Kerala Floods and Landslides 2018

Joint Rapid Damage and Needs Assessment Report

September 2018

WORLD BANK GROUP

ASIAN DEVELOPMENT BANK

ACKNOWLEDGEMENT

Joint Rapid Damage and Needs Assessment (JRDNA) report was prepared in response to a request from the Department of Economic Affairs (DEA), Government of India (GoI) and the Government of Kerala (GoK). The JRDNA preparation was undertaken jointly by GoK, World Bank (WB) and Asian Development Bank (ADB) officials.

The team met with various line departments, and district officers of different sectors within the GoK that have been involved in damage enumeration. The team extends its appreciation to Mr. Tom Jose (Chief Secretary), Mr. P. H. Kurien (Additional Chief Secretary, Revenue and Disaster Management), Mr. Manoj Joshi (Principal Secretary, Finance), secretaries of all line departments, District Collectors, and other sector groups for meeting and sharing valuable information and insights on the ground situation.

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The JRDNA Team[1]

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ABBREVIATIONS & ACRONYMS

ADB	Asian Development Bank
AEUs	Agroecological Units
BPL	Below Poverty Line
CHC	Community Health Centres
CMG	Crisis Management Group
DDMA	District Disaster Management Authority
DDMP	District Disaster Management Plans
DEA	Department of Economic Affairs
DEOC	District Emergency Operations Centre
DH	District Hospitals
DM Act, 2005	Disaster Management Act, 2005 (Central Act 53 of 2005)
DMD	Disaster Management Department, Government of Kerala
DRIP	Dam Rehabilitation and Improvement Project
DRR	Disaster Risk Reduction
GoI	Government of India
GoK	Government of Kerala
HDI	Human Development Index
HVRA	Hazard, Vulnerability and Risk Assessment
ICOMOS	International Council on Monuments and Sites
IDSP	Integrated Disease Surveillance Program
ILDM	Institute of Land and Disaster Management
IMD	Indian Meteorological Department
KILA	Kerala Institute of Local Administration
KRWSA	Kerala Rural Water Supply and Sanitation Agency
KSDMA	Kerala State Disaster Management Authority
KSDMP	Kerala State Disaster Management Plan
KWA	Kerala Water Authority
KSBB	Kerala State Biodiversity Board
KSEB	Kerala State Electricity Board
KTTF	Kerala Tourism Task Force
LSG	Local Self Governments
MDR	Major District Roads
MGNREGA	Mahatma Gandhi National Rural Employment Guarantee Scheme
MSME	Micro, Small and Medium Enterprises
NCDs	Non-Communicable Diseases
NDRF	National Disaster Response Force
NH	National Highways
NHGs	Neighborhood Groups
PMAY	Pradhan Mantri Awas Yojana
PMFBY	Pradhan Mantri Fasal Bima Yojana
R&B	Roads and Buildings
RC	Reinforced Concrete
SH	State Highways
SDMF	State Disaster Mitigation Fund
SDRF	State Disaster Response Force

SEOC	State Emergency Operations Centre
SWM	Solid Waste Management
TDR	Transfer of Developmental Rights
TH	Taluk Level Hospitals
ULBs	Urban Local Bodies
WB	World Bank

EXECUTIVE SUMMARY

1. The heavy monsoon of 2018 brought widespread flooding to several districts of Kerala state and triggered thousands of small to big landslides. The extreme and prolonged rainfall spell in August led to the worst flooding in Kerala in nearly a century impacting almost 5.4 million people, one-sixth of the State's population. Several districts were inundated for more than two weeks due to heavy rains induced floods. A total of 498 casualties have been reported so far due to the floods and subsequent landslides, with over 1.4 million people living in relief camps during the peak of flooding. The Government conducted timely and efficient rescue and relief operations to save many lives. The people of Kerala also showed remarkable resilience in the face of the adversity.

2. The Government of India placed an official request to the Asian Development Bank (ADB) and World Bank (WB) on August 21, 2018 to respond to the Kerala floods. The ADB and WB group mobilized a team to support the GoK in conducting a Joint Rapid Damage and Needs Assessment (JRDNA) to quantify damages and recovery needs to formulate and prioritize sector response, develop a resilient recovery strategy, and identify sources of financing. This JRDNA report is a collaborative effort of the GoK, the WB and the ADB. The objective of the exercise is to lay the groundwork for a recovery and reconstruction framework. The assessment covers all 14 districts in the State which were affected by the floods and landslides to varying extents.

3. An overview of the sector-wise recovery needs estimated are in Table 1 below.

Table 1: Overview of Recovery Needs

Sector	Cost in INR (Millions)	Cost in USD (Millions)
Housing	25,337	362
Public Buildings	1,909	27.3
Transport	85,540	1,222.5
Urban Infrastructure	17,572	251
Rural Infrastructure	52,164	745.2
Livelihoods	38,017	543.0
Health	2,750	39.3
Irrigation & Water Resources	14,833	211.9
Power	3,531	50.7
Natural Environment & Biodiversity	4,545	64.9
Cultural Heritage	874	12.5
Debris/Waste Management	1,745	25
Social Impacts	113	1.7
Total	**248,930**	**3,558**

Note: (i) The values have been rounded so the totals may not match; (ii) Currency rate 1USD = INR 70.

4. A more detailed recovery costs per sub-sectors is in the Table 2 below.

Table 2: Recovery Needs for Sub-sectors

Sector and Sub-sectors	**Cost in INR (Millions)**	**Cost in USD (Millions)**
Housing	**25,337**	**362**
Public Buildings	**1,909**	**27.3**
Transport	**85,540**	**1,222.5**
a. Roads (state)	*76,474*	*1,092.5*
b. Roads (NH)	*9,100*	*130*
Urban	**17,572**	**251.03**
a. Infrastructure	*2,020*	*28.9*
b. Water Supply & Sanitation (Urban)	*15,552*	*222.2*
Rural	**52,164**	**745.2**
a. Infrastructure	*33,040*	*472.3*
b. Water Supply & Sanitation (Rural)	*19,124*	*273.2*
Livelihoods	**38,017**	**543.0**
a. Agriculture	*20,930*	*299.1*
b. Livestock	*1,547*	*22.1*
c. Fisheries	*2,254*	*32.2*
d. Industries/MSME	*6,419*	*91.7*
e. Handloom and Coir	*98*	*1.4*
f. Tourism	*6,769*	*96.6*
Health	**2,750**	**39.3**
Irrigation and Water Resources	**14,833**	**211.9**
Power	**3,531**	**50.7**
Natural Environment & Biodiversity	**4,545**	**64.9**
Cultural Heritage	**874**	**12.5**
Debris/Waste Management	**1,745**	**25**
Social Impacts	**113**	**1.7**
Total	**248,930**	**3,558**
	(₹ 24,893 crores)	***($ 3.56 billion)***

5. The assessment covers the damage and recovery needs for public as well as private assets and sectors. The preliminary recovery costs estimated can guide the relative investments by public and private entities during recovery and reconstruction. For funding such a large-scale recovery program, the governments often plan to use the available resources to support the poorer strata and rural population to revive the social and productive sectors. It is also critical to ensure availability of finance through banking and non-banking institutions including cooperatives for the recovery of the private sector as well.

6. The costs to rehabilitate and reconstruct public goods such as schools, hospitals, roads, power utilities, and water supply systems, among others, will exert substantial pressure on public finances. In view of the massive recovery needs, the government would need to undertake a sustained effort

to mobilize financial resources. As is the case in most recovery programmes, the resources would be pooled through several windows of funding: own resource mobilization including budgetary reallocations, grants from multilateral and bilateral agencies, contributions from the private sector and citizens, new sources of philanthropy, loans from International Financing Institutions (IFIs), and reallocations from existing project portfolios. The resources should be pooled in a way that it would keep the ratio of debt within manageable levels and utilize grants assistance to the extent possible.

7. The recovery programme should be a collective effort of joint resources and expertise of the GoK, the private sector, cooperatives, civil society and development partners, united in the aim to build a resilient Kerala.

8. The assessment report gives a detailed introduction to Kerala's vulnerability to natural disasters and an overview of the 2018 flood and landslides in Chapter 1. The Chapter 2 illustrates the process adopted to conduct the JRDNA and explains the scope as well as limitations of the assessment. The report outlines the sector-wise damages and assesses the recovery needs in Chapter 3. Identifying the need to manage massive amount of debris resulting from flooding, infrastructure damages, and multiple landslides in ecologically fragile areas, Chapter 4 outlines strategies for debris management. Chapter 5 illustrates the social impact of the flooding and land-slides on specific sectors as well as on the vulnerable target groups and provide recommendations for social sector recovery. Sector-wise recommendations on resilient recovery and risk-informed development planning have been summarized in Chapter 6 that can help lay the ground for Kerala's overall recovery framework in the short, medium to long-term. While GoK has an impressive institutional and legal framework to manage disaster response and preparedness, it's imperative to further strengthen the planning and implementation of risk mitigation measures and integrate disaster risk management considerations in sector development strategies. Chapter 7 proposes several priority areas in this regard in the context of Kerala.

CHAPTER 1: INTRODUCTION

1.1 State Profile

1. Kerala, a southwestern coastal state of India, is flanked by the Arabian Sea on the west and the Western Ghats mountains on the east. The state stretches north-south along a coastline of 580 km with a varying width of 35 to 120 km. The terrain divides the State east through west into three distinct regions- hills and valleys, midland and plains and coastal region. The eastern edge, along the Ghats, comprises steep mountains and valleys, covered with dense forests. There are 44 rivers in the state, all of which originate in the Western Ghats, of which 41 flow towards the west into the Arabian Sea and the 3 east flowing rivers form tributaries of the river Cauvery in the neighboring States. The backwaters are a peculiar feature of the State. Canals link the lakes and backwaters to facilitate an uninterrupted inland water navigation system from Thiruvananthapuram to Vadakara, distance of 450 km.

2. Kerala consists of 14 Districts, 21 Revenue divisions, 75 Taluks, 152 Block Panchayats, 941 Gram Panchayats, 87 Municipalities, 6 Corporations, and 1664 Villages. Located between 8°18'N and 12°48'N latitude and 74°52'E & 77°22'E longitude, the State of Kerala encompasses 1.18% of the country, and holds 3.44% of India's population. With a population of 33,406,061 at 860 persons per km^2, it is nearly three times densely populated compared to the rest of India. Kerala is also experiencing a rapid rise in the percentage of the aged population (above 60 years).[2]

3. Kerala's human development indices (HDIs) — primary education, health care and elimination of poverty—are among the best in India. The state has one of the highest literacy rates (94.0%) and life expectancy (74.9 years[3]) among Indian states. Kerala has also made an extensive stride in reducing both rural and urban poverty. From 1973-74 to 2011-12, rural and urban poverty ratio declined from 59.19 per cent to 7.3 per cent and from 62.74 per cent to 15.3 percent respectively, whereas in India these figures declined from 56.44 per cent to 30.9 per cent for rural and 49.01 per cent to 26.4 percent for urban[4]. Per Capita GSDP at Current Prices INR 179,778 (USD 2481.58) is above the Indian average. Kerala's economy largely depends on emigrants working in foreign countries (mainly in the Gulf countries) and the remittances annually contribute more than a fifth of the GSDP. The service sector (including tourism, public administration, banking and finance, transportation, and communications), agricultural and fishing industries dominate the economy.

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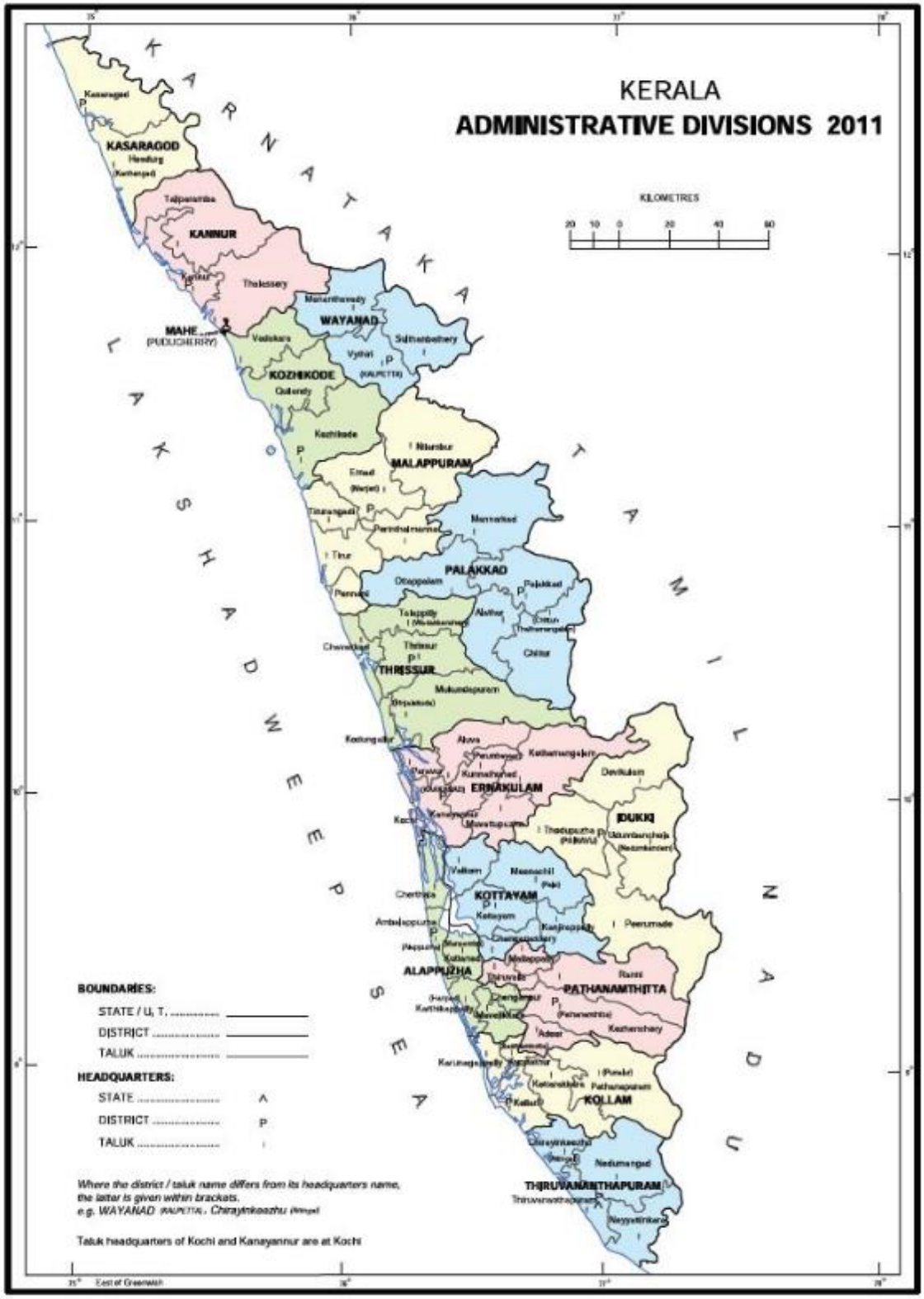
[2] Kerala Department of Economics and Statistics Website, Basic Statistics, Last updated Jan 23, 2018 http://www.ecostat.kerala.gov.in/index.php/geography

[3] Abridged Life Tables 2010-2014, Office of the Registrar General & Census Commissioner, India pg. 5 http://www.censusindia.gov.in/Vital_Statistics/SRS_Life_Table/2.Analysis_2010-14.pdf

[4] Kerala State Planning Board, Economic Review 2016, Macro Economic Profile http://spb.kerala.gov.in/EconomicReview2016/web/chapter01_04.php

Figure 1: Administrative Boundaries of Kerala



Source: Kerala Administrative Divisions, Kerala State Commission for Minorities
http://www.kscminorities.org/pdf/Kerala_Administrative_Divisions.pdf

1.2 Vulnerability to Natural Disasters[5]

4. Kerala's geographical location, weather pattern and high population density make it prone to severe natural as well as human-induced disasters. HDIs being a composite index of consumption rate, education and health, is an indicator of the socio-economic vulnerability of the population. The higher the HDI, the higher is the coping capacity, but greater is the cumulative loss potential and degree of risk. Thus, Kerala has higher level of disaster risks as compared to the rest of the country. Additionally, Kerala is prone to a host of natural hazards such as cyclone, monsoon storm surge, coastal erosion, sea level rise, tsunami, flood, drought, lightning, landslide (debris flows), land subsidence (due to tunnel erosion or soil piping), and earthquake.

