GOVERNMENT OF KERALA
KERALA STATE PLANNING BOARD

FOURTEENTH FIVE-YEAR PLAN
(2022-2027)

WORKING GROUP ON
DISASTER MANAGEMENT

Perspective Planning Division
March 2022

FOREWORD

Kerala is the only State in India to formulate and implement Five-Year Plans. The Government of Kerala believes that the planning process is important for promoting economic growth and ensuring social justice in the State. A significant feature of the process of formulation of Plans in the State is its participatory and inclusive nature.

In September 2021, the State Planning Board initiated a programme of consultation and discussion for the formulation of the 14th Five-Year Plan. The State Planning Board constituted 44 Working Groups, with more than 1200 members in order to gain expert opinion on a range of socio-economic issues pertinent to this Plan. The members of the Working Groups represented a wide spectrum of society and include scholars, administrators, social and political activists and other experts. Members of the Working Groups contributed their specialised knowledge in different sectors, best practices in the field, issues of concern, and future strategies required in these sectors. The Report of each Working Group reflects the collective views of the members of the Group and the content of each Report will contribute to the formulation of the 14th Five-Year Plan. The Report has been finalised after several rounds of discussions and consultations held between September to December 2021.

This document is the Report of the Working Group on "Disaster Management". The Co-Chairpersons of Working Group were Dr. Sreekumar Chattopadhyay and Dr. A Jayathilak IAS. Sri.V Namasivayam, Member of the State Planning Board co-ordinated the activities of the Working Group. Dr. V. Santhosh, Chief, and Perspective Planning Division was the Convenor of the Working Group and Smt. Sangeetha.P .K , Research officer, Perspective Planning Division was Co-Convenor. The terms of reference of the Working Group and its members are in Appendix 1 of the Report.

Member Secretary

PREFACE

This report brought out by the Working Group on "Disaster Management" constituted by the State Planning Board as part of formulating the Fourteenth Five Year Plan includes a general narration of the Disaster Management programmes Framework in the State, future perspectives and a working plan for 14th Plan period. It also made an attempt to evaluate and progress of the schemes undertaken during the Thirteenth Five Year Plan Period.

We would like to place on record the invaluable inputs provided by the officials of Revenue department, KSDMA and other Members of the Working Group in developing this report and the services rendered by the concerned Member of State Planning Board, Sri. V. Namasivayam, concerned division Chief Dr. V. Santhosh and the Staff of the Perspective Planning Division, State Planning Board in compiling this report, which we are sure would serve as a blueprint for the comprehensive and effective management of Disaster Management programmes in the State through the next five years and beyond.

Dr. Sreekumar Chattopadhyay
Former Scientist, NCESS
Expert Co-Chairperson

Dr. A. Jayathilak IAS,
Additional Chief Secretary, Revenue and Disaster Management
Official Co- Chairperson

CONTENTS

List of Tables		03
List of Figures		03
List of Boxes		04
Summary		05
Chapter 1	Introduction	07
1.1	Conceptual change of disaster management and Sendai framework	07
1.2	Risk reduction and sustainable development	08
1.3	Socio-ecological frame for disaster management	09
1.4	Disaster management in Kerala and emerging challenges	11
Chapter 2	Review of work done during 13th Five Year Plan and lessons learnt	15
2.1	Incidence of disasters and management initiatives	15
2.2	Experience of vulnerable sections	18
2.3	Report of the SPB commissioned study on Flood and landslides	19
2.4	Flood level marking survey and installation of flood level markers	19
2.5	Lessons learnt	20
2.6	Hot spot of disaster risk and management challenges	21
Chapter 3	Future perspectives and critical issue	23
3.1	Science and Technological considerations for disaster risk reduction	23
3.2	Coastal risk reduction	26
3.3	Extreme rainfall events	26
3.4	Landslide	27
3.5	Flood	30
3.6	Sustainable housing in hazard zones	32
3.7	Climate change	34
3.8	Planning for long term	34

3.9	Stake holder consultation for problem identification and possible solutions	34
Chapter 4	Recommendations	35
4.1	Understanding disaster risk	35
4.2	Strengthening disaster risk governance	37
4.3	Investing in disaster risk reduction for resilience	38
4.4	Enhancing disaster preparedness for effective response	40
4.5	Resilient home and disaster literacy campaign	43
4.6	Sendai target and proposed Kerala's action	43
4.7	Financial requirement	43
Annexure I	Identified Hazard types in Kerala in Section 2.2 of the State Disaster Management Plan	44
Annexure II A	Performance of the 13th Five year Plan	45
Annexure II B	Action Taken by KSDMA for major disasters during 13th plan period	73
Annexure III	Sendai framework and AR6 report	91
Annexure IV	Science and Technology perspectives under Sendai framework	94
Annexure V	Coastal risk reduction	136
Annexure VI	Stakeholder consultation	143
Annexure VII	Building resilient home	191
Annexure VIII	Budget break up	194
Appendix		209

LIST OF TABLES

Table 1	Sendai Framework and proposed Kerala's action	43
Table 2	Financial requirements	44

LIST OF FIGURES

Figure 1	Multi-hazard vulnerability of Kerala	12
Figure 2	Flood Hazard - Historical 1 in 50 years	68
Figure 3	Coastal erosion zones	69
Figure 4	Example of site suitability for sire installation	88

LIST OF BOXES

Box No. 1	Sendai Framework: Priorities and targets	08
Box No. 2	Social-ecological framework	10
Box No. 3	Steps to build social-ecological resilience	10
Box No. 4	Newspaper report on State's resilience after 2018 Flood	13

SUMMARY

Kerala is multi hazard prone. The State is prone to 17 Natural Hazards and 22 Anthropogenic Hazards that have disaster potential. Institutional mechanism for disaster risk reduction has developed significantly during the 13th five year plan period as compared to the 12th five year plan owing to the induction and functioning of technically competent staff. During the 13th five year plan period the Kerala State Disaster management Authority (KSDMA) working under Revenue department could build its own headquarters building and forayed into innovative resilience building measures with a long term perspective. During the 13th FY plan period KSDMA was involved in the management of Puttingal Fire Cracker Accident, Cyclone Ockhi, Nipah epidemic control, Floods and Landslides of 2018 and 2019 and Covid19. The KSDMA was able to introduce many amendments in various rules and regulations in the state for disaster risk reduction. Several landmark judgments from the High Court could also be seen upholding the views of KSDMA. Thus, nationally, KSDMA became noted as the 5th best disaster management authority. A major achievement in the 13th FY plan period is the decentralisation of disaster risk reduction and resilience building concepts to local governments who completed preparing the local government disaster management plans.

In the 14th five year plan period, KSDMA desires to focus on achieving the targets laid in the Sendai Framework by systematically approaching risks and focusing on resilience building. A flagship programme will be disaster literacy campaigns for ensuring resilient homes in the State. Other major initiatives will include creating anticipatory action hubs, creating risk transfer mechanisms, mainstreaming risk informed planning and rapid adaptation of advanced science and technological solutions. Risk information will be updated based on climate change scenarios as highlighted in AR6 reports of IPCC and attempts will be made to downscale the scenarios using a Coordinated Regional Climate Downscaling experiment (CORDEX) exercise and this will be made available to local governments for risk informed development planning. The open source disaster risk reduction decision support software tool Risk Changes developed by Asian Institute of Technology, Bangkok will be customised for the use of Kerala and mainstreamed into development planning. The last mile connectivity early warning system having sirens, strobe lights, location based messaging system and CAP alerts will be commissioned. School and hospital safety plans will be prepared for all schools and hospitals and will be made mandatory. The Netherlands-Kerala partnership for disaster risk reduction will be institutionalised and carried forward through the Chief Secretary level Round Tables. Technical advice and capacity building assistance will be sought from appropriate academic and professional entities in the Netherlands for building long term resilience of the State. Focus will be to utilise Ecological Disaster Risk Reduction approaches and promote soft solutions including community capacity building. Thus, during the 14th Five Year plan period, the focus will be in resilience building through mainstreaming risk informed planning at the local government level and ensuring that the message of disaster risk reduction reaches every household in the State.

CHAPTER 1
INTRODUCTION

Disaster management gradually evolved as an important component of sustainable development and part of the planning process. It is a matter of global concern. Almost all countries in the world confront disasters of one type or other. The World Meteorological Organisation (WMO) document indicates that between 1970 and 2019, weather, climate and water hazards accounted for 50% of all disasters, 45% of all reported deaths and 74% of all economic losses that translates to 2.06 million deaths and US$ 3.6 trillion in economic losses. Death tolls have fallen over the decades due to advances in early warning systems worldwide, however, economic losses increased many folds. The average per day reported losses from 2010 to 2019 were seven times the amount reported between 1970 and 1979. Data on Asia indicated that the number of disasters has increased over the years. It was from one disaster on average every fifteen days to one every three days over the last 50 years. As the frequency of disaster is increasing and the economic loss is also multiplying, it is now a common global endeavour to manage disaster through global and regional cooperation, share knowledge and build resilient society to navigate the future challenges, particularly the emerging scenario due to climate change and environmental stress. The emerging trend of increasing loss perhaps manifests that investment in the pathways of disaster is increasing. This provides an important lesson for locating and relocating human artefacts, primarily a challenge of planning and governance. Investigation of the social dimension of disaster is thus gaining growing importance.

Concern about a natural disaster is perhaps as old as human history. The origin of many of the socio-cultural norms of human society cutting across geographical boundaries may be traced to the human quest to avoid the destructive impact of extreme natural events. The earth system processes turn into disasters when they affect human society in their extreme form. There are events, which are systemic in nature and are mainly related to geophysical and some atmospheric processes, apparently beyond the control of human action. There are also events where local human actions like land use change, industrialization, urbanisation etc accelerate the natural processes like soil erosion, landslides, air pollution, carbon emission etc., and through cumulation, contribute to global change like that in case of climate change. Anthropogenic forcing have emerged as an important modifier of dynamic natural processes. There are also disasters like the incidence of disease, accidents, war and other social abrasions affecting human lives and property. Therefore, disaster management, be it of natural origin or societal origin, is primarily concerned with human action to minimize the loss of human lives and property in extreme conditions.

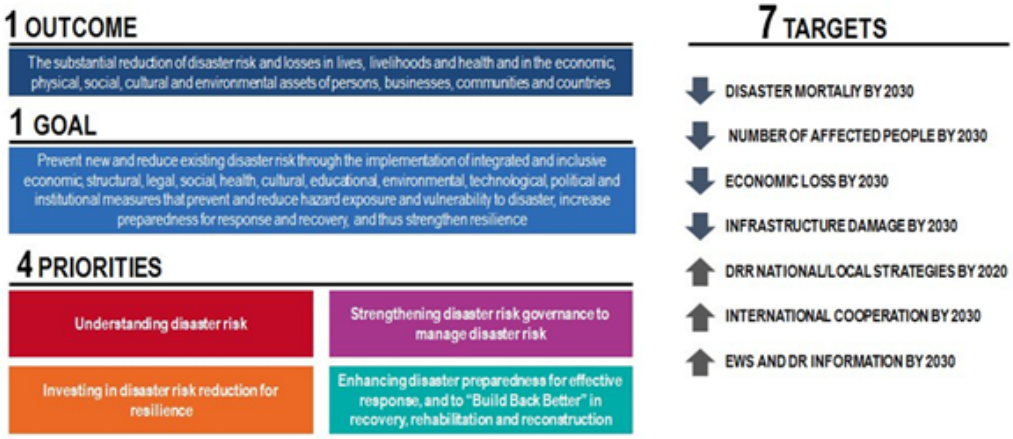
1.1 Conceptual change and Sendai framework

There had been conceptual changes and accordingly, the approach to disaster management has changed. A stand-alone reactive measure to cope with emergencies and provide relief has now yielded a proactive, comprehensive approach to address all aspects of a disaster cycle that covers strategic issues like preparedness, resilience, risk reduction, mitigation, reconstruction, and recovery reactive issues like response and relief. The thrust on disaster

risk reduction (DRR) perhaps began with UN initiatives in 1987 when the UN general assembly announced to observe the 1990s as the International Decade for Natural Disaster Risk Reduction (IDNDR). Since then there have been three World Conferences on disaster risk reduction in 1994 (Yokohama), 2005 (Kobe), and 2015 (Sendai). The Yokohama Strategy and Plan of Action for a Safer World (1994), as the first major international framework for disaster risk reduction, recognized the interrelation between sustainable development and DRR. Ever since, this close interrelation was continuously strengthened within the key global agreements, from MDGs to the Johannesburg Plan of Implementation (Johannesburg, September 2002), to the "Hyogo Framework for Action (2005-2015)" and to the "Future We Want" (Rio, June 2012), to the Sendai Framework for DRR (Sendai, Mach 2016) and the 2030 Agenda for Sustainable Development (New York, September 2015).

The Sendai conference identified four priority areas for action with a time frame of 2015-2030. These are: (i) Understanding disaster risk, (ii) Strengthening disaster risk governance to manage disaster risk, (iii) Investing in disaster risk reduction for resilience and (iv) Enhancing disaster preparedness for effective responses and 'build back better' in recovery, rehabilitation and reconstruction. There are also seven targets expected to be achieved by 2030 (Box 1). The World Congress on Disaster management held in Mumbai (2019) reaffirmed the commitment to the Sendai framework and stressed on reducing risk and building resilience for disaster management.

Box 1: Sendai Framework: Priorities and targets



1.2 Risk Reduction and Sustainable development

Disaster risk reduction (DRR) is an integral part of social and economic development, and is essential if development is sustainable for the future. This has been recognized by several global documents on DRR and sustainable development. The UN Commission on Sustainable Development (UNCSD) addressed risk management and vulnerability in the context of its thematic issues of water, sanitation, and human settlements in its 2004-2005

cycle and drought and desertification in its 2006-2007 cycle.

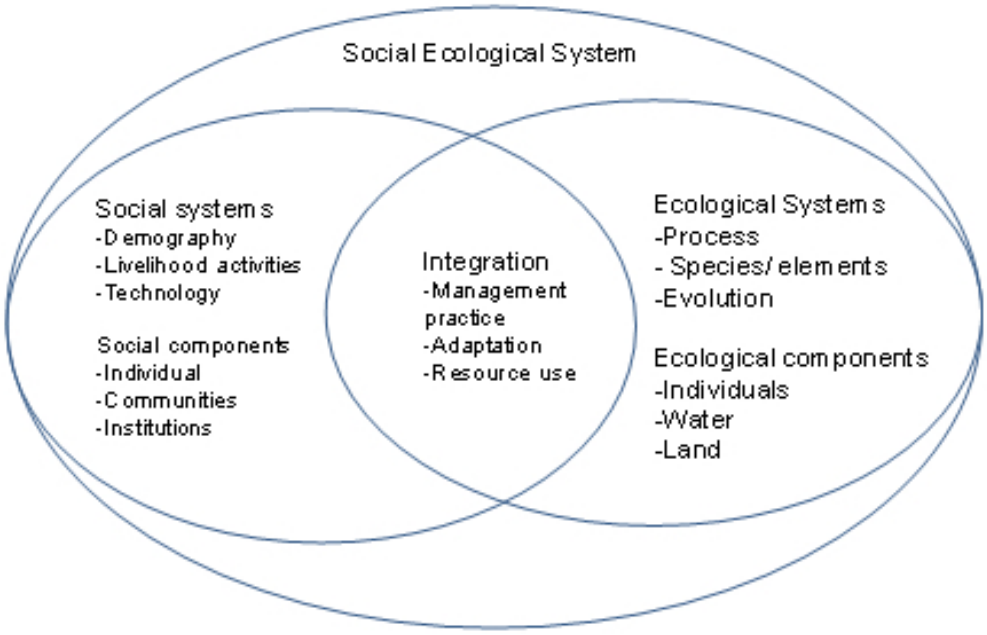
The 2030 Agenda for Sustainable Development recognizes and reaffirms the urgent need to reduce the risk of disasters. In addition to direct references to the Third UN Conference on DRR (Sendai Framework) outcomes, there are specific opportunities to achieve SDGs by reducing disaster risk. For example, by reducing exposure and vulnerability of the poor to disasters or building resilient infrastructure. There are also several SDGs like SDG 4 (Building and upgrading education facilities and ensuring healthy lives), SDG 9 (Building resilient infrastructure, promoting inclusive and sustainable industrialization and foster innovation) and SDG 11 (Make cities and human settlements inclusive, safe, resilient and sustainable) and targets that can contribute to reducing disaster risk and building resilience, even where disaster risk reduction is not explicit.

1.3 Socio-ecological frame for disaster management

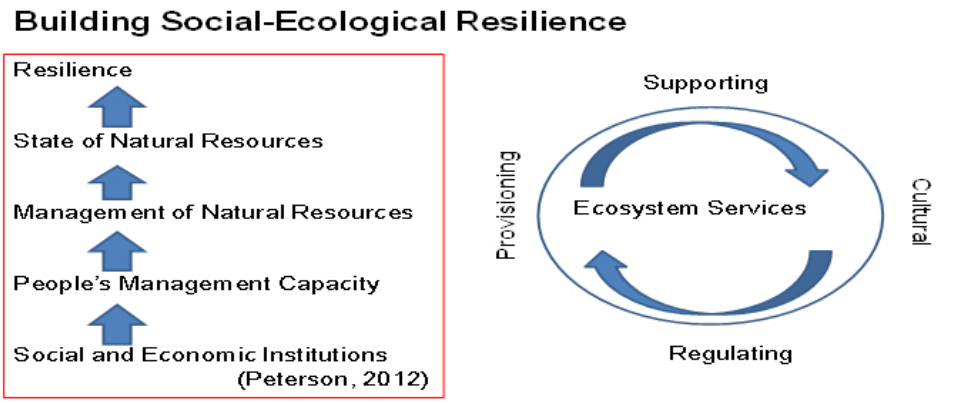
Review of disaster management literature and historical evolution of disaster management activities five broad thematic areas are evident (Aguilar Jr. et al., 2016). These are '(i) disasters as catalysts of different types of change in the society, the state, and the science; (ii) the relationship between disasters and social inequality; (iii) the attribution to nature of the ability as an actor in history, which raises questions about how to conceptualize nature's agency; (iv) disasters as constituting a specific type of modern discourse; and (v) the limitations to the geographical frame of the national discourse on disasters'. Although these observations were made in the context of the Philippines, the lessons are useful for other countries and provide a broad idea about the nature of issues involved in disaster management.

Globally, disaster management now forms a part of the total planning process to build social and ecological resilience in the face of extreme events, be it natural or of societal origin. The social-ecological resilience frame is advocated in this context. This frame considers social and ecological systems as interactive and relational-dialectic (Box 2). Understanding the function of both the systems and how they are mutually modified/ re-enforced provides the necessary information to devise proper management practices. The steps necessary to building resilience is provided in Box 3. This scheme is quite appropriate for Kerala, where the thrust is on institution building, people-centric development and institutionalization of the planning processes at different hierarchic levels including local areas

Box 2: Social-ecological framework



Box 3: Steps to build social-ecological resilience



1.4 Disaster management in Kerala and emerging challenges

Disaster management in Kerala has a long history. It was part of crisis management, a post-disaster activity. For that matter, the all India scenario was also similar. Only after Tsunami in 2004 did disaster management gain serious attention, and the Government of India started framing policy for a more comprehensive and proactive approach.

The Disaster Management Act, 2005 (Central Act 53 of 2005) mandates the establishment of the State Disaster Management Authority, State Executive Committee and District Disaster Management Authorities. Accordingly, the Government of Kerala framed the Kerala State Disaster Management Rules, 2007 vide Kerala Extraordinary Gazette S.R.O No. 201/2007 dated 1st March 2007 (amendments vide S.R.O No. 583/2013 dated 17th July 2013 and S.R.O. No.263/2016 dated 2nd March, 2016) and notified the State Disaster Management Authority, the State Executive Committee, and the District Disaster Management Authorities. The State Authority is chaired by the Chief Minister and convened by the Additional Chief Secretary, Revenue and Disaster Management. The Chief Secretary (inter alia Chairperson of the State Executive Committee) is the Chief Executive Officer of KSDMA. The other ex-officio members are Hon'ble Minister for Home and Vigilance, Hon'ble Minister for Agriculture, Additional Chief Secretary, Home and Head of State Emergency Operations Centre, who is inter alia the Member Secretary of the Authority.

Section 23 (1) of the DM Act, 2005 makes it mandatory for every State to have a State Disaster Management Plan (SDMP) for every State and vide Section 23 (6) 'appropriate provisions shall be made by the State Government for financing for the measures to be carried out under the State plan'. KSDMA has developed the State Disaster Management Plan for the period 2016-17, and the Government has approved the same vide GO (Rt) No. 3667/2016/DMD dated 9th September 2016. The plan also lays a perspective for disaster risk reduction in the next 5 years in line with the SENDAI framework for disaster risk reduction adopted by India and for the period 2015-30.

1.4.1 Vulnerability of Kerala

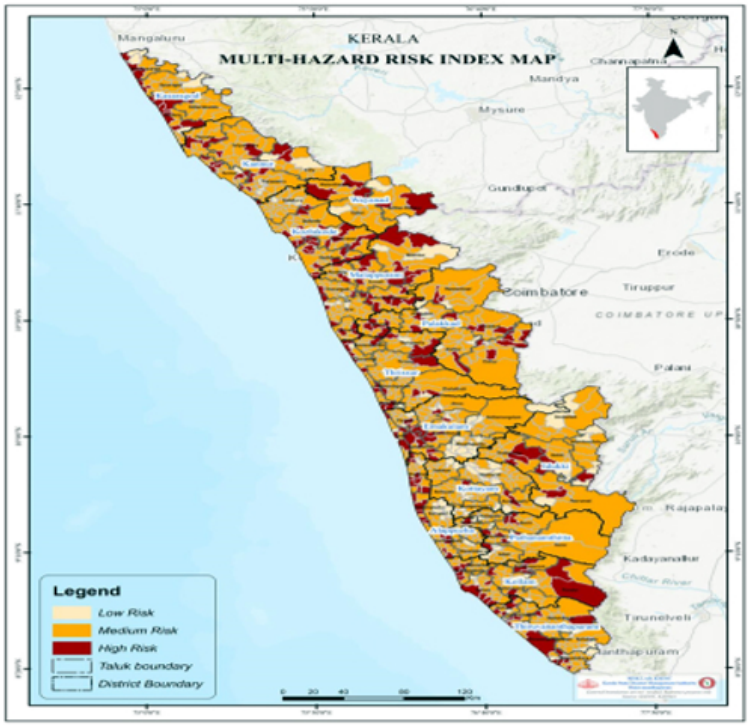
At the instance of the Department of Revenue and Disaster Management, Government of Kerala, Centre for Earth Science Studies (CESS), now rechristened National Centre for Earth Science Studies (NCESS) prepared the first set of disaster-prone maps for Kerala on a scale of 1:50,000. This attempt has drawn the attention of policy makers to the multiple hazards that the state is exposed to. KSDMA subsequently worked on these data-based and further fine-tuned the information.

Kerala is multi hazard-prone. The State is prone to 17 Natural Hazards and 22 Anthropogenic Hazards that have disaster potential (Annexure 1). Based on the multi-hazard vulnerability assessment risk map has been prepared at the Taluk level (Fig 1). The future focus for disaster management shall be primarily to empower the local communities of the taluks to prepare effectively for disaster risk reduction from an 'all hazards perspective' as directed by the Government of India.

1.4.2 Disasters during 13th Five Year Plan period

The 13th Five Year plan period (2016-2021) in Kerala will perhaps go down in the history as the period when there was a disaster every year, and the state has to pass through a very trying time. There were climatic and water-related hazards and also biological hazards. It began with drought (2016), cyclone Ockhi (2017), Nipah virus (2017), flood (2018), post-flood draught (2019), flood (2019), Covid-19 (2020, 2021) and cyclone Tauktae (2021). Besides, there were landslides during every monsoon. The cyclone Ockhi in 2017 was a very severe cyclonic storm with the highest wind speed hovering around 155km/h (3 minutes duration) and 185km/h (1 minute duration). This storm originated from a low pressure formed over the southwest Bay of Bengal. It caused severe damage. The year 2017 also witnessed the Nipah virus outbreak, causing a serious health hazard. The flood in 2018, declared as a national calamity was devastating in nature, covering the entire state and causing an estimated loss of 31,000 crores, apart from the loss of human lives. It was one of the events having a recurrence interval of 100 years. A similar fatal flood affected the State in 1924, which is now part of the folklore. Kerala's performance to tackle the 2018 flood was exemplary and drew world attention. The Government machinery, NGOs, students and common people across the social groups worked in tandem like a well-oiled machine and delivered the humanitarian service, which is unprecedented and set a new standard for other states to emulate. This achievement is principally attributed to the resilience of the state, particularly social resilience (Box 4).

Figure 1: Multi-hazard vulnerability of Kerala



Box 4: Newspaper report on State's resilience after 2018 Flood

State's resilience holds through the great deluge

As assessed by a UN team, the State will need about ₹31,000 crore to repair the losses in the floods

S. ANANDAN
KOCHI

Coastal Kerala was clutching at straws in the crushing wake of Cyclone Ockhi when the year 2018 dawned over it.

The skies turned ominous again in July. The sea turned rough and menacing waves began to nibble away at the hem of the coast. Just when it all looked receding, the skies opened again, sending down torrents, forcing the State to sound an extreme degree of alert across its 14 districts.

In no time, torrential downpour began to leave a trail of destruction across lowland and the high ranges alike. Massive landslips defaced the hilly districts of Idukki and Wayanad, killing several people and forcing those it rendered homeless to seek refuge in relief shelters.

The lowlands of Alappuzha and Kottayam got submerged. Shutters of the State's reservoirs were raised - some like the massive Idukki dam after 26 years - to release water into rivers that were already in spate.

Life in Pathanamthitta, Ernakulam, Thrissur, Palakkad, and Kozhikode suffered severe laceration as swollen rivers bludgeoned their way through villages and cities.

Central and State agencies were called in for rescue and relief works. Amidst the gloom, the resilient fishers rose like the phoenix to ferry stranded people to safety.

The image of K.P. Jaisal, a fisherman from Malappuram, lying prone in the floodwaters for a group of women to step on his back and board a dinghy, became the defining picture of selflessness.

The floods marked a watershed in Kerala's history. At last count, it snuffed out nearly 500 lives and temporarily displaced about 14 lakh people. Damage to property, livestock, livelihood and environment was grave. The State lost about 2.5% of its GDP, as all enterprises and sectors got marooned in the floods. As assessed by a UN team, the State would need about ₹31,000 crore to repair the losses.

An arduous challenge. But an opportunity to rebuild the State to ensure better standards of living to all sections of society all the same, says K.M. Abraham, former Chief Secretary and project implementation chairman of the Rebuild Kerala initiative.

"In doing so, we should pave the way for adopting higher standards of infrastructure in repair and reconstruction. We need to envision major projects for the State. The structures in our new Kerala should have ecological safeguards and standards built into their design so that we will be able to withstand an event like this better in future," he says.

An opportunity to rebuild the State to ensure better standards of living to all sections

K.M. ABRAHAM
Chairman, Rebuild Kerala

Rebuild plan

"The departments are focussed on producing sector-wise plans which will be incorporated into the Rebuild Kerala development programme. Work is going on at a rapid pace in the roads, public transport, water resources, environment, agriculture, livestock and fisheries sectors, to name a few. Each sector plan will identify immediate interventions and their cross-sectoral linkages that can be taken forward with results in six months, 18 months, and beyond. Different sectors need studies to pick among the alterna tives to arrive at the best solution It is expected that by the end o January, these plans can be sub mitted for approval within go vernment. Once these plans ar ready, they will be tied togethe by a financial architecture whic will identify the financial instru tion or other source of funds to f nance the planned interve tions," says Mr. Abraham.

CHAPTER 2
REVIEW OF WORK DONE DURING 13TH FIVE YEAR PLAN AND LESSONS

The recurring incidence of disaster has been extremely stressful for the state on the ecological, economic and social fronts. The state's performance was spectacular and drew the attention of international agencies. The Government of Kerala has taken several steps to avert risks, build resilience and strengthen institutions. Policy changes were brought in with significant judicial interventions. The Kerala State Disaster Management Authority (KSDMA) evolved from a nascent institution of 7 members to a vibrant technical body commending services of more than 50 specialists with capacities in multiple domains ranging from social science to medicine. It has performed admirably in disaster management. While during the 12th plan period, human resources mainly were through central and multilateral projects. The 13th plan period saw the Government taking up the financial responsibility of maintaining a technical team for disaster risk management at the State and district level dedicated to the State and District Disaster Management Authorities. There were significant achievements in almost all disaster cycle sectors, with more than 85% of financial utilisation. KSDMA initiated various activities to make the state risk resilient as listed here:

i) Community-based disaster risk reduction
ii) Strengthening of State disaster response force
iii) Strengthening of Kerala fire and rescue services
iv) Strengthening of the network of emergency operation centres
v) Strengthening instrumented monitoring and science and technology for disaster risk reduction
vi) Mainstreaming disaster risk reduction
vii) Updating hazard, vulnerability and risk assessment of the state and updating the district and state disaster management plans
viii) Policy level intervention
ix) UNICEF funded programme on Mainstreaming Disaster Risk Resilience
x) SPHERE India (a coalition of NGOs) funded programme
xi) UNDP-Government of India project on enhancing institutional and community resilience to disaster and climate change and
xii) Study on possibility of Risk transfer

The details of these initiatives and action taken by KSDMA for managing major disasters during the 13th Five Year plan are given in Annexure II. Here we attempt a brief review and highlight the lessons learnt during management actions.

2.1 Incidence of disasters and management initiatives

The 13th plan period began with an incidence of drought in 2016-17 due to deficit rainfall during both the monsoon seasons. There was a significant shortage of water affecting domestic as well as agricultural sectors. Urgent measures were undertaken to draw water from the Neyyar reservoir to the Aruvikara reservoir through a pipeline to mitigate the

drinking water problem in Thiruvananthapuram city. By the end of 2017 (November), Cyclone Ockhi had affected the Kerala coast. A low-pressure system rapidly turned into a cyclone affecting the fishing population, particularly those who ventured into sea fishing in early dates. Problems of early warning and lack of long-distance communication systems were identified as major lacunae to alert the fishing population.

Kerala faced floods of historic proportions in the year 2018. It was of a catastrophic nature equivalent to a similar calamity that occurred 94 years back in 1924. The flood-affected 1260 villages in 13 districts, with 7 districts being affected in total. The government could enlist the support of the United Nations Organisation for a Post Disaster Need Assessment (PDNA). Accordingly, the PDNA conducted a damage assessment and estimated a loss of ₹26,720 crores and a build-back-better need of ₹31,000 crores. It was for the first time in the country that the entire PDNA exercise was being conducted in any State in such a comprehensive manner. In continuation of the preparedness measures, the State undertook and coordinated a historic and world-recognized disaster response showcasing the advancement and ability of the State in the management of catastrophic situations.

In total, 34 lakhs individuals were housed in 12,253 relief camps during and post-flood period. Apart from providing hygienic food and other relief items, the Government ensured health care facilities in the relief camps and during post-flooding situations, specifically with necessary steps to avoid epidemics. Child health and psycho-social care were also taken care of. The Government facilitated sanitation for flood-affected wards in all Grama Panchayaths, Municipalities, and Corporations. Within 40 days after floods, as many as 6,93,287 houses were cleaned, which accounted for more than 99% of the flood-affected houses. Besides, 7610 public buildings and 3,00,956 wells were also cleaned, in addition to public places, roads and bridges. Carcasses of 5,850 large animals, 8,807 small animals and 8,22,553 birds were buried. Most of this work was done by voluntary teams. Experts from as far as West Bengal were brought in to bury carcasses of animals. Non-biodegradable waste was handled by specialised teams from Clean Kerala Company. Kerala State Electricity Board (KSEB) undertook to reinstate 25.7 lakh electricity connections, which was 98% of the total disconnections in just 14 days. Attention was also paid and necessary provisions were made to reissue lost certificates or other valuable documents from the respective agencies, including Universities. 'Document adalaths' was set up in all districts for speedy provisioning of duplicate or new certificates to those who lost them in the floods. Kudumbashree's services were enlisted to extend non-interest bearing loans of upto ₹ 1 lakh per family for purchasing household goods for discounted rates. The original equipment manufacturers came forward based on the request of the State Government to offer products for a much-subsidised rate for those who availed of these loans.

As many as 2,36,000 farmers have been provided with relief assistance till 5-12-2018 as per the minimum relief code of the State Government. The minimum relief for crop loss in Kerala is several times higher than that of the minimum relief offered by the Government of India. The government has also extended additional support for free seeds for farmers. The Ujeeevana scheme was launched by the Government for supporting Micro Small and Medium Enterprises (MSEMs) sector, which is not usually covered. As many as 4859

MSEMs and 17,224 shops were affected during the floods. In total, 1995 MSMEs and Shops and Other Establishments supported this scheme. The government took innovative measures to provide the minimum relief assistance to houses affected by floods. The rates were fixed according to the geographical location of the house and the extent of the damage. In total 3,70,436 houses have been affected by the floods, with 15 to 100% damage. Assistance was paid to eligible 3,61,029 families. Financial incentive was provided for the relocation of families in vulnerable areas under the vulnerability linked relocation plan. Following international best practices, the house construction was carried out in a totally owner-driven manner. The government promoted housing facilitation centres for flood-affected individuals to access modern house construction practices.

As a part of rescue and rehabilitation measures, animal rescue camps were started on a need basis for providing temporary shelter, feed, fodder and medical aid to the rescued animals. Assistance was provided to flood-affected livestock farmers, as part of insurance claim settlement. Animal disease control was also ensured. A special programme 'Donate a Cow' was organised to encourage and motivate the public to contribute financially by donating a milch cow or heifer for the most flood-affected dairy farmers. Around 300 milch animals were distributed to dairy farmers who lost their animals due to the flood. Special rehabilitation programmes for flood-affected dairy farmers were also taken up.

There was timely and proper intervention in the sector of civil supplies ensuring subsidies food item availability for all sections of the society, including free ration to all the plantation workers of the State. Schemes were also taken up for house construction for the flood-affected people whose homes were lost/severely damaged with the co-operation and support of various co-operative institutions functioning in the State.

Kerala is well known for its health care system. Health indices provide a strong base for the globally acclaimed Kerala development model. This sector witnessed massive mobilisation and involvement of health inspector/multipurpose health workers, local ASHA, AWW and Kudumbasree volunteers and members of WHSNCs besides doctors and other health service personnel. Daily Medical camps were organized apart from ensuring routine functioning of PHC/Hospitals in the affected areas. When the flood water started receding, steps were initiated to safely return the victims of this disaster. Counselling services were arranged for those traumatised in the disaster. Steps were initiated to clean and chlorinate all drinking water sources. Anticipating a large-scale outbreak of water-borne diseases, all possible preventive measures were taken.

In a novel initiative, KSDMA organised a public transparency and accountability statement to meet in 13 out of 14 districts at the same time, in a fixed format on 20-7-2019. The programme was titled Janakeeyam Ee Athijeevanam – Nammal Namukkayi (Participatory Resurgence – We for Ourselves). District Collectors presented the status report, including financial statements before the general public and people's representatives of the districts. This laid a new benchmark for Disaster Response and Reconstruction accountability in the country. Every week the status of recovery was updated in the public domain. Affected can trace their appeals in the public domain. Names and addresses of all those who got ex-gratia were published on district websites.

Kerala went through severe dryness after the flood incidence of 2018. The temperature increased significantly and rivers and drinking water sources were drastically depleted. There were problems of drinking water faced in many parts of the State.

During the South West monsoon of 2019, another deluge hit the state, wherein 1038 villages from 13 districts were notified of floods and landslides, and 125 lives were lost. Sectors like housing, power, and agriculture were affected badly. The state has to go through all the stress and strain of disaster management. Removal of debris from public spaces, rivers, canals and rivulets was one of the important activities after the 2018 and 2019 floods.

The year 2020 witnessed the outbreak of Covid 19, a pandemic affecting all countries in the world. It is a fatal disease claiming huge loss of human lives. The pandemic continues to haunt the world in 2021 also. All measures were taken to provide health care and other livelihood support as the pandemic had virtually brought the world to a halt. Kerala lost several lives. Nevertheless, Kerala's performance in handling health emergencies is globally recognised.

The year 2021 also experienced life and property damage due to Cyclone Tauktae.
Kerala has been included in the second phase of the National Cyclone Risk Mitigation Project with World Bank assistance. The four components of the project are (i) Early Warning Dissemination Systems [100% CSS], (ii) Cyclone Risk Mitigation Infrastructure [75% CSS], (iii) Technical Assistance for Multi Hazard Risk Management [100% CSS], (iv) Project Implementation Support [100% CSS]. Plan provision is provided to the second component (Cyclone Risk Mitigation Infrastructure) and the objective is to increase the preparedness and reduce the vulnerability of coastal communities through strategic infrastructure investments, i.e., improving their capacity/access to emergency shelter, evacuation routes and protecting critical infrastructure against cyclones and hydro-meteorological hazards to reduce potential damages and ensure the continuation of services.

The first Multi-Purpose Cyclone Shelter was inaugurated in June 2020 at Mararikulam, Alappuzha. Out of 17 Shelters in 9 coastal districts, 7 Shelters have been completed and inaugurated. The works of the remaining 10 shelters are in progress. The State has taken necessary measures for Early Warning Dissemination Systems (EWDS).

2.2 Experience of vulnerable sections
There were special attention to vulnerable sections, particularly daily wage earners and economically weaker sections. Livelihood support under the Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS) wage employment was provided to 14.72 lakh families as of June 2019. A total of 16.96 lakh individuals were benefited with a generation of a total of more than 7.6 crore person days. In the post-flood period, ₹ 2,068.74 crore worth of employment was generated. An amount of ₹ 700.14 crores was disbursed to the beneficiaries as unskilled wages by the Central Government through Direct Benefit Transfer.

The SC/ST families were specially taken care of. An amount of ₹37.57 crores was distributed to flood-affected SC/ST families as relief by rearranging the annual plan allocation of the

SC/ST department in 2018-19. The department also incurred the cost of distributing food and non-food items cleaning the flood-affected SC/ST institutions and colonies. Moreover, through sponsorship, the department distributed gas stoves worth ₹2.12 crore to 8,487 SC/ ST families.

2.3 Report of the SPB commissioned study on flood and landslide

The Kerala State Planning Board appointed a committee comprising leading scientists and experts in the country under the chairmanship of Prof. K P Sudheer, Executive Vice President, Kerala State Committee on Science, Technology and Environment (KSCSTE) to examine extreme rainfall events and floods of 2018 and 2019 and incidences landslides. The committee addressed the following issues:

1. The reasons for the occurrence of such EREs and their major causative factors;
2. The capability and potential for accurate forecasting of such events with sufficient lead times;
3. Reviewing indicators and methods to locate areas prone to severe landslides during such EREs and remedial measures for minimising such hazards and their consequences;
4. Reviewing current maps of areas prone to flood hazard during such EREs and mitigation measures to minimise such hazards; and
5. The role of changing land use in these hazards

After detailed deliberations, the Committee advanced a set of recommendations spelling out various activities. The Committee has analysed spatial and non-spatial data collected from different agencies and departments. Therefore, an important suggestion is that a centralised facility/ repository to store and share data may be created. The facility should be a single point contact, where all the data collecting departments should submit the data related to natural/man-made resources and data related to various hazards. This will (a) eliminate the generation of redundant data, (b) bring uniformity to data from different sources, and (c) ensure data quality. A policy should also be developed for sharing the data between different departments or academic and research organisations. During interactions with the survivors of landslides, the Committee observed that the traditional/ancestral knowledge of environmental and biological signals had been used to cope with natural hazards, which helped them to forecast the hazards. Hence, the Committee suggests carrying out research investigations to understand the scientific background behind these linkages. This may help develop early warning systems. The committee's recommendations have been considered for chalking out the outline for 14th Five Year Plan preparation as discussed in the next chapter.

2.4 Flood Level Marking Survey and Installation of Flood Level Markers

The Government of Kerala, decided to conduct Flood Level Marking Survey along seven major flood-affected rivers (Achankovil, Manimala, Pamba, Meenachil, Periyar, Chalakudy, and Bharatapuzha Rivers) in Kerala in the context of Flood-2018. The main objective of the project was to determine the MSL (mean sea level) Height of Flood Levels that rose along the river banks and to establish permanent markers in the field for future reference. The project is being implemented jointly by the Institute of Land and Disaster Management (ILDM),

Survey of India, Kerala Land Records Modernization Mission (KLRMM), and Kerala State Nirmithi Kendra utilizing the River Management Fund of Revenue Department. The project involves Identification of Suitable Locations for Flood Marker Installation, Collection of High Water Marks and their height measurement, Design and Estimate Preparation, Installation of Platforms, High Precision Spirit Level Survey and Double Tertiary Spirit Level Survey (MSL Surveys), Gravity Observation and Geoid Model Generation, ETS Survey, DGPS Survey, Data Processing and Determination of MSL Height of Flood Levels, and Fixing of Flood Level Markers on platforms. Flood Level Markers were proposed for 121 locations in these seven rivers. The entire work has been completed in Achankovil, Pamba, Manimala and Meenachil Rivers and Flood Level Markers were installed in 48 locations in these rivers. The completed survey works and installation are progressing in Periyar, Chalakudy and Bharatapuzha Rivers. The MSL height data processing is also in progress in the Survey of India. The data generated and flood level markers installed in the field will be useful for accurate flood zonation mapping, flood modelling, warning and forecasting. ILDM plans to develop Flood Zonation Maps for these seven rivers, which will be useful for disaster management and river basin management endures of the Government.

2.5 Lessons learnt

The lessons learnt from disaster management can be discussed under three broad heads as follows:

a) **Consolidation of institutional mechanism:** Kerala, like in many other sectors, has been at the forefront of disaster management initiatives in the country. Kerala has perhaps the most vibrant State Disaster Management Authority (KSDMA), which is well aware of its functions, proactive, ready to take responsibility and provides services as and when required. The administrative and technical arms of the government and the institutional structure of disaster management have made significant progress during this plan period. This strength is well tested during emergencies. The distinguishing feature of Kerala's disaster response is the strength and commitment of Kerala's larger society and the polity that continue to support the government machinery and also works as checks and balances.

b) N**eed for scientific interventions and extended knowledge base:** The recommendations of the technical committee provides a broad outline about the nature of scientific input that the State needs for scientific disaster risk mitigation programmes and enhance risk resilience. The severity of the climate and extreme biological events are major contributing factors triggering the disasters. There is scope to strengthen the early warning system. The scientific analysis has also brought out that there is a knowledge gap, a lack of disaster risk awareness and also a lack of scientifically designed mitigation measures. Large scale vulnerability assessment and risk zonation are necessary for flood plains and landslide-prone areas. The coastal zone requires an in-depth analysis of coastal processes round the year as the wave direction and direction of sediment movement change temporally and has been spatially modified due to various interventions along the shoreline.

c) **People matters:** People's participation is now considered as a key feature for disaster

management at the global level. Kerala's practice of people's participation and decentralized planning has earned global recognition. The long tradition of involving people for development purposes since the launching of the People's Plan Campaign (PPC) in 1996 and subsequent continuous attempts to innovate and strengthen local self-government has contributed to increased awareness and, at the same tim,e heightened desire of the common people to take part in governance and welfare of the society. Kerala's socio-political investment in decentralization and creation of democratic space at the grass-root level has paid its dividend, which is well manifested during the disasters. This is very significant to build a disaster risk resilience society. Kerala is well placed in this trajectory. It also provides important lessons for other states and the country.

d) **Innovation:** There is a need for an innovative approach to tackle disasters. This innovation should try to integrate local knowledge with frontier technical knowledge. This will be useful, especially for managing the disasters like landslides. Innovation is also necessary for settlement consolidation.

e) **Social network**: Social networks play a very important role in disaster management activities. It is important to further strengthen this network and disseminate disaster-related information through these networks. This can be part of disaster governance.

f) **Command-control:** Regular monitoring of disaster-related activities and providing proper guidance require command control. The decentralized system can effectively work during emergencies only through proper command–control system. This has been amply demonstrated in Kerala during an emergency situation.

g) **Communicating to people:** Proper communication and taking people in confidence during an emergency are very important. The Government of Kerala has drawn wide attention both during the flood and Covid 19 management for transparent communication. This is also an important lesson.

2.6 Hot spots of disaster risk and management challenges

The incidence of disaster and its intensity varies spatially. The areas facing high risk are noted here.

i) **The coastal areas** are prone to cyclones, storm surges and sea erosion, which are recurring events affecting the coastal communities during every monsoon. Shifting the population from vulnerable areas is one of the measures considered in this context. The LIFE mission had initiated the process of identification of settlements and shifting them in a safe locality. Combating coastal erosion by constructing groynes and sea walls is a common practice. The effectiveness of these measures might have to be evaluated, particularly considering the emerging scenario of sea-level rise related to climate change. Growing vegetative shields all along the coast is an important measure to reduce the fury of the coastal surge.

ii) **Kuttanad and adjoining lowlands** surrounding the Vembanad lake experience flood problem even during normal monsoon years. A sizable part of this area remains waterlogged for a long time due to peculiar physiographic conditions. A special package has been worked out to address Kuttanad's problem. Settlement consolidation,

reshaping the Padasekharams and developing service nodes for promoting development in selected places are issues warranting due attention.'

iii) **The flood plains** are prone to flood. Flood plain zonation, room for river and land use management are challenging issues for disaster management.

iv) **Landslide** is one of the natural hazards in Kerala, that occur almost every year during monsoon months. The plateau scarp of the Western Ghats all along the State is prone to landslides. The districts of Idukki and Wayanad are mostly affected. Areas having >30% slope are vulnerable, however, the recent incidence of landslides indicates that in many cases, these are linked to slope modification and land use change. Finer scale landslide zonation and vulnerability mapping are necessary to combat the problem.

v) **Drought** affects many parts of the state, particularly in Kasaragod, Kannur, Wayanad and Palakkad, and the coastal stretches. The vulnerable section of society faces the problem. Although drought in Kerala is of short duration and not so severe, still it is an important issue warranting attention.

vi) Climate change is emerging as a serious problem, potential to aggravate disaster as a regular phenomenon. The frequency of disasters has already increased. It is going to be more severe all-pervading affecting the entire state. Some specific issues are noted as follows:

a) Sea level rise due to global warming will inundate several coastal stretches and adjoining lowlands. The height of the tide water will increase due to elevated sea levels. This height will further increase when tide water enters the creeks and narrow inlets/ tidal canals. Settlements surrounding the Vembanad lake and Asthamudi lake will be inundated. There are already reports of such incidences. It will be a challenge to manage the emerging issues of settlement rehabilitation and associated problems

b) Climate change will reduce the frequency interval of extreme rainfall events causing frequent flood disasters.

c) The changing rainfall pattern- high-intensity rainfall followed by drought condition- will increase the landslide problem.

d) Due to an increase in atmospheric temperature, there will be a loss of soil moisture, consequently friability of soil will enhance. As a result, the rate of soil erosion will increase during high-intensity rainfall.

e) There will be prolonged drought and the consequent problem of water availability and food security.

f) There is increasing coastal erosion, indirectly promoted by higher sea levels and increased frequency of high tides and storm surges.

