GOVERNMENT OF KERALA

Abstract

Local Self Government Department- Resilient Kerala Program for Results (PforR)- Guidelines for Preparation of Risk Informed Master Plan - Approved -Orders issued.

LOCAL SELF GOVERNMENT (EWB) DEPARTMENT

G.O.(Ms)No.120/2022/LSGD Dated,Thiruvananthapuram, 09-06-2022

Read 1 e-mail message dated 02.06.2022 from Director General, KILA

ORDER

State of Kerala has had to face a number of disasters in recent years that inflicted widespread loss of life, extensive damage to property and habitats and significant disruption of livelihoods. The State has been taking up initiatives to better its preparedness to deal with natural hazards and climate change shocks. Rebuild Kerala Development Programme-2 (RKDP-2), a World Bank supported programme, was launched to make Kerala resilient to future Disasters. Risk-informed Urban Planning and Development is one of the components identified for policy reforms. AFD (Agence Francaise de Developpement) and KfW Development Bank are also partners in this intervention.

Integrating risk information with land use planning is expected to reduce impact of hazards on life, property and environment in a community. Equipping a Local Government's Master Plan with Risk Information and Disaster Risk Reduction strategies will provide a template to local governments to incorporate strategies, projects and actions that can lower risk in development planning and implementation and also mitigate the impact of disasters as and when they occur.

The Resilient Kerala Program for Results (PforR) is being implemented during the period 2021-2026. Disaster preparedness of local governments through climate and disaster risk informed urban planning is one of the objectives. LSGD Planning (CTP) and Kerala Institute of Local Administration (KILA), after detailed deliberations and consultations with various associated agencies/ institutions, stake holders and experts, have drafted and submitted draft guidelines for preparation of Risk Informed

Master Plans. These guidelines are intended to serve as a standard for mainstreaming hazard and risk information in the master plan process and are expected to act as a directive document for making Local Government Master Plans risk informed. The guidelines also provide the methodology for preparation of these master plans in alignment with the Town and Country Planning Act (as amended in 2021) and with the Janakeeyasoothranam Plan framework of Local Governments.

Government are pleased to approve the Guidelines for Preparation of Risk Informed Master Plan attached as Annexure to this Order.

(By order of the Governor)
SARADA MURALEEDHARAN I A S
ADDITIONAL CHIEF SECRETARY

To:

Principal Director , LSGD

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Section Officer

GUIDELINE
FOR
PREPARATION
OF
RISK INFORMED MASTER PLAN

MAY 2022 – Version 2

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1. INTRODUCTION

The state of Kerala is vulnerable to a multitude of hazards and has suffered many major natural hazard events in recent years one after the other, starting with Cyclone Ockhi in 2017, floods and landslides in 2018, 2019 and 2020. The 2018 floods inflicted widespread loss of life and damage to property and habitats leading to economic losses of nearly Rs.26,720 crores (US$3.74 billion). These events and their impacts highlighted the level of under-preparedness of the State to deal with natural hazards and climate change shocks.

Rebuild Kerala Development Programme (RKDP) — the state's strategic roadmap for recovery, rebuilding and resilience was launched to rebuild Kerala better and to make Kerala resilient to future Disasters. The World Bank offered to extend support to this programme in key policy and institutional reforms. Risk-informed Urban Planning and Development is one of the components thus identified. Government of Kerala (GoK) has already initiated other reforms laid out in the Rebuild Kerala Development Program (RKDP) such as the participatory local level disaster management plans and the risk-informed master planning for cities and towns.

1.1 The need for Risk Informed Master Plans

Disasters cannot be completely avoided but the Vulnerability of people and assets to various hazards can be substantially and sustainably reduced through planned prevention, mitigation and preparedness measures. The impacts of hazards on different regions vary based on numerous factors; in urban areas where there is concentration of people, establishments and infrastructure, the damages caused by hazards would be manifold compared to less developed areas. Unplanned developments and lack of investment in resilient infrastructure and services increase the likely disaster impact on a community. Risk reduction measures are more effective and less costly than remedial measures. Integrating risk information with land use planning has the potential to reduce impact of hazards on life, property and environment in a community.

Master Plans are statutory documents, prepared by Local Self Governments (LSGs), for guiding future development in a sustainable manner with focus on spatial and land use planning. Disaster Risk Reduction strategies in it shall strive to lower Risk in existing developments and also in preventing exposure of new developments to Hazards.

It is to be noted that Risk informed Master Plan is a Master Plan defined under Section 2 (r) of the Kerala Town and Country Planning Act, 2016 (KTCP Act, 2016).

1.2 Purpose of this guideline

This guideline aims at supporting Local Self Governments across the State to prepare Risk Informed Master Plans (RIMPs) in a structured manner, starting with the 10 Municipalities in the Manimala – Pampa- Achenkovil river basin. It is not meant to provide a road map for the preparation of a Master Plan in its entirety but to give sufficient guiding principle and directions for mainstreaming Disaster Risk information in the Master Plan. The focus is on

risk reduction at the interface between societies and the natural environment, and integrating risk reduction into the land use planning process.

It must be noted that the likely impacts of a hazard on exposed elements and the possible mitigation measures are highly context specific and cannot be the same in every town. Risk itself is dynamic and many drivers and factors affect it. Assessments are often made on assumptions and generalisation and the primary objective of risk information in a RIMP is to help reduce the impact of a hazard on individual owners and the society at large.

The process proposed for mainstreaming Risk, in Master Plan, in this guideline attempts to build on the LSG Disaster Management Plan and the system already in place for preparing it.

The guideline provide information on various hazards and their characteristics so as to make those involved in the process understand and appreciate the subject better. Structured and participatory process of risk assessment would ensure wider acceptance for the Risk Reduction proposals and would help convince the community of the need for implementing them.

1.3 Objectives

- Identify different types of natural hazards and their characteristics.
- Identify physical, socio-economic and environmental factors contributing to vulnerability of exposed elements.
- Propose techniques and models for risk assessment and mapping
- Propose broad risk reduction strategies.
- Propose methodology to integrate risk into land use planning
- Suggest design and siting standards for typical situations

1.4 Legal framework

Section 30(2)(vi) of Disaster Management Act 2005, necessitates District Disaster Management Authority to lay down guideline for disaster management plans by the departments of government at district level and the local authorities in the district.

As per Section 39 of DM Act, it shall be the responsibility of every department of the government of a State to integrate into its development plans and projects, the measures for prevention of disaster and mitigation.

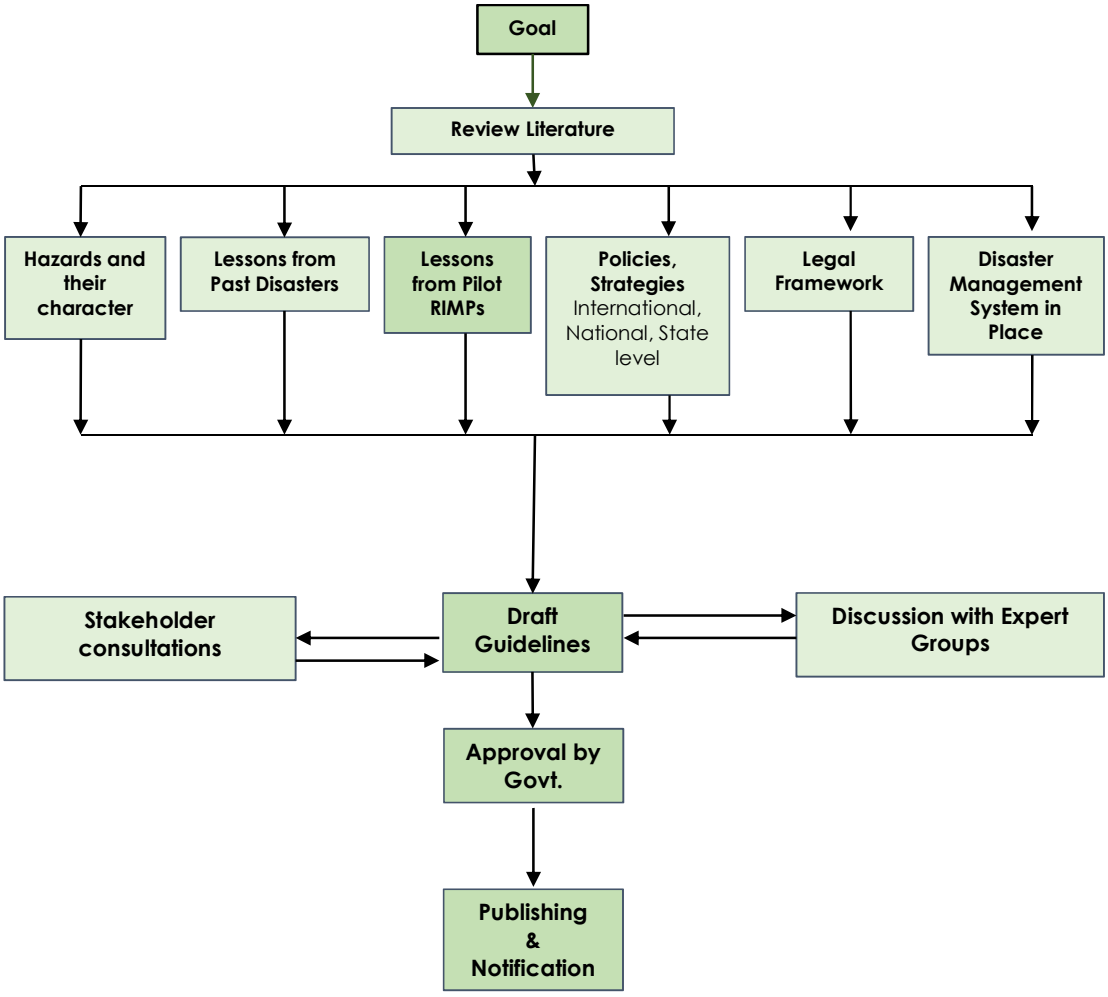
Kerala Town and Country Planning Act, 2016 section 34 subsection (3) (vii) stipulates that Master Plan, prepared under it, shall provide for current issues, prospects and proposals regarding aspects listed thereunder including natural hazard prone areas.

The floods of 2018 and the massive damages it inflicted, made Government of Kerala to decide that Disaster Risk Reduction should be mainstreamed in development planning and projects. Accordingly, amendments have been effected in the Kerala Town and Country Planning Act, 2016 Section 34. The Kerala Town and Country Planning (Amendment) Act,

2021 specifically suggests to include situational analysis in respect of hazard, vulnerability, risk and proposals for mitigation and resilience in the master plan for a local planning area.

As per the Kerala Town and Country Planning Act, 2016, the power and responsibility of preparing Master Plan for an area is vested with the Local Self Governments (LSGs). LSGD Planning provides technical support to the LSGs for the preparation of Master Plans.

1.5 Methodology and preparation of the Guideline



The methodology for preparation of the guideline is elaborated here. As part of Rebuild Kerala Development Program (RKDP), Government of Kerala (GoK) had decided to implement the Resilient Kerala Program for Results (PforR) during the period 2021-2026 in which disaster preparedness through climate and disaster risk informed urban planning is one of the objectives. To facilitate and standardize the process of preparation of such Risk Informed Master Plans, the necessity for a guideline was realized.

For the preparation of the draft guideline, a team was constituted from within the LSGD Planning. The team reviewed available literature on the subject, including the Disaster Management Act 2005, National Disaster Management Plan, State Disaster Management

Plan, District Disaster Management Plans, Local Disaster Management Plans, impact of past disasters, policies & strategies at international national and state levels, existing disaster management system in Kerala etc. Some of the best practices from international and national scenarios were studied. The experience gained from the preparation of two pilot Risk Informed Master Plans (Chengannur and Mananthawady) is also used in preparing this guideline. Risk assessment methods adopted in different parts of the world were also referred for creating a risk assessment methodology that can be used in Kerala context. Disaster risk reduction measures and development control regulations published by various authorities were referred and suggestions regarding these were incorporated in the guideline.

Expert group discussions and consultations were organized by LSGD Planning and Kerala Institute of Local Administration (KILA) with State Resource Group Members, Planning Board, all District Town Planners etc for enhancing the contents of the guideline. For the refinement of the draft, State level workshops with stakeholders like Kerala State Disaster Management Authority (KSDMA), Local self-Government Institutions in the Pampa basin, Kerala State Remote Sensing and Environment Centre (KSREC), Kerala State Land Use Board (KSLUB) etc. were conducted with support from KILA. Feedback on the preliminary draft obtained from CEREMA (Centre for Studies and Expertise on Risks, the Environment, Mobility and Urban Planning - the major French public agency for developing public expertise in the fields of urban planning, regional cohesion, and ecological and energy transition for resilient and climate neutral cities and regions) also has been incorporated in this version of the draft guideline.

The guideline shall be used as a standard for mainstreaming hazard and risk information in the master planning process. It is expected that the guideline will act as a directive document for making Master Plans risk informed.

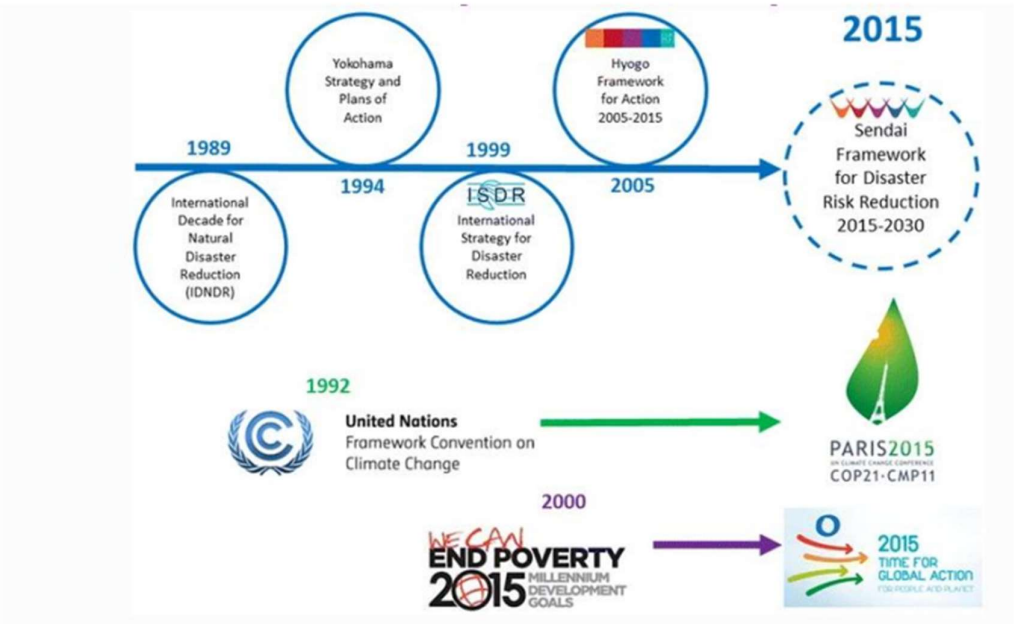
2. MAJOR POLICIES, GUIDELINE AND LESSONS CONCEIVED IN DISASTER RISK REDUCTION

2.1 International frame work

-Sendai Framework for Disaster Risk Reduction 2015-2030

The Sendai Framework is the successor instrument to the Hyogo Framework for Action (HFA) 2005-2015: Building the Resilience of Nations and Communities to Disasters

Twenty five years of international commitments to disaster risk reduction



Source : (UNISDR 2015)

The Sendai Framework for Disaster Risk Reduction 2015-2030 (Sendai Framework) is a voluntary, non-binding agreement that sets a far-reaching, people-centred approach to disaster risk reduction. It outlines seven global targets to be achieved between 2015 and 2030. It was adopted by UN Member States on 18 March 2015 at the third UN World Conference on Disaster Risk Reduction in Sendai City, Japan.

It aims to achieve substantial reduction of disaster risk and losses in lives, livelihoods and health and in the economic, physical, social, cultural and environmental assets of persons, businesses, communities and countries over the next 15 years. The Sendai Framework applies to risks that are “small-scale and large-scale, frequent and infrequent, sudden and slow-onset disasters, caused by natural or man- made hazards as well as related environmental, technological and biological hazards and risks. It aims to guide the multi-hazard management of disaster risk in development at all levels as well as within and across all sectors” (Sendai Framework, 2015)

The seven targets are:

The Sendai Framework outlines four priorities for action to prevent new and reduce existing disaster risks:

i. Understanding disaster risk;
ii. Strengthening disaster risk governance to manage disaster risk;
iii. Investing in disaster reduction for resilience and;
iv. Enhancing disaster preparedness for effective response, and to "Build Back Better" in recovery, rehabilitation and reconstruction.

The Sendai Framework works hand in hand with the other 2030 Agenda agreements, including The Paris Agreement on Climate Change, The Addis Ababa Action Agenda on Financing for Development, the New Urban Agenda, and the Sustainable Development Goals.

2.2 National frame work

2.2.1 National Disaster Management Act, 2005:

National Disaster Management Act 2005 lays down institutional and coordination mechanism for effective Disaster Management at the national, state, district and the local levels.

The institutional arrangements have been set up consistent with the paradigm shift from the relief-centric approach of the past to a proactive, holistic and integrated approach for Disaster Risk Reduction (DRR) by way of strengthening disaster preparedness, mitigation, and emergency response.

The Act enables for the following:

Institutional Mechanism
- National Disaster Management Authority ,State Disaster Management Authority, District Disaster Management Authority
- National Executive Committee, State Executive Committee
- National Disaster Response Force

Financial Arrangements
- National Disaster Response Fund, State Disaster Response Fund and District Disaster Response Fund
- National Disaster Mitigation Fund & similar such fund at state and district levels
- Capacity Building Grant
- Response Reserve

Capacity Development
- National Institute of Disaster Management

Other Institutions
- Civil Defense
- Fire Services
- Home Guards

i. **The National Disaster Management Authority or NDMA:** It is the nodal central body for disaster management coordination, with the Prime Minister as its Chairperson. It is responsible for laying down policies, plans and guideline for disaster management to ensure an effective & strong response during any disaster.

ii. **The National Executive Committee or NEC**: To assists NDMA in the performance of its functions.

iii. **National Plan:** For disaster management for the whole of the country. The National Plan is prepared by the National Executive Committee having regard to the National Policy and in consultation with the State Governments and expert bodies or organisations in the field of disaster management and is approved by the National Authority. The national plan is reviewed and updated annually. See 2.2.3 for more details.

iv. **State Disaster Management Authority**: –Chief Minister is the Chairman of the Authority and the Authority has the responsibility for laying down policies and Plans for disaster management in the State.

v. **State Executive Committee:** To assist SDMA in the performance of its functions. They have the responsibility for implementing the National Plan and the State Plan and to act as the coordinating and monitoring body for management of disaster in the State.

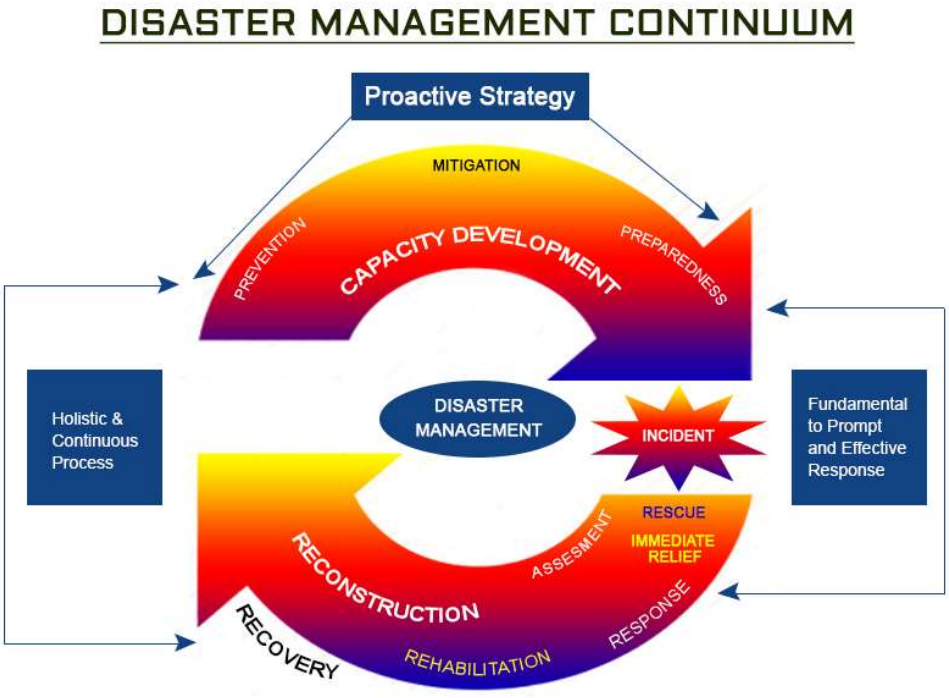
vi. **State Disaster Management Plan:** is prepared by the SEC having regard to the guideline laid down by the National Authority and after such consultation with local

authorities, district authorities and the people's representatives. See 2.3.3 for more details.

vii. **District Disaster Management Authority:** District Collector or District Magistrate or Deputy Commissioner shall be the Chairperson. DDMA shall act as the district planning, coordinating and implementing body for disaster management and take all measures for the purpose of disaster management in the district in accordance with the guideline laid down by the National Authority and the State Authority.

viii. **District Disaster Management Plan:** There shall be a Plan for disaster management in every district of the State. The District Plan, to be reviewed and updated annually, shall include the area in the district vulnerable to different forms of disasters; and the measures to be taken, for prevention and mitigation of disaster, by Departments of the Government at the district level and local authorities in the district.

2.2.2 National Policy on Disaster Management 2009:



The National Policy on Disaster Management (NPDM) has been prepared in tune with and in pursuance of the Disaster Management Act, 2005. NPDM provides the framework/roadmap for handling disasters in a holistic manner.

It emphasises a paradigm shift in Disaster Management, from the erstwhile relief-centric response to a proactive prevention, mitigation and preparedness-driven approach for conserving developmental gains and also to minimise losses of life, livelihoods and property.

The Policy covers all aspects of disaster management covering institutional, legal and financial arrangements; disaster prevention, mitigation and preparedness, techno-legal regime; response, relief and rehabilitation; reconstruction and recovery; capacity development; knowledge management and research and development.

It focuses on the areas where action is needed and the institutional mechanism through which such action can be channelized.

The NPDM addresses the concerns of all the sections of the society including differently abled persons, women, children and other disadvantaged groups. In terms of grant of relief and formulating measures for rehabilitation of the affected persons due to disasters, the issue of equity/inclusiveness has been accorded due consideration.

The NPDM aims to bring in transparency and accountability in all aspects of disaster management through involvement of community, community based organizations, Panchayat Raj Institutions (PRIs), local bodies and civil society.

The themes underpinning the policy are:

- Community based Disaster Management, including last mile integration of the policy, plans and execution.
- Capacity development in all spheres.
- Consolidation of past initiatives and best practices.
- Cooperation with agencies at national and international levels. Multi-sectoral synergy.

The policy suggests that as a first step towards addressing disaster vulnerabilities, Central Ministries and Departments, national agencies, knowledge-based institutions and DM authorities at the State and District levels need to carry out risk and vulnerability assessment of all disaster prone areas. Hazard zonation mapping and vulnerability analysis based on GIS and remote sensing data, needs to mandatorily include a ground check component. Action plans for checking unplanned urbanization and ensuring safer human habitat against all forms of disasters will be recognized as priority areas.

Full document is available at https://nidm.gov.in/PDF/policies/ndm_policy2009.pdf

2.2.3 National Disaster Management Plan 2019:

The NDMP can be considered to have five main pillars:

I. Conforming to the national legal mandates—the DM Act 2005 and the NPDM 2009
II. Participating proactively to realising the global goals as per agreements to which India is signatory—Sendai Framework for DRR, Sustainable Development Goals (SDGs) and Conference of Parties (COP21) Paris Agreement on Climate Change
III. Prime Minister's Ten Point Agenda for DRR articulating contemporary national priories
IV. Social inclusion as a ubiquitous and cross-cutting principle
V. Mainstreaming DRR as an integral feature,

The Prime Minister, enunciated a Ten-Point Agenda in his inaugural speech at the Asian Ministerial Conference on Disaster Risk Reduction 2016, held in New Delhi during November 2016 (AMCDRR).

The ten key elements consist of the following:

1. All development sectors must imbibe the principles of disaster risk management
2. Risk coverage must include all, starting from poor households to SMEs to multi-national corporations to nation states
3. Women's leadership and greater involvement should be central to disaster risk management
4. Invest in risk mapping globally to improve global understanding of Nature and disaster risks
5. Leverage technology to enhance the efficiency of disaster risk management efforts
6. Develop a network of universities to work on disaster-related issues
7. Utilise the opportunities provided by social media and mobile technologies for disaster risk reduction
8. Build on local capacity and initiative to enhance disaster risk reduction
9. Make use of every opportunity to learn from disasters and, to achieve that, there must be studies on the lessons after every disaster
10. Bring about greater cohesion in international response to disasters

The NDMP broadly covers topics such as Hazard Risks and Challenges, Coherence and Mutual Reinforcement of Three Post-2015 Global Frameworks for DRR, Social Inclusion in DRR, Mainstreaming DRR, Building Disaster Resilience – Responsibility Framework, Preparedness and Response, Recovery and Building Back Better, overview on Capacity Development, Financial Arrangements, Strengthening Disaster Risk Governance, International Cooperation and Maintaining, Monitoring, and Updating the Plan.

The measures included in the NDMP, which is a dynamic document, are indicative and not exhaustive. Based on global practices and national experiences, the plan will incorporate changes during the periodic reviews and updates.

The NDMP will be implemented within short, medium, and long-term timeframes.

Full document is available at https://ndma.gov.in/sites/default/files/PDF/ndmp-2019.pdf

2.3 State Framework

2.3.1 Kerala State Disaster Management Rules, 2007

As provided under section 78 of the Disaster Management Act 2005, Government of Kerala have issued these rules. The Rules provide for the constitution of State Disaster Management Authority, Advisory Committee, State Executive Committee and the District Disaster Management Authorities.

Full document is available at
https://sdma.kerala.gov.in/wp-content/uploads/2018/12/a7KSDMA-Rules-2007.pdf

2.3.2 Kerala State Disaster Management Policy, 2010

In accordance with Section 18 (2) (a) of DM Act 2005, the Kerala State Disaster Management Authority (KSDMA) has prepared the Kerala State Disaster Management Policy and published vide GO (MS) No. 240/2010/DMD dated 19-06-2010. The policy shall be revisited once in 10 years.

Overall goal of the Policy is to institute structures and systems to establish directive principles for effective risk reduction and crisis management in order to minimise human, property, environment and livelihood losses and to contribute to sustainable development and better standards of living for poor and vulnerable sections.

It states the need for such a policy as follows:

"While disasters cannot be completely avoided, the vulnerability to various hazards can be sustainably and substantially reduced by planned prevention, mitigation and preparedness measures. Therefore the current perceptions of disaster management that considers disasters as rare occurrences that can be managed by emergency response services require a paradigm shift. The new approach emanates from the conviction that disaster mitigation and preparedness should be built into the development process and it should be multi-disciplinary spanning across all sectors of development." The policy underscores that investments in prevention, mitigation and preparedness are more cost effective than expenditure on relief and rehabilitation.

The policy framework is structured in such a way that Kerala State Disaster Management Authority provides the overall direction and guidance to various entities leveraging the resources and capability of existing entities and building new capabilities without treating disaster management as a separate sector or discipline.

The policy also identifies State nodal departments for different type of disasters.

The policy states that the State government shall follow national building codes and other codes as laid down by Bureau of Indian Standards. Departments/ District Administration/ Local Authorities shall ensure that existing bye-laws, land use zoning regulations and development control regulations correspond to the requirements for safe construction as laid down by various agencies for seismic zone III.

The policy also calls for the Government to promote Disaster resistant building design, construction practices and retrofitting techniques; Modern technologies such as Remote sensing and GIS shall be used to the extent possible; Risk financing shall be explored; Strengthening Institutional Mechanisms and Capacity building; Training to all stakeholders and the establishment of Kerala State Institute of Disaster Management.

The roles of Key stake holders are also specified in the Plan with KSDMA to act as the nodal agency for prevention, mitigation and preparedness measures.

The Policy categorises disasters as hydro meteorological, Geological, Chemical Industrial & Nuclear, Biological and Man-made Disasters.

The Policy identifies the 3 phases of DM as below:

- Pre disaster phase - prevention, mitigation and preparedness.
- Disaster response phase/during disaster.
- Post disaster phase - recovery (rehabilitation and reconstruction).

In the Pre-Disaster phase, the policy defines the role of the stakeholders involved such as KSDMA, State level departments, District Collector, District disaster management authority, Local authorities, NGOs, Communities involved, Cooperate Sector etc.

In the Pre disaster phase, KSDMP 2010, Specifies certain key features such as Hazard Analysis and Risk and Vulnerability Assessment, Preparation of Disaster Management Plans, Inventory of Resource / Capacity Assessment and Enhancement, Early warning systems, Incident command system, Funding, Community based disaster management etc.

In the Disaster response phase, the policy defines the role of the stakeholders and also specifies key activities such as, Implementation and Operationalization of Disaster Management - Response Plan, Evacuation search & rescue, sufficient food and water supply, sanitation mechanisms and temporary shelters, Restoration of Basic infrastructures and essential services, Maintenance of law & order, Immediate relief, Damage & need Assessment.

In the Post disaster phase - recovery, the policy defines the role of the stakeholders and also specifies key activities such as Damage assessment and estimation of funds, Restoration of livelihoods, Physical reconstruction, Project Management.

The policy provides a very clear approach for Hazard analysis and vulnerability assessment as follows:

“7.1.2.1 Hazard Analysis and Risk and Vulnerability Assessment

Before commencing any preventive, mitigating and preparedness activities, it is important to analyse different types of hazards and assess the risks and vulnerabilities of the State. Kerala State Disaster Management Authority would co-ordinate with all relevant agencies and state departments for a thorough assessment of hazards, risks and vulnerability. A data base of past disasters should also be prepared for analysis.

Attempt shall be made to identify hazards in various regions and to classify into zones based on hazard potential. Hazard specific zonation maps shall be prepared. Measure of the expected losses of people, structures and region and assessment of degree of vulnerability of any given structure/people/region to the impact of the hazard shall be made. These analyses shall be made in consultation with the local community so that they should realise the hazards in their villages and understand the risks and vulnerabilities involved to facilitate risk reduction.

These assessments shall be used for developing detailed prevention, preparedness and mitigation measures like strengthening capacities of communities, Land use planning & zoning, retrofitting of buildings and structures, developing scientific disaster resistant

construction practices for various disaster prone areas etc. The construction activities and other activities that affect the environment will be monitored by relevant departments in vulnerable regions particularly in landslide, earthquake and cyclone prone areas and in areas where dams are located. Environmentally fragile regions like wet lands, Western Ghats, coastal areas and biological hotspots and the rivers in the State will be protected by legal enforcement from detrimental interventions that may cause disasters."

Full document available at
https://sdma.kerala.gov.in/wp-content/uploads/2018/12/a5KSDMA-Policy-2010.pdf

2.3.3 Kerala State Disaster Management Plan, 2016

The Kerala State Disaster Management Plan (KSDMP) is an ever evolving document formulated under the Disaster Management Act, 2005 (DM Act, 2005) which establishes a multi-stakeholder framework for the partnership of governmental entities, non-government agencies, private sector enterprises and individuals for Disaster Risk Reduction in the State.