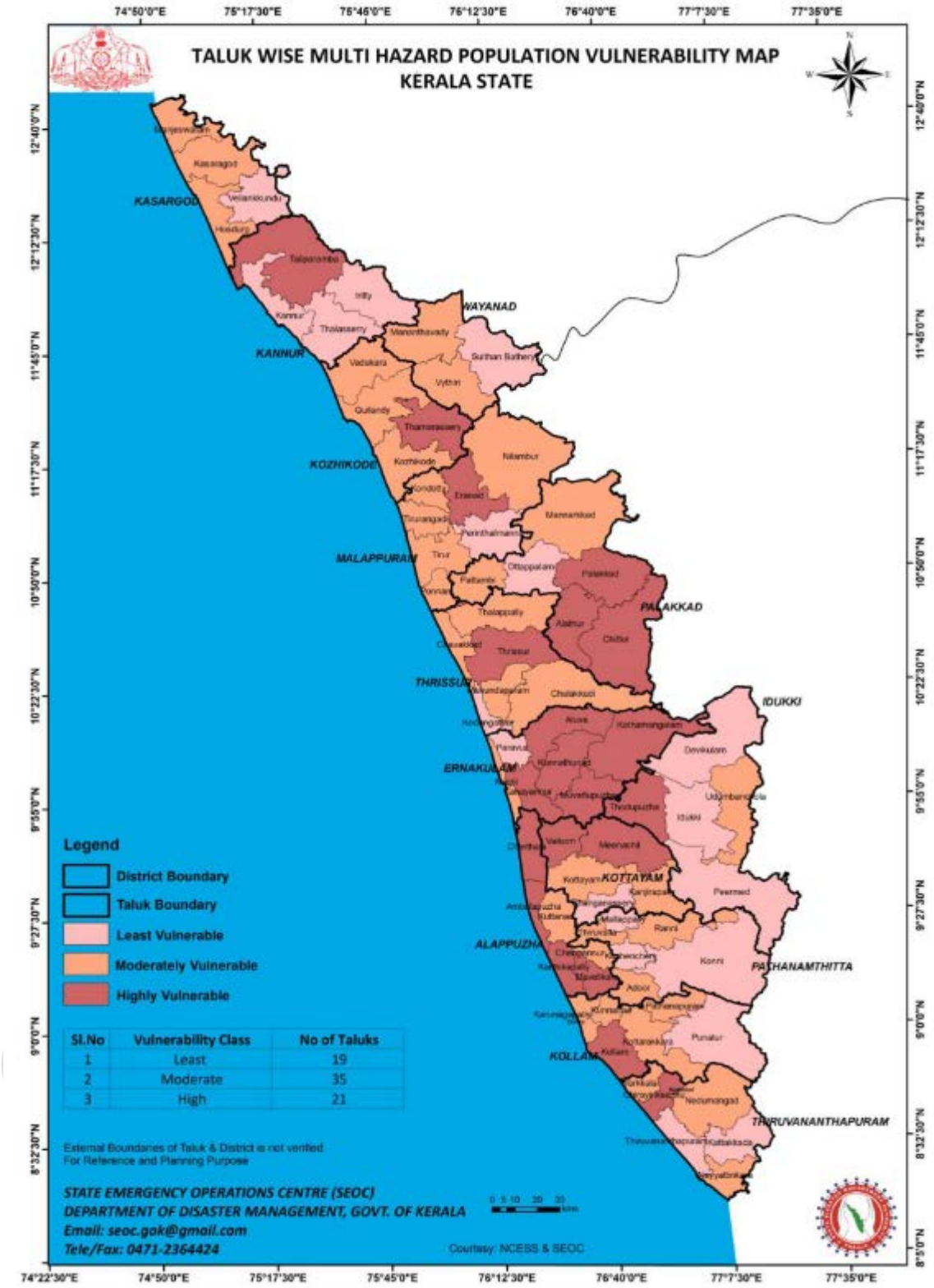
5. The State experiences a high incidence of lightning, especially during April, May, October and November. Around 70 people die every year due to lightning. 14.8% of the state is prone to flooding (CESS, 2010). The western flank of the Western Ghats covering the eastern part of Kerala is one of the major landslide prone areas of the country. 1500 sq.km. in the Western Ghats is vulnerable and every year with the onset of monsoon, landslides are reported. The mountain regions experience several landslides during the monsoon season. It is known that a total of 65 fatal landslides occurred between 1961 and 2009 causing the death of 257 individuals (Kuriakose, 2010). The coastline is prone to erosion, monsoon storm surges and sea level rise. Land subsidence due to tunnel erosion or soil piping is a slow hazard that has recently been affecting hilly areas.

6. Additionally, Kerala experiences seasonal drought conditions every year during summer months. Between 1881 to 2000, Kerala experienced 66 drought years. More than 50% of Kerala's land area is moderately to severely drought susceptible. After the drought years of 2002-2004, 2010, and 2012, Kerala State was officially mapped as mild to moderately arid by the Indian Meteorological Department (IMD). In 2017, the IMD stated that the year brought the worst drought in 115 years. Increasing incidence of droughts is mainly due to weather anomalies, change in land use, traditional practices and lifestyle of people.

7. Kerala has a humid tropical climate, the dominant climatic phenomena being the South-West (June to September) and the North-East (October to December) monsoons. The former is more significant with respect to the amount of rainfall (80% of total). Kerala has an average annual precipitation of 3000 mm, with about 90% of the rainfall occurring during the six monsoon months. The heavy discharges resulting from the high intensity monsoon storms lead to severe flooding in all rivers.

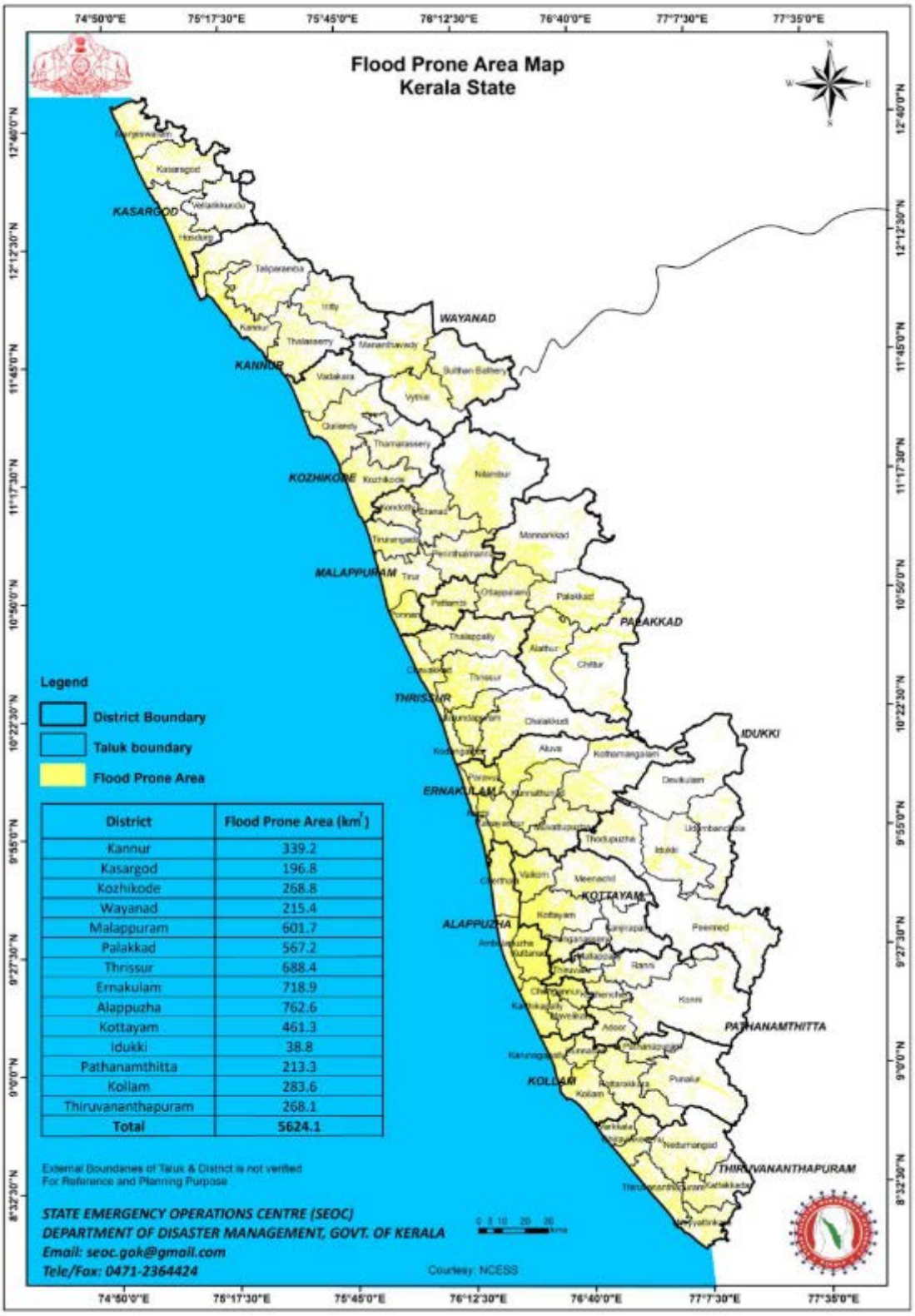
[5] Kerala State Disaster Management Authority: Government of Kerala, State Disaster Management Plan 2016, http://sdma.kerala.gov.in/publications/DMP/Kerala%20State%20Disaster%20Management%20Plan%202016.pdf
Kerala State Disaster Management Authority: Government of Kerala, Kerala State Disaster Management Plan Profile, http://documents.gov.in/KL/16344.pdf

Figure 2: Population Vulnerability to Natural Hazards



Source: Kerala State Disaster Management Plan 2016, Kerala State Disaster Management Authority

Figure 3: Flood Susceptibility Map of Kerala



Source: Kerala State Disaster Management Plan 2016, Kerala State Disaster Management Authority

8. Although Kerala does not experience floods as severe as in the Indo-Gangetic Plains, floods are becoming more frequent and severe, and are now the most common natural hazard in Kerala. Increasing flood plain occupancy and reclamation of water bodies and wetlands results in increasing flood damages. Riverine flooding is recurring consequent to heavy or continuous rainfall exceeding the absorptive capacity of soil and water bodies, and the carriage capacity of the rivers in the state.

1.3 The Disaster: Rainfall of Monsoon 2018

9. Kerala received 2346.6 mm of rainfall from 1 June 2018 to 19 August 2018 in contrast to an expected 1649.5 mm of rainfall (IMD data). This rainfall was about 42% above the normal. Further, the rainfall over Kerala during June, July and 1st to the 19th of August was 15%, 18% and 164% respectively, above normal. Thirty-five dams across the state were opened to release flood runoff. All five overflow gates of the Idukki Dam were opened, for the first time in 26 years. Heavy rains in Wayanad and Idukki caused severe landslides. A total of 498 casualties have been reported so far with over 1.4 million affected people taking shelter in relief camps, during this period. Preliminary estimates of damages provided by Government of Kerala (GoK) were in the range of INR 19,512 Cr. (USD 2.8 billion). According to the Additional Memorandum submitted by the State of Kerala to the Government of India on September 13, 2018, between August 1 – 31, 59,345 ha of agricultural land was affected, 40,188 large animals and 751,303 birds perished, 9,538 km of roads were impacted, and 605,675 individuals were directly affected. Thus, the total claim of the state was revised with an increase of INR 4796.35 crores.

10. Water levels in several reservoirs were almost near their capacity due to continuous rainfall from 1st June, 2018. Due to heavy rainfall, the first onset of flooding occurred towards the end of July, 2018. Severe rainfall was experienced at several places from 8-9 August, 2018. The 1-day rainfall of 398mm, 305mm, 255mm, 254mm, 211mm and 214mm was recorded at Nilambur in Malappuram district, Mananthavady in Wayanad district, Peermade, Munnar Kerala State Electricity Board (KSEB) and Myladumpara in Idukki district and Pallakad in Pallakad district respectively on 9 August 2018. This led to further flooding at several places during 8-10 August 2018. Another severe spell of rainfall started from 14th August and continued till 19th August 2018, resulting in disastrous flooding in 13 out of 14 districts. As per the IMD, it has been found that the rainfall depths recorded during the 15-17, August 2018 were comparable to the severe storm that occurred in the year 1924.

11. Due to this high rainfall there was an absence of appreciable storage reservoirs upstream, along with the shrinkage of carrying capacity of lakes and rivers. The limited capacity of Vembanad Lake and Thottappally spillway worsened the flooding in the Kuttanad region and the backwaters. The worst affected districts noticed were Wayanad (Kabini sub-basin), Idukki (Periyar sub-basin), Aluva & Chalakudy (Periyar and Chalakudy) sub-basins, Chengannur and Pathanamthitta (both in Pamba sub-basin). According to satellite image analysis-based flood affected area maps provided by the National Remote Sensing Centre (NRSC), between 16th July to 28th August 2018, 65,188 hectares of the land area was inundated.

12. Figure 4 and

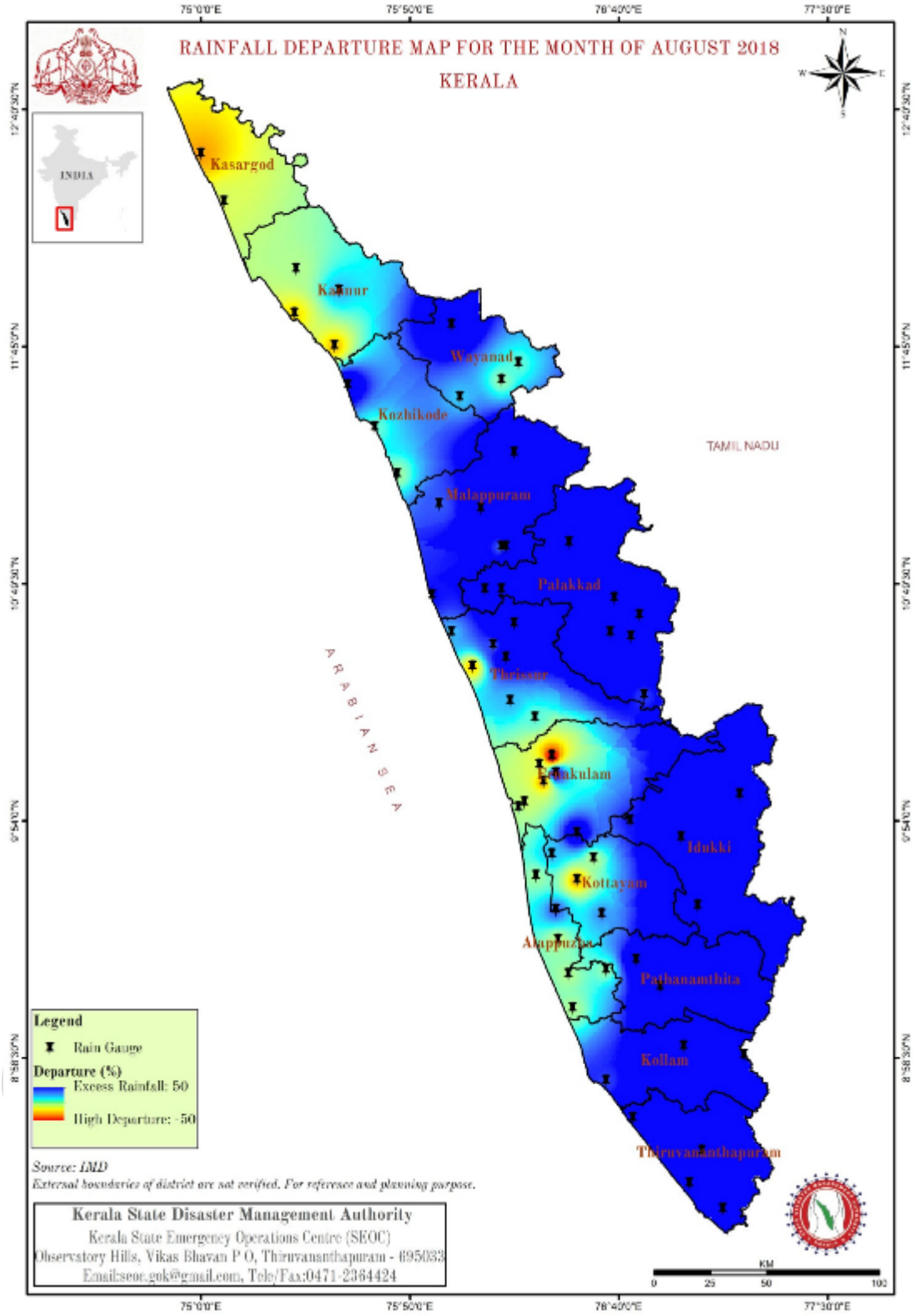
13. Figure 5 shows the flood affected areas in this time span. Many areas were under water for more than two weeks.

