.

The review of city level key agencies brought the need for early warning system for all hazards to the forefront. Currently, there is no EOC established and operationalized within the Madurai Corporation (ULB) to support EWS or to undertake disaster management initiatives. Hotspots such as low lying areas and shelters have been identified, mapped for flood hazard by Madurai Corporation. Hazard map updating process has not been undertaken and technology such as GIS is not envisaged for the mapping exercise.

The Hazard, Risk and Vulnerability Assessment (HRVA) is at various stages of completion in the city. HRVA data format was prepared and circulated to collect necessary details to assess risk and vulnerability of particular locations. Need for technical analysis dissemination through user friendly formats is realized. Since city level risk assessment has not been completed, critical infrastructures, critical locations, vulnerable population to enable/enhance the mitigation and response delivery mechanism have not been identified. Systematic collection, collation, maintenance and updating of relevant data required to make an effective EWS is limited.

There is no separate budget allocation for creating and operationalizing EWS. However, the ULB is proactive in warning dissemination by using the locally available communication modes (sirens and vehicle mounted PAS).

User needs assessment has not been undertaken by MMC to demand specialized products from technical agencies (like IMD, CWC). The same is true for lack of coordination between technical agencies to make effort to understand local user specific needs to disseminate relevant information.

Coordination between national to state and local level agencies is very important in early warning system. Failure at one level or lack of coordination across them could lead to the failure of the whole system.

Limited formal links except for the protocols defined by the agency's mandate (IMD is mandated/requested to send forecast to specific departments at state and district levels) exists between different agencies in Madurai city. The city level Emergency Operation Centre (EOC) and city disaster management cell are not operational in Madurai. In the absence of EOC, hazard early warning in the city is being conveyed by the state and district agencies.

For hydro-meteorological and geological hazards, the issuance of warnings is the responsibility of technical agencies; however, roles and responsibilities of various state and city stakeholders for implementation of early warning need to be clarified and reflected in the state and city level disaster management plan, regulatory frameworks, planning, budgetary, coordination and operational mechanisms. Coordination mechanism for health hazards is well-established in the city and Madurai Corporation has data/information sharing mechanism with district and state level health research institutions. It is also observed that no direct link is established with local media. Media depend on information hosted on public domain.

Currently, there are no formal feedback mechanisms observed in Madurai city between technical and disaster management agencies, and between ULB and communities at risk. However during annual pre-monsoon meetings, limited discussions are held on the results of actions taken in the previous year. Systematic feedback and evaluation at all levels is needed for determining system efficiency. It helps to understand whether the established mechanisms are able to translate the information gathered to take preventive measures.