According to Section 23 (4) (a) to (f) of the DM Act, 2005, the SDMP should deal with: a) The vulnerability of different parts of the State to different forms of disasters b) The measures to be adopted for prevention and mitigation of disasters c) The manner in which the mitigation measures shall be integrated with the development plans and projects d) The capacity-building and preparedness measures to be taken e) The roles and responsibilities of each Department of the Government of the State in relation to the measures specified in clauses (b), (c) and (d) above f) The roles and responsibilities of different Departments of the Government of the State in responding to any threatening disaster situation or disaster.

With the motto "Towards a Safer State", the Kerala State Disaster Management Authority has approved the State Disaster Management Plan 2016 as mandated by the Disaster Management Act, 2005.

The Plan presents 39 types of known and reported hazard types in Kerala that may turn disastrous in the event of lack of proper preparedness and risk reduction plans. A review of available material for assessing the climate change vulnerability and consequent increase in the hydro-meteorological hazard foot print of Kerala is also included in the Plan.

The plan affirms the need to mainstream Disaster Risk Reduction into development planning in the State. State Government, Government Departments, Institutions, NGOs, families and individuals in Kerala has a responsibility to reduce disaster risks in the State. The Plan enlists the basic responsibilities of stakeholders in disaster risk reduction.

The Plan also deals with the response and relief procedures; rehabilitation and reconstruction; and dispute resolution methods to be adopted.

Available funds and provisions of funding for disaster risk reduction in the state are also presented in the Plan. It also presents a method for streamlining the budgeting of State Disaster Response Fund as per the guideline of the 14th Finance Commission.

The Plan also provides a broad approach for the Hazard Vulnerability Risk Assessment. Full document is available at https://sdma.kerala.gov.in/wp-content/uploads/2018/11/Kerala%20State%20Disaster%20Management%20Plan%202016.pdf

2.3.4 District Disaster Management Plans

As provided in the DM Act 2005, District Disaster Management Authorities (DDMAs) act as the district planning, coordinating and implementing body for disaster management and take all measures for the purpose of disaster management in the district in accordance with the guideline laid down by the National Authority and the State Authority.

Every district in Kerala has a District Disaster Management Plan prepared by the DDMA and approved by the KSDMA.

The District Plan, to be reviewed and updated annually, include inter-alia:

a. The area in the district vulnerable to different forms of disasters;

b. The measures to be taken, for prevention and mitigation of disaster, by Departments of the Government at the district level and local authorities in the district;

c. The response plans and procedures, in the event of a disaster.

The full documents of Disaster Management Plans of Pathanamthitta, Alappuzha and Kottayam districts (the 3 districts in which the Manimala –Pampa- Achenkovil river basin falls) are available at the following links:

https://sdma.kerala.gov.in/wp-content/uploads/2018/11/3-Pathanamthitta-final.pdf

https://sdma.kerala.gov.in/wp-content/uploads/2018/11/4-Alappuzha-final.pdf

https://sdma.kerala.gov.in/wp-content/uploads/2018/11/5-Kottayam-final.pdf

2.3.5 Local Disaster Management Plans and Nammal Namukkai

GO (MS) No.156/2019/LSGD, dtd. 4/12/2019 was issued by Government, for ensuring people's participation and leaderly intervention of local self-government institutions in disaster mitigation, preparation and disaster management areas and for the planning and implementation of such plans at local self-government level as part of annual plans.

The GO reiterates responsibility of LSGIs in preparing local DM Plans with mitigation and preparedness measures as stated in GO 499/ 2019 of Planning and Economic Affairs department. It provides that a local DM Plan should contain the following:

- LSG Profile
- Hazard and Vulnerability Profile
- Capacity and resources
- Response Plan
- Preparedness, mitigation and community resilience plan

The GO states the need for the formation of Emergency Response Team (ERT) of local volunteers, as provided in the DM Act 2005. Each ward should have such a team comprising minimum of 8 persons. Each LSGI should have 4 ERTs for managing camps, rescue operations etc.

Roles and Responsibilities of LSGI in Disaster Management as specified in the GO is as follows:

1. They shall integrate DM Plan proposals with Annual Plan proposals
2. They shall ensure formation of Incident Response Team at LSGI level and the ERTs.
3. Ensure maintenance of buildings of LSGIs that can be used as camps
4. Make arrangements for the shifting people to camps etc.
5. Ensure water and electricity in such centres
6. Give enough publicity for the rehabilitation programs of Government.

The GO also provides for the constitution of Local Resource group in each LSGI comprising of 20 members for data collection and situation analysis relating to DM. In addition to the above, each ward should also form groups of not less than 20 members.

Process to follow for the preparation of local DM Plans is as below:

- Data collection and situation analysis by the Local Resource Group.
- Draft DM Plan based on 1 above.
- Discussion of DM Plan in Grama sabha
- Discussion in Panchayth Committee
- Separate Development Seminar
- DM Plan for the approval of Panchayath Samithi

The Environment-Climate Change- Disaster Risk reduction working group shall ensure coordination of the preparation of DM Plan. Annual Plans shall include projects aimed at Disaster Risk Reduction and shall be submitted for the approval of District Planning Committees. District Planning Committees shall organise seminars and proposals for DRR. KILA and KSDMA shall organise all training programmes connected with these.

Rebuild Kerala Initiative (RKI) has launched a campaign with the aim to utilize the knowledge, experience and ideas of the entire people of the state in a participatory and practicable manner for rebuilding Kerala. Preparation of Disaster Management Plan by every Self Government Institutions is an important component of the above campaign formulated in People's Planning mode.

The aim is to rebuild Kerala in a mighty manner to withstand future calamities. Demand came up from the civil society to adopt localized and community based disaster management/ resistance programmes. Knowledge, experience, ideas, wisdom and involvement of the people of the state can heighten the efficacy and practicability of the task at hand. Department of Local Self Government- standardized template of tables and guideline for garnering data required for the preparation of Disaster Management Plans of

Local Self Government Institutions. Detailed instruction on this was issued by Government vide G.O (MS) No.14/2020/LSGD Dtd. Thiruvananthapuram 14/01/2020.

This campaign named as Nammal Namukkayi and modelled along the lines of people's planning has two major components:

i. Extensive campaign with active participation of the people to identify the required corrections and policy changes to ensure resilience.
ii. ii. Preparation of Disaster Management Plan at every local self-government institutions.

All the Local Disaster Management Plans are available at https://sdma.kerala.gov.in/lsg-dm-plans/
Full unedited English version of the framework, Templates and Guidelines is available at https://sdma.kerala.gov.in/wp-content/uploads/2020/10/Local-Governemnt-Diaster-Management-Plan-Guidelines-and-Template.pdf

2.4 Lessons conceived from the 2 pilot Risk Informed Master Plans prepared for Mananthawadi and Chengannur.

The mega flood of 2018 in Kerala warranted urgent need to build foundations of multi resilience in Kerala. The World Bank extended support to the state initiative 'Rebuild Kerala Development Programme' (RKDP) and the preparation of Risk Informed Master Plan for two Urban Local Bodies was done under Prior Action 7. The prior action was completed in 2021 and pilot Master Plans for Mananthavady Municipality in Wayanad District and Chengannur Municipality in Alappuzha District were prepared and published as per the provisions of the Kerala Town and Country Planning Act, 2016.

The two pilot Master Plans helped to identify various issues and challenges faced during the process of preparation of Risk Informed Master Plans. Lack of availability of detailed and reliable hazard data at scale suitable for the Master Plan, lack of expertise in extracting and analysing necessary data from high resolution satellite imageries, capacity shortage of the local planning teams etc. are some of the issues identified. Expertise in the field of Disaster Management, Environmental sciences, Geology, Geography, Hydrology, etc. are needed for the proper assessment and analysis of various possible hazards and in the formulation of DRR strategies. Documentation of hazard and disaster events need to be carried out in detail. There should be a mechanism in place for sharing of spatial data among different Govt. Departments/ Authorities and Agencies.

The methodology adopted for the preparation of the two master plans were different. For Mananthavady Master Plan, the spatial map of flood and landslide prone areas were prepared using satellite imagery, field data and the hazard maps from KSDMA. In the case of Chengannur Master Plan, the hazard prone areas were delineated mainly based on 2018 floods.

Relevant details pertaining to hazard identification and risk assessment in the two Master Plans are provided in Annexure I.

3. NATURAL HAZARDS AND THE HAZARD PROFILE OF KERALA

The contents of this chapter is mostly adopted from the Kerala State Disaster Management Plan 2016. The full document is available at https://sdma.kerala.gov.in/wpcontent/uploads/2018/11/Kerala%20State%20Disaster%20Management%20Plan%202016.pdf

3.1 Introduction

Hazards can occur anywhere in the planet. However, there are some regions and areas that are particularly prone to these hazardous events and some hazards are specific to certain locations. Hazards are the origins of disasters. The State of Kerala is vulnerable to many natural and manmade hazards and hence is a multi-hazard prone State.

Hazard is a process, phenomenon or human activity that may cause loss of life, injury or other health impacts, property damage, social and economic disruption or environmental degradation. (UNDRR)

Disaster is 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 (UNISDR). It results in loss or damage to life, property or environment and can be caused by natural, man-made and technological hazards, as well as various factors that influence the exposure and vulnerability of a community.

Disaster is when the threat of a hazard become reality, and impacts a vulnerable society. Given its proximity to the sea with a coastline of 589.5 km, steep gradient along the slopes of the Western Ghats, presence of numerous rivers, lakes, backwaters and estuaries and 14 per cent of its total area susceptible to landslides, Kerala is geographically highly vulnerable to natural hazards. It is prone to a host of natural hazards such as cyclone, monsoon storm surge, coastal erosion, sea level rise, tsunami, flood, drought, lightning, landslide (debris flows), land subsidence (due to tunnel erosion or soil piping) and earthquake. Kerala, being one of the most densely populated states (860 persons per square kilometres), is more vulnerable to greater damages and losses during disasters.

3.2 Classification of Hazards

As stated in National Disaster Management Plan (NDMP), hazards can be classified under the following 5 categories, which is used globally for Sendai target monitoring:

Geophysical: 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. Hydro-meteorological factors are important contributors to some of these processes.

Hydrological: Events caused by deviations in the normal water cycle and/or overflow of bodies of water caused by wind set-up (floods, avalanches etc.).

Meteorological: Events caused by short-lived/small to meso-scale atmospheric processes (cyclones, storms etc).

Climatological: Events caused by long-lived meso- to macro-scale processes (droughts, wildfires etc.)

Biological: Process or phenomenon of organic origin or conveyed by biological vectors, including exposure to pathogenic micro-organisms, toxins and bioactive substances that may cause loss of life, injury, illness or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage. (disease epidemics, insect/animal plagues etc.)

Classification by Causes

From the perspective of causes, hazards can be divided into two types, that is, hazards caused by natural factors and hazards caused by human factors (anthropogenic hazards) that are associated with natural environments.

Natural hazards

Natural hazard events can be characterized by their magnitude or intensity, speed of onset, duration, and area of extent. For example, earthquakes have short durations and usually affect a relatively small region, whereas droughts are slow to develop and fade away and often affect large regions. In some cases hazards may be cascaded, as in the flood caused by a hurricane or the tsunami that is created by an earthquake.

Anthropogenic Hazards

Man-made and technological hazards are events that are caused by humans and occur in or close to human settlements. They include conflicts, industrial accidents, transport accidents, environmental degradation and pollution.

3.2 Hazard profile of Kerala

The Kerala State Disaster Management Plan 2016, identifies all districts of Kerala as multi-hazard prone. Since Kerala has comparatively high density of population with characteristic scattered homestead development, the disaster risk assumes special significance, be it a rural or urban area. Kerala has a humid tropical climate, the dominant climatic phenomena being the South-West (June to September) and the North-East (October to December) monsoons. Kerala has an average annual precipitation of 3000 mm, with about 90% of the rainfall occurring during the six monsoon months. The high intensity monsoon storms cause heavy discharges in all the rivers and result in severe floods, making floods the most common of natural hazards that affects the State. Nearly 14.8% of the State is prone to flooding. (KSDMP 2016)

Apart from floods, the mountain regions of the state experience several landslides during the monsoon season. It is known that a total of 65 fatal landslides occurred between 1961 and 2009 causing the death of 257 individuals (KSDMP 2016). Landslides are a major hazard along the Western Ghats in Wayanad, Kozhikode, Idukki and Kottayam districts.

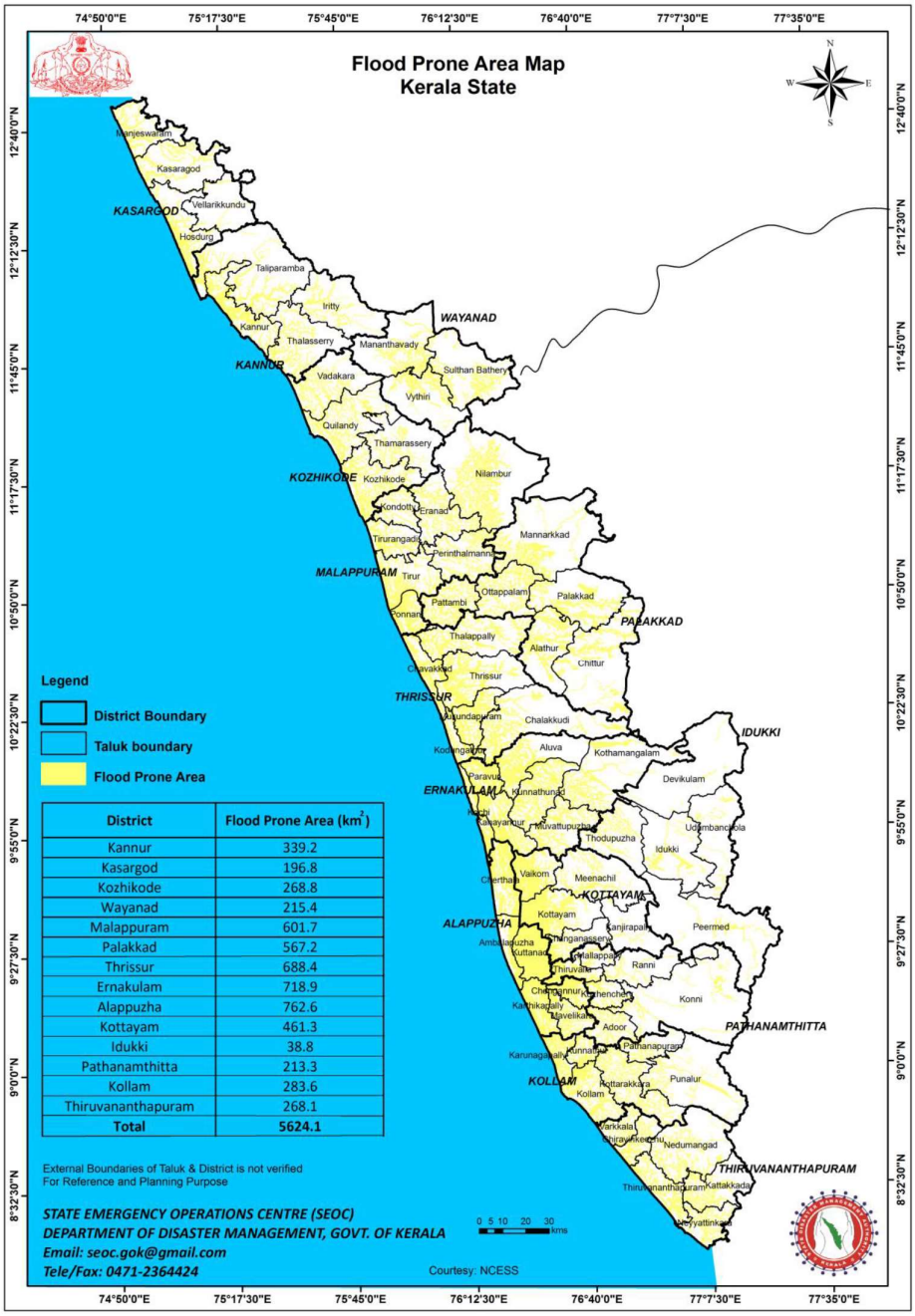
The state is also exposed to droughts and more than 50% of Kerala's land area is moderately to severely drought susceptible. Between 1871 and 2000, the state experienced several moderate drought years and 43 severe or disastrous droughts. Dry rivers and lowering water tables in summer have led to water scarcity both in urban and rural areas.

Kerala's State Disaster Management Plan assesses 39 types of known and reported hazard types in the State and they are grouped under two categories based on the major triggering factors, they being Naturally Triggered Hazards (Natural Hazards) and Anthropogenically Triggered Hazards (Anthropogenic Hazards). Not all of these hazards turn into disasters that are 'beyond the coping capacity of the community of the affected area'. These events may occur in isolation or in tandem or as cascading events. For example, a flood may cause many factories on its banks to be inundated that may release toxic substances into rivers and contaminate flood plains. A brief of the major natural hazards as mentioned in the Kerala State Disaster Management Plan, 2016 is given below:

- **Floods**

Floods are the most common of natural hazards that affect people, infrastructure and natural environment in Kerala. Riverine flooding is a recurring event consequent to heavy or continuous rainfall exceeding the absorptive capacity of soil and flow capacity of streams and rivers. This causes a watercourse to overflow its banks onto flood plains. Flood plains are therefore 'flood prone' and are hazardous if the developmental activities in them exceed an acceptable level. Frequency of inundation depends essentially on rainfall, channel slope, relative height of the banks, materials that make up stream banks and land use in flood plain. Reclamation and settlement in flood plain areas is a major cause of flood damage in Kerala. Smooth textured areas on either sides of major streams with high reflectance are often flood plains. The presence of meandering streams, terraces, minor interspersed water bodies etc. indicate low lying areas subjected to inundation. Changing nature of the flood plains both natural and manmade, loss of vegetation in upper catchments and land use practices that promote runoff are also to be taken into consideration while assessing flood proneness.

As per the KSDMP, 5642.68 km2 of area which is 14.52% of the total area of the state is prone to floods. In Alappuzha district more than 50% of area is identified as flood prone. These are mostly confined to the Kuttanad region that host seasonally waterlogged flat lands with waterways connected to Vembanad lake. The Kole lands of Thrissur district, the coastal tracts of Ernakulam and Malappuram districts and the western part of Kottayam district flanking Vembanad Lake are other major areas prone to floods. Even though Wayanad district is located in an elevated plateau region flood prone areas are noted in the broad flat bottom valleys and flood plains adjacent to Mananthavadi River. Idukki district is the least flood prone area in Kerala owing to the rugged topography and absence of flat bottom valleys.



District	Flood Prone Area (km²)
Kannur	339.2
Kasargod	196.8
Kozhikode	268.8
Wayanad	215.4
Malappuram	601.7
Palakkad	567.2
Thrissur	688.4
Ernakulam	718.9
Alappuzha	762.6
Kottayam	461.3
Idukki	38.8
Pathanamthitta	213.3
Kollam	283.6
Thiruvananthapuram	268.1
Total	**5624.1**

Figure 3:1 Flood susceptibility map of Kerala

Source: KSDMP 2016

Frequency and magnitude of floods in the state seems to be on the rise. Factors contributing to the increase in magnitude of floods are reclamation of wetlands and water bodies, increase in impermeable built-up area, increase in roads with impervious surfaces, deforestation in the upper catchments etc. Population pressure and flood plain occupancy has resulted in more exposure of life and property to floods. Urban flooding is also very common in most of the urban centres of the State. Lack of separate storm water drains and sewerage aggravate the situation. Flash floods are common in the hilly tracts of Kerala. Most

often flash floods are triggered by the occurrence of Debris Flows (landslides) during intense rainfall conditions.

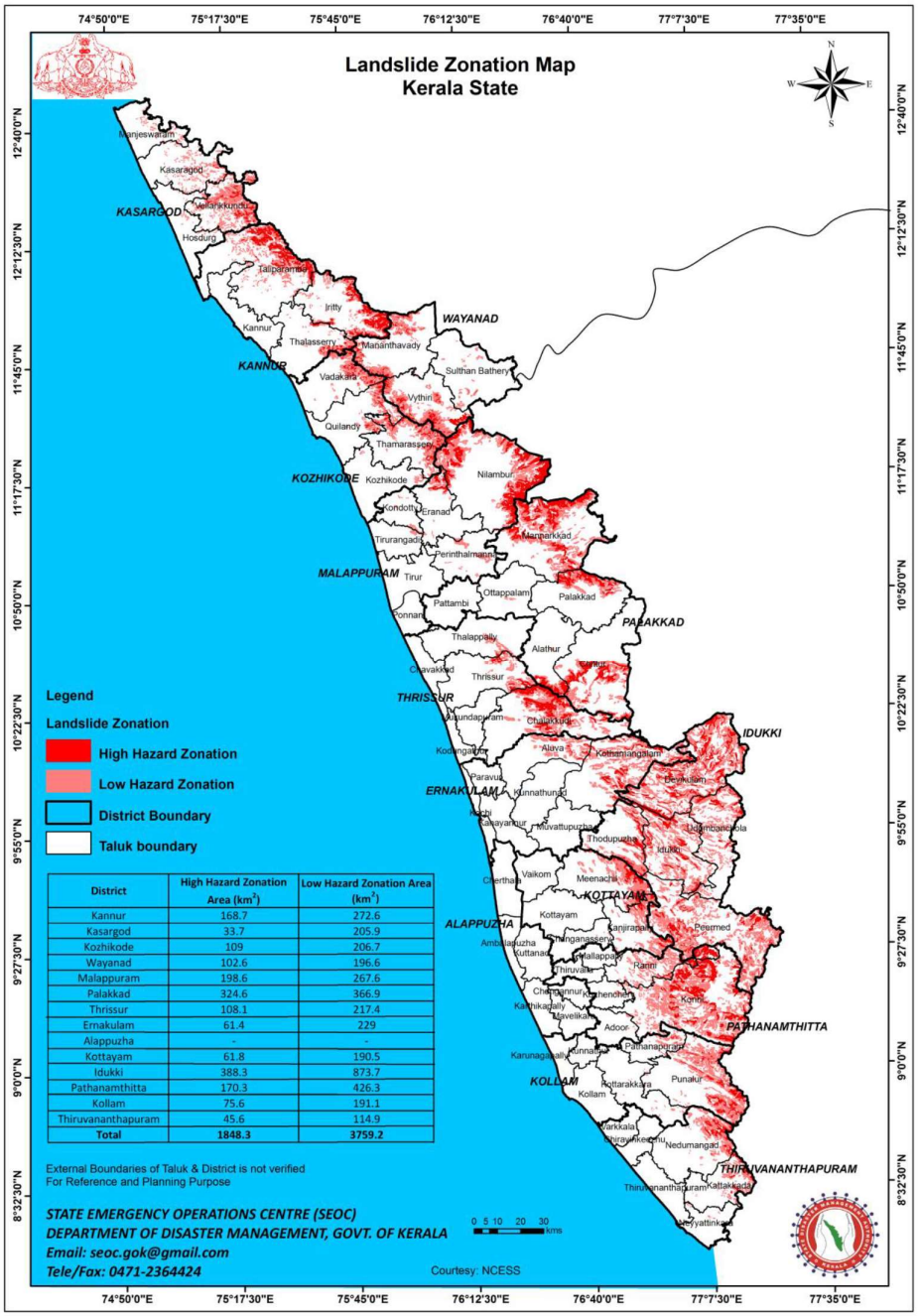
Population of 27 taluks of Kerala is highly vulnerable to riverine floods. These taluks are also those having the highest population density. Peermedu, Idukki, Devikulam and Vellarikundu taluks are the least vulnerable to flooding. The rest of the 45 taluks are moderately vulnerable. The major cities that frequently experience urban flooding are Thiruvananthapuram, Kochi and Kozhikode. Encroachment of river banks and infilling of paddy lands and wetlands increase the vulnerability to floods. Even during summer most of the urban cities are getting flooded.

- **Landslides**

The highlands of Kerala experience several types of landslides, of which debris flows are the most common. They are called 'Urul Pottal' in the local vernacular. The characteristic pattern of this phenomenon is the swift and sudden downslope movement of highly water saturated overburden containing a varied assemblage of debris material ranging in size from soil particles to boulders, destroying and carrying with it everything that is lying in its path. The west facing Western Ghats scarps that run the entire extent of the mountain system is the most prone physiographic unit for landslides (KSDMP 2016, Thampi et al., 1995). These scarp faces are characterized by thin soil (regolith) cover modified heavily by anthropogenic activity. Highlands of the region experience an annual average rainfall as high as 500 cm from the South-West, North-East and Pre-Monsoon showers.

The processes leading to landslides were accelerated by anthropogenic disturbances such as deforestation since the early 18th century, terracing and obstruction of ephemeral streams and cultivation of crops lacking capability to add root cohesion in steep slopes. The events have become more destructive given the increasing vulnerability of population and property (Kuriakose et al., 2009). As per the KSDMP, prolonged and intense rainfall or more particularly a combination of the two and the resultant persistence and variations of pore pressure is the most important trigger of landslides. The initiation of most of the landslides was in typical hollows generally having degraded natural vegetation. It is known that continuous and high intensity rainfall of about 4 hours may cause a steep rise in the perched water table up to critical levels in regolith filled bed rock depressions and the persistence of this level for nearly10 hours may lead to shallow landslides in the catchment (Kuriakose et al., 2008).

All except 1 of the 14 districts in the state are prone to landslides. Wayanad and Kozhikode districts are prone to deep seated landslides while Idukki and Kottayam are prone to shallow landslides. A very recent study indicates that the additional cohesion provided by vegetation roots in soil is an important contributor to slope stability in the scarp faces of the Western Ghats of Kerala (Kuriakose, 2010).



District	High Hazard Zonation Area (km²)	Low Hazard Zonation Area (km²)
Kannur	168.7	272.6
Kasargod	33.7	205.9
Kozhikode	109	206.7
Wayanad	102.6	196.6
Malappuram	198.6	267.6
Palakkad	324.6	366.9
Thrissur	108.1	217.4
Ernakulam	61.4	229
Alappuzha	-	-
Kottayam	61.8	190.5
Idukki	388.3	873.7
Pathanamthitta	170.3	426.3
Kollam	75.6	191.1
Thiruvananthapuram	45.6	114.9
Total	**1848.3**	**3759.2**

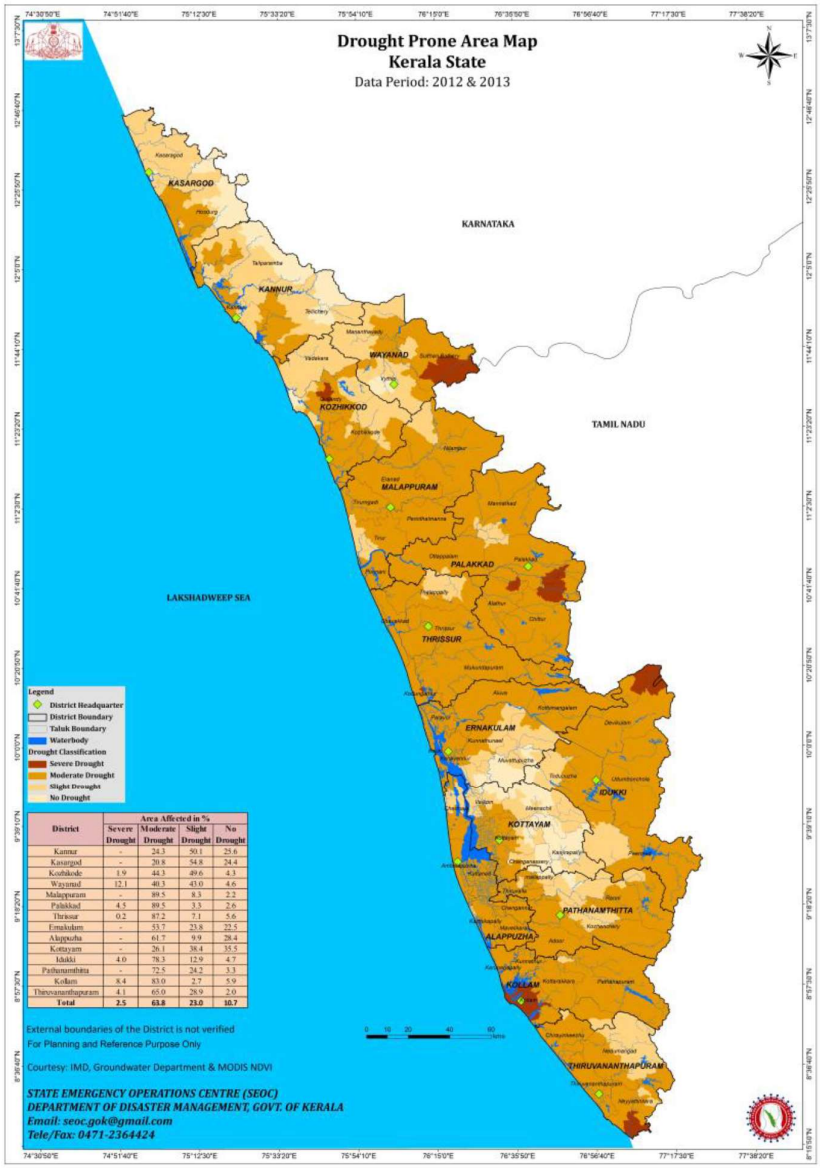
Figure 3:2 Landslide susceptibility map of Kerala

Source: KSDMP 2016

- **Drought**

The State of Kerala experiences seasonal drought conditions every year during the summer months (KSCSTE, 2007). Even in the years of normal rainfall, summer water scarcity problems are severe in the midland and highland regions. With the implementation of a number of irrigation projects, the idea of drought in Kerala slowly shifted to unirrigated paddy, and upland crops. The water scarcity in summer is mainly reflected in dry rivers and lowering of water table. This adversely affects the rural and urban drinking water supply. In the period 1881 to 2000, Kerala experienced 66 drought years. It is noticed that aridity index

of different parts of the state has increased which is an indication of increase in the frequency of drought years. The changes in the land and water management practices affected the fresh water availability during summer months. Although the deviation in the annual rainfall received in Kerala, in any year from the long term average is very small, there is considerable variation in the rainfall availability during different seasons.



District	Area Affected in %			
	Severe Drought	Moderate Drought	Slight Drought	No Drought
Kannur	-	24.3	50.1	25.6
Kasargod	-	20.8	54.8	24.4
Kozhikode	1.9	44.3	49.6	4.3
Wayanad	12.1	40.3	43.0	4.6
Malappuram	-	89.5	8.3	2.2
Palakkad	4.5	89.5	3.3	2.6
Thrissur	0.2	87.2	7.1	5.6
Ernakulam	-	53.7	23.8	22.5
Alappuzha	-	61.7	9.9	28.4
Kottayam	-	26.1	38.4	35.5
Idukki	4.0	78.3	12.9	4.7
Pathanamthitta	-	72.5	24.2	3.3
Kollam	8.4	83.0	2.7	5.9
Thiruvananthapuram	4.1	65.0	28.9	2.0
Total	2.5	63.8	23.0	10.7

Figure 3:3 Drought susceptibility map of Kerala

Source: KSDMP 2016

As per the KSDMP, more than 50% of the land area of the state is moderately to severely drought susceptible.