Table 3: District wise rainfall during 1 June 2018 to 22 August 2018

District	Normal Rainfall (mm)	Actual Rainfall (mm)	Departure from Normal (%)	
Kerala State	1701.4	2394.1	41	Excess
Alappuzha	1380.6	1784	29	Excess
Kannur	2333.2	2573.3	10	Normal
Ernakulam	1680.4	2477.8	47	Excess
Idukki	1851.7	3555.5	92	Large Excess
Kasaragod	2609.8	2287.1	-12	Normal
Kollam	1038.9	1579.3	52	Excess
Kottayam	1531.1	2307	51	Excess
Kozhikode	2250.4	2898	29	Excess
Malappuram	1761.9	2637.2	50	Excess
Palakkad	1321.7	2285.6	73	Large Excess
Pathanamthitta	1357.5	1968	45	Excess
Thiruvananthapuram	672.1	966.7	44	Excess
Thrissur	1824.2	2077.6	14	Normal
Wayanad	2281.3	2884.5	26	Excess

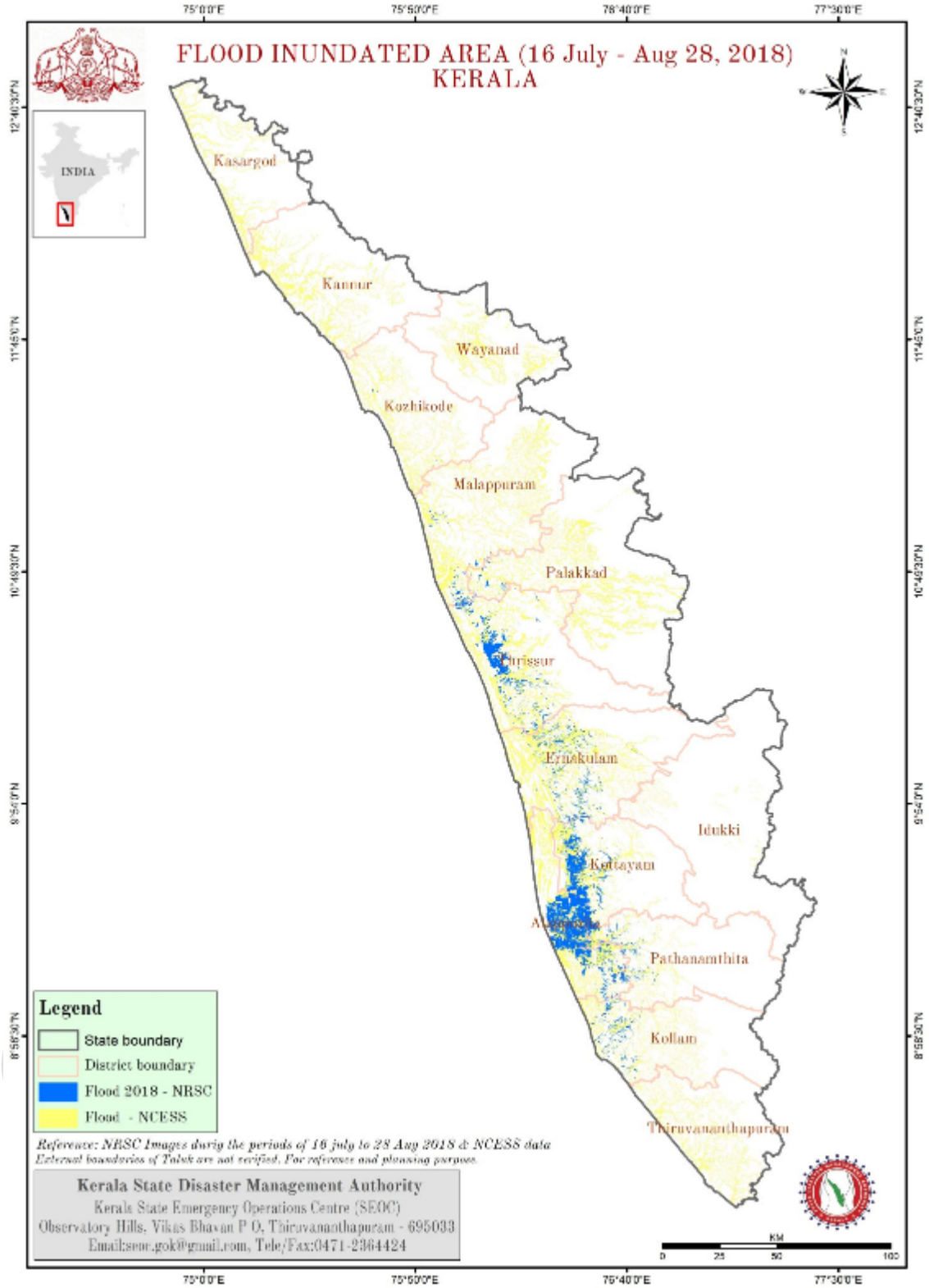
*(*Sources: Study Report Kerala Floods of August 2018, Government of India: Central Water Commission Hydrological Studies Organization, September 2018)

Figure 4: Rainfall Departure Map



Source: IMD, State Relief Commissioner, Disaster Management, Additional Memorandum, Kerala Floods 2018

Figure 5: Flood affected areas plotted against the flood prone areas of Kerala



Source: IMD, State Relief Commissioner, Disaster Management, Additional Memorandum, Kerala Floods 2018

1.4 Government Response

14. The GoK's extensive disaster response and rescue activities during the floods helped saving many lives. The central government and other states also provided support to GoK's response and relief efforts. 57 teams of National Disaster Response Force and 435 boats were deployed for search and rescue in addition to five companies of paramilitary forces, armed forces and coast guards with 40 Helicopters; 20 aircrafts, 2 ships, 10 columns and 10 teams of Engineering Task Force. The Kerala State Disaster Management Authority placed the State on a red alert because of the intense flooding. Several water treatment plants were forced to cease pumping water, resulting in poor access to clean and potable water, in many districts of the state.

15. The Prime Minister has announced financial assistance of INR 600 Crores (USD 85 million), ex gratia of INR 200,000 (USD 2,800) per person to the next kin of the deceased and INR 50,000 (USD 700) to those seriously injured. Pradhan Mantri Awas Yojana (PMAY) houses would be provided to the villages whose kutcha (mud brick) houses have been destroyed in the flood. The Ministry of Rural Development has sanctioned INR 1,800 crore (approx. USD 260 million) under Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGA) for 2018-19 for 5.5 crore person days of work. Directions are issued to insurance companies to hold special camps for assessments and timely release of compensation to the affected families/beneficiaries under social security schemes, fast clearance Fasal Bima Yojana to agriculturists/farmers, and to National Highway Authority of India to repair national highways damaged due to floods on priority. 50,000 MT of rice and wheat, 100 MT of pulses and 9,300 kl of kerosene have been arranged for the immediate relief with more quantities underway.

CHAPTER 2: PROCESS AND METHODOLOGY OF THE ASSESSMENT

1. This Joint Rapid Disaster and Needs Assessment (JRDNA) report is a collaborative effort of the GoK, the World Bank (WB) and the Asian Development Bank (ADB) in response to a request from the Government of India (GoI). The objective of the exercise is to undertake a rapid assessment of the damages and needs after Kerala Floods, and lay the groundwork for a recovery and reconstruction framework.

2.1 Assessment Process

2. A request from GoI was received on 21st August 2018 by the World Bank (WB) and Asian Development Bank (ADB) to mobilize a team for response to Kerala floods. A Joint team led by the Department of Economic Affairs (DEA), GoI, with representation from the WB and ADB, visited Kerala on August 29, 2018. The JRDNA team of WB and ADB visited the affected districts during September 11-20 to prepare a rapid multi-sectoral assessment report of the damages and needs. The field visits were made to 10 affected districts, viz: Wayanad, Malappuram, Kozhikode, Alappuzha, Ernakulam, Thrissur, Palakkad, Idukki, Kottayam and Pathanamthitta. Table 4 below shows the schedule of JRDNA activities.

Table 4: Assessment Time Frame

Date	Activity
August 21, 2018	ADB and WB received DEA's request to mobilize a joint team in response Kerala floods
August 28, 2018	DEA convened a meeting with ADB and WB Group at New Delhi
August 29, 2018	DEA led joint mission of ADB and WB to Kerala
September 7, 2018	ADB and WB received DEA's request to conduct a joint Rapid Damage and Needs Assessment (JRDNA) in Kerala on priority basis
September 11-15	JRDNA team undertakes field visits in 10 most affected districts and holds sector-wise meetings with district administration and line agencies
September 16	Sector teams arrives in Thiruvananthapuram and collates sector observations and damage information in consultation with line departments
September 17-20	Meetings with GoK counterparts and JRDNA draft report preparation
September 22	Preliminary JRDNA findings and draft report discussed with GoK
October 05	Preliminary JRDNA findings discussed with DEA/GOI in New Delhi

3. Data collection and aggregation templates for damage and needs assessment were distributed to the sector teams who customized these templates to the specific context and as per the data availability. The team conducted detailed interviews with sectoral counterparts from the respective line departments of the most affected districts to understand their data collection methodologies and to fill any gaps that may exist. Sector teams also conducted field visits to understand the extent and type of damages. This report primarily relies on the data collected by the district officials of GoK and collated at the state level. A sector-by-sector analysis of the damage was undertaken, utilizing specific templates for information recording and gathering to ensure consistency of information. A currency conversion rate of USD 1= INR 70 has been used.

2.2 Assessment Scope and Methodology

4. This assessment covers the damage caused by severe flooding and landslides associated with abnormally high rainfall during 2018 monsoon season in Kerala. The assessment covers all 14 districts in the State which were affected by the floods and landslides to varying extents. The following sectors are covered in the assessment: i) Housing; ii) Public Buildings; iii) Transport; iv) Urban Infrastructure; iv) Rural Infrastructure; vi) Livelihoods (including Agriculture, Livestock, Fisheries, Industries/MSMEs, Tourism, Handloom and Coir); vii) Health; viii) Irrigation and Water Resources; ix) Power; x) Natural Environment & Biodiversity; and xi) Cultural Heritage. The report also outlines strategies for debris management and illustrates the social impact of the flooding and landslides on specific sectors as well as on the vulnerable target groups and provides recommendations for social sector recovery.

5. The focus of this assessment report is to assess the scope of the physical damages as per GoK collected information and estimate the corresponding needs for recovery, including the loss of livelihoods. It provides a preliminary estimate of the extent of damages and total cost of corresponding recovery (including reconstruction) needs. The recovery needs are computed and expressed as the financing requirement for restoring damages with a "build back better" factor for quality improvements and risk mitigation, where possible.

6. Teams visited the ten most severely affected districts during September 12-15, 2018. The JRDNA team's estimation of the damages neither supersedes nor disregards the damage and needs assessment made by other entities. It presents a consolidated view based on relevant information received and the expertise of a multi-institutional and interdisciplinary assessment team.

2.3 Limitations and Caveats

7. The assessment is intended to quantify the consequences of the disaster and identify recovery needs. The team's analysis is based on discussions with the state government, short field visits, and relies primarily on the assessments carried out by the GoK and data available at the time of the mission. The final recovery needs would be contingent upon future policy decisions by GoK that may include aspects of overall vulnerability reduction and increasing resilience of the communities. Preliminary findings of the JRDNA were discussed and presented to GoK on September 22, 2018 and to GoI on October 05, 2018.

8. The assessment covers the flood impact in public as well as private sectors. The recovery costs estimated do not imply any commitment of funding by the GoK. In view of the massive recovery needs, the government would need to undertake a sustained effort to mobilize financial resources. As is the case in most recovery programmes, the resources would be pooled through several windows of funding: own resource mobilization including budgetary reallocations, grants from central government, multilateral and bilateral agencies, contributions from the private sector and citizens, new sources of philanthropy, loans and credits from IFIs, and reallocations from existing project portfolios.

CHAPTER 3: DAMAGE AND NEEDS ASSESSMENT

3.1 Housing

Sector Context

1. Kerala is one of the most urbanized states in the country, which at 47% urbanization (Census 2011) [6] comes in after Tamil Nadu. Kerala has a fairly good quality building stock, 83.5% of its total stock was classified as *pucca*[7], with 12.7% as *semi-pucca* and 2.6% as *kutcha* [8]. Keralites also live in India's largest homes. As many as 79% of rural households and 84% of the urban population in Kerala live in houses with more than three rooms[9]. Of the total number of houses, 66% were classified as of good quality, 28% as livable and 5% as dilapidated. 94% of the houses have electrical connections, 95% of the houses have latrine facilities, with rural households also showing a high 93% of latrines within premises. 62% of the houses relied on wells as the main water source, while close to 30% had tap water as their main source[10]. Kerala has lower than 12% of its population Below Poverty Line (BPL)[11].

Flood Impact

2. The Monsoon 2018 Kerala Floods (and landslides) caused widespread damage of housing and human settlements. 22,132 houses were damaged requiring reconstruction, and 104,636 houses were partially damaged requiring repairs. About 30% of the fully damaged and 20% of the partially damaged houses were *Kutcha.* Of the houses to be rebuilt, 30% of the kutcha and 20% of the pucca may require relocation[12] due to loss of land and unsafe locations. Housing in rural areas bore the brunt of the floods and landslides. The impacts were also widespread in urban areas. Diverse range of communities and settlements, including, remote tribal hamlets, riverside settlements, heritage settlements, peri-urban neighborhoods across the state have suffered the damages. Household assets were also lost, but the JRDNA was unable to account for it due to unavailability of data. Some social groups: elderly, persons with disabilities, female-headed households, Scheduled Tribes and Scheduled Castes (ST/SCs) may face difficulties in rebuilding and repairing their homes since most of them live on the verge of poverty and have limited resources.

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[6] (PDF) Census Towns in Kerala: Challenges of Urban Transformation. Available from: https://www.researchgate.net/publication/265552035_Census_Towns_in_Kerala_Challenges_of_Urban_Transformation [accessed Sep 17 2018].

[7] **Pucca House:** Wall material: Burnt bricks, stones (packed with lime or cement), cement concrete, timber, ekra etc. Roof Material: Tiles, GCI (Galvanized Corrugated Iron), asbestos cement sheet, RBC (Reinforced Brick Concrete), RCC (Reinforced Cement Concrete) and timber etc.
Semi -Pucca: A house that has walls made up of pucca material, but roof is made up of the material other than those used for pucca house.
Kutcha: The walls and/or roof of which are made of material other than those mentioned above, such as unburnt bricks, bamboos, mud, grass, reeds, thatch, loosely packed stones, etc. are treated as kutcha house.
(for the JRDNA Semi-pucca and Kutcha categories have been combined as Kutcha)
http://mospi.nic.in/sites/default/files/Statistical_year_book_india_chapters/HOUSING-WRITEUP_0.pdf

[8] http://mospi.nic.in/statistical-year-book-india/2017/197

[9] http://www.censusindia.gov.in/vital_statistics/BASELINE%20TABLES07062016.pdf

[10] http://www.censusindia.gov.in/vital_statistics/BASELINE%20TABLES07062016.pdf

[11] http://spb.kerala.gov.in/EconomicReview2016/web/chapter01_04.php

[12] JRDNA assumptions

Damage analysis

3. The serious damage to housing resulted primarily from: a) landslides in the higher reaches, where entire or part of the houses were lost and existing housing settlement sites became unsafe; b) flooding in the middle and lower reaches in the vicinity of river courses where fast flowing and fast rising flood waters, led to scouring of foundations and structural damages in the buildings; and c) unprecedented flooding in the lower reaches, especially in the low lying areas of the state where long period of submergence led to structural damages in the buildings and part or full settlement of buildings, in addition to heavy silt deposition.

4. The kutcha houses are primarily low strength masonry with mud mortar, often built-in low-lying areas or otherwise vulnerable sites. These intrinsically weak buildings suffered widespread damage. Other common building types such as cement-mortared masonry and frame RC buildings with reinforced concrete (RC) roof, both sloping and flat also suffered mainly due to land subsidence and partial or complete washing away of the site. The large number houses that suffered partial damage suffered damage of electrical wiring, plumbing, flooring, door and window shutters and frames, weakening of plinth, walls and plaster disfiguration. Compound walls, water wells and external toilets have also suffered extensive damage.

Table 5: Housing Damages

	Fully damaged			**Partially damaged**			**Total**
	Kutcha	***Pucca***	***Total (A)***	***Kutcha***	***Pucca***	***Total (B)***	**(A+B)**
District	**Units**	**Units**	**Units**	**Units**	**Units**	**Units**	**Units**
Alappuzha	2,830	2,056	4886	4,519	17,517	22,036	26,922
Ernakulam	6	3,619	3625	8	23,110	23,118	26,743
Idukki	632	1,716	2348	1,437	3,920	5,357	7,705
Kannur	0	11	11	113	397	510	521
Kasaragod	0	0	0	0	26	26	26
Kollam	49	7	56	414	80	494	550
Kottayam	95	946	1031	1,737	9,582	11,319	12,360
Kozhikode	118	237	355	1,126	4,726	5,852	6,207
Malappuram	784	296	1080	2,824	2,734	5,558	6,638
Palakkad	539	231	770	2,265	971	3,235	4,005
Pathanamthitta	463	669	1132	2,052	9,233	11,285	12,417
Thiruvananthapuram	16	73	89	107	546	653	742
Thrissur	916	4,412	5328	2,184	10,561	12,745	18,073
Wayanad	514	897	1411	1,494	3,606	5,100	6,511
Sub-total	**6,962**	**15,170**	**22,132**	**20,280**	**87,009**	**107,288**	**129,420**

Note: Housing data received from the Government of Kerala (September 18, 2018) and from the Districts (September 12 to 15, 2018). Housing data from Palakkad district received during a field visit on September 12 to 15, 2018 did not contain a breakdown of kutcha and pucca houses. Based on the state average, it was assumed that 70% of the houses is kutcha and 30% is pucca.

Immediate response:

5. The GoK and the people of Kerala rose up to the occasion. Many affected people were evacuated to government identified shelters and camps. Majority of families have returned, while certain families continue to live in camps. Kits with food and non-food items were prepared and distributed and continue to be distributed in certain parts. All concerned line departments have

undertaken work of restoring services on a war footing. Local Self-Government Department has developed the 'Rebuild Kerala' mobile application. Trained volunteers, under the supervision of Government engineers, educational institutions and professional associations have taken up a rapid visual survey and to gather extensive socio-economic data.