CHAPTER 3
FUTURE PERSPECTIVES AND CRITICAL ISSUES

Tasks of Kerala may include acting on three fronts: Place, Policy and People. Disaster risk assessment of the land is necessary to control land use and communicate risk factors to the people living there. A strong policy guideline for land and water management and implementation of the policy is necessary as in most cases; there is failure in executing the rules and regulations. If people are aware of the risk involved in using a particular land and a clear cut policy is formulated to govern land use, a socio-technical-political space will evolve from coordinating activities. This will ensure people's participation and governance. Besides, it is important to strengthen research and developments related to disaster management in its entire dimension, including climate change and assess the effectiveness of structural and non-structural measures. Disaster management is a problem to be tackled from socio-ecological perspectives under sustainability science. Finally, all the activities may be directed to create 'safe operating space', which is diminishing day by day. With long experience of people's plan campaign and local self-government it may not be difficult to set up local disaster management authorities, which can undertake a series of activities under the disaster management cycle.

During the 12th and 13th FY Plan periods, emphasis was on institution building from State to Local Government level. The 14th plan should focus on achieving the targets set under the Sendai framework in light of the AR6 report (Annexure III). Disaster events have short and long term impacts on the quality of life of individuals and families, and for those who experience severe losses, their vision of hope and happiness are often shaken. Rural communities confronted with the vagaries of climate change will need to become more resilient if they are to survive and thrive. Household-level Resilience is the capacity of a social-ecological system to cope with shocks of disasters without changing its fundamental identity, which is measurable through livelihood diversity, wealth, and a comprehensive resilience index based on a combination of human, financial, physical, social, and natural capital. Households with greater social connectivity have greater resilience. Households that are more socially networked have a wider range of livelihood strategies and greater overall capital and therefore, they are more resilient.

3.1 Science and Technological Considerations for Disaster Risk Reduction (DRR)

A detailed review of science and technological requirements for disaster risk reduction as envisaged under SENDAI framework is provided in Annexure IV. Salient features are indicated here.

1. Science, technology and innovation play a crucial role in the Sendai Framework for Disaster Risk Reduction 2015-2030. The latter indeed emphasizes the need for enhanced scientific and specific technological solutions for all the phases of the disaster management cycle, namely, disaster preparedness, disaster reduction, disaster mitigation, and post-disaster rehabilitation, prioritizing the development and dissemination of science-based risk knowledge, initiatives, technology, and innovations.
2. The fundamental role of technology remains the same - helping to achieve resilience

goals better, faster, more reliable and even more sustainable. Emerging technologies like Artificial Intelligence (AI), Internet of Things (IoT), Block chain, and Big Data in developed nations have proved that they can revolutionize the way disaster managers and decision-makers acquire, analyse, and act on disaster events their rescue efforts. Emerging technologies and innovations can also enhance decision support systems' processing and analytical capacity. Such systems are technology (software) tools that support decision-making by facilitating the comparison of different options for (in the context of natural hazards) risk management (e.g., through a calculation or visualization of the costs and benefits of different approaches).

3. Several advanced technologies and systems that have already entered the marketplace in recent years could provide vital support to the State DM plans and communication programmes, but cannot be considered in isolation, since each has its limitations. The cost of these technologies, as well as the connected devices and systems discussed above, are declining. It is also pertinent to note that newer technologies could also emerge with time, replacing or making the above discussions partially or fully obsolete.
4. Usually, DM technologies are not a big consumer market, and there is no one-stop solution for all challenges. Technological applications being considered for DM, therefore, must not be a product but should be a customized, modular solution, to act as an enabler of a calculated and science-oriented approach to infrastructural planning, collecting and managing data, forecasting, monitoring and, engaging communities in DM, funding, and supporting long-term resilience. Continued developments in this field are necessary for supporting increased understanding of hazards, exposure, vulnerabilities, and resilience rebuilding.
5. When modern-day tools are not working, we are left with our own minds and skillsets. For that reason, it's critical to study up and learn the skills to ensure survival come what may. Over generations, people in disaster zones have developed traditional technologies as efficient solutions to many of their disaster-related problems. These technologies are considered culturally compatible and inclusive to the indigenous populations. Nonetheless, many of these technologies and methods have only restricted applicability and possess the limited potential to reduce the impact of disasters, considering the severity of natural disasters such as flash rains, flash floods, landslides, and cyclones. Hence the need is always there for the application of modern technologies in disaster management, wherever and whenever possible.
6. The convergence of science and technology can foster innovation that offers useful tools to cope with emerging hazards. The effectiveness of technological innovations in DRR has been proven in many cases, including early warning systems and innovations in construction to enhance the resilience of buildings and infrastructure. The emerging technologies and innovations described above can address most of the immediate technical challenges that impede investment in risk reduction, disaster preparedness, disaster mitigation, and post-disaster rehabilitation. Improvements in risk assessment capacity, including greater accuracy in the identification of hazard-prone regions and structures at risk, should allow better decisions on the investment of scarce risk reduction resources.

7. In an emergency, response time is critical. Gaining rapid access to pre-event data, analyzing the current situation on the ground, identifying the most critical areas in need of attention and then communicating cross-agency to all responders ensures the best use of available resources in the recovery effort. The unpredictable nature of disasters necessitates that the administration always is prepared for the worst. A significant degree of that preparation lies in the ability to have complete coordination and communication solutions. Innovation is the key to such a solution.
8. Cyclone Ockhi and the floods 2018, has proved the importance of timely alert dissemination in typical state-wide disaster operations. Accordingly, the project Early Warning Dissemination System (EWDS) was born to reduce the vulnerability of the state populace by tackling the existing gaps in the dissemination of warnings to the communities.
9. Plans need to be evolved for the up-gradation of State EWDS to the next generation with a perfect amalgamation of sensors, software, domain knowledge and relevant workflows into intelligent information ecosystems delivering actionable information is the key to a successful and reliable comprehensive Early Warning Dissemination System. Provision shall be there to capture constant real-time events and changes in the geography through satellite imagery, sensors, crowd, and transforming every raw geospatial data into relevant actionable information.
10. Drone technologies hold significant promise to improve disaster aid delivery. Robots and drones can beam real-time video directly to EOCs to produce real-time maps of disaster-affected areas and populations in extremis. Artificial intelligence can be deployed to comb social media posts from disaster zones to improve responders' decision-making, and analyse mobile phone data to predict key demographic variables related to vulnerability.
11. Technology plays a critical role in responding to the disaster well and its relief distribution too. While technology cannot replace the vital resources people need in disaster – food, water, shelter, or comfort from loved ones - it is transforming disaster relief efforts and paving the way for an evolving approach to aid distribution; one that can reach more people, faster, and help communities to develop resilience, before the next disaster strikes.
12. In the world of public safety and disaster response, the importance of a comprehensive disaster management blueprint that includes a robust Unified Communications (UC) strategy cannot be understated. Securing DM communication infrastructure is a crucial aspect of a unified communications plan considering the exponential growth of Bring Your Own Device (BYOD) and IoT devices that have become even more crucial with the sizeable, displaced workforce created by COVID Pandemic since the outbreak of the virus in 2020. Establishing solutions that ensure resilience and sustainability can also help organizations better manage critical events that might negatively impact business continuity. Prioritizing the importance of critical event communications and eliminating delays owing to organizational silos that impede rapid and unified communication are the major challenges that must drive the DM technologies in coming years.

ICT is only a tool and it should not be treated as a panacea for all issues arising in disaster management. As is the case with any other tool, the effectiveness of ICT in reducing disaster risk depends on how it is used. The use of ICT for disaster management should not be a choice between this medium/technology against that medium/technology. The very reason for the existence of so many channels is that none of them is suitable for every situation. One medium that might fit best under a certain set of circumstances might be of little use under another. Thus, what is required is not a competition between different media and technologies, but instead, using the best combination depending upon the circumstances.

3.2 Coastal risk reduction

Beaches with hard protection structures (seawalls and groynes) with no beach occupies more than half of the coast (about 270 km) in place of beaches all along the coast. The other half is stable, partially stable (prone to erosion with depleting beach) or accreting. When compared to 1960s a new normal is in place with significantly modified coastal morphology and landscape due to human interventions. Changing settlement patterns and new economic investments have increased the demand for limited coastal land. Climate change-related processes have significantly altered the physical processes that influence erosion and accretion. A new normal exists now compared to when coastal protection designs were initiated in 1960s'. This new normal necessitates a new approach to coastal management and protection, considering ecosystem-based management accommodating climate change impacts. Already coastal erosion is approved as a disaster by the State. A new approach needs to follow the concept that the beach is the best protection for the coast and sufficient space is needed for the shoreline to adjust with waves and other forces from the sea. Sand dunes, dune vegetation and natural vegetation, provide additional protection. New approach has to consider governance, capacity development, data generation, sustenance of available beach, sustenance of coastal ecosystems and morphology including beaches, technology adaptation, enforcement of policies and existing laws like CRZ, enhancing climate resilience and ensuring people's participation through the local bodies and community organisations (Annexure V).

3.3 Extreme Rainfall Events

- The current rain gauge network in the State is not sufficient to capture the high spatial variability of rainfall because of the orographic barrier and the limited predictive capability of the rainfall forecast models. Therefore, the network density needs to be enhanced to the theoretical level of 1 rain gauge in every 50 square km (approximately 800 numbers). However, considering the varying spatial variability across the different physiographic regions of the State, it is suggested to install a dense network of Automatic Rain Gauges (ARG/AWS; ~ 500 numbers). Priority may be given to regions receiving high-intensity rainfall in short time periods including slopes that have the potential for flash floods. The distribution of the proposed rain gauges can be 50 per cent in the high lands, 35 per cent in the midlands, and the remaining 15 per cent in the low lands and coastal regions.
- It is suggested that a major share (~50 per cent) of the new installations should be Automatic Weather Stations (which can also monitor meteorological parameters such

as temperature, pressure, wind direction, wind speed, and sunshine hours) and all of them be connected to a central location through telemetry. These observations would in the long run help to improve the predictive capabilities of the forecast models on a regional scale.

- The land acquisition for installation of new rain gauges, if required, be done in consultation with IMD and other departments in the State, and be completed at the earliest.
- Identify the rain gauges operated by other agencies in the State and link them to the centralised facility being proposed.
- Facilitate the development of the Regional ERE and Flood forecast system combined with Artificial Intelligence (AI) to predict flash floods and to trigger an advance warning through research studies or start-ups.
- The experts observed that there is a temporal change in the size distribution and circulation pattern of the dust aerosols in the State that have an impact on the changing rainfall patterns. However, this needs further research as it is an emerging area of research worldwide. The significance of forest fires across the WG on the aerosol concentration may also be considered.

3.4 Landslides

While the devastating landslides in the State during the last two years were primarily initiated by the EREs, the major reason for most of them was the instability of the slopes caused due to various anthropogenic activities. Therefore, preventive measures should certainly include slope stabilisation. The following are some of the possible remedial measures:

- Provide a vegetation cover to the degraded slope by either promoting natural vegetation growth or by planting suitable indigenous species that help slope stabilisation (example vetiver). The use of vetiver as a binder in laterite cutting is to be evaluated.
- In areas where clear-felling of trees was done, the deep tap roots should be removed and refilled with the earth. This is to avoid over saturation and decay of the taproot system which will lead to soil piping and landslides.
- In areas where plantation crops are planned, the selection of crops, as well as the soil pits for planting them, needs to be carefully chosen according to the package of practice. Unscientific use of machinery for pit formation may lead to increased disturbance of the overburden and cause additional water-holding, resulting in oversaturation
- The following activities should be avoided so as to prevent the possibility of landslides:
- Cutting and levelling for construction of houses on the toe region of slopes having more than 25 per cent inclination and a slope length exceeding 100 m.
- Diversion or blocking of stream channels (up to third order) in the upper slopes, especially above the settlement.
- Ponding of water in the sloping sections over a 25 per cent slope.
- Soil conservation practices through contour bunding, or terracing in slopes of more than 25 per cent.
- Seasonal cultivation with tilling or pitting activity in the high sloping areas.
- Any activity in those sections where either ground cracks or piping has been initiated.

- Encroachment of stream banks in the highland region for cultivation or settlement.
- Alignment of open irrigation channels on hill flanks with more than 25 per cent slope.
- Construction of roads without adequate engineering design in the unstable slopes, especially in those segments having higher soil thickness. The hollow portions are to be treated carefully.
- Construction of dwelling units in the hollow portions which have been filled up with debris.
- Construction of dwelling units on the immediate lower part of a sloping segment that is critically disposed of.
- The following activities can be promoted so as to prevent landslide occurrence:
- Drainage of excess rainwater from steeper sections of slope through lined predefined channels.
- Afforestation/ tree crops with no tilling activity in such areas with more than 33 per cent slope.
- Maintenance of tree belts at suitable intervals in those slopes subjected to seasonal cultivation.
- Delineate stable and unstable areas in the uppermost catchments of drainage basins.
- Preservation of existing patches of natural forest cover.
- Permanent grass cover in extremely sloping sections (> 50 per cent slope).
- Land zonation at the micro watershed level involving the local community
- Create awareness among the local population regarding landslides.
- All drainage lines (of all orders) are to be maintained properly, especially during rains. The first and lower order streams get obliterated by agricultural practices such as contour bunding and terracing. These are the areas liable for failures during high rainfall times. The configuration of the basement rock will allow subsurface water to exhort high pore pressure in these areas, which are known as topographical hollows (places where lower-order streams are located). Therefore, before the monsoon, all streams / nallas in the slopes need to be cleaned and opened up for the free flow of storm water.

1. Since the topographic hollows are the areas where the failure takes place, the location of the hollows needs to be identified, and new houses/buildings to be allowed at least 50 m from either side of the stream channel / hollow area.
2. The Government of Kerala should constitute a Committee to conduct in-depth studies and develop guidelines for best practices for allowing mining activities near topographic hollows. A "codebook" may be developed and a strong regulatory system may be enforced. Stone quarries should not be allowed near the topographic hollows with more than 1 m overburden; they should be 200 m away from such localities.
3. While constructing village roads in the high sloping areas, care should be taken to ensure the free flow of streams across the roads by providing culverts
4. The current practice is that only the critical and high hazard areas are now regulated for activities. Settlements are allowed in the downslope of critical and high hazard areas. These areas are susceptible to high causalities during a landslide event. Therefore, an estimate of the runout distance for landslides needs to be assessed based on slope and

overburden volume in the high hazard zones to regulate settlements downstream of the slopes.

5. In many hill-road sections, toppling has occurred during rains where the road cuttings in the laterite are more than 3 m. This will cause disruptions in the traffic movement and destabilisation of the upper slope. Proper protection should be given to these laterite road cuttings with adequate weeping holes. In the unprotected slopes, it is better to give a deep-rooted bio cover like Vetiver (locally known as Ramacham) if other methods are not feasible.
6. While constructing buildings and houses on the hill slopes, the slope geometry is to be maintained. In other words, the cutting and filling of the slopes for construction in the high slope area should be discouraged.
7. The run out zone of the unstable upper area is to be considered while planning any infrastructural development on the lower slopes.
8. Artificial impounding of water on slopes should be discouraged. In areas identified as high hazard zones, the construction of swimming pools and theme parks to promote tourism should also be discouraged.
9. In long slope areas, the toe part should be protected from development activities. In unavoidable circumstances, any disturbance in the toe area should be accompanied by strengthening/protecting of upper slope areas.
10. Provide ditch traps and fencing at a highly hazard zone prone to rock falls. Blasting is not a good option because it may trigger further rock falls. Controlled blasting under the supervision of an expert could be done in case of an emergency.
11. Unstable slopes can be modified by re-grading, geotextile mats, vegetation and bio-engineering and geotechnical measures such as soil nailing, and wire machine. Anthropogenic activities that can cause saturation of the soil are to be strictly regulated in critical/prone areas. However, in locations where exceptionally deteriorated conditions of moderate dimensions already exist, the slope geometry needs to be scientifically changed to reduce the stress on the unstable mass. This may be done by providing restraining structures to increase the resistance to slide movements. These include providing a buttress, shear keys, retaining walls, rock bolts, and piles. Grouting and electro-osmosis can also be resorted to in very specific cases.
12. The Government should encourage people to secure insurance coverage for their assets in high-risk areas.
13. The Government should identify (construct if needed) multipurpose shelters designed by qualified architects for temporarily rehabilitating the affected people before and during an event. These shelters in normal times could be used for other purposes such as marriage or meetings for generating funds for its maintenance. These shelters should be at locations that are safe from both floods and landslides.
14. Modify the existing landslide-prone area maps (prepared by NCESS) by considering additional causative factors and past occurrences of landslides. A cadastral level mapping with micro watershed boundaries may be desirable in the high hazard zones. In case of an area which is yet to be covered under cadastral survey, maps in a 1:5,000

scale may be prepared based on topographical maps, high-resolution image, and aerial photographs.

15. The risk level of the landslide occurrence should be estimated and depicted on the refined hazard zonation maps at the cadastral level by incorporating vulnerability that considers population data, land use, infrastructure, assets, etc.
16. Locations of current landslide incidences should be mapped in the hazard zonation maps prepared by NCESS (1:50,000 scale) for ready reference.
17. Initiate studies that can help develop rainfall intensity-based probability for landslide occurrences.

3.5 Flood

The floods of 2018 and 2019 have a large return period (more than 100 years). To fully alleviate the impacts of such floods is practically difficult because any structural measure would not have considered such a high return period of floods due to their very low probability of occurrence. However, mitigation measures and preparedness can be planned to reduce the negative impacts of such calamities. The following are some of the suggestions to reduce the impact of floods in the future:

1. As the catchment area of most of the reservoirs of the State drains forest areas, they do not experience heavy silting, unlike the reservoirs in other parts of India, especially the ones in Himalayan Rivers. However, the storage capacity of most of the reservoirs in the State might have been reduced to varying extents as there was no periodic desilting action performed in the past decades. This capacity reduction would certainly have lowered the originally designed efficiency of the system. Therefore, the committee recommends that the storage capacity of all the reservoirs shall be evaluated at periodical intervals, say 10-20 years, to determine the amount of siltation on a priority basis, and desilting be planned accordingly if required.
2. Several rivers that have reservoirs did not have larger flows in the past as the reservoir releases were minimal. Therefore, the concept of floodways and flood fringe can be introduced for flood zoning. The floodway is a high-risk area, which should be kept free of any construction to allow the free movement of floodwater. The level of risk can be determined based on factors like depth and velocity of floodwater, duration of flooding, available flood storage capacity, or rate of rising of floodwater. In the flood fringe area, constructions may be permitted under certain conditions. In regulated rivers, this can be ensured by the controlled release of water (may be of magnitude corresponding to a 2-5-year return period of the virgin catchment) on specified intervals (example, once in 2-3 years) during active monsoon season. Such actions would ensure no encroachment into the river beds immediate downstream of dams.
3. Buffer zones are to be demarcated on both the banks of the rivers (50-100 m from the bank) based on the geomorphological characteristics, where no construction is to be allowed. However, the cultivation of seasonal crops can be permitted in these buffer zones. Riverbank maps prepared under the River Bank Protection and Sand Auditing project being executed by the Institute of Land Development and Management

(ILDM), Revenue Department, Government of Kerala may be used for this purpose. In fact, agencies involved in riverbank mapping and sand auditing projects may be entrusted with this job of buffer zone demarcation.

4. The Committee observed several obstructions in the flow channels (including rivers), which caused reduction/restriction of flow downstream, resulting in the accumulation of water upstream. This was noted at different locations (Mukkom, Sreekandapuram, etc.) in the 2019 floods. This was specifically observed in the Kallayi River, where sediment accumulation resulted in an island formation that obstructed the river flow by almost 80 per cent. In addition, dumping of construction debris was observed in the river bed at many locations, which also caused restrictions to the free flow of floodwater. Therefore, a smooth passage for the flood flow needs to be maintained in rivers. This can be done by periodical monitoring and clearing river channels/drainage lines. This will reduce the bed roughness of rivers and ensure sufficient conveyance capacity. River cross-section data generated under river bank mapping and sand auditing projects under ILDM may be used for this purpose. River rejuvenation programme as initiated for a couple of rivers like Killi Ar, Karamana may be encouraged and executed throughout the state involving local people, and local self-government departments (LSGDs), preferably following nature-based solutions.
5. The existing reservoirs in the State are conservation-oriented, and the policy is to harvest water as much as possible to the full capacity during the rainy season. None of them had an operating policy that considered flood control until 2018. After 2018, some of the dams have considered flood control in their revised operation policy. In the case of other reservoirs, it is suggested to revisit the rule curves by considering the dams as multi-purpose and multi-reservoir water resources systems and develop integrated reservoir operation policies so as to maintain the balance between flood control and other objectives, such as hydropower generation, irrigation and drinking water uses. In addition, a relook at increasing the flood cushion in most of the reservoirs can be attempted.
6. Wetlands such as rice fields, ponds, and lakes used to play a major role in flood control. While there are a large number of wetlands in the State, most of them have deteriorated or been abandoned or reclaimed and have become ineffective in their primary role. Therefore, it is suggested to restore the wetlands in the State on priority. In areas of a larger loss of wetlands in river flood plains, creation of artificial wetlands is also suggested to hold floodwater.
7. Most of the river beds and flood plains have been deposited with sediments during the last two major floods. This has caused a further reduction in carrying capacity. Therefore, rejuvenation of the rivers to their original capacity is required.
8. Wherever feasible, consider constructing levees and floodwalls. This should be done after a proper scientific feasibility study.
9. It appears that a zonation of flood hazard has not been done for most of the rivers. What is available is only the flood-prone area map, which would only help in planning developmental activities. Flood impact mitigation requires the flood zones

corresponding to different return period floods or return period rainfall. Since the floods are mostly caused by the EREs, it is recommended to simulate and demarcate the flood inundation zones corresponding to different rainfall return periods (example 10, 25, 50, 100, 150 years). In addition, such maps can be prepared for different ensemble magnitudes of rainfall (without assigning any return period), and a library can be built using the simulations. During the onset of EREs, case-based reasoning can be performed on this library to approximate the possible flooding areas, which can be used for evacuation/mitigation. Such models, when developed, can also be used on a real-time basis to demarcate the approximate flooding zones.

10. In addition to the flood hazard zone mapping through simulation, flood risk maps should also be developed. Flood risk maps will show the possible adverse consequences to people, health, livestock, economic activity, the environment, and cultural heritage in the event of floods. The map should show at least the risk to the potentially affected people (during day-time and night-time), including the indicative number of transitory people (example, tourists), aspects of economic activity, protected areas and natural environment, and where present, the facilities causing accidental pollution should they be flooded.
11. An effective flood warning system is to be developed and implemented on priority. Since the predictive capability of the rainfall forecast models is limited, the flood warning systems cannot be fully dependent on the rainfall forecasts. Therefore, flood warning systems that depend on flood discharge at upstream locations and the time of travel to a downstream location may be planned and developed. This kind of warning system will mitigate human/livestock casualties. Telemetry systems can be effectively utilised for this purpose.
12. Develop operation and maintenance manuals for flood gates and shutters. Perform maintenance, operation, and monitoring during the pre-monsoon period, and rectify the issues at regular intervals. Trials and test operational procedures should be performed at defined intervals. Ensure timely gate operations during flood events.
13. The Committee notes that flood accumulation in the lower Kuttanad region was mostly due to insufficient capacity to discharge the flood water to the ocean. Therefore, it is suggested to clear the sandbars near the Thottappalli Spillway regularly and ensure the original width of the channel (downstream of the spillway) for smooth flow of the floodwater. Also, an increase of the width (~to 300 m) of the lead channel to the Thottappalli spillway is recommended.
14. It is noted that the dwellings in the lower Kuttanad region are scattered and are aligned along the bunds. This reduces the effectiveness of evacuation in case of a severe flood event. Therefore, it is suggested to facilitate settlement at identified clusters.
15. Since forests cover the majority of the catchment area of the rivers of the State, research studies may be carried out to understand the significance of forested watersheds in flood hydrological response.

3.6 Sustainable Housing in Hazard Zones

In the flood-prone areas of the State, building controls are not stand-alone solutions to

mitigate flood risk. Instead, they need to be implemented in conjunction with other flood mitigation measures. Building controls are important to reduce damage to buildings and their contents. Setting the minimum floor levels for residential buildings and other structures in flood risk areas can reduce the frequency and extent of flood damage. The minimum floor level should be determined from the flood levels derived from significant historical flood events or floods of specific annual exceedance probabilities.

- Erection of fences/compound walls, whether solid or open, can affect the flood flow behaviour and flooding pattern by altering flow paths. The impact of such structures will depend on the type of fence and its location relative to the flow path. Hence, controls should be considered in relation to the type of fencing permitted, or to limit its location or height depending on the geographic area. In general, solid fencing, especially to ground level, should not be erected across flow paths where it might act as a dam. Open fencing is preferable.
- Flow velocities, flow depths and associated debris loads can affect the structural soundness. Hence, the structural soundness of the buildings in the flood-prone areas needs to be considered for the local hydraulic conditions.
- Emergency services (for example, water treatment and distribution, power generation and distribution, and communication services) might be disrupted during floods. Hence, the vulnerability of the emergency services to floods must be minimised. Service providers should also consider the emergency response and recovery planning for floods for key assets.
- Landslides lead to the complete destruction of houses and buildings that fall directly in the flow path. Moreover, it was seen that the walls of the buildings that are constructed with load-bearing masonry walls and reinforced concrete slabs were completely destroyed and the slab collapsed as a whole (pancaking type failure). It is difficult to design buildings that are resistant to landslides or floods. Nevertheless, it is recommended that all buildings in areas prone to landslides and floods be designed as per the norms of seismic zone 3, though the region is not in a seismic area. The justification is that the provisions for design in seismic zone 3 regions will lead to better lateral resistance and ensure that the pancaking collapse does not occur. Further, the foundations will also be such that there is better resistance against the force of mud and water.
- If unavoidable, habitations in the flood plain could be designed as in the case of buildings in the coastal areas that are prone to tsunamis; i.e., the same regulations as in the case of tsunamis could be followed.
- Habitations in steep terrains could be designed such that the slopes are reinforced/strengthened by soil nailing. Further, the design should follow the provisions of design for seismic zone 3. As far as possible, the steep slopes should not be disturbed; if inevitable, the building design should be made in such a way that the slopes need not be altered.
- Model structures may be constructed by following the existing provisions for coastal areas taking into account the effects of scouring, lateral impact of boulders and mud, and the maximum expected flood levels.

3.7 Climate Change

- Currently, disaster management plans are made based on past events. As a result, the state is less prepared when a disaster hits.
- Climate action plan for the future would require a risk/vulnerability assessment based on "future" climate projections. The floods, cyclones, sea level, and other extreme events are projected to increase further in the future. Climate projections for 2020–2100 are available for such an assessment.
- The rapid growth in population, urbanisation, and land use changes in the near future will multiply the threat. This is another factor to be considered, while building a climate-resilient Kerala for tomorrow.
- The aim should not only be reactive to disasters or in mitigating risks as such but also on disaster risk reduction in the short, medium, and long term.
- To do so the risks are to be identified which in the case of long-term risks requires a long-term vision on the development of (new) risks in the various sectors or Categories.
- Although 100% prevention of disasters will not be possible, reduction based on proper insight and planned prevention measures is to be aimed at. The document can give the recommendation to prepare for a long-term vision and already include the first analysis of risks resulting from for example climate change, (un)planned urban development in relation to heavy rainfall and resulting floods and other risks to which Kerala might be prone now and in the future.

3.8 Planning for the long term

- It is only within the framework of planning for the long term that the inter-departmental linkages, mutually enhancing or negating approaches, synergies and risks can be identified
- The development plan of each sector, being a "stand-alone" system, does not promote such analysis of inter-dependencies and therefore a platform for inter-departmental risk-informed planning may be created
- Although there are Nodal Officers and Virtual Cadre Officers identified in each department, the pro-active engagement still remains limited due to various reasons.
- To ensure a "risk-informed development planning", the inclusion of DM and CC representatives in the sectoral planning process could be recommended.
- Need for regular Research and Studies that KSDMA should be taking up, including social changes in land use practises and its impact on changing profiles of risks and vulnerabilities

3.9 Stakeholder consultation for problem identification and possible solutions

In order to identify problems and possible solutions, KSDMA conducted a detailed technical stakeholder consultation on 29-30 January 2020 (https://sdma.kerala.gov.in/wp-cotent/uploads/2020/10/RKI-report_Technical-Stakeholders-Consultation_for-PDF-for-Wesite pdf). Major findings of this consultation are worthy to consider when framing long term and future goals. Recommendations in each sector are given in Annexure VI.

CHAPTER 4
RECOMMENDATIONS

The disaster management systems of Kerala had a paradigm shift post-2018 floods through the Rebuild Kerala Initiative and Nammal Namukkay programme of the Government through which the mantle of Disaster Risk Reduction has been devolved to Local Governments. All Local Governments prepared local disaster management plans. Risk informed planning is being mainstreamed.

In light of the experiences from various disasters that occurred in the State, stakeholder consultations, the global experiences assimilated, and considering Rebuild Kerala Development Plan, the following suggestions are put forth.

The Government had constituted a high-level committee for optimising the state response to potential disasters in future vide GO (Rt) No. 86/2017/DMD dated 12-12-2017. The committee's recommendations were considered by the Government and several of these recommendations were implemented. However, some are yet to be implemented. These recommendations are still relevant and therefore are also considered hereunder.

Globally, the priorities for action in disaster risk reduction till 2030 has been well laid in the SENDAI Framework. Recommendations for actions by Government in the 14th FY plan period linked to the SENDAI Framework are given below.

4.1 Priority 1. Understanding disaster risk

Science, technology and innovation contribute to resilience by: empowering and giving a voice to people, including the most vulnerable; extending access to education and health; making possible the monitoring of environmental risks; connecting people; and enabling the development of early warning systems. Innovation drives economic diversification, which allows economies to adapt to shocks and to thrive. Innovation in infrastructure protects against failure and negative impacts on communities. Moreover, new technologies and innovative products and services could decouple economic development from environmental degradation, promoting environmental sustainability (UNESC, 2019 (E/CN.16/2019/3)).

A Resilient State is achieved only by utilising cutting edge science and technology and innovations to increase the ease of living of citizens. Innovations are not often just tangible ones. There are also systemic innovations that contribute to increasing resilience. One of the major hurdles faced by KSDMA in adopting S & T and new innovations in Resilience Building is the existing procurement measures of the Government. Each new innovation can only be validated after testing them on an experimental basis and this requires liberal financial stipulations and a systematic method for selection and retention of such technologies.

The recommendations in this domain are:

- KSDMA shall have a Science and Technology Experimentation Fund and Innovation Fund through State Disaster Mitigation Fund, both to be used liberally

for experimentation by utilising innovative services/products/systems available in the global market and for fostering innovation in disaster resilience building in the private sector through Start-ups. An advisory committee chaired by a leading Science/ Technology visionary/entrepreneur/academician may select services/products/systems and innovation/research proposals and evaluate/mentor such proposals for eventual adoption and mainstreaming if successful, and rejection if unsuccessful. (Nodal agency: KSDMA)

- Co-develop and customise the open source disaster risk reduction decision support software tool Risk Changes developed by the Asian Institute of Technology, Bangkok and mainstream it into development planning. (Nodal agency: KSDMA, KILA)
- Facilitate Geological Survey of India to conduct landslide susceptibility maps on a scale appropriate for planning at the local level for highly landslide susceptible Local Governments (at least 1:5,000 scale). (Nodal agency: GSI, KSDMA)
- Promote investigations on cascading hazards and develop frameworks for the management of cascading hazards. (Nodal agency: KSDMA)
- Develop disaster damage and loss database (for 30 years) disaggregated up to local government level. (Nodal agency: KSDMA, DDMAs, Kudumbashree)
- Equip at least 75% of Higher Secondary level State Government and Aided schools in the State with Earth Science education with environmental sensing equipment useful for DRR education such as automated weather stations, stream gauges, groundwater monitoring loggers, soil moisture monitoring equipment etc. with funding from State Disaster Mitigation Fund and linked through KSWAN to KSDMA. (Nodal agency: KSDMA, General Education)
- Financially support Citizen Science Initiatives such as citizen centric river flow monitoring, rainfall monitoring, slope monitoring, flash flood monitoring through registered NGOs and Citizen Science Collaborations and develop an online portal for assimilating data derived from such initiatives. (Nodal agency: KSDMA, DDMA)
- Fund, facilitate, co-host and/or co-fund hazard, vulnerability and risk assessment and early warning research by interns, students, academics and professionals of national and international universities, academic and research institutions. (Nodal agency: KSDMA, DDMA)
- Procure coastal bathymetric data of Kerala for facilitating coastal inundation modelling. (Nodal agency: KSDMA)
- Support the Geological Survey of India in developing a landslide early warning system. (Nodal agency: GSI, KSDMA)
- Support the Water Resources Department in developing a flood early warning system. (Nodal agency: Water Resources Department, KSDMA)
- Support research institutions in Kerala in maintaining a seismic monitoring network. (Nodal agency: KSCSTE, KSDMA)
- Support India Meteorological Department in maintaining an automated weather station network. (Nodal agency: IMD, KSDMA)
- Develop living labs in a mountain slope, at a coastal site, a below mean sea level area

and a midland site with extensive benchmarking instrumentation for monitoring and benchmarking environmental fluxes for facilitating hazard, vulnerability and risk assessment and early warning research. (Nodal agency: KSDMA, DDMAs)

- Conduct an epidemic risk assessment of emerging epidemics (Nipah, Visceral Leishmaniasis, etc) having pandemic potential in collaboration with Virology Institute of Kerala, Community Medicine Departments of Medical Colleges, ICMR and Universities of Kerala and identify environmental drivers promoting the prevalence of epidemics in such hotspots. (Nodal agency: KSDMA)
- Incorporate landslide runout zones in landslide susceptibility maps of Kerala. (Nodal agency: KSDMA, ITC-Centre for Disaster Resilience, University of Twente)
- Create spatial tools for calculating the disaster loss potential of houses. (Nodal agency: KSDMA, ITC-Centre for Disaster Resilience, University of Twente)
- Create a framework for vulnerability assessment of Micro, Small and Medium Enterprises to hydro-meteorological hazards. (Nodal agency: KSDMA, ITC-Centre for Disaster Resilience, University of Twente)
- Map urban and rural heat islands in light of climate change scenarios. (Nodal agency: KSDMA, Geohazards Society, Woodwell Climate Centre)
- Map and assess the wind hazard potential in light of climate change scenarios. (Nodal agency: KSDMA, Geohazards Society, Woodwell Climate Centre)
- Conduct a vulnerability assessment of domestic animals and poultry in light of climate change scenarios. (Nodal agency: KSDMA, Animal Husbandry Department, Dairy Department, Agriculture University, Kerala)
- Publish and incorporate flood return probability maps, landslide susceptibility map prepared by GSI and lightning susceptibility maps in disaster management plans. (Nodal agency: KSDMA)
- Update the drought susceptibility and MAH accident susceptibility maps. (Nodal agency: KSDMA)
- Climate change and disaster management components should be mandatory in school and college curricula.

4.2 Priority 2. Strengthening disaster risk governance

Mainstreaming disaster risk management into development planning

- Priority shall be accorded for achieving the SENDAI framework. A special task force under the Member of Planning Board for Disaster Management may be constituted to document the on-going efforts of departments that may improve to capacitate the respective departments based on Training Needs Assessment. (Nodal agency: KSDMA)

Resilient Design Standards and Enforcement

- Improve flood, landslide protection design standards. (Nodal Department: Water Resources, Public Works Department, LSG Engineering Department).
- Enhance vulnerability linked relocation plan to fund on priority under SDMF and other reconstruction schemes. (Nodal agency: KSDMA)

- Ensure that all house constructions funded under Government funds are designed considering the hazard exposure of the site and following resilient construction practice suitable for the climate change scenarios of 1 in 30 years. (Nodal agency: Local Self Government Department)
- Develop guidelines and designs for climate change resilient community (local government) and public infrastructure and ensure proper enforcement for all structural measures to improve the quality of community (local government) infrastructure services. (Nodal Department: Local Self Government Department, Public Works Department, Kerala Engineering Research Institute, Kerala Highway Research Institute, Local Self Government Engineering Department)
- Institutional mechanisms to enforce resilience and risk reduction measures stipulated in Municipal and Panchayath Building Rules may be updated by Local Governments with a self-certification (valid for a specific period) and random third party auditing mechanism involving certified Civil Engineers. (Nodal agency: Local Government Department)
- Develop disaster forensic investigation guidelines. (Nodal agency: KSDMA)
- Support Kerala Highway Research Institute in the design of Climate Change and Disaster Resilient transportation networks. (Nodal agency: KHRI, KSDMA)
- Create a network of young researchers for facilitating the conduct of disaster forensic studies. (Nodal agency: KSDMA)
- Green building concept may be promoted and construction based on responsibly sourced wood may be promoted as availability of construction grade rock and sand is reducing drastically. In order to increase hardwood availability, the Government may consider amending necessary Acts, rules and regulations to promote and facilitate the cultivation of hardwood as plantations and sourced and made available in bulk. (Nodal agency: Local Self Government Department, Forest Department, Revenue Department, Housing Department, KSDMA)
- Develop a framework for implementing Ecosystem-based disaster risk reduction solutions in the State. (Nodal department: KSDMA)
- Prepare a comprehensive drought preparedness and mitigation plan and partly fund the plan through the State Disaster Mitigation Fund. (Nodal Department: Water Resources, Agriculture, KSDMA)

4.3 Priority 3. Investing in disaster risk reduction for resilience

- Construct and amend facilities in the schools identified as multi-purpose emergency shelters and improve access to such shelters. Hand over the shelters to the communities (local governments) with corpus funds for operation and maintenance. (Nodal Department: LSGD Public Works Department, DDMA)
- Prepare resilience plans for all fishing villages considering the coastal inundation scenario of 2050 in RCP 6 and implement the plan by 2035 by converging various development grants under the leadership of the Local Self Government (Nodal department: Fisheries, Local Government)
- Retrofit government and aided schools and health infrastructure in hazard-prone areas

to increase safety. (Nodal Department: Education, Health, Local Self Government Public Works Department)

- Ecosystem-based disaster risk reduction (Eco-DRR) is the sustainable management, conservation and restoration of ecosystems to provide services that reduce disaster risk by mitigating hazards and by increasing livelihood resilience (PEDRR). As part of the Ecosystem DRR programme, the following items will be taken up during the 14th FY plan period, they being:
  - Develop eco-safe rural roads standards with bioengineering solutions in highly landslide prone Panchayaths and implement at least one pilot. (Nodal Department: Local Self Government, KILA, Soil Conservation Department, KSDMA)
  - Promote Miyawaki Forests for coastal protection through Local Governments and implement pilot projects in selected Panchayaths with continued monitoring of 3 years for quantifying the risk reduction contributions by this initiative. (Nodal department: KSDMA, Local Self Government, Tourism)
  - Promote lightweight construction practices using eco-safe materials. (Nodal department: KSDMA, Housing Board)
  - Document and quantify best practices that contribute to ecosystem-based disaster risk reduction in the State. (Nodal department: KSDMA, KILA)
- A checklist was furnished to the Government by the advisory committee constituted vide GO (Rt) No. 644/2018/DMD dated 30-11-2018. It is expected that by following the checklist, the Engineer of the concerned Local Self Government and the District Geologist (representative) can identify whether a proposed site for construction is landslide susceptible or not and whether building permits should be issued or not in such sites. This checklist may be made part of the KMBR/KPBR. (Nodal Department: Local Self Government)
- Implement a comprehensive risk transfer programme. (Nodal department: Finance, Insurance)
- Two-way communication systems for deep-sea fishermen shall be devised and/or facilitated at a subsidised cost to the user community. While examining the Shore to Sea Communication Systems available with the Fishermen in Kerala, the Committee found that Mobile Communication is available up to about 20 KMs offshore. Other than this, there is only one System, a UHF based Radio Trunking Digital Mobile Radio (DMR) offered by Wiwanet, which is a start-up Private Company, offering a 100 KMs range (extendable to 200 KMs), with 2 way Voice & Message Communications. The opinion of the Committee constituted vide GO (Rt) No. 86/2017/DMD dated 12-12-2017 with respect to this proven Communication System of C-Mobile is that the Govt. may like to take a considered call in respect of providing effective Communication and Location Information Systems to the Fishermen. (Nodal department: Fisheries Department)
- The Fisheries Department and Harbour Engineering Department should immediately revamp the Coastal Alert Codes as prescribed by the International Maritime Organisation, including setting up Flags and Lights of varying colour codes. (Nodal department: Fisheries Department, Harbour Engineering Department)

- The Fisheries Department must also ensure the installation and functionality of adequate Public Announcement Systems in all Fisheries Stations and Fish Landing Sites along the coast, wherever the Systems are not yet installed or are dysfunctional. (Nodal department: Fisheries Department)
- The Fisheries Department shall maintain the Mobile numbers of all Coastal Grama Panchayath Presidents, Secretaries, Block Panchayath Presidents, Municipal Chairpersons, Mayors, Religious Leaders and active NGO Leaders in the Coastal areas in the NIC Email based SMS service, and all Alerts and Warnings received shall be transmitted to these numbers also. (Nodal department: Fisheries Department)
- Utilise 80% of State Disaster Mitigation Fund through Local Self Governments for resilience-building projects. (Nodal department: KSDMA, KILA, Local Self Government Department)
- Support Disaster, Risk and Vulnerability Conference organised by MG University. (Nodal department: KSDMA)
- Continuous capacity building programmes for reducing risk for sectoral departments and agencies. (Nodal department: KSDMA)
- Information, Education and Communication programmes for reducing risks and increasing resilience. (Nodal department: KSDMA)
- There may be a scheme for providing relief to the active loans of Below Poverty Line Families impacted by major disasters. (Nodal department: Finance)

4.4 Priority 4. Enhancing disaster preparedness for effective response
Community-based disaster risk management (CBDRM)

- Design and implement a disaster literacy campaign with a focus on prevention strategies and resilience-building (Nodal agency: KSDMA)
- Create a theme of resilient homes and increase awareness for the creation of resilient homes through the literacy campaign (Nodal agency: KSDMA and all Departments)
    1. Resilient homes are not "disaster-proof". Resilience is the capacity to absorb shocks, sustain no or minor repairable damage and retain functionality with the investment of minimum cost and time.
    2. The resilience of homes are much more than disaster-proof houses. It can only be achieved if approached from the larger perspective of climate change adaptation and self-sufficiency.
    3. The concept of resilient homes should encapsulate three aspects
        - Resilience of families
        - Resilience of neighbourhood
        - Resilience of buildings

Details of the elements and interventions required for building resilience under these three items are given in the Annexure VII.

- Support Social Justice Department in mainstreaming disability-inclusive disaster risk reduction programme (Nodal agency: Social Justice Department, KSDMA)
- Implement inclusive disaster risk reduction programmes such as transgender-inclusive

disaster risk reduction, women inclusive disaster risk reduction and scheduled caste and scheduled tribe inclusive disaster risk reduction (Nodal agency: KSDMA)

- Capacity building for Members of Legislative Assembly and Members of Parliament in Orange Book, SDRF and SDMF. (Nodal agency: KSDMA)
- Information, Education and Communication programmes for reducing risks and increasing resilience. (Nodal agency: KSDMA)
- Increase awareness of early warning codes in communities. (Nodal agency: KSDMA)
- Continuous capacity building programmes for sectoral departments, virtual cadre and agencies. (Nodal agency: KSDMA)
- Popularise crop insurance schemes (Nodal agency: Agriculture Department)
- Disaster Risk Reduction introductory training from KSDMA shall be made an essential requirement in the Government trainings carried out by IMG to new entrants in service, the mid-career training and executive training (Nodal agency: IMG)
- Training and capacity building programmes for people's representatives and officials of Local Governments (Nodal agency: KILA)
- Strengthen Inter-Agency Groups and involvement of NGOs and Citizens Initiatives for disaster risk reduction. (Nodal agency: KSDMA, DDMA)
- Ensure continued maintenance of water kiosks. (Nodal agency: KSDMA, DDMA)
- Priority shall be accorded for achieving the SENDAI framework. A special task force under the Member of Planning Board for Disaster Management may be constituted to document the ongoing efforts of departments that may improve to capacitate the respective departments based on Training Needs Assessment and to implement selected risk reduction strategies. (Nodal agency: KSDMA).
- Creation of a recovery framework and vulnerability linked relocation policy for Kerala (Nodal agency: KSDMA).
- Popularise alternate technology for freshwater such as condensation based water making equipment, developing abandoned quarry ponds as new water sources and evaporation trapping. (Nodal agency: KSDMA, DDMA, KERI, CWRDM)

2. Improving climate change assessments and early warning systems

- Include more weather models and weather services from private and public organisations into the decision support system of KSEOC for improving ensemble predictions (Nodal agency: KSDMA)
- Ensure continued upkeep of the last mile connectivity early warning systems developed through NCRMP (Nodal agency: KSDMA)
- Ensure the introduction of CAP alert and SMS blasting for early warning (Nodal agency: KSDMA)
- Standardised early warning codes (Nodal agency: KSDMA)
- Create safety walls in all schools that communicate standard first aid procedures and safe behaviour (Nodal agency: KSDMA, General Education Department)
- Undertake Coordinated Regional Climate Downscaling Exercise (CORDEX) exercise with the Netherlands Weather Services (KNMI) for availing climate change scenarios to local governments for better governance. (Nodal agency: KSDMA, KILA)

- SEOC may avail business accounts of all social media platforms popular in the State and spread information through all possible channels. (Nodal agency: KSDMA)

3. Improving emergency response systems

- There are presently multiple volunteer teams organised and funded by the Government for Disaster Response: Civil Defence, Aapda Mitra, Sannadham Volunteers, and Local Government Emergency Response Teams. Civil Defence Volunteers is the only one of the above that has a legal backing under the Civil Defence Act, 1968. Therefore, the Civil Defence Volunteer scheme may be adapted to accommodate Sannadham volunteers, Aapda Mitra volunteers and Emergency Response Teams after required standardisation through specific training. In effect, there may be only one formal scheme of voluntarism for Disaster Response in the State, which may be through the legally backed Civil Defence Scheme. This will ensure streamlining of financial and capacity building efforts for volunteer involvement in Disaster Response. (Nodal agency: GAD, Home)
- Narrow band satellite-based two-way communications are available through BSNL which may be provided to Grama Panchayath offices, Block Panchayath Offices, all Police Stations, all Fire Stations, Taluk Offices, DEOC and KSEOC utilising the funds for emergency response equipment procurement available from State Disaster Response Fund. There are outdated analogue VHF systems lying in various Revenue offices. These systems may be handed over to the Kerala Police. (Nodal agency: KSDMA, Local Government Department, Police, Fire & Rescue Services and Revenue)
- State Disaster Response Force (SDRF), consisting of 455 Officers and men, may be created on the exact pattern of the NDRF at the National level. This Force will be sub-divided into 7 Search & Rescue (SAR) Teams, located 1 each at Range level, 2 Teams at Battalion HQrs at KEPA, Thrissur, with 1 Training Team. Each of these Teams shall comprise 49 Police personnel of appropriate Ranks and Categories. The rest of the strength will be the Casualty Reserve and Admin Reserve. The method of recruitment for the SDRF, being a specialised Force, should be exclusively by direct recruitment, and the qualifications required are to be similar to that of recruitment to the India Reserve Battalion (Regular Wing). They should be put to specialised training in all kinds of Disaster Rescue activities and also will be provided with the latest Equipments in Rescue, similar to the Equipment available to the NDRF. The Police and Fire & Rescue personnel may be deployed on deputation, while the Civil Defence personnel may be engaged on a contract for a minimum period of 3 years. This may also be a motivation for youth to join Civil Defence. (Nodal agency: Home)
- The committee constituted vide GO (Rt) No. 86/2017/DMD dated 12-12-2017 strongly recommended the formation of such a Team, which may be known as the Advanced Tactical Disaster Response Team (ATDRT), to be formed as part of the proposed State Disaster Response Force (SDRF) with the existing technical graduates in the Police and Fire and Rescue Services. The personnel of this Team need to be only 10 to 12 in number, and they should be adequately trained (and cross-trained) in

operating the sophisticated equipment for Rescue and Relief Operations, as given in the respective section. (Nodal agency: Home)

- Strengthen Fire and Rescue Services with adequate high-value critical response machinery to fulfil its mandate of being the first responder to emergencies in the State with partial financial support from SDRF. (Nodal agency: Fire and Rescue Services)
- Establish an advanced tactical disaster response team with human resources from Fire & Rescue Services and Police. (Nodal agency: Police, Fire and Rescue Services)
- Increase the capacity and capability of Marine Enforcement, Coastal Police, and Coastal Wardens with human resources and machinery to ensure coastal security, disaster response, and in-sea accidents. (Nodal agency: Police)

4.5 Resilient homes and disaster literacy campaign

Every hazard is first felt by the individuals and the households. Therefore, the core theme of the 14th FY plan for KSDMA shall be "Resilient Homes" & "Disaster Literacy Campaign".