- **Coastal erosion**

The 589.5 km coast of Kerala is one of the most densely populated land areas in the country but a major stretch of Kerala's coastline is eroding rapidly. This coastline is exposed

to high waves, storm surges, Tsunami and 'Kalla kadal', a phenomenon that occurs during the pre-monsoon season and monsoon breaks along the Kerala coast inundating low lying coasts for a few days. During high tides the water level can reach 3-4 m above Maximum Water Level (MWL).

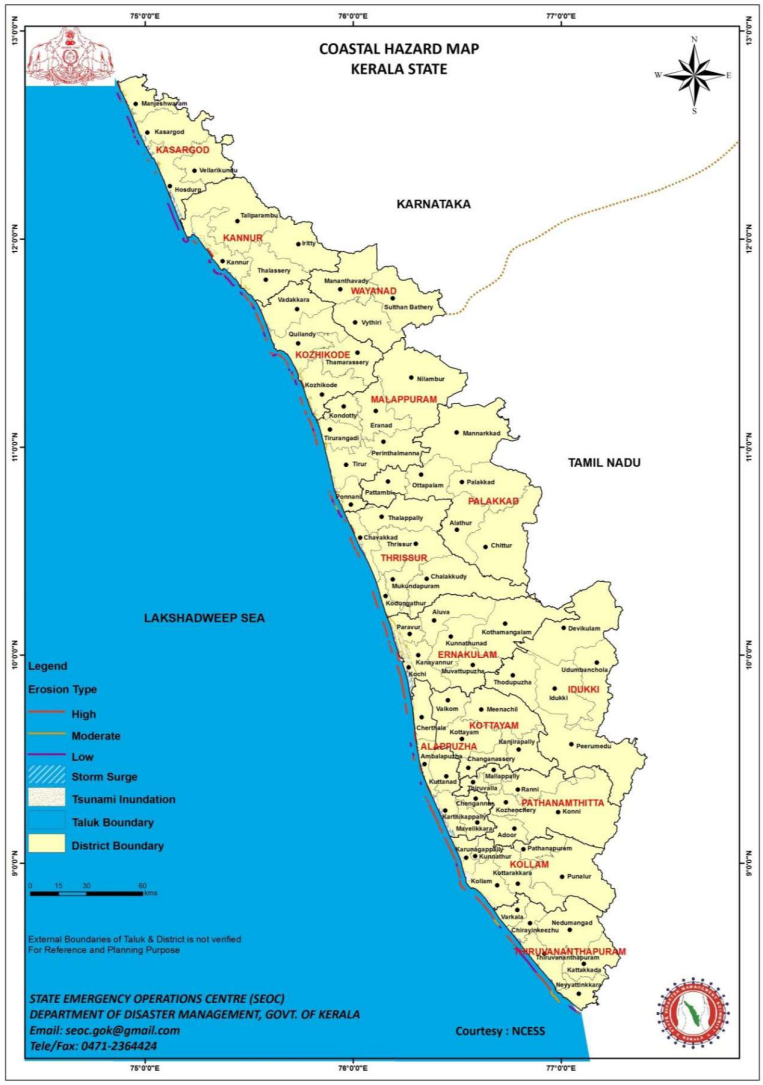


Figure 3:4 Coastal hazard susceptible area of Kerala

Source: KSDMP 2016

Salt water intrusion during the summer season due to rampant ground water exploitation and tidal effects also affects the coastal community. Coastal erosion results in the loss of life and property of the coastal fisher population who are one of the most downtrodden communities of the state. Every year hundreds of houses are damaged due to the furry of the sea.

Department of Irrigation has identified several stretches spread along the nine coastal districts of Kerala as erosion prone. Of the nine coastal districts, the coastline of Thiruvananthapuram district is the most prone to erosion. About 23% of Thiruvananthapuram coastline is affected by erosion. About 310 km of the coastal stretch of

Kerala has seawalls, riprap revetments, groynes etc. The other districts that are highly prone to erosion, but are partly safeguarded by artificial means are Kollam and Ernakulam.

- **Wind**

Wind speed is high along the coast of Kerala, often exceeding 50 km/hr. This causes significant damage to life and property. Although cyclones are rare in the state, Gustnados are recurrent. "Gustnadoes" typically appear as a swirl of dust or debris along the "gust front" of a thunderstorm. Water sprouts have been reported from various coastal areas of the state. Gustnadoes account for a large number of the weakest tornado reports each year. Their localized impact and damaging effects have allowed them to be counted as tornadoes but most are probably not "true" tornadoes. The strong, straight line winds that can follow behind the gustnadoes are likely to cause more damage than the gustnadoes themselves. Cyclones Ockhi that occurred in 2017 resulted in the death of nearly 60 people.

Figure 3:5 Gustnado at Kollam, 2016
Source: KSDMP 2016

- **Earthquake**

India has been divided into 4 seismic zones namely zone II, zone III, zone IV and zone V according to the maximum intensity of earthquake expected. The state has been included in the earthquake Zone III, where the maximum expected magnitude is 6.5. Though the state of Kerala had experienced several occurrences of earthquakes since the historic times, the events that occurred during the past half-century were well documented, because of the availability of seismic records. A large number of micro earthquakes or mild tremors have been recorded many parts of the State.

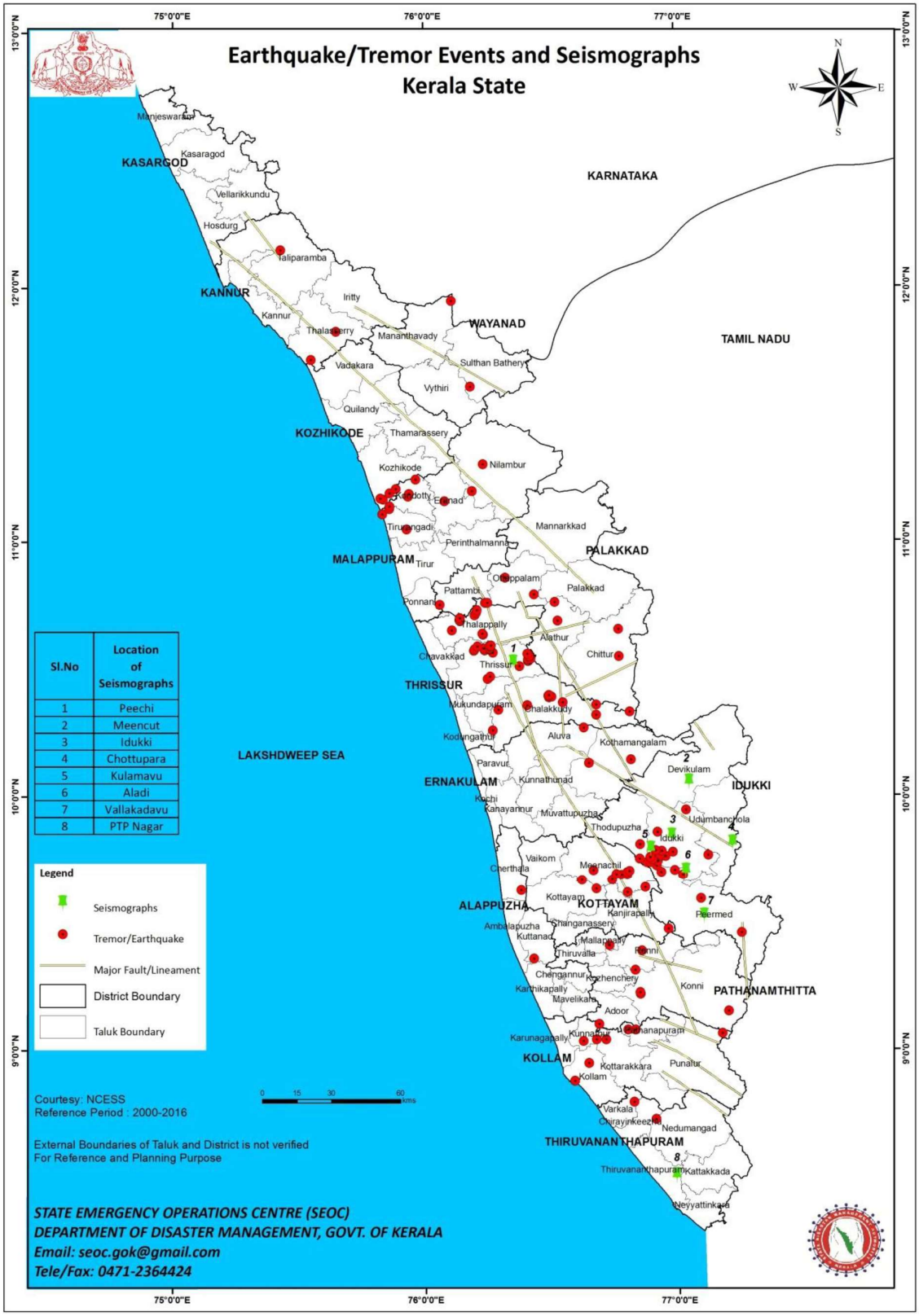


Figure 3:6 Lineaments and past earthquake locations in Kerala

Source: KSDMP 2016

- **Soil piping**

Land subsidence due to tunnel erosion or soil piping which is a slow hazard, is recently noticed to be affecting the hilly areas in the state. This often goes unnoticed and is a hazard with potential of causing landslides, infrastructural damages and crop loss covering vast areas in the high land regions of the state. Soil piping or "tunnel erosion" is the formation of subsurface tunnels due to subsurface soil erosion. They may lie very close to the ground surface or extend several meters below ground. Once initiated they become cumulative with time, the conduits expand due to subsurface erosion leading to roof collapse and subsidence features on surface.

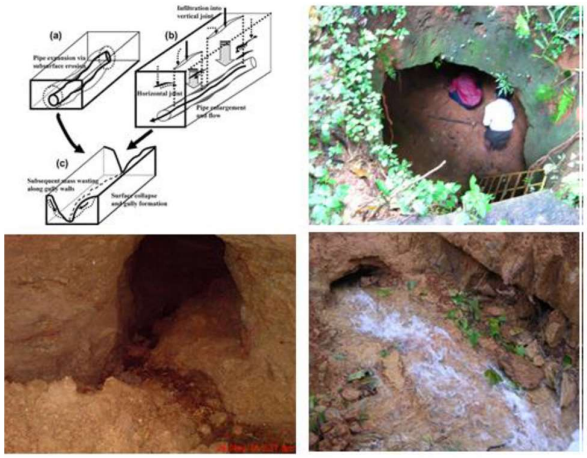


Figure 3:7 Soil Piping
Source: KSDMP 2016

During the last decade many soil piping incidences were reported from different places in Kerala. In 2005, National Centre for Earth Science Studies (NCESS) investigated land-subsidence in the Chattivayal locality of Thirumeni village, Kannur, Kerala. It was found out to be due to soil piping process. This was the first major incidence reported by NCESS on soil piping. At that time it was thought that it may be an isolated incidence. But subsequently such incidences were reported from many other places in Kerala.

3.3 Recent History of Natural Disasters in the State

Natural disasters, particularly the floods and landslides have played a key role in the evolution of contemporary Kerala. In Kerala, within a short period of last 80 years, there has occurred a rapid socio-economic transformation from an agrarian society to a highly urbanized consumerist society. Parallel to this societal transformation, the population pressure along the coastline forced the then marginalized sections of the community to migrate from the coastal belt to the relatively inhospitable terrain of the Western Ghats (George and Chattopadhyay, 2001). As per the KSDMP, in the past 80 years the coastal plains recorded a population growth of 306%, whereas the highlands, foot hills and uplands together experienced a growth of 1342% (Nair et al., 1997). This population with a density of 860 persons/sq.km (Census of India 2011) is more or less widely distributed across all geomorphic units of the state, exposing them to multiple hazards. Along with that, narrow roads, high density of road network, density of coastal population and the general higher standard of living of the public as compared to the rest of the country are factors that increase the vulnerability of the population to disasters.

Figure 3:8 A house affected by 2004 Tsunami in Kerala

The tsunami that took shape in the Indian Ocean in 2004 ravaged Kerala also, killing over 170 people and completely destroying more than 6,000 houses in the coastal Kerala. The cyclone Ockhi that occurred in 2017 also resulted in the death of nearly 60 people. The floods and landslides in 2018 shattered almost the entire state. The landslides of 2019 in the Malabar region were more catastrophic compared to the 2018 landslides in the region.

Figure 3:10 An aerial view of flooded Chengannur
Source: www.onmanorama.com

The worst known flood event in Kerala in the last 100 years occurred when Periyar River breeched its banks in 1924. The flood popularly known as the great flood of 99 (1099 Malayalam Era) divides the memory of the nonagenarians of Kerala into before and after the floods of 99. The flood of 99 devastated Travancore, Kochi and Malabar regions. Many districts of the present day Kerala were deeply submerged in water by this flood from Thrissur to Alappuzha and even parts of Idukki. Multiple major landslides were triggered in Karinthiri Malai probably due to toe erosion which irreparably damaged the then Munnar road. Munnar town was devastated and the Kundala Valley Railway, one of India's fist monorail services, was completely destroyed. Mountain Karinthiri was washed away and the road that connected Kochi with Munnar was destroyed forever. Present day road from Ernakulam to Munnar was constructed after this incident through an alternate alignment. Another flood that occurred in 1961 also resulted in heavy damage.

Figure 3:9 Landslide in Munnar, Kerala 2018 ©eos.org

Between 1961 and 2016 a total of 295 valuable lives were lost in 85 major landslide events. The most severe, in terms of fatalities, was the Amboori landslide (Thiruvananthapuram) of 9th November 2001 that resulted in 38 casualties. On 14th October, 2012 in Puthusherry West Village of Palakkad district a major landslide covering 2.65 km2 occurred in the forest area adjoining the Coimbatore-Palakkad railway line. Population of 10 taluks of Kerala is highly vulnerable to landslides in terms of population density; 25 taluks come under moderately vulnerable category and 14 come under least vulnerable category.

In the recent past, until 2012, the state had not experienced severe meteorological, agricultural and hydrological drought. A 29% deficit in the monsoon season (June to December) in 2012 lead to agricultural and hydrological drought which peaked during the period August 2012 to May 2013. For the first time, Kerala was mapped as mild to moderately arid by Indian Meteorological Department in December 2012. Prior to this, official declaration of drought had happened in March 2010 and December 2003. In 2010,

17 taluks of the state were declared as drought affected while in 2003, 7 districts, 7 taluks and 119 villages were declared as drought hit. Other known meteorological drought years were 1983, 1986, 1987, 1992, 1997, 1998, 2002 and 2004.

Major Natural Disasters reported in Kerala

Year	Major Natural Disasters
1341	The Periyar flood destroys Muziris
1924	The great flood of 99 devastates Travancore, Kochi and Malabar
1961	Floods and destruction by a 56 per cent above-normal rainfall
2001	Landslides in Amboori claim 38 lives
2004	Indian Ocean tsunami ravages costal districts
2013	Floods and landslides spread havoc in Idukki district
2017	Cyclone Ockhi, Thiruvananthapuram
2018	Floods and landslides throughout Kerala
2019	Floods and landslides throughout Kerala

Table 3:1 Probable hazards in the municipalities of Manimala –Pampa -Achenkovil Basin (Extract from a draft prepared by KSDMA 2022)

District	LSG Name	Flood RI	Landslide RI	Drought RI	Lightning RI	EQ RI	Coastal RI	Forest Fire RI	Heat RI
Alappuzha	Alappuzha Municipality	Moderate Risk	No Risk	High Risk	Moderate Risk	High Risk	Low Risk	No Risk	High Risk
Alappuzha	Chengannur Municipality	High Risk	No Risk	Moderate Risk	Moderate Risk	Moderate Risk	No Risk	No Risk	High Risk
Alappuzha	Haripad Municipality	High Risk	No Risk	Moderate Risk	Moderate Risk	Low Risk	No Risk	No Risk	High Risk
Alappuzha	Kayamkulam Municipality	Moderate Risk	No Risk	High Risk	Moderate Risk	Moderate Risk	No Risk	No Risk	High Risk
Alappuzha	Mavelikara Municipality	Moderate Risk	No Risk	Moderate Risk	Moderate Risk	Low Risk	No Risk	No Risk	Low Risk
Kottayam	Changanassery Municipality	Moderate Risk	No Risk	High Risk	Moderate Risk	Moderate Risk	No Risk	No Risk	High Risk
Pathanamthitta	Adoor Municipality	Low Risk	No Risk	Moderate Risk	Low Risk	Low Risk	No Risk	No Risk	High Risk
Pathanamthitta	Pandalam Municipality	High Risk	No Risk	High Risk	Moderate Risk	High Risk	No Risk	No Risk	High Risk
Pathanamthitta	Pathanamthitta Municipality	Moderate Risk	Low Risk	Moderate Risk	Moderate Risk	High Risk	No Risk	No Risk	High Risk
Pathanamthitta	Thiruvalla Municipality	High Risk	No Risk	Moderate Risk	Moderate Risk	Moderate Risk	No Risk	No Risk	High Risk

Impact of Climate change

Kerala anticipates the effects of global climate change to bring an increase in extreme rainfall and with it the probability of urban flooding during the north-east monsoon period, a water shortage during peak summer months, along with a subsequent increase in urban temperature, and a potential increase in coastal erosion along the highly populated coastline due to rising sea-levels. The impacts of climate change aggravated by lack of adaptive capacity of the State to floods, droughts, and mudflows are expected to increase in both frequency and severity. Another impact being witnessed is progressive coastal erosion affecting nearly 63% of the State's 580 km of coastline.

4. DISASTER MANAGEMENT SYSTEM IN KERALA

4.1 Introduction

Like most other states in the country, disaster management initiative in Kerala had also been traditionally post-disaster relief and rebuilding centric. Following the enactment of National Disaster Management Act in 2005, disaster management related initiatives in Kerala have received wider consideration particularly in constituting various institutional set ups and drafting policy framework on disaster management. Through various provisions of the National Disaster Management Act, 2005, the state developed disaster management framework at various levels.

Kerala has established a Policy Techno – Legal Framework for disaster management in the State which creates an enabling regulatory environment and compliance regime and facilitates the activities of different phases of disasters. The policy level initiatives include State Disaster Management Rules, State Disaster Management Policy, State Disaster Management Plans, District Disaster Management Plans for 14 districts, various department disaster management plans etc.

Kerala State Disaster Management Rules, 2007 emphasises the whole structure of disaster management spectrum in the state including constituting the powers and function of various state institution such as SDMA, DDMA, State Executive Committee etc.

As the guiding principle of the State for disaster management, the State Disaster Management Policy is formulated by the Department of Revenue and Disaster Management and promulgated by the State Disaster Management Authority. The Policy underscores an integrated approach to disaster management covering all phases of managing disasters such as prevention, mitigation and preparedness (pre-disaster phases), Disaster response phase (during disaster) and recovery (Post Disaster phase) emphasizing the roles and responsibilities of each institutional set up of the state in each stages of the Disaster Management.

The State Disaster Management Plan 2016, calls for a framework for mainstreaming disaster management in the State and necessitates the departments of the State Government to give priority to hazard identification and risk assessment in their plans and schemes and allocation of a portion of plan funds for efforts that directly or indirectly help in disaster management.

All the districts in the state have prepared their respective District disaster management plans as per the guideline of the National Disaster Management Authority.

The contents of this chapter is mostly adopted from the Kerala Disaster Management Plan 2016, the Kerala State Disaster Management Policy 2010, and the Kerala State Disaster Management Rules, 2007.

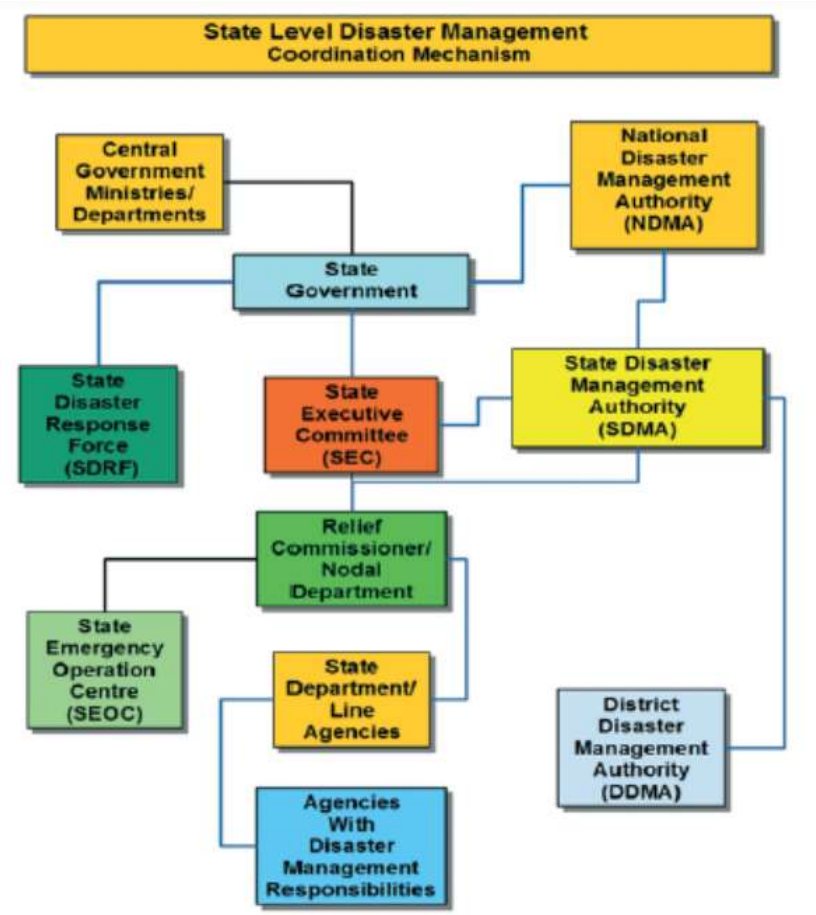


Figure 4:1 Disaster Management System in Kerala

Source: KSDMA

4.2 Institutional Arrangement

At the state level, three high profile entities are established for the multi-sectoral coordination of disaster management: State Disaster Management Authority (SDMA) and State Executive Committee (SEC) and State Crisis Management Committee. The mission of these entities is to provide policy and management guidance as well as coordination activities at the time of emergency situation.

4.2.1 Kerala State Disaster Management Authority

Kerala State Disaster Management Authority functions as the apex decision-making body and facilitate, co-ordinate, review and monitor all disaster related activities in the state including capacity building. The Authority lays down the State Disaster Management policy and guideline to be followed by the government departments and approve the State Disaster Management Plan and Departmental plans. The Authority is provided with statutory powers to facilitate, coordinate and monitor the activities related to disaster management utilizing the resources and expertise of relevant Government departments, district administration, local authorities, non-governmental organizations, the public sector, international development agencies, donors and the community.

4.2.2 Department of Revenue and Disaster Management

Presently the lead role in disaster management in the state including response, relief and rehabilitation is vested with the Revenue and Disaster Management Department which was known as the Department of Revenue until 2002. It has the prime management role of all types of disasters that include both natural and manmade. It has the role of inter-departmental coordination, planning and response to disaster management. It is the nodal department for management of all types of natural disasters that include water and climate related disasters and geological disasters. The scope of Department of Revenue has been enhanced to include prevention, mitigation and preparedness aspects of Disaster Management apart from its traditional responsibility of relief and rehabilitation. Under Revenue and Disaster Management Department two leading, specialized line agencies are created, State Emergency Operation Centre (SEOC) and Institute of Land and Disaster Management (ILDM).

4.2.3 State Emergency Operations Centre (SEOC)

SEOC is the state nodal office for the collection, compilation and analysis of any data necessary for disaster risk assessment from all government departments and institutions on a no cost basis.

SEOC is for the disaster related information dissemination including warning and precautions. It is also the State Drought Monitoring Cell.

Objectives of SEOC

- Conduct and regularly update the HVRA of the state
- Prepare the State and District DM Plans
- Conceptualize and implement hazard early warning systems
- Create and maintain the disaster database of the state
- Undertake research projects on topics relevant to disaster risk reduction
- Foster research collaboration with external agencies
- Emergency Coordination
- Preparation of calamity memoranda for submission to Government of India

4.2.4 Disaster Management Centre of Institute of Land and Disaster Management

The Institute of Land and Disaster Management (ILDM) is the administrative training institute of Land Revenue Department. The ILDM houses the Disaster Management Centre.

ILDM is responsible for training and research, documentation and development of state level information base, generation of technical data banks, generating short and long-term rehabilitation measures and for imparting appropriate training to State and District level officials on disaster management. This institute promotes sharing and dissemination of specialized knowledge on disaster management among various implementation agencies, NGOs, private sector and the community in the state.

Functions

- Training and capacity building of various stakeholders in disaster management
- Offsite training and capacity building of various stakeholders in disaster management
- Preparation of Standard Operating Procedures for anthropogenic hazards (petro-chemical emergencies and festivities)
- Maintenance and upkeep of the disaster management department's VHF radio network in the State

4.2.5 Nodal Departments in Disaster Management (KSDMP, 2016)

Other nodal departments on disaster management are Home, Public health, Agriculture, Animals Husbandry, Forest, Factories & Boilers, Water Resource and Public Works Department - having roles in handling disaster in their respective areas. Table shows the nodal departments in the state dealing with major disasters and respective roles.

Table 4:1 State nodal departments dealing with major disasters

Sl. No	Category	Type	Preparedness	Response	Recovery	Mitigation
1	Natural Hazards	Flood	WR	LR	LR	WR
2		Land slides	LSG	LR	LR	LSG
3		Drought	WR	LR	LR	LSG & Agri
4		Coastal hazards	LSG	LR & Fi	LR & Fi	WR & Fi
5		Wind	LSG	LR	LR	LSG
6		Lightning	LSG	LR	LR	LSG
7		Earthquakes	LSG	LR	LR	LSG
8		Human epidemics	HS	HS	HS	HS
9		Plant disease epidemics and pest attack on crops	AGD	AGD	AGD	AGD
10		Avian epidemics	AH	AH	AH	AH
11		Animal epidemics	AH	AH	AH	AH
12		Pest attack of human habitations	AGD	AGD	AGD	AGD
13		Forest Fire	FD	FD	FD	FD
14		Meteorite /asteroid impacts	LR	LR	LR	LR
15		Soil Piping	LSG	LR	LR	LSG
16		Heat wave/sunburn/sunstroke	LR & LD	HS	HS	LR & LD
17		Natural background radiation	HS	HS	HS	HS

1	**Anthropogenic hazards**	Stampedes	P	P	P	P
2		Fire cracker accidents	LR & P	P & FS	P & FS	LR
3		Petro-chemical transportation accidents	P & OC	P & OC	P & OC	P & OC
3		Industrial accidents	PB & FB	PB & FB	PB & FB	PB & FB
4		Dam break	KSEB & WR	KSEB & WR	KSEB & WR	KSEB & WR
5		Dam spillway operation related floods & accidents	KSEB & WR	KSEB & WR	KSEB & WR	KSEB & WR
6		Oil spill	PCB, OC, OHA	PCB, OC, OHA	PCB, OC, OHA	PCB, OC, OHA
7		Road accidents involving civilian transport vehicles	P	P	P	P
8		Human induced forest fire	FD	FD	FD	FD
9		Human-animal conflicts	FD & LSG	FD & LSG	FD & LSG	FD & LSG
10		Fire accidents in buildings and market places	LSG & FS	LSG & FS	LSG & FS	LSG & FS
11		Boat capsizing	TD, IND & KWTC	TD, IND & KWTC	TD, IND & KWTC	TD, IND & KWTC
12		Accidental drowning	SYW & TD	FS	FS	SYW & TD
13		Building collapse	LSG & PWD	FS	FS	LSG & PWD
14		Hooch accident	E	E	E	E
15		Air accidents	AAI	AAI	AAI	AAI
16		Rail accidents	IR	IR	IR	IR
17		Terrorism, riots and Naxalite attacks	P	P	P	P
18		Nuclear and radiological accidents	RS & BARC	RS & BARC	RS & BARC	RS & BARC
19		Space debris impacts	P	P	P	P
20		Biological accidents	HS, FSa	HS, FSa	HS, FSa	HS, FSa
21		Occupational hazards and recreational – area related hazards	LSGD, LD & TD	LSGD, LD & TD	LSGD, LD & TD	LSGD, LD & TD

22		Accidents in Armed forces premises and assets	AF	AF	AF	AF
Disaster occurring outside the state's administrative boundaries in which tourists from Kerala of non-residential Keralaites are affected			SDMA of the Respective State and NORKA		As decided by SEC or KSDMA	
AAI: Airport Authority of India; AF: Armed Forces (Indian Army, Navy, Air Force, Coast Guard, Indo Tibetan Board Police, Central Reserve Police Force; Defence Security Corps); AG: Agriculture Department; AH: Animal Husbandry; BARC: Baba Atomic Research Centre; E: Excise Department; FB: Factories and Boilers Department; FD: Forest Department; Fi: Fisheries; FS: Fire and Rescue Services; FSa: Food Safety; HS: Health Services; IND: Inland Navigation Department; IR: Indian Railway; KSEB: Kerala State Electricity Board Ltd.; KWTC: Kerala Water Transport Corporation; LD: Labour Department; LR: Land Revenue Department; LSG: Local Self-Government; P: Police; WR: Water Resources Department; OC: Oil Companies; OHA: Oil Handling Companies; PCB: Pollution Control Board; PWD: Public Works Department; RS: Radiation Safety Department; SYW: Sports & Youth Welfare Department; TD: Tourism Department						

4.2.6 Disaster Response Force

For the purpose of specialized response to threatening disaster situations, State Disaster Response Force has been constituted with headquarters at Peerumedu Taluk in Idukki District. It has a well-trained force with strength of 100 members deployed in Trivandrum, Ernakulam, Thrissur and Kannur ranges of the police. This force functions under the guidance of Home Department. Moreover, a Regional Response Centre of National Disaster Response Force is also set up in Kozhikode, in addition to the Seasonal Response Centre in Idukki.

4.2.7 District Disaster Management Authorities

At the district level, the District Disaster Management Authority is the organization to take all measures for the purpose of disaster management covering all 14 districts of Kerala. The Authority (DDMA) is chaired by the District Collector, and such number of other members, not exceeding seven. The District Authority acts as the district planning, coordinating and implementing body for disaster management and take all measures for the purposes of disaster management in the district in accordance with the guideline laid down by the National Authority and the State Authority. It is empowered to coordinate disaster management activities and mobilize resources of all relevant Departments at district level.

4.2.8 District Emergency Operations Centre

DEOCs are functional in all Districts in the State. The DEOCs functions in close proximity to the Office of the District Collector in the respective collectorates.

4.2.9 Taluk Control Rooms

Taluk Control Rooms are operationalized during the monsoon season or based on the need as determined by the DEOC or SEOC. The Taluk Control Rooms functions in the Taluk Office

4.2.10 Village Office

All Village Officers of the State have Closed User Group mobile phone numbers provided by the Government. In addition, most village offices are equipped with internet facilities. Based on the hazard susceptibility, villages have been selected and are equipped with VHF Radio Network.

4.2.11 Local Authorities

Local self-governments work in close harmony with various government departments under the supervision of District Disaster Management Authority. They are responsible for ensuring compliance to various disaster management specifications and codes stipulated by relevant agencies based on hazard zonation and risk and vulnerability assessments. The local authorities shall coordinate community based disaster preparedness activities of the district.