Reconstruction, Recovery and Resilience building needs

Need Analysis

6. A regional approach needs to be taken, for both reconstruction and relocation needs. The needs for housing reconstruction in the Kuttanad area for example from the house type, the ground strata conditions, the land use planning perspectives are very different from those of the high lands. There must be region specific menu of options including (but not limited to) design, implementation arrangements, enabling mechanisms. There is also need for safe, durable transition housing for the interim period.

7. **JRDNA Estimates:** Preliminary estimates of recovery needs have been developed based on data provided by Government of Kerala (GoK) and assumptions made in JRDNA. These are in the range of INR 25,337 million (USD 362 million) [13]. See Table 6-8 for details.

8. **JRDNA Estimates following GoK's, 'LIFE' (Livelihood Inclusion and Financial Empowerment) Mission for landless and homeless:** The recovery cost (including additional cost of repair of partially damaged houses) is INR 20,509 million (USD 293 million)[14]. The provisions as per the scheme include:

- Assistance for house building as INR 400,000 (approximately USD 5,700).
- The cost of land is estimated as INR 600,000 (approximately USD 8,600) per house (It is assumed that relocation for 30% of the fully damaged *kutcha* houses and 20% of the fully damaged *pucca* houses will be required)

9. Additional provision for repair of partially damaged *kutcha* and *pucca* houses is estimated as 20% of the reconstruction costs and has been added to the total recovery cost.

Recovery Needs (short-medium term)

10. Based on the sectoral findings and field visits, the following steps are necessary to ensure a strong recovery and reconstruction effort in the short and medium term:

- A post-disaster housing reconstruction policy covering all types of affected social groups and locations, including a socio-technical facilitation mechanism
- The relocation needs innovative financing techniques like TDR (Transfer of Development Rights) land-pooling, others.
- A house-by-house damage assessment and eligibility survey.
- A geophysical survey of shortlisted relocation sites.

[13] Total Cost including cost of House reconstruction, Basic Services Provision, Land Acquisition, rental and shifting allowance

[14] Total Cost including cost of House reconstruction and Land Acquisition

- Boundary walls built at a high cost suffered extensive damage, enhanced localized flooding and disrupted rescue efforts. The reconstruction should encourage bio-fences in rural areas and permeable fences in urban areas.
- Large quantity of construction debris generated should be recycled into construction products to be used for reconstruction.
- The use of pre-fab/pre-cast technologies should be used cautiously giving due weightage to user preference. Choice of technologies and material should also aim at reviving local economy to be encouraged.
- Kuttanad specific reconstruction approach, building bye-laws and revised land use planning should be developed.

Table 6: Cost for Repair of partially damaged and Reconstruction of the Fully Damaged Houses

District	Fully Damaged		Partially Damaged		Total		
	Number of units	INR million	Number of units	INR million	Number of units	INR million	USD million
Alappuzha	4,886	2,201	22,036	2,183	26,922	4,384	62.63
Ernakulam	3,625	1,884	23,118	2,404	26,743	4,288	61.26
Idukki	2,348	1,145	5,357	523	7,705	1,668	23.83
Kannur	11	6	510	50	521	56	0.8
Kasaragod	0	0	26	3	26	3	0.04
Kollam	56	23	494	41	550	65	0.92
Kottayam	1,041	530	11,319	1,135	12,360	1,665	23.79
Kozhikode	355	170	5,852	582	6,207	752	10.74
Malappuram	1,080	468	5,558	510	6,638	978	13.97
Palakkad	770	336	3,235	282	4,005	618	8.83
Pathanamthitta	1,132	533	11,285	1,124	12,417	1,657	23.68
Thiruvananthapuram	89	44	653	65	742	110	1.57
Thrissur	5,328	2,661	12,745	1,273	18,073	3,934	56.2
Wayanad	1,411	672	5,100	495	6,511	1,167	16.67
Total	**22,132**	**10,673.20**	**107,288**	**10,671.24**	**129,420**	**21,344.44**	**304.92**

Note:

a. The average unit cost of reconstructing the fully damaged *kutcha* houses is estimated as INR400,000 (approximately USD5,700).

b. The average unit cost of reconstructing 40% of the fully damaged *pucca* houses is estimated as INR400,000 (approximately USD5,700) and for balance 60% as INR600,000 (approximately USD8,600).

c. The average unit cost of repairing the partially damaged *kutcha* and *pucca* houses is estimated as 20% of the reconstruction costs.

Table 7: Relocation - Total cost of basic services, land required for relocation, cost of land acquisition, and transition shelters arrangements

District	Cost of Basic Services	Area of land required	Cost of land acquisition	Cost of transition shelters	Total Cost of Land for Relocation	
	INR million	Acre	INR million	INR million	INR million	USD million
Alappuzha	166.03	30.2	755.08	49.15	970.25	13.9
Ernakulam	113.13	17.39	434.76	28.3	576.19	8.2
Idukki	76.29	12.77	319.24	20.78	416.31	5.9
Kannur	0.34	0.05	1.32	0.09	1.75	0
Kasaragod	-	-	-	-	-	0
Kollam	1.98	0.39	9.65	0.63	12.26	0.2
Kottayam	32.94	5.22	130.44	8.49	171.87	2.5
Kozhikode	11.64	1.98	49.61	3.23	64.48	0.9
Malappuram	37.46	7.06	176.4	11.48	225.34	3.2
Palakkad	26.61	4.98	124.57	8.11	159.29	2.3
Pathanamthitta	37.54	6.54	163.39	10.64	211.57	3
Thiruvananthapuram	2.85	0.46	11.62	0.76	15.23	0.2
Thrissur	170.63	27.73	693.36	45.13	909.12	13
Wayanad	46.49	8	199.88	13.01	259.38	3.7
Total	**723.94**	**122.77**	**3,069.32**	**199.78**	**3,993.04**	**57.0**

Note:

a. For want of precise data the number of houses that may need relocation is estimated as 30% of the fully damaged *kutcha* houses and 20% of the fully damaged *pucca* houses.

b. The cost of providing basic services is estimated as 30% of the reconstruction cost of houses that require relocation.

c. Of the households that require relocation, it is assumed that 50% will move to individual plots and 50% to group housing. Land requirement for the individual plots is estimated as 0.02 acre (two *cents*). For group housing, additional 30% land is added for providing basic services and community infrastructure.

d. The cost of land is estimated as INR25 million (approximately USD357,000) per acre.

e. For households requiring relocation, provision has been made for: (i) rental assistance for 12 months @ INR 2,000/month; and (ii) an additional onetime shifting allowance of INR 15,000.

Table 8: Total Cost of Housing Reconstruction

District	Reconstruction and Repair Cost	Relocation Cost	Total Cost	
	INR million	INR million	INR million	USD million
Alappuzha	4,384.41	970.25	5,354.66	76.5
Ernakulam	4,288.36	576.19	4,864.55	69.49
Idukki	1,667.76	416.31	2,084.07	29.77
Kannur	56.05	1.75	57.8	0.83
Kasaragod	2.7	0	2.7	0.04
Kollam	64.68	12.26	76.94	1.1
Kottayam	1,665.41	171.87	1,837.27	26.25
Kozhikode	752.02	64.48	816.51	11.66
Malappuram	977.78	225.34	1,203.11	17.19
Palakkad	617.81	159.29	777.1	11.1
Pathanamthitta	1,657.47	211.57	1,869.04	26.7
Thiruvananthapuram	109.7	15.23	124.94	1.78
Thrissur	3,933.70	909.12	4,842.83	69.18
Wayanad	1,166.58	259.38	1,425.97	20.37
Total	**21,344.44**	**3,993.04**	**25,337.48**	**361.96**

Resilience needs (medium-long term):

- Set up Authorities to protect Kuttanad Backwaters, Kole Lands, Highlands and other such ecologically fragile and disaster vulnerable regions with a mandate including building bye laws, land use planning, tourism and other infrastructure.
- Undertake Revise Panchayat Building Rules including Panchayat level land use planning
- Set up a Construction and Demolition Waste recycling plants as per the national guidelines.

Figure 6: Ernakulam District

A house of an inland fisher families that are located next to a river course that witnessed flooding of this scale for the 1st time. Families continue to live in the unsafe houses as no viable alternative has been made available to them and they do not have the resources to rent a house. They are also concerned about household assets in case they move

Figure 7: Palakkad District

A 45 Ha landslide which also resulted in the tragic death of 3 humans. This area had no prior landslides. A tribal settlement comprising 18 families of Kattunaicken has got isolated an dthe site has been declared as unsafe for continued occupation and will have to be reloacted

Figure 8: Thrissur District

A road side landslide that caused the death of 19 people and destroyed 4 houses. The stability of the landslide can only be determined post the upcoming North-East monsoon and the safety of the houses and human settlements in the immediate vicinity can only be determined then.

3.2 Public Buildings

Sector Context

11. Public buildings[15] and associated infrastructure are vital to community's operation and quality of life. Functional aspect of these buildings is crucial for social, economic, physical well-being of the society. Interconnectivity/Interconnectedness of public facilities are very important during extreme hazard events. Damage to the public buildings and inability to meet the expected service delivery has far reaching consequences. Damage to critical infrastructure, especially health care and evacuation shelters disable community function, lives are lost and can become an obstacle for immediate recovery. Equipment and public records in public buildings if not safeguarded is either temporarily inaccessible or destroyed.

Flood Impact

12. Incessant rains, floods and landslides damaged many public buildings, including the equipment and amenities which led to the disruption of the routine functioning of these facilities. Flood water took several days to recede making several public buildings completely non-functional and, in most cases leading to weakening of load bearing walls and partial/full collapse of building. Following flood waters receding, the debris and mud left behind took several days to clean, effectively allowing these buildings to function partially/normally nearly 10-15 days after the flooding event. Buildings in direct path of landslide debris flow suffered significant damage making them unfit for use. Further, equipment, public records and documents stored in these buildings were also destroyed due to the inundation.

Damage Analysis

13. As per the information from Government of Kerala, a total of about 1,619 public buildings are damaged, of which 774 correspond to education buildings, 50 belong to group of Livelihood based/veterinary clinics, Market Buildings, and remaining 795 are categorized as other category (which includes, Post Office, Panchayat Buildings, Tourism, Bus Shelters, miscellaneous). Damage to health services buildings are included in the Health section. Damage to public buildings are categorized and shown in Tables below. The extent of loss of public records and documents is still being assessed.

[15] Public Buildings for this assessment is defined as buildings which provide public services, occupied and owned by a government institution.

Table 9: Damage to Education Buildings

District	Primary Schools	Secondary Schools	Higher / Technical Education Institute	Anganwadi Centers (AWCs)	Total
Alappuzha	63	6	7	122	198
Ernakulam	12	6	12	43	73
Idukki	12	9	9	37	67
Kannur				7	7
Kollam	2			3	5
Kottayam	7	1		31	39
Kozhikode	2	4		32	38
Malappuram	61	13		2	76
Pathanamthitta	28	24	2	88	142
Thrissur	27	6		14	47
Wayanad	19	6	4	53	82
Total	**233**	**75**	**34**	**432**	**774**

Table 10: Damage to Livelihood Based/Veterinary Centres & Market Type Buildings

District	Livestock / Veterinary Centers	Slaughter Houses/ Areas	Markets (rural haats and urban markets)	Total
Alappuzha	8		2	10
Ernakulam			5	5
Idukki	1	2		3
Kollam			1	1
Kottayam			1	1
Kozhikode	4			4
Palakkad				
Pathanamthitta	7	8	8	23
Thrissur		1	1	2
Wayanad	1			1
Total	**21**	**11**	**18**	**50**

Table 11: Damage to Other Category Buildings

District	Post Office /Panchayat Buildings/ Others	Cremation Ground/ Graveyards	Tourism Buildings	PWD Buildings	Bus Shelters	Misc.	Total
Alappuzha	32	3				19	54
Ernakulam	60	1				28	89
Idukki						34	34
Kannur		1					1
Kollam	9	1					10
Kottayam	6	3				3	12
Kozhikode	5					43	48
Malappuram	22						22
Palakkad						116	116
Pathanamthitta	34	2			2	21	59
Thrissur	282	1		24			307

District	Post Office /Panchayat Buildings/ Others	Cremation Ground/ Graveyards	Tourism Buildings	PWD Buildings	Bus Shelters	Misc.	Total
Wayanad	26		4	13			43
Total	**476**	**12**	**4**	**37**	**2**	**264**	**795**

14. Damage to 'Other' category includes buildings such as Post Offices, Gram Panchayat Offices, Tourism, Agriculture Offices (Krishi Bhawans), Fire & Emergency Services, Government offices, Revenue Inspectors Office, Block Office and Bus Shelters. Some districts have recorded the various public buildings under Miscellaneous category. These buildings house many vital public services and suffered losses to infrastructure as well as furniture and equipment. These buildings house many vital public services and suffered losses to infrastructure as well as furniture and equipment.

Reconstruction, Recovery and Resilience building needs

Reconstruction Needs

15. The cost estimates are based on data provided by Government of Kerala for the restoration of damaged structures as well as preliminary estimates for equipment losses. The assessment includes an additional 20% for furniture and other equipment on top of the estimate provided by GoK, and quality upgrade.

16. The total reconstruction needs for public buildings amount to INR 1,908.56 million (USD 27.27million). Abstract of the total number of units damaged and the cost of reconstruction is provided in Table 12.

Table 12: District Wise Total Reconstruction Cost of Public Buildings & Overall Summary

District	Description	Building Use Type			District Total
		Education	Livelihood/Markets	Others	
Kollam	Nos / Units	5	1	10	16
	Estimated cost (INR million)	1.04	0.51	4.17	5.72
	Estimated cost (USD million)	0.01	0.01	0.06	0.08
Pathanamthitta	Nos / Units	142	23	59	224
	Estimated cost (INR million)	101.96	15.48	48.54	165.98
	Estimated cost (USD million)	1.46	0.22	0.69	2.37
Alappuzha	Nos / Units	198	10	54	262
	Estimated cost (INR million)	207.28	7.19	137.15	351.61
	Estimated cost (USD million)	2.96	0.10	1.96	5.02
Kottayam	Nos / Units	39	1	12	52
	Estimated cost (INR million)	253.85	1.20	7.27	262.32
	Estimated cost (USD million)	3.63	0.02	0.10	3.75
Idukki	Nos / Units	67	3	34	104
	Estimated cost (INR million)	245.86	4.44	178.31	428.61
	Estimated cost (USD million)	3.51	0.06	2.55	6.12
Ernakulam	Nos / Units	73	5	89	167
	Estimated cost (INR million)	46.48	3.00	164.14	213.63

District	Description	Building Use Type			District Total
		Education	Livelihood/Markets	Others	
	Estimated cost (USD million)	0.66	0.04	2.34	3.05
Thrissur	Nos / Units	47	2	307	356
	Estimated cost (INR million)	35.48	0.84	112.80	149.12
	Estimated cost (USD million)	0.51	0.01	1.61	2.13
Palakkad	Nos / Units			116	116
	Estimated cost (INR million)			56.52	56.52
	Estimated cost (USD million)			0.81	0.81
Malappuram	Nos / Units	76		22	98
	Estimated cost (INR million)	25.50		12.83	38.34
	Estimated cost (USD million)	0.36		0.18	0.55
Kozhikode	Nos / Units	38	4	48	90
	Estimated cost (INR million)	10.86	4.17	31.40	46.44
	Estimated cost (USD million)	0.16	0.06	0.45	0.66
Wayanad	Nos / Units	82	1	43	126
	Estimated cost (INR million)	141.62	0.24	46.49	188.35
	Estimated cost (USD million)	2.02		0.66	2.69
Kannur	Nos / Units	7		1	8
	Estimated cost (INR million)	1.32		0.60	1.92
	Estimated cost (USD million)	0.02		0.01	0.03
Overall Summary	**Nos / Units**	**774**	**50**	**795**	**1619**
	Estimated cost (INR million)	**1071.26**	**37.07**	**800.23**	**1908.56**
	Estimated cost (USD million)	**15.30**	**0.53**	**11.43**	**27.27**

Reconstruction/Recovery Needs:

17. Following measures are proposed, but not restricted to the key areas:

- Create comprehensive inventory/database of all public buildings and determine exposure to hazards
- Develop guidelines to protect public buildings and its content in a timely manner, and further develop protection standards for new facilities
- Public buildings identified for risk exposure should undergo safety/hazard audit or vulnerability assessment to identify entry points for strengthening of weak structural and on-structural elements, result of the audit shall recommend steps to prevent or reduce future damage
- Majority of existing public buildings and new buildings under construction may be in the influence zone of the hazard. Based on the safety audit, determine ways to protect the public buildings/facilities through flood/landslide protection measures or retrofitting initiative. Investment in protection measures (floodproofing, elevation, boulder fall protection) can be incorporated considering following factors: life safety, contents in the building & intended use during emergency.
- Introduce survivability concept in Public Buildings to deal with during and after disaster, and add new features such as emergency communications / emergency lighting / emergency water provision (rain water harvesting) etc.
- For public buildings with key emergency function, undertake ‘all risk” insurance policy as indicated in the hazard zones

Resilience needs (medium-long term):

18. Functioning of public buildings as per business rules and continuity of operations are important during and after extreme hazard events. Based on the sectoral findings, key discussions with the facility managers and the user groups, field visits in the aftermath of the devastating Aug 2018 floods and landslides, following resilience building measures are proposed, but not restricted to, key areas:

- Adopt higher standards for infrastructure design to make it resilient to climate change and other hazards
- Hazard zoning to inform siting/placement of public building and allied infrastructure
- Undertake maintenance and protection measures in a timely manner for existing buildings and formal procedure for safety inspection/audit of buildings, replacement programme for buildings which have topped the service life and are structurally deficient/deterrent to public health.
- Develop new protection guidelines / standards for public buildings / critical facilities.
- Determine select public buildings as emergency facility and undertake structural and non-structural mitigation measures (example: elevating structural and non-structural elements in police station, emergency shelters, fire station, health centre above the flood level; floodproofing)
- Protect and build redundancy measures in public buildings/critical facilities, and ensure the buildings are accessible and operable during and following most hazard events.