6. Review of EWS in Navi Mumbai

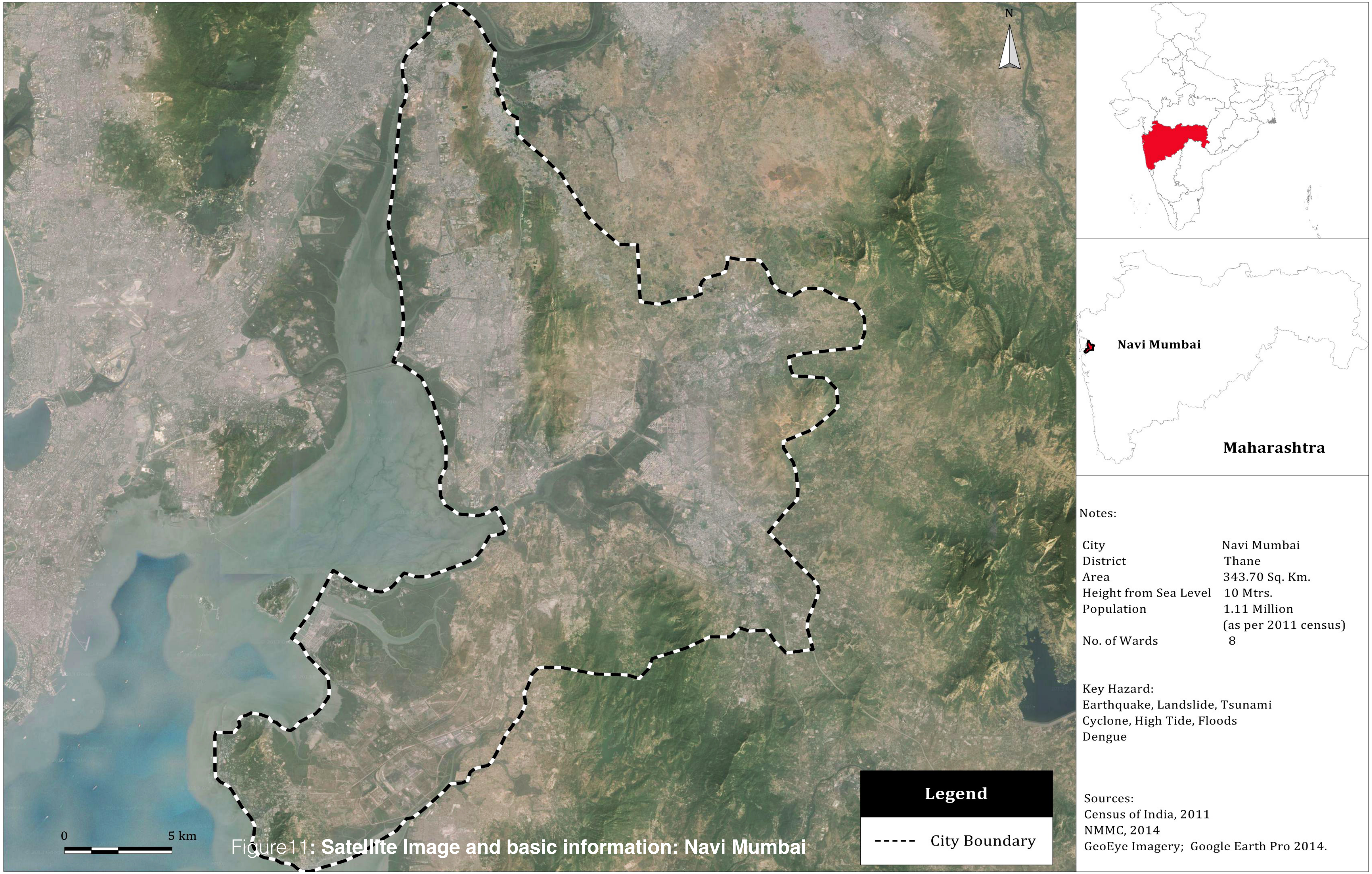


Figure11: **Satellite Image and basic information: Navi Mumbai**

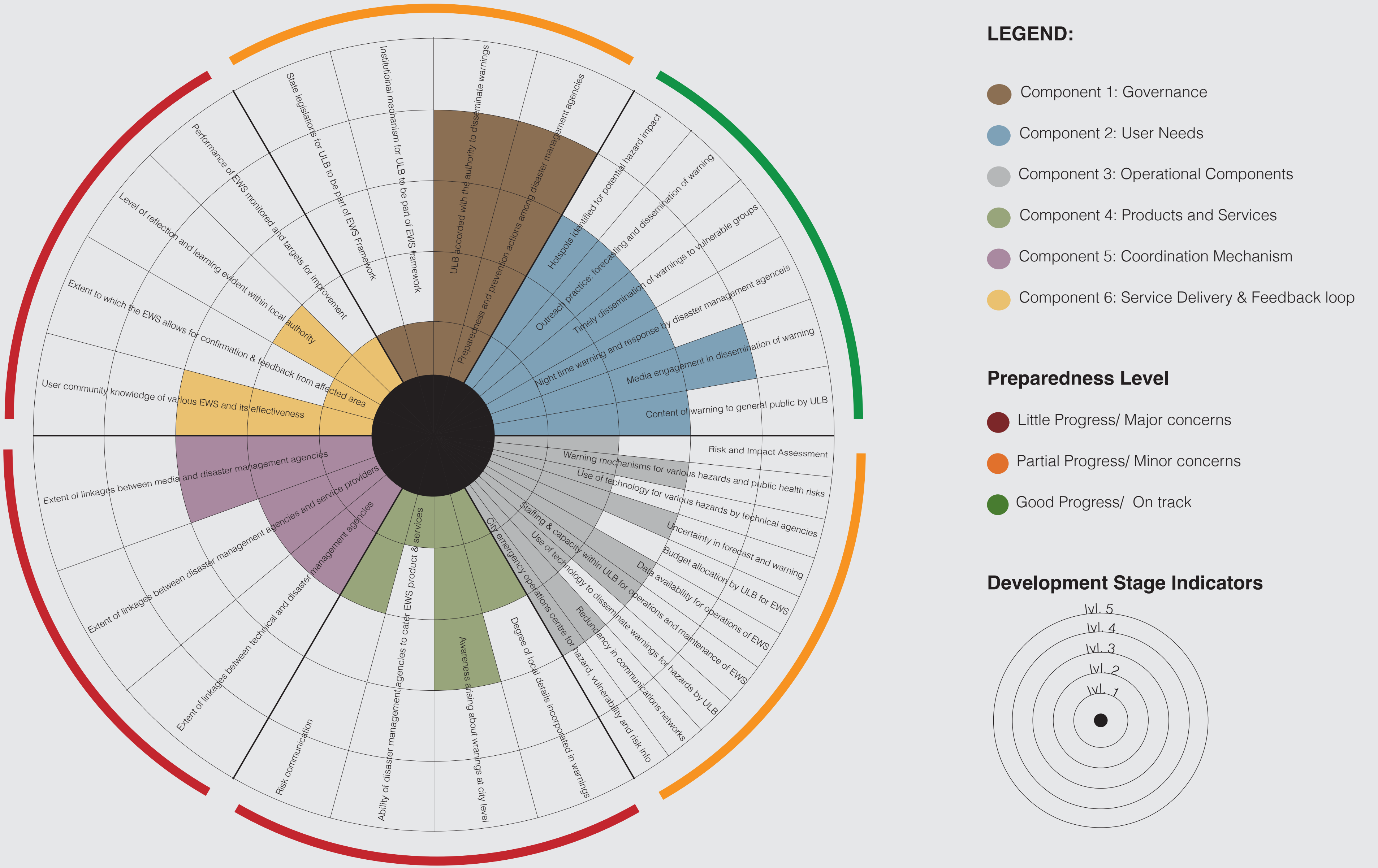


Figure 12**: Preparedness of EWS indicators for Navi Mumbai**

6.1 SUMMARY

Navi Mumbai is a newly planned city and much of the city development needs are designed taking into consideration of possible impact of hydro-meteorological disasters. Regulatory mechanisms, like restriction on activities, which can probably trigger an event such as landslide, are in place.
The Maharashtra State Disaster Management Plan addresses planning arrangements only at the district level. Navi Mumbai City Disaster Management plan mainly focuses on the roles and responsibilities during or post disaster. Currently NMMC manages the disaster situation through an EOC and two control rooms. There is no institutional mechanism within the NMMC (ULB) to establish and operationalize EWS.

City is dependent on technical agencies like Regional Meteorological Centre (IMD), INCOIS and Coast Guards for forecast/ information. Currently, the onus of dissemination of warning and response lies with the NMMC (DM Cell) through media and other protocols, which restricts the outreach (time, space and communities at risk). Value addition to the warning received by technical agencies is restricted to visual display (readability). Information sources including satellite cloud cover and locally installed rain gauge stations were evident in NMMC.

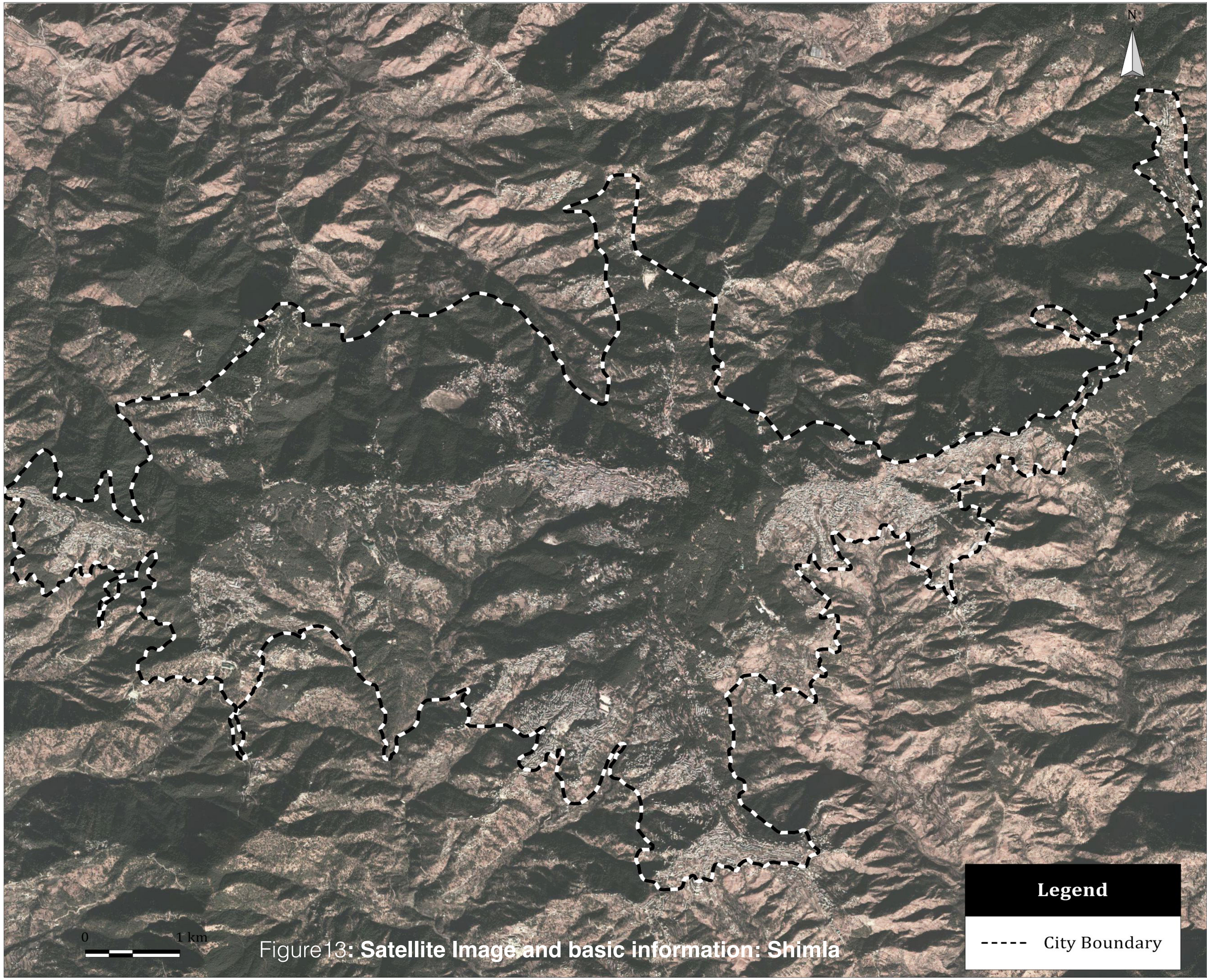
City-level risk assessment is yet to be undertaken to enable/enhance the preparedness and response delivery mechanism. Without detailed hazard, vulnerability and risk assessment may limit response actions to target locations and groups/ communities. Systematic collection, collation, maintenance and updating of relevant data are required to strengthen the warning mechanism.