4.6 Sendai target and proposed Kerala's action

In light of the various vulnerabilities, resilient Kerala may be built by thematically striving to achieve the seven targets of the SENDAI Framework (Table 1)

Table 1: Sendai Framework and proposed Kerala's action

Sl. No	SENDAI Target	Kerala's Action
1	Reduce Disaster Mortality by 2030	Strengthen Anticipatory Actions through Disaster Literacy Campaigns
2	Reduce Number of affected people by 2030	Create Resilient Homes
3	Reduce economic loss by 2030	Create Risk Transfer Mechanisms
4	Reduce infrastructure loss by 2030	Mainstream Risk-Informed Planning
5	Ensure Local Strategies for DRR by 2030	Continue Strengthening State, District and Local Government Disaster Management Institutional mechanisms
6	Increase International Cooperation by 2030	Institutionalise the Netherlands-Kerala technological partnership on Disaster Risk Reduction under the Netherlands-Kerala Water Partnership
7	Increase access to Early Warnings Systems and Disaster Risk Information by 2030	Adopt advanced science and technology for disaster risk reduction and actively promote citizen science

4.7 Financial requirement (Details are in the Annexure VIII)

Table 2 : Financial requirements

Priority	Year (Rupees in lakh)					Total
	I	II	III	IV	V	
1.Understanding disaster risk	775	1184	875	1077	954	4865
2.Strengthening disaster risk governance	1328	1379	1380	1404	1402	6893
3.Investing in disaster risk reduction for resilience	538	739	889	820	870	3856
4.Enhancing disaster preparedness for effective response	2335.5	2245.5	2404.5	2001	2046	11032.5
Total	4976.5	5547.5	5548.5	5302	5272	26646.5

Annexure 1:

Identified Hazard types in Kerala in Section 2.2 of the State Disaster Management Plan

Sl. No	Category	Type
1	Natural Hazards	Flood (Riverine, Urban and Flash Floods)
2		Landslides (includes debris flows, rock fall, rock avalanche, rock slide, landslips and mud slips)
3		Drought
4		Coastal hazards (High waves, Storm surges, Kallakadal, Tsunami, Salt Water Intrusion, Coastal erosion)
5		Wind (Cyclone, Gustnados, Gusty winds)
6		Lightning
7		Earthquakes
8		Human epidemics
9		Plant disease epidemics and pest attack on crops
10		Avian epidemics
11		Animal epidemics
12		Pest attack of human habitations
13		Forest Fire
14		Meteorite/asteroid impacts
15		Soil Piping
16		Heat wave/sunburn/sunstroke
17		Natural background radiation

1	Anthropogenic	Stampedes
2	Hazards	Fire cracker accidents
3		Petro-chemical transportation accidents
3		Industrial accidents
4		Dam break
5		Dam spillway operation related floods & accidents
6		Oil spill
7		Road accidents involving civilian transport vehicles
8		Human induced forest fire
9		Human-animal conflicts
10		Fire accidents in buildings and market places
11		Boat capsizing
12		Accidental drowning
13		Building collapse
14		Hooch accident
15		Air accidents
16		Rail accidents
17		Terrorism, riots and Naxalite attacks
18		Nuclear and radiological accidents
19		Space debris impacts
20		Biological accidents
21		Occupational and recreational area related hazards
22		Accidents in Armed Forces premises
23	Disasters outside State's administrative boundaries, affecting Keralites	

ANNEXURE II A

Performance of 13th Five Year Plan

A detailed 5-year plan was prepared and approved vide Ltr. No. 300/2016/AGRI (W10)/ SPB dated 21-10-2016 by the Planning Board for the 13th Five Year Plan period. This plan contained 7 sub-heads with detailed plans for disaster risk reduction and response. Financial utilisation from 2017 to 2021 (4 years) is given below:

Major Head/Minor Head of Development (Scheme-wise)	13th Five Year Plan (2017-18 to 2021-22)		
	Total Outlay (2017-18 to 2021-22) (Rs. in lakhs)	Total Expenditure (as on July 2021)	Percentage
Disaster Management, Mitigation and Rehabilitation	2526.00	1844.26	73.01
National Cyclone Risks Mitigation Project (State Share)	1250.00	1373.69	109.90
Sub Total	3776.00	3217.95	85.22

The 13th plan period saw tremendous development in the disaster management sector; from a 7 member technical team, the technical capacity of KSDMA grew to having more than 50 sectoral specialists from social science to medicine.

Policy changes were brought in, judicial interventions were significant, thus from a nascent institution of 7 members, KSDMA evolved into a high technical think tank body with capacities in multiple domains during the 13th plan period. While during the 12th plan period human resource was mostly through central and multilateral projects, the 13th plan period saw the Government taking up the financial responsibility of maintaining a technical team for disaster risk management at the State and district level dedicated for the State and District Disaster Management Authorities.

Highlights

The 13th Five Year Plan was centred around 7 sub-heads. The achievements under each of the sub-heads is given below. Specific actions taken in the context of Cyclone Ockhi 2017, Floods 2018 & 2019 and Covid19 by KSDMA are given as a brief separately. The activities under National Cyclone Risk Mitigation Project (NCRM) will be a separate session.

1. Community based disaster risk reduction

The interventions made by KSDMA in Community Based Disaster Risk Reduction in the 13th five year plan period was significant. The focus was to invert the pyramid of disaster management from a top to bottom approach to a people centric approach wherein focus was on preparedness. Major and notable achievements in the domain are listed below and links to the relevant pages and materials in the KSDMA website are given as hyperlinks to the sub-heading.

Domain	Link	Main Achievement
Disability Inclusive Disaster Risk Reduction	https://sdma.kerala.gov.in/disability-disaster-risk-reduction/	• India's first formal disability inclusive DRR programme with citation as best practice in the National Guidelines for Disaster Management on Disability Inclusive DRR • Training on disability friendly evacuation, alerts and warnings in sign language, audio warnings in DAISY format and IEC materials in Braille • NDMA has acknowledged the project of KSDMA as praise worthy for replication in other states and have circulated the toolkits developed by KSDMA to other states. Ltr. No. 05/239/2021/NDMA/CBT dated 27-7-2021

Inter Agency Groups	https://sdma.kerala.gov.in/interagency1/	• Formal NGO Collaboration platforms in all 14 districts notified and functional under Section 22 (2) (f), Section 24 (j), Section 30 (xiii) and Section 30 (xxvii) of the Disaster Management Act, 2005 • Sector specific trainings provided to NGOs in IAG
Civil Defence	https://www.cds.fire.kerala.gov.in/	• Facilitated the creation of Civil Defence in all 14 districts of the State • Provided ₹230 lakhs for capacity building of Civil Defence • Provided support in developing and conducting trainings for Civil Defence Volunteers • Partially handed over the Civil Defence Institute to Civil Defence
Samoohika Sannadha Sena	https://sdma.kerala.gov.in/sannadha-sena/	• Facilitated the creation of India's first Government level directorate for voluntarism • Conducts regular training for Samoohika Sannadha Sena volunteers • Created, hosted and conducted several trainings and developed training modules for Samoohika Sannadha Sena
Aapda Mitra	https://sdma.kerala.gov.in/aapda-mitra/	• Funded by NDMA, created and trained 200 community response volunteers in Kottayam District • Equipped with responders kits • To be extended to the remaining 13 districts
Emergency Response Teams of Local Governments	https://sdma.kerala.gov.in/emergency-response-teams-2/	• Four teams in each LSG viz. First Aid, Shelter management, Search-Rescue-Evacuation, Early Warning Dissemination • Training support provided to KILA • Co-developed training modules
Beach Safety	https://sdma.kerala.gov.in/beach-safety-2017/	Supported District Tourism Promotion Councils (DTPCs) of 17 recognised beaches with hand mics, binoculars, rescue surf boards, life jackets, life buoys, goggles, snorkelling masks and beach umbrellas

2. Strengthening State Disaster Response Force

The Disaster Management Act, 2005 has made the statutory provisions for the constitution of the National Disaster Response Force (NDRF) for the purpose of specialised response to natural and man-made disasters. Likewise, every State shall have a State Disaster Response Force (SDRF) for the purpose of specialised response. The State has constituted SDRF with 100 men vide GO (Ms). No. 262/2012/Home dated 17-10-2012. The SDRF is envisaged as a specialised force that would undertake disaster response activities particularly related to Chemical, Biological, Radiological and Nuclear disasters, mass-gathering related stampedes and rescue from deep waters (marine and inland). Currently, the SDRF lacks sufficient training and equipment for training to keep the force under constant preparedness. The force is directly under the control of the Home Secretary in her capacity as Member to KSDMA. Salary for the 100 men is provided from the Home Department. The Crisis Management Group for Anthropogenic Hazards chaired by Home Secretary, in its meeting held on 1-11-2016 has directed the State Police Chief to take steps to place the SDRF at Mankattuparamba, KAP IV, Kuttikkanam KAP V and Adoor, KAP III. Each team will have 10 members of Fire and Rescue Services too.

However, an operational State Disaster Response Force is still to be formed in Kerala by the Home Department.

3. Strengthening Kerala Fire and Rescue Services

During the 12th plan period itself a total of Rs. 123.25 lakhs was provided to Kerala Fire and Rescue Services. This included an amount of Rs. 3,71,62,960/- remaining with Kerala Fire and Rescue Services at the beginning of the plan period. The department reported that an amount of Rs. 123.25 lakhs was resumed by the Government owing to austerity measures.

4. Strengthening the network of Emergency Operations Centres

During the 13th plan period KSDMA ensured that all districts in the State had District Emergency Operations Centres. The State EOC became fully functional in the new state of the art building funded under 12th and 13th Plans of the State from 29-1-2019. The EOCs were equipped with satellite phones, mobile phones, telephones, hotlines, WhatsApp, laptops, desktops, television sets etc. Further, each DEOC was standardised with the availability of one Police, one Fire and Rescue and one Revenue official.

The SEOC currently operates with the following:

- Fusion Centre: Facilitates inter-departmental operations and fusion of multiple information in a single location. Desk in-charges and departmental officers deputed to SEOC works out of the fusion centre. In effect, Fusion Centre is the heart of SEOC. The incident management system composed of GIS and incident command tools have been made functional in the State EOC. The detailed organogram and the functions of various sectoral experts can be seen here https://sdma.kerala.gov.in/organogram/
- Drought Monitoring Cell: The Drought Monitoring Cell examines the various triggers laid by Government of India for drought response triggering and advises the Government on drought management guidelines to be issued after examining the conditions prevailing in the State from time to time. There is no separate staff for Drought Monitoring Cell
- IT & Communication Centre: The Early Warning Dissemination System, the Server, the internal communication system, etc. deployed by the SEOC and NCRMP will be

under the IT & Communication Centre. Long term maintenance and management of the system will also be the responsibility of the IT & Communication Centre.

- Planning: The Planning Department will be leading the preparation of the State Disaster Management Plan. They will also support requests from the Districts for the preparation and updation of the District Disaster Management Plans.
- Capacity Building and Projects: This team will coordinate in implementing social outreach projects and capacity building programmes prepared by KSDMA
- Risk Lab: Deals with managing the geodatabase of SEOC and supports the preparation of State and District Disaster Management Plans and EOCs with Geospatial information and analysis. This was funded under the Rebuild Kerala Development programmes

KSEOC has provided one Hazard Analyst to each DDMA and these experts facilitate close liaison between DDMAs and KSDMA. In addition, temporary EOCs are facilitated for Sabarimala Pilgrim Season and Thrissur Pooram.

The SEOC has multiple servers, seamless wired and wireless high speed internet, hotlines, IPBX, firewalls, GIS and Remote Sensing Software, satellite phones, VSAT hubs etc.

A detailed infrastructure inventory in a geospatial environment has been created by KSDMA and offered in public domain which includes facilities that may be used as relief camps. Helipad locations per district, trained volunteers in each district, Emergency Response Vehicles, contact numbers of Taluk Control Rooms etc. which may be found here https://sdma.kerala.gov.in/emergency-resources/

Domain	Link	Main Achievement
Incident Response System	https://sdma.kerala.gov.in/incident-response-system-2/	• The State has notified incident response system upto Taluk level vide GO (Rt) No. 442/2021/DMD dated 27-5-2021 and has been laid in the Orange Book of Disaster Management 2 – Monsoon Preparedness and Response Guidelines. • Guidelines of IRS can be seen in the link • IRS in Taluks can be seen in the link

Daily Disaster Alerts	https://sdma.kerala.gov.in/archives/	KSDMA through multiple official social media channels provides regular updates of extreme weather, sea state, river water levels and reservoir levels in Malayalam. The EOC has dedicated human resource for ensuring this. This has been identified as a best practice by NDMA
India Disaster Resource Network (IDRN)	https://sdma.kerala.gov.in/idrn-2/	The IDRN contains detailed and updated resource inventory for disaster response. SEOC oversees its updation
State Emergency Director	https://sdma.kerala.gov.in/state-emeregency-directory/	The SEOC maintains an Emergency Director, updated once in 6 months
Emergency Response Vehicles	https://sdma.kerala.gov.in/wp-content/uploads/2021/05/Emergency-Response-Vehicle-details-10-05-2021_ERV_Website.pdf	SEOC maintains an inventory of Emergency Response Vehicles and contacts for petro-chemical accident response
Infrastructure Inventory	https://sdma.kerala.gov.in/infrastructure-facilities/	SEOC manages a detailed and public infrastructure inventory which could be used for setting up relief camps or large contaminants in times of crisis
Trained Volunteers	https://sdma.kerala.gov.in/wp-content/uploads/2021/03/Aapda-Mitra-volunteers-list.pdf	SEOC maintains a list of trained volunteers who were trained under the AAPDA MITRA scheme
Satellite Phones	https://sdma.kerala.gov.in/dam-emergency-satellite-phone-numbers/	SEOC and DEOCs were equipped with Satellite Phones during the 13th plan period. Dam sites of Irrigation and KSEB are also equipped with Satellite phones

Helipad locations	https://sdma.kerala.gov.in/helipad-location-and-maps/	A complete list of helicopter landing sites and a geo-database of the same are made available in public domain for use during emergencies
Augmenting SEOC	https://sdma.kerala.gov.in/augmenting-state-eoc/	Funded by NDMA. Established a video conferencing facility in SEOC

5. Strengthening instrumented monitoring and science and technology for disaster risk reduction

During the 13th plan period, KSDMA invested its time, funds and energy in the following science and technology projects. Details of each project can be found in the corresponding hyperlink.

Domain	Link	Main Achievement
Soil Piping	https://sdma.kerala.gov.in/research-on-soil-piping/	Soil Piping notified as a State Specific Disaster
Landslide susceptibility assessment and preparedness strategies, Thiruvambadi Gramapanchayath, Kozhikode District Kerala	https://sdma.kerala.gov.in/thiruvambadi-landslide-preparedness/	Local Self Government Level landslide management plan
Supply chain logistics in Kuttanad Taluk, Alappuzha	https://sdma.kerala.gov.in/study-on-supply-chain-logistics/	The bottlenecks of ensuring seamless supply chain during disasters and the solutions thereof
Dynamically downscaling the regional climate: simulation of extreme rainfall events and their impacts over the State of Kerala in the near future	https://sdma.kerala.gov.in/downscaling-climate-change-forecast-2017/	Path forward for dynamic downscaling of regional climate
Drought risk reduction in Vadakarapathy Panchayath, Palakkad	https://sdma.kerala.gov.in/drought-risk-reduction/	Local Self Government Level drought mitigation solutions

Monitoring & forecasting Weather	https://sdma.kerala.gov.in/weather/	In addition to data from IMD, during the 13th plan period, KSDMA also sourced the services of M/S Skymet, M/S The Weather Company IBM and M/S Earth Networks for monitoring & forecasting of weather. • IMD – offered 100 AWS (15 deployed) - Land allotted by KSDMA across the state • Skymet – 100 AWS functional • Earth Networks - Lightning alerts • IBM TWC - Hyperlocal predictions of rainfall, temperature, wind
Rivers	https://sdma.kerala.gov.in/rivers/	The river flow in the State is presently monitored through a network of 38 gauges of CWC which were facilitated by KSDMA during the 13th plan period
Sea State	https://sdma.kerala.gov.in/sea-state-2/	Daily sea state in the Indian Ocean Region is received from IMD/INCOIS and the same is communicated in Malayalam with sea area maps
Reservoirs	https://sdma.kerala.gov.in/reservoirs/	The daily water level of reservoirs are collected, collated and published in public domain by KSDMA and analysed for rule curve linked reservoir management

Cyclone	https://sdma.kerala.gov.in/cyclone/	Post Cyclone Ockhi, owing to the continued persuasion of KSDMA and the Government, the IMD has established an Area Cyclone Warning Centre in Thiruvananthapuram
Seismic Monitoring Network	https://sdma.kerala.gov.in/earthquake-2/	KSDMA had funded KSEB to establish a seismic monitoring network in 2010. Continued support was also given to maintain the network during the plan period. Presently they are dysfunctional
Landslide Early Warning	https://sdma.kerala.gov.in/landslide-early-warning/	KSDMA is supporting three major research projects that are by Kerala University, Kerala Development & Innovation Strategic Council (K-DISC) and Geological Survey of India 2020
UV Radio Meter Network	https://sdma.kerala.gov.in/ultra-violet-radio-meter-network/	Heat related disasters in Kerala are increasing. Recognising this, the Government notified Heat Wave, Sun Stroke and Sun Burn as State Specific Disasters vide GO (Ms) No. 9/2019/DMD dated 9-3-2019. Following this, KSDMA with the support of UNDP decided to establish 14 Ultra Violet Radiometers in Kerala so as to ensure continued monitoring of UV levels in the State as such a network or data was not forthcoming from IMD. The system is in testing phase as of now

Flood Forecasting	Development ongoing; lead by Dept. of Irrigation	• Flood Early Warning System by name FEWS • Collaboratively undertaken by Irrigation Department, Kerala State Science Technology and • Environment Council, Kerala State Disaster Management Authority and Kerala State Electricity Board • KSDMA is supporting in technical evaluation and provisioning real time weather forecasts from Private and Public Forecasters
Development of an integrated Surakshaayanam Portal and App	StartUp Mission Initiative	A basic mobile APP and portal for administration of alerts and warnings to be issued to various DEOCs and an APP which has both citizen and administrative provisions were commissioned in 2020.
KSEOC investigation series	https://sdma.kerala.gov.in/research-reports/	The technical team of KSEOC conducted 17 specific studies. Various reports prepared during the period can be found in the link

6. Mainstreaming disaster risk reduction

As every disaster is an opportunity, starting with drought in 2016 and Cyclone Ockhi in 2017, mainstreaming of disaster risk reduction received significant attention and capacitating local self-Governments in disaster risk management became the main focus of the Government, realising that proactive risk informed development planning and implementation is also important than a merely focussing on response centric regulatory mechanism. Various activities that were carried out under this sub-head are given below

Domain	Link	Main Achievement
Headquarters of KSDMA	https://sdma.kerala.gov.in/office-of-sdma/, https://sdma.kerala.gov.in/kseoc/	• Inaugurated on 29-1-2019 • Houses the following: • Office of KSDMA • Kerala State Emergency Operations Centre which has the following facilities o Fusion Centre o Drought Monitoring Cell o IT & Communication Centre o Planning o Capacity Building and Projects o Risk Lab - Geospatial data analytics

		• First of its kind initiative in India • Joint initiative of KILA & KSDMA funded under Rebuild Kerala Initiative - Nammal Namukkai • Completed DM Plans of all Local Self Governments • Co-developed training modules and conducted trainings • Provided human resource support to all District Planning Offices for coordinating the plan preparation, evaluation and capacity building • Provided all available Geospatial layers for Local Governments to plan https://dmp.kila.ac.in/ • Conducted quality assessment of the plans and identified needs for improving the plans into operational level
Local Self Government Disaster Management Plans	https://sdma.kerala.gov.in/local-self-government-dm-plans/, https://sdma.kerala.gov.in/lsg-dm-plans/	
Minimum Standards of Relief	https://sdma.kerala.gov.in/wp-content/uploads/2020/10/Minimum-Standards-of-Relief-Kerala.pdf	Laid under Section 19 of the Disaster Management Act, 2005

Minimum Standards of Relief - Housing		GO (Ms) No. 7/2018/ DMD dated 21-06-2018, the Government declared the minimum relief code for housing damages for the entire state as follows: • Severely damaged house is defined as a house with >75% damage • Severely damaged or fully damaged houses will be eligible for Rs 4 lakhs • If the land in which the house was located is identified as non-inhabitable, then the owner will be entitled for upto ₹6 lakhs for purchase of land, given the condition that the owner does not have any other land parcel in his/her name in the State
Departmental Disaster Management Plans	https://sdma.kerala.gov.in/drought-risk-reduction/	• Homeopathy (2015), PWDNH (2017), Health (2018), Fire and Rescue Services (2017) Soil Survey Department (2020) and Animal Husbandry (2020) have submitted their DM Plans • There is a general lack of interest in preparing the departmental DM Plans and submission to KSDMA despite facilitating numerous trainings and follow ups

Crisis Management Plans	https://sdma.kerala.gov.in/crisis-management-plans/	• Crisis Management Plans for Indian Super League 2018-19, FIFA U17 World Cup 2017 and Thrissur Pooram 2018 were prepared and operationally implemented
Advisory committees under Section 17 of Disaster Management Act 2005	https://sdma.kerala.gov.in/advisory-committee/	6 advisory committees were constituted during the 13th plan period and they are functional. The committees are for Landslides, House Construction in Landslide Prone Areas, Minimum relief code for housing, School Safety, Optimising response to disasters and Monitoring the operations as per Rule Curve of all major dams in the state
Human Resources	https://sdma.kerala.gov.in/office/, https://sdma.kerala.gov.in/team-seoc/, https://sdma.kerala.gov.in/team-deoc/, https://sdma.kerala.gov.in/lsg-dm-plan-coordinators/	The technical and administrative team of KSDMA has evolved over the 13th plan period from 7 to over 50. Detailed organogram can be seen here https://sdma.kerala.gov.in/organogram/

Virtual Cadre	https://sdma.kerala.gov.in/virtual-cadre/, https://sdma.kerala.gov.in/virtual-cadre-2/	• Creating a network of champions of disaster management • Developed training modules and conducted trainings for Agriculture, Animal Husbandry, Health, Land Revenue, Mining and Geology, Irrigation, Soil Conservation, Water Resources, Civil Supplies, Education, Fisheries, Ground Water, LSG planning, Panchayats and Tourism departments
Regional Response Centre of National Disaster Response Force (NDRF)	https://sdma.kerala.gov.in/ndrf/	Facilitated the creation of a Regional Response Centre of NDRF with 2 teams
Annual Reports	https://sdma.kerala.gov.in/annual-reports/	For the first time since its inception in 2007, during the 13th plan, KSDMA published 3 Annual Reports which are statutory to be published as laid in the Disaster Management Act, 2005. Fourth Annual Report is awaiting approval of the Government

Hospital Safety	https://sdma.kerala.gov.in/hospital-safety/	• Developed templates for hospital safety plans • Created training modules and trained virtual cadre from Dept. of Health and Family Welfare in creating Departmental Disaster Management Plans • Hospital safety plans of 14 district hospitals were prepared
School Safety	https://sdma.kerala.gov.in/school-safety-2/	• Developed school safety guidelines and templates for school safety plans • Prepared school safety plans for 28 schools • Separate kids corner (https://sdma.kerala.gov.in/kids-corner-2/) for training in school safety • Created training modules and trained virtual cadre from Dept. of Education in creating Departmental Disaster Management Plans • Provided all materials in sign language and Braille

Youtube Channel	https://www.youtube.com/c/kralaStateDisasterManagementAuthorityKSDMA https://sdma.kerala.gov.in/videos/	• Started a channel exclusively for KSDMA • Have more than 31 informative videos and documentaries on disaster risk reduction • Concurrent safety warnings in sign language issued through the YouTube channel • IPCC 2021 report special series on sectoral impacts in Kerala by sectoral experts of KSDMA
Satheerthyan - Child Inclusive DRR	https://sdma.kerala.gov.in/kids-corner/	• KSDMA's flagship programme for Child Inclusive DRR • Developed puzzles and games for imparting DRR into children • Conducted a 5 day online camp for children on DRR with over 2500 attendees • Exclusive theme song prepared for children (https://www.youtube.com/watch?v=fHsax-JLOzJI)
Brochures	https://sdma.kerala.gov.in/brochures-2/	Over 20 brochures on disaster risk reduction in multiple languages prepared and published during the 13th plan period. In addition Audio Brochures in DAISY formats were made on precautionary measures for persons with visibility impairment

Best Practises	https://sdma.kerala.gov.in/best-practices/	Eight best practice documents were published during the 13th plan period
Water Kiosks	https://sdma.kerala.gov.in/water-kiosks/	Established a network of 4659 water kiosks across the drought prone local self governments of Kerala
Print, Visual and Audio Campaigns		Regular IEC campaigns including news paper advertisements were carried out during the 13th plan period. Focus was given on propagating the concept of Individual Safety Kits
Operation Breakthrough	https://sdma.kerala.gov.in/kochi-2019/, https://irrigation.kerala.gov.in/sites/default/files/2021-08/kochiflood.pdf	Kochi City was flooded due to improper urban drainage during the rainy spell of 21-10-2019. Critical assets including the main power sub-station and arterial roads were flooded. District Collector directly responded to the event. It was essential that an urban flood mitigation project is launched following the best practises of Operation Anantha. Accordingly, vide GO (Ms) No. 35/2019/DMD dated 11-11-2019, Operation Breakthrough was approved.

Towards a Safer State series of events	KSDMA organised, co-organised or sponsored numerous capacity building and scientific conferences, workshops and training in the 13th plan period. Reports of each of them can be found in the links	• 2017 - 5 events including two national conferences and one international conference (https://sdma.kerala.gov.in/events-2017/) • 2018 - 10 events including two mock drills (https://sdma.kerala.gov.in/events-2018/) • 2019 - 38 events (https://sdma.kerala.gov.in/events-2019/) • 2020 - 30 events (https://sdma.kerala.gov.in/events-2020/) • 2021 - 19 events (https://sdma.kerala.gov.in/events-2021/)

Capacity building and projects group of KSDMA conducted several training programme. The number of trained individuals per year are documented and the abstract is as follows:

Year	Female	Male	Total Trained
2018	5324	5663	10,987
2019	6806	6437	13,153
2020	3015	3505	6520
2021	3054	4865	7919

7. Updating Hazard, Vulnerability and Risk Assessment of the State and updating the district and state disaster management plans

KSDMA primarily had to face the various force majeure conditions in the State starting from 2017. However, significant progress has been made in updating the HVRA of the State and the process of updating the State and District Disaster Management Plans are in the final stage. KSDMA also co-anchored the process of finalising the local government level disaster management plans which is a major achievement. New risk maps have been prepared and are to be used in the revision of the State and District Disaster Management Plans. Several district and state level consultations were also organised for preparing the Disaster Management Plans, detailed reports of which may be found in the event reports of the respective years.

Domain	Link	Main Achievement
Geodatabase for Disaster Management	https://sdma.kerala.gov.in/hazard-maps/, https://sdma.kerala.gov.in/event-specific-maps/	During the 13th plan period, KSDMA has created a detailed Geodatabase for use in the decision support system. The database consists of hazard specific information and various elements at risk. Data are mostly made publicly available for facilitating open research and development
Flood Inundation Area and Depth Modelling	Prepared in collaboration with UNEP	The flood inundation area and depth maps of varying return intervals for the entire state was prepared with the technical support of UNEP for the entire state with a 30 m DEM. Further, flood inundation maps of the same return probabilities for the climate change scenario rainfall of RCP 8.5 were also prepared. These maps are being readied to be used for local self governments for scenario planning
Coastal Erosion Zones	https://www.irrigation.kerala.gov.in/coastline-kerala	With data of shoreline changes from NCCR, KSDMA prepared a coastal erosion and accretion zone map which was validated with field data gathered by Dept. of Irrigation, post Cyclone Tauktae coastal erosion. A combined map is published and used for planning purposes

Landslide Susceptibility maps	Prepared by Geological Survey of India	Under the National Landslide Susceptibility Mapping project the GSI has completed landslide susceptibility for all hilly districts except Idukki. The final out put is awaited from GSI
Orange Book of Disaster Management 2 – Monsoon Preparedness and Response Guidelines (in Malayalam)	https://sdma.kerala.gov.in/wp-content/uploads/2021/05/orange-book_2021.pdf	Post 2018 floods, KSDMA prepared a detailed Monsoon Preparedness and Response Guidelines covering the responsibility of all concerned departments for operational use during the monsoon season and during non-seasonal thunderstorms and floods. The book is titled Orange Book 2 and is revised every year before monsoon and published by 25th of May every year. The document also lays the Incident Response System guidelines of the State
Orange Book of Disaster Management 1 – Standard Operations Procedures (SOP) & Emergency Supports Functions Plan (ESFP)	https://sdma.kerala.gov.in/wp-content/uploads/2020/06/Orange-Book-of-Disaster-Management-1-2020.pdf	Orange Book 1, this document covers the SOPs and ESFPs of various events linked to their magnitude
Handbook on First Aid Skills (in Malayalam)	https://sdma.kerala.gov.in/wp-content/uploads/2020/06/First-Aid-Handbook.pdf	This handbook provides illustrated pages on first aid
Handbook on School Safety (in Malayalam)	https://sdma.kerala.gov.in/wp-content/uploads/2019/06/School-safety-booklet-1.pdf	This handbook provides guidelines to teachers, students and parent teach associations on various factors to consider for safer schooling

Handbook on Safe Construction Practices - Floods and Landslides (in Malayalam)	https://sdma.kerala.gov.in/wp-content/uploads/2019/06/Handbook-JAN-2019.pdf	This handbook provides illustrated guidelines on carrying out constructions in flood and landslide prone areas
Aapdha Mitra Community Rescue Volunteer Training Guidelines (in Malayalam)	https://sdma.kerala.gov.in/wp-content/uploads/2018/12/Aapda-Mithra_Training-module.pdf	Illustrated handbook for training community rescue volunteers
Covid19 Academy	https://sdma.kerala.gov.in/covid19-academy/	Public awareness building virtual programme with expert lectures and certification collaboratively organised with SPHERE India
America with Kerala	https://sdma.kerala.gov.in/america-with-kerala/	Coorganised with the Centre for Public Policy Research (CPPR), Kochi and U.S. Consulate General in Chennai. Three-day workshops in Thiruvananthapuram, Kochi and Kozhikode on Community Based Disaster Risk Reduction, Policy Planning and Infrastructure Development and Curriculum on Disaster Management for Higher Education
Hazard and Vulnerability Assessment Report – Neelakurinji Blooming Season 2018	https://sdma.kerala.gov.in/wp-content/uploads/2020/10/Neelakurinji_Final_-Report.pdf	Detailed assessment of the hazard and vulnerabilities that are there in areas where there is tourist attraction owing to the blooming of the Neelakurinji and preventive measures to reduce disasters in such areas

Climate change inclusive assessment of hazards were attempted for the first time in India, particularly on flood hazards. KSDMA collaborated with UNEP and with the support of CIMA Foundation prepared the CMIP5 based RCP 8.5 climate scenarios and consequent

flood hazards for 10 yr, 25 yr, 50 yr, 100 yr, 200 yr and 500 yr return probabilities. Historical rainfall return probabilities of 10 yr, 25 yr, 50 yr, 100 yr, 200 yr and 500 yr were also used to generate flood hazard scenarios. The assessment revealed that the 100 yr historical data based scenario is comparable with the RCP 8.5, 50 yr return probability scenario. This is alarming for a state like Kerala and therefore requires drastic landuse policy reforms and human behavioural changes to adapt.

KSDMA also updated the coastal erosion prone area maps of Kerala and with the support of Dept. of Irrigation, field validated the map.\

8. Policy level interventions of KSDMA

Significant policy level interventions were done by KSDMA in the 13th plan period.

- No permission for blasting type quarrying in the high hazard zones of Kerala (Upheld in WP (C) No. 4022 of 2017 dated 16-11-2018)
- Restriction in construction types in Wayanad district owing to hazard proneness based on the advice of KSDMA (Upheld in WP(C) No. 24873 of 2015 (H) dated 3-11-2015)
- Limiting extraction of ground water to 25% of the permitted amount in light of drought (Upheld in WP (C) No. 2986/2017 (W) dated 11-04-2017)
- Prevention of obstruction of streams and natural drains - based on the direction of KSDMA, the Government amended the Kerala Municipal/Panchayath building rules in S.R.O. No. 828/2019 dated 8-11-2019 and included Section 22 (4) "No construction shall be made to obstruct the natural drains and streams in a plot. Failure to comply with this instruction will invite penalization under Section 51 of the Disaster Management Act, 2005 (Central Act, 53 of 2005)".
- Report of the Technical Committee for suggesting amendments to the techno-legal regime (https://sdma.kerala.gov.in/wp-content/uploads/2019/10/14-FINAL-RECOMMENDATIONS-TLR-IN-DM.pdf) - The report was issued to Local Self Government Department to amend the Kerala Municipal & Panchayath Building Rules by the State Executive Committee of KSDMA
- Notified Coastal Erosion, Lightning, Soil Piping, Strong Wind and Sun Burn/Sun Stroke/Heat Wave as State Specific Disasters
- Ensured the involvement of technically competent officer of local government in the assessment of damages to houses in disasters vide GO (Ms) No. 3/2018/DMD dated 27-03-2018
- Laid the standard operating procedure for providing relief assistance to the dependents of those who are missing in notified disasters approved vide GO (Rt) No. 172/2018/DMD dated 27-03-2018
- Vulnerability Linked Relocation Plan: A vulnerability linked relocation plan for the coastal areas were facilitated vide GO (Ms) No. 6/2018/DMD dated 2-6-20218 and for the flood/landslide affected areas vide GO (Ms) No. 7/2019/DMD dated 27-2-

Figure 2: Flood Hazard - Historical 1 in 50 yrs

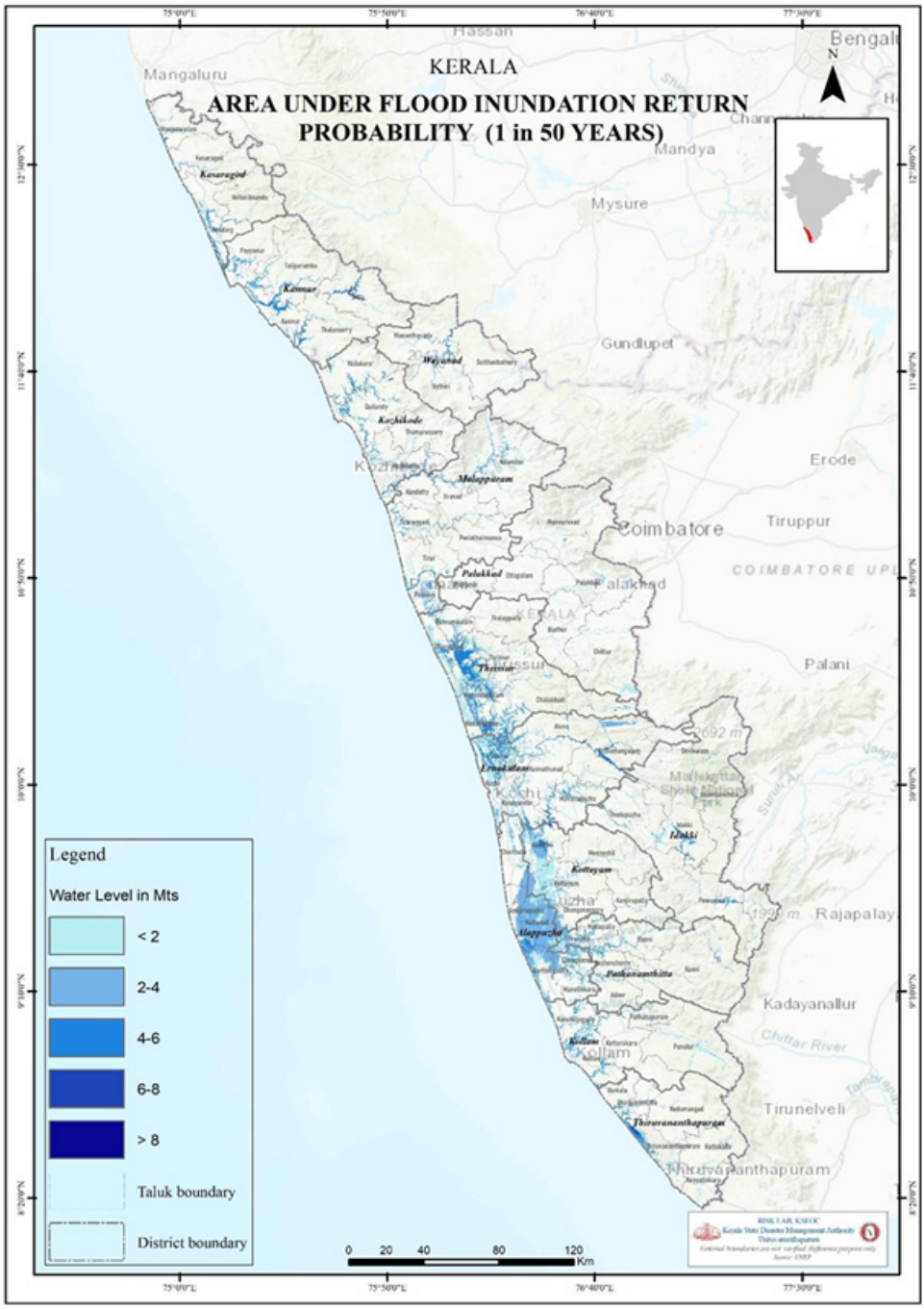
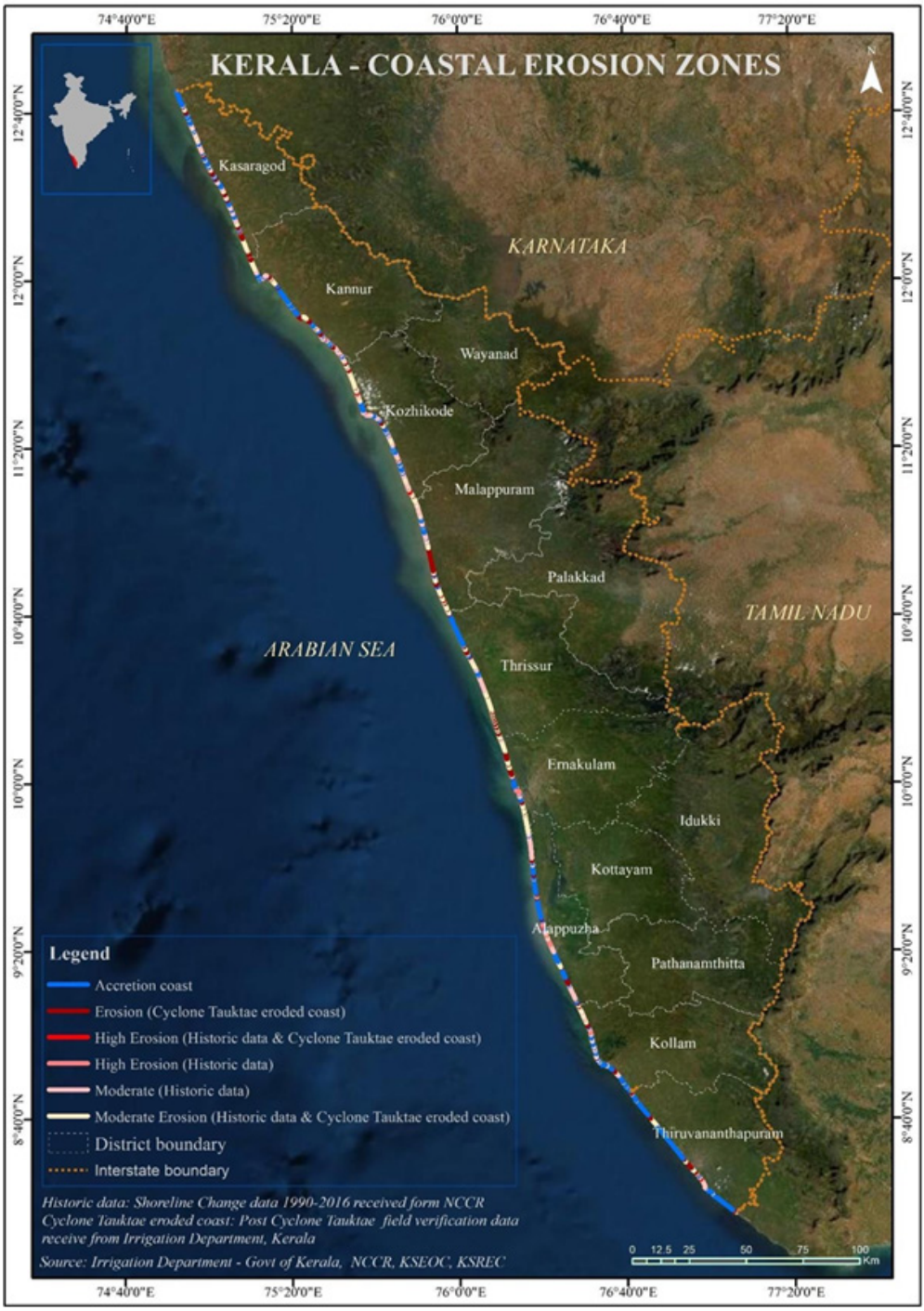


Figure 3: Coastal erosion zones



2019 whereby damaged houses in vulnerable or totally eroded lands due to floods or landslides were offered Rs. 6 lakhs for purchase of land suitable for construction of houses and Rs. 4 lakhs for damaged houses. Post Kerala Floods 2018, the Government directed the Geological Survey of India vide GO (Ms) No. 20/2018/DMD dated 7-9-2018 to map the landslides that occurred in 2018. In total 1626 landslides were investigated. Based on the site-specific investigations, GSI recommended 689 dwelling units to be relocated. Further, in 2019 a rapid assessment of the safety of areas affected by landslides/debris flows and the sites where radial cracks were formed in the sloped due to aborted landslides were deemed necessary. Accordingly, officers of Mining and Geology, Ground Water and Soil Conservation Departments were paired into 49 teams and trained by KSDMA with the assistance of landslide experts and Geological Survey of India. Each team had one Geologist and a Soil Conservation Officer. The teams were deployed in 9 districts vide GO (Rt) No. 520/2019/DMD dated 19-8-2019. In total 719 sites were investigated. Based on the site-specific investigations, the teams recommended dwelling units at 411 sites to be relocated. The Government vide GO (Ms) No. 25/2019/DMD dated 23-8-2019 made the vulnerability linked relocation plan applicable to the dwelling units which were identified as vulnerable by these teams. As many as 2900 families benefited from this scheme.