3.3 Transport

Sector Context

19. The roads/highways are the dominant mode of transport in Kerala with about 75 percent of freight and 85 percent of passenger share. Kerala has a dense road network, roughly three times the national average. Of the 152,000 km of road network in the state, the primary road network, which carries about 80 percent of road traffic and the mainstay of economic activities, includes about 1,500 km of national highways (NH), about 4,300 km of state highways (SH) and 28,300 km of major district roads (MDR). The SH and MDR networks are primarily managed by the Roads and Buildings (R&BD) wings of the Public Works Department, while the National Highways are managed jointly by NHAI and Ministry of Road Transport Highways through the NH unit of the R&BD.

Flood Impact

20. Based on the primary and secondary data collected by the R&BD, about 2,004 km of SH and 13,246 km of MDR across 14 districts have suffered varying degree of damages during the recent floods. The NH wing has also estimated damage of about 580 km of NHs. The post-flood impact analysis indicates heavy damages due to land slide/slips in the roads in four hill districts of Idukki, Wayanad, Pathanamthitta and Palakkad, whereas roads in the seven districts of Alappuzha, Thrissur, Ernakulam, Kozhikode, Malappuram, Kollam and Kottayam have sustained flash floods, erosion, water stagnation and other flood induced damages. The roads in Thiruvananthapuram, Kasaragod and Kannur districts have sustained minimal damage.

Damage Analysis

21. 1,090 km of SHs and 6,527 km of MDRs have sustained light damages (Table 13) and would largely require pavement rehabilitation through patching, shoulder repairs and limited debris clearance. 734 km of SHs and 6,463 km of MDRs have sustained medium to heavy pavement damages (Table 14) and would require re-laying of surfacing and limited repair of drainage, cross drainage and protection works. 179 km of SH and 256 Km of MDR have been fully damaged (Table 14) and would require full depth pavement reconstruction, significant repair/reconstruction of drainage, cross drainage and slope protection works and limited road raising, and new cross drainage works.

Need Analysis

22. The needs analysis was carried out individually for all 14 districts under the three categories of lightly damaged, severely damaged and fully damaged criteria, as summarized in Tables 11, 12 and 13. The overall cumulative damages for SH and MDR are estimated to be INR 7,647 Cr (USD 1.092 billion). For the National Highways managed by the NH wing of the state, an additional need of INR 911 Cr (USD 130 million) has been assessed, which is proposed to be met out of the MoRTH central funds.

Immediate response

23. GoK, using its own resources, have started providing immediate short-term repair of pavements and cross drainage structure, clearance of debris and temporary protection works to restore the access and keep the roads trafficable. The major repair works can only be undertaken starting November 2018, post North-East monsoon. It is estimated that about INR 898 Cr. (USD 128 million) would be required for immediate needs. GoK should also continue rehabilitation of the lightly damaged roads, largely through measures like pothole patching, to keep the roads trafficable.

Table 13: Lightly Damaged SH & MDR

District Name	Road Length Affected (in km)		Total Cost	
	MDR	SH	INR million	Million USD
Alappuzha	173.51	13.05	199.3	2.85
Ernakulam	1167.83	120.78	1090.2	15.57
Idukki	401.44	469.56	2375.5	33.94
Kannur	783.58	13.7	400	5.71
Kasaragod	320.62	42	186.4	2.66
Kollam	413.61	5.3	257.6	3.68
Kottayam	528.22	62.63	389.7	5.57
Kozhikode	495	0	247.5	3.54
Malappuram	427.16	192.76	1585.9	22.66
Palakkad	691.79	137.77	1107.2	15.82
Pathanamthitta	299.67	0	154.3	2.2
Thiruvananthapuram	274.48	14	153.6	2.19
Thrissur	505	18.6	716.3	10.23
Wayanad	44.74	0	115.4	1.65
Total	**6526.66**	**1090.15**	**8978.8**	**128.27**

Recovery, Reconstruction and Resilience building needs

24. The need analysis was carried out using the current (2016) Schedule of rates, suitably adjusted with district wise indices issued by GoK during October 2017. The individual item and block

rates were also calibrated with current market rates operating in ongoing World Bank funded Second Kerala State Transport Project. To enhance disaster resilience, measures e.g. replacement of all damaged pipe culverts with box/slab culverts with larger waterway, additional slope protection, lined drainage, downstream erosion protection of CD structures, batter slope correction and limited raising of road stretches were included in the needs assessment.

Recovery Needs (immediate to short term):

25. Based on the needs assessment, 7,197 km of roads (734 km of SH & 6,463 km of MDR) are severely damaged but are recoverable. 36 major and 178 minor bridges, 362 culverts, 43 km length of retaining wall and 169 km of road side drainage works are severely damaged. It is estimated that about INR4146 Cr (USD 592 million) would be required for recovering severely damaged SH & MDRs.

Table 14: Severely Damaged SH & MDR

District Name	Road Length Affected (in km)		Total Cost	
	MDR	SH	INR Million	Million USD
Alappuzha	260.26	0	1238.5	17.69
Ernakulam	780.85	71.43	3554.5	50.78
Idukki	1798.28	158.78	12297.3	175.68
Kannur	126.75	45.92	1115.7	15.94
Kasaragod	92.75	48.14	924.7	13.21
Kollam	285.05	8.3	1801.8	25.74
Kottayam	571.97	65.63	2588.6	36.98
Kozhikode	486.98	16.02	2333.9	33.34
Malappuram	299.41	28.04	1285	18.36
Palakkad	466.32	4.5	2206	31.51
Pathanamthitta	227.17	8.2	5771.7	82.45
Thiruvananthapuram	355.3	33.7	1688.4	24.12
Thrissur	227	171.35	2441.1	34.87
Wayanad	485.39	74.33	2215.6	31.65
Total	**6463.48**	**734.33**	**41462.7**	**592.32**

Reconstruction and Resilience Needs (short-medium term):

26. Based on the needs assessment, overall 435 km of roads (179 km of SH & 256 km of MDR) are fully damaged and needs to be reconstructed. Two major and 28 minor bridges, 208 culverts, 20 km length of retaining wall and 39 km of road side drainage works are fully damaged. It is estimated that about INR2,603 Cr. (USD 372 million) would be required for reconstructing damaged SH & MDRs. This amount also includes the estimates for resilience needs of about INR1732 Cr (USD 247 million) to enhance disaster resilience works, where additional 62 km of raising of roads, 157 new culverts, 142 km length of new slope stability/protection measures are proposed. Reconstruction of bridges/culverts need to be assigned priority followed by adequate hill slope protection and flood protection works.

Table 15: Fully Damaged SH & MDR & Resilience Building

District Name	Road Length Affected (in km)		Total Cost	
	MDR	SH	INR Million	Million USD
Alappuzha	51.61	45.474	6209.2	88.7
Ernakulam	0.00*	0.00*	423.9	6.06
Idukki	118.7	117.25	6688.1	95.54
Kannur	0.00*	0.00*	10.8	0.15
Kasaragod	0	0	0	0
Kollam	0	0	0	0
Kottayam	21.67	5.5	4950.2	70.72
Kozhikode	0.00*	0.00*	384.8	5.5
Malappuram	0.00*	0.00*	890.8	12.73
Palakkad	27.1	0.00*	1096.7	15.67
Pathanamthitta	14	0.00*	140.4	2.01
Thiruvananthapuram	0	0	0	0
Thrissur	0.3	3	1987.6	28.39
Wayanad	22.2	8.2	3249.8	46.43
Total	**255.58**	**179.42**	**26032.3**	**371.89**

**Note: The cost includes the cost of additional resilience measures.*

Recovery Strategy

Short Term Strategy: Aimed at restoration of traffic and arresting further asset deterioration

- Patching, shoulder repairs and limited debris clearance

Medium to Long-Term Strategy:

"Building Back Better" with rejigged approach to planning and design with disaster and climate resilience

- Site Specific Climate Adaptations based on flood and landslide hazard vulnerability assessment i.e. flood maps, landslide zonation based on geological and geomorphological studies and super-imposed micro climate data.
- Adopting "Life cycle cost" approach and "Environmentally Optimized Design" measures to rehabilitation and reconstruction of road pavement i.e. long-life pavement, rigid pavements, semi-rigid pavements, soil stabilization, use of NRMB and other local materials.
- Retrofit CD structures with downstream erosion protection (e.g. aprons).
- Design new CD structures using latest flood and hydrological data with climate projections.
- Packaged landslide protection works: Combination of Gabions, Breast wall, other slope protection using bio-engineering measures (e.g. geo-grids with grass sodding/rip-raps) and improve coverage of road side plantations.
- Augment contracting capacity in the state with specific capacity building measures, targeted outreach program to contractors in the neighboring states, setting up an equipment pooling and leasing arrangement.

Technical Assistance

- Road network level vulnerability assessment with specific focus on geo-hazard and flooding risks and development of climate proofing framework (USD 3 million).
- Enhance existing GIS mapping of the highway network with details of the river systems, geo-hazard zones and micro-climates (USD 1.0 million).

- Develop Center of Excellence in PWD for climate and disaster resilience (could be accommodated under KSTP).
- Develop bio-engineering / horticulture cell within PWD (e.g. in Himachal Pradesh) to develop specifications and promote use in slope stability management.

3.4 Urban Infrastructure

Sector Context

27. About 50 percent of Kerala's population lives in urban areas spread across 93 Urban Local Bodies (ULBs) with 65% concentrated in mid-small sized ULBs with 20,000-100,000 population per municipality, while the remaining 35% are in bigger ULBs (six municipal corporations and municipalities with population more than 100,000 people). Kerala is one of the most decentralized States in India. Despite Kerala's decentralized service delivery set-up, the coverage, quality of urban and rural services and infrastructure are still limited. The Kerala State Disaster Management Plan (KSDMP) highlights that high density of population, narrow roads, high density of road network, as compared to the rest of the country, are factors that increase the vulnerability of the population to disasters.

28. The key institution in the urban water supply is Kerala Water Authority (KWA). 77.70% of urban population of Kerala has drinking water sources within their premises, way above national average of 46.6%, while 34.9% have piped water supply connections. KWA is vested with the responsibility of providing urban water supply. Although floods are the most common natural hazard, lack of adequate storage and drainage systems have revealed the vulnerability of the infrastructure in the hills and plains to these events.

Flood Impact

29. The floods and landslides triggered by the excessive rainfall, affected urban infrastructure and disrupted service delivery in the municipalities located in all the affected districts of Kerala. Substantive damages were noticed in urban roads, with impacts ranging from partially damaged to totally washed up of roads and collapse of bridges and culverts.

30. The damage to water infrastructure has disrupted water supply coverage in most urban areas. Siltation of leading channels, intake wells, electro-mechanical equipment, led to sub-optimal performance of clarifloculators, choking of filters, resulting in significant reduction in quality and production capacity. Extensive damages have also incurred on many transmission, distribution and civil structures supporting water supply systems. Damages to sewerage systems were limited to large municipalities. Lack of adequate solid waste management (SWM) infrastructure compounded the impacts across the state. In addition, damages of household level individual toilets and waste washed down by the floods, widely scattered on bridges and water bodies, and are likely to contaminate the water and choke river management structures.

Damage Analysis

31. About 326 km of roads and 2 minor bridges are partially damaged requiring debris clearance, improvement in subbase, re-carpeting and repair/reconstruction of super structures, to make them motorable. 4 km of road stretch, and 1 bridge were reported as fully damaged, requiring significant

repair/reconstruction to improved standards. In the sanitation sector, about 11,640 individual/ household toilets were damaged.

32. Damaged systems in the water supply sector requiring interventions include 75 water intake structures, leading channels and infiltration galleries (59 schemes); 109 structures such as clarifiers, filters and flocculators associated with 45 WTPs; 293 electro mechanical units including motor, pump sets and sub stations and related components; pipelines and appurtenances at 203 locations, access/approach roads to intake wells and pipeline bridges, raw water pumping units and filter media, and over 2,800 house service connections.

Immediate response

33. The local governments and the respective line departments/ agencies have initiated immediate repairs to restore services such as: drinking water supply, roads, transport and epidemic prevention measure, clearance of boulders, debris, silt, trees, landslides. Activities such as repairing drain/culverts, desilting of small water channels, and replacement of damaged transmission and distribution pipes, etc. has also been taken up. Sewage/septage from inundated areas were transported and treated at the nearest available treatment plants, while accumulated solid waste was removed to various locations for segregation and processing.

Reconstruction, Recovery and Resilience building needs

Need Analysis

34. Damages to infrastructure in the municipalities were categorized as partial and full and are summarized in para on "*Damage Analysis*". Damages to toilets was categorized as either damaged or not damaged. The overall cumulative recovery needs for infrastructure to be immediately restored is estimated at INR 26.52 crores (i.e. USD 3.78 million)[16], while about INR 18.01 crores (USD 2.6 million) will be required for reconstruction of damaged toilets.

35. Needs in the water supply sector are assessed based on (i) immediate repair and rectification; (ii) reconstructing assets for better resilience; (iii) water grid connectivity in a spatial unit basis; (iii) partial or full relocation of submerged components; (iv) expanding service delivery through full utilization of installed capacity and (v) providing functional scheme coverage to highly flood prone areas which do not have adequate reliable water sources. The estimated costs for short-medium term reconstruction/restoration of damaged assets to address critical losses in service level is INR333.44INR 329.14 crores (USD 47.63 million).

Reconstruction Needs

36. Estimates at LSGD unit rates, suitably adjusted for increases in cost of construction / restoration of infrastructure to improved standards, with extra provision for municipalities in the hilly districts vis-à-vis others in the plains, were calibrated with current market rates. Improved designs include construction of paver block or cement concrete roads, wherever required, for reconstruction of fully damaged roads in the short term and redesign /upgradation of the partially damaged or existing roads, is proposed to enhance disaster resilience.

[16] As estimated by LSGD

37. In the water sector reconstruction needs include (i) cleaning, desilting and repairing intake structures and clarifiers; (ii) cleaning, repacking and substituting filter media; (iii) repair and replacement of damaged electromechanical components; (iv) re-laying dislocated pipelines and appurtenances including pipeline bridges and approach roads and (v) repairing of storage facilities. Shifting of assets from flood prone areas for better resilience should also be considered.

Recovery Needs (Short-Medium term)

38. Recovery needs to target providing improved service delivery through (i) utilization of installed capacity by filling gaps in assets, (ii) construction of drains along roads, wherever feasible, (iii) reconstruction and disaster risk reduction of water supply schemes in flood affected areas to reduce vulnerability, (iv) establishment of septage treatment, solid waste collection and processing facilities to address potential emergence of vector borne diseases.

Table 16: Urban: Reconstruction/Recovery Needs in Short-Medium Term (INR Millions)

Sr. No	Districts	Urban Infrastructure					
		Roads	Drainage	Sanitation	Water Supply		
		Damaged Roads	Damaged culverts	Toilets	Repair/ Reconstruction	Critical loss in service level	Recovery - Urgent Flood Resilience
1	Alappuzha	0	0	110	22.4	0	-
2	Ernakulam	250	0	20	81.9	2943.5	5
3	Idukki	0	0	0	6.3	0	-
4	Kannur	0	0	0	0.7	0	-
5	Kasaragod	0	0	0	0	0	-
6	Kollam	140	0	0	11.2	0	-
7	Kottayam	0	0	30	60.2	18.9	15
8	Kozhikode	300	0	0	0.7	0	-
9	Malappuram	0	0	30	28	0	1
10	Palakkad	0	0	10	0.7	0	22
11	Pathanamthitta	0	0	60	24.5	0	-
12	Thiruvananthapuram	90	0	0	11.9	0	-
13	Thrissur	270	0	30	20.3	44.8	-
14	Wayanad	0	0	0	3.5	5.6	-
	Sub-Total	**1040.0**	**0**	**300.0**	**278.6**	**3012.8**	**43.0**
	Total in INR million	**1350.0**			**3334.4**		
	Total in USD million	**19.23**			**47.63**		

Resilience needs

Urban Infrastructure

39. The long-term reconstruction needs for urban infrastructure include measures to build resilient and sustainable infrastructure supported by: (i) zonation of areas vulnerable to various hazards and climate change effects; and incorporating appropriate measures in town planning

standards and processes[17]; (ii) development of technical guidelines and specifications for creation and maintenance of infrastructure; (iii) capacity building of local bodies; (iv) introduction of policies to relocate vulnerable settlements/houses/buildings from risk prone zones to safe zones based on the outcomes of hazard mapping.