There is no separate budget allocation for creating and operationalizing EWS. However, the ULB is proactive in warning dissemination using the locally available communication modes (sirens and vehicle mounted PAS). Initiative to collect information from the local level is attempted (evident through installation of 19 rain gauge stations). City has an EOC with two control rooms and eight Zonal Officers with specific responsibilities to manage the facilities. The EOC and control rooms are mainly geared for relief operations. EOC is manned by government officials on deputation with the help of supporting temporarily hired staff, which is functional round the year. Capacity (human resources as well as infrastructure) to add value or to improve the delivery mechanism of forecast/ potential impact is yet to be developed.

Active awareness building measures are undertaken for frequent hazards. Local institutions have helped develop customized warning products for fishermen community. The warnings include action points in case of an event and are targeted at hydro-meteorological hazards.

Lack of formal links and feedback mechanism exists between different institutions within the city. Links between local agencies, such as PWD/ engineering – health/traffic, if established, can stage better response and reduce the overhead costs substantially.

7. Review of EWS in Shimla



Notes:

City	Shimla
District	Shimla
Area	19.99 Sq. Km.
Height from Sea Level	2397.59 Mtrs.
Population	0.169 Million (as per 2011 census)
No. of Wards	25

Key Hazard:
Earthquake, Landslide, Land Sinking
Hailstorm, Severe Storms, including lightning & high winds (Thunderstorms)
Flash Flood/cloud Burst
Heavy Snow Falls

Sources:
Census of India, 2011
Shimla Municipal Corporation, 2014
GeoEye Imagery; Google Earth Pro 2014.

Figure13: **Satellite Image and basic information: Shimla**

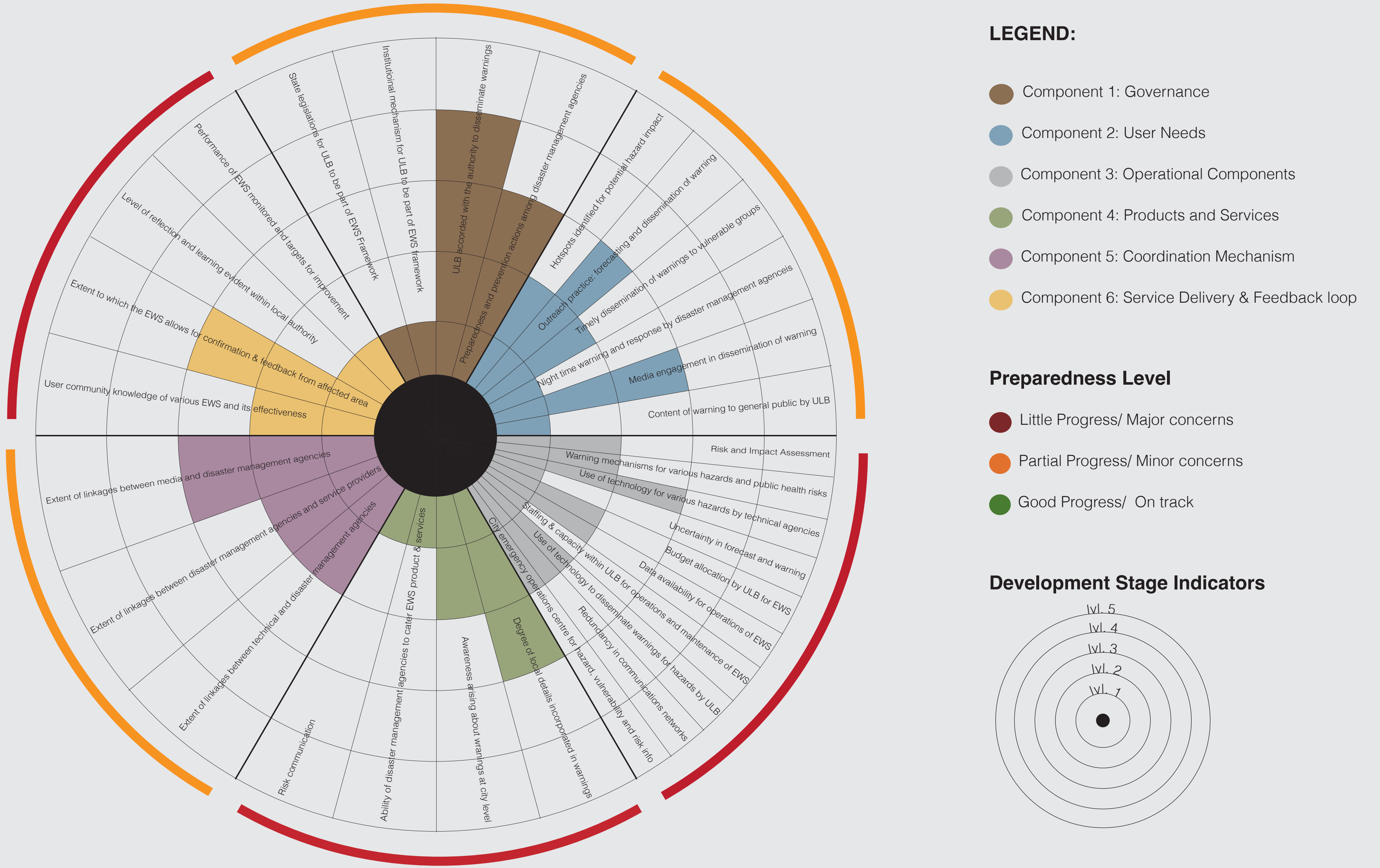


Figure 14**: Preparedness of EWS indicators for Shimla**

7.1 SUMMARY

Shimla city, being the capital of Himachal Pradesh, has distinct advantage of institutional presence and resources for management of severe event (disasters) and risk reduction activities. The city has the presence of institutions catering to the needs of services in disaster management. Key institutions include: HPSDMA/DM Cell Department of Revenue, Meteorological Centre (Shimla), Geology Wing of Industries Department, Aryabhatta Geoinformatics and Space Application Centre (AGiSAC), IDSP (State Surveillance Unit), and Municipal Corporation of Shimla (Urban Local Body). The city is also implementing a range of programmes on disaster risk reduction and climate risk management aspects.