Local authorities should conduct detailed damage assessment and support the government departments in implementing the Post Disaster Recover Activities. The involvement of local bodies and members of Panchayath Raj Institutions is extremely important in effective implementation. The local bodies should ensure inclusion of all affected persons; evolve mechanisms to avoid duplication and to couple rehabilitation and reconstruction with regular development projects.

4.3 Role and Responsibilities of other Stakeholders

Some of the key roles of the stakeholders in DM as provided in KSDMP 2016 are listed below:

4.3.1 State Government

- The State Government shall ensure that mainstreaming disaster management ie the methods and means of integrating disaster risk reduction measures into development plans is scrupulously implemented
- Specific budgetary heads of accounts are made available to all departments for allocating funds for disaster management as per Section 39 (c) of DM Act, 2005 which amounts to at-least 10% of the department's annual plan budget
- The State Government shall ensure that there is a professionally trained virtual cadre of officers in all the departments of the State for disaster management

4.3.2 Public Works Department

- Conduct structural audit of all public buildings in the State
- Conduct structural audit of all bridges in the PWD roads
- Identify and enlist life line buildings and priority buildings in the state and prepare a retrofitting plan for the buildings based on the structural audit report as required
- Provide technical support and expertise for repair, restoration and reconstruction of public infrastructure

- Create a quick response team for responding to building collapse and bridge collapse
- Ensure prompt construction of new temporary roads and bridges for diverting traffic from the affected area
- Prepare for construction of temporary facilities like that of medical post, temporary shelters, etc. at short notice
- Ensure that vulnerable PWD roads as identified in the vulnerability assessment annexures are made disaster resilient

4.3.3 Local Self-Government Department Engineering Wing

- Conduct structural audit of all bridges in the LSG roads
- Identify and enlist life line buildings and priority buildings in LSG control
- Provide technical support and expertise for repair, restoration and reconstruction of public infrastructure in LSG areas
- Implement road/bridge repair works as approved from State Disaster Response Fund as per norms
- Create a quick response team for responding to building collapse and bridge collapse
- Ensure that vulnerable LSG roads as identified in the vulnerability assessment annexures are made disaster resilient

4.3.4 Dam Safety Authority

- Prepare and publish the operations manual of all spill ways in the state
- Ensure that worst case scenario dam break modelling in light of seismically induced dam break and exceedance of Peak Maximum Flood are prepared and vulnerability assessment based on the model output is prepared and published.

4.4 Hazard Data Sources

4.4.1 National Database on Emergency Management, NRSC

NDEM is a platform for organizing disaster information created and hosted by National Remote Sensing Centre at www.ndmcc.nrsc.gov.in. https://ndem.nrsc.gov.in/ SEOC has dedicated human resource with expertise in managing the NDEM platform. NDEM offers a platform for updating geo-location based disaster information and cross analyzing the information against multiple layers.

National Database for Emergency Management (NDEM) serves as national repository of GIS based database for entire country coupled with set of Decision Support System tools to assist the State / Central Disaster Management Authorities in decision making during emergency situations.

It is established as a state-of-art facility with structured framework with multi-institutional participation to assist the disaster managers of all States/UTs for preparedness, hazard/risk zonation, damage assessment, and emergency response under the behest of Ministry of

Home Affairs (MHA), Government of India. NDEM services have been operationalised since 2013 providing timely information along with disaster specific products for effective decision making.

Current activities to support disaster management are: Near Real Time Flood & Cyclone monitoring & mapping in the country, Flood Hazard/Risk Zonation for Flood prone states, Spatial Flood Early Warning, forest fire alerts, landslide zonation and inventory, agricultural drought studies and Capacity Building & Institutionalization is being done to the stake holders.

4.4.2 India Meteorological Department Meteorological Centre, Thiruvananthapuram

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

4.4.3 Kerala State Disaster Management Authority (KSDMA)

The KSDMA, Thiruvananthapuram constituted under DM Act 2005 is a statutory non-autonomous body under the Chairmanship of the Chief Minister of Kerala. The website https://sdma.kerala.gov.in/ provides information related to governance (applicable legal frameworks and policies), hazard preparedness, mitigation, capacity building, and response system pertaining to disasters and disaster management.

Different types of hazards that are susceptible at state level and district level are specified in the website. Indicative maps showing extent of hazard prone areas or hazard zones for individual hazards such as flood, landslide, drought, soil piping, coastal hazard, natural radio activity, road accident hazard, major industrial accident hazard and major festival hazard are provided in the preparedness part. It is learnt from the discussions conducted with KSDMA that the data used for generating maps use DEM with 30m resolution and Toposheets with 20m contours.

The data available at KSDMA presently lacks the granularity that is required for city level spatial planning. Land use planning require maps showing hazard information with DEM having sub metre level accuracy for effective planning. Hence, KSDMA may be supported in generating local level hazard maps that could be used for spatial planning.

5. IDENTIFICATION OF HAZARDS, MAPPING & RISK ASSESSMENT

5.1 Hazard Identification

Identification of likely hazards that can occur in an area is one of the foremost important steps in managing Disaster. In the context of climate change and increasing environmental degradation, tracking hazard events and reliable forecast of future probabilistic hazards is challenging and require multi-disciplinary approaches.

State Disaster Management Authority (SDMA)/ State Executive Committee (SEC) and District Disaster Management Authorities are the authorities, empowered by the DM Act 2005, to provide necessary technical assistance or give advice to Local Governments in the state on management of disasters (Ref DM Act Section 22 (2) (k)).

The vulnerability of different parts of the State to different forms of disasters and the measures to be adopted for prevention and mitigation of disasters are to be included in the State Disaster Management Plan (Ref. DM Act Section 23 (4) (a) and (b)).

DM Act Section 31 (3) provides that the District Disaster Management Plan prepared by the District Disaster management Authority shall include (a) areas in the district vulnerable to different forms of disasters; and (b) measures to be taken, for prevention and mitigation of disaster, by the local authorities in the district and the Government departments at the district level.

District Disaster Management Plans are prepared for all the districts in Kerala and they do provide information on likely hazards in the districts. One such information i.e. Flood susceptibility map of Alappuzha district extracted from Alappuzha District Disaster Management Plan 2015 is given in Figure 5:1.

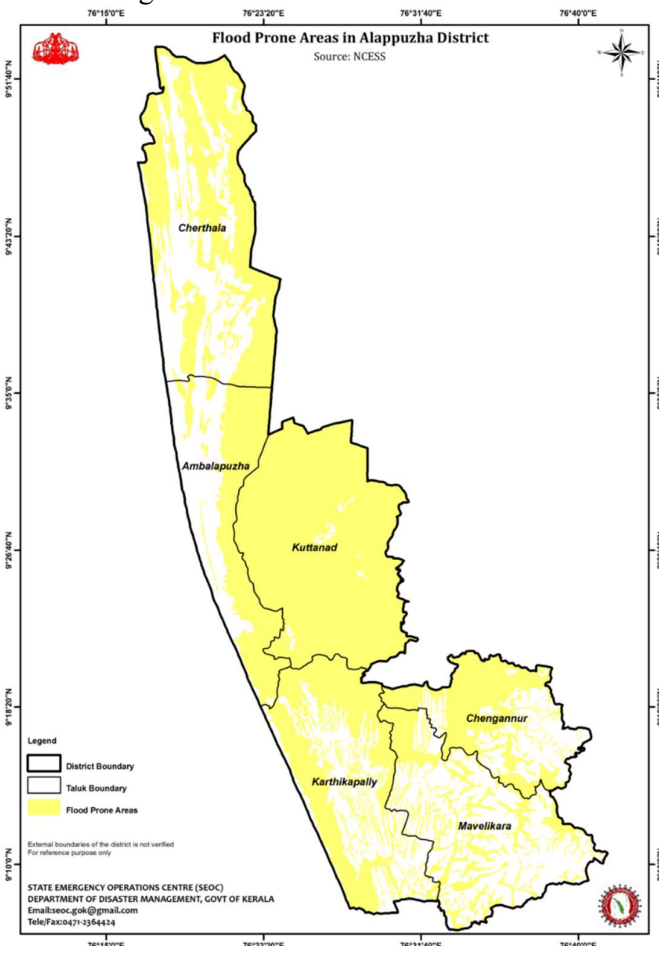


Figure 5:1 Flood Susceptibility Map of Alappuzha District

Local Disaster Management Plans prepared by the local Governments under the campaign "Nammal Namukkai" is another source of information on likley hazrads. However, these Plans are yet to be approved by the respective DDMAs.

Flood information of Chengannur municipality extracted from the Local Disaster Management Plan for Chengannur 2020 is given in Figure 5:2.

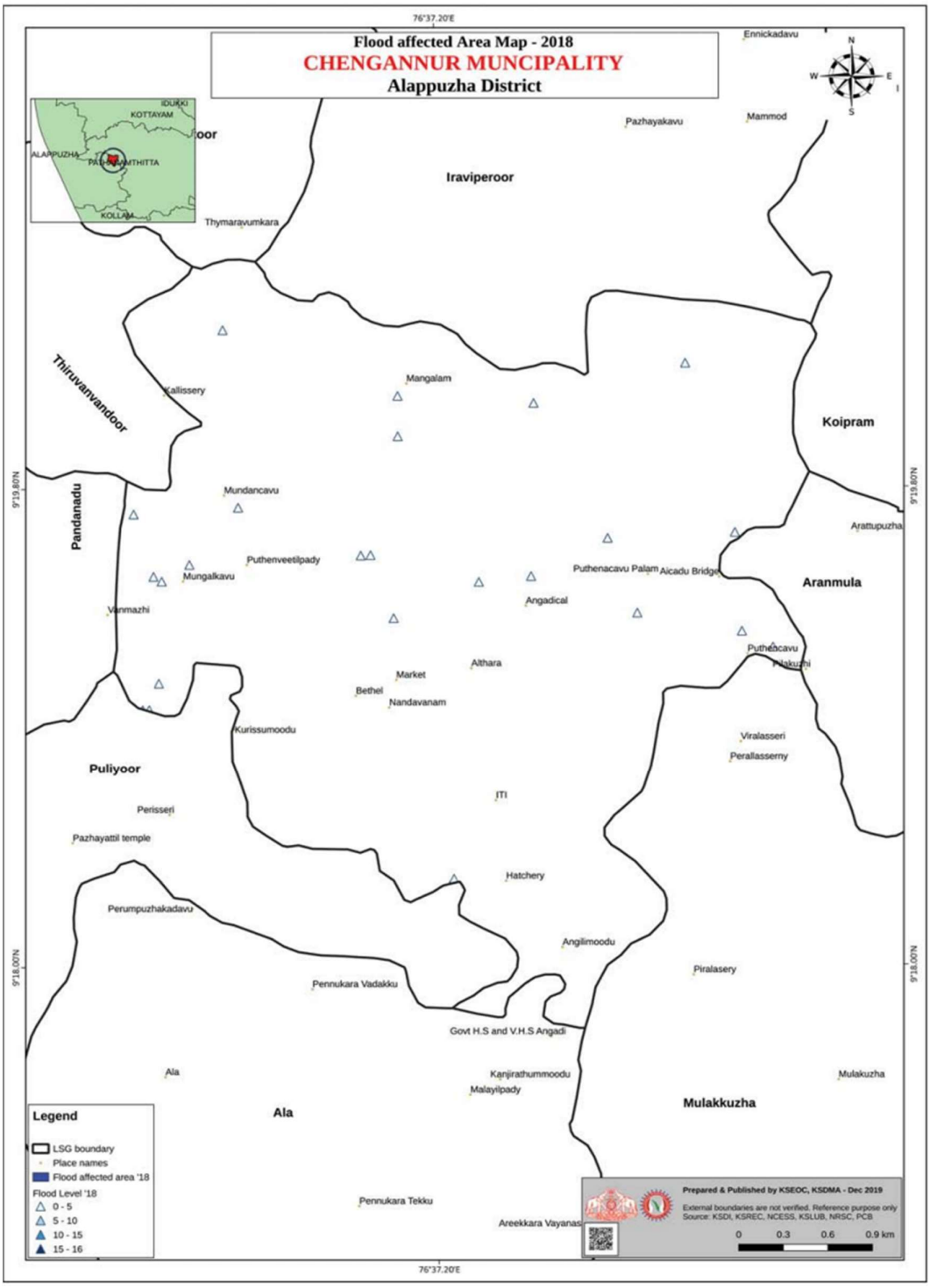


Figure 5:2 Flood affected area Map – 2018 of Chengannur Municipality

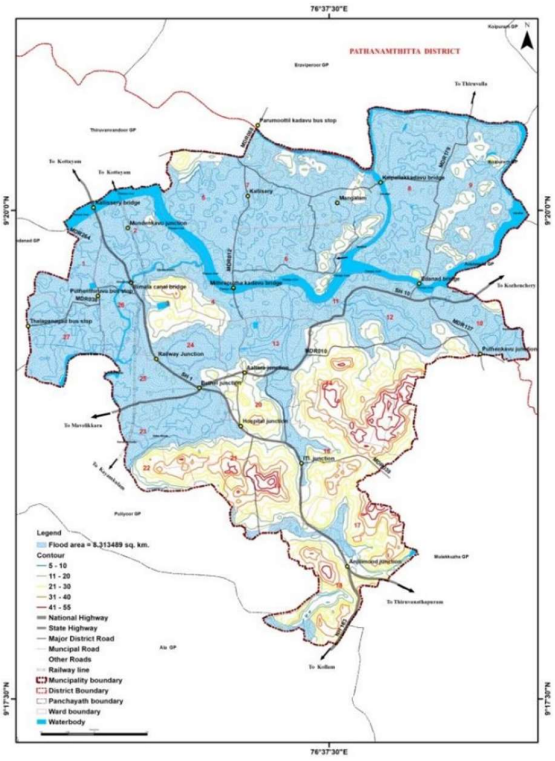


Figure 5:4 Chengannur 2018 flooded area

Experience from enforcing zoning regulations of Master Plans in the state suggests that development restrictions of any sort would be met with resentment. For the same reason, identification of hazard prone areas is sensitive and would be subjected to public scrutiny. In the pilot RIMP, prepared for Mananthawadi, hazard prone areas were identified largely from the post 2018 flood documentation titled "Rebuild Malabar". In the RIMP for Chengannur, hazard prone areas were identified through flood simulation in DEM supported by field data of 2018 floods. Figure 5:4 shows Chengannur 2018 flooded area with contours. Figure 5:3 shows the same flooded area superimposed on existing landuse (2019).

The Hazard Maps presently available in public domain, published by KSDMA, are learnt to be based either on Toposheet maps of 1:50,000 scale or Digital Elevation Model (DEM) of 30m resolution. These maps are good for planning purpose at the state/ district levels. For the initial analysis of Hazards at town level also these are very useful. However, for land use planning at town level, a more accurate delineation of hazard prone areas is required. High resolution satellite imagery/ LiDAR/ Aerial photography is preferred for the purpose.

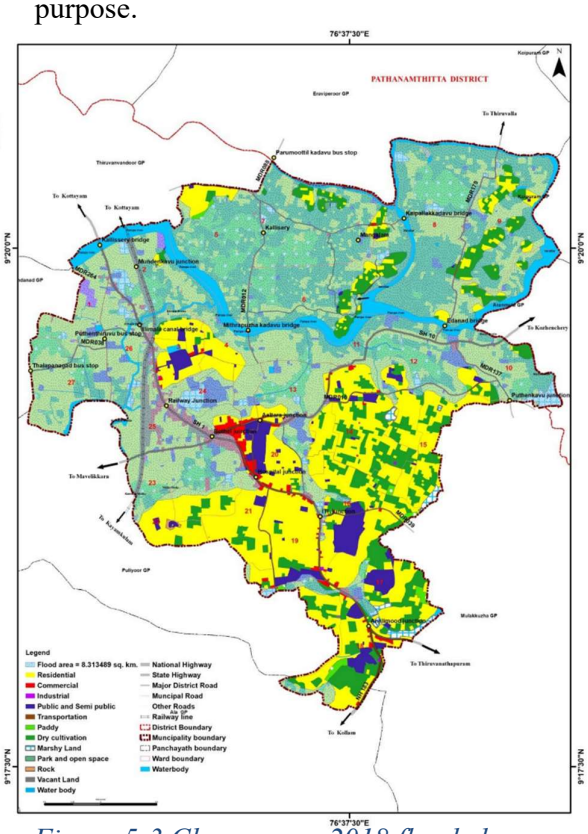


Figure 5:3 Chengannur 2018 flooded area superimposed on existing landuse (2019)

5.1.1 Hazard Maps

For the purpose of this guideline, a **hazard map** implies a map that highlights areas that are affected by or are vulnerable to a particular hazard. Plan prepared as part of "Nammal Namukkayi" campaign (Local Disaster Management Plan) and the DDMP shall form the basis for hazard identification. These Plans must have identified likely hazards in a local area. However, any natural hazard which is categorised as high or moderate by KSDMA for

the local planning area must also be mapped and analysed, if not already included in these Plans.

It is expected that the SDMA/ DDMA would provide large scale hazard maps, for different design scenarios. If such refined hazard maps are not available, for the preparation of Master Plan, methodology followed in Chengannur or Mananthawadi or any other methodology in consultation with DDMA may be followed.

Suggested approach is as below:

- Adopt hazard map for the identified hazard from the Local Disaster Management Plan/ District Disaster Management Plan / KSDMA. From the district disaster management Plan, local level hazard map may be extracted, if not already there in the Local Disaster Management Plan

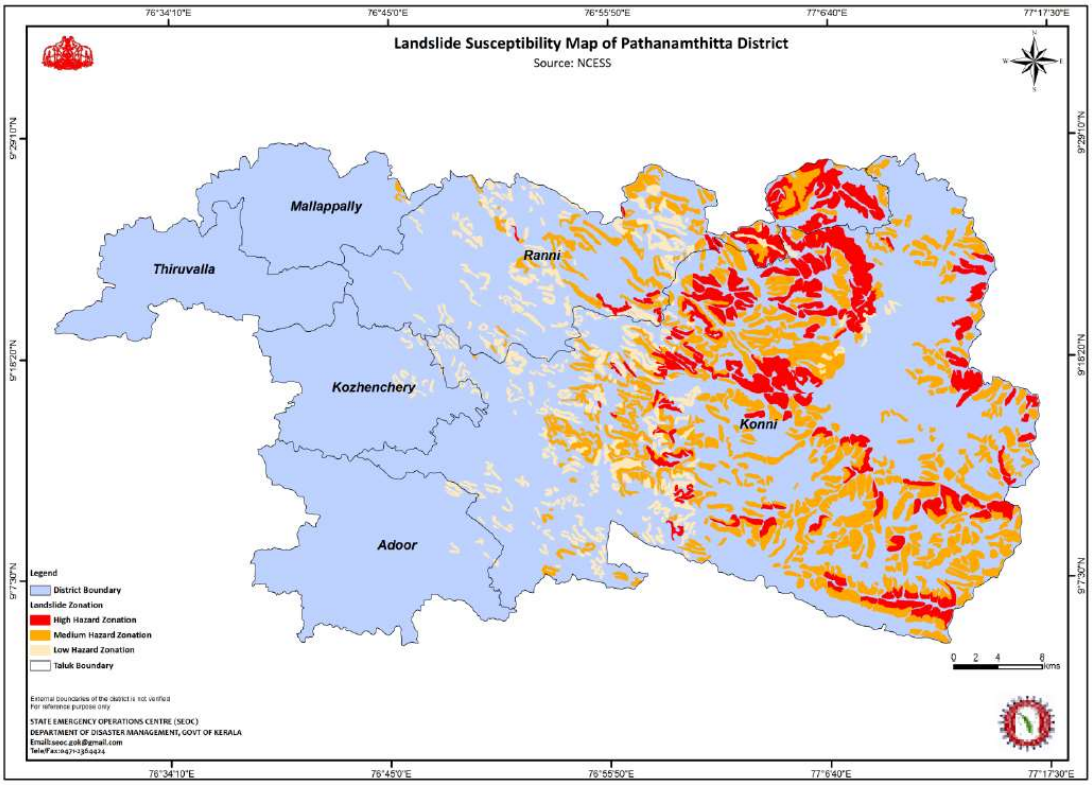


Figure 5:5 Landslide Susceptibility map of Pathanamthitta District
Source: DDMP, Pathanamthitta 2015

- For flood hazard, flood hazard probability map for different return periods prepared by KSDMA can be used. From the raster file available, inundation depth can be reclassified as per requirement (eg. <0.6m, 0.6 – 1.5 m and >1.5 m).

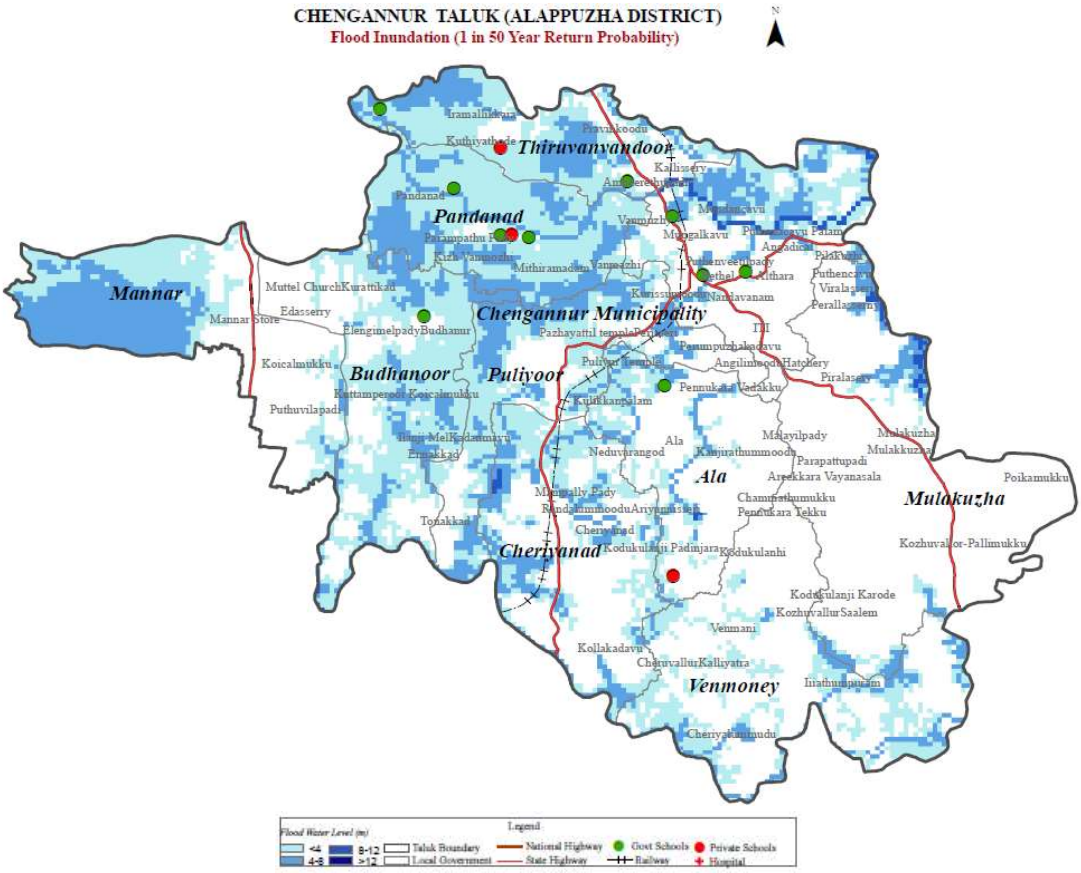


Figure 5:6 Flood inundation map of Chengannur Taluk (1 in 50 year probability) Source: KSDMA

- Consider 1 in 50-year return probability as design event.
- Hazard zones for landslide and drought are available in the KSDMA website and in the DDMPs. These maps can be used for planning purpose.
- Hazard map prepared by community level mapping can also be used.
- Ground truthing of data shall be done wherever possible.

5.1.2 Likely Impacts of Hazard

Hazard map alone is not sufficient to understand a hazard and its likely impact on a community. It is important that lessons learnt from the past events are properly integrated in mitigation measures. In addition to the inputs from technical institutions/ authorities, local understanding on hazard shall also be considered in evolving DRR strategies. Local knowledge on areas affected in the past, the damages inflicted, factors that contributed to the damages, mitigation measures that would have reduced the damages etc. would be invaluable in formulating mitigation and preparedness strategies.

Suggested approach is as below:

- Review Post Disaster damage assessment reports/ studies.

- Collect and review records available with government / educational / research /non-governmental/social organizations. These may also include reports, magazines, manuscripts etc available with libraries, schools, clubs, NGOs etc.
- Target group discussions with experts, local residents, student group, etc
- Major events occurred during at least in the last two decades must be considered.
- Field Information shall also be considered wherever possible.
- For the collection, compilation and analysis of data, participatory and multi-disciplinary approach with involvement of various technical organization, experts, senior citizen, governments / educational / research / non-governmental/ social organizations, social workers, self-help groups, etc shall be attempted.
- As per Rule (3) of the Kerala Town & Country (Preparation and Sanctioning of Master Plans) Rules 2021, it is mandatory for the LSG to constitute a Special committee for the preparation of the Master Plan. This committee should be assisted by the Bio-diversity Climate change and Disaster management (CC&DM) working group in the field verification of the hazard maps.

5.1.3 Local community level mapping / reconnaissance survey

In the absence of authentic hazard data of required quality or for general verification of hazard map obtained through other sources, community level hazard identification mapping / reconnaissance survey lead by Local Resource Groups may be resorted to at ward level. For mapping of approximate spatial location, the cadastral base map may be used.

Major events occurred during at least in the last two decades must be considered.

The identified hazards can be recorded as suggested in the "Standardized template of tables and guidelines for garnering data required for the preparation of Disaster Management Plans of Local Self Government Institutions" issued vide G.O (MS) No.14/2020/LSGD Dtd. Thiruvananthapuram 14/10/2020. Full document is available at https://go.lsgkerala.gov.in/files/go20200114_25367.pdf

5.2 Risk Assessment - Approach

Disaster risk assessment is a qualitative or quantitative approach to determine the nature and extent of disaster risk by analysing potential hazards and evaluating existing conditions of exposure and vulnerability that together could harm people, property, services, livelihoods and the environment on which they depend (UNDRR).

The proposed approach to risk assessment is based on three reinforcing pillars that collectively contribute to understanding urban risk: A hazard impact assessment, an institutional assessment, and a socioeconomic assessment as explained in the report by World Bank – "Urban Risk Assessments – Understanding Disaster and Climate Risk in cities".

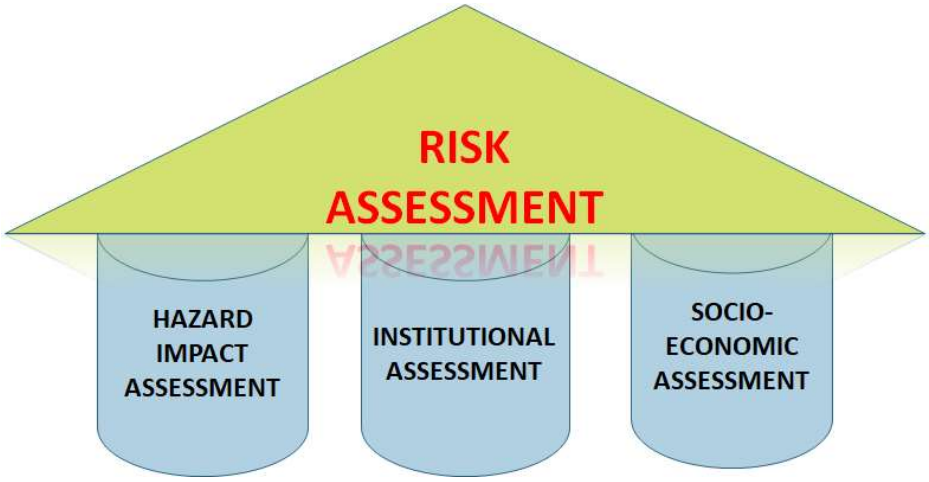


Figure 5:7 Pillars of Risk Assessment

At the primary level, the assessment requires only limited financial resources and institutional capacity, and can help cities identify hazard-prone areas, basic climate change challenges, and capacity for disaster preparedness and response. At the secondary level, the assessment relies on techniques requiring more financial and technical resources to be able to develop actual risk mapping, resilience studies, and institutional gap analysis. At the tertiary level, the assessment will require greater resources, institutional capacity, and data availability to make use of advanced risk management tools and to undertake detailed disaster and climate change modelling. Based on the identified needs, priorities and resources available, local governments can select the most appropriate level of risk assessment for their local body (WB – URA).

5.2.1 Hazard Impact Assessment

The hazard impact assessment focuses on

(1) Understanding hazard trends,
(2) Identifying populations and physical assets at risk of hazards and climate change, and
(3) Quantifying potential impacts of future hazards.

- At a primary level, the assessment is based on developing simple maps of hazard impacts, showing locations of historic disasters in a city with current population and assets in those areas. Based on secondary data collection and stakeholder consultations, develop simple maps of hazard impacts showing where hazards have historically affected a local body.
- At a secondary level, the hazard impact assessment involves estimating impacts for selected hazard scenarios based on simplified loss models. Here, more detailed risk maps are developed, and scenarios of economic and social loss are defined based on impact modelling.
- At a tertiary level, the hazard impact assessment involves probabilistic risk modelling of different hazard scenarios to show the potential economic loss of exposed elements. (WB – URA)

5.2.2 Institutional Assessment

Understanding a local body's institutional landscape with respect to climate change, disaster risk reduction and management, and poverty should be part of identifying climate change-related vulnerabilities and coming up with the best and most cost-effective approaches to reducing them. This will strengthen a local body's understanding of how climate change affects service delivery and ultimately support streamlining risk management across local level agencies. The institutional assessment aids in developing an effective institutional policy for managing disaster and climate change risk.

- At a primary level, institutional assessment involves mapping institutions and organizations that are explicitly responsible for addressing all the phases of disaster risk management (risk preparedness, disaster response, post-disaster reconstruction, and risk reduction and climate change adaptation) and climate risk management.
- At the secondary level, the institutional assessment develops an inventory of planning instruments, including the technical capabilities of staff, the services and outputs provided from one agency to another, policies, projects, and programs.
- At the tertiary level, the institutional assessment focuses on a gap assessment of current services, management tools, policies, and programs. (WB – URA)

5.2.3 Socioeconomic Assessment

The socioeconomic assessment focuses on identifying location and degree of residents' vulnerability.

- At a primary level, the socioeconomic assessment identifies demographic, welfare, human development, and investment variables to understand the impact of poverty, and environmental degradation on disaster and climate change risk.
- At a secondary level, the socioeconomic assessment develops a comparative ranking of areas based on qualitatively codifying selected variables within areas of the city.
- At the tertiary level, the socioeconomic assessment provides more refined and detailed analysis at the community level based on household surveys on issues of hazards and vulnerability. (WB – URA)

5.3 Risk Assessment methodology

The vulnerability of communities and households can be analysed in a holistic qualitative manner using a large number of criteria that characterize physical, social, economic and environmental aspects. Vulnerability is, multi-dimensional (physical, social, economic, environmental, institutional, and human factors define it), dynamic (it changes over time), scale-dependent (it can be expressed on different scales from individuals to countries), and site-specific (each location might need its own approach) (http://drm.cenn.org).