Water supply

40. KWA needs to initiate auditing of its assets from climate change perspective to ensure that the designs of all ongoing and proposed works are built with resilient measures based on the lessons learned. Shifting of sources to sustainable locations such as reservoirs and interlinking of strategically important schemes should be considered as long-term risk mitigation measures. Expansion of pipe water coverage with service connection, mapping of key systems, and automation of systems for better disaster management should also be included in its long-term priorities. KWA has prioritized long term investment of INR 11,497 million (USD 158.7 million) over the next 10 years. A Technical Assistance of INR 145 million (USD 2 million) may be granted to KWA for planning, monitoring and development of detailed designs incorporating disaster resilient features.

Table 17: Urban: Reconstruction, Recovery and Resilience building needs in Medium to Long Term

Sr. No	Districts	Urban Infrastructure				
		Roads		Drainage		Water Supply
		Roads	Protective Structures	Drains	Cross-drainage structures	Recovery - Service Level Improvement
1	Alappuzha	0	0	0	0	2081
2	Ernakulam	30	20	120	10	-
3	Idukki	0	0	0	0	6
4	Kannur	0	0	0	0	-
5	Kasaragod	0	0	0	0	-
6	Kollam	0	10	70	10	-
7	Kottayam	0	0	0	0	410
8	Kozhikode	0	20	140	10	3823
9	Malappuram	0	0	0	0	629
10	Palakkad	0	0	0	0	1646
11	Pathanamthitta	0	0	0	0	561
12	Thiruvananthapuram	0	10	40	0	-
13	Thrissur	30	20	130	10	2584
14	Wayanad	0	0	0	0	484
	Sub-Total	**70.0**	**80.0**	**500.0**	**50.0**	**12,224.0**
	Total in INR Millions	**700.0**				**12,224.0**
	Total in USD Millions	**10.0**				**174.63**

[17] Includes revision of building and construction standards of urban and rural infrastructure incorporating climate resilient features, with procedures and processes for auditing compliance

Urban Water Supply: Assumptions

Short – Medium Term:

Urgent reconstruction measures are considered under short term. There are three distinct type of works included. (i) Repair works of inundated and damaged equipment and facilities – desilting works, repair to electro mechanical equipment, repair to damaged/washed away pipelines etc., costs approximately INR 27.69 Crores; (ii) Performance optimization works – rectification works in schemes where there has been significant reduction in performance noticed after the flood. This includes revamping works in western part islands (Parur etc.) of Ernakulam district that was badly affected. The total cost of these works is estimated at INR is 301.28 Crores; and (iii) urgent flood resilience work – includes shifting of components, specifically electrical installations, from river front to more secure locations, is estimated at INR 4.3 Crores. The total costs of works to be completed in the short -medium term is estimated at INR 333.44 crores (USD 47.63 million).

Medium-Long Term:

Urgent recovery works are considered under this. There are two different type of works both targeting service level improvement in 9 severely flood affected districts considered in this. (i) Full utilization of installed capacity. In the flood affected and adjacent areas of these district there are functional schemes servicing par below their optimal capacities. These schemes have all most all bulk water components (source, treatment, transmission and distribution mains) in place. With a little strengthening and expansion these schemes would provide 135 lpcd daily supply to its target areas. The total cost of this is INR 1,222.4 crores (USD 174.63 million).

3.5 Rural Infrastructure

Sector Context

41. Kerala is one of the most decentralized States in India. The public service delivery in the rural areas of Kerala is distributed between the three PRI structures i.e. District, Block and Gram Panchayats. Most of the infrastructure at the village levels are implemented by Gram Panchayats. Coverage and quality of the public services and infrastructure by these agencies is impacted due to lack of sufficient resources.

42. The key sectoral institutions for rural water supply are Kerala Water Authority (KWA), and Kerala Rural Water Supply and Sanitation Agency (KRWSA). Of the 6.5 million rural households in Kerala, 25% are covered by individual piped water connections, 38% live in villages having water supply facilities, while remaining 37% depend on open well sources. GoK pioneered reforms in the rural water sector since 1999, by introducing demand responsive strategies, household connections and O&M cost recovery through the implementation of community-managed water management schemes.

Flood Impact

43. Intra-city, intra-village mobility was extensively disrupted in the rural areas due to extensive damage to transport infrastructure. Damages to water supply infrastructure operated and maintained by both KWA and community managed schemes were impacted due to: silting of sources; damages to intake structures, pump houses, treatment and distribution networks, handpumps, ponds, spring channels, tube wells, raw water intake points, electrical installations at substations, choking of filter beds and damages to other structures such as retaining walls. Damages are also

widespread to public owned handpumps, ponds, spring channels, tube wells etc. In absence of centralized septage and solid waste management, extended periods of inundation has contaminated individual drinking water sources and other local water bodies.

Damage analysis

44. 9,487 kms of roads, 787 minor bridges/culverts in rural areas[18], were partially damaged requiring: debris clearance, improvement in subbase, re-carpeting and reconstruction/ repair of super structures. 1,482 kms of roads and 313 culverts were fully damaged requiring significant repair /reconstruction to improved standards. About 83,506 individual/household toilets were also damaged.

45. Out of 1,122 water supply schemes, 583 operated by Jalanidhi, 116 operated by LSGD and other community managed schemes, and 423 managed by KWA were substantially damaged. Among these, 51 schemes were majorly affected resulting in an overall production loss of around 600 MLD. Many surface water sources became nonfunctional due to sedimentation of sources. Around 246,000 wells were affected in 387 flood affected GPs[19], in addition to many open wells, which became inundated and unusable.

Immediate response

46. Immediate repair works were undertaken to restore: transport connectivity, health and sanitation services including clearance of boulders/ debris of ruble, silt, trees, etc. Repairs were also made to potholes and structures like drain culverts, and desilting of small water channels was carried out.

47. KWA provided drinking water through tankers to flood affected areas and carried out restoration/repairs to revive water supply schemes. The schemes were also supplemented through use of standby pumps, replacement of damaged pipes with plastic hoses, desilting of water sources, diverting water from other schemes and temporary restoration of key infrastructure components using readily available materials. This was supplemented by voluntary organizations and communities distributing water bottles and cans to people in relief camps. Local administration and health departments supported cleaning and chlorination of wells by training and guiding the affected communities. Schemes under Jalanidhi already handed over to community / local governments have not yet been revived due to financial constraints.

Reconstruction, Recovery and Resilience building needs

Needs Analysis

48. The needs analysis was carried out categorizing the damages to infrastructure in the rural areas as partially damaged and fully damaged, while the damage to toilets were concluded as fully damaged. Accordingly, cumulative damages of rural infrastructure to be immediately restored is estimated at INR 77.3 crores (i.e. USD 11.04 million)[20], while sanitation, about INR 129.4 crores (USD 18.5 million) will be required for reconstruction of damaged toilets. About INR 158.90 crores (USD

[18] Includes areas administered by District, Block and Gram Panchayats

19 As per information available on September 18, 2018

[20] As estimated by LSGD

22.7 million) will be required for restoration of potable water supply in rural areas, to contain any outburst of water and or vector borne diseases.

Reconstruction/Recovery Needs

49. As mentioned above under urban infrastructure LSGD unit rates have been suitably adjusted to address the increase in cost of construction / restoration for infrastructure to improved standards in the hilly districts vis-à-vis the plains. Improved designs include construction of paver block or cement concrete roads, wherever required, for reconstruction of fully damaged roads in the short term and redesign /upgradation of the partially damaged or existing roads, is proposed to enhance disaster resilience. These efforts should be supplemented with guidelines, supervision and regular monitoring to ensure disaster resilient features are incorporated and implemented by the contractors.

Reconstruction/Restoration (Short-medium term)

50. Based on the need assessment and enhanced designs of the partially damaged rural infrastructure - a total of INR 1,031 crores (USD 147.3 million) will be required for restoration of roads and sanitation facilities in the short to medium term[21]. In the water supply sector, works that require urgent execution to bring back the water supply to pre-flood scenarios including schemes where complete reconstruction or rehabilitation of components needs to be undertaken would total to about INR 462.0 crores (USD 66.0 million). Details are in Table 18 below:

Table 18: Rural: Reconstruction/Recovery Needs in Short-Medium Term (INR Crores)

Sr. No	Districts	Rural Infrastructure			Water Supply					
		Roads	Drainage	Sanitation	Jalanidhi (KRWSA)		KWA		LSGD	
		Damaged Roads	Damaged culverts	Toilets	Total No of Affected Schemes	Cost of Reconstruction / Revamping	Total No of Affected Schemes	Cost of Reconstruction/ Revamping	Total No of Affected Schemes	Cost of Reconstruction/ Revamping
1	Alappuzha	801.4	8.5	1027	0	0	23	71.5	8	5.4
2	Ernakulam	749.8	11.6	110	0	6	89	164.3	0	0
3	Idukki	898.7	26.5	63	228	128.8	35	254.4	59	10.2
4	Kannur	250.1	2.9	4	18	8.8	4	0.5	1	2.5
5	Kasaragod	37.7	0.3	0	3	2.3	0	0	0	0
6	Kollam	186.8	1.5	6	0	0	32	12.1	0	0
7	Kottayam	490.8	6	204	38	15.8	27	129	0	0
8	Kozhikode	473.8	7.3	3	108	51.7	17	43.9	26	5.6
9	Malappuram	1059.6	5.1	84	63	24	18	7.2	0	0
10	Palakkad	963.9	16	46	24	10.2	26	49.2	0	0
11	Pathanamthitta	985.3	13.1	414	15	6.7	37	265.8	22	10.7

[21] Short to medium term 1-3 years

12	Thiruvananthapuram	57.4	0.8	0	0	0	25	20.1	0	0
13	Thrissur	458.4	10.4	184	43	25.9	78	125.3	0	0
14	Wayanad	592.1	10.4	40	43	22.3	12	109	0	0
	Sub-Total	**8005.8**	**120.5**	**2184.1**	**583**	**302.4**	**423**	**1,252.3**	**116**	**34.4**
Total in INR Million		**10,310.4**			**1,589.0**					
Total in USD million		**147.3**			**22.0**					

Disaster Risk Reduction measures (Medium-Long term)

51. Extensive capacity building of the engineering cadre of local bodies is required for incorporating improved designs as a disaster risk reduction measures for roads and other rural infrastructure to mitigate future risks. Some of the high-risk water supply components that were damaged during the floods should be redesigned to address risks from similar disasters and enhance reliability of supply. The works mainly include increasing floor height of pump houses, locating transformers and other vulnerable installations to safer locations.

Reduction of dependency on water from Open-wells (Medium- Long Term)

52. KWA currently utilizes only 46% (1,150 MLD) as against an installed capacity of 2,500 MLD for water supply in the state[22]. KWA should expand network of new connections in the vulnerable areas for optimum utilization of the spare capacity, thereby reducing dependency on open wells or tube wells by individual households and other essential services in the rural areas. The costs towards these interventions are given in Table 19 below:

Table 19: Rural: Reconstruction, Recovery and Resilience building needs in Medium to Long Term

Sr. No	Districts	Rural Infrastructure				Water Supply					
		Roads		Drainage		KWA/KRWSSA					
		Roads	Protective Structures	Drains	Cross-drainage structures	DRR Works	Cost of DRR works	Utilization of unused capacity of WTPs	Costs	Schemes in highly vulnerable areas	Costs
1	Alappuzha	666.4	247.5	1,979.90	210.8	0	0	1	90	0	0
2	Ernakulam	329.4	206	1,648.10	169.1	1	50	1	5	1	245
3	Idukki	430.8	250.1	1,250.30	94.1	0	0	8	372.5	3	1,250.00
4	Kannur	254.9	81.3	650.4	72.5	0	0	0	0	0	0
5	Kasaragod	11.4	9.9	79.3	8.3	0	0	0	0	0	0
6	Kollam	33.6	47.1	377	39	0	0	0	0	0	0
7	Kottayam	272.7	139.8	1,118.40	113.9	1	1.5	3	160	0	0
8	Kozhikode	38	115.4	923.4	101.7	6	22.5	3	3,670.00	0	0
9	Malappuram	104.8	259.8	2,078.60	215.4	2	1.8	0	0	0	0
10	Palakkad	310.3	255	2,040.10	211.7	3	33.5	5	3,180.00	1	1,000.00
11	Pathanamthitta	504.6	277	1,384.80	63.6	0	0	14	4,050.00	4	1,320.00
12	Thiruvananthapuram	144.7	26.1	209.2	22.2	0	0	0	0	0	0
13	Thrissur	178.2	123.9	991.5	107.2	0	0	1	20	0	-
14	Wayanad	236.3	160.6	803.1	47.4	0	0	4	1,260.00	1	820

[22] Source: Water Sector Study Report, December 2017

	Sub-Total	**3,516**	**2,199**	**15,534**	**1,476**	**13**	**109.3**	**40**	**12,807.5**	**10**	**4,635.0**
Total in INR Millions		**22,726**				**17,552**					
Total in USD Millions		**325**				**250.7**					

Resilience needs:

- Technical Assistance: Water Resources Department should undertake a climate risk analysis of all existing and proposed water supply schemes focusing on source sustainability, map risks and identify actions for enhancing resilience against recurring floods and droughts in the state (USD 2 million) and implement recommendations for remedial actions building climate resilient infrastructure.
- Long term (beyond 5 years): The state should make investments of about INR 16,794 million (USD 240 million) to provide piped water supply to households in the flood affected rural areas to enhance resilience of the population from future disasters.

3.6 Livelihoods (Agriculture, Livestock, Tourism, Fisheries, Micro Enterprise, Handloom and Coir)

53. The agriculture and allied sectors, handloom and coir, industries and tourism sectors are significant contributors to Kerala's economy. The floods have had a massive impact on the livelihoods of people in these sectors. As per assessments in six livelihood sectors namely agriculture, livestock (animal husbandry), fisheries, coir and handloom, industries and tourism, at least 1.3 million households have been affected, with most of losses in agriculture. The total recovery cost is estimated at INR 38,010 million (USD 543 million).

54. Post floods, robust approaches are required to rebuild social capital and livelihoods. The situation on the ground is challenging; paddy fields in the lowlands continue to be inundated; plantations in the highlands that have been washed away face a long road to recovery. In many places, community assets and productive infrastructure have sustained significant damages. Many traders have suffered huge inventory losses. Kerala has an estimated 3 million migrant laborers, majority of whom have reportedly lost their livelihoods and returned to their native areas. In building back better, multifaceted strategies need to be adopted that combine short term measures for rapid recovery as well as medium-long term measures that build resilience among affected communities.

55. The tables below summarize the estimated damages and corresponding recovery costs for the six livelihood sectors. Majority of the damage and losses in livelihoods sector belong to private sector and entities. However, the government may consider providing some relief measures to kick-start the economic recovery among the impacted communities and enterprises. The overall recovery needs in these sectors can be met by joint support of the state and financial institutions depending on the nature and urgency of the interventions.

Table 20: Summary of damages to livelihoods and recovery needs in key sectors

Sectors	Livelihoods affected (HH)	Estimated recovery needs (USD million)
Agriculture • 51,194 hectares of agriculture land damaged due to silting or washing away of top soil erosion; • 236,650 hectares of crops damaged, with maximum losses are in Pepper, Cardamom, Banana and Paddy; • Agricultural input stocks worth USD 5.2 million damaged; • Damages of USD 6.3 million sustained in community and public infrastructure / institutions. • Total estimated losses: USD 2,159 million.	1.08 million	299
Livestock • Over 1.65 million livestock units lost, with majority of losses in poultry and ducks; • Highest milch animal losses in Ernakulam district; • Highest poultry bird losses in Malappuram district; • 19,940 cattle / poultry sheds damaged; • 214 dairy cooperatives and 95 veterinary institutions damaged. • Total estimated losses: USD 24.6 million.	100,000	22.1
Fisheries • 12,280 hectares of aquaculture / fish farms damaged; • 903 farming units and 3010 fishing households impacted; • 1203 boats completely damaged; fishing nets worth USD 0.2 million fully damaged; • 30 units of hatcheries, fisheries, govt run farms, aquariums fully damaged with estimated losses of USD 2.71 million. • Livelihoods of 393 women working in fisheries related microenterprises affected; • Total estimated losses: USD 20.16 million	3,010	32.2
Handloom and Coir • At least 659 weaver units and 123 coir units suffered estimated losses including damages / losses to workspace / sheds, looms and other tools, products / input stocks. • Total estimated losses: USD 1.4 million	2,400	1.4
Industries (Microenterprises) • 3,590 nano, micro and small enterprises suffered losses to infrastructure, equipment and stocks estimated at USD 91.7 million. Livelihoods of 20,964 workers affected; • An additional 810 microenterprises linked to Kudumbashree suffered losses and damages, affecting 3,551 women entrepreneurs; • Other adverse impacts include revenue losses due to business foregone, disruption of supply chains and potentially higher production / business costs in the short-medium term. • Total estimated losses: USD 91.7 million	20,964	91.7
Tourism • The floods have impacted hotels, jetties, navigation canals, parks, restaurants, sanctuaries and other tourist infrastructural assets across cultural and heritage sites, backwaters, hill-stations and eco-tourism sites like wild life sanctuaries.	95,500	96.6

Sectors	Livelihoods affected (HH)	Estimated recovery needs (USD million)
• The total damages to infrastructure are estimated at a total of INR 5,088 million (USD 72.7 million), with the districts of Alappuzha, Idukki and Ernakulum suffering the highest damages. • While this includes both public and private assets, privately-owned infrastructure has suffered three times the damages. • Community-owned infrastructure in Ernakulum district has also sustained significant damages. Income losses due to cancellations and reduced tourist footfalls is estimated at INR 17,010 million (USD 243 million), with 19% of the tourism work-force directly impacted.		
TOTAL	**1.3 million**	**543**

Table 21: District wise Sector Recovery Needs

District	Agriculture	Livestock	Fisheries	Industries / MSMEs	Handloom / Coir	Tourism	TOTAL
Alappuzha	26.1	6.16	5.25	7.78	0.03	24.85	70.1
Ernakulam	6.6	4.04	2.08	56.12	0.9	11.8	81.5
Idukki	156.8	0.65	0.47	1.29	0	19.21	178.4
Kannur	2.3	0.14	0.18	0.01	0.01	0.1	2.7
Kasaragod	1.2	0.02	0	0	0	0	1.2
Kollam	2.9	0.36	0.7	0.73	0	1.15	5.9
Kottayam	11.2	0.8	3.82	1.19	0.05	8.14	25.2
Kozhikode	3	0.31	0.49	0.63	0.01	1.19	5.6
Malappuram	9.7	1.42	0.98	0.6	0	1	13.7
Palakkad	11.4	0.27	0.38	0.74	0.01	3.33	16.1
Pathanamthitta	27.4	3.28	0.33	4.65	0.24	7.62	43.6
Thiruvananthapuram	3.5	0.13	0.25	0.29	0	0	4.2
Thrissur	11.2	3.65	16.21	17.1	0.11	9.64	57.9
Wayanad	25.8	0.85	1.1	0.56	0	8.57	36.9
TOTAL	**299.1**	**22.1**	**32.2**	**91.7**	**1.4**	**96.6**	**543.0**

3.6.1 Agriculture

Sector Context

56. 52% of Kerala's geographical area is under cultivation[23]. Kerala's 23 diverse agroecological units are ideal for the cultivation of a wide variety of crops, including cereals, pulses, fruits,

[23] Agriculture Statistics, 2016-17, Department of Economics & Statistics

vegetables, tubers, spices, oilseeds, plantation crops and medicinal plants. The low-lands of Kerala are known for sprawling paddy fields featuring cultivation of over 600 varieties of paddy. The hill districts are suited for spices and plantation crops. Kerala is known as the spice capital of India; the state leads the country in the production of several commodities; the state accounts for 89% of small cardamom production and 98% of nutmeg production in the country. The state also accounts for 34% of national pepper production[24]. Kerala also produces about 70% of the natural rubber in the country[25], and is a major producer of other commodities such as cashew, ginger, tapioca and jackfruit. Export of agricultural products is the top contributor to Kerala's total exports. Total exports of agricultural products in 2017-18 was 0.236 million MT valued at USD 267 million[26].