- A checklist was furnished to the Government by the advisory constituted vide GO (Rt) No. 644/2018/DMD dated 30-11-2018. It is expected that by following the checklist, the Engineer of the concerned Local Self Government and the District Geologist (representative) can identify whether a proposed site for construction is landslide susceptible or not and whether building permits should be issued or not in such sites. This checklist may be made part of the KMBR/KPBR.
- Convinced the Government to extend relief assistance for rebuilding houses to people living in Government land (Purambok) by providing support of Rs. 6 lakhs to buy land or provide assignable land to relocate and then provide Rs. 4 lakhs to build a house. Approved vide GO (Ms) No. 1/2019/DMD dated 11-1-2019

9. UNICEF funded programmes

Focusing on three priorities of Sendai framework on Disaster risk reduction namely (i) Understanding disaster risk; (ii) Strengthening disaster risk governance to manage disaster risk; (iii) Investing in disaster reduction for resilience, KSDMA launched a project in partnership with UNICEF in 2019 titled "Mainstreaming Disaster risk resilience". The thrust areas of the project were Child Centred Risk Informed Planning, School Safety Programmes and Strengthening Inter Agency Group activities. Details of the project can be seen here https://sdma.kerala.gov.in/unicef-2019/, https://sdma.kerala.gov.in/unicef-2020/

10. SPHERE India funded programmes

Kerala State Disaster Management Authority (KSDMA) collaborated with Sphere India (A coalition of NGOs) in 2019. The collaboration aimed at the following:

- Update District Disaster Management Plans of all 14 districts
- Create an institutional framework for NGO collaboration

As a result of the project, all 14 districts formed Inter Agency Groups (IAGs) under respective DDMAs for NGO coordination. A total of 420 NGOs spread across the State are now part of the IAG network of DDMAs. Detailed reports of the programme can be found here https://sdma.kerala.gov.in/sphere-india-2019-20/

11. UNDP funded programmes

Government of India – UNDP project on enhancing institutional & community resilience to disasters & climate change was implemented in the state of Kerala since 2013 till 2017. Visible developments were made by the project with regard to mainstreaming disaster risk reduction & climate change adaptation. One of the major achievements of the project was with regard to preparing community disaster management plans in Munrothuruthu & Peringara villages of Kollam and Pathanamthitta districts respectively. One of the key contributions of the project was doing the training needs assessment in the health sector of the State. In the Urban Risk Reduction component, the project was mainstreamed in Thiruvananthapuram corporation which has earmarked its own funds for disaster risk reduction activities. Under the capacity development initiative of the project, 2012 community members and 1119 government officials were trained. Detailed report can be found here https://sdma.kerala.gov.in/wp-content/uploads/2019/11/Final-digital-report.pdf

Further, in 2018 and 19 UNDP supported KSDMA in various post disaster mitigation and capacity building.

Prathyudhanam: KSDMA started implementing a disability inclusive disaster risk reduction programme in 2015. In order to partially support post flood 2018 housing reconstruction efforts of weaker sections, KSDMA through United Nations Development Programme (UNDP) mobilised Rs. 8.25 crores from the UN CERF. The UNDP support was for 5000 flood affected weaker families in Pathanamthitta, Idukki and Wayanad District with Rs. 16,500/- family. Hon'ble Chief Minister benevolently extended an additional support of Rs. 10 crores from Chief Minister's Distress Relief Fund to raise the support to Rs. 25,000/- per family for 7300 families of Pathanamthitta, Alappuzha, Kottayam, Idukki, Ernakulam, Thrissur, Palakkad and Wayanad districts. Beneficiaries of the project were:

- Families with cancer patients, dwelling in houses that experienced at least 15% damage in Kerala Floods 2018
- Families with dialysis patients, dwelling in houses that experienced at least 15% damage in Kerala Floods 2018
- Families with bedridden, differently abled members, dwelling in houses that experienced at least 15% damage in Kerala Floods 2018
- Widowed mothers with minor children dwelling in houses that experienced at least 15% damage in Kerala Floods 2018

If only eligible families were not present under the preceding criteria that a beneficiary were to be chosen from the succeeding criteria. The beneficiaries were chosen only from the existing approved list of flood house damaged beneficiaries.

Prathyudhanam is a pioneering scheme in the country where additional financial assistance

is provided to disaster affected people with compounded vulnerability and it truly upholds the tenet of "Leave No One Behind". In total 4563 families benefited from the scheme.

Shelter Hubs: Ten facilitation centres were established and operated with the financial support of UNDP Shelter Project in Kerala from November 2018 to June 2019 in Pathanamthitta, Idukki and Wayanad with the aim of providing technical assistance to multiple stakeholders involved in house reconstruction such as beneficiaries, masons, contractors etc. The activities of shelter hubs focused on promoting disaster resilient and sustainable construction practices through consultancy, outreach, advocacy, networking and resource mapping. With Habitat Technology Group as the implementing agency, within a period of eight months, shelter hubs a) Provided on-site technical assistance to 3597 flood affected house owners and b) Oriented 934 masons (including 369 Kudumbashree women masons), 203 house owners, 60 contractors and 373 civil engineering diploma students in disaster resilient and sustainable construction practices. Report of the operations of Shelter Hubs may be found here https://sdma.kerala.gov.in/wp-content/uploads/2020/11/Report_Shelter-Hubs_UNDP.pdf

IEC materials: Under the UNDP Shelter Project in Kerala from October 2018 to December 2019, the following IEC materials were prepared and published; Surakshitha Bhavana Nirmanam - Pralayavum Urulpottalum- Handbook on flood and landslide resilient construction, Flood Resilient Construction Practices, Landslides in Kerala, Disability Inclusive house construction, Disaster Resilient Construction Practices. They can be found here https://sdma.kerala.gov.in/iec-materials/

Round tables: Two round table conferences were conducted on the following topics. Report can be found here. https://sdma.kerala.gov.in/round-tables/

- "Developing appropriate technologies and strategies for housing in hilly terrains (Idukki and Wayanad)" at Kozhikode on 15-12-2018
- "Living with Water: Developing Appropriate strategies for housing in Kuttanadu" at Thiruvananthapuram on 17-12-2018

Capacity Building: Four specific capacity building programmes were organised under the project. The reports of the programmes may be found here https://sdma.kerala.gov.in/capacity-building/

- Orientation Seminar on Disaster Resilient Construction Practices for Registered Architects and Licensed Civil Engineers, 20 November 2019 at Thiruvananthapuram and 22 November 2019, Kozhikode
- Training of Trainers for Kerala State Nirmithi Kendra Trainers on Disaster Resilient Construction Technologies, 29-31 October 2019.
- Training on Disaster Resilient Construction and Quality Monitoring for LIFE Mission Rebuild Hub Personnel, 17-19 November 2019, Thiruvananthapuram and 26-28 November 2019, Kozhikode.
- Workshop on Retrofitting and Plot-Specific Landslide Mitigation for LIFE Mission rebuild hub (Surakshitha Koodorukkum Keralam) engineers as well as LSGD engineers, 8-9 April 2019.

12. Risk Transfer

In light of the increasing vulnerability to disasters in Kerala the Government of Kerala decided to study the possibility of the risk transfer mechanism for disaster financing in the State, in order to be prepared against financial shocks due to extreme weather events and disasters. The Government constituted a committee vide GO (Rt) No. 256/2021/DMD dated 20/02/2021 to study disaster risk financing.

The committee reviewed the state's disaster risk financing mechanisms. The review suggests that Kerala may be able to implement a sustainable disaster risk financing structure and new risk transfer mechanisms, including climate risk insurance programmes. Furthermore, the Committee recommended the measures to be followed in order to develop a regulatory body for implementing the risk transfer mechanisms and its financial structure. Also, the Committee offered suggestions for improving the administrative and technological structures for the effective implementation of risk transfer mechanisms. In this report, the Risk Transfer Mechanism Committee proposes a framework to mitigate the problem of natural disasters and their impact on the economy. In addition to reducing the financial burden of the state, climate risk insurance supports society at large in preparing to face future disasters and overcoming financial loss due to catastrophes. As a result, existing government authorities in the State will work more efficiently, and the state will become more prepared and better enabled to cope with any eventuality. In its entirety, the Committee opens up a paradigm shift in the approach to disaster financing, recovery and reconstruction, as well as developing pre-disaster preparedness and capacity building. In addition, it offers insights for policies and programs for sustainable development to combat the effects of climate change.

ANNEXURE II B

Action Taken by KSDMA for major disasters during 13th plan period

The 13th plan period was a time when Kerala faced historic disasters. KSDMA had led the response, rehabilitation and mitigation actions in each of these major events.

1. Drought 2016-17

The South West and North East Monsoon seasons of Kerala in 2016 faced a deficit of -34% and -62% in rainfall during the season. This affected the early part of 2017 resulting in significant shortage of drinking water. The Karif and Rabi Seasons of 2016-17 therefore had to be notified as drought affected.

A landmark initiative was launched by KSDMA and Kerala Water Authority to facilitate drinking water in Thiruvananthapuram City. SDMA provided Rs. 6 crores to KWA to establish a pipeline for pumping water from Neyyar Reservoir to Aruvikkara Reservoir. The activity was completed in less than 14 days.

The interministerial central team visited Kerala and based on the Memorandum prepared and defended by KSDMA the Govt. of India allotted Rs. 31.72 crores as additional allotment from National Disaster Response Fund to State Disaster Response Fund.

2. Cyclone Ockhi 2017

On 30-11-2017, Cyclone Ockhi passed about 70 km away from Kerala coast. Kerala in the last 100 years had not experienced a major Cyclonic Storm impact of this magnitude. Many apprehensions were there about the issuance of early warning. However, the Two Hundred Eleventh Report of the Parliamentary Standing Committee on Home Affairs titled "The Cyclone Ockhi - its impacts on fishermen and damage caused by it", laid on the table on 4-4-2018 demystified many of these speculations. Action taken by KSDMA can be found in detail in the Annual Report of 2017-18 of KSDMA, here https://sdma.kerala.gov.in/wp-content/uploads/2021/06/SDMA-2017-18-Annual-Report-Malayalam.pdf

It was very evident that detection of the Cyclone as a cyclone was delayed owing to the rapid intensification nature of the event and therefore the Standard Operating Procedures to be followed by India Meteorological Department in issuance of warnings could not be followed. Lack of long distance communication systems meant the fishermen who had ventured into the sea on early dates could not be alerted of the low pressure system which rapidly turned into a Cyclone.

3. Floods 2018

Kerala faced floods of historic proportions in the year 2018. Floods of 2018 were a consequence of extreme rainfall, a catastrophic natural disaster equivalent to a similar calamity that occurred 94 years back in 1924. Detailed report on damages and action taken can be seen in ' 2018' – Report of Kerala Floods 2018 (in Malayalam), 2019. Department of Information and Public Relations, Government of Kerala. Several studies and reports on Kerala floods 2018 could be found in https://sdma.kerala.gov.in/floods_2018/

The Government of Kerala commissioned a Post Disaster Need Assessment (PDNA) to be led by the United Nations Organizations. Accordingly, the PDNA concluded with a damage and loss estimate of ₹26,720 crores and a build-back-better need of ₹31,000 crores. Sector wise assessment as in the PDNA is given below. It was for the first time in the country that the entire PDNA exercise was being conducted in any State in such a comprehensive manner.

The flood affected 1260 villages in 13 districts, with 7 districts being affected in total. In continuation of the preparedness measures, the State undertook and coordinated a historic and world recognized disaster response showcasing the advancement and ability of the State in management of catastrophic situations. Detailed, dated wise response is provided in Annexure 1.

The Humanitarian Assistance and Disaster Response request of KSDMA was duly honoured by Central Forces and Armed Forces. This resulted in 58 teams of NDRF, 23 columns of the Army, 104 boats, 94 rescue teams of the Navy, 1 medical team, 9 helicopters, 2 Air crafts, 94 boats, 36 teams of the Coast Guard, 49 boats, 2 helicopters, 2 Aircrafts, 27 boats (hired), 22 Helicopters of the Airforce, 23 Aircrafts, 2 companies of the Border Security Force, 1 water vehicle team and 10 teams of CRPF being deployed along with 2927 fishermen and 669 boats operating in the State over a period from 14th July to 31st August. As many as

14,50,707 individuals were housed in 3,879 relief camps on 21st August 2018.
The Government requested the support of UN Organisations and the World Bank and Asian Development Bank for conducting a Post Disaster Need Assessment. The World Bank and ADB conducted a Joint Rapid Disaster Needs Assessment while the UN Organizations and the World Bank together conducted the more comprehensive Post Disaster Need Assessment. The United Nations Development Programme immediately came forward and extended additional human resource support to Kerala State Disaster Management Authority.

Relief Camps: In total 34 lakhs individuals were housed in 12,253 relief camps during the period from 29-05-2018 to 30-08-2018. High quality food in hygienic conditions was provided to all individuals in the camps. Bio-toilets and chemical toilets were arranged in most camps. In the backwater and lake areas, toilets in tourist houseboats were opened for the general public.

Health Care: The Government ensured that health care in the relief camps and post flooding situation is addressed specifically with necessary steps to avoid any epidemics. Every camp was visited by a team of medical professionals including doctors, at least once in a day. Psycho-social care was provided massively and as many as 83,000 individuals were provided with specific mental health assistance. Child health and psycho-social support was ensured and mass messaging in affected areas were sent out to ensure that children are not exposed to the visible impacts of their damaged homes. Massive and widespread distribution of doxycycline was undertaken to prevent any possible epidemics due to bacterial and protozoa attacks.

Camp to home relief kits and gratuitous relief of ₹10,000: Every family was provided with a relief kit containing over 22 items. Such kits were distributed to more than 7,15,000 families. The kit contained essential items for immediate home making. Further, in line with the norms of assistance from National Disaster Response Fund, the Government provided ₹10,000 per family which is ₹6,200 more than the National minimum standards of relief, for families whose household items and clothes have been lost in the calamity. The additional amount of ₹6,200 was paid from the Chief Minister's Distress Relief Fund. This assistance was given to 6,85,184 families. In addition, the Government is distributing a continued relief kit worth ₹500 for all backward and marginalised families till December 2018. Free monthly ration of rice is also provided to eligible ratio-card holders till December 2019. This is undertaken with the financial support of the Chief Minister's Distress Relief Fund.

Sanitation drive: The Government ordered ₹25,000 for all flood affected Grama Panchayath Wards and ₹50,000 for all flood affected Municipality and Corporation Wards from SDRF. Within a span of 40 days after floods, as many as 6,93,287 houses were cleaned which accounted for more than 99% of the flood affected houses. Those that could not be cleaned were either non-inhabitable or completely destroyed. 7610 public buildings and 3,00,956 wells were also cleaned, in addition to public places, roads and bridges. Carcasses of 5,850 large animals, 8,807 small animals and 8,22,553 birds were buried. Most of this

Sector	Damage	Loss	Total Effect (D + L)		Total Recovery Needs	
	INR Crores	INR Crores	INR Crores	USD Million	INR Crores	USD Million
Social Sectors						
Housing, Land and Settlements	5,027	1,383	6,410	916	5,443	778
Health and Nutrition	499	28	527	75	600	86
Education and Child Protection	175	4	179	26	214	31
Cultural Heritage	38	37	75	11	80	11
SUB-TOTAL	**5,739**	**1,452**	**7,191**	**1,028**	**6,337**	**906**
Productive sectors						
Agriculture, Fisheries and Livestock	2,975	4,180	7,155	1,022	4,498	643
SUB-TOTAL	**2,975**	**4,180**	**7,155**	**1,022**	**4,498**	**643**
Infrastructure sectors						
Water, Sanitation and Hygiene	890	471	1,361	195	1,331	190
Transportation[a,b,c]					10,046	1,435
Power[b,c]					353	50
Irrigation[b,c]					1,483	212
Other infrastructure[b,c]					2,446	349
SUB-TOTAL	**890**	**471**	**1,361**	**195**	**15,659**	**2,236**
Cross-cutting sectors						
Environment	26	0.04	26	4	148	21
Employment and Livelihoods	881	9,477	10,358	1,480	3,896	557
Disaster Risk Reduction	17	583	599	86	110	16
Gender and Social Inclusion	0.9	0	0.9	0.13	35	5
Local Governance	28	0	28	4	32	5
SUB-TOTAL	**953**	**10,060**	**11,013**	**1,574**	**4,221**	**604**
TOTAL (A)	**10,557**	**16,163**	**26,720**	**3,819**	**30,715**	**4,389**
Integrated Water Resources Management (B)	0	0	0	0	24	3
GRAND TOTAL (A+B)					**30,739**	**4,392**
GRAND TOTAL (ROUNDED OFF)					**31,000**	**4,400**

[a] Recovery costs for roads from urban and rural infrastructure sections are included

[b] In Rapid Damage and Needs Assessment, the cost of damage and loss has not been quantified

[c] Estimates taken from the World Bank–Asian Development Bank Joint Rapid Damage and Needs Assessment (JRDNA)

Note: Figures are rounded and so column totals may not add up precisely

work was done by voluntary teams. Experts from as far as West Bengal were brought in, to bury carcasses of animals. Non-biodegradable waste was handled by specialised teams from Clean Kerala Company.

Electricity reconnection: The flood caused a damage of ₹85 crores even as per the meagre National Disaster Response Fund norms of assistance to the Kerala State Electricity Board (KSEB). However, the KSEB reinstated 25.7 lakh electricity connections, which was 98% of the total disconnections in just 14 days.

Valuable documents: The Government issued orders to all Government aided and funded institutions in the State, including Universities and Local Self Governments that no fee should be collected from any individual who lost his/her certificates or other valuable documents in the floods for issuing a duplicate or new certificate. The Government also lead 'document adalaths' in all districts for speedy provisioning of duplicate or new certificates to those who lost them in the floods.

Resurgent Kerala Loan for flood affected families: The Government of Kerala through the Kudumbashree, which is the Women Self Help Groups apex body of the Government, facilitated a non-interest bearing loan of upto ₹ 1 lakh per family for purchasing household goods for discounted rates. The original equipment manufacturers came forward based on the request of the State Government to offer products for a very subsidised rate for those who availed these loans. The interest subvention for this loan was provided from Chief Minister's Distress Relief Fund. As on date 43,388 families have been provided with this loan amounting to ₹374 crores.

Agriculture: As many as 2,36,000 farmers have been provided with relief assistance till 5-12-2018 as per the minimum relief code of the State Government. The minimum relief for crop loss in Kerala is several times higher than that of the minimum relief offered by the Government of India. For example, a banana plant with bunch will get ₹100 of which only ₹2.72 is from the State Disaster Response Fund (SDRF) while the remaining is paid from the State Budget. As on date ₹60 crores have been expended from SDRF for agricultural crop loss while ₹110 crores have been expended from State Budget in addition to the above mentioned ₹60 crores from SDRF for the same purpose; ₹18 crores worth crop insurance has also been provided to farmers. Government has also extended additional support for free seeds for farmers.

Ujeeevana scheme for Micro Small and Medium Enterprises: This sector is not at all addressed in the National norms of assistance under Disaster Response Fund. Hence, this sector is usually ignored, post disaster. In Kerala as many as 4859 MSEMs and 17,224 shops were affected in the floods amounting to a loss of ₹1102 crores and ₹361.88 crores respectively.

The Government of Kerala, as a country's first has provided a resurgence support margin money of 25% of the loan amount or Rs. 2 lakhs, whichever is the lowest or an interest subvention of 9% for a maximum loan of Rs. 10 lakhs under a specially designed scheme called Ujeevana Scheme. In total, 1995 MSMEs and Shops and Other Establishments availed this scheme with the total loan amount of ₹93 crores.

Housing Sector: Kerala provides the highest relief assistance for affected families in natural calamities in almost all sectors. The minimum relief assistance offered to houses affected by floods in varying degrees is given below:

Damage Percentage	Rate of Assistance				
	Hills - CMDRF	Hills - SDRF	Plains - CMDRF	Plains - SDRF	Total
<15%	No relief permissible as per the norms of SDRF/NDRF				
15%	4,800	5,200	4,800	5,200	10,000
16-29%	29,500	30,500	31,500	2,8500	60,000
30-59%	74,000	51,000	77,500	47,500	1,25,000
60-74%	1,73,500	76,500	1,79,000	71,000	2,50,000
75-100%	2,98,100	1,01,900	3,04,900	95,100	4,00,000

For Hill areas and Plains, the rates of assistance are fixed separately. In total 3,70,436 houses have been affected by the floods with 15 to 100% damage. Assistance was paid to eligible 3,61,029 families.

Financial incentive was provided for relocation of families in vulnerable areas under the vulnerability linked relocation plan

Following international best practice, the house construction was carried out in a totally owner driven manner. Government facilitated housing facilitation centres for the flood affected individuals to avail access to modern house construction practises.

Support to livelihood: Under the Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS) wage employment was provided to 14.72 lakh families as on June 2019. A total of 16.96 lakh individuals were benefited. Out of this, after August 16, 2018, employment was provided to 10.31 lakh families, of which 4.83 lakh families were newly employed as on June12, 2019 after August 16, 2018. This amounts to 12.02 lakh individuals who were provided employment after August 16, 2018, of which 6.12 lakh individuals were newly employed after the flood. As a result, a total of more than 7.6 crore person days were generated. In the post-flood period, ₹ 2,068.74 crore worth of employment was generated. An amount of ₹ 700.14 crore was disbursed to the beneficiaries as unskilled wages by the Central Government through Direct Benefit Transfer.

Animal care: Animal rescue camps were also started on a need basis for providing temporary shelter, feed, fodder and medical aid to the rescued animals. A total number of 1,172 such camps including satellite camps were set up in the affected areas which catered to the need of 80,538 animals. Nearly 40,813.5 litres of milk were distributed to relief camps throughout the state. The expense of ₹ 14.28 lakh was borne by the Dairy Cooperatives. An amount of ₹ 33.75 lakh was provided to flood affected livestock farmers, as part of insurance claim settlement. An amount of ₹ 21.99 crore was distributed to livestock

and poultry farmers in the State as compensation relief through the Animal Husbandry Department from State Disaster Relief Fund. The Animal Disease Control Project office had prepared a disease forecast and disease control protocol to be put in force immediately. Surveillance was strengthened for detecting outbreaks of diseases if any. The Central team from Government of India comprising Scientists from New Delhi & Southern Regional Disease Diagnostic Laboratory, Bangalore visited the flood affected areas and animal camps and expressed satisfaction on the action taken by the Department. Donate a Cow Programme was organised to encourage and motivate the public to contribute financially for donating a milch cow or heifer for the most flood affected dairy farmers. Around 300 milch animals were distributed to dairy farmers who lost their animals due to flood. A Special Rehabilitation Programme for flood affected dairy farmers worth ₹22 crore was implemented by the Dairy Development Department during the year 2018-19. A total of 3,000 milch animals were distributed. About 2,130 farmers were assisted for shed renovation / shed construction and other assistance in a need-based manner.

Civil Supplies: In August 2018, Government sanctioned free ration of 5 kg rice to all card holders in the flood affected areas. From September to December, 2018 the non-priority card holders in the flood affected areas were sanctioned 5 kg of rice/month at the expense of transportation & handling charges (₹1/kg). Free ration (15 kg of rice) was sanctioned to all the plantation workers of the State. In addition, the selected families among the flood affected (ration priority card holders, NREGA job card holders, SC/ST, women centred families, widows, differently abled and destitute) were distributed subsistence kit worth ₹ 500 during the months from October to December, by the Kerala State Civil Supplies Corporation. A total of 10,89,175 kits worth ₹54,45,87,500 were distributed till January 2019. An additional allotment of 12,000 KL of non-subsidised kerosene from GoI, was distributed in the State with priority to the flood affected areas at the rate at which it was allotted by GoI, with the State Government bearing the transportation and handling charges.

Inclusion of marginalised: An amount of ₹37.57 crore was distributed to flood affected SC/ST families as relief by rearranging annual plan allocation of the SC/ST department in 2018-19. The department also incurred the cost of distribution of food and non-food items, cleaning the flood affected SC/ST institutions and colonies. Moreover, the department distributed gas stove worth ₹2.12 crore to 8,487 SC/ST families through sponsorship.

Co-operative sector: The Co-operation Department was quick to assess the damages caused by the deluge and formulate a strategy that culminated in the conceiving of project CARe-Kerala (Co-operative Alliance to Rebuild Kerala). The project encompasses three independent schemes viz; 'CARe-Home', CARe-Loan and CARe-Grace of which the 'CARe Home' is the most important one. Under this scheme houses are constructed for the flood affected people whose homes were lost/severely damaged with the co-operation and support of various co-operative institutions functioning in the State. The 'CARe-Home' project is carried out by undertaking the construction through Co-operative Societies in the respective areas at a cost of ₹5 lakh/house utilising the funds sourced through various Co-operative Societies (₹44.98 crore) and the State Disaster Response Fund (SDRF- ₹58 lakh).

The implementation of the project is entrusted with the Registrar of Co-operative Societies under the guidance of the State Level Implementation Committee.

Health care: The Incident command centre and control rooms were set up in the Directorate of Health services and all district headquarters by the State Government. The control room contact numbers were shared with the community also. Guidelines for prevention and control of communicable diseases and also for systematic functioning of relief camps were formulated and circulated. A Health inspector/Multipurpose health worker was entrusted to supervise the health and sanitation part of all relief camps. Local ASHA, AWW and Kudumbasree volunteers and members of WHSNCs instructed to involve in full scale in relief camps. Medical officers of local PHCs were instructed to provide and supervise necessary medical aid to flood victims. Daily Medical camps were organized in these camps apart from ensuring routine functioning of PHC/Hospitals in the affected areas. Advisories to Health workers, public and NGOs regarding the preventive health aspects were formulated and circulated in both English and Malayalam languages. Focus was given to prevent food borne infection, water borne diseases, leptospirosis, snake bites, and any unusual symptoms to be reported immediately to respective PHCs. When the flood water started receding, steps were initiated, for safe return of the victims of this disaster. Counselling services were arranged for those traumatised in the disaster; steps are taken to ensure continuation of case management of NCD cases. Steps were initiated to clean and super chlorinate all drinking water sources and safe disposal of carcasses as per standard guidelines with help from officers of the Animal Husbandry department. Anticipating a large-scale outbreak of water borne diseases, all possible preventive steps were taken.

Janakeeyam E Athijeevanam 2019: Transparency and accountability statement of Kerala Floods 2018 Response and Reconstruction. KSDMA organised a public transparency and accountability statement to meet in 13 out of 14 districts at the same time, in a fixed format on 20-7-2019. The programme was titled Janakeeyam Ee Athijeevanam – Nammal Namukkayi (Participatory Resurgence – We for Ourselves). District Collectors presented the status report including financial statements before the general public and people's representatives of the districts. This lays a new benchmark in the country for Disaster Response and Reconstruction accountability. The programme was live telecasted through the Official Facebook Page of District Collectors which may be found here https://sdma.kerala.gov.in/janakeeyam-e-athijeevanam-2019/

Every week the status of recovery was updated in the public domain. Affected can trace their appeals in the public domain. Names and addresses of all those who got ex-gratia were published in district websites.

4. Heat 2019

Post floods 2018, Kerala went through severe dryness. Temperature increased significantly and rivers and drinking water sources drastically depleted.

	SEOC issued public alert prescribing specific actions for citizens to comply as the model outputs from IMD indicated increasing heat regimes
2-03-2019	SEOC issued preparedness instructions to various departments for compliance as per the Heat SOP Labour timings in the state rescheduled. Manual labour restricted from 11 am to 3 pm
6-03-2019	State Executive Committee meeting decided to declare Heat Wave, Sun Stroke and Sun Burn as State Specific Calamity
9-03-2019	GO (Ms) No. 9/2019/DMD dated 9-03-2019 – Heat wave, sun burn and sun stroke notified as state specific disasters
16-03-2019	Operated a helicopter in Attappady, Palakkad for extinguishing forest fire
20-03-2019	Circular Number DM B2/32/2019-DMD dated 20-03-2019 – detailed circular issued with specific instructions to DDMAs for response and relief from Heat Wave, Sun Burn and Sun Stroke
21-03-2019	Released Rs. 50 lakhs each to all District Collectors for Heat Wave, Sun Burn and Sun Stroke vide GO (Rt) No. 225/2019/DMD dated 21-03-2019
22-03-2019 onwards	Continuing public alert. Raised the level to extreme caution and published in all print, audio and visual media as continuous press releases
27-03-2018	Chief Secretary held a video conference with all District Collectors and reviewed the situation. Created 3 task forces for coordinating response and relief actions
Status report	• Integrated Disease Surveillance Programme (IDSP) database indicated 356 cases of sun stroke (9), sun burn (182), heat rash (165) from all 14 districts during the period 1-03-2019 to 26-03-2019 • 1 death confirmed due to Sun Stroke in Ernakulam District • The situation continued till 29-3-2019

5. Floods 2019

During the South West monsoon of 2019, another deluge had hit the state, wherein 1038 villages from 13 districts were notified as affected by floods & landslides and 125 lives were lost. Sectors like housing, power, agriculture were affected badly and the damages have been reported in the memorandum. The state was hit by major floods in the two consecutive years of 2018 & 2019. Detailed action taken report may be found here https://sdma.kerala.

gov.in/wp-content/uploads/2020/03/Memorandum-pages-deleted-Copy-compressed.pdf

In total 1038 villages have been notified as flood and/or landslide affected. In continuation of the preparedness measures, the State undertook and coordinated a historic and world recognized disaster response showcasing the advancement and ability of the State in management of catastrophic situations.

The Humanitarian Assistance and Disaster Response request of KSDMA was duly honoured by Central Forces and Armed Forces. This resulted in 13 teams of NDRF, 16 columns of the Army, 1 helicopter, 2 aircrafts of the Airforce, 15 teams of Coast Guard, 13,662 personnel of Police and 100 teams of Fire and Rescue Services were used.

In total 6.12 lakhs individuals were housed in 3151 relief camps. High quality food in hygienic conditions was provided to all individuals in the camps. Bio-toilets and chemical toilets were arranged in most camps. In the backwater and lake areas, toilets in tourist houseboats were opened for the general public.

In line with the norms of assistance from the National Disaster Response Fund, the Government provided ₹10,000 per family. This assistance is already paid to ~1,31,838 flood affected families.

Out of 2.16 lakh houses that had debris, 2.08 lakhs houses have been cleaned. Out of 1.48 lakh wells that were contaminated, 1.42 lakh have been sanitised. A total of 91,340 kgs of organic waste and 6.23 lakh kgs of non-organic waste was safely disposed. As many as 1204 animal and 1.03 lakh bird carcasses were buried. 1967 houses have been fully (100%) damaged and 19,297 houses have been severely damaged (>75%).

Financial incentive was provided for relocation of families in vulnerable areas under the vulnerability linked relocation plan.

A total of 445 transformers, 31,129 poles and 17,074 kms of conductors were damaged and this entire network has already been repaired.

Removal of debris from public spaces, rivers, canals and rivulets: Under section 34(d) of the Disaster Management Act, 2005, 'removal of debris' is a statutory function of District Disaster Management Authorities. In order to remove the debris accumulated as result of floods of 2018 and 2019, Government released a total amount of Rs. 25.73 crores to pay off the bills.

6. Covid19

Preliminary information on the viral infection in Wuhan, China was issued by KSEOC to the Directorate of Health Services (DHS) on 19 January 2020. Need for public health surveillance was flagged to DHS.

List of Indian students who returned from China in December 2019 was shared with DHS on 02-02-2020. When the Chinese Government asked the students to return amid COVID-19 crisis, KSDMA played a strong role in liaising with the Indian Embassy to convince Chinese authorities to permit the students to stay back in India.

State Executive Committee meeting notified Coronavirus as 'State Specific Disaster' after its meeting on 03-02-2020, vide G.O.(Ms)No.3/2020/DMD Dated, Thiruvananthapuram, 04/02/2020, according to which Health Department would be the Nodal Department and Disaster Management Department would support through response mechanism and SDRF. The declaration as State Specific Disaster was done to ensure that the entire machinery of the state would be used for the containment of the virus. However, subsequently on 07-02-2020, declaration of Coronavirus as 'State Specific Disaster' was withdrawn after the Health Department informed that the likelihood of transmission and spread of infection from the primary imported cases to others have reduced.

COVID-19 was deemed to be treated as a notified disaster with permission to use SDRF for COVID-19 control activities (upto 35%), vide GO (Ms) No. 9/2020/DMD dated 17/03/2020.

Based on the recommendation of KSDMA, vide GO (Ms) No. 10/2020/DMD dated 19/03/2020, Kerala was notified as Covid19 affected.

KSDMA modelled the spread potential of Covid19 on 28-3-2020 using the SEIR model and presented it to the Crisis Management Group on 8-4-2020. A special team for Covid19 management was created with Dr. Ratheesh H, Dr. Anish T.S, Associate Professors, Department of Community Medicine, Trivandrum Medical College and Dr. Birenjith, Assistant Professor, Bartonhill Engineering College at KSDMA. The modelling is still continuing and KSDMA also conducted an early assessment of requirements to model the possibility of a Third Wave of Covid19 with involvement of experts from across the world, the report of which may be found here https://sdma.kerala.gov.in/wp-content/uploads/2021/07/Modelling_3rdWave_Report.pdf

Based on the assessments of spread, KSDMA also proposed a contingency management plan which the Government approved vide GO (Rt) No. 440/2020/DMD dated 30-4-2020. It was this contingency plan which lead to the creation of Covid Frontline Treatment Centres (CFLTCs).

KSDMA laid the containment zone determination protocols of the State and since August 2020 is notifying containment zones in the State.

As part of wider capacity building, KSDMA in collaboration with UNICEF and SPHERE India conducted Covid19 Academy – the virtual platform in Malayalam which had over 1000 audience members on a daily basis.

As part of KSDMA's disability inclusive disaster risk reduction programme, the Volunteers of Aapda Mitra were used to distribute essential support instruments to persons with disability across the state. This included supply of batteries for cochlear implants, other essential support medicines etc.

The Inter Agency Groups (IAGs) of the State were used to facilitate Covid19 response, the report of which may be found here https://sdma.kerala.gov.in/wp-content/uploads/2020/12/Report_IAG-Covid-Response_-28.5.pdf

7. Cyclone Tauktae 2021

Cyclone Tauktae prevailed over Arabian Sea between 14-19th May 2021. As the cyclone moved parallel to the west coast, it caused heavy to extremely heavy rainfall activity, strong winds, and tidal waves to affect Kerala on 14th -15th May 2021. A total of 11 people lost their lives due to the impact of Cyclone Tauktae. The causes of the deaths of people were falling trees and electric posts, lightning, drowning, and electric shocks that occurred during the cyclone. In addition, 22 people were seriously injured and hospitalised. 220 houses were fully damaged and 4199 houses were partially damaged. 24,433 ha of crop loss was reported. In total 180 camps were opened housing 7041 individuals.

KSDMA, as soon as the Cyclone alerts were issued, had taken steps to deploy 9 teams of National Disaster Response Force. Newspaper advertisements and social media advertisements were issued. Specific sign language alerts and methods for safeguarding katcha roofs were also issued as video clips. Mass alerts focussing on areas where cyclone footprint was predicted was issued.

3. National Cyclone Risk Mitigation Project

National Cyclone Risk Mitigation Project is a centrally sponsored programme intended to reduce the vulnerability to cyclone and other hydro-meteorological hazards of coastal communities with World Bank assistance in 13 coastal states in India. According to vulnerability status, the Government of India had included Kerala in the Phase II of the NCRMP. The four components of the project are (i) Early Warning Dissemination Systems [100% CSS], (ii) Cyclone Risk Mitigation Infrastructure [75% CSS], (iii) Technical Assistance for Multi Hazard Risk Management [100% CSS], (iv) Project Implementation Support [100% CSS]

Plan provision is provided to the second component (Cyclone Risk Mitigation Infrastructure) and the objective is to increase the preparedness and reduce the vulnerability of coastal communities through strategic infrastructure investments, i.e., improving their capacity/ access to emergency shelter, evacuation routes and protecting critical infrastructure against cyclones and hydro meteorological hazards to reduce potential damages and ensure continuation of services.

1. Multi Purpose Cyclone Shelters

The first Multi-Purpose Cyclone Shelter was inaugurated in June 2020 at Mararikulam, Alappuzha. Construction of Multipurpose Cyclone Shelters (MPCS) in 9 coastal Districts of Kerala. Out of 17 Shelters, 7 Shelters have been completed and inaugurated. The works of the remaining 10 shelters are in progress.

The MPCS are at the following locations:

Sl. No.	LSGI where MPCS is located	District	Adjoining Coastal LSGIs Served by the MPCS

1	Thiruvananthapuram Corporation (Muttathara)	Thiruvananthapuram	Kadinamkulam, Vilappil
2	Thazhava	Kollam	Alappad, Kulashekharapuram, Karuvatta, Karunagapally Municipality, Thodiyoor, Sooranad South, Sooranaadu North, Ochira, Klappana
3	Mararikulam North	Alappuzha	Cherthala South, Mararikulam South
4	Cheruthana	Alappuzha	Thrikunnappuzha, Karthikapally, Haripad, Veeyapuram
5	Kumarapuram	Alappuzha	Kumarapuram
6	Vadakekkara (Thuruthipuram)	Ernakulam	Pallippuram, Eriyad (Kozhikode), Chittattukara, Chendamangalam
7	Pallippuram	Erna kulam	Kuzhuppily, Eriyad, edavanakkade, Chittattukara, Ezhikara

8	Kadappuram	Thrissur	Chavakkad Municipality, Orumanayor, Engandiyur
9	Eriyad (Azhikode)	Thrissur	Edavilangu, Pallipuram, Kodungallur Municipality
10	Perumbadappu (Palappetty)	Malappuram	Veliyamcode, Punnayurkulam
11	Vettam (Paravanna)	Malappuram	Niramaruthur, Mangalam
12	Kozhikode Corporation (Kasaba)	Kozhikode	Elathur, Beypore
13	Kannur Corporation (Chalad)	Kannur	Muzhappilangad, Azhikode
14	Kathirur	Kannur	Thalassery Municipality
15	Kumbla	Kasaragod	Mangalpady, Mogral-Puthur
16	Madhur (Kudlu)	Kasaragod	Mogral -Puthur, Kasargod Municipality
17	Pullur Periya	Kasaragod	Pallikkare, Ajanoor

2. Early Warning Dissemination Systems

Early Warning Dissemination Systems (EWDS) is in the making. The contract has been awarded to M/S CMS Computers Pvt. Ltd. The equipment has been supplied. The salient components of the EWDS are:

Aggregation of all Alerts & Warnings: The main objective is to augment, empower and enable SEOC to aggregate all incoming, or commercially available alert inputs and convert them to open-standards-based data exchange formats like Common Alert Protocol (CAP), or XML/REST or SOAP services etc for automated data collation and swift processing.

Alert Processing: The alert status, resolution time, first responder activities etc shall be monitored on a Unified Operator Dashboard which comes with the project Command & Control (C&C) Platform. Using multiple software tools such as GIS, C&C Platform and Decision Support System (DSS), the SEOC will swiftly analyze and prioritise each of these inputs both manually and in auto.

Alert Dissemination over Multiple Platform: Based on the confidence level of DSS and Incident Commander approvals, the alert messages will be broadcasted, pan-state, over every available communication channel using their disparate protocols, after appending digital signature. The Alert Siren Hooters/Strobes at last-mile locations will be activated from any of the EOC, with due authorisation. Other communication platforms that will form part of the Alert Dissemination bus are as follows:

- Sirens, Loud Speakers, Coloured Strobe Lights, IP Video Cameras
- Public Digital Signage integration with Smart Cities
- Auto status updates on Websites & Social Media forums
- Digitally signed emails to subscribers registered on the Government portal V. Override for Radio and TV with CAP messages. (On clearance from TRAI) VI. Cell phones (push notification) – (*On the integration of LBAS)
- Both SMS & Cell Broadcast (CB), (*On the integration of LBAS)
- Voice message on Residential telephones, (*On the integration of LBAS)

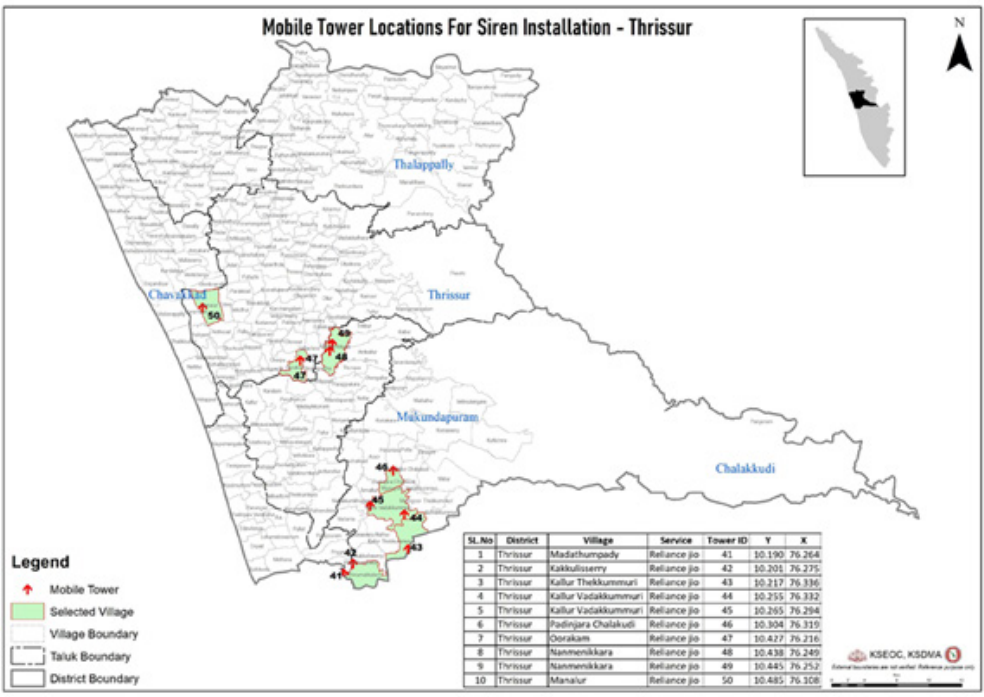
***Location-Based Alert System (LBAS):** LBAS is a major sub-system and one of the last-mile of any EWDS. NDMA has authorised the Dept of Telecommunication to process the procurement and supply of LBAS centrally for all states. Hence, the LBAS component was delinked from the state EWDS project. (LBAS enables the EWDS to have the capability to send both Cell Broadcast (CB) and SMS alerts to mobile users within the demarcated disaster area(s) directly from the Telecom Operator/s subscriber database.)

Enabling of EOCs: The processed SEOC data with the C&C platform will be extended to all District and Taluk EOCs, and even with the First Responders – on a required basis. Apart from the much-required intercom, a video surveillance camera, GPS clocks, WiFi points etc will be installed at each of these distant locations to remotely monitor, coordinate and administer the activities centrally from SEOC.

Secure Connectivity between Stakeholders: Encrypted Virtual Private Network (VPN) tunnels will be established between all EOCs and other Project End Points, to secure the EOC communications, as part of the EWDS project. Irrespective of geographical separation, this VPN connectivity offers a working atmosphere akin to a virtual office – befitting the primary aims of EWDS. On availability of such arrangement, the entire network system will function, as if on a Local Area Network (LAN), and hence can, not only share their resources and data securely, but also in its centralized management, utilization monitoring, security, and even its operational status or availability.

Citizen Helpdesk: The EWDS project also has a Contact Centre module that can integrate and supplement the efforts of the state 112. Known as Citizen Helpdesk, this Public Safety Answering Point (PSAP), is equipped to receive video, text and crowd-source data from various social forums, apart from the traditional callers. This project module is also enabled with voice biometrics, analytic tools, Computer-Aided Dispatch (CAD) and Automatic Vehicle Location (AVL) technologies not only to swiftly guide dispatchers to the incident spot but also for periodic interaction between the first-responders and EOCs.

Figure 4: Example of site suitability for sire installation



Sl. No	District	Village	Service	Tower ID	Y	X
1	Thrissur	Madathumpady	Reliance jio	41	10.190	76.264
2	Thrissur	Kakkulisserry	Reliance jio	42	10.201	76.275
3	Thrissur	Kallur Thekkummuri	Reliance jio	43	10.217	76.336
4	Thrissur	Kallur Vadakkummuri	Reliance jio	44	10.255	76.332
5	Thrissur	Kallur Vadakkummuri	Reliance jio	45	10.265	76.294
6	Thrissur	Padinjara Chalakudi	Reliance jio	46	10.304	76.319
7	Thrissur	Oorakam	Reliance jio	47	10.427	76.216
8	Thrissur	Nanmenikkara	Reliance jio	48	10.438	76.249
9	Thrissur	Nanmenikkara	Reliance jio	49	10.445	76.252
10	Thrissur	Manalur	Reliance jio	50	10.485	76.308

3. Technical Assistance for Multi Hazard Risk Assessment

Under this scheme an MoU has been signed with Kerala Institute for Local Administration (KILA) for training and capacity building of citizens and institutional stakeholders in coastal villages for focused response to disasters.

4. Summary

In short, KSDMA was able to achieve significant progress in multiple sectors related to Disaster Risk Management. Starting from Community Participation to Technological Advancements; numerous legal interventions and policy changes could be brought about by KSDMA in the 13th plan period. However, challenges still remain to achieve a resilient society.

However, it may be noted that KSDMA achieved these with very limited staff till 2017 (7 technical staff) and subsequently with additional technical staff. Despite such significant progress made and repeated recommendations by the Subject Committees of Legislative Assembly, the KSDMA is yet to get any non-plan allocation for its functioning. This significantly burdens the plan funds as SDMA's administrative expenses are also covered from the plan allocation.

Another significant issue that KSDMA faces is the lack of permanent staff. While highly

qualified subject experts work with KSDMA and that they are provided specialised training to focus in DRR, many highly qualified and trained staff left KSDMA due to lack of permanency or long term contracts. Talent and quality cannot be attracted and maintained with short term (1 year) contracts and if talent and quality staff are not maintained, institutional continuity to projects with medium to long term aims cannot be achieved in fullest.

It is noted that professionals and technical officers of disaster management are utilised for non-professional and non-technical tasks and adhoc course changes in targets are also being assigned. Further, it is noted that several contract positions approved by the Government in KSDMA are vacant which is affecting the technical functioning of KSDMA. It may be noted that the focus of KSDMA, DDMA and 13th Working Groups in Local Governments are for building disaster resilience and not primarily for disaster response.

The guiding document for assessment of an event and its severity as a Disaster, or not, in the country, is the recommendation of the 15th Finance Commission (FFC). The Statement of Hon'ble Union Minister for Home Affairs, Government of India in the Parliament in Hindi on 22-12-2017 is clear about this.

Vide GOI Office Memorandum No. 33-5/2021-NDM-I dated 12-01-2022, Section 8 of Guidelines on Constitution of the State Disaster Response Fund (SDRF), recommended by the 15th Finance Commission (FFC), only the undermentioned Disasters can be nationally recognised as Disasters:

A. Drought,
B. Floods,
C. Cyclones,
D. Earthquakes,
E. Hailstorms,
F. Landslides,
G. Cloud-Bursts,
H. Natural Fires,
I. Tsunamis,
J. Avalanches,
K. Pest Attacks and ,
L. Severe Cold/Frost
M. Covid19

In addition, as approved by the 14th Finance Commission, the State Government has declared State Specific Disasters, as below.