The institutional framework for early warning system (severe weather warning) is limited to information received from the Meteorological Office (MO), Shimla, and the mechanism established by IDSP for disease outbreak. Given the city dynamics and limitations due to geographical location and spread, a well-established EWS for geophysical and hydro-meteorological hazards is the need of the hour. The City Disaster Management Cell of SMC rolled out the first City Disaster Management Plan in 2012 (under the GoI-UNDP Disaster Risk Reduction Programme). The document indicated the hazard profile of the city, vulnerability and risk posed to the city for various hazards, and outlines the mitigation and response plan for the city. The section of the plan also outlines the trigger mechanism for various hazards. However, discussions with key stakeholders in the city and the state department reveal that there is need for greater coordination and establishment of EWS in the city.

The overall vulnerability of Shimla to various hazards is high complex function of hazard intensity, population (densely-packed settlements, settlements in dangerous and environmentally fragile zones), exposure of assets, remoteness/ accessibility, socio–economic factors, services and utilities outreach and infrastructure vulnerability (critical buildings, transport – roads and railways, communications). The city of Shimla now has a larger and more densely-packed population, coupled with terrain challenges the exposure to risk of damage caused by hazard events stands to be significant. Well-established EWS to potential hazard risks will ameliorate disaster risk management concerns of the city.

The review of key agencies brought to the forefront, the need for early warning system for all hazards. Success of any EWS will depend on the detailed understanding of city risks. In case of Shimla, qualitative risk assessment has been undertaken and key locations and hotspots are known to SMC and stakeholders. This information is, however, rudimentary and cannot be used for potential impact assessment or warning to vulnerable population in the city. Post-Uttarakhand Tragedy (June 2013) there has been a growing concern for developing early warning system and addressing the forecast needs and dissemination mechanism to the stakeholders.

At present, the only evidence of forecast is developed for weather events by the Meteorological Office (MO) in Shimla. This forecast also needs significant improvement so as to identify and track extreme events within the geographical area of the city. Lack of field studies and updating of vulnerability assessment limits the dissemination to intended users. The target for warning is purely based on past experiences and from observed phenomenon in some cases (sinking zones, building tilts, mass wasting and debris flow). Translation of severe weather warning to potential impact is not analysed at the moment. City and state level agencies realize the need for precise local weather forecast and plan for establishment of monitoring mechanism for geophysical hazards in the city.

Health advisories and warning are currently provided by health department and IDSP upon realization of disease breakout. Technology used to monitor, nowcast and disseminate hydro-meteorological event warning and geophysical event alerts is currently limited and lacks required data/information to address city specific needs.

The current method of dissemination of extreme weather warning to all nodal agencies is through mail/fax and SMS being sent from MO, Shimla, to government departments. The information is also disseminated to general public through local media (print, radio and television. General public are unable to translate the forecast into warning or actionable points. Addressing the last mile connectivity is still an issue.

SMC has been supported by UNDP for preparation of the City DM Plan and there has been significant effort to capture the operational components for disaster management and risk reduction in the CDMP. The City EOC is located in the city. Though these developments are very recent, there is a need to further strengthen the mechanisms within the City EOC and develop a SOP for functioning of the EOC with appropriate number of trained staff on a 24X7 basis. In the absence of the functional State EOC, the strengthening of City EOC is imperative.

Due to terrain constraints and the threats of hazard, the EOC has to be established at both the state and the city levels. In the non-emergency period, the city EOC can be advised to collate data and monitor specific hazard risks such as slope instability, sinking zones and ground failure due to wrong construction practices and update the risk profile of the city. This database shall strengthen the EWS mechanism and help to establish threshold levels for hotspots and risk zones and determine potential impact for key hazards.

Evidence of warning mechanism exists only for severe weather events and for health risks. Information from the technical agencies is passed on to the disaster management agencies/response agencies and based on the past understanding of the events, response is initiated. The staging of response may differ due to lesser understanding of the severity/intensity of the event or due to no real time information management system from the impact zones/areas. Two of the agencies (MO Shimla and IDSP) currently providing these warnings realize the need for development of their products and services.

The lack of user needs assessment across all stakeholders could be the reason for isolated technology incorporation, product development, service delivery plans and integrated with the CDMP. Both MO Shimla and IDSP undertake awareness programmes on their respective subjects and, in addition, a wide range of departments in the state also conduct public awareness campaigns on life safety and preparedness (including drills) for earthquakes, landslides, cloud bursts/flash floods and fire.