Quick Risk Estimation (QRE) Tool developed by UNDRR has been designed for the purpose of identifying and understanding current and future risks/ stress/ shocks and exposure threats to both human and physical assets. In this tool the main inputs are Exposure rating, Vulnerability rating (which includes infrastructure, productive sectors, Essential or basic services and Human & social aspects), and current level of response rating.

However, the QRE is not a full-scale risk assessment tool, rather a multi stakeholder engagement process to establish a common understanding of risk in a city. A grading system for each parameter is used for risk assessment. To make the qualitative grading more rational, a refinement to the grading system is proposed here. Thus, for the 6 parameters identified for grading in the QRE tool, we are proposing 7 parameters (environmental vulnerability is introduced additionally) and sub parameters are introduced with different levels of rating. These sub parameters are easily quantifiable and the rating is made more predictable.

These inputs can also be related to the three pillars of urban risk assessment suggested in the World Bank Report earlier mentioned. ie Land, Physical, Basic services and Environmental vulnerability aspects reflects Hazard impact assessment; current level of response rating reflects Institutional assessment; and Social and Economic vulnerability rating reflects Socio economic assessment.

Unlike the QRE tool, where the risk assessment is at city level, here in the proposed methodology, the assessment is proposed at cadastral level. Since hazard risk is a product of hazard impact and vulnerability of the exposed population, hazard impact and vulnerability rating are proposed to be done separately and a risk matrix is proposed to be generated with hazard impact index and vulnerability index in two axis and their combined matrix will give the risk grading of the particular area.

5.3.1 Hazard Impact Rating

Hazard impact will be graded on a scale of 0-10, with value10 has most impact. For assessing the hazard impact, 3 parameters can be considered viz Hazard intensity, return probability and hazard duration. The sub parameters are assigned weightages ie Hazard intensity - 60%, Return Probability - 30% and Hazard duration -10%.

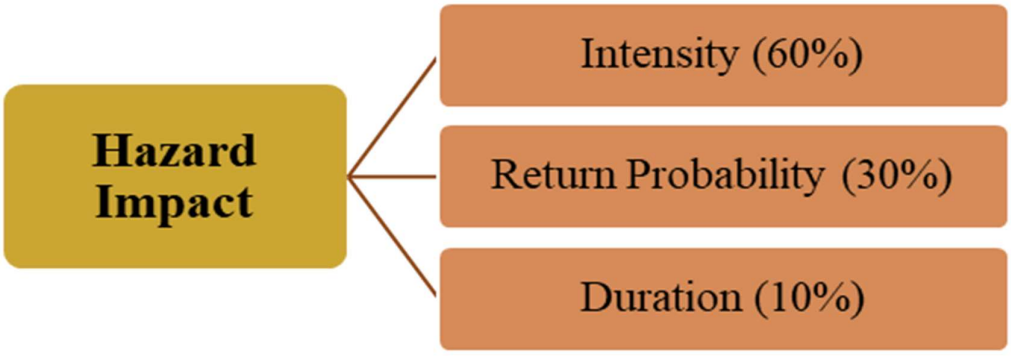


Figure 5:8 Parameters in Hazard Impact Rating

5.3.1.1 Hazard Intensity

- This refers to the likely intensity of the hazard the land in question will be subjected to.
- Hazard intensity of design event can be considered, if different return probability hazard maps are available. Alternatively, the intensity experienced in the major event in the past can also be considered.
- Cadastral level data can be retrieved by overlaying hazard probability map with cadastral sheet.
- In the case of flood, inundation level can be used for intensity of hazard. Inundation of > 1.5m will be considered High, 0.6 -1.5m moderate and <0.6m Low.

Criteria	Value
High	6
Moderate	4
Low	2

5.3.1.2 Hazard Return Probability

- Cadastral level data can be obtained by overlaying hazard return probability map with cadastral sheet.

Criteria	Value
1 in 10 years	3
1 in 25 years	2.5
1 in 50 years	2
1 in 100 years	1.5
1 in 200 years	1
1 in 500 years	0.5

5.3.1.3 Hazard duration

- Cadastral level data can be obtained by overlaying hazard duration map with cadastral sheet.

Criteria	Value
>5 days	1
2--5 days	0.67
<2 days	0.33

- For flood, hazard return probability, Hazard intensity and hazard duration data will be available.
- For other hazards mainly hazard intensity map is available. In that case hazard impact rating can be done by dividing 0-10 grading equally to different intensity level of hazard.
- In the Risk Matrix, Hazard Impact forms the row and is graded from Very Low (score of 0-2) to Very High (Score of 8-10).

For different types of hazards, parameters relating to hazard impact can be considered as shown in the table below.

Table 5:1 Parameters relating to hazard impact

Criteria	Flood	Land slide	Coastal Flooding & Coastal Erosion	Cyclone
Hazard Impact				
Hazard Return Probability	√	NA	NA	√
Hazard Intensity	√	√	√	√
Hazard Duration	√	NA	NA	NA

5.3.2 Vulnerability Rating

Vulnerability rating is proposed to be done on a scale of 0-100, with value100 as the most vulnerable. In the Risk Matrix, Vulnerability Rating forms the Columns and is graded from Insignificant (score of 0-10) to Very High (score of 76-100). For vulnerability rating 6 parameters are considered. The weightage assigned for these parameters are as follows.

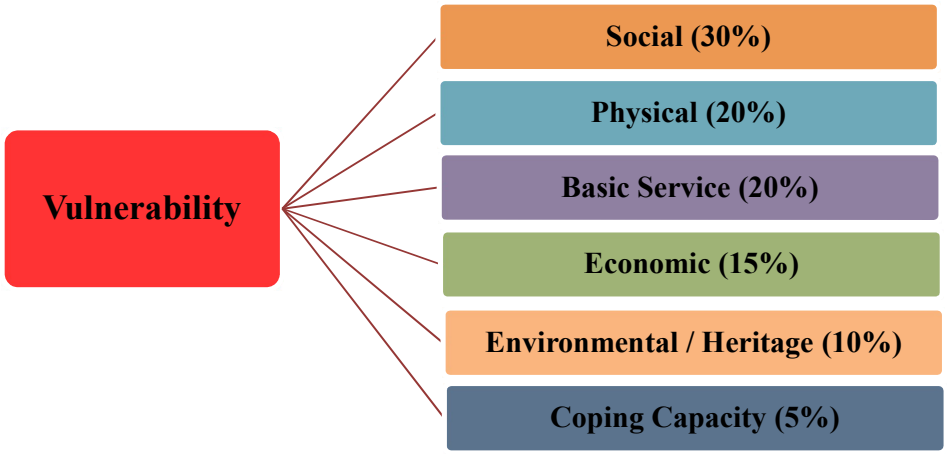


Figure 5:9 Parameters in Vulnerability Rating

Data for many of the above parameters are ideally to be collected from household surveys, like the social and the economic parameters. However considering time and effort required for such an exercise, data available at ward level are proposed in the Guideline. If resources permit, data can be collected at household level and analysed at survey number level or ward level.

5.3.2.1 Social

30% weightage is given to Social vulnerability which includes sub parameters – Population likely to be affected (25%), Economically backward population (20%), Women headed family (10%), Children below 6 years (10%), Population above 60 years (10%), Differently

abled / population with severe illness (10%), Transgender population (10%) and Socially backward population (5%).

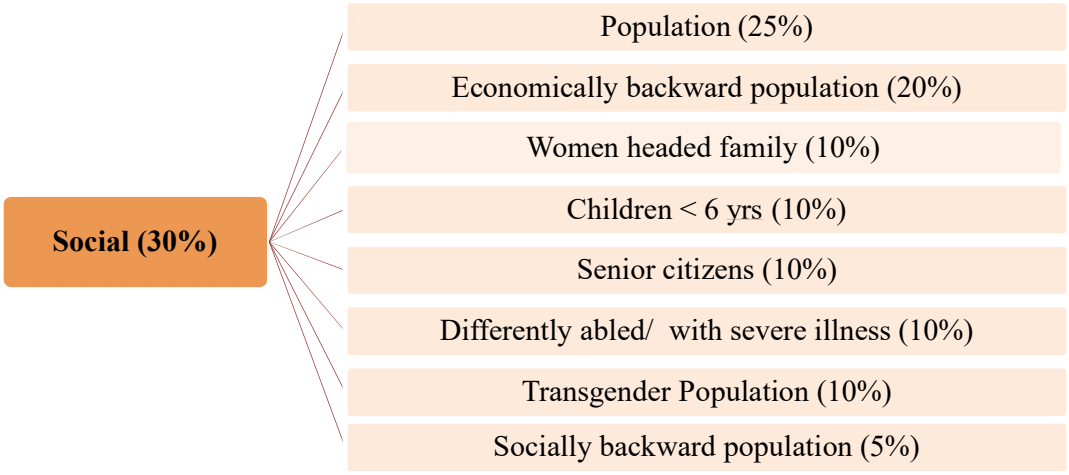


Figure 5:10 Parameters in Social Vulnerability rating

5.3.2.1.1 Population

Percentage of population likely to be affected by the hazard in a ward is assessed here.

Criteria	Value
> 75% population likely to be affected	7.5
51 – 75% population likely to be affected	5.62
26-50 % population likely to be affected	3.75
<26% population likely to be affected	1.87

- Ward level data can be obtained by combining census data with hazard map.

5.3.2.1.2 Economically backward population

Percentage of AAY (Antyodaya Anna Yojana) and PHH (Priority Household) ration card holders in a ward is assessed here.

Criteria	Value
> 20% AAY/PHH card holders	6
10-20% AAY/PHH card holders	4.5
5-10% AAY/PHH card holders	3
<5% AAY/PHH card holders	1.5

- Ward level data can be obtained by combining secondary data (civil supplies department / LSGI) with hazard map.

5.3.2.1.3 Women headed family

Percentage of women headed families in a ward is graded here.

Criteria	Value
> 20% women headed families	3

10-20% women headed families	2.25
5-10% women headed families	1.5
< 5% women headed families	0.75

- Ward level data can be obtained by combining secondary data with hazard map.

5.3.2.1.4 Children with age < 6 years

Criteria	Value
> 20% of ward population is children < 6 yrs	3
10-20% of ward population is children < 6 yrs	2.25
5-10% of ward population is children < 6 yrs	1.5
< 5% of ward population is children < 6 yrs	0.75

- Ward level data can be collected from census data.

5.3.2.1.5 Senior Citizens

Percentage of population with age above 60 years in a ward is evaluated here.

Criteria	Value
> 20% of ward population is senior citizens	3
10-20% of ward population is senior citizens	2.25
5-10% of ward population is senior citizens	1.5
< 5% of ward population is senior citizens	0.75

- Ward level data can be collected from Socio economic survey or other secondary data.

5.3.2.1.6 Differently abled / population with severe illness

Criteria	Value
> 20% of ward population is differently abled/ with severe illness	3
10-20% of ward population is differently abled/ with severe illness	2.25
5-10% of ward population is differently abled/ with severe illness	1.5
< 5% of ward population is differently abled/ with severe illness	0.75

- Ward level data can be collected from Socio economic survey or other secondary data.

5.3.2.1.7 Transgender population

Percentage of transgender population in a ward is appraised here for the grading.

Criteria	Value
> 5% of ward population is transgender	3
3-5% of ward population is transgender	2.25
2-3% of ward population is transgender	1.5
< 2% of ward population is transgender	0.75

- Ward level data can be obtained by combining secondary data with hazard map.

5.3.2.1.8 Socially backward population

Percentage of socially backward population (SC/ST) in a ward is considered here for the scoring.

Criteria	Value
> 20% of ward population is socially backward	1.5
10-20% of ward population is socially backward	1.13
5-10% of ward population is socially backward	0.75
< 5% of ward population is socially backward	0.38

- Ward level data can be collected from census data.

5.3.2.2 Physical

20% weightage is given to physical vulnerability which includes sub parameters –Buildings (50% weightage in physical vulnerability), Transportation (35% weightage in physical vulnerability) and Land cover and (15% weightage in physical vulnerability).

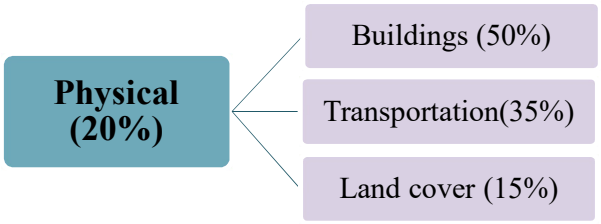


Figure 5:11 Parameters in Physical Vulnerability rating

5.3.2.2.1 Buildings

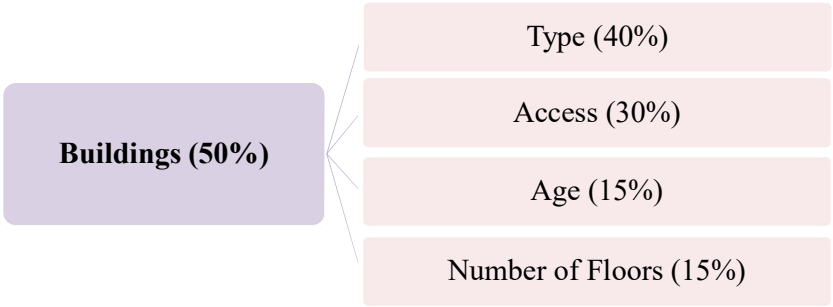


Figure 5:12 Sub-parameters to rate building vulnerability

a. Building Type

Criteria	Value
Kutcha/Dilapidated	4
Moderate	2.67
Pucca	1.33

- Cadastral level data can be taken from the primary survey. If more than one building in a survey number, average value is taken considering the all the buildings.

b. Connectivity/ Access

Criteria	Value
No Access	3
< 3 m road	2
3-7 m road	1
> 7m road	0

- Cadastral level data can be taken from the primary survey. If more than one building in a survey number, average value is taken considering the all the buildings.

c. Age

Criteria	Value
> 50 years	1.5
10 -50 years	1
< 10 years	0.5

- Cadastral level data can be taken from the primary survey. If more than one building in a survey number, average value is taken considering the all the buildings.

d. Number of floors

Criteria	Value
1 floor	0.75
2-3 floors	0.5
>3 floors	0.25

- Cadastral level data can be taken from the primary survey. If more than one building in a survey number, average value is taken considering the all the buildings.

- Other factors remaining the same, for flood, vulnerability decreases with the increase in the number of floors. But for other hazards, vulnerability may increase with the increase in the number of floors depending on the type of hazard. In such cases, the grading can be done as shown below.

Criteria	Value
1 floor	0.25
2-3 floors	0.5
>3 floors	0.75

5.3.2.2.2 Transportation

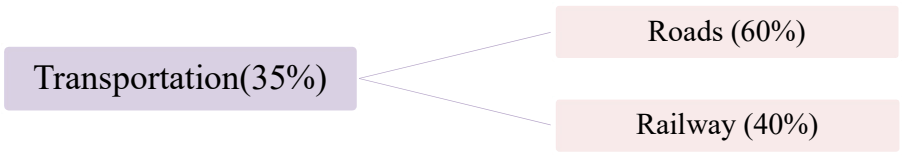


Figure 5:13 Sub-parameters to rate transportation vulnerability

a. Roads

Percentage of roads likely to be affected by the hazard is considered here

Criteria	Value
> 75% of roads in a survey number is likely to be affected	4.2
51 – 75% of roads in a survey number is likely to be affected	3.15
26-50% of roads in a survey number is likely to be affected	2.1
<26% of roads in a survey number is likely to be affected	1.05

- Data can be obtained at ward level by combining connectivity / transportation map with hazard map.

b. Railways

Percentage of railways likely to be affected by the hazard is considered here

Criteria	Value
> 75% of railway in a survey number is likely to be affected	2.8
51 – 75% of railway in a survey number is likely to be affected	2.1
26-50% of railway in a survey number is likely to be affected	1.4
<26% of railway in a survey number is likely to be affected	0.7

- Data can be obtained at ward level by combining connectivity / transportation map with hazard map.

5.3.2.2.3 Land cover

Criteria	Value
Built	3
Unbuilt	1.5
Undevelopable areas	0

- Cadastral level data can be obtained by combining land cover map with cadastral sheet.

5.3.2.3 Essential or Basic Service

20% weightage is given to Basic service vulnerability which includes sub parameters – Social Infrastructures (45% weightage), Water supply (30% weightage) and Sanitation (25% weightage).

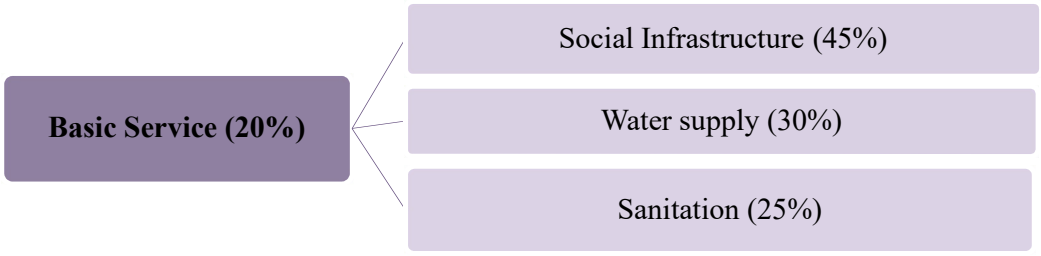


Figure 5:14 Parameters in Basic Service Vulnerability rating

5.3.2.3.1 Social Infrastructure

Whether Social Infrastructures like Hospitals, Schools, Community Halls, Police Station, Fire Station, Village Office, LSG office, Pumping stations, Treatment plants, Electric sub stations, Transformers etc are affected and the impact of those infrastructures is assessed here.

Criteria	Value
Critical infrastructure which has impact on whole LSG or >75% of LSG likely to be affected	9
Critical infrastructure which has impact on 51-90% of LSG likely to be affected	6.75
Critical infrastructure which has impact on 26-50% of LSG likely to be affected	4.5
Critical infrastructure which has impact on <26% of LSG likely to be affected	2.25

- Ward level data can be obtained by combining social infrastructure mapping with hazard map and ward map.

5.3.2.3.2 Water supply

Here % of households in a ward, whose potable water supply likely to be affected is analysed. If the source of drinking water is piped connection, it is assumed to be not affected. But the source is well or other open water source, it is assumed to be affected.

Criteria	Value
> 75% households likely to be affected	6
51 - 75% households likely to be affected	4.5
26-50% households likely to be affected	3
<26% households likely to be affected	1.5

- Ward level data can be collected from secondary data or from primary survey.

5.3.2.3.3 Sanitation

Here % of households in a ward, whose sanitation facilities likely to be affected is assessed. If the households have sewerage connection, it is assumed to be not affected. But if the sanitation facility is septic tank, soak pit etc, it is assumed to be affected.

Criteria	Value
> 75% households likely to be affected	5
51 - 75% households likely to be affected	3.75
26-50% households likely to be affected	2.5
<26% households likely to be affected	1.25

- Ward level data can be collected from secondary data or from primary survey.

5.3.2.4 Economic

15% weightage is given to Economic vulnerability which includes sub parameters – Population whose livelihood from local economic sectors (60% weightage) and Economic zone likely to be affected (40% weightage).

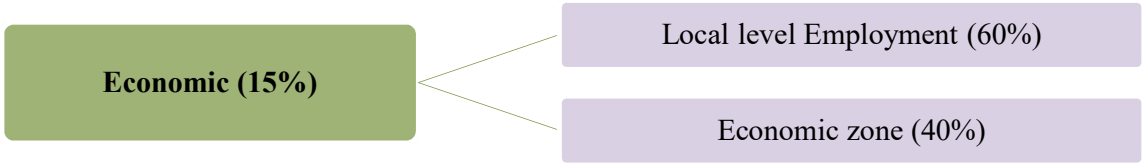


Figure 5:15 Parameters in Economic Vulnerability rating

5.3.2.4.1 Local level employment

Here % of population employed in informal sector/ daily wages/ local level economic sector/ agriculture is analysed.

Criteria	Value
> 20% of population employed in above sectors	9
10-20% of population employed in above sectors	6.75
5-10% of population employed in above sectors	4.5
<5% of population employed in above sectors	2.25

- Ward level data can be collected from Socio economic survey for Master Plan preparation.

5.3.2.4.2 Economic Zone likely to be affected

Here % of area of economic activities (Tourism, Commercial, Industrial, Agriculture, Fisheries, Animal Husbandry etc.) likely to be affected in a ward is analysed.

Criteria	Value
> 20% area of economic zone likely to be affected	6
10 – 20% area of economic zone likely to be affected	4.5
5-10% area of economic zone likely to be affected	3
<5% area of economic zone likely to be affected	1.5

- Ward level data can be obtained from land use map, secondary data etc. combined with hazard map and ward map.

5.3.2.5 Environmental/Heritage

10% weightage is given to Environmental/Heritage vulnerability which includes sub parameters – Areas of ecologic importance (60% weightage) and Heritage area (40% weightage).

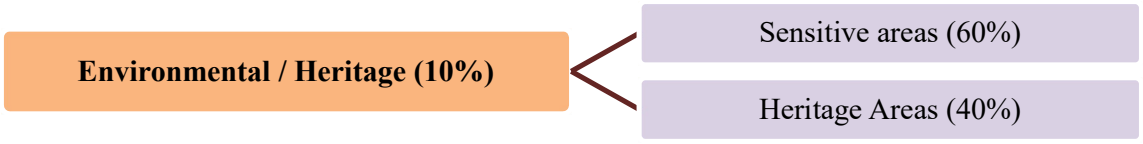


Figure 5:16 Parameters in Environmental/ Heritage Vulnerability rating

5.3.2.5.1 Areas of Ecologic Importance

Here % of area of ecologic importance in a survey number is evaluated.

Criteria	Value
>25% area is of ecological importance	6
10-25% area is of ecological importance	4
<10% area is of ecological importance	2

- Cadastral level data can be collected from integrating landuse map, hazard map and cadastral map.

5.3.2.5.2 Heritage Area

Here the number of Heritage area/ structures in a survey number is analysed.

Criteria	Value
>5 heritage area / structure	4
3-5 heritage area / structure	2.67
1-2 heritage area / structure	1.33

- Cadastral level data can be collected from combining landuse map, hazard map and cadastral map.

5.3.2.6 Coping Capacity / Level of Response Measures

5% weightage is given to Coping capacity of the local body which considers the different actions that has been listed in the LSGDMP. Sub parameters includes– Local Disaster Management Plan updation (20% weightage), Constitution of Steering Committee (20% weightage), Constitution of Emergency Response Team (20% weightage), Formulation of Evacuation Plan (20% weightage), and Disaster Risk Reduction activities (20% weightage).

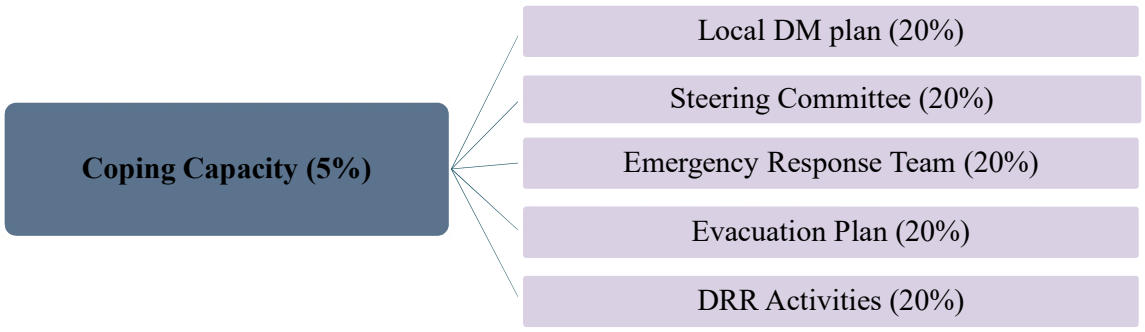


Figure 5:17 Parameters in Coping Capacity rating

5.3.2.6.1 Local Disaster Management Plan

Here, it is checked whether local disaster management plan for the town is recently updated or not.

Criteria	Value
Not Updated	1
Updated	0

- LSG level data can be collected from LSGI

5.3.2.6.2 Steering Committee

Here, it is checked whether steering committee as per the local disaster management plan for the LSGI is constituted or not.

Criteria	Value
Not Constituted	1
Constituted	0

- LSG level data can be collected from LSGI

5.3.2.6.3 Emergency Response Team

Here, it is checked whether Emergency response team as per the local disaster management plan for the LSGI is constituted or not.

Criteria	Value
Not Constituted	1
Constituted	0

- LSG level data can be collected from LSGI

5.3.2.6.4 Evacuation Plan

Here, it is checked whether Evacuation plan for the LSGI is formulated or not.

Criteria	Value
Not Formulated	1
Formulated	0

- LSG level data can be collected from LSGI

5.3.2.6.5 Disaster Risk Reduction Activities

Here, it is checked whether Disaster Risk Reduction activities as per the local disaster management plan for the town are carried out or not.

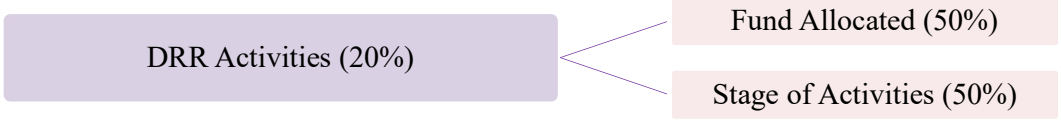


Figure 5:18 Sub-parameters to rate DRR Activities

a. Fund Allocation (50% Weightage)

Criteria	Value
Fund not Allocated	0.5
Fund Allocated	0

- LSG level data can be collected from LSGI

b. Stage of Activities (50% Weightage)

Criteria	Value
Not Started	0.5
Started	0

- LSG level data can be collected from LSGI

Note: When assessing vulnerability, adhere to the 6 parameters and the weightage given to those parameters as far as possible. For the sub parameters, addition or omission can be done according to different hazard types, availability of data and importance of sub-parameters in the town concerned. Different weightage to sub-parameter can be assigned according to the perceived importance of that parameter in the town.

5.4.3 Risk Matrix

- Calculate the cumulative index of the Hazard impact which will be a value between 0-10.
- Calculate the Vulnerability index which will be the cumulative index of 6 parameters considered and that will be a value between 0-100.
- The hazard impact index will be graded as follows
  Low, Moderate, High, and Very High
- The vulnerability index will be graded as follows
  Low, Moderate, High and Very High
- This hazard index grading and vulnerability index grading will be plotted in a matrix as shown below and their combined effect will give the risk intensity of the area under consideration.

			Hazard Impact			
			Low	Moderate	High	Very High
			0 - 2.5	*2.5-5*	*5-7.5*	*7.5-10*
Vulnerability	Low	*0- 25*	L1	L2	M3	M4
	Moderate	*26 - 50*	L2	M3	M4	H5
	High	*51 - 75*	M3	M4	H5	H6
	Very High	*76 - 100*	M4	H5	H6	VH7

Figure 5:19 Risk Matrix

After the risk assessment, risk mapping of each hazard can be done.

Figure 5:20 shows the indicative image of flood risk map of a town using the above methodology.

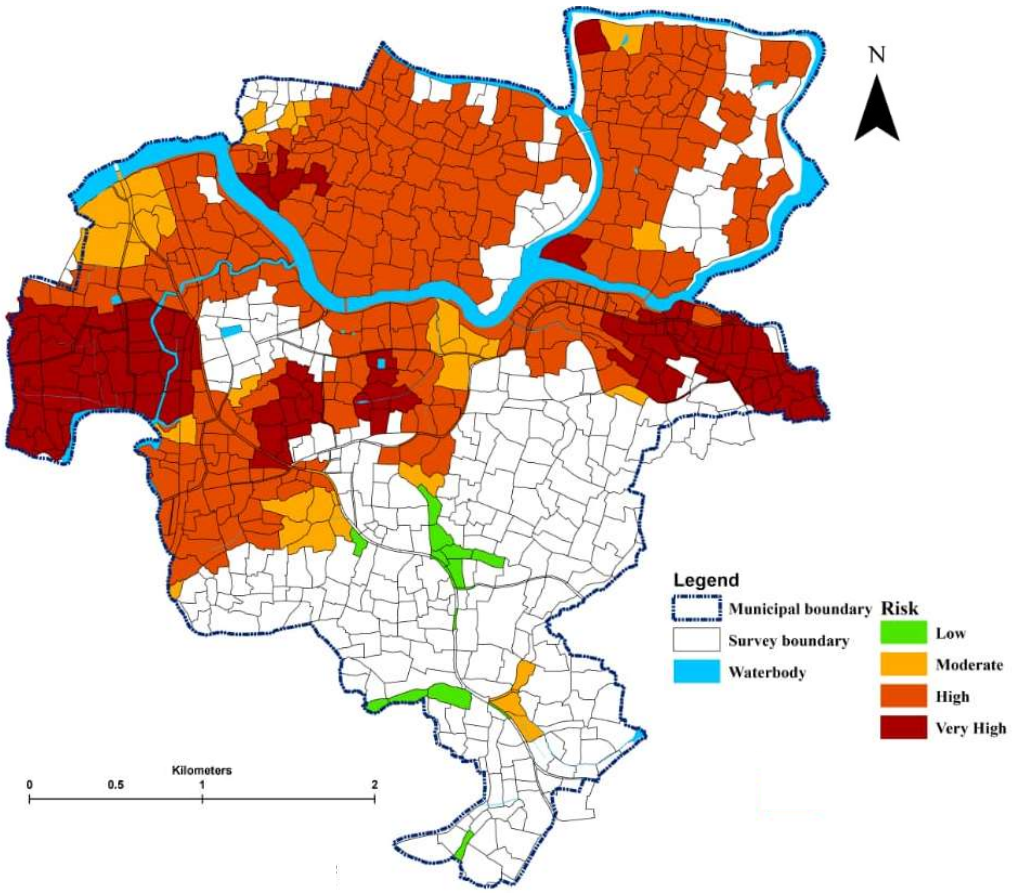


Figure 5:20 Indicative Flood Risk Map of a town

Risk assessment done at the cadastral level for the entire hazard prone area shall be over-layed with existing land use plan in Geographic Information System (GIS) for further analysis and for the preparation of Risk Reduction Plan, Sector level proposals, and the proposed Land Use Plan.

5.4 Multi Hazard Risk Mapping

- Weightage for each risk will be location specific. By consultation with local resource group and subject experts, this weightage can be fixed.
- Usual ways for assigning weightage is based on probability of hazards or their impacts in the study area or the economic damage it brings.
- Based on the weightage assigned a Composite Risk Index for the different hazards can be generated and this can be mapped.

6. DISASTER RISK REDUCTION STRATEGIES

A comprehensive approach is necessary to manage risks from natural hazards. There are a range of actions that can be taken to reduce the risk associated with natural hazards. Managing risk depends on the circumstances in the area which are shaped by a combination of factors. Such factors can include available resources; experiences with hazard events; advanced warning systems and perceived ability to mitigate or prevent natural hazard impacts. These measures fall into four main categories:

- Acceptance of the occurrence of natural disasters and adoption of adaptive strategies that include loss sharing, adjustment to the ways in which resources are used (particularly land, by land use planning) and temporary or permanent migration away from the areas of high risk from natural hazards.
- Education and awareness for key stakeholders. Educating the community, business and industry, and relevant government services on ways to minimise losses associated with natural hazards can influence short-term development and investment decisions, settlement patterns and behaviours before, during and after natural hazard events.
- Implementation of a program of structural works. These may be an important part of an overall strategy to reduce and avoid natural hazard impacts. However, structural works on their own should not be treated as the solution but rather as means to reduce the probability of a natural hazard causing a disaster or to lessen the impact of natural hazard events.
- Adoption of diversified responses, such as using technological methods accompanied by education, land use planning and consequent adjustments, refined warning systems, insurance and readjustments in the design and siting of structures.