N. Coastal Erosion – State Specific
O. Wind Damages – State Specific
P. Lightning – State Specific
Q. Soil Piping – State Specific
R. Heat Wave/Sun stroke/Sun burn - State Specific

The Kerala State Disaster Management Authority (KSDMA) and the District Disaster Management Authorities (DDMA), in their Disaster Management Plans, have also listed the undermentioned types of events that have the potential to cause Disasters:

1. Heavy Rains,
2. Human induced fires
3. Firecracker Explosions,
4. Petrol Chemical Transportation Accidents,
5. Hooch Tragedies,
6. Ethanol/Methanol Transportation Accidents,
7. Major Road Accidents involving Civilian Transport Vehicles,
8. Major Rail Accidents,
9. Fire Accidents in Buildings and Market places,
10. Air Accidents,
11. Boat Capsizing,
12. Biological Accidents,
13. Building Collapse,
14. Oil Spills,
15. Industrial Accidents,
16. Accidental Drowning,
17. Human Epidemics,
18. Heat Wave,
19. Plant and Pest Epidemics,
20. Animal Epidemics,
21. Avian Epidemics,
22. Stampedes,
23. Pest Attack on Human habitations,
24. Meteorite Impacts,
25. Terrorism/Riots/Naxalite Attacks,
26. Accidents involving Armed Forces premises and Assets,
27. Occupational Hazards and Recreational Area related Hazards
28. Climate change vulnerability
29. Space Debris impact,
30. Human-Animal conflicts,
31. Nuclear and Radiological Accidents, and
32. Dam Break/Dam Spillway related Floods and Accidents

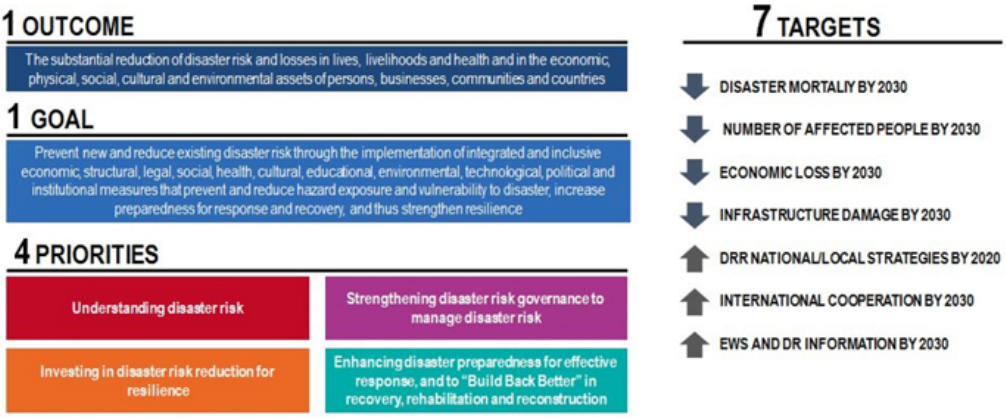
The high level committee constituted vide GO (Rt) No. 86/2017/DMD dated 12-12-2017 vide that 'technically speaking, the above 32 types of Disasters cannot be treated as nationally recognised Disasters. They are more in the nature of unfortunate Manmade/Natural/ Accidental localised events leading to loss of life/property/severe damage. Of course, all of them require immediate response, damage control and mitigation measures by the concerned departments, but they are more related to issues of Public Safety than Disaster Management. The KSDMA and DDMAs must focus only on Preparedness, Response, Rehabilitation and Mitigation of recognised Disasters as listed at (A) to (R) above. Forcing or imposing Individual or Public Safety issues like those at (1) to (32) above, upon the functions of KSDMA and DDMAs would lead to diluting its focus and thereby losing its edge for being prepared to face major calamities.

ANNEXURE III

Future perspectives

The 14th plan shall focus on achieving the 7 targets of SENDAI framework in light of the AR6 report.

SENDAI FRAMEWORK



AR6 Report and what is in it for Kerala as a perspective for future

AR6 Pointer	Take for Kerala
• A.3. Global mean sea level (GMSL) is rising... • A.9. Coastal communities are exposed to multiple climate-related hazards...	• This implies that Kerala's lowlands and coastal area has to be more concerned of coastal and riverine flooding impacts. Increased wave action may lead to more coastal erosion. • More room for River and More Room for Ocean • Invest on preserving the presently 'stable' coasts as against investing in protecting the already eroding coast • Conscious landuse change needs to be brought in • Promote Clustered living – vulnerability linked relocation plan has to be mainstreamed
• A.8. Changes in the ocean have impacted marine ecosystems... • B.5. A decrease in global biomass of marine animal communities, their production, and fisheries catch potential, and a shift in species composition...	• Coastal livelihood patterns to drastically change & this needs to be promoted in a faster pace unlike as in the past and may have to be a time bound action. • Resilience of fishermen community – better fishing gear and efficient boats

• C.1. Impacts of climate-related changes…increasingly challenge current governance efforts… • C.1.4 Financial, technological, institutional and other barriers exist for implementing responses to current and projected negative impacts… • C.3. Coastal communities face challenging choices in crafting context-specific and integrated responses…All types of options, including protection, accommodation, ecosystem-based adaptation, coastal advance and retreat…	• Rolling plan vs rigid plan • One solution and one time solution may not last • Protection vs retreat needs to be considered at a faster pace • Adaptive and evolving administrative and financial mechanisms for targeted risk reduction • Static rate contracts and expenditure based allocation patterns to risk linked allocation
• C.4. Emissions reductions coupled with coordinated sustained and increasingly ambitious adaptation actions…	• In light of the IPCC report and the special reports, the State may have to expedite its effort for evolving methods for risk informed spatial planning • Resilience building shall be a mainstream developmental prerequisite for any and all projects. Key Performance Indicators for Resilience needs to be evolved for local self governments based on terrain and ecological mapping units like Agro-Climatic Zones. • In general, Kerala addressed some of the key areas in the IPCC Report in the Rebuild Kerala Development Plan. While the plan is in place, Kerala needs to introspect whether resilience and climate change adaptation were considered while implementing infrastructural developments and implementing projects

Prime Minister's 10 point Agenda for Disaster Risk Reduction is a pragmatic perspective towards achieving the above. The 10 point agenda are:

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

Disaster Management institutional mechanisms have to be therefore responsive to emerging crises to reduce catastrophic impacts, but focus must be in making the society resilient through medium and long term interventions. Thus, a science and society based approach capitalising on the three strong pillars of Kerala's society, they being local administration, education and health care, is the way forward. Climate change is increasing the negative impacts in Kerala as evident from the flood hazard assessment jointly conducted by KSDMA and UNEP. Adaptation to climate change should be citizen centric and technologically advanced that captures the transitions in landuse and demographic patterns.

Disaster risks are exacerbated by a crucial factor that has been silently rising in the state, which is the land use pattern and practises. Multiple, incongruent Acts, orders and rules on land use do not allow the development of a single land management policy/regulation which official agencies can enforce. Due to this reason, business and habitation zones have overlapped over the years. This is further compounded by the State's high density of population of 860 people per sq km (2011 Census), narrow roads, dense and intrinsic road network, high density of coastal population and the general higher standard of living of the public.

The widespread flooding in urban and semi-urban areas of Kerala is primarily owing to the lack of risk-informed urban planning, non-compliance to design standards, and non-incorporation of resilient features in urban infrastructure. Uncontrolled expansion of habitations on the banks of the rivers/water bodies, encroaching into water channels/bodies and constricting the floodplains, inadequate storm water drainage and silting of minor storage ponds and flood plains in urban and urban sprawl areas have only added to flood risks.

The impacts of climate change are largely present through increases in the intensity and frequency of extreme weather events, unpredictability of precipitation, and changes to water regimes and peak seasonal runoff, caused in part by erratic precipitation, and rising temperatures. The state has had to face serious droughts in 2013 and 2017.

Another impact being witnessed is progressive coastal erosion affecting nearly 63 per cent of the state's 580 kms coastline. While the Local Government Department has taken legislative steps to mainstream risk informed spatial planning starting with the lessons learned from the local government disaster management plans prepared in 2019-20, other Government departments are yet to follow suit and accept the prominent role of local governments in disaster resilience building of the society and incorporate risk information in planning. Heat impacts, lightning impacts and wind impacts are becoming more and more evident.

During the 12th and 13th FY Plan periods emphasis was on institution building from State to Local Government level. Disaster events have short and long term impact on the quality of life of individuals and families and for those who experienced severe losses their vision

of hope and happiness are often shaken. Rural communities confronted with the vagaries of climate change, will need to become more resilient if they are to survive and thrive. Household level Resilience is the capacity of a social-ecological system to cope with shocks of disasters without changing its fundamental identity which are measurable through livelihood diversity, wealth, and a comprehensive resilience index based on a combination of human, financial, physical, social, and natural capital. Households with greater social connectivity have greater resilience. Households that are more socially networked have a wider range of livelihood strategies and greater overall capital and therefore, they are more resilient.

ANNEXURE IV

A review of Technological Considerations for DRR under Sendai Frame

1. Various phases of Disaster Management (DM) are Prevention, Mitigation, Preparedness, Response and Recovery. Each of the activities that dictate the effectiveness of every DM phase can be further categorised as:-

a) Human (Qualitatively trained, adequate number of personnel)
b) Technology (The modern-day Information and Communication Technologies (ICTs), that support the DM operations)
c) Process (The Standard Operating Procedures (SOP), policies, practices and guidelines etc). The link between the above two.

2. This section primarily focuses on the Technology component. Effective Disaster Management is dependent on the timely delivery of information to those who need it. Types of information and technologies needed to support a disaster management operation must essentially cover areas from disaster sensing, early warning, search and rescue, damage assessments, supply chain coordination, medical support, disbursement of reliefs, to even the welfare of family and friends. Accordingly, the associated communication channels or stakeholders involve government authorities, first-responders, relief workers, volunteer force, private sector organizations, and more. The use of modern tools with skillsets in DM has therefore gained impetus from the unprecedented development in Information and Communication Technologies (ICT), which have wide-ranging applications not only in disaster preparedness, reduction, mitigation, and management, but also to support the dissimilar communication requirements between these diverse stakeholders.

3. Role of Technology. Advanced technologies have the potential to transform disaster management, and its response, especially if we successfully integrate the emerging technologies with our existing infrastructure. Technologies such as Artificial Intelligence, Internet of Things (IoT), Big Data, Block chain, etc, can help drastically change the State disaster response and relief capabilities. Further other new-gen technologies such as social media, smartphone apps, robotics, drone technologies, cloud computing etc have the capabilities to transform various disaster resilience challenges of the SDMA, specially in multi-hazard disaster scenarios. Although property damages cannot be avoided, using these modern technologies, we can considerably reduce the loss of life and minimise the inherent system delays. However, while implementation these state-of-art technologies parallelly,

we also have to review and revise the coupled disaster warning arrangements, respond and rescue procedures.

4. Characteristics of DM Technologies. Effective and early solutions to rebound easily from disasters using emerging technologies share several common characteristics in that they are:-

a) **Multipurpose:** solutions are relevant and useful before, during and after emergencies, as well as in daily life. Examples include handheld phones, which are employed in a range of solutions, from disaster risk assessment and monitoring to emergency response and early warning systems;
b) **Easy to learn and adapt:** for example, there is no need for formal training in the use of social media or mobile apps, making them useful and widely acceptable for emergency response. Similarly, the use of drones used for remote sensing and photography can be modified to conduct aerial surveys;
c) **Scalable:** they should grow to accommodate demand. Social media for emergency response provide scale and enable anyone to reach a large audience;
d) **Accessible and affordable:** The cost of 5G enabled mobile phones have crashed below 5K. Similarly, the drones have low operation costs, allow frequent missions, offer increased spatial coverage, do not require any typical installation routines and can be deployed rapidly.

5. As seen above, most of these characteristics arise from ICT and are bringing increased possibilities of digitalization, reach and connectivity. Further, reductions in the cost of such technologies, have democratised access thereto, allowing swift inroads to new solutions and catalysts for several innovations to emerge. This opportunity is opening several technology areas, that appear to have significant potential to support DM operations and disaster resilience through innovation.

6. Role of Information Communication Technology (ICT). The term ICT, broadly encompasses all backend and frontend systems, information technology user-end hardware, networking devices, storage and processing systems, communication equipment and applications, allied security equipment etc. Together, they play a significant role in highlighting risk areas, vulnerabilities and potentially affected populations by producing geographically referenced analysis through, for example, a Geographic Information System (GIS). Every alert received has to be corroborated, analysed and the processed EOC data and information should be reliably and securely communicated to the end-user or field responders at the fastest available means. The role of ICT is therefore to keep the flow of real-time data and information, at all stages of disaster management. Some of the ICT technology advancements proposed for inclusion in the proceedings of the 14th Five Year DM Plan are enumerated in the succeeding paragraphs.

Common Alerting Protocol (CAP)

7. The CAP is an open, XML (open standard) based data interchange format that can be used to collect all types of hazard warnings and reports locally, regionally and nationally, for input into a wide range of information management and warning dissemination systems.

CAP standardizes the content of alerts and notifications across all hazards, including law enforcement and public safety, as well as natural hazards such as accidents, forest fires, severe weather, tsunamis, etc. Systems using CAP can quickly and simultaneously launch Internet messages, news feeds, television text captions, highway or smart-city digital signboard messages, and synthesized voiceover automated telephone calls or public announcements with a single authoritative and secure alerting from EOC. It is understood that CAP implementation is centrally being steered by NDMA, and Kerala DM is presently ready for its implementation and roll-out. Following are some of the key benefits of CAP over traditional individual systems:-

a) Automatic multi-channel, simultaneous dissemination of warnings ensure extended reach with enhanced effectiveness of alerting.
b) A simplified and swift method of alerting over multiple dissemination channels without duplication of effort.
c) Enhanced situational awareness at all levels, local, state, regional and national, by pviding a continual real-time database of all warnings, by detecting patterns in local responses.
d) Special alerting needs for the differently-abled (like deaf and hearing-impaired, the blind, visually-impaired), and the multi-lingual populace will be better served through their customised communication channels.
e) The CAP will allow smooth technology refresh and up-gradation of infrastructure or its complete replacement without disrupting entire systems.
g) CAP can also ensure interoperability between systems and improve their services without facing barriers due to technological 'legacies'.
h) Flood and cyclone forecasting rely on computer simulations, machine learning can help predict the location and severity of floods, with the CAP interface. Big Data

8. Among developed nations, Big data is an indispensable modern-day tool for the damage analysis and economic impact estimation of those affected, in a pre and post-disaster scenario. Apart from the estimations of the economic impact, Big data can bring out simulations or data, on how long it took to return to normal, or where to target the post-disaster assistance, etc. Monitoring data such as social media communications, financial transactions, and mobile phone activity during and after a disaster can not only monitor people movements to deliver help effectively but also can reveal the true outcome of the response, public reactions etc. Another potential use of Big data is monitoring and accounting of financial transactions, alongwith the supply-chain management during and after any disaster event. For better or worse, each disaster generates an enormous amount of data. By mining information from previous disasters, we can collect valuable insights and precious lessons that help forecast future incidents. Combined with sensor data, field info, and GIS tools, Big data analytics allows DM to be better armed to deal with the challenges posed by future disaster events.

9. Big Data & DM. Growing digitalization and increasing investments in IoT is creating an avalanche of data generated by sensors, CCTV cameras, mobile phones, financial transactions, office automation and other Internet activities, to name a few. While the huge

amount of data being generated is being mined for routine office purposes, Big data, as a crisis analysis tool, hold enormous potential for disaster management. The use of traditional relational databases to handle future challenges could become yet another disaster by itself since they are inefficient and insufficient to manage large voluminous data generated at the envisaged volumes and speed. Further, data analytics would become the topping tool for Big data to tackle the resulting needs of data optimisation and customisation. A Big data-driven network for Kerala DM is strongly suggested as it can help mitigate disaster in the following ways:-

a) **Management of Infrastructure.** Knowing where and how resources are located or being allocated is one of the most important aspects of DM. With advancements in Big data technology, officials can easily track each of the available resources and they can forecast the upcoming needs well in advance.

b) **Population Tracking.** Big Data helps the response agencies by identifying and tracking populations such as elder groups of people, regions where there is a large concentration of children and infants etc.

c) **Logistics Planning.** Big Data systems can help in coordinating various activities with the rescue workers and first responders to identify the local resources in support of their logistic planning. The availability of real-time communication is also an added advantage to obtain public reactions and feedback from those who are affected.

d) **Eliminating Duplicates.** Can securely link with other data systems like Aadhaar based digital ID system, Ration card records, Insurance database etc to deliver targeted benefits to those affected without duplication.

e **Weather Forecasting.** Big data analysis techniques can be applied to improve weather forecasting, (like temperature extremes, precipitation etc) by identifying patterns of atmospheric circulation present before past heat waves and cold or rain spells to create a model that can accurately forecast such climate extremes several hours in advance.

10. Big data analytics is a process of examining large, multiple and varied data sets to uncover information such as hidden patterns, unknown correlations, trends, associations and behavioural patterns, from multiple data formats. With the increasing computerisation of files and records among various state government departments, coupled with the growing proliferation of smartphones and social media activities across various demographics, the amount of digital data generated has risen at a meteoric pace. Since no standard or data format or framework has been maintained at the outset, it may appear to be a difficult job. However, with the emergence of Big data together with analytics technology, this work has become considerably simple and its outcome not only offers the potential to provide powerful insights and can revolutionize interdepartmental working, office efficiency, file security, office collaboration and overall accounting etc, but also allows the prediction of disasters, optimize its preparations, mapping evacuation routes, pinpointing flooded areas and formulating rescue strategies. By embracing analytics with Big data, DM agencies will be able to respond more quickly and effectively to the inevitable.

11. Bigdata Applications. A variety of big data tools are available today for the analysis of both structured and (increasingly) unstructured data (such as sensor data, images, e-mails,

and social network data) to identify patterns, trends, and correlations. Big data analysis also aids the allocation of funds in the post-disaster phase for rescue and rebuilding operations, in traffic accidents, outbreaks of mass epidemics, floods, big data analysis help rescue route design, staff arrangement, and material disposition through disaster management platform. Other applications include some or all of the following:

a) Natural language processing techniques can be applied to the analysis of large volumes of text-based data, such as e-mails, documents, and social media posts;
b) Pattern recognition techniques can be applied to the analysis of images to identify objects (or changes) in catalogues of digital images;
c) Change detection algorithms can be applied to earth observation imagery to quickly identify impacted geographic regions and damage to individual buildings and infrastructure.
d) Speech-to-text conversion techniques can be applied to transform audio into searchable text.

12. In short, Big data analytics offers a new era of value-added tools for disaster management and its responses. The data created during each disaster are so humongous, where its manual processing presents huge challenges. When Big data analytics is effectively applied to the records such as personal details, medical records, the geo location of infrastructure, the tracking of survivors etc, it reveals crucial, prioritised information to DM, with the least human intervention and time.

Block chain

13. Block chain by itself is known as the most disaster-resilient, secure technology and hence is the backbone for all digital currencies like Bitcoin. Block chain is a distributed and immutable ledger technology that can increase transparency in disaster response and support its resilience by bolstering analysis and accountability within supply chains while ensuring strict compliance to SOPs and other regulatory systems. Common handling errors in accountability, storage and bookkeeping often breed mistrust during high pressure working. In such instances, misinformation can often derail efforts and cause danger. Block chain-encoded data can automate routine decision-making in high-pressure disaster environments and can help mitigate confusion and inefficiencies that plague so many disaster-response efforts. This can also accelerate decisions and relieve pressure on strained field personnel, social workers and DM managers. Block chain can therefore provide the much-required coherence and consistency to each transaction that comprises delicately interwoven systems for resilience, helping them to be flexible during disruption.

14. Applications of Block chain in DM. With the complex nature of disaster management, utilizing new technologies to improve response logistics, fund management and an overall reduction in costs is crucial. Block chain would significantly reduce the overheads of claims and would make the process easier, and victims would receive benefits expeditiously. Further, implementing Block chain in DM, could greatly reduce costs, unify efforts, converge services and speed response efforts. The use of Block chain technologies in DM can also ensure increased interoperability, transparency and coordination between all stakeholders

associated with DM operations. Block chain, although complex to understand, can easily integrate our complicated land-revenue records. Below are some of the possible Block chain use-cases in DM:-

a) Common Platform. Blockchain brings collaboration and coordination among all stakeholders involved in the relief operations by having a single, trusted data ledger.
b) Immutable Data. Once data is recorded, it cannot be easily changed, creating an audit trail and trusted system for the collection and distribution of goods and services.
c) Secure Sharing & Accounting. Documents and personally identifiable information can be securely managed and shared with need-to-know parties. This enables compliance with all security and privacy regulations and concerns.
d) Records & Reporting. Demands and service requests from multiple corners and different operating areas can be recorded on a single network platform by trusted participants and different agencies. This can prevent duplication of records, wastage of time and effort.
e) Tracking & Visibility. Movement of inventory and supplies can be tracked from receipt point to the warehouses, until delivery to the end-user. This improves transparency and facilitates increased supply-chain management, leading to smooth accounting and avoidance of duplication of efforts among multiple agencies.
f) Honouring Efforts. Every individual effort can be captured, tracked, accounted and rewarded or audited. Volunteer efforts can also be easily incentivized and even if just recognition can lead to more public participation and community engagement.
g) Transparent Audit. Each transaction need can be verified and cleared by 3rd parties to increase trust.
h) Fundraising. Another way block chain technology is for fundraising activities that accept crypto currencies. Several western organizations, including Direct Relief, Humanity Road, Save the Children and many others accept crypto currencies such as Bitcoin as part of their fundraising activities.

Battling Disasters – "Artificial Intelligence (AI)" our Best Bet?

15. AI in Disaster Management. The exponential growth of telecom connectivity, together with the emergence of ubiquitous mobile communication technologies gave us enough ammunition to fight the Covid pandemic, in ways we never thought possible. Building further on this experience and data, multiple stakeholders like government, private and even with open media and research entities can further consolidate these datasets using the modern technology tools available in the industry, can reap immense benefits, in an amazingly responsive way. Moreover, it can also provide a platform to DM authorities and researchers not only in predicting and tracking the disasters more quickly, but also deal with them more effectively in their early mitigation and response.

16. It is often said, that AI usually beats natural stupidities and human errors. Algorithms that adapt and improve themselves based on the data input can help spot emerging patterns, problems and opportunities that more conventional means may miss. From early warning systems for disasters; to change detection before and after an event, planning for rescue

efforts, coordinating response, the myriad applications of AI and Machine Learning (ML) can augment almost any DM and disaster resilience effort.

17. Forecasting Outbreaks. The early we detect and track the virus, the better we can fight it. A Canadian start-up BlueDot using a Machine Learning algorithm, predicted the Wuhan virus outbreak by monitoring and analysing the data from openly available media reports, social media bursts and alerted its clients, including governments, hospitals, and businesses, on the unusual bump in pneumonia cases in Wuhan, China. In fact, BlueDot wasn't alone. An automated service called "HealthMap" at Boston Children's Hospital also caught those early vital signs, by using an AI model supplied by Metabiota, based in San Francisco. That both AIs' could spot an outbreak on the other side of the world is pretty amazing, and such early warnings save lives.

18. Potential Use-cases of AI in DM. Examples of AI are already operational, such as voice and facial recognition, and commercialized by-products such as the IBM Watson computer system, which integrates AI into the analysis of Big Data. Watson has been applied to disaster scenarios by having it analyse weather and census data to help DM organizations prepare for a crisis and optimally allocate resources. Some of the other functional scenarios where AI can aid DM operations are:-

a) Decision-making in a multi-hazard situation, involving multiple actors is a significantly complex task. Improvements in Big data and data optimization using AI tools have greatly improved the capacity and capabilities of Decision Support Systems (DSS) while the availability of open-source software has increased access to these tools.
b) AI-powered image recognition and change detection technologies can quickly identify damaged infrastructure like buildings and roads, flooding, etc, and loose soil or landslides.
c) The use of AI-based algorithms and predictive analytics within EOC can help to forecast disasters and hasten recovery and response times. Most of the AI tools can also generate heat maps over GIS by integrating different streams of data.
4. d) With the integration of weather data, population settlements (from land-revenue records), AI can dynamically map and predict, potential areas of wildfire risk, its possible spread etc over a GIS map.
e) Similarly, AI-based chatbots or voice response systems can reduce the workload of Helpdesk agents significantly, while dealing with high call volumes during emergencies to deliver more effective outcomes.
f) AI can be used to analyse and validate data obtained from social media. Predictive analysis can process multiple data streams and eliminate unreliable data to extract more accurate responses.
g) Innovations in camera technology, time-stamping, image and video analytics, made it possible to measure full interior dimensions remotely, damage assessments and for making cost estimations, during the verification of insurance claims, with greater speed and accuracy.
h) AI tools are available to process various Twitter feeds and the large number of tweets

generated during a crisis, using machine learning techniques.

i) Predictive Analytics. AI can be used to analyse past data to predict what would happen in the event of a particular disaster. The data can be integrated with online dashboards so that emergency personnel can respond in real-time.

j) Open Tools for Change Detection. AI tools can be effectively put in use for image recognition of satellite photos to identify damaged buildings, flooding, impassable roads, etc. For example, DigitalGlobe provides open-source software for disaster response that learns how to recognize damaged buildings from satellite photos. Following the Nepal earthquakes in 2015, relief groups used pre-and-post disaster imagery and utilized crowdsourced data analysis and machine learning to identify priority locations, where damage is severe or that have not yet been accessed and assessed by the SAR teams.

Internet of Things (IoT)

19. The advent of sensor technologies, cloud computing, robust wireless technologies with internet integration and data analysis has enabled the emergence of a sophisticated, real-time system and valuable tool for DM known as the Internet of Things (IoT). Disaster Management is an ideal use case for IoT applications since field sensors can send real-time indicators for several potentially dangerous situations, well in advance before they go out of control. Therefore, IoT offers an opportunity to handle disaster situations more proactively than we handle major emergencies today.

20. The use of sensors for monitoring the conditions that could trigger disasters is not new. Almost all modern data communication networks can support data collection and processing from a widely distributed array of sensors and devices. This can support more accurate weather modelling with alerts and warnings, which can, in turn, improvise DM strategies and operations more proactively. Some of the proactive scenarios where IoT can be deployed are:-

a) Forward deployment of solar-powered IoT-based systems can help detect potentially dangerous situations such as forest fire by measuring carbon dioxide levels, moistur and temperature.

b) Ultrasound based flood sensors are being deployed mostly as standalone systems to monitor rising river levels and to detect flooding. However, their integration with network backhaul and EOCs can further enhance their potential multifold.

c) Ground-based vibration sensors can detect earth movements that might signal earthquakes or landslides.

d) When in need, any handphone can act as an IoT device. In the event of an unfolding emergency, using its GPS location, the responders or the EOCs can determine exactly where a caller is located. The GIS tools can aid the EOCs to guide the first-responders, if the location of the caller is accessible by car, foot, boat or helicopter, and enable them to plan the best way to carry out their rescue. With the same navigation apps on phones or more advanced mapping technologies, the responders can be further informed on the depth of the surrounding waters, because to the blind eye, it would have been impossible to know where the street lay beneath the flooding.

e) Similarly, responders can better handle emergencies through the data generated from wearables and personal technology. The information transferred from mobile phone apps, smartwatches or connected medical devices can be analyzed to help prioritize response and rescues. Such wearable technologies can identify callers and make decisions, when every second counts, about the urgency of each case based on relevant data, such as age and illnesses. In an era of IoT and wearable devices, what matters is not only the quantity of data collected but also how these data are managed and analyzed. Technology and big data analytics aided by artificial intelligence are transforming IoT based disaster relief efforts by enhancing prediction and preparation abilities, and by accelerating response time and enhancing responders' ability to operate efficiently even when resources are scarce.

f) More recently, IoT was employed to ensure the transportation of temperature-sensitivecovid vaccines, and supply chain management of critical medicines.

21. Proactive vs Reactive IoT Working. The use of solar ensures that the forward-deployed sensors will continue to function even during electrical outages. Similarly, by integrating these IoT sensors with low-power wireless technologies like LoRaWAN or 3G/LTE/5G cellular networks, and then to a controller program can activate any alert systems like a siren, making the whole system real-time and proactive. Alternately, allowing the sensors to transmit data directly to the EOCs, will ensure the activation of the early warning systems after the due process of monitoring and executive decision-making. Further, the IoT data can also be uploaded and stored in the cloud for others to access, or to share timely and regular information with the public, on their mobile platforms. With addons like data analytics, the software can send customised messages to the public and DM authorities, as and when the risk thresholds are reached. Such an arrangement can be made scalable, by adding more sensors and monitoring points.

Mobile Technologies takes Centre Stage

22. As mobile phones have evolved in functionality, their impact on disaster preparedness and relief has grown. From voice calls to text messages, and now location-based services, cameras and Internet access, mobile phones have a diverse set of features, that can be leveraged by the public and disaster community, in times of crisis. The spread of mobile phones today makes them the most powerful, popular and universal communication device. Accordingly, the potential mobile use cases can range from raising public awareness and reaching the vulnerable population about disaster risks and preparedness or dissemination of early warnings of impending danger to developing location-specific parameters, in implementing awareness and preparedness programs. Some of the lesser-known examples of mobile usage in DM are:-

a) Real-time mapping of the vulnerable population within an area.
b) Status of the nearby shelter together with its balance capacity.
c) Broadcast mass-message to the affected community, about their escape route with map, ETA of assistance, etc.
d) Ask the community to post their welfare and urgent needs on the DM website or social media.

e) Spread awareness on Do's and Don'ts and issue updated guidance and weather reports etc.

Drones & Robots – Flying Samurai?

23. Technology can go where people cannot and where rescue efforts put the lives of responders at risk. Drones and Robots aren't just toys for children anymore, but with the innovations in computing technology, they have proved their support to various DM operations by complementing responders or delivering supplies or acting as early warning disseminators often in challenging terrain and life-threatening operational environments. In recent times, DM organisations have requested support from private agencies and hobbyists dealing with these advanced gadgets, to fast track state disaster relief efforts. Offering high-resolution outputs, they can be used with available GIS imagery tools, for a superior, real-time spatial analysis, as is often the case after cyclones. Advancements in drone technology also unlock new possibilities in the field of disaster relief such as disaster assessment, logistical support and transportation of emergency medical supplies to isolated communities. For instance, drones and robots have been used to locate survivors and transmit information to first-responder teams. Many states are already employing these devices to drop humanitarian aid, medical kits and for making Public Announcements (PA). Being autonomous, they can access hard-to-reach areas and perform data-gathering tasks that are otherwise unsafe or impossible for humans - without endangering rescuers' lives.

24. Drones as Digital Responders. Aerial robotics, including Unmanned Aerial Vehicles (UAVs), aka drones, has shown tremendous potential, even during pre-disaster preparedness. Using these technology gadgets, organizations can map terrain more effectively, assess changes in real-time, increase situational awareness through high-resolution mapping and deliver items faster, cheaper and more efficiently. Lower in cost, lighter in weight and quieter than helicopters or planes, with pre-programmed routes that enable them to fly in life-threatening conditions, these "digital responders" provide access to otherwise unreachable areas. In addition, infrared cameras and advanced listening systems enable UAVs to uncover survivors from rubble or among flames and live-stream night footage, increasing the success of critical rescue efforts. Given below are some of the examples of how both drone and robotic technologies can impact disaster operations and support their response:-

a) Drone technologies can offer aerial support for mapping, damage assessment, and search & rescue operations, among others. Further, drones can augment satellite remote sensing data to provide quick assessments of damage and people affected so that disaster response can be prioritized.
b) Drones flying with Cell on Wheels (CoW), popularly known as flying Cows are one of the latest development.
c) Robotic technologies are the ideal tool to locate dangerous leaks in chemical or radioactive pipes or industries.
d) Drones fitted with a PA system can be used as an early alert disseminator.
e) Apart from locating missing persons, drones can be deployed to remotely manage wildfire data for firefighters.

f) Drones offer an ideal solution for rapid and granular evaluation of the situation, particularly when access to the affected area is restricted due to disaster damages.

g) Drone imagery can identify which houses are unsafe and guide the affected to the nearest rescue shelters. With the help of analytics and survey tools, an estimation can be made to determine in advance, how much food would be needed for those at the shelters.

h) Through dedicated social media or over a cloud-based mapping platform, the volunteers and hobbyists can upload their personal drone and phone imageries with geotag information. These images could further be placed on a GIS map as an overlay to extract a better appreciation of the evolving situation, with fresh insights. Incidentally, this procedure also offers the fastest method of mapping the damaged areas.

Age of Social Media

25. It is human nature to share information of common interest. Mobile solutions, social media and digital communities together provide a new, cheap and yet popular way for their users to communicate. Technology proliferation and awareness on social communications have evolved together to change the way, people perceive and respond to disaster information and how we communicate during disasters. As disasters unfold, citizens increasingly turn to social media to seek and share information. Various agencies use social media to involve community members as first-line informants and responders. This approach creates shared awareness further leads to faster, more efficient responses which ultimately supports beneficiaries and commits citizens to increase resilience to disasters and crises. DM authorities and governmental organizations can monitor social media for situational awareness, including patterns of serious needs, available resources and deployed responses.

26. Given the reach of social media, when a disaster occurs, people check social media platforms such as Twitter and Facebook to explore and share disaster-related local information. Monitoring and analysing these open communications can help DM organisations not only to first learn about the evolving event but also to understand the extent and the seriousness of damage it would cause, where and whether to evacuate and what kind of support victims might need etc. While social media make it possible to share information more rapidly, widely, and easily than ever before, their technological characteristics could benefit DM only if we share reliable and most updated information. In addition to being a communication utility, social media offers several value-added opportunities to educate the public, on knowledge of various hazards, crowdsource the disaster data, obtain feedback on operations, and provide information on logistic needs.

27. When information from authorities become scarce, the rumours take the centre stage, which can further lead to chaos and insecurity among the public. Conversely, Social media has the potential to enhance the knowledge on hazards, allow for data collection, give voice to people and provide information on overall logistics and humanitarian needs. The data obtained through social media can be analyzed using various AI tools, for real-time info, public feedback and even for countering the fake information in circulation. Some of the modern-day operating scenarios where Social media can be effectively deployed for DM operations are:-

a) **Social media as Sensors.** Technology allows the public to share their views and experiences through social media. During disaster events, each of their posts can become the eyes and ears of disaster management and response. When people who are experiencing the situation firsthand relay their experience online, it offers several valuable insights like location, time of the event, its seriousness, what's happening on the front lines etc, so that the authorities can better prepare themselves and take the emergency seriously.

b) **Geotagging & Timestamping.** Social media postings with geotagged images and time-stamps can significantly help EOCs in the prediction of an evolving situation, or impending crisis, almost in real-time. Similarly, the integration of geotagged data from connected devices and crowdsources can enhance the accuracies of satellite-generated precipitation reports and even offer real-time forecasting of flood risks. Social media provides direct, valuable insights from the user and can alert officials to affected areas, road closures, power outages, accidents, and many more.

c) **Social Media Mining.** Big Data can help fill in gaps of information that may be crucial to a rapid response. When disasters like a flood-hit community are hard enough to cause an evacuation, it's important to know what roads are open, where gas is available and if anyone is trapped.

d) **Situvation Report (Sitrep).** Although satellite imagery is effective, it isn't always available, can't be real-time and may not show the whole picture. Eyewitness level pictures and posts via social media from the affected area, however, can be extremely effective in showing potential hazardous locations. Utilizing satellite and social media information in tandem provides responders with a clearer picture of the situation that may not be as easily seen from one point of view.

e) **Helpdeesk.** It is common for the emergency helpdesk numbers to get overloaded and busy, during disaster events, making social media such as Twitter a simple popular communication alternate. Twitter live or Townhall meetings are a real-time open platform accessible to the public, as an alternate for direct interaction with various government agencies. Availability of such alternate avenues can result in unprecedented collaboration on the platform in responding to any emerging crisis. A variety of information, such as helpline numbers, transport or food schedules, weather forecasts, relief efforts and safety tips etc can be shared with hashtags and during townhall briefings.

f) **Status Update.** People can use social media applications to reach out to friends and relatives, to let them know of impending natural disasters before they hit. Additionally, platforms such as Facebook, Google, Twitter etc allow people to mark themselves as safe after emergencies, so loved ones know their status. The feature is helpful for both disaster response teams and worried friends and family alike. EOCs can also utilize such social media to reach targeted users and provide accessible, large-scale early warning of disasters.

g) **Reunion of Separated Families.** Disasters can separate people from their families, and trends like crisis mapping just may help emergency responders find them. Facebook and Google have incorporated some advanced resources to connect people with their

loved ones during and after disasters in real-time. This feature allows for an immediate way to reconnect post-disaster. In short, anyone can enter information related to a missing person in an attempt to connect themselves or others with those they are looking for. For this, Google has a "Person Finder" application while Facebook maintains "Safety Check Service". Both these services are typical examples of Big data as a recovery tool.

h) **Real-time Crisis Mapping.** Using the above-indicated person-finder and safety-check tools, DM authorities can reach out to the people who are close to disaster areas, for more real-time updates regarding the situation. EOC teams can plot such socially gathered or eyewitness information on their interactive GIS map, for the overall crisis mapping and for planning the best course of rescue operations, helping the affected get cleared of danger early.

i) **Geo-Mapping of Spread.** Using AI engine as a backend, both Google and Facebook have generated maps that display population density, demographics, and travel patterns, enabling DM planners to swiftly decide where to send supplies or how to mitigate an outbreak. Similarly, Facebook, Google, and Twitter are jointly working to identify and eliminate misinformation, directing users to reliable sources.

j) **Social Media Analysis.** Real-time information from Facebook, Twitter, Instagram and YouTube can be analysed and validated by AI to filter and classify information and make predictive analyses. Artificial Intelligence for Disaster Response (AIDR) is a free and open platform, created to process, filter and classify social media messages related to emergencies, disasters, and crises. was the large number of tweets generated during a crisis. The software collects tweets based on hashtags and keywords and then uses AI to further classify them by topic.

k) **Surveillance of Emerging Infectious Diseases** is vital for the early identification of public health threats. Technological progress in wearable technologies and the expansion of social media has made it possible to construct mathematical models for the study of disease dynamics and epidemic prediction. Understanding patient mobility patterns has enabled simulation of the spread of Covid and prediction or identification of next potential hotspots. Social media tools and epidemic intelligence methods, used by health and research institutions, can facilitate risk assessment, outbreak detection, its spread, next hotspot prediction etc. (For more: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4720248/).

Crowd-Souring

28. Crowdsourcing enables the use of the information supplied by crowds or the public as sources of real-time data. With the increasing availability of internet coverage and access to mobile, wearable devices and smartphones, crowdsourcing allows the pooling of the public's contribution either by chat, email, website updates, or social media posts. Meaningful extraction of data from the vast amount of real-time information generated by the participatory mapping of citizens is gaining recognition since it can complement, update and improve accuracies in other official information. Being the voluntary contribution of data, DM organisations can also access this information without much cost. When the

crowd sourced data is integrated into DM plans, it can prompt further value-addition based on local risks. An important impact of crowdsourcing is that the process by itself becomes a way in which participating public learn about their risks; thus an avenue of disaster risk communication.

29. The connected sensors too can provide real-time information on a variety of physical characteristics, such as temperature, water pressure and level, and the presence of smoke, humidity, among others, which can provide critical information on geographical areas impacted by a flood or wildfire. Every sensor data can be further supplemented by leveraging volunteered geographic information on the damage and impacts from individual posts on social networks. Such crowd sourced data can provide relatively high accuracy in identifying impacted areas.

30. Crowd-Sensing. Knowingly or unknowingly, the advent of smartphones has created several new opportunities for the public/crowd to participate in DM operations, in helping to respond to disasters. A few of the suggested crowd roles in DM are:-

a) **Crowd as Sensors:** Usage of data generated by internal sensors of mobile phones. Mobile phones are continuously generating data from their internal sensors, including GPS, accelerometers, gyroscopes and magnetometers. Today, the smart-watches and Fitbit devices connected by BlueTooth with their phones too gather considerable data. These data are collected (opportunistic crowdsourcing) with little, if any, data processing by the user.
b) **Crowd as Reporters:** Mobile users offer their own information on events (e.g. taking a photo of the damage, tweeting about weather conditions, or live video of an accident site etc.). This user-generated content can include as supplementary information (e.g. hashtags) if verified correct.
c) **Crowd as Computers:** Collection, analysis and usage of data generated by usage of apps and social media. The smartphone user-processed open data, if collected and analysed using modern technologies like Big Data, can yield, valuable processed data for DM. Like the crowd as the sensor, there is no direct effort to share the data by the user. Further, the collection of data on people's movements during an emergency utilizing mobile phone data, for example, can be useful in organizing emergency assistance planning, logistics and in the distribution of relief efforts.
d) **Crowd as Fund Souce:** Raising money for disaster victims using text messaging and crowdfunding platforms. Many social media sites have options to donate money to relief efforts for disasters, giving people in affluent or unaffected areas the opportunity of helping others in need. Setting up official social webpages, therefore, require no mention, since scamsters can dupe others by setting up fake sites, in an attempt to scam others during disasters.
e) **Crowd as Microtaskers:** Users create content such as adding roads or changes to buildings, that is normally missing in satellite images. Here, users with specific skills can act as active participants for an open project like "Open Disaster Mapping Initiative". Social network posts on Twitter have been leveraged to provide real-time mapping

of floods and have demonstrated a relatively high level of accuracy when compared against post-event imagery.

31. Cloud-Source. Leveraging real-time crowd-sourced data is especially useful for crisis mapping. Key examples include OpenStreetMap, which has been used as a basis for several crisis mapping projects, and Ushahidi. Ushahidi, is open-source crisis-mapping software that creates a database of geotagged and time-stamped reports drawn from public contributions through several sources, including SMS, email, SMS, or tweets. This information builds a comprehensive, real-time picture of what is happening on the ground. Today, Ushahidi V3, or "Ushahidi in the Cloud", can be accessed by anyone on their smartphone. The platform has been used in 140 countries, reaching over 100,000 live deployments.

32. Volunteered Street-level Imagery. Street-level imagery, gathered by open-source communities or companies such as Google or Mapillary or OpenStreetMap can often provide the most updated, three-dimensional at ground level, with detailed characteristics of the built environment that may not be available through earth observations, such as occupancy, shared walls, and connecting roofs, as well as information on the structural condition. These updates can augment the existing GIS data of EOCs, aimed at addressing gaps in information on the built environment that is normally not available through aerial or satellite imagery. Improvements in the availability and affordability of camera technologies, such as omnidirectional imagery cameras which provide a 360° image around the photographed location, will continue to enhance the coverage, quality, and frequency of street-level imagery.

FM Radio

33. Radio and television broadcasting still remains vital for informing the public about preparedness and response procedures. Road warriors and travellers, in particular tune to local FM channels for traffic-related information like road-blocks, traffic diversion, speed restrictions, weather updates etc. If the disaster area is under FM radio coverage, the DM authorities must corroborate with the local FM Radio stations to broadcast public safety updates, instructions, shelter, relief goods, other citizen services opened for the affected communities and even the information on the missing family and friends etc. As SOP or routine practice, all FM Radio stations must be made to broadcast these public safety snippets at standard time schedules, say from the first five minutes from the start of every hour (from 00 to 05 minutes), that could further vary with each FM station. Further, the affected can call up the FM stations, to seek urgent help or reach out to the outside world.

34. Community participation is key to the long-term survival of FM radio, and therefore, off-air community activities (in which communities participate in producing radio programs), such as DM workshops, are very important. Such practice will not only enhance the popularity of FM stations but also, will aid in strengthening communities, in support of the profitability of radio stations. Similar actions could also be initiated over every other TV service, till the implementation of CAP.

Disaster Scenario Simulation & Training.

35. Outdated Monotonous Training Techniques. Drills are routinely conducted as part

of training and disaster education to keep the force ready to face any emerging challenges posed by natural disasters. However, participants are not always interested in or committed to such pieces of monotonous training. Using hazard maps and photos of past disaster areas, it is often difficult to explain or convince the purpose of this type of traditional preparedness training to communities and children, entirely. Even for a literate to understand the risk from the hazard maps, they have to, read the depth and other markings using numerical values to imagine the disaster scenario.

36. Gaps in Coordination Between Forces. When a disaster occurs, the defence forces, fire, police, and health agencies individually respond by deploying the specific aid and services that each agency has been professionally trained to provide. However, what is not always prepared for, are the unique and unanticipated inter-agency interactions (variables) that often have to be encountered which may warrant unplanned coordination but are nonetheless necessary to effectively mitigate the emergency and the extent of damage (outcome). External and internal factors within each agency can influence the effectiveness of that agency's response and, in turn, the overall effectiveness of the coordinated response. Any inconsistency or conflict in coordination and/or collaboration amongst responding agencies will produce a performance gap between the optimal and actual actions taken. Minimization of these performance gaps is the ultimate objective of disaster preparedness and training.

37. Modern Tools of Training. Hence, there is a need to upscale our training methods and SOPs constantly, by adopting emerging technologies and innovations, while assessing the potential impact these opportunities can make on our DM operations. Keeping pace with these challenges is difficult; however, modern tools like Virtual Reality (VR) and Augmented Reality (AR) technologies are here to solve these issues. A simulation exercise must be a fully simulated, interactive exercise that tests the capability of a DM organization to respond to a simulated emergency, disaster or crisis. Preparing for emergencies before they occur, not only helps to ensure the plan of action is achievable and actionable but also guarantee enhanced coordination, better understanding and "common language" amongst the various agencies.

38. Cost-Effective Training Tool. With the advancements in visualisation, Virtual Reality (VR) based training programs offers a cost-effective opportunity for training and are to be planned to prepare for multi-hazard or large-scale disasters. For disaster management, VR enables rescue teams and first responders to simulate the area of operation and optimize their strategies using 3D models. These training solutions are also useful for individuals in critical infrastructure to find quick exit routes and avoid injury during emergencies. By confronting these stressful and unpredictable situations through VR, the responders can feel more prepared, experienced, and ready to tackle these situations when they occur in real life.

39. It is impractical to assume that simple exercises focused on a given legacy format and skill set is sufficient to assure competency in stressful DM operations. Periodical training capsules, after factoring in each of the previous 'lessons learnt' are needed to strengthen,

upgrade and instil the correct practices, coordination associated with the performance standards, including fluency in decision-making skills, and increase problem-solving capacity.

Kerala Early Warning Dissemination System (EWDS) 1.0

40. Records and past experiences suggest that the DM tends to spend more time, resources, and money in disaster relief activities than its efforts towards risk reduction or its prevention. Prevention and risk reduction is always more valuable than relief distribution. The EWDS project is a people-centred, state-wide project, more of a preventive and disaster mitigation measure.

41. Return of Investment (RoI). Warnings issued well before an event, enable people to protect at least some valuables, property, livestock, and infrastructure. In general, the longer the warning time, the greater the property and livelihood can be protected. By reducing the impact of disasters, the government avoids the financial and political burden of massive rehabilitation costs. In short, the availability of EWDS will help the State to reduce economic losses and mitigate the number of injuries or deaths from a disaster, by providing information that allows individuals and communities to protect their lives and property. If the overall damage estimation associated with an event is estimated to say, Rs 100 crores, and if the effects of that recurring disaster could be reduced or prevented by an EWDS costing Rs 100 Crores, it should be proudly considered as a state asset.