Flood Impact

57. The floods caused widespread damage to the agriculture sector of Kerala. Districts such as Idukki that are characterized by hilly terrain of the Western Ghats saw large tracts of agricultural land and plantation crops wiped out due to torrential rainfall and massive flow of water. The mid-lands and low-lands (Kuttanad and Kole regions) on the other hand were characterized by massive flooding and inundation of fields, resulting in rotting of crops and wilting of trees, causing significant losses to farmers. Preliminary observations indicate changes in soil acidity levels in several regions. Over 1.08 million farmer households have been affected by the floods. The total cultivated area affected by floods is an estimated 236,650 ha which is 11% of the state's area under cultivation.

Estimated damages

58. At least 51,194 hectares of agricultural land have been damaged due to silt deposition or soil erosion / soil being washed away due to landslides. This has affected an estimated 315,000 farmers. As per state government norms, INR 12,200 per hectare is provided to farmers for desilting / removal of debris, while INR 37,500 per hectare is provided to farmers who have lost substantial portion of top soil due to landslides. The actual cost of restoration is estimated to be substantially higher as per discussions with farmers and district level agriculture department officials. Some of the farm lands damaged by landslides may no longer be cultivable, while others may be reclaimed after significant investment over multiple years. A clearer picture may be available only after a detailed assessment. For the purpose of this assessment, average land restoration costs have been estimated at INR 30,000 per hectare for desilting / levelling, and INR 150,000 for reclamation of top soil in landslide affected farms.

[24] Spice Board of India, 2017-18
[25] Rubber Board
[26] Agriculture and Processed Food Products Export Development Authority (APEDA), 2017-18

Table 22: Estimated damage to agricultural land

District	Area affected by landslip/ landslides (43,000 farmers)	Area affected by silting (272,000 farmers)	Estimated recovery costs	
			INR million	USD million
Alappuzha		20500	615	8.8
Ernakulam		405	12.2	0.2
Idukki	782.86	1080	149.8	2.1
Kannur	52.6	280	16.3	0.2
Kottayam	41	1530	52.1	0.7
Malappuram	124.76	969	47.8	0.7
Palakkad	152	682	43.3	0.6
Pathanamthitta	112.8	22500	691.9	9.9
Thrissur	412	310	71.1	1
Wayanad	680	580	119.4	1.7
Total	**2,358**	**48,836**	**1819**	**26.0**

Source: Department of Agriculture Development & Farmers' Welfare, Kerala

59. Total cropped area affected by floods is estimated at 236,650 hectares. The most affected crops are Pepper (98,000 ha), Cardamom (35,750 ha), Paddy (35,820 ha), Banana (21,620 ha), Tapioca (12,100 ha) and vegetables (10,850 ha). Total crop losses are estimated at INR 149 billion (USD 2,122 million), with the maximum losses in Pepper, Cardamom and Banana crops. The table below lists the estimated production and monetary losses in each crop. Crop loss calculations are based on data provided by the Department of Agriculture, GoK, as well as discussions with district-level agriculture department officials and farmers.

Table 23: Estimated area, crop production losses, and monetary losses

Category	Crop	No. farmers	Area damaged (ha)	Production loss (MT)	Crop production losses	
					INR million	USD million
Cereals	Paddy (nursery)	21,250	820	57,400	1,549.8	22.1
	Paddy	1,41,655	35,000	2,45,000	6,615.0	94.5
	Millets (Ragi, sorghum, foxtail millets etc.)	62	15	105	2.8	0.0
Pulses	Cowpea	60	20	30	1.5	0.0
	Black gram	44	9	14	1.1	0.0
	Green gram	32	5	8	0.6	0.0
Vegetables / Tubers	Vegetables (cucumber, brinjal, snakegourd, bitter gourd etc.)	1,35,650	10,850	1,30,200	5,208.0	74.4
	Tapioca	34,200	12,100	1,81,500	5,445.0	77.8
	Other tubers (colocassia, yams etc.)	68,210	4,520	1,35,600	4,746.0	67.8
Fruits	Banana	88,600	21,620	4,32,400	21,620.0	308.9

Category	Crop	No. farmers	Area damaged (ha)	Production loss (MT)	Crop production losses	
					INR million	USD million
	Pineapple	1,850	850	25,500	1,020.0	14.6
	Jackfruit	875	5	350	10.5	0.2
	Mango	900	7	126	12.6	0.2
	Other fruits (Papaya, Rambutan, guava, chikoo etc.)	2,680	20	240	12.0	0.2
Condiments and spices	Pepper	3,95,000	98,000	1,47,000	58,800.0	840.0
	Ginger	6,200	1,020	30,600	1,224.0	17.5
	Turmeric	2,100	105	3,150	141.8	2.0
	Cardamom	1,07,250	35,750	35,750	35,750.0	510.7
	Clove	325	55	6	4.2	0.1
	Nutmeg	6,750	1,200	1,200	480.0	6.9
	Betelvine	10,600	150	5,700	1,140.0	16.3
Oil seeds	Coconut	38,650	7,100	49,700	2,485.0	35.5
	Groundnut	65	10	15	2.3	0.0
	Sesamum	35	5	2	0.2	0.0
Plantation crops	Rubber	3,700	1,220	3,050	366.0	5.2
	Coffee	1,250	365	449	179.6	2.6
	Arecanut	16,370	5,230	7,845	1,569.0	22.4
	Cashew	345	74	74	7.4	0.1
	Cocoa	2,230	410	451	90.2	1.3
Medicinal plants	Medicinal plants (Aloevera, Kacholam, Koduveli, kurunthotti, shatavari etc.)	10	5	30	15.1	0.2
Others	Sugarcane	465	110	1,100	5.5	0.1
Total		**1,087,413**	**236,650**	**1,494,594**	**148,505**	**2,122**

Source: Department of Agriculture Development & Farmers' Welfare, Kerala

60. Idukki is the most affected district in terms of crop losses, with an estimated 132,767 hectares of crops suffering damages due to landslides / floods. The other districts that suffered significant damages to standing crops are Wayanad, Alappuzha and Pathanamthitta.

Table 24: District-wise estimates of affected Agriculture area

District	Area damaged (ha)	Estimated crop losses		Estimated Recovery Needs	
		INR million	USD million	INR million	USD million
Alappuzha	17,812	5,893	84	1,181	16.9
Ernakulam	4,372	3,580	51	437	6.2
Idukki	132,767	92,913	1,327	10,578	151.1
Kannur	1,681	900	13	140	2
Kasaragod	788	626	9	84	1.2
Kollam	1,901	1,605	23	201	2.9

Kottayam	9,398	4,103	59	712	10.2
Kozhikode	2,143	1,791	26	205	2.9
Malappuram	6,348	4,682	67	616	8.8
Palakkad	9,921	3,897	56	738	10.5
Pathanamthitta	15,009	9,902	141	1,200	17.1
Thiruvananthapuram	2,237	1,749	25	239	3.4
Thrissur	7,593	4,427	63	698	10
Wayanad	24,681	12,546	179	1,663	23.8
Total	**236,650**	**148,505**	**2,122**	**18,678**	**267**

Source: Department of Agriculture Development & Farmers' Welfare, Kerala

61. The floods also resulted in damages to agricultural input stocks, farm equipment and machinery, and damages to community assets and public infrastructure. The table below summarizes these damages and the estimated losses. In addition to these estimates, large-scale damages to farm bunds and pumping units were observed, particularly in the Kuttanad wetlands. These losses are tabulated in the section on Irrigation.

Table 25: Estimated losses in assets and infrastructure

Item		**Estimated losses**	
		INR million	**USD million**
Agricultural input stocks			
	Seeds	2.4	0.03
	Fertilizers	358.1	5.12
Tools and equipment			
	Farm Machinery and Equipment	156.0	2.23
Community assets & public infrastructure			
	Public sector assets such as laboratories, furniture, buildings, vehicles, polyhouse and rain shelters, fire safety devices, generators, electronic equipment etc.	49.4	0.71
	Seed farms and other farms (farm office building, seed store, furniture, fencing, marketing places, poly houses, hi-tech agri systems like hydroponics units, integrated farming system components, equipment and machinery etc.)	81.7	1.17
	Community owned assets (like storage places, Agro service centres) and infrastructure etc.	46.5	0.66
	Marketing infrastructure	2.3	0.03
	Kerala Agricultural University (damages to crops/seeds and planting material, infrastructural damages and capital losses)	102.2	1.46
Total		**798.6**	**11.4**

Source: Department of Agriculture Development & Farmers' Welfare, Kerala

Immediate Response

62. Preliminary assessment of farmland damages and crop losses is nearly complete in all the districts. The Agriculture department has started receiving and processing applications for claims under the National Calamity Relief Assistance scheme in several districts. For example, at the time of assessment, Kottayam had transferred compensation to 11,284 farmers. The processing of crop insurance claims has commenced as well, albeit at a slower rate; a total of INR 7.98 million (USD 114,000) in payouts has been transferred to 438 farmers in Kottayam. In some paddy cultivated districts, seed stocks have been arranged for resowing. For example, Kottayam has arranged 280 MT of paddy seeds for re-sowing in 3468 ha, of which 200 MT has been distributed to farmers.

Reconstruction, Recovery and Resilience building needs

63. ***Need Analysis***: Reconstruction and recovery needs are estimated at INR 20.9 billion (USD 299 million) in the short-medium term. This will include the investment required to restore damaged agricultural lands, build back individual, community and public infrastructural assets, and the cost of inputs for one season (for crops) / one year (for plantations) to restore crops and plantations.

Reconstruction / Recovery needs:

64. ***Reconstruction needs:*** Reconstruction needs are estimated at INR 2257 million (USD 32.2 million) and includes restoration of agricultural land through levelling / desilting / reclamation, and reconstruction and repair of essential individual, community and public infrastructure as well as tools and equipment. Land restoration measures need to be supplemented by provision of a subsidized package including nutrients and soil ameliorants such as dolomite and lime to counter increase in soil acidity due to washing away of topsoil.

65. ***Recovery needs (short-medium term):*** Recovery needs are estimated at INR 18,678 million (USD 267 million) and represents the cost of inputs required by farmers to restore crops. Cost of input calculations are based on per-hectare cost of cultivation figures published by the Directorate of Economics & Statistics, Dept of Agriculture, GoK as well as discussions with farmers and agriculture department officials in the affected districts. For seasonal crops (e.g. paddy), cost of inputs for one season has been considered. For plantations / trees with longer gestation periods, cost of inputs for one year has been considered in recovery needs after which farmers may be able to generate income through intercropping and other means.

Table 26: Estimated Recovery Needs

Target Asset/typology for reconstruction/recovery	**Reconstruction/Recovery Cost**	
	INR million	**USD million**
Levelling / Desilting / Reclamation of agricultural land	1819	26.0
Reconstruction / repair of essential community / public infrastructure and tools & equipment	438	6
Restoration of damaged crops (cost of inputs for one season / year)	18,678	267
Total	**20,935**	**299**

Resilience needs (medium-long term):

66. The following medium-long term interventions are recommended to improve resilience of Kerala's agricultural sector.

67. Shift to agroecological approach: The state needs to consider an agroecological approach to the agricultural sector with climate-smart elements. Based on agroecological conditions including soil, climate, terrain and water, Kerala can be divided into 23 agroecological units (AEUs). In each AEU, the farming systems and investments can be tailored to the specific agroecological conditions in terms of determining suitable crops and varieties, risk analysis of climate hazards and identification of specific mitigation measures, optimum resource use, and introduction of appropriate modern technologies.

68. Improving resilience in Kuttanad wetlands: An example of the agroecological approach is in the Kuttanad wetland ecosystem that is characterized by a network of canals and widespread backwater paddy cultivation. For improved resilience and disaster preparedness, this agroecological zone requires specific investments that include environment-friendly bunding (using bio-bunding, border planting, geotextiles, coconut planting etc.); investments in more effective pumping units; deepening of drainage channels; capacity building of farming households in allied activities such as animal husbandry and fisheries through cage culture. Recent studies commissioned by the state on mitigating agrarian distress in the Kuttanad wetland ecosystem outline several measures to improve resilience and productivity in this region and may be considered for implementation.

69. Innovative approaches targeting individual and zonal resilience: While the flooding event resulted in destruction of a majority of the paddy crop in Kuttanad, it also cleared much of the water hyacinth presenting an opportunity for better canal management. Water hyacinth is an invasive species that clogs canals in this region, contributing to water pollution, impeding water navigation and affecting fish reproduction and growth. The state, through institutions such as Kudumbashree, can explore innovative models of processing water hyacinth to make biofuels, biofertilizers, geotextiles, plywood, crafts and other products. Such techniques have been successfully demonstrated by several entities in India (e.g. North Eastern Development Finance Corporation Limited, Kerala's Kottapuram Integrated Development Society), as well as in other countries. This can be an alternate source of income for small farmer households in this region, particularly women and marginalized sections, which will contribute to increasing their resilience.

70. Multi-institutional studies to identify vulnerabilities and strategies in hilly regions: The hilly regions of Kerala suffered a large number of landslides and continue to be vulnerable to further collapse in many areas. Hazard zonation studies need to be undertaken. A multi-institutional team comprising geologists, plantation and disaster resilience experts need to undertake a comprehensive assessment of the region, and identify the type of plants suited for sloping areas, the right mix of plantation crops combining trees with longer roots with those with shorter roots in order to bind the soil better, soil conservation measures, water harvesting strategies etc.

71. Improve awareness of crop insurance: In addition to national schemes such as the Pradhan Mantri Fasal Bima Yojana (PMFBY) and the Weather Based Crop Insurance Scheme (WBCIS), Kerala has its own crop insurance scheme. However, uptake remains less than 10% across the state. The Department of Agriculture must invest in increasing awareness of crop insurance schemes to increase uptake and resilience.

3.6.2 Livestock

Sector Context

72. An estimated 8.8 million households in Kerala are involved in animal husbandry activities[27]. Nearly 94% of the livestock population is concentrated in rural areas. 80% of the livestock farmers are estimated to be small / marginal farmers and agricultural laborers, and 60% are women. The total number of cattle in the state is 1.32 million, 94% of which are crossbred breeds[28]. Total numbers of buffaloes, goats, pigs, poultry birds and ducks are 98,645, 1.2 million, 55,359, 12.75 million and 1 million respectively[29].

Flood Impact

73. The floods resulted in significant livestock losses as well as damages to essential institutions. As per estimates, the sector suffered losses of over 1.65 million livestock units, damages to stored animal produce and feed, damages to 19,940 cattle / poultry sheds and damages to community and public infrastructure / institutions including 214 dairy cooperatives and 95 veterinary centres. While estimates of the number of households affected are still being assessed by the state, the quantum of livestock losses indicates that at least 100,000 households have been affected, with significant short-term impact on household incomes. Losses in terms of feed and fodder are substantial which, coupled with damages to key institutions, indicates significant disruption of forward and backward linkages.