Some of the strategies aimed at Disaster Risk Reduction, based mainly from 'Planning for Hazards: Land use Solutions for Colorado' (https://planningforhazards.com/), and the Guidelines issued by the National Disaster Management Authority (https://ndma.gov.in/Governance/Guidelines), are given below for information:

6.1 Communicate to the community

The community awareness on disaster risks helps to take pragmatic and proactive decisions with the active support of the community.

Once Hazard Identification and Risk Assessment (HIRA) is complete, it is essential to use that information to the fullest extent possible. Begin by communicating the results of the HIRA and opportunities for mitigation extensively both internally and externally to the community. This will allow community members to understand and contribute to the development or refinement of mitigation actions to address identified risks.

Risk involved in each survey number with respect to each hazard can be communicated to the community by representing risk through a risk map and can be made available to the public.

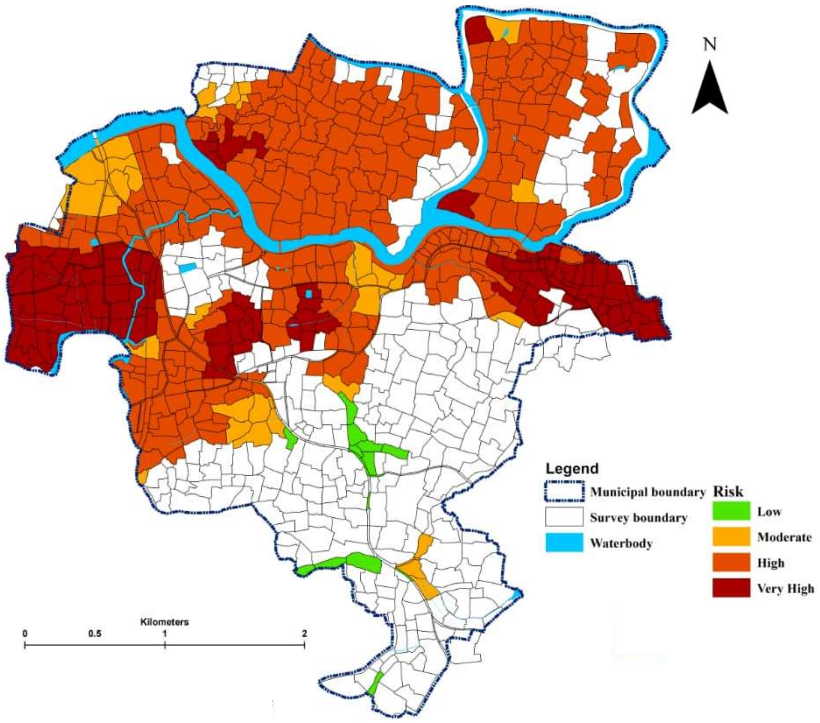


Figure 6:1 Indicative Flood Risk Map of a town

6.2 Include Disaster Risk Reduction Element in Master Plan

Integrating hazard mitigation and risk reduction into comprehensive plans is a key approach that provides an umbrella, or overarching policy framework, for various other planning tools.

General considerations for integrating hazards into comprehensive plans include the following:

- Hazard mitigation measures are not only infrastructure-related. They can include community level communication, preparedness planning, and other non-structural measures.
- Whenever possible, mitigation measures should work to mimic natural processes rather than engineered solution.
- The safety of vulnerable communities related to natural hazard risks and other factors should receive particular attention in the comprehensive plan.
- Hazard mitigation is to be integrated throughout the plan elements.
- Land Use**:** Establish land-use policies that discourage development or redevelopment within natural hazard prone areas. Provide adequate space for expected future growth in areas located outside natural hazard areas. The goals and objectives of land use plans should reflect risk analysis and translate them into the planned specific programs and projects, structural and non-structural in nature.

- Transportation: Provide adequate connections within and between different zones. Ensure road layouts and connections support response requirements for emergency services.
- Conservation/Resource Protection: Identify areas that are community and natural assets and also that, when protected or restricted to development, would reduce risk to natural hazards. For example, avoiding development in wetlands provides a tangible resource to the community while also reducing exposure of people and structures to flood.
- Economic Development: Communicate the short- and long-term economic benefits of planning for hazards and developing resilient communities (e.g., lower long-term infrastructure repair costs). Evaluate whether economic development policies promote commercial or industrial expansion in areas vulnerable to hazards.
- Public Facilities: Identify appropriate locations for all public facilities, but especially critical facilities whose continued operation is essential during or following a major hazard event. For example, police and fire stations, disaster management offices, hospitals, water treatment plants, and community centers are important facilities that should not be located in hazardous areas.
- Housing: Ensuring that the location and design of new or improved housing complies not only with existing building codes, but with potential hazards in mind. Identify opportunities to strengthen or replace structures identified as vulnerable to hazards. Consider whether a disproportionate amount of affordable housing is located within known hazard areas. Address the challenges communities face in locating dense residential areas away from hazards.
- Recreation and Tourism: Areas that serve as recreation opportunities can also serve hazard mitigation purposes by limiting development. This element could also include recommendations for land acquisition.

6.2.1 Overlay Zoning

Showing known hazard areas on the proposed land use map provides maximum transparency to a community's citizens and decision-makers.

It is needed that the proposed land use should be consistent with the hazard risk areas. For instance, areas marked for "higher density residential development" should not overlap with floodplains or areas with steep slopes. The proposed land use map can work in concert with an adopted hazard mitigation plan to ensure that the Master Plan promotes safe growth and reconciles any conflicts between development strategies and mitigation strategies.

An overlay zone applies an additional layer of standards to all areas within a defined overlay boundary, regardless of the underlying base zoning district. For example, an area with single-family homes that is zoned R-1 might also be within a hillside overlay zone. In this example, the permitted uses might allow construction of a single-family home according to the R-1 standards; however, the hillside overlay zone might prevent construction without first obtaining a geo-technical report. Overlay zoning supplements or supersedes existing regulations within an underlying base zoning district.

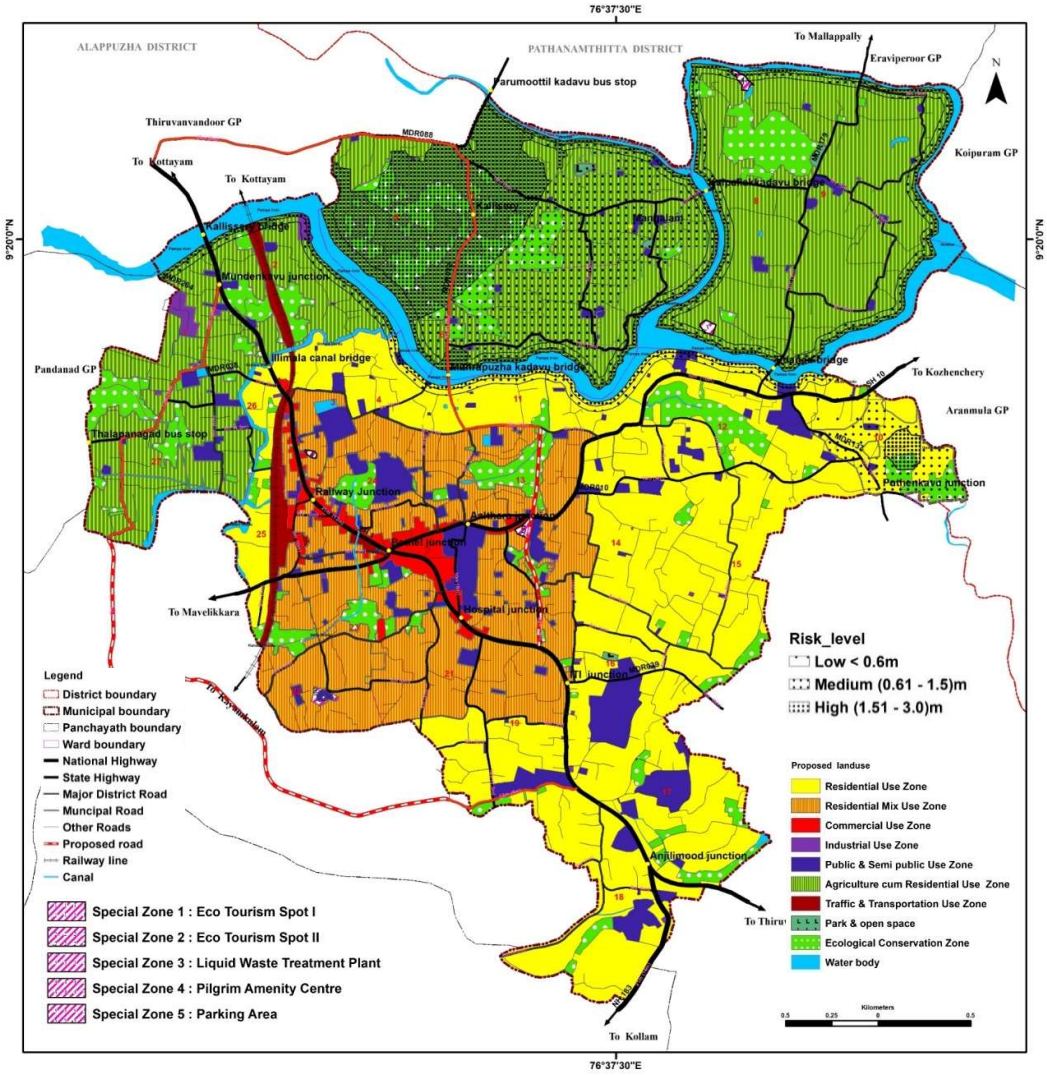


Figure 6:2: Proposed land use along with Hazard information of Chengannur Master Plan (Draft)

6.2.2 Land Use Zoning and Development Control Regulations

6.2.2.1 Flood Prone Areas

Haphazard developmental activities in the flood plains of the rivers and encroachments into the waterways have led to increase in flood losses as well as flood risk. Hence, effective measures are to be taken for regulating unplanned growth in the floodplains and preventing encroachment in the waterways. In order to regulate land use in the floodplains and to restrict the damage caused by floods, floodplain zoning can be adopted. Floodplain of a river should be cautiously developed. A conceptual illustration of flood plain zoning extracted from "Hawkesbury's Flood Risk Management Plan: 15 Years in the making", conference paper, Floodplain Management Association National Conference 28-31 May 2013 Tweed Heads NSW is shown in Figure 6:3.

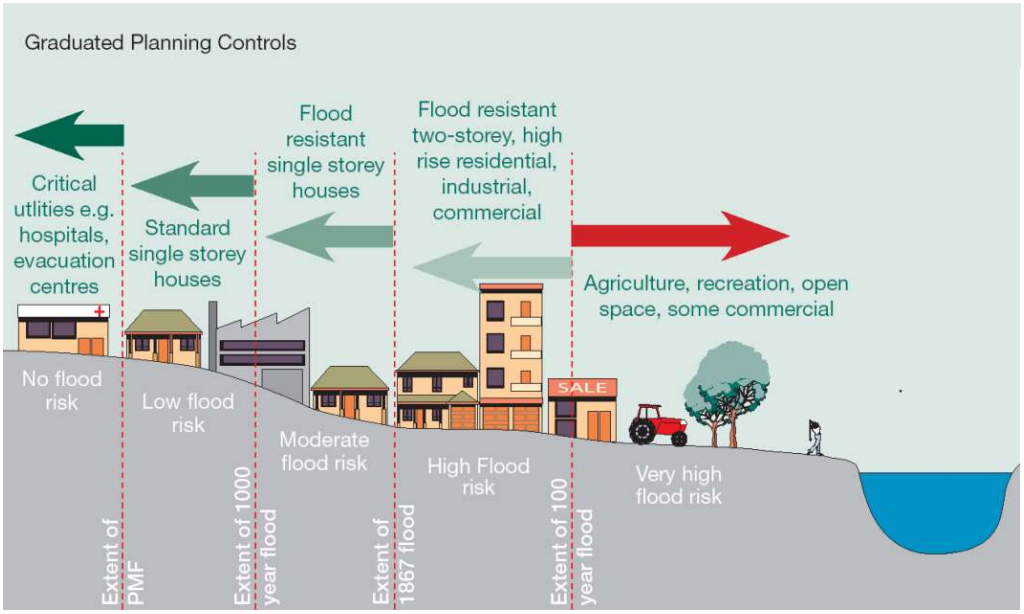


Figure 6:3 Conceptual image of Flood plain zoning

a. Regulation of Land Use in Flood Prone Areas

National Disaster Management Guidelines: Management of floods (NDMA, Government of India, 2008) suggest the following:

- The area likely to be affected by floods up to a 10-year frequency should be kept reserved only for activities of play grounds, gardens, parks etc. Residential or public buildings, or any commercial buildings, industries, and public utilities should be prohibited in this zone.
- In area liable to flooding in a 25-year frequency flood, residential buildings could be permitted with certain stipulation of construction on stilts (columns), minimum plinth levels, prohibition for construction of basements and minimum levels of approach roads, etc. In urban areas there could be double storeyed buildings. Ground floors could be utilised for schools and other non-residential purposes.
- Public and Semi Public institutions, Government offices, and residential areas should be located outside the 25 year flood or a 10 year rainfall contour, provided that the buildings if constructed between the 10 and 25 year contours should have either high plinth level above 25 year flood mark or constructed on columns or stilts, with ground area left for the unimportant uses;
- Installations and Buildings of critical infrastructure facilities should be located in such a fashion that the area is above the levels corresponding to a 100 year flood or the maximum observed flood levels whichever higher. Similarly they should also be above the levels corresponding to a 50 year rainfall flooding and the likely submersion due to drainage congestion.
- Certain areas on either side of the existing and proposed drains should be declared as green belts where no building or other activity should be allowed. These green belts, at suitable locations, can also be developed as parks and gardens. Unplanned growth needs

to be restricted so that the construction of structures obstructing natural drainage or resulting in increased flood hazard is not allowed.

- Infrastructure such as playgrounds and parks can be located in areas vulnerable to frequent floods. Since every city needs some open areas and gardens, by restricting building activity in a vulnerable area, it will be possible to develop parks and play grounds, which would provide a proper environment for the growth of the city.
- Any vital infrastructure should be built on plinth or stilts. Vegetation should be promoted on the flood plain, if possible flood resistant in nature.
- Steep earth banks and slopes on river sides and the sides of gorges should be avoided.
- Build at least 500 m away from the sea coast or at an elevation 3 m above the High Tide Level.

b. Building Regulations for Flood prone Areas

Measures are to be taken for making the structures and buildings capable of withstanding the floods and serving as temporary shelters for the flood affected people. National Disaster Management Guidelines for management of floods recommends Bye-laws for Buildings in Flood Prone Areas and suggest incorporation of certain provisions by the state governments / SDMAs / local bodies in the building bye-laws for buildings in flood prone areas as follows:

- Plinth levels of all buildings should be 0.6 m above the drainage/flood submersion levels under the mean annual flood.
- In the areas liable to floods, all the buildings should preferably be double and multiple storeys.
- Wherever there are single storey buildings, a stairway should be provided to the roofs so that temporary shelter can be taken there.
- The roof levels of the single storey buildings and the first floor level in double-storey buildings should be above 100-year flood levels so that the human beings and movable property can be temporarily sheltered there during periods of danger on account of floods.

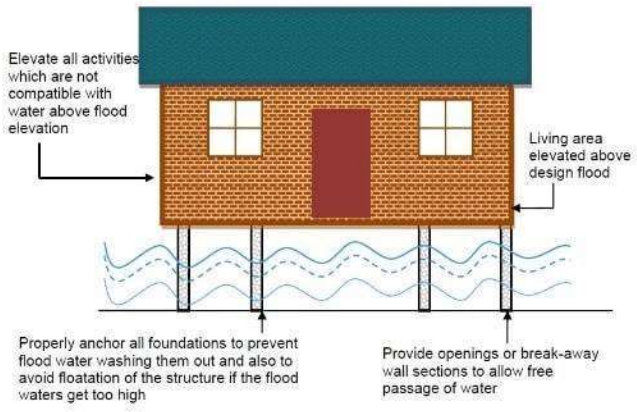


Figure 6:4 Elevated buildings
Source: https://theconstructor.org/building/flood-resistant-building-structures/21187/

Detailed guideline with respect to General Protection of Habitat/Buildings from Flood Damage, Specific Protection of Houses against Inundation Effects, Recommendation for Construction of Flood Resistant Houses, Protection of Existing Houses from Rain and Flood Damage etc are available in the publication of Building Materials & Technology Promotion Council's Guidelines for Improving Flood Resistance of Housing 2010 and the National Disaster Management Guidelines- management of floods (NDMA, Government of India, 2008).

It may also be noted that storm water drainage capacities have been getting very easily overwhelmed whenever rainfall of higher intensity has been experienced. Further, the systems very often do not work to the designed capacities because of very poor maintenance. Large scale encroachments on the natural drains and the river flood plains are also a major problem in many cities and towns. Consequently the capacity of the natural drains has decreased, resulting in flooding. Improper disposal of solid waste, including domestic, commercial and industrial waste and dumping of construction debris into the drains also contribute significantly to reducing their capacities. It is imperative to take better operations and maintenance actions.

Urban flooding is significantly different from riverine flooding as in the event of heavy/ high intensity rainfall there is higher runoff which increases the flood peaks and flood volumes many times.

Guidelines for the management of Urban Floods prepared by the National Disaster Management Authority – "Management of Urban Flooding" (NDMA, Government of India, 2010) is available at

https://www.ndma.gov.in/sites/default/files/PDF/Guidelines/management_urban_flooding.pdf

6.2.2.2 Landslide Susceptible Areas

Landslide affects not only human beings but also destroys nature and affects economy and development of the regions. Hence, simplified regulations which are adoptable and enforceable within the changing socio-economic and physical development shall be evolved.

Landslide Hazard Zonation (LHZ) mapping is a tool to identify those areas which are, or could be, affected by landslides and assessing the probability of such landslides occurring within a specified period of time. Study of the regional geology and geomorphic setting, slope conditions including existing and potential instability, and land use information are included in the preparation of a LHZ map. Susceptibility maps can be used to understand the type of landslide size expected in a specific area and how it behaves in the area. The effects of landslides on people and structures can be lessened by restricting, prohibiting, or imposing conditions on hazard-zone activity.

a. Regulation of Land Use in Landslide Susceptible Areas

Vulnerability to landslide hazards is a function of location, type of human activity, use, and frequency of landslide events. Landslide hazards and the risk involved can be minimised by removing or converting existing developments, or discouraging or regulating new development in unstable areas. In order to ensure environmentally sound development of hill areas, the following restrictions and conditions may be proposed for future activities as per 'National Landslide Risk Management Strategy' (NDMA, Government of India, 2019):

- An integrated development plan may be prepared taking into consideration environmental and other relevant factors.
- Water bodies including underground water bodies in water scarce areas should be protected.

- Where cutting of hill slope in an area causes ecological damage and slope instability in adjacent areas, such cuttings shall not be undertaken unless appropriate measures are taken to avoid or prevent such damages.

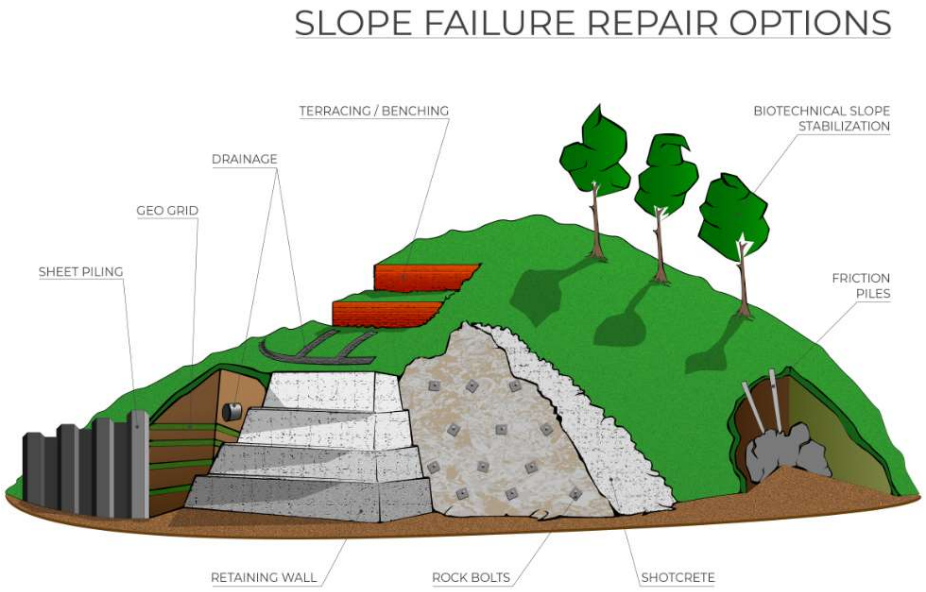


Figure 6:5 Slope Stabilisation techniques
Source: https://pilebuck.com/engineering/landslide-mitigation-techniques/

- No construction should be ordinarily undertaken in areas having slope above 30º or areas which fall in landslide hazard zones or areas falling on the spring lines and first order streams identified by the State Government on the basis of available scientific evidence.
- Construction may be permitted in areas with slope between 10º to 30º or spring recharge areas or old landslide zones with such restrictions, if necessary.

Other effective measures to be taken into consideration in landslide hazard zones include:

- Areas in the proximity of rivers and in the recharge zone of water bodies are vulnerable to landslides and such areas shall be made free from human intervention. Buffer zones of suitable width, which are free from construction activities, may be provided on either side of the rivers.
- Most of the disasters occur due to cut slope failures and hence the cut slope has to be treated and stabilised and the drainage has to be maintained. Unplanned constructions, encroachments, and blockade of surface drainage are observed to pose a serious threat to the stability of the hill slopes.
- If the construction of public and residential facilities is carried out in land slide susceptible areas characterised by earth flow and debris flow, it is advisable to plant trees with strong and deep-rooted perennials that function to hold the slope and also to arrange surface drains and household wastewater with waterproof construction.
- Prevent cutting and levelling for construction on the toe region of slopes having more than 25 per cent inclination and a slope length exceeding 100m. Platforms around houses

shall be made impervious, gardens and cultivated terraces shall be developed together with quarrying, and all household wastewater be drained into paved ravines.

- Prevent construction of roads without adequate engineering design in the unstable slopes especially in those segments having higher soil thickness.

b. Building Regulations for Landslide Susceptible Areas

After taking all necessary steps for stability of slope, construction should be done according to Indian standard norms so that the building does not fail. Also, proper measures need to be taken to protect building from falling debris or slope.

Some safe building practices to be followed suggested in Landslide Preparedness Guidelines for Safety of Buildings on Slopes (NIDM, Government of India, 2019) are:

- Maintain single, low-slope path down or across steep slopes;
- Discourage as far as possible, play areas, caves and excavations on steep slope.
- Design the house with split levels to minimise disturbance to the hill slope, thus controlling erosion and earth slip.
- Retain natural vegetation to the maximum during site clearance.
- Use flexible structures that incorporate properly designed brickwork, timber or steel frames, timber or panel cladding.
- If any cutting is done before construction, make sure to keep it supported with engineered retaining wall or batter to the appropriate slope.
- Filling material should be clean and well compacted. It should also be supported or battered to appropriate slope.
- A structural ring beam around top of doors and windows and walls connected to columns should be provided to ensure structural integrity so that structure can act as one unit.
- All elements of the building should be properly tied together. Connections between posts, beams, columns, wall to wall framing should be ensured as it would not let the structure to break into separate elements.
- Triangular gable end walls must be structurally supported.
- The mud or adobe walls, brick piers, corners and perimeters of opening must be reinforced.
- Use removable window and door protections like plywood, steel shutters for debris flow.
- The house shall be built parallel to the contour lines and not perpendicular to it.

Indian Standards & Guidelines for Landslide safety of National Building Code of India, 2016 are to be complied with.

Slope geometry correction, providing protection to the toe of slope by retaining structures, management of the surface and sub-surface water including the development of pore pressures, nailing, bolting, anchoring, micro piling, application of geo-grids and geo-textiles

and afforestation are some of the Geotechnical measures commonly used for improving the stability of problematic slopes and landslide sites.

Detailed guidelines with respect to Mitigation of Landslides, Contemporary Building Materials Used in Hilly Areas and Required Changes etc. are available in the documents NDMA – Guidelines for the management of landslides and avalanches, USGS - Science for a changing world, Landslide types and processes U.S. Department of the Interior, U.S. Geological Survey, Fact Sheet 2004-3072, July 2004 and National Landslide Risk Management Strategy' (NDMA, Government of India, 2019).

6.2.2.3 Earthquake Susceptible Areas

Kerala belongs to Seismic Zone III as per National Disaster Management Guidelines-management of earthquakes. Major earthquakes occurred in India have established that the casualties are caused primarily due to the collapse of buildings. In seismic zone III, the areas which have soil conditions and the level of water table favourable for liquefaction or settlements under earthquake vibrations will have greater risk to buildings and structures. Under these zones, those hilly areas which are identified to have poor slope stability conditions and where landslides could be triggered by earthquake or where due to prior saturated conditions, mud flow could be initiated by earthquakes will be specially risk prone. To protect lives, some extra cost should be paid for earthquake resistant constructions.

a. Regulation of Land Use in Earthquake Susceptible Areas

Being in Seismic Zone III, the following measures prescribed in the National Disaster Management Guidelines - management of earthquakes (NDMA, Government of India, 2007), may be adopted for making earthquake safe developments in Kerala.

- Vital public utilities as well as communication and transportation facilities should be located and constructed in a way that maximizes their potential to remain functional during and after an earthquake.
- It is best to choose sites that do not liquefy during strong earthquake shaking.
- In areas where seismic activity could produce liquefaction, location of public utilities and facilities should be allowed only if adequate mitigation measures could be incorporated into the project.
- Land uses in close proximity to water retention levees or dams should be restricted unless such facilities have been determined to incorporate adequate seismic stability.
- New developments in areas of identified seismic hazard shall be proposed only if such hazard can be appropriately mitigated.

b. Building Regulations for Earthquake Susceptible Areas

Some of the measures which may be adopted for making earthquake safe constructions in Kerala are the following:

- All new buildings shall be designed and constructed to resist stresses produced by earthquakes.
- Constructions should comply with the requirements of NBC of India.

- Earthquake Resistant Features should be provided in Houses and other buildings.
- It is best to make only light weight houses on hill slopes.
- In a hill area, houses at lower levels should be built first. Also, houses built uphill should be small.
- Natural waterways shall not be interrupted.
- Build retaining walls to prevent local failure of uphill slopes, and even to protect the waterways.

Simplified Guidelines for Earthquake Safety of Buildings from National Building Code of India 2016 provides detailed guideline for earthquake safe constructions. Full text is available at https://nidm.gov.in/safety_earthquake.asp.

Detailed guideline with respect to earthquake resistant building construction are available in National Disaster Management Guidelines - management of earthquakes; Indian Standards On Earthquake Engineering; Analysis of Land Use Management for Earthquake Disaster Reduction in the Asia Pacific Region, Paper No. 1337 of 13th World Conference on Earthquake Engineering, Vancouver, B.C., Canada, August 1-6, 2004, https://nidm.gov.in/safety_earthquake.asp, Report of the Training Programme on Earthquake Resistant Construction Practices and Recent Building Codes by NIDM.

6.2.2.4 Cyclone Prone Areas

Cyclones are characterized by their destructive potential to damage structures such as houses, lifeline infrastructure such as power and communication towers, hospitals, food storage facilities, roads, bridges, culverts, crops, etc., due to high velocity winds. Urban and rural communities in unprotected, low- lying coastal areas or river floodplains are considered vulnerable to cyclones. Furthermore, the degree of exposure of land and buildings will affect the velocity of the cyclone wind at ground level, with open country, seashore areas and rolling plains being the most vulnerable.

Storm surge, which is a coastal phenomenon, is the inherent catastrophic feature of cyclones the world over. Storm surge inundates low-lying areas in the coastal areas resulting in loss of life and destruction of property, besides eroding beaches and embankments, destroying vegetation and reducing soil fertility.

Although it is not possible to completely avoid natural disasters, their effects can be minimised by taking some known long and short-term structural and non-structural mitigation measures and improved response mechanisms.

a. Regulation of Land Use in Cyclone Prone Areas

Areas prone to cyclonic storms are along the sea coast of India where the cyclonic wind velocities of 39 meter per second or more are specified in the Wind Velocity Map given in IS 875 (part 3) to a small scale and easily identified in the Vulnerability Atlas of India where the Maps are drawn state wise on a larger scale.

- In these cyclone prone areas, those areas which are likely to be subjected to heavy rain induced floods or to flooding by sea-water under the conditions of storm surge, are especially risky due to damage by flood flow and inundation under water. Hence in such

regions close to the coast, a site above the likely inundation level should be chosen for building construction. In case of non-availability of high level natural ground, construction should be done on stilts with no masonry or cross bracings up to maximum surge level, or on raised earthen mounds to avoid flooding / inundation but knee bracing may be used.

- In hilly regions, construction along ridges should be avoided since they experience an accentuation of wind velocity whereas valley experiences lower speeds in general. Though sometimes in long narrow valleys wind may gain high speed along valley.
- Areas vulnerable to the effects of tropical cyclones such as wind, flooding and storm surges may be earmarked for use as parks, sports facilities; wildlife preserves, or open grazing land.

b. Building Regulations for Cyclone Prone Areas

While constructing buildings in cyclone prone areas, the following measures may be adopted.

- The local community shall be encouraged to construct houses which will be cyclone resistant.
- Sloping RCC roofs (say 1 in 5 or 6 slope) shall be used to provide quick rain water drainage and avoid any seepage or leakage.
- The doors and windows will be of aluminium with anodized fixtures. The size and thickness of the doors and windows must be of heavy gauge quality.
- Improvement of a building sites by raising the ground level to protect against flood and storm surges
- Low cost housing may be strengthened to resist wind and flood damage. Houses subjected to intense winds are literally pulled apart by the wind moving around and over the building. In preventing this effect, the construction materials are often not as important as the manner in which they are used
- New buildings should be designed to be wind and water resistant.
- The building design shall be able to withstand seismic forces in regions which are additionally vulnerable to earthquake hazard.
- Infrastructure should be inspected prior to the cyclone season and strengthened against wind and floods.
- Communications lines should be located away from the coastal areas or installed underground.
- Buildings or silos used to store food supplies must be protected against the winds and water.

Suggestions for improvements in materials and methods of construction for better resistance to cyclones are provided in the document National Disaster Management Guidelines: Management of cyclones (NDMA, Government of India, 2008).