42. The upcoming EWDS system will alert the public about natural calamities much early than the existing traditional arrangements and can shift them to safer places during impending natural calamities. Further, over two-way real-time audio-video collaboration between all remote locations and SEOC, the local administration will be better equipped to take up rescue operations more effectively. Thus the state EWDS system aims to substantially reduce, deaths, injuries, and losses from severe disaster events.

43. A fundamental precondition for disaster risk reduction is the availability of well-functioning EWDS tools that deliver accurate, reliable and understandable, unaltered warnings, promptly, to authorities, operational disaster managers and populations at risk, to enable early actions to reduce the impacts of potential disasters in long-term development and economic growth of the state.

44. Kerala EWDS in Nutshell. Kerala State EWDS follows an all-source approach while addressing the existing issues, as any undue delay in the issuance of a warning, could result in catastrophic losses. As the EWDS last-mile, sirens will be installed at all the remote locations, viz telecom towers, MPCSs, district and taluk EOCs, and fish landing centres, PHQ, and even at District Fire Stations. The incoming all-source alerts will be aggregated, compiled, and processed using an AI-based DSS and C&C system at SEOC over a unified operator dashboard. Since the project remote locations are connected over a VPN, whatever data is available with SEOC can also be accessed by the remote locations and their inputs can be appended on a need basis. Further, the EWDS also permits the dissemination of digitally signed alerts and warnings over every available communication medium, at the click of the mouse.

45. Key Components of State EWDS. EWDS to be effective, few elements must coexist successfully. They are risk knowledge and prediction, monitoring and warning services, dissemination and communications, and response capability. If any of these components is weak or missing, the entire EWDS can fail. Accordingly, the state EWDS project consists of the following major technical components:-

a) Mult-hazard, All-source Alert aggregation & Monitoring Platform. All disaster alerts and warnings produced by various public, private, commercial, open agencies and crowdsources, will be aggregated and will be presented to the incident management system with its priority rankings and confidence level;
b) Forecast& Prediction Processing Platform, an AI-enabled, Decision Support Platform, which recommends the best course of actions, SOPs, measures and disaster prevention guidelines to a unified operator dashboard
c) Warning Information & Dissemination Platform, which can connect to any communication technology over open standards and disseminate digitally signed warnings on authorisation;
d) Pan-State VPN Network for Multi-agency Coordination. A redundant wired and cellular wireless connectivity with all remote EOCs, first responders and control rooms of Matsya Bhavan that offers all SEOC applications with full audio-video collaboration. Moreover, an Enterprise Network & Element Management Tool (EMS) tool will proactively monitor the health and serviceability of the entire network and its connected devices;
e) Citizen Helpdesk with the multi-hazard database is an advanced contact centre, that can integrate with any/all other call centres (including 112), with operator tools such as Computer Assisted Emergency Aid Dispatcher (CAD), Automatic Vehicle Tracking (AVL) & Responder Tracking, voice biometrics, Customer Relationship Management (CRM), chatbots, social media integration, and crowdsourcing etc;
f) Sirens with Public Announcement (PA) systems are designated as the project last-mile. Every siren location will also have a high-intensity LED strobe light that will light up as per the colour of the alert-in-force.

46. EWDS 2.0. People must understand their risks; respect the EWDS warning service and understand how to react to each warning message. Towards this, formulation of new policies, education and preparedness programmes etc play a key role. EWDS systems to be more effective, they are to be accompanied by critical infrastructure, safe evacuation routes, shelters for affected and livestock, secure hospitals, and so forth. Even greater benefit can be achieved with the introduction and promulgation of Common Alert Protocol (CAP) certified systems, and Location-Based Alert Systems (LBAS), that rely on routine functions to increase their benefit relative to their cost.

47. Importance of Incident Commander in EWDS. Timely alerting reduce loss of life and property damage. Hence, it is most essential for the decision-makers manning EOCs to understand the expected consequences of taking action, in terms of the probability of false and missed alerts, the cost savings due to mitigation actions and the cost of a false alert.

He must be aware of the trade-off between timeliness, warning reliability, the cost of a false alert, and damage avoided as a function of lead time, which must be modelled to determine the cost efficiency of the outcome. A major factor in realizing the benefit is the capacity and commitment to act on the information in the appropriate time and manner.

48. Therefore, the one critical step is the willingness and confidence to act on a warning and take appropriate individual and collective measures to protect lives and property. The individual's willingness to act cannot be taken for granted. Therefore a completely effective warning system engages its expected beneficiaries by raising awareness and knowledge of risks and ensuring that the actions taken are realistic. Farmers, whose livelihoods depend on a few cows, will likely value those cows as much if not more than their own lives and this must be considered when responses to hazards are developed. Hence, it must be remembered that the increase in lead time provides precious time for the completion of preventative measures, whereas the decreased warning time will result in proportionate economic loss and deep wounds in people minds.

Flirting with Technologies - Fueling the Next Wave of Innovations

49. Leveraging Emerging Technologies & Innovation. Emerging technologies and innovations can substantially help reduce the impact of climate and disaster risks by improving risk and impact understanding. Some of these practical and affordable technology resilience suggestions are presented in the succeeding paragraphs.

50. **Disruption in Research & Development (R&D) Process.** Starting from universities to start-up villages and most tech companies are keenly looking forward, to the guidance, support, and collaborative development of technologies with governments, manufacturers, and end-users. In the past, no such platforms existed for the direct engagement between academia, R&D agencies and their potential partners, or markets. In addition to being customer-focused and need-based development, such collaborative engagement can also reduce the risk of entering emerging markets at the last minute, where technology companies often misunderstand their customers or push unwanted products for their gains. Hence, the easiest way to begin innovation in DM is by opening the technology arena, in the hope of eyeing a new ground-breaking solution that can help the DM, from beginning to end. More importantly, this type of shift to academia-research-innovator-user interaction can not only spark the growth of national capacities to innovate affordable, practical solutions but also can yield better technology development partners, and stronger markets, thus also fulfilling the dream of "Make-in-India". Earlier the State embraces this new path, more likely the benefit from being one of the first movers, in this potentially vast opportunity.

51. **SDMA as Incubation Centre.** Encourage university, industrial participation and research studies using Kerala DM facilities and expertise. This opens an excellent opportunity for the students, researchers and the faculty to interact directly with the DM efforts of the state. With this approach, these trainees can not only learn with nature, while engaging them hands-on with the technologies but also develop critical thinking skills and apply them to conflict resolution, thus instilling a sense of caring for their environment. Moreover, it also enables the creation of a knowledge base of DM trained professionals,

should it need to be used in the event of any unfortunate situation, accident or disaster emergencies or its further professional development from thereon. Such activity will result in creating networks of trained manpower, as well as in enhancing knowledge and producing materials and technologies to help decision-makers and stakeholders build or strengthen their capacities in disaster risk management.

52. **The SDMA Mobile App.** As indicated before, the public is increasingly using digital technologies and sharing valuable information in support of disaster management. It is also quicker, more organised and cheaper, compared with traditional methods. In addition, such efforts can enhance the knowledge based on GIS imagery and associated data, by providing greater granularity, making relief efforts more effective, faster and targeted. Going forward, Kerala SDMA must develop a two-way, interactive, custom mobile app for leveraging the benefits offered by the avenues of Crowd Sourcing and Crowd Funding. Umpteen incentives can be offered not only to its developers but also to the users of the SDMA App, thru Public-Private Participation (PPP). Every citizen must have the feeling that the SDMA App offers adequate value-addition to him/her to maintain it, as the frequently used app on his hand device, akin to Whatsapp today. Towards this, some of the recommended features alongwith its incentives for the installation and use of such a dedicated SDMA App on smartphones are:-

a) Free (No one-time or recurring or hidden user charges) all-in-one App with an easy-to-use interface that puts weather and disaster alerts, DM preparedness, shelter and rescue information directly into the hands of the Public.
b) Default basic insurance coverage for all app users, linked to their ration card and Aadhaar ID.
c) Public to list their valuables to be insured using the app. 50% premium contributions from Disaster Relief funds.
d) The benefit of nil insurance premiums for BPL card holders.
e) Customised alerts, specific to the mobile user location and areas of interest on impending local events
f) Distribution of QR code enabled coupon distribution for various DM/DRR services and food, ration kits, or queue token numbers etc
g) Automatic damage assessments and rescue efforts, based on user inputs like photos, videos etc.
h) Integration with UPI payment gateways and various insurance agencies.
i) Quick validation of claims and damage compensations, on the basis of user submissions.
j) Faster settlement of insurance claims and lower processing or nil transactions costs
k) Payment of incentives based on the timeliness, correctness and value of the input (akin to the incentive payments of Indian Customs)
l) Issuing of disaster victim digital certificates
m) SOS button to initiate a call with Citizen Helpdesk or 112 or 1070. Tight integration with 112, 108, 1070 and other first responder services like Fire, Police or Ambulance services

n) Route map to the nearest shelter.
o) Integration with online health consulting and "insurance-as-a-service" platforms
p) Tie-up with all Telecom Service Providers, for enabling free mobile top-up and talk time for users within the disaster-affected area
q) Digital payment integration for easy disbursement of disaster funds.
r) Provision of a "donate button with integration to Crowdfunding schemes, SDRF and reputed Cloud-funding portals.
s) Edutainment games, tips on various DM activities including disaster preparedness and hazard awareness, to help them learn key Disaster Risk Reduction (DRR) concepts.
t) Links to other government services and websites
u) Multi-lingual capability.
v) Compatibility with both iOS and Android devices
w) Progressively, develop this App on the line of "FirstNet".
x) Open-source development for community participation, scalability and modularity.

53. **App Challenge to Develop One-Stop SDMA App.** It would be ideal to conduct a nationwide contest to spur creativity, convergence technologies, ideas (on the integration of various public services and utilities), and for the overall innovative development of user-friendly interfaces with a data analytics integrated dashboard for the said app. Platforms such as GitHub already provide open-source code, algorithms, adequate ideas and tools for jumpstarting the initial works. Winners can be decided based on the Key Performance Indicators (KPI) and Service-Level Agreement (SLA defines the level of service expected) published as part of the "App Challenge". Some of the prizes, incentives and awards that can be considered for the app contest are:-

a) Cash Award / Prize money and Gold certification for the winners.
b) Participation in upcoming events, as a "partner" in government development.
c) Internship with SDMA and SEOC for individual participation.
d) Partnerships and exchanges between other DM agencies and research centres (domestic or international) to further access technical expertise and foster longer-term collaboration.
e) Government-sponsored advertisements for enhanced visibility for their company.
f) Joint webinars, time/space slots in government programs, press releases and multi-level media coverage to present the company and solutions to the national audience.
g) Award ceremony at the suitable platform, under the aegis of IITs, Federation of Indian Industry (FII) or, Confederation of Indian Industry (CII) etc
h) Stamp of recognition and KSDMA Certification for selected entries
i) Support to the entry towards Start-up missions
j) Provisioning of free working space, power, network etc for five, three and one years (for the top three winners).
k) Empanelment for other Govt projects, with a waiver or relaxation of lock-in amounts such as EMD, performance security or pre-qualification (PQ) etc

54. **Enlarge the Pie.** The following para outline how emerging technologies and innovations

can be used to apply improved risk and damage information to enhance risk reduction and preparedness and to the financial management of disasters. Let the theme be "Change now - Future belongs to those who prepare today"!

55. **Digital Disbursement of Funds.** Covid pandemic has drastically changed how the public, buy goods or access various services. Scan to pay mobile payment services such as Google pay, PayTM, UPI etc are well-acknowledged forms of payment through mobile networks, which enables access to financial services, even when the banking system is not functioning, either due to its infrastructure damages or prolonged lock-downs. Hence, in the aftermath of a disaster, coupon distribution over mobile or mobile payments can facilitate monetary credits necessary to buy the daily necessities and other essentials for survival. Further, payments through mobile phones have enabled those without credit to receive loans and funds, with minimal cost, delays and efforts. These types of evolved, proven and accepted options of accessing financial tools are ideal to re-build the livelihoods after disasters. Moreover, this also could automatically, increase financial literacy and contribute to the overall poverty alleviation efforts of the State.

56. **Donate Button Helps.** There are people, who have the habit to donate immediately after watching heart-wrenching images on the news. Furthermore, mobile money transaction is a highly useful way for friends, family and relief organizations to transfer funds to those affected by disasters. Provisioning of a "donate button on the SDMA app", can garner such donations. Similarly, Facebook has allowed charities to add a direct donate button on their Facebook pages, making it easier for people to donate through their mobiles.

57. **Damage & Impact Assessment.** Technology has improved the collection of data on ex-post damages and losses as government and insurance company surveyors can access connected devices and systems on-demand and custom audit smartphone apps to facilitate the timely collection and unaltered information. This can be made possible by the installation of sensors, IoT devices, and sharing of live videos with user handsets. In short, the public must be encouraged to set up IoT systems as part of their immovable assets and the live streaming of its data to the insurance and DM agencies to be incentivised.

58. R**isk Reduction & Reduce Premium.** The government must enter into partnerships and/or technology agreements with the insurance sector, to near real-time impact assessment, insurance underwriting and faster claims settlement. Availability of such an arrangement can result in, underwriting and claims adjustment expenses can be made considerably lower than in the case of indemnity insurance and also the payouts can be made much more quickly allowing normal livelihood and businesses to recover much faster. In addition, improvements in the ability to set premiums based on accurate assessments of risk should support more effective and yet flexible risk-based pricing of insurance coverage. Thus, the risk-based insurance premium can provide important incentives to policyholders to invest in DRR programs of the government to benefit from lower premiums.

59. **Insurance as a DM Service.** While still in its infancy, few of the new generation insurance companies have begun to encourage the use of connected devices such as water leak detectors, flood sensors, live cameras, fire and smoke detectors among their policyholders by offering

discounts on premiums for policyholders willing to install (or installed). These devices share the generated data with insurance companies. DM authorities can encourage insurance agencies to sell their product as a package of connected devices (water leak sensor and fire detector, smoke detectors, door sensor etc) for insurers to provide to their policyholders to detect potential water inundation, fire and theft etc. Similarly, the insurance package can be further expanded against the fight of pandemics / epidemics, by adding body health or bio-medical sensors.

60. In the case of road accidents, if insurance claims can be linked to the wearing of helmets and seatbelts, progressively, the disaster compensation can also be factored in as an extension of DM services. Further, linking insurance claims with the UIADI network can help the digital accounting and effective distribution of relief/benefits to the needy with the help of Aadhaar based (iris and/or fingerprints) authentication.

Fighting Corona 2.0 - The Next Wave of Pandemic

61. **Combating Epidemic with ICT.** Both pandemics and epidemics are accelerants and catalysts to innovations and it's a known fact that successful outcomes are built around good processes that help identify what tasks are imperative to achieve larger business goals and to resurrect early from the aftereffects of a pandemic. Timely health information helps anticipate and prevent potential epidemics. Systems that operate on data indicators of pathologies and syndromes likely to lead to epidemics are necessary.

62. **Revolution in Primary Healthcare.** The nature of the Covid pandemic is such that senior citizens and those with other lifestyle diseases or patients suffering from earlier medical complications are at the highest risk of death. An in-person visit to a doctor for something as routine, as a prescription renewal or a regular check-up, could put these categories of citizens at high risk of contracting the virus. Hence, most hospitals were forced to re-equip themselves with telemedicine facilities, to enable the high-risk patients to see their doctor without leaving the house. Moreover, the Covid pandemic has proved that every healthcare system (long wait times, lack of equipment, oxygen and doctors) can collapse, at its rise to the peak.

63. **Thus the Covid pandemic has shifted the paradigm of where our primary healthcare delivery takes place today.** For years, telemedicine has lingered on the side-lines as a high convenience system, and the Govt together with the medical community has not shown much interest in offering inroads to this technology. Out of necessity, the popularity of remote healthcare has skyrocketed, as the traditional-care settings are not only getting overwhelmed by the pandemic but also exposing the healthcare workers. The primary screening of Covid cases can be easily undertaken by such systems remotely, as it can offload several such primary tasks from hospitals. Hence, the State endeavour must be to set up a parallel electronics-based healthcare solution.

64. **E-Health as Health Surveillance System.** All medical or health centres, including private hospitals, bio-medical support and distribution agencies, must have common communication, coordination and accounting arrangements that allow them to share resources to effectively and function under stressful circumstances. When an emergency or

disaster or epidemic occurs, there should be a process and standard procedure to share their resources under a common framework. By spreading the resources to nearby hospitals and creating a plan together, more patients can be treated quickly and successfully.

65. **Covid-19 Innovations & Practices.** Thanks to the Covid-19 pandemic; the worldwide participation of the research communities and technology groups in the fight against the Covid pandemic has brought several innovations in predicting, preventing and controlling emerging infectious diseases. Some of the suggested technology improvements in the medical/health field are as follows:-

l) **Geo-Mapping the Spread.** Using AI engine, social network platform like Facebook has generated maps that display population density, demographics, and travel patterns, enabling DM researchers and health authorities to decide where to send supplies or how to mitigate an outbreak. Similarly, Facebook, Google, and Twitter can identify and eliminate misinformation about the pandemic, directing users to reliable sources.

m) **IoT for Remote Monitoring.** By coupling chatbots, smartphone apps with wearable technologies, that offer a variety of services like activity charts, pedometers, health parameter checks, (such as heart rate/pulse, patent fall, temperature, oxygenation) etc can offer several value-additions in health monitoring. Without human intervention, these intelligent apps can share data, with the family doctor or health authorities, when an anomaly is detected or based on the schedule for the periodical dosage review and change of prescription etc. Further running AI/ML models over such data can reveal early signs and symptoms, that human doctors often miss - from heart conditions to cancer. AI can quickly learn from the patterns presented and can transfer its analysis to a dashboard in a presentable format. While AI can't stop a pandemic from spreading, it can be used to prevent future pandemics. In an IoT world, a network of sensors placed throughout the living and workspaces can be used to monitor individuals for infections, acting as an early detection system - preventing virus outbreaks from becoming epidemics. Love it or hate it, medical technology is exploding with no end in sight.

n) **Telemedicine.** For years, telemedicine has lingered on the side-lines as a high convenience system, and the Govt together with the medical community has not shown much interest in using this technology. Out of necessity, the popularity of remote healthcare has skyrocketed, as the traditional-care settings have not only got overwhelmed by the pandemic but also exposed the healthcare workers. Telemedicine technologies can be used for every primary screening of health cases as they can prevent overcrowding and offloading of several such primary tasks from hospitals.

o) **Confronting the Next War, You Can't See.** Considering today's technology environment, the basic telemedicine system by itself is outdated and hence may not survive long. Apps offering single-sign-on with the convergence of various services viz, laboratories, ambulance, insurances, paramedics, medicine & prescription food deliveries and value-added features such as schedulers, reminders, home-nursing and other on-call conveniences will thrive in coming days. A grading or rating or feedback based system can be energised to ensure competition and quality among these empanelled

service agencies. Five-star hospitals may, however, opt for enterprise-class telehealth solutions featuring higher innovations with the networked tools, such as AI, Robotics, IoT, remote health monitoring Biotechnologies etc. But, still wonder how such facilities can be utilised by dentists and for other dentistry works, till proper robotic technologies are developed.

a) **Inventory Management over GIS.** As the first step, the DM or the Health authorities can demand the integration of telehealth systems with their inventory management and GIS data systems. This would enable backend Bigdata technologies to offer comprehensive situation awareness at their command and control centres, to successfully manage any similar crisis in future. In addition to basic logistics details, the inventory data could include, bed tracking, staff status, medicines, oxygen status, tools for quarantine facility management, etc. Integration of data analytics can further offer value-additions such as common operational maps, situational awareness dashboards, asset tracking, financial tracking etc.

b) **AI in Bio-Technology.** The burgeoning AI-enabled biomedical system can offer aged or palliative care patients remote care and automate rote aspects of a traditional clinical visit via, few queries or text messages, asking them questions about their symptoms. When patients report flu-like symptoms such as cough, shortness of breath, and fever, the chatbots can ask more pointed follow-up questions related to, say the Covid-19 virus. Further, Chatbots can be programmed routinely to communicate with isolated and quarantined people, take vital information, deliver medication reminders and ease patient fears.

c) **Chatbots NG.** The latest generation of chatbots can set up appointments, reminders and schedule a video conference with a doctor. While chatbots can't be trusted for final diagnoses, integration of chatbots with AI and Big data can draw positive conclusions, whether someone is contagion risk, or need the next level of screening, thus preventing overcrowding in hospitals. With more patient sampling and customisation, the system can be fine-tuned to a higher confidence level. Further, using data analysis algorithms and geo-data at the backend, experts can predict where, when, and how the pandemic is progressing.

d) **3D Printing Save Lives.** The surge in demand for critical items and spares puts pressure on entire healthcare supply chains. During critical situations, reports of shortages are usual, not only for the consumables like gloves, masks, gowns, and aprons but also, for the critical respirators, goggles, face shields, valves etc, placing both the medical staff and the patients at risk. 3D Printers can be considered as an alternative aid for the local manufacture of such critical spares/items, to deal with supply shortages.

e) **Fighting Airborne Pathogens.** The BioFlash is a portable aerosol sampler, capable of testing air quality, both indoors and outdoors. BioFlash works by collecting aerosols and identifying the presence of dangerous pathogens using sensitive, specific and rapid detection in near-real time without laboratory analysis. Not only can BioFlash detect COVID-19 and its variants, but it can also be used by anyone, giving them immediate

results, in minutes, which helps stop the spread of COVID-19 and other airborne pathogens at the entry point like airports. Emerging variants are a threat to pandemic recovery; however, with the opening of schools, devices like BioFlash would be highly critical for our mitigation strategy to help prevent transmission by airborne pathogens, among unvaccinated next generation.

66. Data Collection from Health Information Management System (HIMS). Automation of the health records is necessary for the operation and expansion of e-health initiatives. To improve the health systems and overcome the deficiencies in the sector, ICT can be used at different stages, including:

a) Encourage widespread use of e-health, from primary health centres and ESI hospitals while ensuring capacity building in health care and academic institutions.
b) Setup telemedicine as the first line of consulting. Integrate such telemedicine systems with mobile App for appointments, medicine distribution and overall queue management at hospitals.
c) For BPL categories, set up telemedicine centres, on the lines of Akshaya Kendras, or at Kudumbasree levels.
d) Raise awareness in the government health sector to promote improvements in quality of care and follow-up;
e) To ensure a balance between public benefit and their data privacy, data encryption and anonymization must be ensured, right from the source to storage.

Next Phase of DM Transformation – Technology First

67. Technology Flavours & Innovations. While there are many difficulties and barriers to any adoption of new technologies and practices, excuses can no longer stop us from embracing technologies that could have a positive impact on Disaster Management and everyday lives. The following paragraphs describe some of the use of emerging technologies and innovation, on how they can be planned and applied, in the 14th Five-Year DM functions of disaster risk reduction, management and damage assessment.

68. Connected Devices. In the era of smart cities, smart devices, smart everything, why not have smart weather, smart risk management and smart environmental monitoring to automatically provide meaningful weather insights and make our lives better? The growing network of connected devices provides a new source of data on the physical parameters of the natural and built environment. Technological advances in the types and quality of sensors have increased their reliability and precision and have expanded the scope and interoperability within networks of connected devices. Sensors are also increasingly integrated into consumer goods. Smartphones, for example, often include pressure sensors (which can signal weather changes, storm development), proximity sensors and accelerometers (which can signal seismic activity). Crowdsource these data using the proposed SDMA App and return the processed data back to the App to allow a greater diversity of devices to communicate with each other without human intervention. The implementation of 5G mobile networks and LEO broadband will greatly expand the speed and capacity for information transmission from connected devices.

69. Agro-Met Weather Station on No-Cost? We cannot change the weather, but its prior knowledge helps reduce losses and damages. Automatic Weather Station (AWS) that measures weather parameters such as Rainfall, Wind Speed, Wind Direction, Air Temperature, Relative Humidity, Barometric Pressure, Solar Radiation, Leaf Wetness, Soil Moisture, Soil Temperature and others using precision IoT based sensors and a Data Logger, is being proposed for Pan-state implementation, on the lines of Private-Public Participation (PPP). The data logger installed at State Government buildings captures data from each of these sensors and either store it locally or forwards it to the 3rd party servers of commercial weather agencies like Windy, SkyMet, Earth Networks, IBM, etc at defined intervals. These commercial agencies, in turn, compile and process every received raw data using various AI and ML algorithms and present it to their customers in a user-friendly GUI format. As part of the return services, these 3rd party commercial weather agencies shall provide free subscription of their APIs to the State EOC and other Govt customers (for integration with existing systems and arrangements) on no capital or recurring costs, with no implication on the concerns of data security or other privacy-related issues. Being modular and scalable, this model can be further expanded by adding other services like ClimaCell, or with crowd-sourced data using mobile apps, on a need basis.

70. Improvements in Dam Safety. All-weather, AI cameras with network connectivity to control centres can monitor even minor variations in water levels, or water flow and discharge characteristics. A live video feed to be streamed to control centres that can be further viewed using Virtual Reality goggles, to offer flood monitoring, with real-time views of water levels.

71. Flood Warning Systems. A network of water level sensors installed along the river banks with the LoRaWAN support can address the weaknesses in the remote cellular network, to provide automated warnings to local administration, as and when a potential hazard is emerging. Big data analytical techniques offer opportunities to automate the integration of forecast information on hazards into early warnings and communications on appropriate coping strategies.

72. Community based Flood Warning. The prompt detection of large water ponds, flooded roads or swollen riverbeds is critical for both people and infrastructure safety. The proposed counter technology solution consists of a transmitter and a receiver, connected to a network of water level and air temperature sensors. The transmitters can be installed along the riverbanks, other flood-prone areas and the receivers are to be installed at residences close to the river banks or flood-prone sites. The transmitter's attached flood sensor detects rising water levels and communicates with the receiver when the water reaches a critical threshold (i.e. critical level to trigger an alert). This arrangement further can be connected to the Internet gateway devices to auto-trigger alerts at control rooms and EOCs. Alternately, over a cloud integration, the flood warning can be disseminated to mobile phone apps or vulnerable communities downstream or relevant agencies by subscription. Community participation can be ensured with the tie-up with insurance companies, and other incentives like tax waiver/holiday, or subsidies.

73. Non-contact Flood Monitoring. A radar sensor safely mounted away from any rising floods (either underneath the bridge or similar river-side constructions) will actively monitor the water level of the downstream torrent. To completely avoid false alerts, a coded magnetic switch (limit switch) can be further installed as a secondary monitoring sensor. Furthermore, a surveillance camera can also be added as part of the whole solution, if the network bandwidth is adequate. The moment the defined pre-stage limit value is exceeded the system control triggers a signal automatically to the nominated control centre. If the water level further increases to the next preset limit of the alert stage, the same system control can be made to trigger the local siren or any public warning system. The associated data logger records all the values and passes the data to the control room on a required basis. Compared to other IoT solutions, this option is free of false alarms since the system is based on the cross-sectional profile, the water level and the roughness of the river bed, the controller not only computes the exact mean velocity in the cross-section for each measurement but also compensate for the interference effects from wind, rain, light and speed of flowing water.

74. Digital Nose for Wildfire Detection. Traditional camera and satellite-based solutions can take hours or even days to identify or locate a fire because they rely on the smoke plume and heat developing enough to be detected from a long distance. By the time firefighters arrive at the scene, the fires have often grown too large to be extinguished and can no longer be controlled. Hence, wildfire needs to be detected early before it spreads and goes out of control. IoT startup Dryad Networks has launched Silvanet, a large-scale IoT network for the early detection of wildfires, in under 60 minutes - even during the smouldering phase. Dryad uses a network of solar-powered gas sensors (from Bosch Sensortec) to monitor the air composition, temperature, humidity and air pressure. This "electronic nose" uses AI to differentiate a possible fire from something like a vehicle passing by. The solar-powered gateways with sensors, attached to trees at a height of about three metres and establish a large-scale IoT infrastructure, to send alerts over distributed LoRaWAN mesh network and then to a cloud-based monitoring platform, which issues alerts with GPS coordinate of that sensor. Border gateways that are located close to civilization, typically at the edge of a forest connect to the cloud platform either over 3G/4G (LTE-M), or via a satellite network, or over ethernet using a wired connection. The cloud-based dashboard lets customers analyze and monitor indicators and issue alerts to the DM managers.

75. Landslides Detection. Landslides pose a recurrent hazard to human life and livelihood in the western ghats region of Kerala, especially after heavy rains. Scientists of IIT Mandi have developed a low-cost technology for detecting landslides, using a motion sensor or accelerometer commonly found in smartphones. Using the accelerometer and a data logger to record the extent of the movement, a range of data is captured to track even small displacements in soil which later triggers major landslides. The device measures every such movement of the soil, and when it crosses the preset threshold (which could result in a landslide), it triggers the local EWDS system and sends text messages to DM officials, so that they can evacuate and stop vehicular movement to and around the area. Scientists at

the IIT are constantly improving the AI algorithm, with machine learning techniques to enable them to predict landslides at least 24 hours in advance.

76. Open Toolsets for Landslide Warning. Earth observation imagery from NASA providing precipitation data and information on indicators of landslide susceptibility has been integrated into their prediction model to provide real-time forecasting of landslide risk globally. This landslide hazard assessment model monitors rainfall levels that could trigger landslides and matches that data against landslide susceptibility factors, such as recent forest fire or tree removal, proximity to the tectonic fault, bedrock strength, and land grade to provide a real-time assessment of potential landslide risk of a site, that is updated every 30 minutes. According to historical records, this model has provided false positive landslide warnings in 3% of cases, true positive warnings for 63% of the landslides and nil warnings for the rest percentage.

77. Lightning Detection. A programmed Raspberry Pi can be converted as a lightning detector or as a lightning sensor and from a kilometre or two, it can sense even a little change in the gamma. Using LoRaWAN, the details can be forwarded to any remote server periodically.

78. Myshake. It is a free mobile App, for the monitoring and reporting of seismic activity, nearby a smartphone. It uses ground-motion sensors within each phone to detect earthquakes. If an earthquake of a significant magnitude is detected, a message warns of shaking before it begins. If matched from multiple phone reports, the Berkeley Seismological Laboratory (BSL) will publish/announce the GPS coordinates (obtained from the mobile devices). It has opened a new way to build a cost-effective, scalable, and crowd-sourced seismic tracking system.

79. LoRaWAN Network. The LoRa gateways can interconnect in a multi-hop mesh network, making it possible to cover an average distance of over 12kms. This technology makes it economically viable to build a remote network, even in areas of poor internet connectivity or where there is no mobile network coverage. Thus, by adding third-party compatible sensors, several IoT applications that include, monitoring of agriculture, drought, weather, etc can be set up. These small IoT technologies offer umpteen opportunities for the collection of remote information, which makes it possible to predict and substitute human efforts with automatic machines and increase production and efficiency.

80. Road Congestion Tax. Vehicle Parking on the sides of public roads and pavements often affects the swift and smooth movements of first-responder vehicles and ambulances. Further, it can also result in accidents, chaos and avoidable roadblocks. Going forward, the vehicle population on the road will increase causing more pollution and roadblocks. As part of the building code, each permit ensures adequate parking space, not only for its occupants but also their visitors. However, these parking spaces are often converted as office space or storage for reasons best known to their owner. Hence, proper legislation is to be brought in, to decongest the public roads and reduce the parking on the pavements by amending RERA regulations and building codes. To disincentivise the conversion of parking spaces, a congestion toll is levied on such violators.

81. Inadequacies of Quality Reference Weather Data. Ranging from agricultural applications to the controlled releases of water from dams & reservoirs are based on timely inputs of meteorological or weather data. These forecasting data are obtained from remote weather reporting stations. The State presently has few weather stations for reporting from the field. This problem of low numbers of remote meteorological observations is affecting the quality and accuracy of weather predictions. The quality of inputs is an important aspect in selecting data sets as a reference for weather prediction. Verified nowcasting algorithms are commercially available today with data, sourced even from mobile handsets of the public. Such type crowdsourced data is especially useful for the verification of traditional and impact-based warnings, like fallen trees, wildfire, road accidents, isolated landslides etc. Precise weather monitoring systems/sensors are an essential and mandatory requirement for assessment and operation as it has direct or indirect effect in applications not only of Disaster Management but also in every other walk of life that include traffic, agriculture, telecommunications, education, construction etc.

Portable Emergency Communication System (PECS)

82. Like every other infrastructure, the continuity of ICTs can also be impacted by both physical damages to the network caused by a disaster, but also due to network congestion in the immediate aftermath of a disaster. All disaster risk management plans must include the availability of portable data communication systems for swift deployment. Hence, Portable Emergency Communication Systems (PECS) are to be planned and made available, at least during the Search and Rescue (SAR) phase, of the DM operations.

83. Based on State disaster maps, PECS are to be distributed to districts, either on a standalone trailer or embedded in operational vehicles, for their swift deployment in all emergencies. Though the component of each PECS could vary, the minimum essential configurations are listed below:-

a) First Responder Terminals

i. Own Mobile Phones: To connect with Cellular on Wheel (CoW) having Interfaces such as GSM, LTE/4G, 5G
ii. Wireless PBX: To connect locally available Analogue/Digital/SIP Phones, over DECT/ WiFi/Cellular protocols
iii. Satellite Interfaces: Low and GEO-orbit satellite phones and data terminals
iv. Analogue and Digital Radios: VHF, UHF, TETRA portable sets

b) IP-based Multi-Service Gateway Router: User terminals will connect to the "Gateway Router" via respective IP/analogue/digital interfaces, for communication over WAN.
c) Antennae & Quasi-antenna Products: Telescopically deployable, open field antennae, on expandable tripods.
d) Power Backup Units: Lightweight power units (e.g., batteries, foldable solar panels, charging ports and generators with fuel and fuel tanks) that facilitate easy portability.
e) User Devices include rugged notebooks/laptops, SIM cards, and tablet PCs that can easily be transported in rugged enclosures/cases.
f) Accessories: To include spare cables, connectors, electrical/mechanical user adapters,

power converters, fuel in portable cans, foldable field chairs and tables, lights, torches, whistles, tents etc.

g) Measurement & Peripheral Devices: Tools for routine maintenance and installation, measurement devices such as power meters, SWR meters, and multimeters.

84. Modern Search & Rescue (SAR) Tool. Every first responder system (drone, ambulance, police vehicles, PECS etc) should be equipped to carry a device that can capture the active International Mobile Subscriber Identities (IMSI) and broadcast SMS messages to those local devices. Today's technology permits the housing of such in a lightweight compact box (almost of the size of a large laptop), that can be further integrated with the CoW system of PECS using wired and wireless (Bluetooth/WiFi/Ethernet) interfaces. The radio signal from this SAR device triggers every active mobile phone within the affected area to transmit their IMSI. The DM staff and the first responders can capture these numbers and can obtain their handset numbers, with their identity and even location. Using these captured details, the first responders can either call or broadcast SMS messages with safety instructions to assure confidence, support and quick services to the affected. With PECS, this system can work independently; however, to obtain complete situational awareness and consolidate the information from the return SMS, the assistance of the local telecom operator may be required. After analysing all the information collected, the DM can prioritise the targets and direct/despatch the nearby first responders to the most critical IMSI location.

85. Support to Telecom Infra. The resilience of communication is of utmost importance at the time of any disaster. The current telecommunications infrastructure of the State is vulnerable to disaster impacts, such as flooding, landslides, high winds etc. This is compounded by ageing infrastructure, poor maintenance and reinforcement as well as the location of critical telecommunications infrastructure in hazard-prone areas. Efforts should therefore be intensified to ensure the resilience of telecommunications infrastructure given the invaluable support they provide in disaster situations by facilitating communication, coordination, and rescue efforts. Availability of specialized communications equipment such as Cell on Wheels (CoW) mobile towers shall further ensure quick restoration of mobile services in hard-hit areas. Enhanced cooperation including formalized agreements and frameworks between all the state telecommunication agencies and SDMA is, therefore, necessary to be formulated under the aegis of STDCC to ensure more effective disaster response and recovery.

86. Importance of Link Redundancies. Unfortunately, disasters can occur at any time without any prior warning. Hence, diversification of network paths and system redundancies are to be included as important considerations of DM plans, to make the State networks more physically resilient to future disasters. Though PECS terminals are considered as an interim alternative, must have adequate interfaces to allow WAN connectivity, from any public or private networks (e.g., local broadband, public WiFi, KSWAN/Kfone systems, cellular, BGAN Satcom, Low Earth Orbiting (LEO) satellites etc) so that the field team can communicate with EOCs. Integration of multiple WAN links also permits aggregation of network bandwidth in addition to accessing multiple WAN communication paths

simultaneously, which are owned and/or operated by different organizations with different policies, in an integrated manner.

87. Public outreach over mobile and social media has become a common utility of everyday life, with over 95 per cent of the state population are using the internet. The disaster impact can be mitigated to a great extent by maintaining a consistent flow of information with those affected. By establishing such a process, the DM organizations can update and maintain their situational awareness, preliminary damage assessments and rescue plans. Such insights become difficult to source when the communication systems fail, as often seen, in the immediate aftermath of a disaster.

88. Low Earth Orbit (LEO) Satellites based Intenet is being touted as the next big connectivity solution. With 5G expected to kick in by 2022, companies will launch a modern suite of solutions, applications and services, that require significantly higher bandwidths with much lower latencies. Similarly, Satcom will completely change the dynamics of Indian broadband, just like the advent of mobile transformed telecommunications, over 20 years ago. Next 4-5 years, we may see Satcom services reaching the common man, offering affordable internet connectivity in rural & remote areas.

89. Management Information System (MIS). In addition, being a vital component in any disaster preparedness plan, MIS is an indispensable tool for a modern EOC for its hazard mapping and vulnerability assessment. Applications of MIS in Disaster Management includes establishing a Decision Support Systems and Disaster Information Network. The KSEOC is already equipped with ArcGIS software with a state-wide vulnerability atlas with layers viz, seismic hazard map, lightning, cyclone and wind hazard map, flood-prone area map, housing stock vulnerability table for each district and LSG. The proposed MIS would have to cater to the following additional types of information:-

a) Planning Information. Certain standard norms, formats and specifications are used in the planning of any activity.
b) Control Information. Reporting the status of activity through a feedback mechanism.
c) Knowledge Information. A collection of information through the library records, past experiences and research studies to build up a knowledge base as information is known as Knowledge Information.
d) Organization Information. When the information becomes an SoP of the organization.
e) Functional / Operational Information. When the information forms the basis of the operation.
f) Database Information. When the information has multiple users and applications, it is called database information.

90. In Disaster Management, MIS systems play an essential role in information exchange in the initial response. Once a disaster occurs, local governments need to conduct the following operations:-

a) Confirming the whereabouts and safety of residents,

b) Establishing and operating evacuation centres,

c) Transporting and managing relief goods,

d) Supporting evacuees and creating evacuee lists, and many more

91. Amendment to Legislation. Making the best use of available ICT, social media and crowdsourcing may require the amendment to legislation on personal data sharing and guidelines to protect privacy, while still encouraging the usage and development of DM technologies. Succeeding this challenge requires bringing together expertise in data science, community participation, and public policy. Fresh legislation, standards and guidelines are expected to not only encourage wider participation of companies, academia, and enhanced sharing of data but also would consider that their interest will be protected while ensuring the citizens' data security. Such an initiative will bring increased acceptance of sharing of private information by the public their government authorities.

92. Data Deluge. Growing access to ICTs, mobiles and the increasing application of IoTs are generating massive volumes of data. Such Big Data has immense relevance for disaster management. However, the growing amount of data poses challenges for its storage, computing/processing, data management, analysis and verification. The overflow of information generated during disasters can paralyse not only our computing and storage inventories but also the DM response due to the lack of the most updated information. This flash flood of data can also be referred to as Big Crisis Data. Making sense of this Big Crisis Data is proving to be yet another incredible challenge for traditional beliefs and concepts.

Trigger for Innovations

93. The Best Practices of Innovation. In a government hierarchy, introducing major technology changes requires certain attributes. Some of the best practices offered by veterans of government innovation are as follows:-

a) Understanding the basic needs is just as important as what you want to innovate or build.
b) Give room for the silent backbenchers to air their opinion.
c) Don't hijack the credits of subordinates
d) Identify those staff who may fear the innovation or their creativity or new practices might cost them their job. Hence, build trust or relocate at the first opportunity.
e) Identify the minimum stakeholders who can actively contribute in advance. Don't overload, by adding more passengers.
f) Start small, test a little, prove and build add-on modules. Not every project needs to be gigantic, sweeping and costly.
g) Don't set unrealistic milestones or goals.
h) To err is human. Don't get into a zero-error syndrome. Always remember, one cannot catch fish without wetting their hands.
i) Take swift decisions. Buying time never earns or result in better results or right decisions.

j) On core subjects, where in-house domain expertise is missing, ask for the professional opinions of respective subject-matter experts.
k) Innovation spawns more innovation, so communicating about innovation activities is a must.
l) Executive sponsorship, if critical to be initiated early and to be sustained.
m) Commit to a transparent review of successes and failures.
n) Last but the least; Always be a learner. Past mistakes and every additional bit of information is going to help you tomorrow.

Summary & Recommendations

94. The summary of strongly recommended technology proposals, described in the preceding paragraphs, to be included as part of the 14th Five-year DM plans are briefly listed below for busy-eyes:-

a) Technologies of the Day. Advanced technologies such as Artificial Intelligence, Internet of Things (IoT), Big Data, Blockchain, etc, have the potential to transform disaster management, disaster response and relief capabilities, and must be integrated with existing SDMA infrastructure. The same is the case with other new-gen technologies such as social media, smartphone apps, robotics, drone technologies, cloud computing etc that have the capabilities to transform various disaster resilience challenges of the SDMA, specially in multi-hazard disaster scenarios. Despite the rapid refresh in ICT, the usual practice of remaining adopted with the legacy set of standards and practices for various DM activities, to be discontinued.

b) LBAS & CAP. Centralised NDMA steered projects such as Location-Based Alert Systems (LBAS) and Common Alert Protocol (CAP) be integrated smoothly with the State EWDS, to attain even greater benefits from the project and to reach out to remote masses, even much quicker and at a lower cost.

c) BigData. Big data, as a crisis analysis tool, hold enormous potential for disaster management. Using Big data utilities, lessons and details of previous disasters can be mined for the collection of various insights that help forecast future incidents and actions taken to reduce its effects.

d) Big Data Analytics. Combining various remote feeds like the sensor data, AWS info, and its analysis with various Big data analytics tools will allow the State DM to be better armed to deal with the challenges posed by future disaster events. Also, by embracing analytics with Big data, DM agencies will be able to respond more quickly and effectively to the inevitable.

e) Blockchain. Implementing blockchain in DM, could greatly reduce costs, unify efforts, converge services and enhance response efforts. Blockchain can provide the much-required coherence and consistency to each transaction and can integrate the complicated land-revenue records, health data etc, helping them to be flexible during disruption. Blockchain technologies can also ensure increased interoperability, transparency and coordination between all stakeholders associated with DM operations.

f) AI & ML. Increased emphasis be made on the incorporation of AI and ML technologies in various educational and training activities of DM. A proactive approach using AI and ML is essential to ensure, real-time organizational insights that allow operational efficiency to thrive in times of crisis and could protect the security and safety of employees, responders and allied stakeholders.

g) EWDS 2.0. The present EWDS is a "Reactive" system, having several human interfaces. In any major disaster event, time is precious and hence the human interfaces are to be shortened. To have a "Proactive" EWDS, the field/remote IoT controls, weather stations, forward-deployed sensor systems (like anemometer, barometer, vibration sensors, flood or water-level monitoring sensors, etc) are to be integrated directly with the EWDS, alongwith its control systems. Priority must be given to frequently recurring disaster-prone sites, and other critical remote sites. Making EWDS systems proactive also means, staff can safely operate the facilities of pumps, gates, obtain weather readings etc remotely from offices, without having to endanger or expose themselves to adverse weather or when the site is inaccessible due to floods or landslides. EWDS 2.0 to ensure, handling of disaster situations more proactively, well in advance, before they go out of control. By reducing the impact of disasters, the government avoids the financial and political burden of massive rehabilitation costs.

h) Ubiquitous Mobile Phones. Mobile phones have become an indispensable device at the hands of every citizen. By utilising the power of this modern-day tool, DM can harvest every information, a person wishes to publish or want others to know. Hence, DM agencies can not only use this mobile phone as a crowdsourcing device but also as a tool for raising public awareness, dissemination of early warnings of impending danger and reaching out to the vulnerable population on disaster risks and preparedness.

i) Drones & Robots. Deploy autonomous Drone systems and Robots, where the 1st responders cannot and where rescue efforts can put the lives of responders at risk. They can access hard-to-reach areas and perform data-gathering tasks that are otherwise unsafe or impossible for humans - without endangering rescuers' lives.

j) Social Media in DM Communications Plans. As disasters unfold, citizens increasingly turn to social media to seek and share information. This technology proliferation and awareness on social communications have changed the way, the public perceives and responds to disaster information. It is time for the DM agencies to adopt social media and change the way, we communicate during disasters, by involving community members, as first-line informants and responders. The most popular, recognizable social media platforms, such as Facebook, Twitter, Google YouTube and Instagram, are the best places to start a disaster management communications plan. It is also time for the public, private, government agencies and other organizations to turn to social media, to make them a more effective and universal platform for providing information, communication and updates during emergencies and disasters.

k) Crowdsourcing. Increasing penetration of the internet, social network, and smartphone usage across all sections of people are creating a large volume of real-time, volunteered information, street-level imagery. Open sharing of public information and social media communications during a disaster event generates a vast amount of real-time data from the voluntary contribution of information. Meaningful extraction of DM specific information generated by the participatory mapping of citizens can complement, update and improve accuracies in official DM information. Being the voluntary contribution of data, DM organisations can also access this information without much cost. When the crowdsourced data is integrated into DM plans, it can prompt further value-addition based on local risks. An important impact of crowdsourcing is that the process by itself becomes a way in which participating public learn about their risks; thus an avenue of disaster risk communication.

l) Updates from Internet Platforms. With current high precision remote sensing data, especially using high precision satellite images, the urban diagnosis has become easier as well as effective. Before and after images help to understand the extent of damages immediately after a disaster. More importantly, open-source communities or companies such as Google or Mapillary or OpenStreetMap provide the most updated, three-dimensional at ground level, with detailed characteristics of the built environment that may not be available through other earth observations, such as occupancy, shared walls, and connecting roofs, as well as information on the structural condition. SEOC must make its best endeavour to source these updates to augment and update, the ArcGIS backend, to minimise the gaps if any.

m) FM Radio. Private and public Radio stations must be encouraged to actively participate in disaster prevention and relief efforts as part of their social responsibilities to the community. FM channels airing for traffic-related information like road-blocks, traffic diversion, speed restrictions, flood water status, other weather updates etc, can help the travellers from getting marooned midway, during a major crisis.

n) AR & VR Tools. Modern tools like Virtual Reality (VR) and Augmented Reality (AR) technologies etc are to be put in use, as part of the training programme, to simulate real-life emergencies, disasters and crises.

o) SDMA as Incubation Centre. Encourage wider participation from universities, industries and research institutions to use the facilities and expertise within the Kerala DM organisation. This opens an excellent opportunity for the students, researchers and the faculty to interact directly with the DM efforts of the state.

p) All-in-One SDMA App. Kerala SDMA must have a fullfledged, two-way, interactive, mobile app for leveraging the benefits offered by the avenues of Crowd Sourcing and Crowd Funding.

q) App Challenge to Develop SDMA App. SDMA must conduct a nationwide contest to spur creativity, the convergence of technologies, ideas (on the integration of various public services and utilities), and applications, for the innovative development of vari-

ous interfaces, with a data analytics integrated dashboard, for the above app. Alternately, a Public-Private Participation (PPP) model can also be considered.

r) Digital Disbursement of Relief. Utilising the developments and innovations taking place in UPI based digital payments, a coupon-based distribution of disaster relief should be considered. This feature can also be an add-on module of the above SDMA mobile app. Creating a facility of a coupon or UPI based mobile payments will enable the distribution of preliminary insurance payments or government monetary credits, necessary to buy the daily bare necessities and other essentials for the survival of the affected.

s) IoT Solutions on PPP Model. The public is increasingly getting familiar with smart homes and connected technologies. As we progress, encouragement must be given to the public to set up DM related IoT systems at their immovable assets and live stream data to the insurance and DM agencies. As part of their risk mitigation services, the insurance companies be permitted to market, insurance as a package, with smart devices and remote sensors, attached to their insurance premiums and compensation payments. Such a type of cooperation must also be suitably incentivised by government interventions. As part of their understanding with insurance firms, the DM authorities can also push for the inclusion of their connected devices (viz, water leak sensor and fire detector, smoke detectors, door sensor etc) for insurers to provide as a consolidated package, to their policyholders to detect potential water inundation, fire and theft etc, before they go out of control. On similar lines, the insurance package can be further expanded against the fight of pandemics / epidemics, by adding body health or bio-medical sensors.

t) Insurance vs Govt Relief. Any cost-benefit analysis of the past records will suggest that the DM tends to spend more time, resources, energy and money in disaster relief activities, than its efforts towards risk reduction, mitigation or its prevention. Prevention is always more valuable and cost-effective than restoration. Improvements in the effectiveness of communications tools, combined with increased access to broadband internet connections and smartphones, provide new opportunities for insurance companies to support risk mitigation by their policyholders. For example, either over the proposed SDMA app or by their own dedicated smartphone apps, insurance companies can allow their policyholders to access information on risk reduction measures, that they can take as well as to receive early warning alerts, in case of imminent risk. Improvements in forecasting can also help insurance companies position claims adjustment resources in advance of a catastrophe to accelerate the adjustment process and pay claims more quickly. Based on their ration-card category, the government can consider, subsidising the insurance premium from SDRF funds.

u) Insurance as DM Service. The widespread use of the internet and smartphone applications across all sections of the population allows faster and transparent implementation of emergency financial support and insurance claim settlement through mobile apps.