8. Review of EWS in Thiruvananthapuram

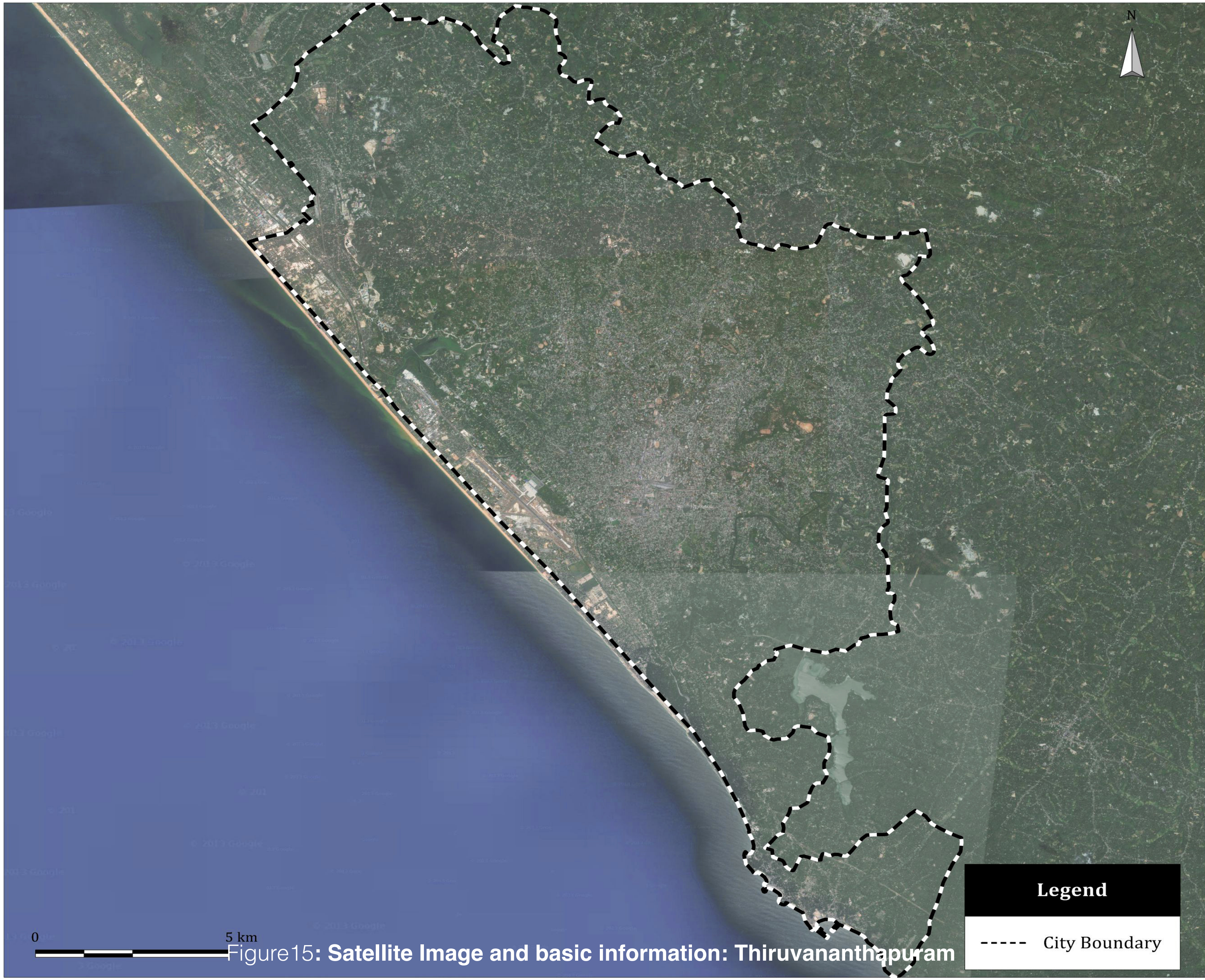


Figure15: Satellite Image and basic information: Thiruvananthapuram

Notes:

City	Thiruvananthapuram
District	Thiruvananthapuram
Area	141.74 Sq. Km.
Height from Sea Level	10 Mtrs.
Population	0.75 Million (as per 2011 census)
No. of Wards	100

Key Hazard:
Tsunami, Earthquake, Landslide
Pluvial Floods, Fluvial Floods, Cyclone,
Lightning, Kaddakadal (Surge)
Dengue, Malaria, Chikangunia

Sources:
Census of India, 2011
Thiruvananthapuram Corporation, 2014
GeoEye Imagery; Google Earth Pro 2014.

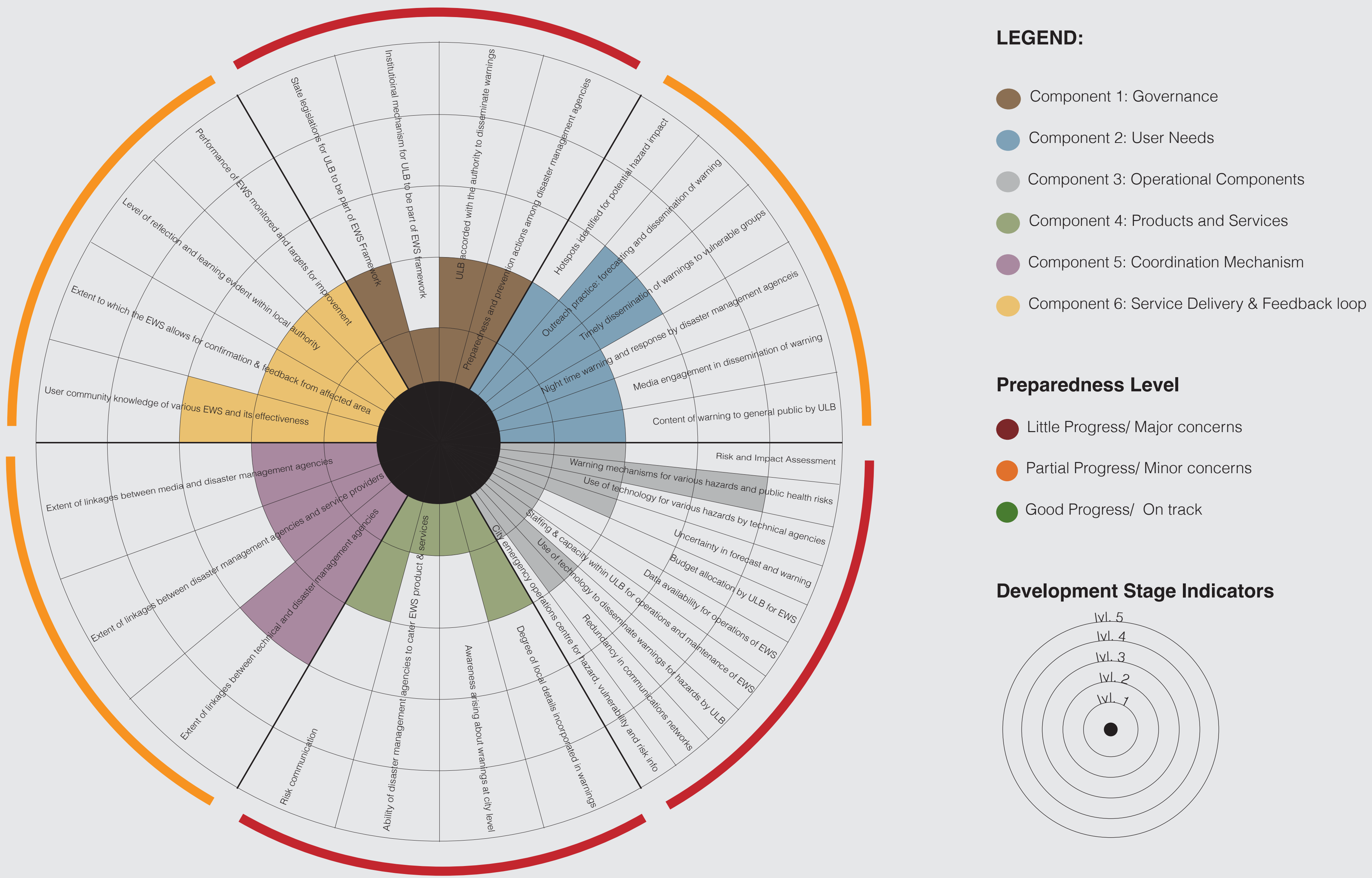


Figure 16**: Preparedness of EWS indicators for Thiruvananthapuram**

8.1 SUMMARY

Thiruvananthapuram, capital city of Kerala state, has well-established links with national level early warning agencies and state level disaster management institutions. Thiruvananthapuram city has a good presence of key national level institutions such as Geological Survey of India (GSI), Indian Meteorological Department (IMD), and Centre for Earth Science Studies (CESS). It also has state level institutions such as KSDMA, ILDM and state IDSP cell. Thiruvananthapuram City Corporation has put in place a City Disaster Management Plan (CDMP). The local government and HRVA Cell (KSDMA) are working towards preparation of hazard, vulnerability and risk assessment.

As per the KSDMA, the need is recognized by the State Government to facilitate community participation in the improvement process of Early Warning System and Disaster Risk Management. Within the state, 295 selected vulnerable villages in all districts have been connected through EWS network; however, there is no involvement of ULB in the current efforts.

Early warning of impending disasters and their effective dissemination by using various alternative communications are the key factors for effective prevention and preparedness. Thiruvananthapuram city lies in the Thiruvananthapuram district and early warning on an impending event is the key responsibility of the District Collector. The District Collector (as ex-officio) is the Chairman of District Disaster Management Authority (DDMA).