6.2.2.5 Drought Prone Areas

Drought is a natural hazard that differs from other hazards since it has a slow onset, evolves over months or even years, affects a large spatial extent, and cause little structural damage. Like other hazards, the impacts of drought span economic, environmental and social sectors and can be reduced through mitigation and preparedness. As per the National Commission on Agriculture, India drought is classified into three categories. They are meteorological, agricultural and hydrological. Drought is also classified on the basis of time of onset as early season, mid season and late season.

a. Land Use and Development Control Regulations in Drought prone areas

The frequency and severity of hydrological drought is often defined on a watershed or river basin scale. Changes in land use (e.g., deforestation), land degradation, and the construction of dams all affect the hydrological characteristics of the basin. Strategies for drought preparedness shall focus mainly on water conservation. Land use plans and development control regulations need to be envisioned with an emphasis on water conservation measures.

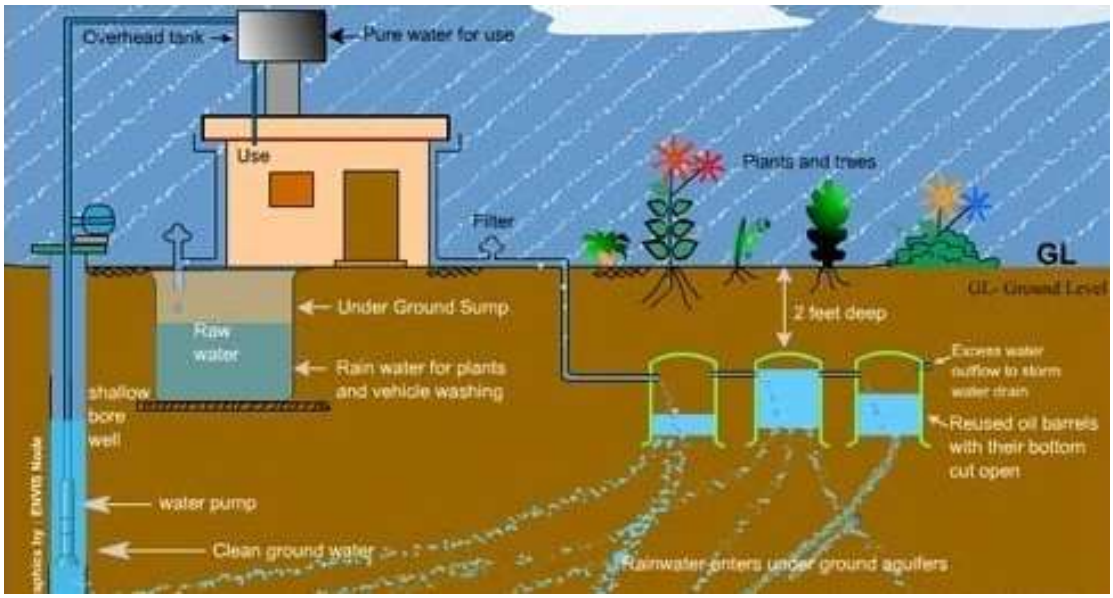


Figure 6:6 Roof Top Rainwater harvesting
Source: https://www.indiamart.com/bsrainharvesting/harvest-rainwater-from-roof.html

To reduce risk due to drought, include measures such as development of water retention and detention structures, rainwater harvesting, water conservation during drought conditions, incorporation of permeable surfaces into future design plans, prevention of overgrazing etc.

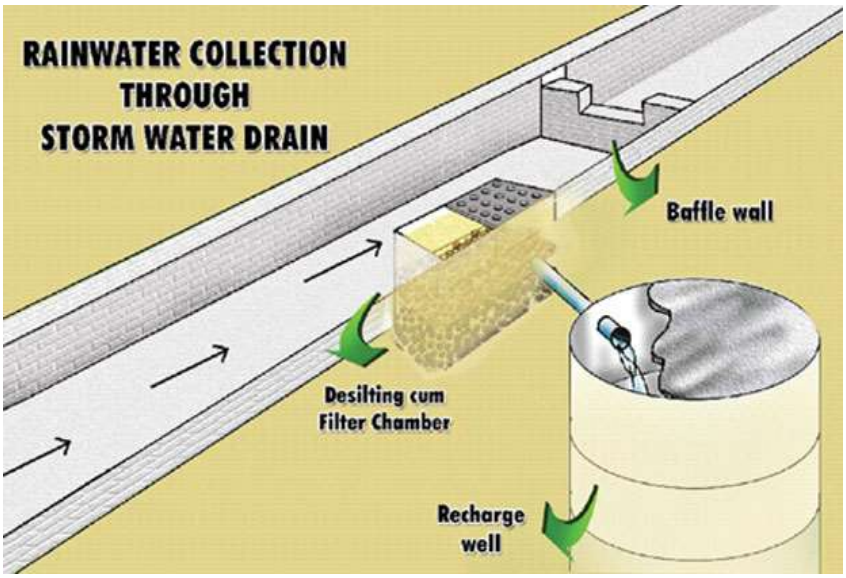


Figure 6:7 Surface runoff harvesting
Source:https://www.indiawaterportal.org/articles/can-storm-water-drains-help-recharging-groundwater-case-chennai-tamil-nadu

Ref: National Disaster Management Guidelines - management of drought, Falling Dominoes: A Planner's Guide to Drought and Cascading Impacts by American Planning Association.

6.2.3 Parks and open space Plan

They are intended to guide a systematic approach for communities to provide and preserve parks, undeveloped lands, and recreation services for the public good. Parks and open space resources within a community may include natural, scenic, cultural, historic, and recreational features or amenities. Interconnected park and open space systems linked by trails, greenways, or other public corridors can be attempted.

Parks and open spaces often overlap with critically sensitive or hazardous areas such as floodplains, steep slopes, or areas prone to wildfire. This provides communities with unique opportunities to pursue the mitigation of natural hazards by avoiding development in these areas jointly with other community goals through the implementation of their parks and open space plan.

Prohibiting development in known flood hazard areas is the only sure method to minimize future flood losses with little to no residual risk. In addition, the use of parks and other undeveloped lands for storm water detention or retention practices can serve not only as a flood mitigation technique but also as a means to conserve water, improve water quality, increase biodiversity, or enhance aesthetics.

Plans for parks and open space can be adopted to support the acquisition or conservation of lands that also happen to be in hazardous areas, such as mountainous locations that are subject to landslides. These areas are preserved not only for their aesthetic and ecological

value, but also to support economic development opportunities that are associated with park and recreational amenities.

In identifying and mapping areas of open land suitable for protection, the plan establishes "Natural Hazard Areas" as the first factor for consideration, including floodplains, areas with a steep slope and geologic hazards such as known fault lines.

6.2.4 Sponge City Approach

Sponge city is similar to the Water Sustainable Urban Design (WSUD) of Australia and the Active Beautiful Clean (ABC) of Singapore that they all aim to guide the urban water management with a top-level strategy, coordinating the relationship between the multi-water cycle, land use and the rainwater system to enhance urban sustainability with a perspective of urban planning and urban design. It involves the integration of different scales of green water infrastructures, which expand the strategy of low Impact Development.

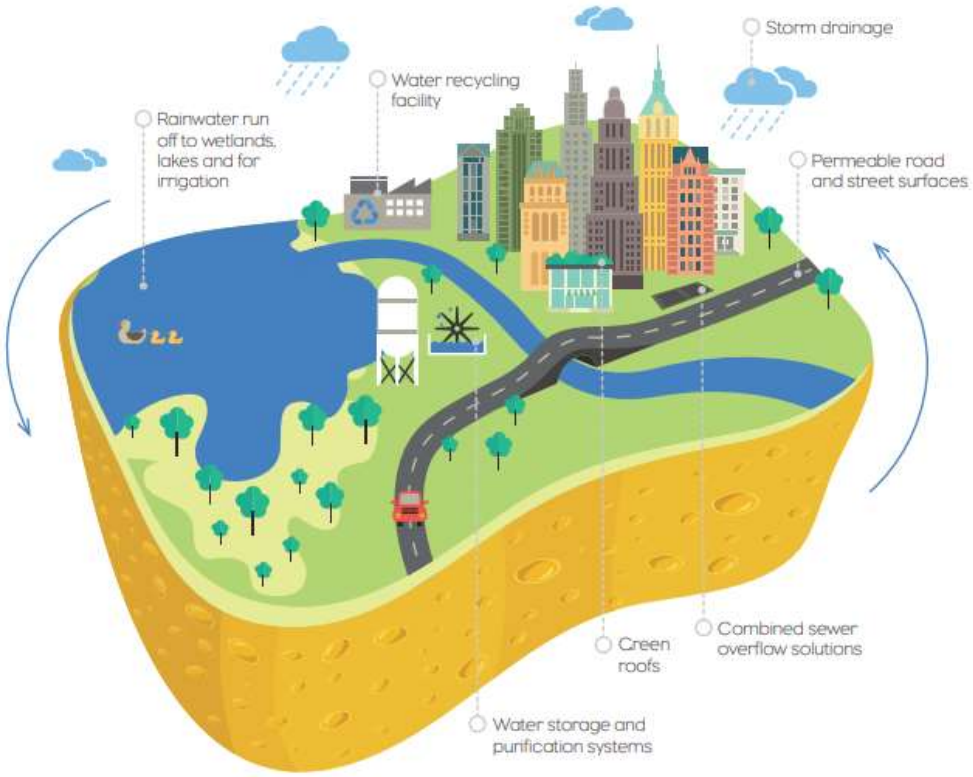


Figure 6:8 Sponge city concept
Source: https://focus.cbbc.org/sponge-citiies/#.YpW6xKhByM8

A sponge city needs to be abundant with spaces that allow water to seep through them. Instead of only impermeable concrete and asphalt, the city needs more:

- **Contiguous open green spaces**, interconnected waterways, channels and ponds across neighbourhoods that can naturally detain and filter water as well as foster urban ecosystems, boost bio-diversity and create cultural and recreational opportunities.

- **Green roofs** that can retain rainwater and naturally filters it before it is recycled or released into the ground.
- **Porous design** interventions across the city, including construction of bio-swales and bio-retention systems to detain run-off and allow for groundwater infiltration; porous roads and pavements that can safely accommodate car and pedestrian traffic while allowing water to be absorbed, permeate and recharge groundwater; drainage systems that allow trickling of water into the ground or that direct storm water run-off into green spaces for natural absorption
- **Water savings and recycling**, including extending water recycling particularly of grey water at the building block level, incentivizing consumers to save water through increased tariffs for increase in consumption, raising awareness campaigns, and improved smart monitoring systems to identify leakages and inefficient use of water.

There is wide range of benefits associated with the implementation of sponge cities. These include:

- **More clean water for the city**. Replenished groundwater and thus greater accessibility to water resources for cities. This also entails greater water self-sufficiency which allows cities to increasingly rely on water sources from within their boundaries
- **Reduction in flood risk** as the city offers more permeable spaces for the natural retention and percolation of water. This leads to better resilience and in particular greater ability to deal with higher flood risks resulting from climate change
- **Lower burdens on drainage systems**, water treatment plant, artificial channels and natural streams. This also entails lower costs for drainage and treatment infrastructure
- **Greener, healthier, more enjoyable urban spaces**. Greener urban spaces improve quality of life, create more pleasant landscape aesthetics and recreational areas that are enjoyable and attract people. This also means increase in land value due to aesthetically more pleasing, cleaner and healthier open spaces close to private properties
- **Enriched biodiversity** around green open spaces, wetlands, urban gardens and green rooftops

Source:
Reviews of Sponge City in China, Yinxue Liu, New Water Policy & Practice Journal • Volume 4, Number 1 • Fall 2017
https://www.worldfuturecouncil.org/sponge-cities-what-is-it-all-about/

6.3 Development Incentives

Incentives are effective strategies for enhancing relationships with the development community, guiding growth and development to desirable areas, and encouraging compliance with community objectives without additional regulation. Incentives can come in the shape of financial savings, increased density, relaxation of regulations, expedited review processes, or waivers of either fees or regulations altogether.

6.3.1 Development Agreement

It is a legally binding contract between a property owner or developer and a local government, often including terms not otherwise required through existing regulations. For hazard mitigation purposes, development agreements can be used to guarantee that a proposed development reduces risk to hazards by requiring it meet certain use requirements, site development standards, conservation practices, or long-term maintenance provisions not already required by land development regulations. Development agreements can also be used as an incentive. For example, if a developer agrees to enter into an agreement to include defensible space elements in a large-scale development in the wild land-urban interface, the local government might offer reduced fees, expedited review, or even density bonuses in exchange.

6.3.2 Transfer of Development Rights

This allows additional density where the community wants to grow in exchange for preservation of sensitive areas that the community wants to protect from future development.

6.4 Improving Buildings & Infrastructure

Building codes establish rules for building safely and provide engineering standards to ensure that structures located in hazard areas can withstand high winds, high waters, earthquake etc. They also protect critical infrastructure, which is the lifeline of a community during and after a major hazard event.

Critical Infrastructure Protection is a strategy to make critical infrastructure more resilient. What qualifies as “critical infrastructure” is defined locally, but generally refers to infrastructure that is necessary to providing vital community and individual functions. It can include both buildings (e.g., schools, town halls, hospitals), and also physical facilities such as roads, storm drains, potable water pipes, or a sewer collection system. Critical infrastructure must be designed, located, and sufficiently protected to remain operational during hazard events and emergencies.

To make these facilities more resilient requires taking actions that removes risk to physical infrastructure. In terms of buildings, examples include: relocation; elevation of the building above the base flood elevation (BFE); dry proofing and wet flood proofing; fire-resistant building materials; and, in some cases, engineered solutions such as levees and floodwalls. In terms of hardening capital facilities, examples include: double sleeving water pipes, elevating roadways prone to flooding above BFE, expanding the capacity of road culverts, removing physical impediments that restrict water flow in rivers and floodplains, and the like.

6.5 Risk Financing & Risk Transfer

Risk financing: involves the retention of risks combined with the adoption of an explicit financing strategy to ensure that adequate funds are available to meet financial needs should a disaster occur. Such financing can be established internally through the accumulation of funds set aside for future use or obtained externally through pre-arranged credit facilities.

The banking sector, capital markets and international lending institutions are sources of risk financing

Risk transfer: involves the shifting of risks to others who, in exchange for a premium, provide compensation when a disaster occurs, ensuring that any financing gap that might emerge is partially or fully bridged. Risk transfer may be obtained through insurance policies or capital market instruments such as catastrophe bonds. The insurance and reinsurance sectors are the main sources of risk transfer, although capital markets provide an alternative source.

More information is available at "Disaster Risk Assessment and Risk Financing A G20 / OECD Methodological Framework" - https://www.oecd.org/gov/risk/G20disasterriskmanagement.pdf

7. PROCESS OF PREPARATION OF RISK INFORMED MASTER PLAN

The preparation and or adoption of Master Plan comes under the power and responsibility of Local Self Governments. The Town and Country Planning Act (TCP Act 2016) had been amended by the GoK to mainstream risk information in Master Plans. Guideline for the utilization of annual plan funds also has been restructured to enable and encourage multi-year investments in urban infrastructure development.

Master plan preparation is a participatory process involving different stages and many stakeholders. The Plan can guide the growth of a town in an informed and planned manner. The floods, landslides and other natural hazards happened in the recent past inflicted huge damage to many of our towns and made us realize the need for better mitigation and preparedness to make our towns resilient to future hazards. Risk informed Master Plans pave way to reduce disaster risks in already developed areas and avoid creation and propagation of new risks as urban areas develop.

Master Plan process takes place mainly in 2 stages: Preparation stage and the Implementation stage. Stakeholders including the local government and the community have crucial roles to play in each of these stages as briefly noted below:

7.1 Preparation Stage

7.1.1 Organizational setup

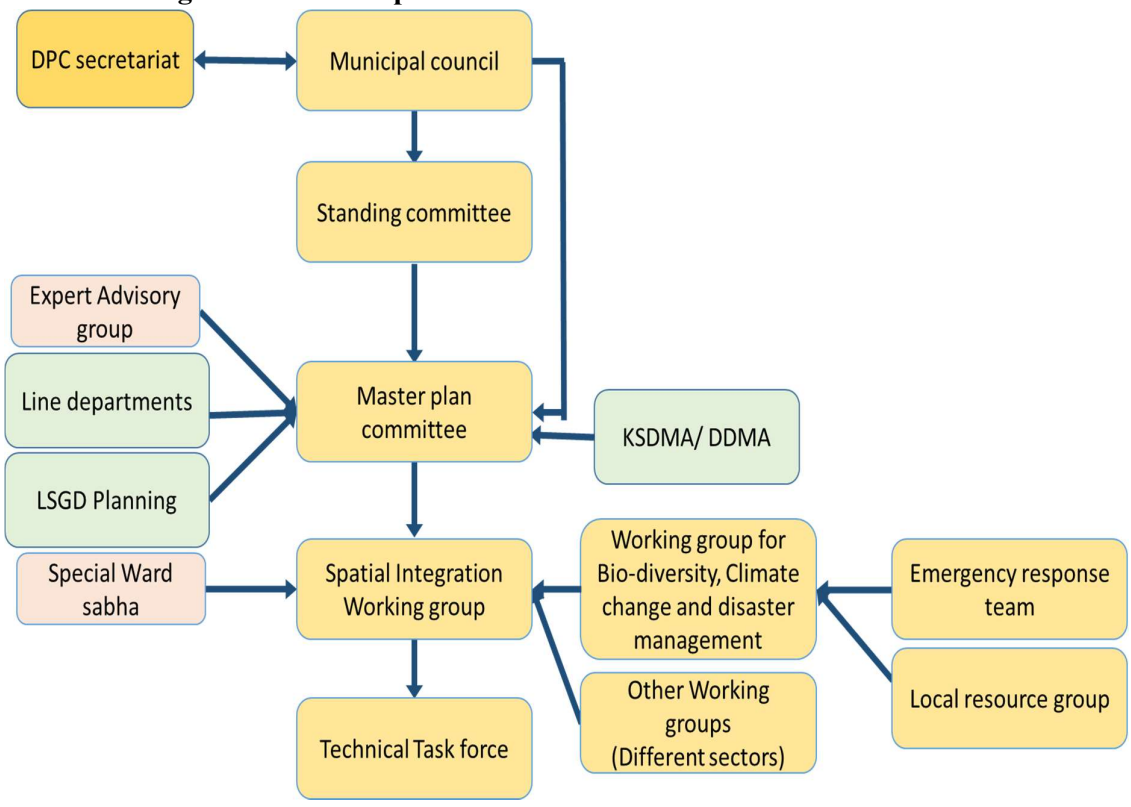


Figure 7:1 Organizational setup for RIMP

The legal statutes pertaining to spatial planning and master plans in our state are the Kerala Municipality Act 1994(KM Act) and the Kerala Town and country planning Act 2016(T&CP Act). Both the acts stipulate public participation in the Master Plan preparation process. Municipal council has the overall responsibility of preparing Master Plans as envisaged in both the Acts. Taking into account the spirit of KM Act and T&CP Act, people's participation is to be ensured during the entire Master Plan preparation process. The technical support for preparation of Master Plan has to be extended by LSGD Planning, District Disaster Management Authority (DDMA) and other departments, to the Municipality.

An organizational setup suggested for the participatory Risk Informed Master Plan preparation taking in to account the provisions in the Acts are shown in Figure 7:1. The role of each of the Stakeholders as per the organizational set setup is detailed as below.

7.1.2 Role of different Stakeholders in the Preparation of Risk Informed Master Plans

7.1.2.1 Municipal Council

The Municipal Councils are local self-governments and it is the prerogative of the council to have planned development within their jurisdiction. The Kerala Municipality Act 1994 endow Municipalities with necessary powers and authority to enable them to function as institutions of self-government. Rule 51(3) of the KM Act mandate every Municipality to prepare a Master Plan for its development in the prescribed manner with focus on scientific spatial planning taking into account its resources and as per the fiscal investment and submit the same to the District Planning Committee. The ultimate authority and responsibility of preparation and implementation of Master Plan rest on the Municipal council.

The municipal council has the lead role in the preparation of RIMP. They have to guide and coordinate the entire process of preparation of RIMP. Municipal council has to constitute different committees suggested, activate the functioning of each committee, ensure public participation through development seminars, special ward sabha etc, and report the progress to DPC and Government.

7.1.2.2 Standing Committee

As per Section 20 of the KM Act, Standing Committees are to be constituted by the municipalities for undertaking specific functions. In Municipal Corporations, the Standing committee for town planning shall be responsible for actions related to Master Plan and in municipalities, standing committee for works shall be responsible for spatial planning and Master Plan preparation,. This delegation of power is as per section 31 of the T&CP Act.

The standing committee shall be responsible for coordinating different tasks for the formation of different committees like Master Plan Committee, Expert Advisory Group etc. It shall advise municipal council on the legal procedures in connection with preparation of Mater Plan; implementation of its proposals; and in convening meetings related to Mater Plan preparation. The standing committee shall scrutinize the Mater Plan at various stages of preparation and review the progress report submitted by the Master Plan committee and give suggestions accordingly. The standing committee shall update the municipal council on

the progress of Mater Plan preparation based on the report submitted by the Master Plan committee.

7.1.2.3 Master Plan committee/special committee

Master Plan committee/special committee has the sole responsibility of preparation of Master Plan. Master Plan committee shall have Municipal (Chairperson), nominated members of the Council, Municipal Secretary (Convener), District town planner, municipal engineer and a person having special expertise and qualification in Town and Country Planning, as members. The Master Plan committee/special committee is to be constituted as per Section 32 and Rule 3 of the T&CP Act and the Master Plan Rules respectively. The municipal council through resolution can delegate all its powers in Master Plan preparation to the Master Plan committee, as provided under section 32 (1) of the TP Act and 3(2) of the Kerala Town & Country Planning (Preparation and Sanctioning of Master Plans) Rules 2021.

The Master Plan committee is responsible for preparing Master Plan in a planned and timely manner. They have a direct and key role in all the four stages of preparation of Master Plan, i.e. data collection, analysis, envisioning process and formulation of development proposals. It is their role to activate the Expert Advisory Group and Spatial Integration working group (SIWG) in the Master Plan preparation process.

The committee shall submit bi-monthly progress report to the standing committee for discussion on Master Plan progress in the council.

7.1.2.4 Expert Advisory Group (EAG)

An expert advisory group having 5 to 7 non-official members shall be formed by the Municipal Council. The advisory group shall consist of at least 3 members who have actively participated in decentralized planning and other members having expertise in different sectors, viz. town planning, disaster management, agriculture, industrial development etc. Their main function is to advise Municipal Council/ Standing Committee/ Master Plan committee on any matter arising during the preparation of the Master Plan. They have to ensure that local aspirations/ local situations are properly incorporated in all stages of Plan preparation. Another function of the EAG is to monitor the Plan preparation and to give suggestions to the Master Plan committee regarding pending activities and actions to be taken. This group shall meet at least once in a month and monitor the activities of spatial integration working group and offer them necessary expert advice group shall also help the Master Plan committee in preparing the progress report on Master Plan preparation.

7.1.2.5 Spatial Integration working group (SIWG)

Spatial Integration working group shall be formed under the Master Plan Committee by the municipal council, as provided under 32(3) of TP Act and 15(3) of Kerala Town & Country Planning (Preparation and Sanctioning of Master Plans) Rules 2021, for data collection, consolidation and analysis, discussion with stake holders and the preparation of Master Plan report and map preparation. The composition of the committee is as follows: Chairperson of the Standing committee dealing with Town Planning (Chairperson), An expert in Town Planning nominated by the Council (Vice Chairperson), Secretary of the municipality

(convener), District Town Planner or nominee (Member Secretary), Resource persons nominated by the Council from the field of planning and development (members) , District officers or nominees of Government departments and agencies (members) and the Municipal Engineer.

The main functions of the SIWG are:

1. Finalize the data check list, procedure of primary survey (land use survey, socio economic survey etc) in consultation with LSGD (Planning), other departments concerned / experts and working groups.
2. Coordinate and monitor the progress of data collection including primary survey-land use survey, socio economic survey, heritage survey, data collection for vulnerability assessment.
3. Activate and involve other working groups in the Master Plan preparation process.
4. Ensure the accuracy of data collected. Ensure the involvement of ward councilors in ensuring the accuracy of data collected (land use map, secondary data, socio economic data etc.)
5. Take a lead role in envisioning process, formulation of development proposals, proposed land use.
6. Take initiative to ensure the involvement of Master Plan Committee/Standing Committee/Council in the envisioning process, formulation of development proposals, proposed land use.
7. The SIWG shall submit monthly progress reports to the Master plan committee.
8. The technical works related to Master Plan shall be coordinated by the office of the Member Secretary of the SIWG.

Technical Task force

The Spatial Integration working group can constitute task force, as provided under 15(3) of Kerala Town & Country Planning (Preparation and Sanctioning of Master Plans) Rules 2021, for performing specific tasks, mainly surveys, map preparation, technical analysis as decided by Spatial Integration working group (SIWG)/other working groups/LSGD planning. A technical task force shall be a Planning Unit , constituted for the purpose in the Municipality or District office of LSGD Planning, headed by an officer not below the rank of Assistant Town Planner in LSGD Planning and consisting of Planner associate, GIS assistant, Engineering assistants, Survey assistants etc. The technical task force may engage different task groups in data collection/surveys/ mapping/ and data analysis for Master Plan preparation. The establishment and operative expenses, except the remuneration of regular LSGD Planning staff or other official members, of planning unit in the Municipality shall be borne by the Municipality.

7.1.2.6 Other Working groups

Along with the working groups formed for five year plan preparation, additional working groups may be formed in connection with the Master Plan preparation, if so recommended by the Master Plan committee. All the working groups formed for various sectors shall

support the SIWG in the Master Plan preparation in data collection and analysis of their respective sectors. They should help for project formulation in respective sectors. The data collection and analysis pertaining to a particular development sector based on the check list finalized by Spatial Integration working group (SIWG) will be that of the working group concerned.

7.1.2.7 Bio-diversity, Climate change and Disaster management (BCC&DM) working group

The working group for Bio-diversity, Climate change and disaster management shall specifically take the responsibility of collecting data and coordinating actions related to Disaster Risk Information and support specific tasks for hazard mapping and integrating risk information in the Master Plan. The hazard maps obtained from DDMA/KSDMA has to be field verified and the working group shall monitor the process. This working group shall formulate proposals and plans for disaster mitigation, risk reduction, response and recovery and shall work with the SIWG during the proposal formulation stage of Master Plan.

7.1.2.8 Local Resource Group (LRG)

As per the guideline for preparing Local DM Plan, a 20-member local resource group is to be formed by the BCC&DM working group. This group shall have the responsibility of data collection and situation analysis in disaster prone areas. The LRG shall also assist in the ground-truthing of the hazard maps provided by KSDMA or DDMA for the preparation of RIMP. It shall also collect local knowledge about disasters and disaster management in the community. They can initiate specific surveys using checklist among the communities affected in the past disasters/ disaster-prone areas.

7.1.2.9 Stake holder departments and agencies

The preparation of Risk Informed Master Plan requires support and assistance from various stakeholders. Data regarding various development sectors and their future plans shall help to orient Master Plan proposals. The stakeholder departments and agencies shall nominate a competent person to be a member of SIWG so that data sharing and effective cooperation can be ensured in the Plan preparation. They also have to support the working groups in this regard. They shall oversee the data analysis and proposal formulation of their respective sectors by the working groups in the Master Plan preparation.

7.1.2.9.1 LSGD Planning

LSGD Planning shall give all necessary technical support as provided under Section 33 of the T&CP Act, to the Council/ Standing Committee/ Master Plan committee/ Spatial Integration working group (SIWG) in data collection, analysis, hazard and risk assessment, vision formulation and any other aspects related to scientific spatial planning. District Town planner and his office shall assist the municipality with all the technical tasks in Master Plan preparation. It is important that a task force/ planning team headed by an officer from LSGD planning be formed for the municipality to facilitate coordinating activities and conducting discussions with various stakeholders and complete different tasks in a timely manner. The

draft checklists of data, forms and other materials including base map required for Master Plan preparation have to be provided to the municipality by LSGD Planning and it is to be finalized in consultation with Master Plan Committee / Spatial Integration working group (SIWG). All the technical support needed for land use survey, socio economic survey, heritage survey, data collection for vulnerability assessment, data analysis, envisioning, formulation of development proposals, preparation of land use map, report etc are to be extended by LSGD planning. District Town Planner shall also provide technical guidance to the technical Task force/ Planning unit.

7.1.2.9.2 KSDMA and DDMA

The hazard maps are to be provided to the municipality by KSDMA or DDMA which shall be utilized by the concerned working group for ground-truthing. These agencies shall provide hazard data with the granularity required for land use planning. The maps provided shall be in large scale. The DDMA shall support the Master Plan committee during proposal formulation and examine the feasibility of proposals to reduce disaster risk.

7.1.2.9.3 Line Departments and agencies

The preparation of Master Plan for a town shall be supported by all Government departments and agencies so that the long term developmental vision for the urban area can be formulated in an informed and implementable manner. The stake holder departments shall provide data, proposals and vision concerning to their sectors to the Master Plan committee and shall actively participate in different stages of Plan preparation. They shall oversee the data analysis and proposal formulation of their respective sectors by the working groups.

7.1.2.10 District Planning Committee (DPC)

DPC as the constitutional body responsible for spatial planning of the district shall take important role in the preparation of Master Plans of various LSGIs in the district. As soon as a new municipal council take charge, DPC through DPC secretariat shall organize a half day awareness workshop for the newly elected members of the municipal council about different aspects of Master Plan preparation. They shall be given clarity regarding the necessity of the Plan, the legal time frame for different activities, committees to be constituted and the roles and functions of municipal council and the committees.

The DPC shall monitor the progress of Master Plan preparation of LSGI at least once in 6 months by conducting workshops, evaluate various activities and ensure progress. This would also enable DPC in realizing the vision envisaged in District Plan at the local level. The DPC shall be consulted before Master Plan publication and the observations, if provided, shall be considered by the municipal council. The DPC shall provide comments on the published Master Plan as mandated in Section 36(5) within 2 months as specified in the Act.

7.1.3 Master Plan Preparation Process

The Master Plan preparation process involves various legal and technical activities to be undertaken by the Municipal council. The technical process flow includes the following activities.

7.1.3.1 Preliminary activities

i. *Awareness creation workshop by the DPC:* Half day workshop to be organized by DPC through DPC secretariat to make aware the municipalities with the Master Plan preparation process.

ii. *Constitution of committees:* Master plan committee, Expert Advisory group, working groups to be formed by the municipality; members for task forces and local resource group to be selected and assigned duties. Technical task force/ Planning unit at the Municipality to be constituted and staff appointed by the Municipality.

iii. *Notification of intention:* The Municipal Council has to take a resolution on its intention to prepare a Master Plan with Risk information mainstreamed (Risk Informed Master Plan).As per Section 36(1) of the T&CP Act, the intention of Master Plan preparation shall be notified in the Official Gazette and published in the notice board and the website of the LSGI, and in at least one newspaper having wide circulation in the area.

iv. *Checklist of data required:* LSGD Planning to provide check list of primary and secondary data to the SIWG

v. *Hazard map:* Collect hazard maps from KSDMA/ DDMA, which shall be verified and updated by ground- truthing by concerned working group

vi. *Base map preparation:* LSGD Planning shall provide base map of the planning area for land use survey for SIWG. Along with basic layers such as survey boundaries, water bodies, roads and other physical features, hazard exposure shall also be provided in base maps.

vii. *Awareness creation:* The people in the local area shall be aware of the Master Plan and shall actively participate in the preparation process. For ensuring participation from community and to gather local knowledge and aspirations, special ward sabha shall be summoned.