The government must, therefore, enter into partnerships and/or technology agreements with the insurance sector, to near real-time impact assessment, insurance underwriting and faster claims settlement. Availability of such an arrangement can result in, underwriting and claims adjustment expenses can be made considerably lower than in the case of indemnity insurance and also the payouts can be made much more quickly allowing normal livelihood and businesses to recover much faster.

v) Digitalisation of Disbursements. The digitalization of finance in post-disaster situations can not only play a crucial role in the preparedness and response to disasters but also drastically improve the financial stability of affected persons, especially in areas, where banking infrastructure is limited or has been devastated. In the aftermath of a disaster, mobile payments can facilitate early recovery investments, the purchase of personal necessities as well as donations and cash-based interventions being executed by various aid agencies. All it requires active collaboration with mobile network providers, insurance agencies and local banks, these services can be further integrated to facilitate, mobile payments for cash for work, coupons for food kits, and other services.

w) Can't Eliminate Epidemics; but Can Minimize their Impact. The Covid-19 pandemic has acted as the catalyst that burns the old system down, while the emerged connected alternate is so much more technology-oriented that will enable human relationships instead of obstructing it, as it does now. The benefit that this pandemic brings, is getting more people, to try out newer technology and its allied health services. This paradigm shift can become the norm of this decade, as people would be reluctant to reverse the change once, they get the feel of these new comforts, – thus not only defeating the spread of infectious diseases but also minimising their impact.

x) Tele-Health & Tele-Medicine. An in-person visit to a doctor for something as routine, as a prescription renewal or a regular check-up, or a referral, could put aged and vulnerable categories of citizens at high risk of contracting, another infectious disease. All hospitals should be directed to re-equip themselves with telemedicine facilities, to enable the high-risk patients to see their doctor without leaving the house.

y) Integration of HIMS Systems. All health care institutions and hospitals should be directed to digitalise their health records and connect to a centralised Health Information Management System (HIMS) managed by the government for collation of health data, centralised management and expansion of e-health initiatives. Such an arrangement will be able to forewarn and predict the possible outbreak of epidemics before its goes out of control.

z) Management of Inventory. The GIS-based disaster information management system is aimed to collect, accumulate, process, and provides data related to disasters such as observations, shelters, damages, and disaster activities. GIS usually holds the basic information system for any disaster-related database at the local, state and regional levels. Time and experience on GIS working, has tremendously changed the concept of mapping with different overlying layers. The DM authorities and first responders

must demand the integration of telehealth systems and HIMS data with their inventory management as yet another GIS data layer. As we migrate to Bigdata technologies, this would enable comprehensive situation awareness at every command and control centre, to successfully manage any crisis in future. In addition to basic logistics details, the data could include, bed tracking, staff status, tools for quarantine facilities management, medicine and PPE status, oxygen levels, common operational map, situational awareness dashboards, asset tracking, financial tracking etc.

aa) Agro-Met Weather Stations to Plug Gaps. We cannot change the weather, but its prior knowledge helps reduce losses and damages. Monitoring weather is very an important parameter not only for DM applications but also for many fields of farmers, horticulturists, turf managers to aid decisions on planting, pest control, irrigation, drought and flood management etc. In the last few years, the accuracy in weather predictions has gone down due to the changing weather patterns and fewer field AWS systems. Heavy rain can occur in one location, and in another location a few meters away, there can be no rainfall. The same is the case with other weather applications. Therefore the weather monitoring network within the state should be expanded as large as possible, to obtain the best reality of the overall weather. Towards this, mult-purpose, multi-service Automatic Weather Station (AWS) that measures parameters such as Rainfall, Wind Speed, Wind Direction, Air Temperature, Relative Humidity, Barometric Pressure, Solar Radiation, Leaf Wetness, Soil Moisture, Soil Temperature and others using precision IoT based sensors and a Data Logger, must be installed on the lines of Private-Public Participation (PPP) model for Pan-state coverage and to plug existing gaps in weather reporting.

bb) Portable Emergency Communication Systems (PECS). On the basis of the State disaster maps, standalone trailer or vehicle-mount PECS are to be procured and distributed to each district HQs, for their swift deployment during emergencies. At least 50% of PECS systems, must-have mobile phone locator systems, to reach out and rescue the affected, at the fastest possible means.

cc) Relationship with Telecom Agencies. Almost all of the technologies require high-speed networks to function at their best; however, the rural and remote areas often tend to lag in broadband coverage and capacities. Reliable broadband and cellular communications networks that provide universal access, including in remote areas of the State, are critical to the disaster applications, emerging technologies and innovations described in this report. Hence, enhanced efforts are to be made under the aegis of STDCC to ensure not only the pan-state reliable internet connectivity with adequate capacity and coverage but also to assure higher penetration of 4G/5G cellular coverage on a pan State basis. Swift restoration of public telecom networks should be prioritized, with emphasis for more Cellular on Wheels (CoW) solutions to allow for temporary mobile connectivity, on as and where basis.

dd) DC-DR Arrangements. The cost of any emerging ICT processing, storage, and networking hardware can be generally high. Though Big Data, or AI or Blockchain itself costs little to generate, its analysis requires high-end hardware, data science expertise and high-end ICT hardware. It may not always be possible to resource upgrade or maintain requisite expertise within a Government environment. Hence, leasing Cloud platforms on competitive terms are recommended for these emerging high-end applications. However, the primary server-storage functions are to be continued on-premise (DC), while its data-recovery (DR), website functions and the public information dashboard etc could be hosted in secure cloud computing platforms offering much-required Server-Storage redundancy, complete data encryption and role-based access security.

ee) Pay-as-Per-Use Concept In Government. Cloud computing is transforming the way the public accesses mobile applications, providing individuals and businesses with access to on-demand information services via the internet. Among other benefits, the availability of cloud computing services offers pay-as-per-use and doesn't need to invest in huge one-time capital. To obtain the advantages of cloud computing, the government must reconsider its budgetary allocations from one-time capital to recurring monthly service or revenue accounts.

ff) Enhancing Social Media Skills. The social media tools are here to stay, in support of the exchange of critical information between those affected by a disaster, and those participating in response, relief and restoration activities. However, social media is constantly evolving, and best practices for its use by DM officials will progressively change as well. It is therefore important for SDMA to monitor and update their social media skills, staff capabilities and practices frequently, by attending social media workshops and seminars, and reading updates and related articles. Being on top of the latest social media trends will enable disaster management and relief personnel to better serve citizens and save lives.

gg) Foster Innovations. Using the advances in Information Technology (IT), the state must create an open knowledge-sharing platform to discuss, how advances in technologies can save lives and socio-economic damage from various natural and accidental disasters. Such informal discussions can foster innovations and knowledge exchange that could help to achieve greater efficiency and responsiveness; reaching more people, sooner, more cost-effectively, and saving more lives.

hh) Addressing Technology Gap. While implementing modern technologies in DM, a significant challenge is to recognise traditional mindsets and anticipate their resistance. To meet these challenges, there is a need to bridge the gap in awareness, bringing together those who are dealing with disasters and those who deal with technological solutions. The reluctance to handle modern technologies is to be overcome with the implementation of staff-friendly policies. Another important aspect is to expand technology literacy among the employees and ensure wider access to the web and mobile

phones, especially among the most vulnerable populations. This approach however also need to consider local capacities and cultural aspects to optimize DM communication objectives.

ii) Prevention vs Rehabilitation. It is the duty of a responsible Government to remain committed to its citizens towards the prevention of disasters, its mitigation, response, and long term rehabilitation of the affected. Post-Ockhi and Floods-2018, the state has invested heavily in its relief rehabilitation efforts. It is time to undertake a rigorous cost-benefit analysis to determine the costs the state DM usually incur for relief distribution and rehabilitations vs the value and benefits of disaster risk prevention and hazard mitigation. In the absence of sufficient data or analysis, a more rudimentary presentation of costs and benefits may be sufficient to determine the size of the investment that is justified for forecasting, early warning and response.

Conclusion

95. Science, technology and innovation play a crucial role in the Sendai Framework for Disaster Risk Reduction 2015-2030. The latter indeed emphasizes the need for enhanced scientific and specific technological solutions for all the phases of disaster management, namely, disaster preparedness, disaster reduction, disaster mitigation, and post-disaster rehabilitation, prioritizing the development and dissemination of science-based risk knowledge, initiatives, technology, and innovations.

96. The fundamental role of technology remains the same - helping to achieve resilience goals better, faster, more reliable and even more sustainable. The use of emerging technologies like AI, IoT, Blockchain, Big Data in developed nations have proved that they can revolutionize the way disaster managers and decision-makers acquire, analyze and act on disaster events and their rescue efforts. Emerging technologies and innovations can also enhance the processing and analytical capacity of decision support systems. Such systems are technology (software) tools that support decision-making by facilitating the comparison of different options for (in the context of natural hazards) risk management (e.g., through a calculation or visualization of the costs and benefits of different approaches).

97. Several advanced technologies and systems that have already entered the marketplace in recent years could provide vital support to the State DM plans and communication programmes, but cannot be considered in isolation, since each of them has its own limitations. The cost of these technologies, as well as the connected devices and systems discussed above, are declining. It is also pertinent to note, with time newer technologies could also emerge, replacing or making the above discussions partially or fully obsolete.

98. Usually, DM technologies are not a big consumer market, and there is no one-stop solution for all challenges. Technological applications being considered for DM, therefore must not be a product but should be a customized, modular solution, to act as an enabler of a calculated and science-oriented approach to infrastructural planning, collecting and managing data, forecasting, monitoring and, engaging communities in DM, funding, and supporting long-term resilience. Continued developments in this field are necessary for

supporting increased understanding of hazards, exposure, vulnerabilities, and resilience rebuilding.

99. When modern-day tools are not working, we are left with our own minds and skillsets. For that reason, it's critical to study up and learn the skills to ensure survival come what may. Over generations, people in disaster zones have developed traditional technologies as efficient solutions to many of their disaster-related problems. These technologies are considered culturally compatible and inclusive to the indigenous populations. Nonetheless, many of these technologies and methods have only restricted applicability and possess the limited potential to reduce the impact of disasters, considering the severity of natural disasters such as flash rains, flash floods, landslides, and cyclones. Hence the need is always there for the application of modern technologies in disaster management, wherever and whenever possible.

100. The convergence of science and technology can foster innovation that offers useful tools to cope with emerging hazards. The effectiveness of technological innovations in DRR has been proven in many cases, including early warning systems and innovations in construction to enhance the resilience of buildings and infrastructure. The emerging technologies and innovations described above can address most of the immediate technical challenges that impede investment in risk reduction, disaster preparedness, disaster mitigation, and post-disaster rehabilitation. Improvements in risk assessment capacity, including greater accuracy in the identification of hazard-prone regions and structures at risk, should allow better decisions on the investment of scarce risk reduction resources.

101. In an emergency, response time is critical. Gaining rapid access to pre-event data, analyzing the current situation on the ground, identifying the most critical areas in need of attention and then communicating cross-agency to all responders ensures the best use of available resources in the recovery effort. The unpredictable nature of disasters necessitates that the administration always is prepared for the worst. A significant degree of that preparation lies in the ability to have complete coordination and communication solutions. Innovation is the key to such a solution.

102. Cyclone Ockhi and the floods 2018, has proved the importance of timely alert dissemination in typical state-wide disaster operations. Accordingly, the project Early Warning Dissemination System (EWDS) was born to reduce the vulnerability of the state populace by tackling the existing gaps in the dissemination of warnings to the communities.

103. Plans need to be evolved for the up-gradation of State EWDS to the next generation with a perfect amalgamation of sensors, software, domain knowledge and relevant workflows into intelligent information ecosystems delivering actionable information is the key to a successful and reliable comprehensive Early Warning Dissemination System. Provision shall be there to capture constant real-time events and changes in the geography through satellite imagery, sensors, crowd, and transforming every raw geospatial data into relevant actionable information.

104. Drone technologies hold significant promise to improve disaster aid delivery. Robots and drones can beam real-time video directly to EOCs to produce real-time maps of disaster-affected areas and populations in extremis. Artificial intelligence can be deployed to comb social media posts from disaster zones to improve responders' decision-making, and analyse mobile phone data to predict key demographic variables related to vulnerability.

105. Technology plays a critical role in responding to the disaster well and its relief distribution too. While technology cannot replace the vital resources people need in disaster – food, water, shelter, or comfort from loved ones - it is transforming disaster relief efforts and paving the way for an evolving approach to aid distribution; one that can reach more people, faster, and help communities to develop resilience, before the next disaster strikes.

106. In the world of public safety and disaster response, the importance of a comprehensive disaster management blueprint that includes a robust Unified Communications (UC) strategy cannot be understated. Securing DM communication infrastructure is a crucial aspect of a unified communications plan considering the exponential growth of Bring Your Own Device (BYOD) and IoT devices that have become even more crucial with the sizeable, displaced workforce created by COVID Pandemic since the outbreak of the virus in 2020. Establishing solutions that ensure resilience and sustainability can also help organizations better manage critical events that might negatively impact business continuity. Prioritizing the importance of critical event communications and eliminating delays owing to organizational silos that impede rapid and unified communication are the major challenges that must drive the DM technologies in coming years.

ICT is only a tool and it should not be treated as a panacea for all issues arising in disaster management. As is the case with any other tool, the effectiveness of ICT in reducing disaster risk depends on how it is used. The use of ICT for disaster management should not be a choice between this medium/technology against that medium/technology. The very reason for the existence of so many channels is that none of them is suitable for every situation. One medium that might fit best under a certain set of circumstances might be of little use under another. Thus, what is required is not a competition between different media and technologies, but instead, using the best combination depending upon the circumstances.

ANNEXURE V
Coastal Risk Reduction

Status of coastal erosion

Monsoon months from June to August have been traditionally experiencing coastal erosion and associated problems. A shift in the erosion pattern is observed in recent times. Recently coastal erosion is reported in non-monsoon seasons also. In addition to eroding coasts, waves overtopping seawalls and causing flooding landward of seawalls have emerged as a major issue . Out of the 590 km of the Kerala coast, the extent of eroding coast is reported as 37.2%, 45%, 60% and 63.2% by Space Application Centre (SAC), National Centre for Coastal Research (NCCR), National Centre for Earth Science Studies (NCESS) and

National Centre for Sustainable Coastal Management respectively. A recent report by the Irrigation department says the total eroding stretch is 50% of the coastline (291 km) out of which about 171 km of the coast need immediate protection. Remaining coasts are either stable, accreting or protected coast. The differences in the extent of eroding sector probably could be due to the differences in the period of assessment, the method used, the maps and imageries used, etc.

Probable reasons for erosion

This process of natural erosion and accretion associated with monsoons and storm events is normally cyclic and periodic and it is always there for a sandy beach. Natural erosion happens in a different manner along coasts adjoining tidal inlets. Erosion along coastal cliffs is episodic and not cyclic. Mudbanks that occur along the Kerala coast during monsoon months modify the location and nature of erosion and accretion at the mudbank regions and adjoining coasts. Mudbanks stopped appearing in some of the earlier mudbank locations, either due to migration or non- occurrence. Changes in the occurrence and migration and non occurrence of mudbanks have altered the erosion sites in mudbank regions.

Coastal morphology and landscape have changed drastically over the last hundred years due to a series of anthropogenic interventions. These have been modifying the natural erosion processes and resulted in the now experiencing coastal erosion scenario. Coastal erosion has reached a stage where erosion due to anthropogenic interventions may have surpassed that due to natural processes.

The coast has 33 tidal inlets where backwaters or rivers join the sea which are normally seasonal (pozhi) with sand bars at the mouth except during monsoon months. Sand bars in many of these seasonal inlets are now removed and modified as fishing harbours with breakwaters. Sand removal is regularly continued in the harbours as part of maintenance dredging which again cause a general depletion in the sediment availability along the coast. Thus construction of harbours has become one of the prominent destabilising factor of the coast.

About 90% of the 590 km long Kerala coast was sandy beach. Hard structures like seawalls and groynes were constructed for protecting the coast from coastal erosion. Currently about 63% of the coast have such coastal protection structures. There are other constructions like promenades, parks, religious centres, fish landing centres, tourism, and industrial establishments constructed in active or newly accreted beaches. Construction of houses is also happening closer to the shoreline as a natural consequence of population increase and retreating shoreline. Another major anthropogenic intervention is mining of beach sand such as mining by industries for heavy minerals, mining of sand from sand bars and tidal inlets (pozhi), maintenance dredging for ports and harbours, and mining and sale of sand accumulated on the sides of harbour breakwaters. This is seriously reducing the availability of sand in the beach which is already affected due to construction of dams and check dams in the rivers that debouch into the Lakshadweep Sea.

These human interventions have reduced the availability of sand in the coastal system and blocked or modified the natural flow of beach sand and locked beach sand preventing its

natural free flow that maintains the dynamic coastal system. These are causing erosion to extend further to new areas and increasing the intensity of erosion. The loss of beach on the seaward side of seawalls and increase in nearshore depth due to scouring seaward of seawalls have added a new dimension to coastal erosion. It is 'wave overtopping' seawalls and causing flooding and damages landward of seawalls.

Climate change related processes like sea level rise, increase in intensity and frequency of storms and cyclones, increased occurrence of high energy waves and changes in its direction, and unseasonal occurrence of storms are other newly emerging concerns. When combined with other reasons, the severity of erosion increases under the changing climate induced processes.

The impact of coastal erosion is much severe and wide spread because of the high density of coastal population and unique settlement pattern close to the shoreline, which differs from rest of India. The normal increase in coastal population itself forces migration and extension of settlement closer to shoreline. There is also a trend of non coastal community people migrating and encroaching towards the coastal zone. All these increase the pressure on land and reduce the very essential free space required for forces from the sea to act in addition to increasing the impacts.

Thus a combination of reasons are there for the increase in the extent of eroding areas, increase in intensity of erosion and increase in its impact.

Coastal protection status

Irrigation department has reported that 63% of the coast (365 km) is protected either by seawalls or by groynes or both. It is also reported that the seawalls/groynes along 35% (128 km) of protected coast only perform satisfactorily. The remaining 65% (237 km) of the protected coast is heavily or partially damaged and is eroding. Construction of coastal protection structures started with few short groins at Chilakkur, south of Varkala about 130 years before. Construction of seawalls and groynes were undertaken in a big way since 1955 which is still continuing as the primary coastal protection measure for the State. In between other measures such as coastal vegetation and beach nourishment were also experimented on an experimental/pilot basis which were not further continued due to practical difficulties in getting sufficient sand for nourishment and limited success. Gabions with rocks filled in polypropylene nets were also tried in certain locations. An artificial submerged reef was constructed at Kovalam in 2009 with international technology support. This could not protect or sustain beach as envisaged. Materials other than granite rocks like geotubes (sand filled), tetrapods, etc. are now being tried. There are some efforts for developing coastal vegetation by Forest Department and FIRMA in identified coastal areas to support coastal protection. The designs for costal protection measures are being provided by CWPRS and IITM. Recently MoES institutions such as NIOT and NCCR are also supporting Irrigation Department and Coastal Area Development Corporation for design of coastal protection structures.

Protection is provided to many of the coastal cliffs in the State by stacking rocks along the base/foot of the cliff.

Approach for 14th Plan

Beaches with hard protection structures (seawalls and groynes) with no beach occupies more than half of the coast (about 270 km) in place of beaches all along the coast. The other half is stable, partially stable (prone to erosion with depleting beach) or accreting. When compared to 1960s a new normal is in place with significantly modified coastal morphology and landscape due to human interventions. Changing settlement patterns and new economic investments have increased the demand for the limited coastal land. Climate change related processes have significantly altered the physical processes that influence erosion and accretion. A new normal is existing now when compared to the period when coastal protection designs were initiated in 1960s'. This new normal necessitates a new approach to coastal management and protection with due consideration to ecosystem based management accommodating climate change impacts. Already coastal erosion is approved as a disaster by the State. New approach needs to follow the concept that beach is the best protection for the coast and sufficient space is needed for the shoreline to adjust with waves and other forces from the sea. Sand dunes, dune vegetation and natural vegetation provide additional protection. New approach has to consider governance, capacity development, data generation, sustenance of available beach, sustenance of coastal ecosystems and morphology including beaches, technology adaptation, enforcement of policies and existing laws like CRZ, enhancing climate resilience and ensuring people's participation through the local bodies and community organisations.

Reduction of risk by controlling further increase of eroding locations

New areas of erosion are being added to the existing ones every year. Extension of the area of erosion needs to be controlled.

- Existing beaches in stable and accreting areas have to be conserved to make these coasts safe from erosion in future.
- Beach management plans to conserve existing beaches may be prepared and implemented to sustain sufficient beaches for the forces of waves to act upon. These plans may consider planting of vegetation and development of artificial dunes based on scientific recommendations
- Regulatory authorities and local bodies should ensure that no encroachment is allowed in beaches and no activities are permitted in newly accreted beach. Accretion temporarily locks beach sand in a particular location which may be required for the beach at a later time.
- Regulatory authorities and local bodies should ensure that activities that may cause damage or loss of beach should not be permitted in the beach and nearshore.
- Construction of breakwaters for fishing harbours is one of the major causative factors for destabilisation of the shoreline. Better designs to allow sand by passing to the down drift side of the harbour may be developed with the support of other agencies, if required. Close scrutiny on the requirement and impacts on shore stability is required before permitting new harbours. An assessment of the functional and design performance of the already constructed fishing harbours is needed before new harbours are permitted.

- Nourishment of beach to compensate loss of beach may be ensured if any human intervention causes loss of beach as directed in CRZ notification.
- Settlement plans may be prepared and implemented for coastal fishing villages considering their long term housing and other needs with provisions for basic services including sanitation, safety and disaster preparedness as envisaged in CRZ notification. This will considerably reduce the impact of erosion.
- 'Punergeham' is a programme to reduce the impact of erosion by moving settlement within 50 m from the high tide line to safer places. This may be further pursed. Coastal area extending 50 m landward from high tide line is reasonable space for allowing the shoreline oscillation due to storm waves.
- Irrigation, Harbour Engineering and Fisheries Departments are directly involved in coastal protection and infrastructure development. Port and Tourism departments are also involved in developing infrastructure. Other attached organisations like Kerala State Coastal Area Development Corporation and Kerala Irrigation Infrastructure Development Corporation are also doing coastal protection and infrastructure works. Lack of coordination among these agencies is evident. Disaster Management Authority or any other authority should take the responsibility of ensuring coordination among these departments in planning and implementing shore management projects.

Strengthening knowledge base

- New approach should consider coastal and nearshore processes, environmental factors, beach availability, availability of construction material including sand for nourishment.
- Existing reports and studies on coastal vulnerability with respect to coastal erosion and flooding may be evaluated by experts and vetted with information from SDMA, local bodies and field units of fisheries department. Irrigation Department has identified 13 critically eroding sites which require immediate intervention.
- Assessment of functional and structural performance of coastal protection measures already implemented may be undertaken. This may be considered in deciding and designing future costal protection measures.
- Mudbanks may be mapped and regularly monitored for its occurrence, non occurrence and movement/migration. This should be considered while planning coastal protection measures.
- Support of expert institutions like NIOT, NCCR, CWPRS, IITs, CUSAT, etc. may be sought for SMP preparation, design and implementation. Irrigation Department is already in the process of signing a MoU with NCCR and KSCADC is collaborating with NIOT. Irrigation Department has a coastal monitoring programme with IITM, Chennai and collaborative programme with CWPRS. These need to be coordinated, restructured and focused to get better results. Disaster Management Authority may take the initiative for this.
- Institutions like Kerala Forest Research Institute (KFRI) may be engaged to identify locations suited for soft measures for coastal protection. The report may be discussed with coastal management experts before implementation.
- Local bodies may be empowered to monitor beach state, status of coastal protection structure and status of erosion regularly.

- Shoreline Management Plan (SMP) may be prepared for the Kerala coast based on regional coastal process study. The SMP may be prepared giving due consideration to sediment cells along the coast. Long term and short term measures for coastal protection have to be based on the SMP. Engineers and coastal experts in the respective departments should get involved at every stage of SMP preparation.
- Emergency measures are required for identified critically eroding coasts to protect assets already in dangerous conditions. A protocol may be developed for emergency response including the type of protection, evacuation of affected people, role of local bodies.
- Criteria may be developed to decide on the type of intervention for an eroding coast giving priority to soft measures. The CWC guidelines (2019) may be adapted with modifications, if necessary.
- An inventory may be made on the availability of materials suited for coastal protection measures like granite, sand, and other alternate materials.
- Coastal cliffs of north Kerala are more stable than that of south Kerala due to the differences in lithology. There are cliffs with frontal beaches and those directly fronting the sea. A cliff management plan considering the differences in nature of lithology, structures, recession agents acting upon the cliff and land use may be prepared with recommendations for cliff stabilisation and land use in identified areas.
- Coastal flooding due to wave overtopping costal protection structures and those in wide accreted beaches have to be mapped. Land use and drainage mapping followed with land use and drainage management plans are to be prepared for addressing the issue.
- All study reports and designs may be scrutinised by a committee of experts including people who are familiar with Kerala coast and the processes. Reports may be provided to the respective local bodies for feedback.

Affected people

- An inventory of land and assets lost due to coastal erosion may be made. Possibility of compensating the losses to the people may be worked out. Reasonable compensation for losses due to coastal erosion may be made mandatory as part of disaster management.
- Arrangements may be made with the support of local bodies to provide accommodation in separate dwelling units for families when they are evacuated from eroding areas. This will ensure respecting the dignity of the coastal community.
- Many man days and working days are lost for fishers due to warnings of rough sea state. Among these there are many days which are suited for fishing. Hence there is an urgent necessity for fine tuning the sea state prediction by downscaling of sea state prediction and proper validation with feedback from fishers. SDMA has to address this.
- There should be schemes for providing compensation for traditional communities for loss of fishing days due to restrictions on going for fishing.

Capacity development

- Engineers of Irrigation and Harbour Engineering department need regular updating of their knowledge and skill in dealing with coastal erosion. It will help critical evaluation of the designs for coastal protection structures received from other agencies and suggest

modifications to tune it to Kerala conditions. Arrangements for regular technical training (including laboratory training in software, data processing, instruments and measurements) may be made with the support of expert institutions like CWPRS, NCCR, NIOT, IITs, CUSAT, etc.

- A dedicated core group of engineers and coastal experts may be developed in the respective departments. Core group should have staff recruited specifically for coastal management.
- An auditing of the functioning of Kerala Engineering Research Institute (KERI) may be done with respect to facilities, manpower and functions with special reference to coastal management. This should lead to enhancement of facilities, selection of appropriate manpower, sustenance of trained manpower, and focused research targets.
- A plan for establishing a dedicated institute for coastal studies including costal engineering may be initiated during this plan period. Establishing a coastal wing in existing organisations like CWRDM could also be thought of.

Coastal protection measures

- Coastal protection measures need to be reoriented for the new normal now in place where the changed coastal geomorphology, human interventions and climate change impacts are factors. The design has to be supported by regional costal process studies considering sediment cells and supplemented with site specific studies.
- Medium and long term interventions for coastal protection may be based on recommendation from SMP studies, Beach Management Plans, Cliff Management Plans and tidal inlet Management Plans with site specific reassessment.
- Protocol for emergency response may be adhered to for protection of identified critically eroding coasts.
- Selection of appropriate coastal protection measures may be decided as per the criterion developed for the purpose. Follow the CWC guidelines (2019) in this respect for deciding the type of protection measure (soft, hard or hybrid and which type of soft, hard and hybrid). The CWC guidelines (2019) may be adapted with modifications, if necessary.

ANNEXURE VI

Stakeholder Consultation for problem identification and possible solutions

Land Management

Key Problems/Challenges	Reasons for the problems	Possible solutions
• Land degradation • Soil erosion • Habitat loss • Forest land fragmentation	• Unscientific land alterations • Government policies • Development activities • Conversion of natural forest into plantations especially for mono-cropping • Mining • Tourism • River valley projects • Alien invasive species • Cultivation along slopes • Internal migration (from midlands to highlands)	• Restoration programme with community participation in riverine areas, industrially polluted areas etc. River Management Committees to be formed. • Policy interventions • Ensure that the East-West surface hydrology is not curtailed by North-South constructions (roads, railway lines) • Agricultural cropping patterns based on agro-ecological zones to be followed. • Watershed Management: Integrated scientific soil and water conservation measures to be implemented. • Buffer zones for critical habitats.

Land laws	• Multiplicity of land laws (Kerala Land Utilisation Order, Land Conservancy Act etc.) • Complexity of numerous land laws and legislations. • Ineffective enforcement of existing regulations.	• Revenue Department should have a dedicated wing to look after land resources. Routine works may be separately handled. • Proposed Land Resources Department/ Wing should devote itself to scientifc land management of the state and plan for allocation and re-allocation of land for different sectors. • Review of all land laws by a competent committee • Simplified comprehensive land code has to be prepared.
Tourism • Unregulated tourists flow • Unplanned development in tourist destinations. • Construction activities in ecological fragile zones (hotels, resorts, widening of roads etc.)	• Lack of proper policy • Lack of guidelines in present building rules with respect to ecological fragile zones (Eg: flood plains, hilly regions etc.)	• Carrying capacity assessment for regulating the number of tourists. • Policy intervention for Tourist Circuit Developments. • Site specific building rules and regulations should be prepared (Amendment to the present KMBR)

Pressure on land resources for settlements	• Dispersive nature of the built-up. • Unavailability of room for river. • Unoccupied houses and flats.	• Cluster/vertical housing should be actively promoted for efficient land use. • Survey of flood plains: Relocate houses in flood plains (Puzha purampokku) – Vulnerability Linked Relocation (10 Lakhs Scheme) • Regulate the construction in flood plains • Avoid construction in fragile ecosystem (Site specific building rules; Eg: Hill area building rules) • Revisit individual land holding limit and no. of houses owned by an individual.
Degradation of river bank ecosystem	Encroachments cultivation on the flood plains.	• Integrated farming with livestock and fisheries. • Vegetative protection should be encouraged. • Indigenous species of plants and trees should be used along with geo-textiles for river bank protection. • Survey of river purambokku on river banks should be carried out. • Zone regulations should be strictly followed.

Land use issues– unavailability of open spaces in cities	Unregulated urbanisation	• Potential based resource planning • Revisit existing government land for providing more planned open spaces
Paddy and wetland conversion	• Economic reasons and development pressure. • Globalisation and economic liberalisation has a direct impact on conversion. • 2018 Amendment of the Wetland and Paddy Conservation act seems to be counter productive. • For construction of roads and other infrastructure.	• Final data bank of paddy and wetland to be completed and should be published within a specified timeline • Integrated farming: animal husbandry, poultry and fisheries may be integrated with potential plantation cultivation • 2018 Amendment should be withdrawn • Farmer's Co-operative Society should be formulated with small scale farmers
Land use issues: monoculture of exotic species Use of pesticides/weedicides and fertilisers Linear intrusions	• Economic reasons and livelihood benefits • For installation of power lines, roads	• Commercial monoculture plantations should be stopped. • Organic farming should be promoted. • Cleared land under power lines may be repurposed for grounded crops in collaboration with Kerala Agricultural University.

Pollution due to industrial land use	• Lack of data on the spatial distribution and area covered by industries. • Effluent discharge leading to soil and water pollution.	• Identification of suitable land for citing different types of industries. • Effluent treatment plants and enforcement of regulations by the Pollution Control Board. • Buffer zones around specific industries should be defined for residential and ecologically sensitive zones. • Ensure eco-restoration of industrially contaminated areas.

Human Settlement

Key Problems/ Challenges	Reasons for the problems	Possible solutions
Urban content of Kerala is 50% (2011 Census) but not manifested either physically or economically. Such an urban spread causes dilution in the economic base of both urban and rural areas of the state.	Lack of proper policy for streamlining the urbanisation of Kerala.	• Revitalise urban areas to compact urban form to perform urban functions complimentary to the rural hinterland and act as an engine of development. • A settlement policy may be formulated at state level. • A Development Plan for all districts may be prepared. • Preparation of Master Plan and Execution Plan for all settlements in Kerala.

Kerala has a very high Generic (Universal/Global) Floor Area Ratio (F.A.R.) of 4. In other parts of India, the Global F.A.R is 1.5 to 2 at the maximum.	It paves way for a huge disaster if a calamity occurs. It makes all spatial plan including Disaster Management Plan ineffective. Pressure on environmentally sensitive land to convert build-up area will be high.	Global F.A.R of the Kerala Municipality Building Rules/Kerala Panchayat Building Rules to be reduced to 2.5 as maximum. However, higher F.A.R may be permitted only through town planning schemes.
Scattered built-up without sufficient area for water retention.	Construction is carried out everywhere.	Restrict construction in safe zones at a high density.
Lack of proper drainage facility.	The water courses are reclaimed and built over.	Revive the drainage system by giving proper linkages wherever missing.
Water is not retained due to destruction of forests.	Since forests are destroyed, the rain water is not held in forest areas and this results in flow of all rain water into rivers/ water bodies leading to floods.	Conserve forests and plant more trees.
Settlement in ecologically sensitive area.	Land in ecologically sensitive areas made available at lower prices and through schemes.	Revisiting Land Use Policy based on hazard maps and relocating communities to safe zones.

Lack of evidence for planning and decision making.	Data quality, data input and collection mechanism leading to issues with aggregation and coordination.	State level observatory integrating all relevant datasets and models may be proposed. UA and LSG level platforms could be built on the state level observatory/ platform. This acts as a focussed early warning and emergency management system. Such platform will support dynamic plan making process for data collection, dissemination and course corrections.
	Unavailability of accurate, up-to-date information. High resolution is unavailable for research purposes.	• Open repository for R&D and active contribution from scientific community and other stakeholders. • High resolution satellite imagery for high risk zones for specific risk reduction measures.
Need for new development	Incentives supporting asset accumulation for particular segment of society influencing the overall affordability of housing.	• Rent control acts to unlock the idle housing stock and open it up to the market at an affordable price. • R&D for promoting and incentivising alternative building technologies.
High economic losses in disaster.	Lack of affordable insurance and other safety nets.	Promote region specific risk insurance schemes and build awareness on such schemes.

Disconnect between development plans and ecology.	Scope of plans limited to administrative boundaries, ignoring or regulating the impact of the region to the settlement.	Re-imagining planning boundaries beyond administrative demarcations and considering watershed boundary, hazards, coastal regulation and other large impact regions.
Usage of high embodied energy materials in the building industry which causes high carbon emission and eventually climate change. The architecture which came into our lifestyle as part of globalisation spoils the habitat and we are dependent on artificial comforts using electrical and mechanical equipment like air conditioners.	Ordinary people are unaware of the materials used in traditional buildings, renewable materials etc. The marketing strategy of MNCs is such that false information is provided to the people about sustainable materials as they intend to promote only high embodied energy materials. Use of high embodied energy materials in architecture does not ensure thermal comfort and hence increases the energy consumption (electricity) causing further carbon emission.	• Building codes/laws should also cater to the aspect of building materials. • Sanction for the building may be subjected to the use of sustainable construction materials (natural materials, renewable materials, low embodied energy materials) so as to reduce the usage of high embodied energy materials such as steel, cement, glass, composite materials etc.
Organic development of human settlement.	No policy	• High density and low rise construction may be encouraged.

Key Problems/Challenges	Reasons for the problems	Possible solutions
	Plantation	
• Crop loss/Reduction in yield • Soil erosion • High pest & disease incidence • Water stagnation within the plantation • Dwindling production in cashew	• Erratic weather pattern • Improper agricultural practises/no disaster preventive practises • Inadequate soil and water conservation measures • Plantation crops are cultivated in more than 30% slope areas	• Adopt soil conservation practises like terracing, contour planting etc. • Cover crops and fruit crops in non-cultivated areas. • Management of shade tree and crop canopy • Crop diversification • Effective pest/disease management • Agro-Ecological Unit (AEU) based effective management practises to improve productivity. • Tea: Subsidy schemes for small farmers
	Plantation: Tea	
High intensity of rainfall in short times	Change in climate for the last five to six decades causing the erratic rainfall pattern	• Proper discharge system for removing excess water from the field • Maintaining the drains and creation of water bodies within plantation
Prolonged drought months	Less shade trees, rainless months and uneven distribution of rainfall	• Drip or sprinkler irrigation wherever possible; • Planting adequate shade trees to combat drought effect
Soil erosion and landslides in plantations	More vacant patches in the field and no proper soil and water conservation	• Vetiver planting along the contour; having staggered trenches; contour drains, boundary drains and vertical drains; • Infilling: So that there is zero vacancy in field

High incidence of pests and diseases	Climate change turned minor pests into major pests; Also there is more incidence of diseases	• Integrated pest and disease management; • Incorporation of organics and biologicals to reduce pesticide loads; better cultural practises
Plantation: Spices		
• Top soil erosion in High ranges and deposition of silt and clay in low lying areas • Prolonged water logging • Crop loss • High disease incidence in cardamom	• Root exposure, and nutrient deficiency • Hard pan formation • Toxicity is increased • Disease incidence • Lack of quality planting material	• Soil health improvement, nutrient management/bio inputs/ Micro irrigation facilities • Hard pan - Removal with machines • Replanting programmes – tolerant/ early bearing varieties through PPP Mode/ Seed Village programme like Micro rhizome technology in ginger • Standard operating protocol for nurseries • Spice regeneration mission projects for Wayanad and Idukki districts
Plantation: Horticulture		

• Low productivity (Vegetables, Fruits) •	• Lack of export market • Lack of possibility of year round production • Reduced farm income • Inadequate water and irrigation management and in turn flood management • Environmental issues	• Streamlining AEU based production technology • Adaptive trials/introduction of new crops and varieties • Supply of quality, disease free planting materials • Supporting public sector hybrid seed production in vegetables • Genetic conservation of land races • Export protocol for fruits and vegetables • Promotional land research interventions in production of winter crops in rain shadow region • Special agri-zones for specific horticultural crops • Community nurseries to cater the needs of farmers • Canopy management for improving the fruit crop production. • Exploiting the flood tolerant potential of minor fruits

Wetlands		
• Flooding of rice fields (Eg: Kuttanad) • Breach of bunds and crop loss • Reduction in yield	• Intense rainfall	• Strengthening/construction of outer bunds • Use of flood tolerant varieties • Limiting additional crop cultivation to 30 % area • Increase income by Integrated Framing System (IFS) • Enforce crop calendar
• Capacity of water channel is reduced	• Silting • Invasion of water weeds	• Desilting for enhancing flood flow • Mechanised removal of weeds periodically. • Streamlining the operation of Thanneer Mukkom Barrage.

• Salinity in rice fields.	• Tidal influx as in Pokkali • Lack of base flow and storage	• Use saline tolerant/ short duration varieties • Ensure location specific seed hubs • Adaptive trials with new varieties • Regulate multi sectoral buildings and ensure they are optimally distributed to different locations. • Policy on land use as townships/agriculture/water bodies/ forest etc.
• Drought	• Lack of summer showers	• Use of drought tolerant/short duration variety • Addition of organic manure • Water spray with drones once in a week (during drought) • Mechanised harvesting in Pokkali

Soil and Land Management		
• Soil erosion • Land slips and landslides	• Impeded drainage • Piping: super saturation at sub-surface	• Proper drainage and disposal of water in high range areas • Constructing terraces/bunds/trenches • Water harvesting structures: Farm ponds/infiltration tanks/percolation ponds • Irrigation facilities: Micro irrigation in areas of water shortage. • Fertigation • Open field precision farming and rain shelters instead of high-tech poly houses. • Soil health management and nutrient balancing through micro nutrient supplements/site specific soil amendments/ enhancing soil microbial diversity.
Fisheries and Aquaculture		

• Flood Loss • Disease Incidence	• Crop loss and low yield • Increase in incidence of pathogens • Surreptitious introduction of exotic breeds	• In lowland and flood prone area: Farming to be restricted to post and pre monsoon seasons • Stocking of advanced fingerlings and stunted seeds • Popularisation of fast growing breeds (to be harvested in 6-8 months.) • Development of waste fed aquaculture systems • Massive stocking of all reservoirs in Kerala • Establishment of hatcheries for supply of Specific Pathogen Free (SPF) seeds in each district. • Disease diagnostic lab in each district and quarantine system in air ports and check posts for invasive species. • Integrated farming & crop rotation
Livestock		

• Loss of livelihood for people • Increase in diseases & loss of meat production • Erosion of indigenous breeds • Zoonotic diseases	• Contributor for methane gas emission • Food-feed competition is increasing as our food is given to animals • Non adapted breeds/varieties	• Methane mitigation measures: Introduction of methane reduction drugs as food additives/Low methane producing breeds/Research on seaweeds as cattle feed supplements • Gene bank for promoting conservation of indigenous breeds like Vechoor Cow/ Kuttanad Buffalo/ Malabari Goat/Parent stock maintenance and propagation • Seed stock nurseries-Calf nurseries/hatcheries for ducklings • Value addition for enhancing income of farmers • Climate specific animal zones • Integrated Farming System
Below Sea Level Farming		

• Acidity problems • Salinity problems • Floods	•	• Strengthening of Kuttandu under Globally Important Agricultural Heritage Systems (GIAHS) • Establishment of natural heritage museum • Promoting silt based agriculture to support coconut and other garden land crops • Promoting of floating raft agriculture • Adoption of coated and slow release fertilisers in Kuttanadu to reduce nitrification of water bodies • Base flow augmentation round the year by linking Muvattupuzha river with Vadayar - Kavanar • Increase environmental flow to deter salinity intrusion, so as to avoid Thanneer Mukkom Bund operation.