Meteorological Centre (IMD) at Thiruvananthapuram provides early warning information on heavy rains, thunderstorm and strong winds to the District Collector of Thiruvananthapuram. The District collector sends these early warning messages to various institutions, including the Thiruvananthapuram Corporation via fax, email and phone calls. Thiruvananthapuram Corporation informs the people within its jurisdiction on receipt of warning from the District Collector's office.

Thiruvananthapuram Corporation has very limited coordination mechanism with state and national agencies providing forecast and warning services. Thiruvananthapuram City Corporation realizes the need of an Emergency Operation Centre (EOC) and to establish link with INCOIS, CESS and IMD to receive warning message.

Centre for Earth Science Studies, in collaboration with Indian National Centre for Ocean Information Services (INCOIS) under the Ministry of Earth Sciences (MoES), Government of India, has installed (in 2011) two coastal stations, off the coastal waters of Thiruvananthapuram, at 30 m depth. The coastal station gives real time data on coastal weather conditions, which include tide, current and wave parameters. This information is vital to the local community, especially the fishermen during extreme weather conditions for safe planning of their activities and also in identification of potential fishing zones. The real time data is disseminated to the various scientific communities/research organizations/institutes 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, off-shore/coastal engineering works and for field of calibration and validation of sea-state forecasting model. CESS also issues voice messages (mobile collaboration with a service provider network for the registered users) in the local languages through radio once at 8:30 a.m. and then at 6:15 p.m.

Health advisories are currently provided by Health Department and IDSP, upon the realization of disease break out. Health department issues health advisories especially before monsoon, as and when the situation warrants.

Early warning mechanism exists only for severe weather events and for health risks in Thiruvananthapuram City. Information from technical agencies are passed on to the disaster management agencies/response agencies and. based on the past understanding of the events/ experiences, response is initiated.

When rainfall amount is expected to exceed by 7 cm per hour, heavy rainfall warning is issued by IMD to the District Collector. The warning is also issued to various agencies, such as public services, PWD, irrigation, hydro-electric, port, telegraphs, railway and Community Project Officials, so that the disaster management machinery can be kept in readiness. The existing system of dissemination of weather warning by IMD to nodal agencies is done through fax, email and SMS. The information is also shared to media and disseminated to the general public through local media (print, radio and television). Local media translate the forecast and warning into local language.

Coordination mechanism is well-established between agencies which are mandated to coordinate the response effort. District Collector's Office is the coordinating agency for early warning and disaster management. There exists no formal feedback mechanism between technical agencies and ULB, and between ULB and communities at risk. Establishing the feedback mechanism can ensure reflection and learning process, thereby improving the efficiency of the current system.

9. Review of EWS in Visakhapatnam

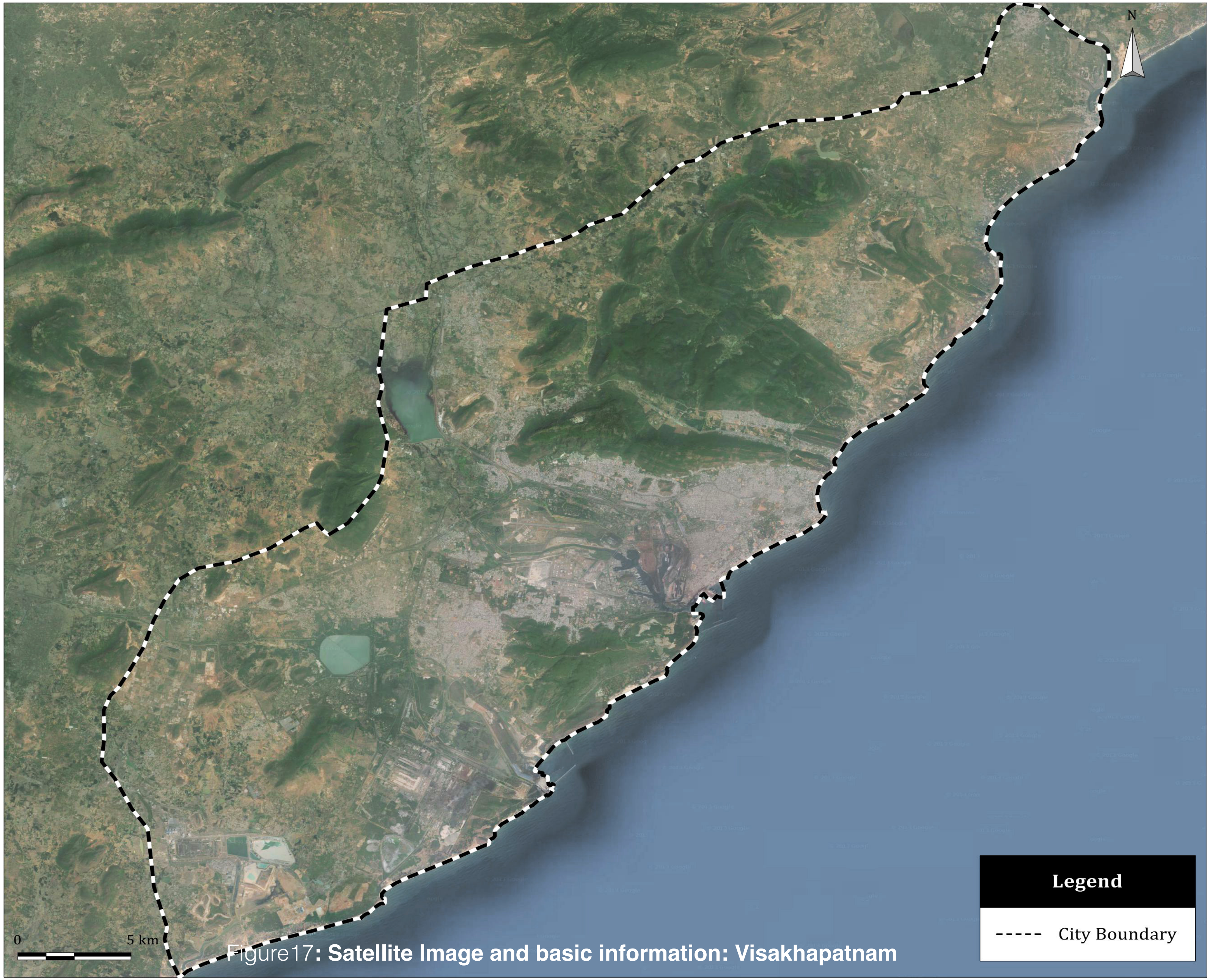


Figure17: **Satellite Image and basic information: Visakhapatnam**

Notes:

City	Visakhapatnam
District	Visakhapatnam
Area	681.96 Sq. Km.
Height from Sea Level	5 Mtrs.
Population	2.91 Million (as per 2011 census)
No. of Wards	72

Key Hazard:
Earthquake, Tsunami
Cyclone, Storm Surge
Pluvial Floods, Fluvial Floods
Heat Waves

Sources:
Census of India, 2011
GVMC, 2014
GeoEye Imagery; Google Earth Pro 2014.