7.1.3.2 Process of preparation of Master Plan.

b. Data collection:

For preparing Master Plans various types and large amount of data are to be collected either from secondary sources or through direct survey. Secondary data can be collected from stakeholder departments and agencies relevant to concerned sectors. Primary data to be collected through land use survey, socio-economic survey, transportation study and

collecting information pertaining to a particular local body viz. street vendors, floating population, tourism etc. Vulnerability of the community has to be assessed using information collected through detailed survey.

c. Data analysis

i. *Sectoral analysis:* Analyse data from development sectors to understand problems and potentials of each sector which will act as an input for development vision formulation and to fix sectoral objectives.

ii. *Local level analysis:* To understand the developmental trend of the area, sensitive and priority areas and sectors in local context

iii. *Vulnerability analysis:* Assess vulnerability of the community to different types of hazards.

iv. *Risk assessment and risk information:* Based on hazard exposure and vulnerability risk of the area is determined.

d. Envisioning

i. Vision
ii. Goal and objectives
iii. Development concept formulation

e. Special ward sabha

For formulating the annual plan for the ULB, the participation of the community is ensured by conducting special ward sabhas. During Master Plan preparation, special Ward sabha for each sector shall be conducted to create awareness among people and to understand their development aspirations. To ensure community participation in Master Plan process, workshops, seminars and other programs also have to be organized.

f. Formulation of proposals and zoning regulation

i. Proposed land use plan
ii. Sectoral proposals
iii. Proposed transport plan
iv. Hazard zonation and zoning regulations

g. Development seminar

For ensuring participation at different levels, Development seminar shall be organised to consult the people, people's representatives, experts, line departments and other interested parties at different stages of Master Plan preparation. The seminars may be organised after envisioning and after proposal formulation. The observations and suggestions from the seminar can be used to improve the Master Plan.

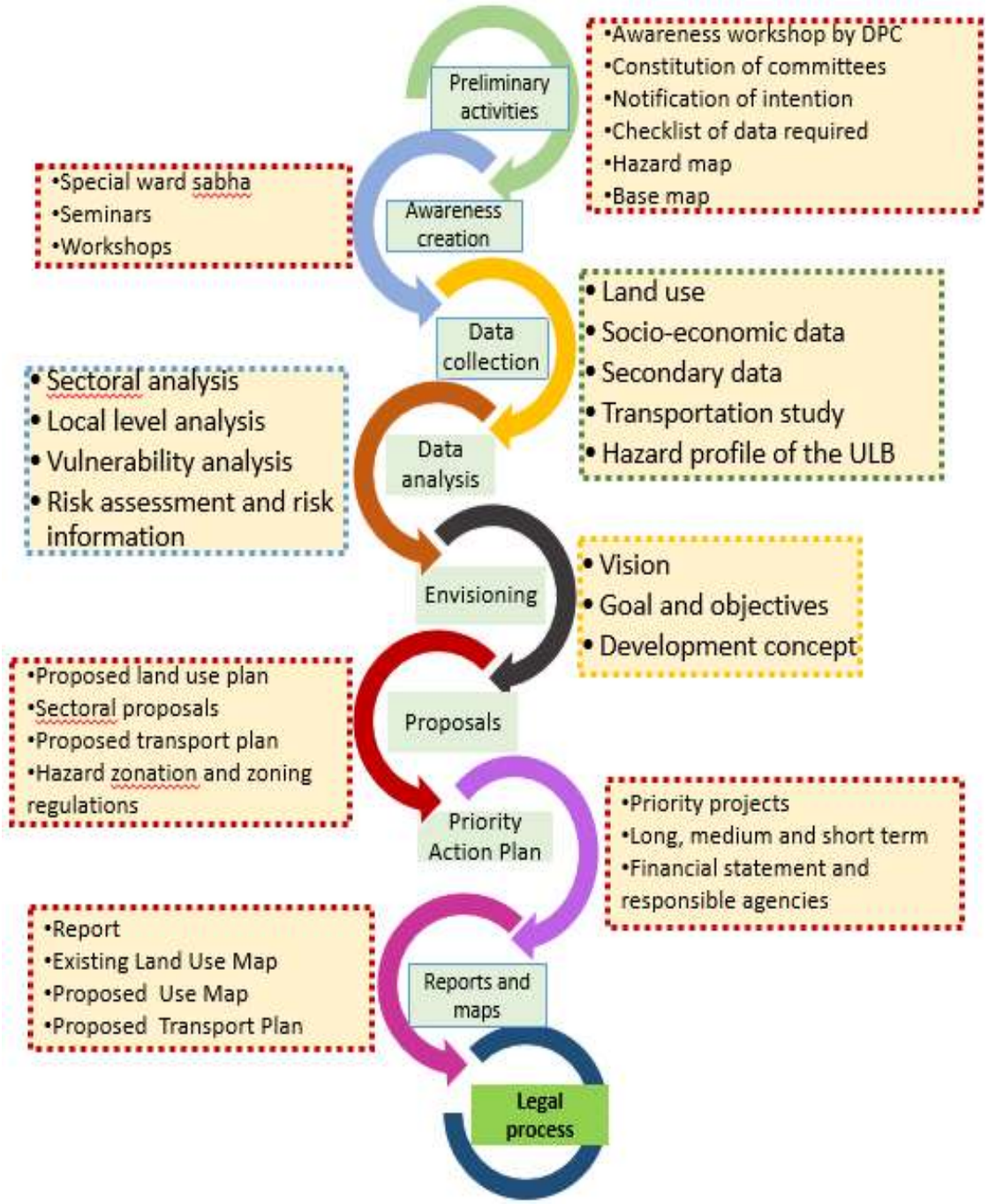


Figure 7:2 Technical process flow for RIMP

h. Priority action plan

Priority Action Plan shall be prepared as part of Master Plan taking into account major schemes and projects envisaged in the Master Plan for the Local Planning Area or part thereof along with development priorities assigned by the Central and State Governments, indicating phasing and prioritization of actions for the implementation of short, medium and long term sectoral programmes, projects and schemes.

i. Preparation of master plan report and maps

Based on data collection and analysis, Master Plan report and maps of existing land use, proposed land use with hazard overlay zones, proposed transport plan shall be prepared. Projects for different sectors, agencies involved in implementing the project, their priority and financial statement shall become part of the report.

7.1.4 Legal process flow of Master Plan preparation

The legal process flow of Master Plan preparation as envisaged in the T&CP Act is detailed below. These actions are to be followed as per T&CP Act in order to make the Master Plan to be a legally valid document for implementation.

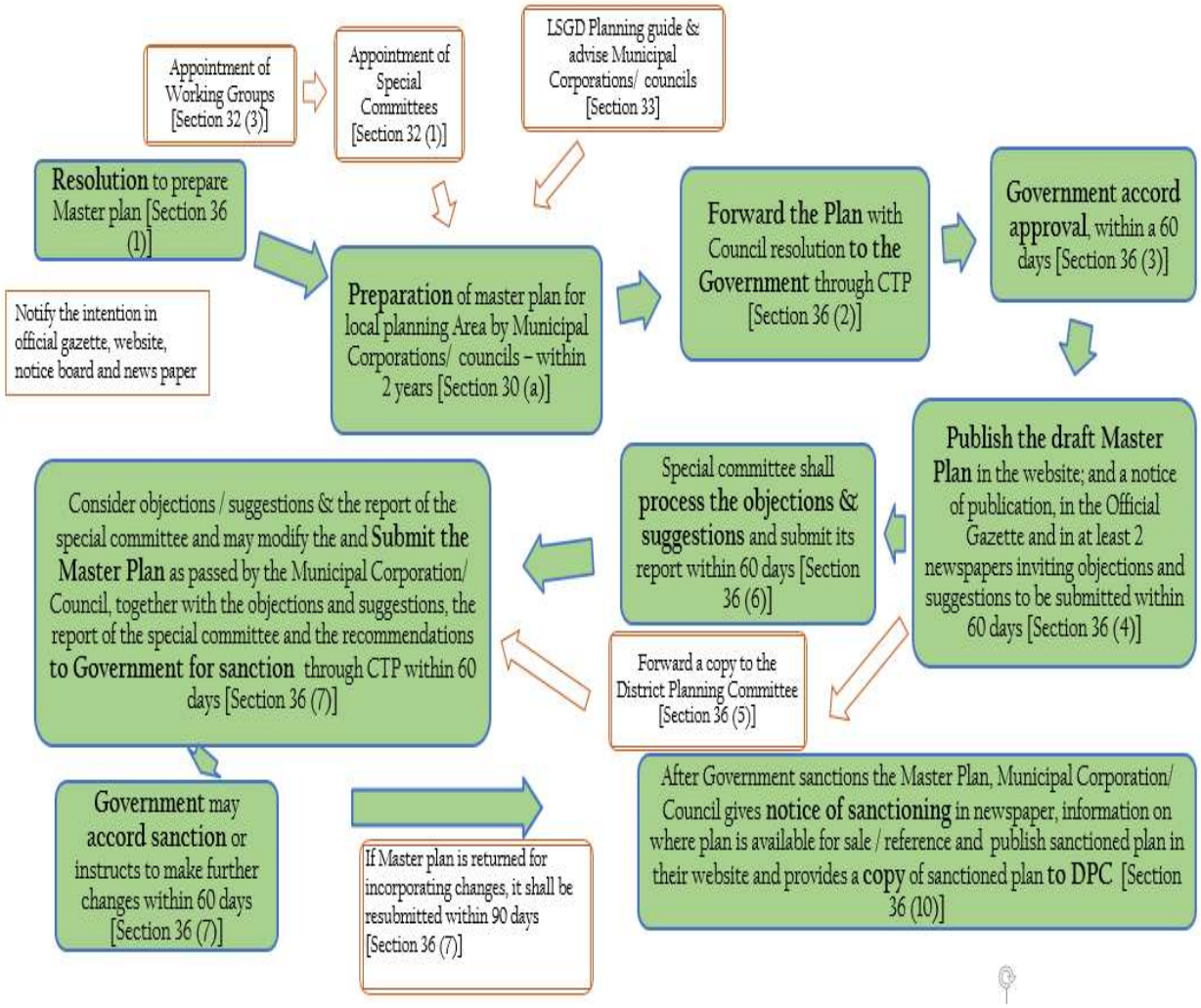
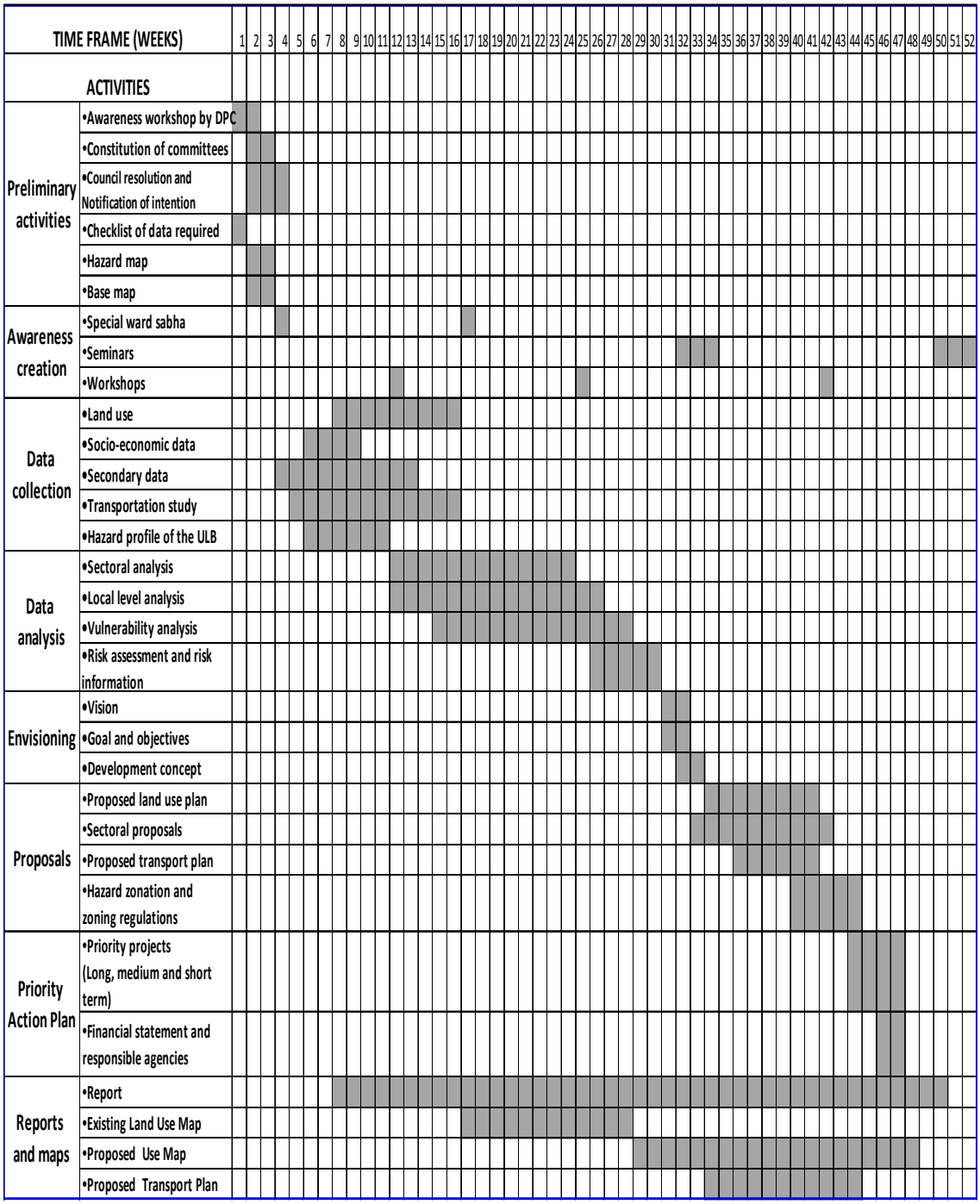


Figure 7:3 Legal process flow for RIMP

7.1.5 Time schedule of Activities

The suggestive time frame for different activities for RIMP preparation is shown in Table 7.1.

Table 7:1 Time frame for activities in RIMP preparation



7.2 Implementation Stage

No Plan can be considered effective if the proposals in it are not implemented. Many of the projects identified in the Master Plan including DRR measures can be taken up by the LSGI itself. However, some could be beyond the purview of the LSGI. LSGI shall take the lead role in ensuring that all developmental activities carried out within its jurisdiction are aligned with the Master Plan proposals.

7.2.1 LSGI

Once the RIMP is sanctioned, the proposals and projects in it shall be taken up for implementation. Financial allocation for the projects shall be considered with priority in the annual plan of the local body.

- Periodic review of the Master Plan shall be made by the LSGI and modifications, if needed, shall be effected.
- Multi-year projects in the Plan to be realized through own funds or state funds or funds from other agencies
- Monitoring of the implementation of the plan shall be continuously and effectively done

7.2.2 District Planning Committee

- Periodic review of implementation of RIMP proposals by District Level Technical Committee
- Shall ensure the inclusion of projects identified in RIMP in annual plans of the LSGI

7.2.3 District Disaster Management Authority

- Facilitate funds for implementation of risk reduction measures.
- Provide Technical support to the LSGIs in matters related to Disaster Risk Reduction
- Coordinate with, and give guideline to, local authorities in the district to ensure that measures for the prevention or mitigation of threatening disaster situation or disaster in the district are carried out promptly and effectively.
- Examine the construction in any area in the district and, if it is of the opinion that the standards for the prevention of disaster or mitigation laid down for such construction is not being or has not been followed, may direct the concerned authority to take such action as may be necessary to secure compliance of such standards.

7.2.4 KSDMA and State Executive Committee

- Recommend provisions of fund for mitigation and preparedness measures.
- Advice, assist and coordinate the activities in disaster management.

7.2.5 Line departments

- Ensure that departmental projects are aligned with Master Plan proposals and Priority Action Plan.
- Ensure that DRR measures identified in Priority Action Plan as part of RIMP are included in the programmes of the department concerned.
- Allocate funds for implementation of risk reduction strategies in RIMP, concerned with the department
- Ensure that projects proposed in Priority Action Plan of Master Plan, which are to be implemented by the department, are taken up and implemented.

8. PRIORITY ACTION PLAN, RESOURCE MOBILISATION, IMPLEMENTATION, MONITORING & REVIEW MECHANISM

8.1 Priority Action Plan

Development projects proposed in the Master Plan have to be implemented by LSGI and the respective departments. Most of these development proposals are not being implemented as no special funds have been allocated for the implementation of these projects or a fixed percentage of the allotted plan funds have been set aside for this purpose. In order to make the implementation of Master Plans more effective, the provisions for the formulation of a Priority Action Plan have been introduced in the Kerala Town and Country Planning Act, 2016 by replacing the provisions for the preparation of Execution Plan.

As per section 2 clause (aaa) of the Kerala Town and Country Planning Act, 2016, "Priority Action Plan means an action plan prepared within the framework of a Plan prepared in accordance with the KT &CP Act, for a district, metropolitan area, local planning area or a special area, as the case may be, indicating priorities and programmes for the spatial development of said area, and it shall form part of the respective plan". Hence, while preparing Risk Informed Master Plan, priority action plan has to be prepared incorporating projects and proposals aimed at Disaster Risk Reduction as well and it will form an integral part of the Master Plan document. Since legal procedures for the preparation and sanctioning of the priority action plan are not provided separately, it will help in the timely implementation of the proposals in the Master Plan. Separate orders and guideline may have to be issued by Government regarding identification and taking up of projects from the Master Plans prepared under the KT &CP Act for Five Year Plans and Annual Plans of the LSGIs, projects of line departments, earmarking of funds etc.

The Priority Action Plan shall take into consideration development priorities assigned by the Central Government, State Government, District Planning Committee etc. along with the Disaster Risk Reduction and Mitigation measures. Necessary consultations with experts and authorities concerned may be made in this regard. Disaster Risk Reduction measures proposed, based on the disaster risk assessments made for the identified vulnerable areas, has to be prioritised and phased so that the strategies, major schemes and projects for risk reduction can be effectively implemented. DRR measures indicating phasing and prioritization of actions for the implementation of short, medium and long term sectoral programmes, projects and schemes shall be categorised and the agencies responsible for implementation of each of the DRR measure shall be identified and mentioned in the priority action plan itself.

A brief description on each selected project may be included as first part of the action plan and the following details may also be included:

A map showing clearly the project area with immediate surroundings; a brief description containing the name of the project, need for the project specifying the importance and benefits of implementation of the project, priority of the project etc.

Development Zone attributed to the project in the proposed Land Use Map shall be mentioned. Responsible agencies to be involved for the detailing and implementation of the projects have to be identified and their roles have to be specified along with the implementation mechanism. The approximate cost of the project, suggestions for funding sources, challenges expected etc. shall also be included in the project description.

It may be noted that in the case of some projects, it may not be workable to specify rigid detailing like project subcomponents, method of implementation etc. In such cases, necessary flexibility may be exercised while rendering suggestions. Finally, phasing of the projects based on priority has to be done and the projects may be listed in the descending order of priority.

8.2 Resource Mobilisation

There are various types of resources required for disaster management. Financial and Human resources are the primary ones. Financial resources, in fact, form the single largest concern as they in turn enable acquisition of other secondary resources required for operational purposes. Financial resources come from various sources, including, government grants, loans, institutional grants, and private donations, product and service charges and mobilisation on the part of communities.

8.2.1 Government Finance

Most of the disaster relief programmes are run jointly by the State and Central governments. Disaster Management is primarily the responsibility of the States. Funds are available in the form of ‘Disaster Response Fund’ for meeting any threatening disaster situation or disaster and ‘Disaster Mitigation Fund’ for projects exclusively for the purpose of mitigation.

‘State Disaster Mitigation fund’ shall be utilised on such mitigation activities that are not covered under any of the existing plan schemes. The provision for relief, rehabilitation and reconstruction should not be a part of State Disaster Mitigation Fund. Suggestive mitigation activities may include support for structural and non-structural mitigation such as raising of plinth level above flood level, identification and establishment of emergency evacuation routes from risk areas to emergency shelters, diversification of livelihoods, risk communication and promoting risk awareness initiatives and training in life saving skills at the community level. It should combine mitigation, livelihoods diversification, access to financial services, formation of social networks, and public awareness in a way that reinforces and consolidates risk reduction and builds resilience. Areas of support may include developing the physical infrastructure to protect human lives or reduce asset losses; strengthening the capacity of local institutions to reduce and manage the impact of shocks, improving community-local government linkages in disaster management planning and implementation and strengthening the capacity of government departments in mitigating the impacts of a potential hazard.

As per State Disaster Management Pan, 2016, all departments shall allocate 10% of their annual plan budget for disaster preparedness, response, recovery and mitigation in their respective sectors.

8.2.2 Local Resources

The local government should look at its own budget, including annual budget for development and special funds for disaster preparedness. It can look to the national government for funding specific projects. Some risk reduction measures, such as non-structural measures, are inexpensive and simple solutions that a local government can afford.

Local businesses, NGOs and the community residents themselves are potential sources of funding and in-kind contributions such as people's time, labour, use of equipment and office/meeting space can lower project costs.

Grants and services from foundations, environmental organizations, volunteer groups, and other non-profit organizations may be worth considering; such organizations are often willing to contribute financial or other resources.

8.2.3 Corporate Social Responsibility (CSR) Fund

Many companies and business groups make financial donations, in-kind contribution, and also volunteer staff skills and time for social work. Many NGOs working in disaster response and preparedness, have in the recent years, tapped into CSR pools to mobilise resources for their activities. This is a healthy and increasing trend that will open new opportunities for resource mobilisation for disaster management in the future.

8.2.4 Risk Sharing & Transfer

Disasters divert important funds for development to disaster relief and rehabilitation. Tools need to be developed that help the poor to manage risks more effectively with alternative sources of finance, such as Insurance. Beyond financing future losses, more efforts need to be made towards a more proactive strategy to reduce and prevent losses. Insurance companies could make risk reduction a condition for providing insurance. Moreover, banks could set disaster reduction as a precondition for granting loans.

8.3 Project Implementation

The ability to use Risk Assessment to prepare an action plan is critical to risk reduction, and its value will ultimately be judged by results on the ground. The action plan should result in strategic short, medium, and long-term structural and non-structural measures to increase resilience and reduce disaster risk. Ideally such plans would then be mainstreamed into broader urban planning and management practices.

Stakeholders should work to establish priorities, highlighting those actions most critical to undertake in relation to the available funding and capacity for implementation. Other factors such as financial feasibility, political and technical complexity, social issues, and distributional and equity issues should also be considered.

Once priorities are established and an action plan is developed, detailed plans are prepared for each project (ranked by priority), including objectives, cost parameters, and a plan of implementation. When considering implementation, the LSGI may decide to treat risks differently in different areas of the local body, with the following options:

a) eliminate or avoid,
b) transfer or share (example through insurance),
c) mitigate (through structural and non-structural interventions),
d) accept and manage the risk.

These priority projects should be included in the LSGI's annual and multiyear plans. Line departments should also take up these projects.

This plan of implementation ideally should address issues such as institutional coordination, sequencing of actions, budget, communications, and monitoring and evaluation.

8.4 Monitoring & Review

There should be a formal process to measure progress, assess how things are proceeding, and decide on what are the needed changes.

It is important to develop mechanisms to track the effectiveness of implemented risk reduction measures. The action plan should have clearly defined tasks and deadlines. Moreover, indicators help keep track of how projects have performed over a period. Indicators contribute to ensuring achievement of objectives and key results areas.

Periodically, the plan should be evaluated in light of progress and changed conditions. DDMA should review progress on a regular basis (annually or bi-annually) and submit recommendations to the organizations responsible for implementation.

In addition, there should also be open channels in which stakeholders, particularly community members can provide feedback and suggestions, and voice their concern and needs. These issues should be discussed at the 'review' meeting and given due consideration when revising the plan.

DDMA should review the DRR plan after a hazard event and make any necessary revisions based on lessons learned from the disaster. In addition, measures implemented before an event should be evaluated post event to see how well they have performed.

ANNEXURE I

Lessons conceived from 2 Pilot RIMPs

1. Master Plan of Mananthavady Town

Mananthavady, a hilly town in Wayanad district, was one among the worst affected towns in the State in the 2018 floods. Environmental degradation, unprecedented rainfall,, hill cutting, filling of Paddy fields, deforestation along with the opening of Banasura dam are suspected to be the major reasons for Floods and Landslide of 2018 in Mananthavady Town. Out of the total area of 80.1 sq.km of the Town, 12.29 sq.km area was affected by the flood.

For the preparation of Risk Informed Master Plan, data and information from 'Rebuild Malabar', an exercise undertaken after the hazard event in 2018 by the district administration with participation from Indian Institute of Architects Calicut Centre, Academic institutions, Volunteers and the Town Planning Department, is heavily relied. In the hazard affected area, housing clusters were identified and vulnerability was assessed using social, economic, physical and psychological parameters. Clusters were thus classified into High, Moderate and Low vulnerable areas. Based on the degree of hazard vulnerability, Development Areas, Development Regulated Areas and Development Limited Areas have been identified in the proposed land use Plan.

Some of the Challenges and issues in the preparation of the Master Plan with respect to Risk are summarised below:

- Spatial data available on damages from the 2018 floods was the data collected as part of 'Rebuild Malabar'. This data was cross checked and verified with respect to Satellite imagery and field verification. The satellite imagery when extracted to the town level resulted in mapping errors while working in GIS. During field verification, it is noted that in many cases, data did not truly reflect the actual area of impact of the disaster.
- The maps in District Disaster Management Plan (DDMP) prepared by KSDMA was in 1: 50,000 scale and it was downscaled to the town level and it proved to be not very accurate in the field verification.
- The GIS flood analysis would have been better with different data sets such as flood accumulation, precipitation, soil type and infiltration, slope and elevation, geomorphology etc. But only limited data were available.
- For assessment of impacts of landslides in the region, available satellite imagery was used.
- It appears that in the landslide hazard map, only the Slope factor is considered, other factors such as soil characteristics, precipitation etc. may also have to be taken into account.

1.1 Methodology adopted for delineating hazard prone area

Each affected and damaged house was marked with geo coordinates and detailed information as per the questionnaire developed were collected. Flood boundaries are marked with sentinel data and field information.

An open source app was used for collecting the data from the field.

Agencies/ institutions consulted

District Disaster Management Authority, Revenue Dept., KSEB, KWA, Irrigation Department, various local bodies, volunteers from various institutions take part in the study conducted through the municipality.

Accuracy and reliability of the data used

Data received from the affected persons from the field are not always accurate or consistent with ground reality. The scale of Hazard maps used are in the range of 1:50000 which is practically of not much use in formulating decisions on Disaster Preparedness at local body level.

Suggestions to improve the process

Require an accurate flood map from competent agencies so that proper Flood Plain Management Policies can be formulated. Collecting Historical flood data, installation of rain water gauge, storm water gauge and stream water gauge, and greater participation and active involvement of stakeholders etc. will be of huge help in improving and streamlining the process.

1.2 Vulnerability assessment

Methodology adopted

List of vulnerability indicators developed by Dixit in the report, "Flood disaster impact and responses in Nepal Tarai's marginalized basins Nepal" were used for Mananthavady. According to the field scenario, 12 relevant parameters were selected.

Vulnerable cluster identification of Mananthavady Town

Each affected household survey data was plotted on the map to identify clusters in the Municipality and accordingly 15 major clusters were identified. 12 vulnerable indicators and supporting data set were extracted to rank each cluster on a scale of 1 - 5 and converted to a weighted scale. Thus the total score of each cluster was determined. The score for all 12 indicators for each cluster was summed up.

Factors considered

Parameters	**Sl . No**	**Indicators**
Physical	a	Occurrence of Flood and Landslide
	b	Severely Damaged Houses
	c	Severely Damaged Plots
	d	Isolated Areas
	e	Houses near High Slope area
	f	Houses near the River banks

Social	g	SC/ST HHs Affected
	h	Livelihood Affected
	i	Dependent Population
Economical	j	Livelihood affected HHs
Access to Drinking Water	k	Affected Drinking Water Sources
Psychological	l	Psychological stress

Analysis of critical facilities

This analysis aims at identifying the critical facilities in the Municipality like educational institutions, police stations, hospitals, fire and rescue stations, etc. These facilities play a central role in disaster response and recovery and, hence, it is important to protect these critical facilities to ensure that disruption of public service is minimized during the disaster.

2. Master Plan of Chengannur Town

In Alappuzha district, other than Kuttanad region the most affected region during the flood of 2018 was Chengannur. Flood plains of Chengannur, which is created by Manimala, Pamba and Achankovil Rivers had been inundated for several days during the floods.

Some of the Challenges and issues in the preparation of the Master Plan with respect to Risk are summarised below:

- The flood hazard prone area identified in the District Disaster Management Plan and in the Local DM Plan are in a much smaller scale than the requirement for a Master Plan. On field verification, inaccuracies were reported.
- No data on height or duration of inundation of 2018 & 2019 floods was available. So the data used for the study was solely based on the primary survey conducted in 2021 and the remarks of the residents on the 2018 and 2019 flood impacts.
- Freely available DEM of ALOS Series JAXA/EORC of 30m resolution was used for simulating flood situation of the past event and also to analyse the drainage pattern. This was one of the limitations.
- A very large extent of the town is flood prone and is inhabited. This is a challenge in getting people accept some of the Disaster Risk Reduction strategies.

2.1 Methodology adopted for delineating hazard prone area

- Methodology adopted: Primary surveys, Secondary data collection- Literature Review (District Disaster Management Plan, 2015 for Alappuzha District)
- Agencies/ institutions consulted: KSDMA, DDMA, NCESS
- The data used for the study was solely based on the primary survey conducted in 2021 and on the remarks by the inhabitants/ residents.

- Suggestions to improve the process: Documentation of various parameters of hazard and disaster events need to be carried out in details. Scientific opinions/suggestions from the concerned departments need to be made available and the present study is to be checked with them.

2.2 Vulnerability assessment

- Methodology adopted

Vulnerability level of wards are identified based on the number of households (HH) affected during past flood events and the damages were assessed through the primary surveys. The identified different Vulnerability Categories are: High, where the flood Affected HH are 200 above; Moderate, where 100 to 200 HH were affected or any complete loss of HH occurred other than the High-risk wards; and Low where less than 100 HH were affected.

Based on the identified vulnerability levels of wards, different vulnerable housing groups were identified. The identified clusters in high and moderate risk wards are to be considered with high priority in any possible future flood events.

The vulnerable built-up clusters are identified based on flood prone area map of town, the total number of houses affected, and the presence of residential areas in the flooded region. The spatial distribution of residential land use is scattered in the town area, so the cluster identification was difficult thus they were mapped by focussing on the major built up areas in the flood prone region. These built-up clusters are identified and marked in the google map.

Vulnerability assessment was carried out for the clusters using various factors such as population density, flood level, elevation of terrain, proximity to water body and presence of low-income housing. These factors were assigned weightages according to their relative importance. A cumulative score is then generated by adding the weighted values. Flood level was given a weightage of 30%, Elevation and Proximity to water bodies were given a weightage of 20% each and Population Density and LIG were given a weightage of 15% each for the vulnerability assessment purpose.