• Flood • Inland flooding • Low water table in Vembanadu induce saline intrusion	• Water management	• Increasing the efficiency of Thottapally spillway • Desilting all the canals in Kuttanad to ensure drainage and free flow of water. • Utilisation of polders as flow through structures by establishment of inlet and outlet sluices • Utilisation of derelict padasekharams as harvesting structures, for drinking water purpose., utilising the unique, impervious nature of soil • Carbon footprinting of farming practises so as to encourage farming that mitigates carbon emission • Demonstrate good agriculture practises by enhancing carbon in soil, render agriculture soil as carbon sink- promote organic farming and good agricultural practises

High incidence of pests and diseases	Climate change turned minor pests into major pests; Also there is more incidence of diseases	• Integrated pest and disease management; • Incorporation of organics and biologicals to reduce pesticide loads; better cultural practises
Plantation: Spices		
• Top soil erosion in High ranges and deposition of silt and clay in low lying areas • Prolonged water logging • Crop loss • High disease incidence in cardamom	• Root exposure, and nutrient deficiency • Hard pan formation • Toxicity is increased • Disease incidence • Lack of quality planting material	• Soil health improvement, nutrient management/bio inputs/Micro irrigation facilities • Hard pan - Removal with machines • Replanting programmes – tolerant/ early bearing varieties through PPP Mode/Seed Village programme like Micro rhizome technology in ginger • Standard operating protocol for nurseries • Spice regeneration mission projects for Wayanad and Idukki districts
Plantation: Horticulture		

• Low productivity (Vegetables, Fruits) •	• Lack of export market • Lack of possibility of year round production • Reduced farm income • Inadequate water and irrigation management and in turn flood management • Environmental issues	• Streamlining AEU based production technology • Adaptive trials/introduction of new crops and varieties • Supply of quality, disease free planting materials • Supporting public sector hybrid seed production in vegetables • Genetic conservation of land races • Export protocol for fruits and vegetables • Promotional land research interventions in production of winter crops in rain shadow region • Special agri-zones for specific horticultural crops • Community nurseries to cater the needs of farmers • Canopy management for improving the fruit crop production. • Exploiting the flood tolerant potential of minor fruits
Wetlands		
• Flooding of rice fields (Eg: Kuttanad) • Breach of bunds and crop loss • Reduction in yield	• Intense rainfall	• Strengthening/construction of outer bunds • Use of flood tolerant varieties • Limiting additional crop cultivation to 30 % area • Increase income by Integrated Framing System (IFS) • Enforce crop calendar

• Capacity of water channel is reduced	• Silting • Invasion of water weeds	• Desilting for enhancing flood flow • Mechanised removal of weeds periodically. • Streamlining the operation of Thanneer Mukkom Barrage.
• Salinity in rice fields.	• Tidal influx as in Pokkali • Lack of base flow and storage	• Use saline tolerant/short duration varieties • Ensure location specific seed hubs • Adaptive trials with new varieties • Regulate multi sectoral buildings and ensure they are optimally distributed to different locations. • Policy on land use as townships/agriculture/water bodies/forest etc.
• Drought	• Lack of summer showers	• Use of drought tolerant/short duration variety • Addition of organic manure • Water spray with drones once in a week (during drought) • Mechanised harvesting in Pokkali
Soil and Land Management		

• Soil erosion • Land slips and landslides	• Impeded drainage • Piping: super saturation at subsurface	• Proper drainage and disposal of water in high range areas • Constructing terraces/bunds/trenches • Water harvesting structures: Farm ponds/infiltration tanks/percolation ponds • Irrigation facilities: Micro irrigation in areas of water shortage. • Fertigation • Open field precision farming and rain shelters instead of high-tech poly houses. • Soil health management and nutrient balancing through micro nutrient supplements/site specific soil amendments/enhancing soil microbial diversity.
Fisheries and Aquaculture		

• Flood Loss • Disease Incidence	• Crop loss and low yield • Increase in incidence of pathogens • Surreptitious introduction of exotic breeds	• In lowland and flood prone area: Farming to be restricted to post and pre monsoon seasons • Stocking of advanced fingerlings and stunted seeds • Popularisation of fast growing breeds (to be harvested in 6-8 months.) • Development of waste fed aquaculture systems • Massive stocking of all reservoirs in Kerala • Establishment of hatcheries for supply of Specific Pathogen Free (SPF) seeds in each district. • Disease diagnostic lab in each district and quarantine system in air ports and check posts for invasive species. • Integrated farming & crop rotation
Livestock		

• Loss of livelihood for people • Increase in diseases & loss of meat production • Erosion of indigenous breeds • Zoonotic diseases	• Contributor for methane gas emission • Food-feed competition is increasing as our food is given to animals • Non adapted breeds/varieties	• Methane mitigation measures: Introduction of methane reduction drugs as food additives/Low methane producing breeds/Research on seaweeds as cattle feed supplements • Gene bank for promoting conservation of indigenous breeds like Vechoor Cow/Kuttanad Buffalo/ Malabari Goat/Parent stock maintenance and propagation • Seed stock nurseries- Calf nurseries/ hatcheries for ducklings • Value addition for enhancing income of farmers • Climate specific animal zones • Integrated Farming System
Below Sea Level Farming		

• Acidity problems • Salinity problems • Floods	•	• Strengthening of Kuttandu under Globally Important Agricultural Heritage Systems (GIAHS) • Establishment of natural heritage museum • Promoting silt based agriculture to support coconut and other garden land crops • Promoting of floating raft agriculture • Adoption of coated and slow release fertilisers in Kuttanadu to reduce nitrification of water bodies • Base flow augmentation round the year by linking Muvattupuzha river with Vadayar - Kavanar • Increase environmental flow to deter salinity intrusion, so as to avoid Thanneer Mukkom Bund operation.

• Flood • Inland flooding • Low water table in Vembanadu induce saline intrusion	• Water management	• Increasing the efficiency of Thottapally spillway • Desilting all the canals in Kuttanad to ensure drainage and free flow of water. • Utilisation of polders as flow through structures by establishment of inlet and outlet sluices • Utilisation of derelict padasekharams as harvesting structures, for drinking water purpose., utilising the unique, impervious nature of soil • Carbon footprinting of farming practises so as to encourage farming that mitigates carbon emission • Demonstrate good agriculture practises by enhancing carbon in soil, render agriculture soil as carbon sink-promote organic farming and good agricultural practises

Key Problems/ Challenges	Reasons for the problems	Possible solutions
Granite Quarrying		
• Unable to prevent illegal quarrying.	• Revenue authorities and police who are competent but not vigilant. • Various licensing agencies are unable to take proper actions against mining without their licence.	• Department of Mining and Geology to be strengthened. • Directions to be issued to Mining and Geology, Revenue, police and other licensing agencies. • Enhance the number of experts in SEIAA from 13 to 16. SEIAA may be provided with 3 zonal environment officers.
• Unscientific mining and blasting.	• Lack of permanent qualified persons like mines manager, mines mate, blast man, foreman etc.	• Academic programmes (degree/ diploma in mining engineering) may be initiated in the state.
• Widespread quarries near settlements.	• Lack of notified areas exclusively for mining.	• Delineation of prospective zones after geo-environmental appraisal. • Distance of the settlement from quarry may be increased up to 100 m.

• Environmental degradation on account of illegal mining	• Lack of competent officers to implement Environmental (Protection) Act, 1986	• Power to implement the Act shall be delegated to District Collectors.
• Public nuisance, destruction of infrastructure like roads, bridges, irrigation canals, and revenue leakages connected with transport of minerals.	• Overloading of minerals beyond goods permit, use of very large vehicles in narrow roads, alteration of vehicles for increasing the carrying capacity.	• Stringent actions from Mining and Geology, Motor Vehicles Department & Police.
• Improper closure of mines	• Meagre amount has been stipulated as a financial guarantee for proper closure of mine.	• Enhance the amount at par with central government mining rules.
• Depletion of ground water recharge.	• Removal of overburden greater than 2 m.	• Quarrying should be limited in such a way that the recharge zone is not compromised.
• Lack of social auditing of quarrying operations.	• No empowered committee exists.	• Local Empowered Committee consisting representatives of LSGI, Revenue and civil societies shall be constituted with proper guidelines.

• Unprotected and unutilized abandoned granite quarries	• Improper utilization of the abandoned quarries.	• Fencing, sign/ warning boards, proper utilization of quarries for activities like drinking/ irrigation water supply, fish farming, recreation, groundwater recharge etc.
• Depletion of natural resources	• Reuse and recycling is not being carried out.	• Effective implementation of construction and demolition Waste Management Rules 2016
• Abnormal hike in price of building materials	• All quarries are under private sector	• Setting up of Natural Resource Corporation as envisaged in the state mining policy. • Govt. can subsidise materials supply to BPL categories.
River/Beach Sand Mining		
• Non availability of construction grade natural sand and resulting over exploitation of granite for manufacturing M- sand.	• No mining takes place for want of Environment Clearance (EC).	• Steps may be taken to obtain EC and to resume river sand mining as done earlier.
• Under-utilization of known available resources.	• Silt accumulated in the reservoirs are not utilized properly	• De-siltation of reservoirs

• Coastal Erosion	• Unscientific mining and over extraction.	• Ban beach mining in erosion prone areas and adopting manual methods for mining in permitted areas.
Laterite and Ordinary Earth Mining		
• Uncontrolled illegal laterite mining leading to groundwater depletion.	• Lack of proper law enforcement	• Law enforcement should be geared up. • Use the existing abandoned laterite quarry pits for groundwater recharge.
• Uncontrolled, unscientific and illegal excavation of ordinary earth material leading to slope failures.	• Toe cutting of slopes without proper protective measures • No proper assessment in granting development permit by LSGI and lack of monitoring of excavation activities.	• Proper assessment is needed before granting permit and stipulation of protective measures to prevent slope failures.

Forest Management

KeyProblems/Challenges	Reasons for the problems	Possible solutions
Coastal Erosion		

• Obstruction/ interception of sediments • Cliff retreat • Artificial engineering structures (breakwater groin etc.) • Sea level rise • Saline intrusion • Threatened livelihoods of fisherman communities • Displacement of communities • Loss of land and property • Hampered access to the beach • Poor aesthetics	• Unscientific human interventions in coastal area–structural and mining etc. • Natural and anthropogenic processes.	• Preparation of micro level maps of the coastal area through participatory approach. • Preparation of action plan based on micro level maps. • Identification of stable zones for the rehabilitation of community in consultation with Local Government and Revenue department. • Construction of cost-effective houses in stable zones with the help of expert agencies/ professionals (Experts- Geotechnical and Structural Engineers, Water and Sanitation, coastal engineers etc.) • Updating Disaster Management plan • Improving the quality of life of the people in the coastal area through appropriate means such as eco-tourism, value addition of products, cage farming, displacing fisherman community towards inland waterways (livelihood) • Sedimentary Cell Approach as a unit for conservation and management • Promotion of indigenous vegetation
Landslides		

The following factors pose challenges: • Physiographic aspects • Anthropogenic activities • Vegetation • Settlements • Groundwater • Drainage choking • Housing and livelihoods • Early warning	• Intense Rainfall and Precipitation • Land use change • Mono cropping/cropping pattern • Construction of structures (modification of slopes) • Water table change • Blockage of natural drainage	• Zonation of Susceptible Areas in cadastral level– High and Medium • Clearance from the geologist to be made necessary for constructions. • Site specific consultation from the geologist before and after a landslide. • Relocation of people in vulnerable locations to stable locations. Clustered village level settlements preferred. • Site specific actions to be taken on relocation during the recovery and rehabilitation stage. • Bring restrictions on agricultural activities- Alternate agricultural activities • Rainfall threshold forecasting • Building awareness at local level • Community based disaster management plans to be prepared. • Local community to be sensitised on natural indicators of hazards. • Interstate governance approach to be adopted in data sharing.
Drought		

• Post Flood Drought • Seasonal Drought • Agricultural Drought • Variations in stream flow • Ground water extraction	• Climate change: Rainfall variations (Significant decrease in annual rainfall– The number of rainy days has decreased) • Changes in eva-po-transpiration due to various reasons • Water scarcity • Land use change (agri-cultural to plantations) • Population density (over exploitation of resources)	• Conservation of tradi-tional water recourses. • Need based subsidies (limit subsidies based on land crop and re-quirements). • Rejuvenation of closed fresh water bodies and surface water through a participatory approach. • Regulation in ground water extraction. • Development of ade-quate number of critical zone observatories (CZOs) in different agro-climatic zones for monitoring long term changes. • Direct recharging in drought prone zones– recharge streams • Water harvesting mea-sures • Ensure quality water supply and awareness of reuse and recycling of water. • Terrain based approach: It should adopt long term measures: source identification, quality assurance etc.) • Prevention of reclama-tion of wetlands. • LSGD based drought management system

Water Management

KeyProblems/ Challenges	Reasons for the problems	Possible solutions
Coastal Erosion		
• Obstruction/ interception of sediments • Cliff retreat • Artificial engineering structures (breakwater groin etc.) • Sea level rise • Saline intrusion • Threatened livelihoods of fisherman communities • Displacement of communities • Loss of land and property • Hampered access to the beach • Poor aesthetics	• Unscientific human interventions in coastal area–structural and mining etc. • Natural and anthropogenic processes.	• Preparation of micro level maps of the coastal area through participatory approach. • Preparation of action plan based on micro level maps. • Identification of stable zones for the rehabilitation of community in consultation with Local Government and Revenue department. • Construction of cost-effective houses in stable zones with the help of expert agencies/ professionals (Experts- Geotechnical and Structural Engineers, Water and Sanitation, coastal engineers etc.) • Updating Disaster Management plan • Improving the quality of life of the people in the coastal area through appropriate means such as eco-tourism, value addition of products, cage farming, displacing fisherman community towards inland waterways (livelihood) • Sedimentary Cell Approach as a unit for conservation and management • Promotion of indigenous vegetation
Landslides		

The following factors pose challenges: • Physiographic aspects • Anthropogenic activities • Vegetation • Settlements • Groundwater • Drainage choking • Housing and livelihoods • Early warning	• Intense Rainfall and Precipitation • Land use change • Mono cropping/cropping pattern • Construction of structures (modification of slopes) • Water table change • Blockage of natural drainage	• Zonation of Susceptible Areas in cadastral level– High and Medium • Clearance from the geologist to be made necessary for constructions. • Site specific consultation from the geologist before and after a landslide. • Relocation of people in vulnerable locations to stable locations. Clustered village level settlements preferred. • Site specific actions to be taken on relocation during the recovery and rehabilitation stage. • Bring restrictions on agricultural activities- Alternate agricultural activities • Rainfall threshold forecasting • Building awareness at local level • Community based disaster management plans to be prepared. • Local community to be sensitised on natural indicators of hazards. • Interstate governance approach to be adopted in data sharing.
Drought		

• Post Flood Drought • Seasonal Drought • Agricultural Drought • Variations in stream flow • Ground water extraction	• Climate change: Rainfall variations (Significant decrease in annual rainfall– The number of rainy days has decreased) • Changes in evapo-transpiration due to various reasons • Water scarcity • Land use change (agricultural to plantations) • Population density (over exploitation of resources)	• Conservation of traditional water recourses. • Need based subsidies (limit subsidies based on land crop and requirements). • Rejuvenation of closed fresh water bodies and surface water through a participatory approach. • Regulation in ground water extraction. • Development of adequate number of critical zone observatories (CZOs) in different agro-climatic zones for monitoring long term changes. • Direct recharging in drought prone zones– recharge streams • Water harvesting measures • Ensure quality water supply and awareness of reuse and recycling of water. • Terrain based approach: It should adopt long term measures: source identification, quality assurance etc.) • Prevention of reclamation of wetlands. • LSGD based drought management system

Transport, Communication and Technology

Key Problems/ Challenges	Reasons for the problems	Possible solutions
Institutions and Institutional Mechanisms		
• Lack of coordinated planned, inclusive action at the local level	• Multiple institutions and multiple lines of control • No clarity on roles and responsibilities • Certain communities left out like tribals, elderly, persons with disabilities (PWDs) and responsibilities	• LSGs to be given the mandate at the local level • Working Group on "Environment, Biodiversity, Climate Change, Disaster" constituted should include representatives from the different communities- Kudumbashree and other SHG members, Elderly Groups, Tribals, TheeraMaitri etc. • Residents associations, libraries, literacy preraks, Community Based Organizations (CBOs) like youth organizations
• Limited powers for local self governments at the local level	• Provision in the Disaster Management Act not reflected in the Panchayati Raj and Nagarapalika Acts • Lack of networking • No forward and backward linkages	• The Panchayati Raj and Nagarapalika Acts to be revisited and provisions made for legitimising the spaces and roles of these community based institutions • Ensure upward integration with Block Level and district level institutions, departments, state government, District Disaster Management Authority (DDMA), Kerala State Disaster Management Authority (KSDMA) • These linkages will ensure promoting synergy in utilisation of resources, neutrality, transparency and in effectively combating local level area specific biases and agendas

• Challenge in incorporating technical, social and ecological factors into local development and Disaster Management (DM) plans	• Lack of capacities at the local level	• Linking with block level and district level expertise available • Developing a list of empaneled experts at block/district level who can be on call to support planning processes.
Capacity Building		
• Challenge to make a local level DM Plan to be a "Living Document"	• Lack of capacities for Risk and Vulnerability Assessments, planning for preparedness and mitigation •	• Developing a comprehensive list of training modules by Kerala Institute of Local Administration (KILA) and KSDMA. • "Vulnerability/Risk Assessment" to be considered under the list of "non-negotiables", and others as "desirables" eg. risk informed micro-enterprise planning • Local development plans to specify the modules it would like to take up in the DM Plan/Local Development Plan.
• Challenge to make local DM Plans as inclusive and participatory	• Lack of capacity/ awareness at community level. • Disaster Management Teams (DMTs) not formed and/ or capacitated.	• Individuals trained by KILA and KSDMA in disaster management, risk informed planning etc. to guide participatory planning processes • Special modules to be developed for DMT and all DMTs to be trained
Early Warning Systems (EWS)		
• EWS, in its present format, not conducive to decision making at panchayat/municipal levels	• Decoding of technical jargon • Lack of clarity on actions to be taken	• Demystifying hazard specific warnings • Linking with actionable points • Standard Operating Procedures (SOPs) for responding to warnings to be evolved at panchayat/ municipality levels based on guidelines developed by KSDMA

• Last Mile Connectivity often missing	• Inaccessible areas/ communities • Lack of ability specific EWS	• DMTs to include community specific/ need appropriate members from the community (Tribal Volunteers/Kudumbasree members/ Youth/Fishermen etc) • Ability specific IEC to be developed, especially for Early Warning Systems, Evacuation Procedures, Camp Management
• Too many messages	• Lack of clarity in roles and responsibilities	• Guidelines to be developed for early warning systems, triggers for actions like evacuation at state level and disseminated • LSGs to adopt/adapt these guidelines as SOPs for their LSG
• Depending on limited communication channels	• Lack of awareness on effective utilisation of other media of communication	• Multiple channels of communication to be adopted • Social media to be utilised for effective communication in times of emergency with adequate safeguards in place to minimise confusion/ false information
• Loss of productive working days due to generalised information	• Predictions not area specific	• KSDMA to provide more localised predictions especially for coastal communities • R&D at state level for micro-level predictions/ trends • Predictions to also take into account the agro-climatic zones specified by the agricultural sector
• Lack of clarity on dealing with localised disasters	• Guidelines lacking on dealing with localised disasters	• EWS, Response plans to also take into account localised disasters • SOPs to be developed for localised disaster management
Vulnerability Assessment		

• Multiple lists available of "Vulnerable families"	• Vulnerability assessment currently sectorally driven • Currently, identifying "vulnerability" is linked with sector specific benefits/ entitlements • Lack of transparency, ulterior motives currently affecting Vulnerability assessment due to its link with entitlements	• Defining "vulnerability" in terms of coping with identified hazards • Parameters to be defined at State level and used by the LSG • These state level parameters to be discussed and approved at Grama/ Ward Sabha • Involve community representatives in Vulnerability assessments • Vulnerability Index to be developed at state level for the LSG to understand their level of vulnerability
• Non availability of current data	• Prohibitive cost and lack of time required for survey/data collection for periodic updation by LSG	• Making periodic updation a part of the system • Outsourcing survey/ data collection to Kudumbashree/ youth clubs on a payment basis • This activity to be budgeted in the Annual Development Plan of LSG
• Confidentiality/Privacy Issues	• Some of the data collected, like Health issues, types of housing, vulnerability assessments, etc. may be sensitive and can be misused for private gains or can even have adverse effects like land prices crashing in areas that are conspicuously marked vulnerable, insurance rates increasing for vulnerable areas and vulnerable people	• State to develop protocols on data storage/ utilisation/sharing etc.
Data, Information and Knowledge Management		

• Limited access to wealth of information already available	• Sectoral data not accessible • Confidentiality of information	• KSDMA to collect and collate all relevant and sector specific data • Provide an interactive, query based information portal that LSGs can access for data related to DM Planning
Risk Informed Planning		
• LSG/community not involved in assessing risks of sectoral development interventions	• Spaces not provided, not articulated as their mandate/right • Lack of capacities	• LSGs to be given the right and responsibility of Risk Audits/ Environment Impact Assessment (EIA) of Sectoral development projects planned • Capacities to be built up for EIA • Skilled human resources to be made available and accessible to support PRIs in Risk audits and EIAs • Grama/ Ward Sabhas to be acknowledged as the representation of the communities and approval of Grama/ Ward sabha to be taken to ensure "do no harm" approach • But for this to be inclusive, various CBOs need to be involved.
Livelihood and Risk Management		
• Livelihood provided by the ecosystem and biodiversity it harbours. • Both are exposed to disaster risk if not protected.	• Biological diversity is natural capital of every nation. • Rules and regulations are not followed meticulously.	• Thus, the prime responsibility of any citizen is the protection of ecosystem and biodiversity from disasters and to mitigate when disaster occur. • The protection must be done as envisaged in the environment act (1986) and biodiversity act (2002). • At the local level, BMCs to be strengthened.
Resilient Public Infrastructure		

• There is a lack of risk sensitive planning. •	• There is no mandatory hazard assessment and related understanding for risk sensitive infrastructure.	• Risk sensitive investment in infrastructure is required. • Public infrastructure may be made and maintained by LSG to be used for rehabilitation centres (located in safe places) when disaster strikes, the same can be used for other cultural event when not in use. • LSG may charge for its use for up keeping the infrastructure ready for use in disaster time. • Similarly public infrastructure needs to be strengthened including school, anganwadi, PHC, panchayat office (with essential services such as sanitation).
Finance		
• Most of the finance goes to development or relief, not for preparedness or mitigation	• There is no mitigation and preparedness fund/ budget •	• Availability/ creation of such fund at LSG level. • Inhabitants/ property in flood (disaster) prone areas are to be insured at all times. • Insurance coverage needs to be ensured across all socio-economic class. • Not only availability but also related education and campaign of microfinance products for vulnerable groups. • Livelihood support to affected people may be ensured which will indirectly enhance local economy.
Social Security		
• Interruption in the performance of the social security due to disaster	• Risk and hazard assessment of social security is not available/ not linked with implementation.	• Social security continuity planning. • Kudumbashree Self Help Groups (SHGs) are to be empowered locally for resilience in terms of budget and capability for social security.
Grievance Redressal		

• There is no place for submission of grievance or people do not know of it.	• Non-availability and lack of awareness of grievance platform and processes.	• Panchayat /LSG level grievance officer should be available and proper mechanism for redressal should be in place.
Mental Health		
• Acute stress reaction • People with existing mental illness • Lack of mental health services at the grass-root level • Long-term mental health issues like de-pression, PTSD • Substance abuse with-drawal symp-toms	• Lack of awareness about mental health issues in general pub-lic and stigma	• Mental health disaster manage-ment teams under District Mental Health Programme (DMHP) in each district. • Training/ capacity building on post-disaster mental health for volunteers, LSG elected represen-tatives, officials, revenue, police, rescue workers etc. • Awareness creation in general public regarding post-disaster mental health issues through IEC. • Regular screening through house visits by ASHAs. • Strengthening the Primary Care Health System to deal with mental health issues long-term and Primary Care integration of Mental Health.
Migrant Population		
• Lack of exact data • Language and cultural barriers • Discrimination in camp	• Lack of enforcement of existing rules and regulation on migrant workers.	• Strict enforcement of existing rules and regulation on migrant workers. • Provide IEC materials on Disaster Risk Reduction (DRR) in their own languages.
Community Role in Safety Audit		

• No provision for conducting safety audit at present • Non-adherence of rules on safety issues by general public	• Lack of clarity on jurisdiction/ responsibility between line departments, roles not clarified.	• Safety audit should be done for all public buildings (schools, hospitals etc.) • Formation of people's committee with experts at local level to undertake safety audit • Awareness creation among target population (residents associations, Kudumbashree, other CBOs)

Transport, Communication and Technology

Key Problems/ Challenges	Reasons for the problems	Possible solutions
Alternate Routes and Vulnerability		
• Absence of alternate routes will result in reducing the accessibility to lifeline facilities	• Either there will not be any alternate route or the available one will not be usable	• Based on the flood map being prepared, the routes that are vulnerable may be identified • Geotag all the lifeline facilities in the region and identify the existing routes, and maintain them as all weather roads • If alternate routes are not available, develop alternate routes for the lifeline facilities which are to be planned at a height above the anticipated flood level
Continuity of Business/Multimodal Transportation/Rescue		
The disasters may result in reducing the accessibility and mobility of the residents.	• Washing out of roads • Failure of bridges and culverts • Calamities like landslips/ landslides • Flooding of roads • Failure of power lines	• Power Charging systems • Portable bridges • Inflatable boats/ Fibre boats • Hovercraft/Hydrofoil • Floating Jetties • Hot Air Balloon • Ropeway/Cable car • Embedded Ropeway for Canals • Drone/Unmanned Aerial Vehicles • Development of canal bund roads • Helipads at strategic location • Revival of waterways

Social Mechanism		
• Absence of trained rescue personnel at local level and public awareness.	• A proper training mechanism was unavailable.	• Formation of Special Task Force and regular updation • Involvement of local NGOs and public • Involvement, participation and control of local bodies • Involvement of experts • Continued Evaluation • Sustainability to be ensured

Design Consideration		
• Failure of roads, bridges and Culverts • Slope Failure • Failure of bank protection for water ways	• Lack of Designed Roads • Reduction of Vent way at bridge locations in design • Debris accumulation leading to blockade of vent • Lack of drainage layer for roads • Inadequate number of CDs and side drains • Lack of maintenance of roads as well as drains • Inadequate land width resulting in unstable side slope	• Drainage layer should be provided to ensure sub surface drainage. • Design should include adequate number of CDs and side drain. • Additional land spans on either side of the bridges in future construction. • Alignment shall match the topography • Climate resilient pavement to be adopted • Eco-friendly bank protection measures • slope design and slope protection measures • Periodic inspection and maintenance of roads and other assets

ANNEXURE VII
BUILDING RESILIENT HOME

Sl. No.	Aspects	Elements	Interventions
1	Resilience of the families	• Inducing behavioural change to develop a culture of safety among individuals and families • Learning life saving skills • Promote Risk Transfer • Providing special attention to vulnerable population listed in the Orange Book • Ensuring safety and well-being of pets, poultry, livestock etc.	• Conduct a comprehensive disaster literacy campaign for citizens of Kerala to achieve SENDAI goals • Provide Safety Kits to all households with a ration card as a one-time emergency response equipment support • Promote and campaign for pet/livestock inclusive anticipatory actions at household level • Promote and popularise Pradhan Manthri Suraksha Bhima Yojana (PMSBY) and Pradhan Mantri Jeevan Jyoti Bima Yojana (PMJJBY) as a method of individual risk transfer and explore possibilities of financially supporting BPL families to enrol every member in these schemes, as a one-time assistance. • Promote and popularise house and household insurance scheme as a risk transfer method and explore possibilities of financially supporting BPL families to enrol every member in such schemes, as a one-time assistance. • Campaign for anticipatory actions at household level for mitigating the effects of hydro-meteorological hazards through Local Governments • Popularise and campaign for the upkeep of homestead gardens by ensuring proper drainage, infiltration, maintenance of trees etc. • Explore possibilities of using unoccupied houses and buildings as temporary shelters for families with consent and incentives to owners through a house bank approach

3	Resilience of the neighbourhood	• Risk informed house citing and layout • Community networking • Spreading the message of We for Ourselves (Nammal Namukkai) • Concept of safety through schools • Concept of school and hospital safety through Local Governments • Inclusion of women in identifying vulnerable population through Kudumbashree • Safety in high raise (>3 stories) buildings, shopping complexes and office complexes	• Support Local Governments in introducing hazard susceptibility assessment as an integral part of housing permit sanctioning process • Develop an app for optimising house citing with hazard susceptibility maps and quick tips for safe construction • Financially support the conduct of first aid and basic life support trainings for Emergency Response Teams of Local Governments • Create a geo-database of vulnerable population as listed in the Orange Book at LSG level with foot soldier support from Kudumbashree • Promote the creation of a last mile disaster warning dissemination system through social media linked to Local Governments • Promote and support training programmes on life saving skills (eg. swimming, Heimlich manoeuvre etc.) for school children through Local Governments under the School Safety programme utilising the services of trained and established swimming trainers identified by Local Self Governments • Promote and support routine safety audit of schools and hospitals through ERTs of Local Self Governments under the Hospital Safety Programme • Promote and support safety audits of high-rise buildings, shopping complexes and office complexes to ensure fire safety, electrical safety and lightning safety through self-check applications and random cross checking by Local Self Governments • Respect Water campaign to reduce drought • Incentivise blue and green infrastructure of local governments • Prepare guidelines for annual pruning of trees in public and private property and explore possibilities of executing this through MGNREGA • Explore possibility of supporting conservation of natural water storages and water kiosks

3	Resilience of the neighbourhood buildings	• Multi-hazard resistant design (citing, spatial layout etc.) • Multi-hazard resistant construction (for structural safety from hazards such as floods, landslides, strong winds, earthquake etc. and also for electrical safety, fire safety, lightning safety and safety from falling) • Environment friendly construction (green and cost-effective materials and technologies) • Regular and timely maintenance (safety checks, repairs etc.) • Retrofitting to improve hazard resilience • Promote alternate construction methods	• Support Local Governments in modifying the techno-legal regime, especially KMBR and KPBR, to include aspects of multi-hazard resilient construction from IS codes and NBC • Support Local Governments in developing mechanisms to ensure compliance to KMBR/KPBR • Promote and financially support cool roofs in concrete roofed structures by providing part financial support to Local Governments • Update and convert resilient construction handbooks published by KSDMA into GitHub open format • Support Research and Development of resilient construction methods and materials • Capacity building programmes for professionals such as civil engineers, architects, masons, contractors etc. in resilient construction practises • Prepare guidelines for identifying public buildings requiring retrofitting • Prepare guidelines for increasing resilience of roofs to wind • Promote lightning safety of buildings and incentivise lighting resilience of schools and hospitals

ANNEXURE VIII
A matrix of actions, term required and costing are given below

Sl. No	Proposal	Term of Implementation	Source of Fund	Cost (in lakhs of ₹)				
				Y1	Y2	Y3	Y4	Y5
Priority 1: Understanding disaster risk								
1	Science and Technology Experimentation Fund and Innovation Fund	ST	SDMF	200	200	200	200	200
2	Co-develop and customise the open source disaster risk reduction decision support software tool Risk-Changes	C	SDMF	10	12	14	16	18
3	Facilitate Geological Survey of India to conduct landslide susceptibility maps of highly hazard prone areas in 5000 scale	C	SPF	10	10	10	10	10
4	Cascading hazards and frameworks for management of cascading hazards	ST	SPF	15	15	0	0	0

5	Disaster damage and loss database	C	SPF	145	70	70	70	70
6	Environmental Monitoring in Schools for promoting DRR education	LT	SDMF	10	200	0	200	200
7	Funding Citizen Science Initiatives for Disaster Risk Reduction	C	SDMF	200	200	200	200	200
8	Support national and international research in HVRA and EWS of Kerala	C	SPF	25	25	25	25	25
9	Procure coastal bathymetric data of Kerala	MT	SDMF	10	100	100	0	0
10	Support Geological Survey of India in developing a landslide early warning system	C	SPF	50	50	50	50	50
11	Support the Water Resources Department in developing a flood early warning system	C	SPF	1	1	1	1	1

12	Support research institutions in Kerala in maintaining a seismic monitoring network	LT	SDMF	60	60	60	60	60
13	Support India Meteorological Department in maintaining an automated weather station network	LT	SPF	20	20	20	20	20
14	Develop & maintain living labs	C	SDMF	2	100	100	100	100
15	Epidemic risk assessment	MT	SDMF	0	50	0	100	0
16	Improve existing landslide susceptibility maps by incorporating runout zones	MT	SPF	0	10	10	10	0
17	Spatial tools for calculating the disaster loss potential of houses	MT	SPF	0	15	15	15	0
18	Framework for vulnerability assessment of Micro, Small and Medium Enterprises to hydro-meteorological hazards	ST	SPF	10	15	0	0	0

19	Map urban and rural heat islands in light of climate change scenarios	ST	SPF	2	10	0	0	0
20	Map and assess the wind hazard potential in light of climate change scenarios	ST	SPF	2	10	0	0	0
21	Conduct a vulnerability assessment of domestic animals and poultry in light of climate change scenarios	ST	SPF	2	10	0	0	0
22	Update the drought susceptibility and MAH accident susceptibility maps	ST	SPF	1	1	0	0	0
Year Total				**775**	**1184**	**875**	**1077**	**954**
Priority Total				**4865**				
Priority 2: Strengthening disaster risk governance								
1	Special task force for assessing resilience capacity improvement	ST	SPF	3	2	0	0	0

2	Supporting the development of landuse act, policies and guidelines	LT	SPF	1	2	2	2	2
3	Create Risk Mitigation Cell	C	SPF	8	10	12	14	16
4	Strengthen Risk Lab	C	SPF	15	25	25	25	25
5	State level interaction platform between SDMA, SEIA, KCZMA, KWA, KRSA and RERA	C	SPF	1	1	1	1	1
6	Disaster waste management guidelines	ST	SPF	2	3	0	0	0
7	Guidelines for disaster risk reduction of heritage sites	MT	SPF	5	7	9	0	0
8	Guidelines for facilitating post disaster livelihood support	MT	SPF	5	7	9	0	0
9	Creation of flood management plans	MT	SPF	10	15	20	25	0
10	Framework for disaster risk reduction of tourism destinations	MT	SPF	0	2	5	0	0

11	Soil piping and Strong Wind risk reduction action plan	ST	SPF	2	2	0	0	0
12	Guidelines for management of dead in the aftermath of a disaster	ST	SPF	2	2	0	0	0
13	Update State Disaster Management Policy	ST	SPF	3	0	0	0	0
14	Mainstreaming School Safety Plans and Hospital Safety Plans	ST	SPF	3	3	1	1	1
15	Mainstreaming Local Self Government Disaster Management Planning	ST	SPF	2	2	0	0	0
16	Empowering Block Panchayaths for Mainstreaming Disaster Risk Reduction	MT	SDMF	304	304	304	304	304
17	Supporting local government disaster management plan preparation	C	SPF	5	5	5	5	5

18	Preparing Departmental Disaster Management Plans	MT	SPF	10	10	10	10	10
19	Inclusive Disaster Risk Reduction	C	SPF	10	10	10	10	10
20	Supporting Resilience Building Units in PWD, water, energy, transport, health, education, and agriculture	MT	SPF	7	7	7	0	0
21	Mainstreaming DRR training in IMG administrative trainings	MT	SPF	3	3	3	3	3
22	Build back better framework for MSMEs	ST	SPF	0	2	0	0	0
23	Financially support vulnerability linked relocation plan	C	SDMF	500	500	500	500	500
24	Strengthening KSDMA, DDMA, SEOC, DEOC	C	SPF	400	425	450	500	525
25	Guidelines for climate change resilient community and public buildings	ST	SPF	2	2	0	0	0

26	Developing disaster forensic investigation guidelines	ST	SPF	3	3	3	0	0
27	Support Kerala Highway Research Institute in the design of Climate Change and Disaster Resilient transportation networks	MT	SPF	0	2	2	2	0
28	Exploring and Promoting hardwood based construction practices	MT	SPF	2	2	2	2	0
29	Promoting resilient designs for houses built under Government Schemes	ST	SPF	15	15	0	0	0
30	Framework for implementing Ecosystem-based disaster risk reduction solutions in the State	ST	SPF	3	3	0	0	0
31	Comprehensive drought preparedness and mitigation plan	MT	SPF	2	3	0	0	0
Year Total				**1328**	**1379**	**1380**	**1404**	**1402**

Priority Total				**6893**				
Priority 3. Investing in disaster risk reduction for resilience								
1	Improve Construct and amend facilities in the schools identified as multi-purpose emergency shelters and improve access to such shelters	LT	SDMF	200	200	200	200	200
2	Create a disaster mitigation plan	LT	SPF	5	5	5	5	5
3	Prepare resilience plans of fishing villages	LT	SDMF	100	100	100	100	100
4	Retrofit government and aided schools and health infrastructure in hazard-prone areas to increase safety	LT	SDMF	200	200	200	200	200
5	Develop eco-safe rural roads standards with bioengineering solutions & implement pilots	LT	SDMF	1	100	250	300	350

6	Promote Miyawaki Forests for coastal protection & implement pilots	MT	SDMF	1	100	100	0	0
7	Promote lightweight construction practises using eco-safe materials	MT	SPF	5	5	5	0	0
8	Document and quantify best practises that contribute to ecosystem based disaster risk reduction in the State	MT	SPF	5	5	5	0	0
9	Promote safe construction practices in landslide and flood prone areas	C	SPF	15	15	15	15	15
10	Facilitate implementation of comprehensive risk transfer programme	MT	SPF	2	2	2	0	0
11	Exploring alternate communication means for deep sea fishermen	MT	SPF	3	5	7	0	0

12	Exploring risk transfer possibilities of Below Poverty Line families who have borrowed funds	ST	SPF	1	2	0	0	0
Year Total				**538**	**739**	**889**	**820**	**870**
Priority Total				**3856**				
Priority 4. Enhancing disaster preparedness for effective response								
1	Disaster Literacy Campaign	LT	SDRF	200	200	315	200	140
2	Create a theme of resilient homes and increase awareness	LT	SDRF	10	15	20	25	30
2	Capacity Building for People's Representatives of Local Self Governments	MT	SDRF	70	0	70	0	70
3	Capacity building for Members of Legislative Assembly and Members of Parliament in Orange Book, SDRF and SDMF	MT	SDRF	30	0	30	0	30

3	Capacity building for officials under the ambit of Local Governments	MT	SDRF	100	100	0	0	0
4	Information, Education and Communication programmes for reducing risks and increasing resilience	C	SDRF	200	200	200	200	200
5	Increase awareness of early warning codes in communities	MT	SPF	3.5	3.5	3.5	0	0
6	Support Disaster, Risk and Vulnerability Conference organised by MG University and other conferences relevant to disaster risk reduction	C	SPF	10	10	10	10	10
7	Continuous capacity building programmes for reducing risk for sectoral departments and agencies	C	SDRF	70	70	70	70	70
8	Implement inclusive disaster risk reduction	C	SPF	3.5	3.5	35	10	10

9	Strengthen Inter Agency Groups	C	SPF	3.5	3.5	35	70	70
10	Revitalising water kiosks	C	SDRF	14	14	14	14	14
11	Popularise alternate technology for potable drinking water	MT	SPF	1	1	2	2	2
12	Include more weather models and weather services from private and public organisations	C	SDRF	100	100	100	100	100
13	Continued upkeep of the last mile connectivity early warning systems	C	SDRF	300	300	300	300	300
14	Introduction of CAP alert and SMS blasting	C	SDRF	100	100	100	100	100
15	Create safety walls in all schools	MT	SDMF	200	200	200	0	0

16	Undertake Coordinated Regional Climate Downscaling Exercise (CORDEX) exercise with the Netherlands Weather Services (KNMI) for availing climate change scenarios to local governments for better governance.	MT	SDMF	20	25	0	0	0
17	Avail business accounts of all social media platforms	C	SDRF	10	10	10	10	10
18	Providing narrow band satellite based emergency communication system to all local governments, block offices, police stations, fire & rescue stations, taluk EOCs, DEOCs and SEOC	C	SDRF	300	300	300	300	300

19	Supporting Fire and Rescue Services for procuring high value critical response equipment	C	SDRF	400	400	400	400	400
20	Supporting Civil Defence	C	SDRF	100	100	100	100	100
21	Supporting Coastal Police for Emergency Response	C	SDRF	50	50	50	50	50
22	Supporting Samoohika Sannadha Sena	C	SDRF	40	40	40	40	40
Year Total				2335.5	2245.5	2404.5	2001	2046
Priority Total				**11032.5**				

APPENDIX
PROCEEDINGS OF THE MEMBER SECRETARY
STATE PLANNING BOARD
(Present: Sri. Teeka Ram Meena IAS)

Sub: - Formulation of Fourteenth Five Year Plan (2022-27) – Constitution of Working Group on Disaster Management – reg.

Read: 1. Note No. 297/2021/PCD/SPB dated: 27/08/2021
2. Guidelines on Working Groups

ORDER No.SPB/437/2021/PPD/W(5) Dated: 7/9/2021

As part of the formulation of Fourteenth Five Year Plan, it has been decided to constitute various Working Group under the priority sectors. Accordingly, the Working Group on Disaster Management is here by constituted with the following members. The Working Group shall also take into consideration the guidelines read 2nd above in fulfilling the tasks outlined in the ToR for the Group.

Co-chairpersons

1. Dr Sreekumar Chattopadhyay, Former Scientist, NCESS, TC 3/1360/2 , LIC lane, Pattom, E-mail Srikumarc53@gmail.com
2. Dr. A. Jayathilak IAS, Additional Chief Secretary, Revenue & Disaster Management, Housing Room No. 201- A,1st Floor, Annex I, Secretariat,Thiruvananthapuram, Phone: 0471- 2333028, 2517214, E-mail: prl.secy.revenue@gmail.com

Members

1. Prof. Dr. C.J van Western, Multi-hazard risk dynamics, Department of Earth Systems Analysis, Faculty of Geoinformation Science and Earth Observation, University of Twente, The Netherlands. Mob: 0031-648863452, Email: c.j.vanwesten@utwente.nl Expert in Multi-hazard Risk Assessments

2. Dr. Sekhar Kuriakose, Member Secretary, KSDMA, Mob:9400202927- E-mail sekhar.lk@gmail.com

3. Dr. Roxy Mathew Koll, Climate Scientist, Centre for Climate Change Research, Indian Institute of Tropical Meteorology, Pune. Mob: +91 9405015676, Email: roxy@tropmet.res.in

4. Ir. Paul Van Meel, Senior Strategic Advisor on IWRM, Govt. of The Netherlands, Nodal Officer for the Netherlands-Kerala partnership round table, Email: paul@vanmeelwm.nl

5. Prof. Dr. Ajith Kaliyath, Urban Chair Professor, Kerala Institute of Local Administration. Email: ajithkaliyath@gmail.com, 9560859486.

6. Ms. Annie George, BedRock. Email: annie@bedroc.in. Mob: 94421 00074

7. Dr. Anish T.S, Associate Professor, Department of Community Medicine, Government Medical College, Thiruvananthapuram. Email: doctrinets@gmail.com

8. Dr. P.T Baburaj, Hon. Director, Inter University Center for Disability Studies (IUCDS), School of Behavioral Sciences Building, M.G University, Email: iucds-mgu@gmail.com

9. Sri. G. Padmanabhan, Former Emergency Analyst, UNDP, India. Email: . Expert in Disaster Management Plans and Governance Systems. Email: gp.geetanjali@gmail.com

10. Dr. Hari Kumar, Regional Coordinator, Geohazards International, Email: hari@geohaz.org

11. Dr K V Thomas, Retired scientist, National Centre for Earth Science Studies, 9400333128

12. Dr. A. Bijukumar, Department of Aquatic Biology and Fisheries, Professor and Head of the Department, Kerala University. Mob: 9447216157, Email: bijupuzhayoram@gmail.com

13. Cdr. Jacob Koottummel, Rtd. Navy Commander and Advisor to KSDMA on Emergency Operations Centres. Email: jacob.koottummel@gmail.com

14. Dr. T.K Prasad, Head, Dept. of Geography, University of Kannur Mob: 94470 85046. Email: tkprasadgeo@kannuruniv.ac.in, tkprasadgeo@gmail.com

Convener

Dr V. Santhosh, Chief, Perspective Planning Division, State Planning Board, drsanspb@gmail.com, Chiefppdspb@gmail.com, Mob:8547434266

Co-Convener

Smt. Sangeetha P.K, Research Officer, Perspective Planning Division, State Planning Board, 9995512505.

Terms of Reference

1. Review the learnings and experience of the flood and landslide events and cyclone Ockhi in the 13th Five Year Plan and recommend necessary steps to upgrade the State Disaster Management Plan and key elements thereof.
2. Measures to provide scientific inputs and scientific value addition into disaster risk-management responses of Local Self Government functioning and community-based response for disaster management, especially for more rapid hazard estimation with greater spatial resolution.

3. Propose new technology inputs to improve and enhance disaster management preparedness, disaster response and aid recovery.
4. Propose measures for a more data-driven system in all phases of disaster management from prevention, mitigation and preparedness to including response, rehabilitation, recovery.
5. Review experience of disaster management for particularly vulnerable sections such as disabled and the elderly and propose specific measures for more inclusive disaster risk reduction and disaster management.
6. Review existence and emergence of hotspots of disaster risk and propose measures for risk reduction and enhanced disaster management measures.
7. Propose measures for further evolution of standardized institutional procedures and technical evaluation processes for mainstreaming disaster risk reduction and disaster management measures in all Government departments in their respective spheres.
8. Assess the financial resources requirements for a modern data- and technology-driven disaster management arrangement in the State.

Terms of Reference (General)

1. The non-official members (and invitees) of the Working Group will be entitled to travelling allowances as per existing government norms. The Class I Officers of GoI will be entitled to travelling allowances as per rules if reimbursement is not allowed from Departments.
2. The expenditure towards TA, DA and Honorarium will be met from the following Head of Account of the State Planning Board "3451-00-101-93"- Preparation of Plans and Conduct of Surveys and Studies.

Sd/-
Member Secretary

To
The Members concerned

Copy to
PS to VC
PA to MS
CA to Member (Sri. V. Namasivayam)
Sr. A.O, SPB
The Accountant General, Kerala
Finance Officer, SPB
Publication Officer, SPB
Sub Treasury, Vellayambalam
Accounts Section
File/Stock File

Forwarded/By order
Sd/-
Chief, PPD, State Planning Board

PROCEEDINGS OF THE MEMBER SECRETARY
STATE PLANNING BOARD
(Present: Sri. Teeka Ram Meena IAS)

Sub: - Formulation of Fourteenth Five Year Plan (2022-27) -Constitution of Working Group on Disaster Management -Co-opted -Members -reg. . .

Read: I. Order of even no. dated: 07/09/2021
2. Minutes of the meeting held on 20/09/2021
3. Guidelines on Working Group.

ORDER No.SPB/437/2021/PPD/W(5) Dated: 29/9/2021

As part of the formulation of Fourteenth Five Year Plan, Working Group on Disaster Management has been constituted vide paper read as 151 above. In the first meeting vide reference 2nd cited, it was decided to co-opt the following experts as members in the Working Group.

I. Sri.Arnarnath Raia, Executive Chairman and Co-founder of InAPP
2. Dr.John Mathai, Scientist (G) (Retired), NCESS.

As per the guidelines on Working Group, the Co-Chairperson is authorised to co-opt additional members in Working Group in consultation with State Planning Board to advise the Group on the subject matter.

In the above circumstances, Sri.Amarnath Raja, Executive Chairnman and Co¬ founder of InApp and Dr.John Mathai, Scientist (G) (Retired), NCESS are hereby co-opted as Members of the Working Group on Disaster Management.
This office proceedings read as 151 above stands modified to that extent.

Sd/¬
Member Secretary

To

The Persons concerned Copy to
PS to VC
PA to MS
CA to Member (Sri. Namasivayam)
Sr. A.O, SPB
The Accountant General, Kerala/ Finance Officer, SPB
Publication Officer, SPB
Sub Treasury Vellayambalam
Accounts Section /File/ Stock File

Forwarded/By order
Sd/-
Chief, PPD, State Planning Board