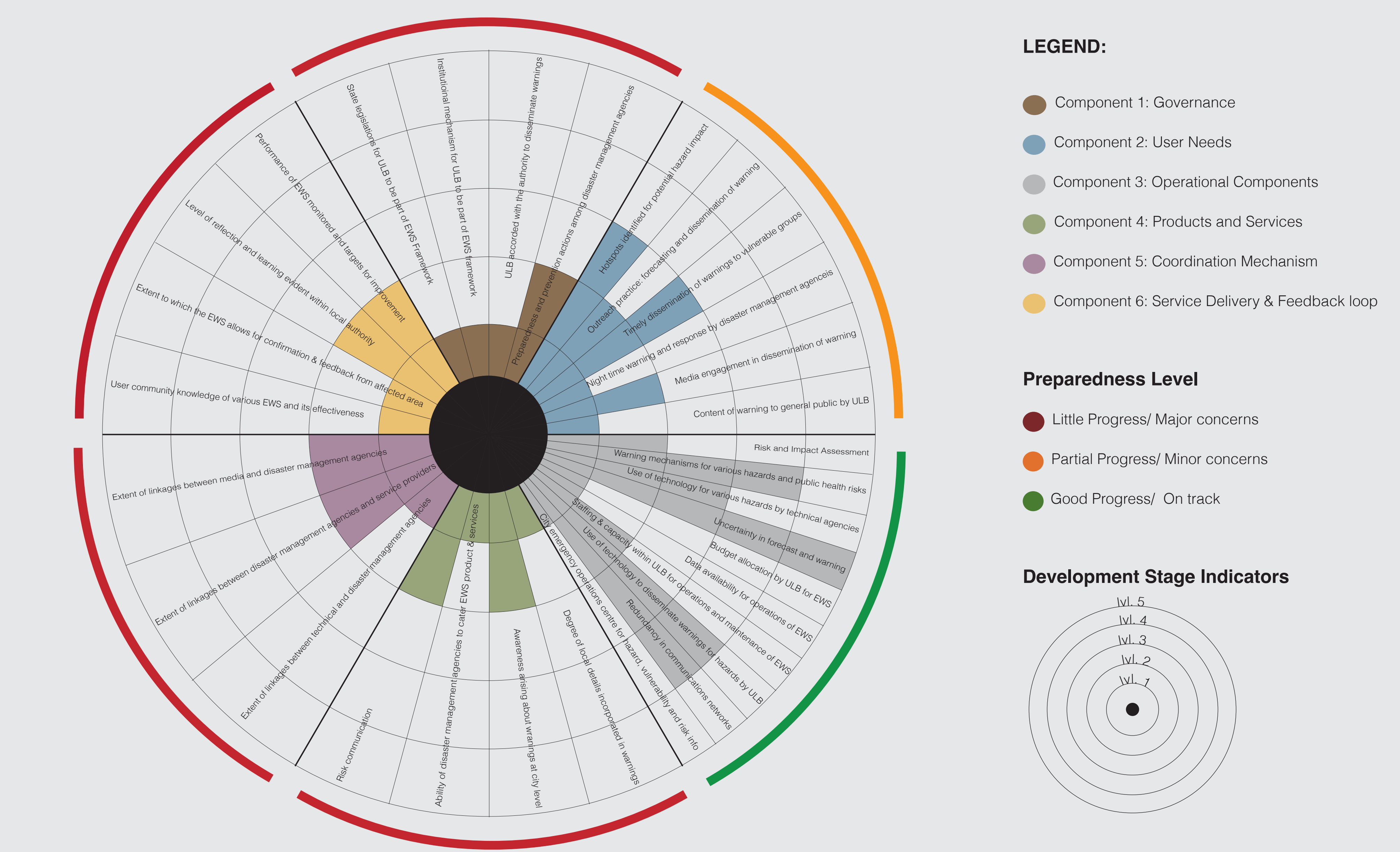


Figure 18**: Preparedness of EWS indicators for Visakhapatnam**

9.1 SUMMARY

Visakhapatnam city has the presence of key institutions catering to the needs of services in early warning and disaster management. Key institutions include: Cyclone Warning Centre (IMD), Irrigation Department, District IDSP Cell, GVMC Fire Service Department and Indian Navy.

Visakhapatnam District Collector's Office is responsible for providing early warning information to relevant agencies and institutions in its jurisdiction such as GVMC (UMB), Irrigation Department, VPT (Port) etc. GVMC has various departments such as engineering, water supply, sewer and drainage, health and social welfare, responsible for specific tasks within GVMC area. GVMC is responsible for carrying out disaster management activities based on information provided by the District Collector. The District Collector's Office receives regular update and warning from the State Disaster Management Department. Cyclone Warning Centre (IMD) at Visakhapatnam provides early warning to the District Collector's Office.

Irrigation Department provides Meghadrigedda dam water release information four to six hours in advance to the District Collector, VPT, Navy and GVMC. Irrigation Department has installed some rain gauge stations at Meghadrigedda dam site. The department conducts monsoon preparation meetings at city.

City level City Disaster Management Plan (CDMP) and Hazard, Risk and Vulnerability Assessment (HRVA) for Visakhapatnam city are not available. However, GVMC is working on preparing CDMP with HRVA. Hotspots such as low lying areas and shelters will be identified during the study.

The review of city level key institutions brought to the forefront, realization of need for early warning system for hydro-met hazard (especially flood, severe rainfall and cyclone) and also establishment of Emergency Operation Centre (EOC). GVMC (ULB) also realized the need of EOC to support EWS and improving disaster management activities in the city and its planning areas.

District Collector of Visakhapatnam has a hotline connection with Cyclone Warning Centre (IMD) and State Disaster Management Department. The Cyclone Warning Centre has a Doppler radar at Visakhapatnam that provides precise information and near real time warning to DM agencies. INCOIS provides tsunami warning to State Relief Commissioner or Secretary Disaster Management Department. In Visakhapatnam, INCOIS established Ocean Information System at Fishing Harbour, which gives ocean state information; such as wave height, wave direction to the fishermen community.

District Collector calls emergency meeting and assigns specific tasks to relevant agencies after receiving warning from the national and state agencies. District Collector monitors the situation very closely and provides further updates to GVMC, VPT, Navy and Irrigation Department.

The existing methods of dissemination of warning by agencies are through formal mail/fax, that are sent to government departments. The same information is also disseminated to the general public and local media, both print and television.

Cyclone Warning Centre (IMD) transmits standard set of warning messages to relevant agencies. This includes fax messages, SMS and phone calls. During any event, centre also runs 24X7 call centre. However, local level details are not incorporated in hydro-met forecast/warning, which is currently given by the district level Disaster Management Authority to ULB. GVMC uses public address system (PAS) to inform the public. Fishermen communities along Visakhapatnam coast are informed by Joint Director (Fisheries) and also by INCOIS using digital display boards.

Coordination mechanism for early warning system and disaster management in Visakhapatnam is formal. Links are established only via District Collector's Office. GVMC is responsible for informing people and undertaking response actions within corporation boundary. Agencies such as GVMC, Irrigation Department have the experience of handling past events and, therefore, coordination mechanism improvement is based on institutional memories and individuals who have been in the forefront of managing the crisis situation.

There is limited formal feedback mechanism observed in Visakhapatnam city between technical, disaster management agencies and between ULB and communities at risk/city stakeholders. During annual pre-monsoon meetings chaired by District Collector, limited discussion is held on activities planned in the previous year and actions taken in the current season. Establishment of feedback mechanism can improve the current functioning.

10. RECOMMENDATIONS & OUTLOOK

Initial results of the review have been shared with the cities during discussion meeting with city stakeholders. Stakeholders from the cities have endorsed the results emanating from the review process. The following set of recommendations have been developed and presented for further action:

Recommendations for improving the EWS for Urban Areas

National / State Institutions

1. State DM Plan should entrust ULB with the responsibility of developing city EWS for specific hazards.

2. For an integrated approach, SDMA should provide an enabling platform to debate, increase coordination and strengthen EWS links across all levels of the government, technical agencies (geological, hydro-meteorological, public health risks), private sector, city level institutions and non-government organizations.

3. IMD's Doppler radar system at city level or within the range of the city has proven to be quite beneficial during cyclone. While the plan to have a radar network is underway, fast-tracking of the same is the need of the hour.

4. IDSP's Health surveillances across cities are found to be relatively useful in detecting outbreaks, since they are directly linked to the state department. Currently, the paper-based approach has a turnaround time of 10 to 15 days for actions. Tools for real time monitoring should be considered.

5. Cities (not the state capital) have limited interactions with state agencies. There is need for enhanced coordination mechanism amongst DM Agencies and ULB.

6. There is a need to create discussion platform for deliberation and discussion between technical agencies (IMD, CWC, GSI, CESS, and INCOIS among others), State Departments and the ULB. In addition, there is a need to create an appropriate framework with due legal process to ensure that roles and responsibilities of the agencies are defined and executed.

Urban Local Bodies

7. The ULB/city government should earmark annual budget for development and maintenance of EWS (Capex & Opex).

8. ULB's DRR agenda should encompass EWS as a critical component. The city government should establish and provide operational services and guide the local development agenda/safeguard infrastructure – assets – communities at risk.

9. Institutionalization of EWS within ULB must ensure integration between line departments and technical agencies. Line departments, in turn, must focus on development of appropriate SOPs for EWS.

10. Cities should invest in a fully operation EOC (24X7) to support risk assessment and EWS. Trained manpower must run the centre's operations.

11. Capacity building of ULB/City Government on EWS (technical and management) is crucial for system development and implementation. The ULB should earmark funds for training so as to assist the process of strengthening the EOC, City DM Plan, communities at risk, media, emergency responders and key stakeholders.

12. Awareness programme should aim at strengthening the level of preparedness. The programmes should be contextualized and scenario-based.

13. Networking and involvement with state, regional and national level institutions will strengthen EWS at city level. Networking brings in exchange of observation data, expertise, joint validation of modelling results, improved decision making, sharing of lessons learnt and best practices.

14. The ULB/city government should identify and link technical and resource institutions within the city for EWS operations.

15. A functional EWS puts forth the requirement to harmonize SOPs that determine response. Standardization of departmental plans and terminology ensures effective response actions. SOPs have to be evaluated and modified through conduct of drills.

16. ULB/City Government should develop hazard analysis, vulnerability assessment and risk assessment (on GIS platform). Climate variability and climate change should be an integral part of the risk assessment.

17. To strengthen disaster preparedness and emergency response, it is important to ensure that emergency response actions are guided through scientific and observed data. The city EOC should harmonize flow of information from all agencies and determine potential impact locations within the city

18. ULB/City Government requires real time data for a range of services (traffic, health, services monitoring – water/sanitation/solid waste management). There is a need to design and develop integrated hydro-meteorological, public health and environmental (say, air quality) monitoring systems in close cooperation with technical agencies, disaster risk management agencies and the ULB. Such an integrated system will be cost-effective and will ensure operations at all times.

19. Event preparedness meetings should be regularized: before winter (for snow/cold wave), summer (heat wave) and monsoon season (tropical cyclone). Pre-Monsoon Preparedness Forum has helped several cities minimize the risk (discussions around monsoon outlook, calibration of model results, preparedness plan).

20. Night time warning has to be an integral part of EWS. If need for evacuation arises, additional measures should be stepped in to stage emergency response. The city DM Plan should make a clear provision for night time warning.

21. Relay of warning information should use a wide variety of options. Select hot spot locations should be equipped with sirens. To maximize outreach of warnings to general public places (railway stations, bus stations/stops, important city junctions, city market places, parks etc.), display screens must be positioned with real time information.

22. Engagement of the media is important to build a culture of safety and resilience. An exclusive weather channel is recommended.

23. It is critical for City Government/ULB to invest in city-level climate scoping studies, promote adaptation and resilience measures across key sectors and integrate with DRR and development planning.

Technical Agencies

24. The ULB and allied institutions require support from technical agencies to build the current understanding of hazard risks, DRR options,\ and expand the understanding to incorporate future threats of climate change and other hazards in decision making for new development and public safety.

25. Development of EWS (monitoring, impact forecasting, warning formulation) has to be hazard specific. EWS development should take into consideration predominant hazards and more frequent/less frequent events (but with a potential for severe damage).

26. Despite technical breakthroughs in earthquake EWS (alerts), efforts should be made by technical agencies to implement EWS in high seismic prone cities. Landslide EWS can be successful in conjunction with appropriate selection of land use criteria for landslide prone region, further combined with environmental monitoring of the risk prone areas.

27. Community-based monitoring has proved to be beneficial for management of geological hazards. A combination of technical and community-focused approach should be adopted for implementation.

28. User understanding of the forecast in technical terms is limited. This is evident from the current set of common information products shared with the user community. Therefore, translation of forecast to warning action has to be backed with action-based information in easy understandable language.

29. Warning mechanism should keep focus on communities at risk. A generic city-level warning may not be appropriate, given the diversity of the built environment in urban areas. In addition, customized local warnings have to be provided to hotspot locations.

30. Warning products should clearly indicate threats to the population/stakeholders. Efforts have to be made by the technical and disaster management agencies to tailor the warning that allows not only understanding the potential event but also determining the potent impact. The warning at the city level should highlight societal impacts and not be broad-based. Stakeholders should be able to distinguish between low impact and high impact events. At the city level, there has to be minimum ambiguity in information when shared with the general public. Communities at risk should be able to perceive risk and react appropriately.

31. Simple and easy to use visualization tools should be made available by technical and disaster management agencies to the citizens. This will ensure participation and effective decision-making.

Summary

It is important at this stage to note that EWS in the seven cities needs to be upgraded 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 report provides insights to issues that need to be addressed for an operational EWS, defines the criteria and measures the development stage indicators for the present situation. The results of this review provide a status and the need to be aware of key design considerations for improvement of existing EWS, as well as for design and implementation of new EWS. It is envisaged that city landscape will have to tailor solutions for public safety, and EWS will be designed and developed on various platforms. It is important to keep these systems people-centric and subsequently build risk knowledge among the stakeholders for success of this system. Criteria Development Matrix can be used as a tool for further review. As EWS systems develop in the city, robust EWS audit mechanism can be rolled in the future to measure system efficiency.