Estimated damages

74. An estimated 1.65 million livestock units were lost in the floods. The largest losses were among poultry birds and ducks with losses of 1.1 million units (over 8% of estimated population) and 0.46 million units respectively. Ernakulam lost the highest number of milch animals (1957), while Malappuram lost the highest number of poultry (384,387). The table below lists the losses in the different livestock categories across districts. Uptake of livestock insurance schemes was observed to be very low for milch animals. Awareness and uptake of national poultry insurance scheme (Poultry Sukshma Bima Yojana) was non-existent.

Table 27: District-wise estimated losses of livestock

District	Cows	Buffaloes	Calves	Heifers	Sheep/ Goats	Poultry	Ducks	Pigs	Quails
Alappuzha	472	32	3502	146	2994	133163	367629	0	0
Ernakulam	1536	421	454	313	2000	216313	13621	0	0
Idukki	134	14	128	32	79	9078	67	28	0
Kannur	42	0	7	13	5	2000	500	0	2000
Kasaragod	6	0	0	0	0	0	0	0	0
Kollam	147	2	138	47	43	5378	0	0	0
Kottayam	267	4	233	50	120	34270	5000	0	0

[27] Livestock Census 2012
[28] ibid
[29] ibid

Kozhikode	40	0	10	9	20	31503	0	0	0
Malappuram	100	0	60	18	167	384387	7238	1	0
Palakkad	89	3	23	19	0	10983	0	0	0
Pathanamthitta	606	7	357	353	198	27457	70339	0	0
Thiruvananthapuram	10	0	50	0	5	10345	200	52	0
Thrissur	1573	10	185	203	651	253642	0	854	0
Wayanad	141	48	19	25	98	25215	178	118	18000
Total	**5163**	**541**	**5166**	**1228**	**6380**	**1143734**	**464772**	**1053**	**20000**

Source: Kerala State Animal Husbandry Department

75. The total monetary loss corresponding to livestock losses is estimated at INR 845.6 million (USD 12.1 million)[30]. Alappuzha, Ernakulam and Thrissur districts suffered the maximum losses.

Table 28: District-wise estimated monetary losses

District	Cows	Buffaloes	Calves	Heifers	Sheep / Goats	Poultry	Ducks	Pigs	Quails	Total	
										INR mn	USD mn
Alappuzha	28.3	2.1	56	4	24	26.6	73.5	0	0	214.6	3.1
Ernakulam	92.2	27.4	7.3	8.6	16	43.3	2.7	0	0	197.4	2.8
Idukki	8	0.9	2	0.9	0.6	1.8	0	0.3	0	14.6	0.2
Kannur	2.5	0	0.1	0.4	0	0.4	0.1	0	0.1	3.6	0.1
Kasaragod	0.4	0	0	0	0	0	0	0	0	0.4	0
Kollam	8.8	0.1	2.2	1.3	0.3	1.1	0	0	0	13.9	0.2
Kottayam	16	0.3	3.7	1.4	1	6.9	1	0	0	30.2	0.4
Kozhikode	2.4	0	0.2	0.2	0.2	6.3	0	0	0	9.3	0.1
Malappuram	6	0	1	0.5	1.3	76.9	1.4	0	0	87.1	1.2
Palakkad	5.3	0.2	0.4	0.5	0	2.2	0	0	0	8.6	0.1
Pathanamthitta	36.4	0.5	5.7	9.7	1.6	5.5	14.1	0	0	73.4	1
Thiruvananthapuram	0.6	0	0.8	0	0	2.1	0	0.5	0	4.1	0.1
Thrissur	94.4	0.7	3	5.6	5.2	50.7	0	8.5	0	168	2.4
Wayanad	8.5	3.1	0.3	0.7	0.8	5	0	1.2	0.9	20.5	0.3
Total	**309.8**	**35.2**	**82.7**	**33.8**	**51.0**	**228.7**	**93.0**	**10.5**	**1.0**	**845.6**	**12.1**

76. Besides loss of animals, farmers suffered losses of INR 173.4 million (USD 2.5 million) in terms of livestock feed and produce that were damaged or washed away due to the floods.

[30] The cost of livestock units are as follows: Cow: INR 60,000, Buffalo: INR 65,000, Calf: INR 16,000, Heifer: INR 27,500, Sheep / Goat: INR 8000, Poultry: INR 200, Duck: INR 200; Pig: INR 10,000, Quail: INR 50

Table 29: Estimated losses of feed / product stocks

Item		Units	INR million	USD million
Product stocks				
	Milk		38.42	0.55
Feed stocks				
	Livestock feed (50 kg bags)	36697 bags	36.69	0.52
	Poultry feed (50 kg bags)	99 bags	0.10	0.001
	Fodder	3417 MT	68.34	0.98
	Hay / straw	3736 MT	29.89	0.43
Total			**173.4**	**2.5**

Source: Kerala State Animal Husbandry Department

77. The floods also caused significant infrastructural damages across the state at the individual and community levels. This includes INR 432 million (USD 6.2 million) in damages to individual / community assets such as cattle and poultry sheds, and INR 267 million (USD 3.8 million) in damages to public institutions such as dairy cooperatives and veterinary centre. 40 out of the 95 veterinary institutions that suffered damages were in Pathanamthitta district.

Table 30: Estimated damages to assets and infrastructure

		Nos	INR million	USD million
Individual / group assets / infrastructure				
	Cattle sheds	18342	366.84	5.24
	Poultry sheds and equipment	1598	65.83	0.94
Public infrastructure				
	Dairy cooperative societies	214	37	0.53
	Veterinary institutions	95	230	3.29
Total			**699.7**	**10.0**

Source: Kerala State Animal Husbandry Department

Immediate Response

78. Since August 18, 2018, 1170 camps have been set up for rescued livestock. The state arranged for veterinary doctors to visit these camps and provide free medical care to the animals. Vaccines and medicines were given free of cost as well. With help from neighboring states as well as agencies such as NECC and NDDB, the state government arranged for food and fodder for the animals in these camps as well as eggs and meat for the people. In addition, cattle feed was provided free of cost for up to 3 weeks to over 80,000 animals. Carcasses of dead animals were disposed in coordination with the Suchitwa Mission.

Reconstruction, Recovery and Resilience building needs

Need Analysis:

79. Reconstruction and recovery needs are estimated at INR 1545 million (USD 22.1 million) comprising the cost of restoring livestock units and reconstruction / repair of damaged individual /

community assets, which include collection centers, Bulk milk chilling centers and processing facilities as well as public institutions that are essential to key animal husbandry value chains.

Reconstruction/Recovery needs:

80. ***Reconstruction needs***: Reconstruction needs are estimated at INR 699.7 million (USD 10 million) and includes reconstruction of assets at the individual / community level such as cattle and poultry sheds and restoration and repair of tools and equipment damaged. The needs take into account rebuilding animal sheds with modern design and better aeration and repairing / reconstructing veterinary institutions and other community units with improved disaster-resistant structures.

Recovery needs (short-medium term):

81. Recovery needs are estimated at INR 845.6 million (USD 12.1 million) and includes replenishment of livestock units lost during the floods. Animals may be needed to be inducted from other states to replenish stocks. Traditional breeds can be promoted in select zones due to their inherent resistance.

Table 31: Estimate of Recovery Needs

Target Asset/typology for reconstruction/recovery	Reconstruction/Recovery Cost	
	INR million	USD million
Reconstruction / restoration of individual assets (sheds / equipment)	432.7	6.18
Reconstruction / restoration of public institutions and infrastructure	267	3.82
Restoration of livestock units	845.6	12.1
Total	**1545**	**22.1**

Resilience needs (medium-long term):

- The following medium-long term interventions are recommended to improve resilience of households dependent on animal husbandry:
- Promote integrated / farm family approach: Animal husbandry needs to be better integrated with crop cultivation at the household level to diversify income sources, improve resilience for smallholder households and realize synergies through complementarities of the two activities. This translates to building greater awareness of animal husbandry activities among households engaged solely in crop cultivation, greater coordination between the agriculture and animal husbandry departments, and bundling of schemes at the household levels. There is substantial potential for commercial and community-run dairy units in Wayanad and Idukki districts. Creation of dairy zones with backward and forward linkages may be explored. Buffalo and duckery units may be promoted in the Kuttanad region to augment and diversify farmer incomes.
- Develop essential infrastructure to strengthen value chain: Veterinary healthcare centres (with night services), bulk coolers, milk collection centres, fodder banks and other essential infrastructure need to be established to improve access to inputs and essential services for households dependent on animal husbandry.
- Improve awareness of livestock insurance: Livestock insurance schemes need to be promoted and farmers encouraged to access these schemes for improved resilience.

- Assessments / studies to improve knowledge-base and planning: Disease mapping in a GIS framework needs to be undertaken. Fodder requirements need to be assessed and mapped, and block level fodder development plans need to be developed. Drug delivery protocols need to be developed.
- Promotion of indigenous breeds: 94% of the cattle in Kerala crossbred varieties. Indigenous cattle breeds that are more disease-resistant can be promoted to improve resilience of households dependent on animal husbandry. Branding and promotion of A2 milk can expand the market for this product and improve margins.
- Promote better animal management techniques to improve productivity: Promote preventive care, improved nutrition including protein bypass supplements and CO3 grass, disease management and other modern techniques to double yield and increase incomes.

3.6.3 Fisheries

Sector Context

82. With a 590 km long coastline, extensive network of brackish water lakes and estuaries, and 332,000 ha of freshwater area, Kerala is home to 1.03 million[31] fisherfolk (about 3 percent of the State's population). Marine and inland fisheries in the state make vital contributions to the state's economy as well as nutrition basket, with marine fisheries accounting for a larger overall share of fish production as well as fisherfolk population. 13.23% of the national marine exports are from Kerala in 2016-2017. The total registered fishing fleet in the state consists of about 4,248 mechanized, 51 deep sea fishing vessels, 29,969 country crafts fitted with outboard motors, and 2,515 non-motorized country crafts.

83. The state's freshwater resources comprise reservoirs, rivers, ponds, tanks, irrigation tanks and paddy fields, including paddy fields in Kuttanad and Kole lands and in Palakkad district. Pokkali fields are traditionally used for prawn filtration when the water is saline (November- May) and for paddy cultivation for rest of the year. The fisheries sector was impacted by the Ockhi cyclone last year. Kerala and Tamil Nadu jointly suffered an estimated drop of around 35,000 tons of fish due to Ockhi disaster in December 2017 with an estimated economic loss of INR 5850 million (USD 83.57) million at landing centre level and INR 8210 million (USD 117.29 million) in retail level.[32]

Fishing for Success!
The sector engaged over 14.50 million people at the primary level and many more along the value chain. Export earnings from the sector was **INR 378,709 million** in 2016-17. The sector contributed about 0.9 per cent to the National Gross Value Added (GVA) and 5.43 per cent to the agricultural GVP (2015-16).
(Source: Kerala Economic Review 2016-2017)

[31] http://www.fisheries.kerala.gov.in/
[32] http://www.cmfri.org.in/news/marine-fish-landings-in-india-increase-by-56-percentage-in-2017

Flood Impact

84. Fisheries sector has suffered significant damages, particularly in Kottayam, Alappuzha, Ernakulam and Thrissur districts. The livelihood of more than 3,010 fisherfolk households was affected by the floods due to damage to boats and fishing nets and bund breaches. Many ornamental fish farms were inundated fully resulting in loss of income to thousands of farmers. Floods have also caused silting in the clam beds, which has reduced clam production by almost half. The water in inland fish ponds or aquariums has also been contaminated and some exotic/invasive species such as Three-spotted Gourami, Moon Gourami, etc. have been observed in lower lying areas because of aquarium breaches.

Damage analysis

85. 12,280 ha of fisheries aquaculture farming area, accounting for 903 farming units have been affected. Alappuzha and Thrissur districts suffered maximum losses in terms of inland fish production (64% of the total affected production). 1203 boats have been completely lost or damaged and fishing nets worth INR 14.3 million (USD 0.2 million) have been fully damaged. A total of 30 units of hatcheries, fisheries departmental farms and aquariums (for ornamental fishes) were fully damaged estimating INR 189.8 million (USD 2.71 million). 393 fisherwomen working in the fisheries related micro-enterprises such as fish drying, fish flouring, fish vending, etc. employed under the Society for Assistance to Fisherwomen, Department of Fisheries have lost their livelihoods due to washing away of their units. District wise losses for different components have been summarized in the table below. The total losses including boats, nets, inland fish tanks, hatcheries and ponds amount to INR 1411.34 million (USD 20.16 million).

Table 32: District-wise estimates of damages / losses in fisheries sector

District	Number of households affected	Fishing implement losses (INR million)	Aquaculture losses* (INR million)	Fisherwomen Micro Enterprises losses (INR million)	Total losses (INR million)	Total losses (INR USD)
Alappuzha	203	0.7	226.7	0.82	228.22	3.26
Ernakulam	334	3.39	86.07	3.13	92.6	1.32
Idukki	81	1.74	19.32	0	21.05	0.3
Kannur	0	0	7.66	0	7.66	0.11
Kasaragod	0	0	0.18	0	0.18	0
Kollam	74	2.99	28.61	0.01	31.62	0.45
Kottayam	1860	7.51	160.35	1.23	169.09	2.42
Kozhikode	18	1.25	20.44	0	21.69	0.31
Malappuram	8	0.12	42.57	0.09	42.77	0.61
Palakkad	57	0.41	16.24	0	16.65	0.24
Pathanamthitta	90	3	12.41	0	15.41	0.22
Thiruvananthapuram	6	1.94	9.77	0.01	11.71	0.17
Thrissur	279	2.78	700.07	2.1	704.95	10.07
Wayanad	0	0	47.74	0	47.74	0.68
Total	**3010**	**25.82**	**1378.12**	**7.39**	**1411.34**	**20.16**

**Aquaculture accounts for total losses including infrastructure in Carp Culture, Pangasius and Air Breathing Fishes, GIF Thilapia in pond, Recirculatory aquaculture system, Shrimp Culture, Brackish water fish in pond, Fish Cage culture, Crab culture, One paddy one fish, Reservoir Fisheries, Ornamental Fish and Fish Seed Rearing Units.*

Immediate response

86. As the result of loss of livelihood, the government of Kerala is providing interest-free loan up to INR 0.1 million (USD 1429) to affected people, 9% interest rate will be paid by the state government. INR 10,000 (USD 143) has been transferred to all affected households and the list is publicly available. Since, many fisherfolk have taken loans and lost their incomes for more than 3 months, the assessment of needs and recovery is estimated to be much higher, especially since repairing of bunds in Kole region is estimated to take much longer.

Reconstruction, Recovery and Resilience building needs

Need Analysis

87. The total cost of recovery is estimated to be INR 2256.81 million (USD 32.24 million). This includes: (a) the replacement costs of boats and nets lost or damaged; (b) estimated value of lost fish stock due to bund breach, breached tanks, brackish water ponds and hatcheries; (c) cost of reconstruction of damaged infrastructure; and (d) inputs required to revive aquaculture such as seeds and feed.

Table 33: **Sector Reconstruction/Recovery Needs**

Target Asset/typology for reconstruction/recovery	**Reconstruction/Recovery Cost**	
	INR million	**USD million**
Replacement of damaged or lost Boats and Nets	25.82	0.37
Reconstruction needs of Microenterprises by Fisherwomen	7.39	0.11
Revival of Aquaculture	2223.59	31.77
Total	**2256.81**	**32.24**

Reconstruction/Recovery Needs:

88. **Reconstruction needs** – The bunds breached due to floods need to be reconstructed using resilient materials. Aquaculture ponds and hatcheries needs to be revived. Damaged or lost boats and fishing nets need to be replaced or repaired. A detailed study needs to be conducted to analyze the extent of damage to the clam beds. Ornamental fish culture units and fish seed rearing units need to be rehabilitated. There is also a demand for good quality fish seeds at subsidized rates. To increase the production of fish seeds and to ensure quality, existing hatcheries, nurseries, fish farms need to be strengthened and few new units needs to be built.

Recovery and Resilience needs (medium-long term):

- Fish production needs to meet the challenges posed by climate change and degradation of environment and more flood resilient systems/management can be considered to promote inland fisheries, which is currently underutilized.

- Creating/improving key facilities in landing centers is necessary. This could include providing drying platforms and cold chain facilities, proper weighing and packaging facilities, transport facilities and marketing linkages to the fishing communities. The management of these facilities can be possibly entrusted to Kudumbashree supported Neighborhood Groups (NHGs) with proper guidance and support particularly in Kole pockets.

- Many fishermen reside in thatched houses near shore that are vulnerable to disasters. Support for climate resilient houses needs to be properly explored. This would also include providing basic resilient infrastructure for fishermen settlements such as drainage systems, internal roads, healthcare centers, drinking water facilities.

- Value chain analysis of major marine and inland fish products needs to be undertaken to understand better the dynamics of the economic activity and explore measures and mechanisms to benefit these communities.
- A study to assess the impact of displaced exotic/invasive species on the ecosystem.

3.6.5 Handloom and Coir

Sector Context

89. Handloom and Coir sector is a major traditional industry in Kerala. Participation of women, landless and marginalized communities in the handloom sub sector is high and provides direct and indirect employment to 175,000 HH. Kerala's handloom industry carries a vital role in the state's economy because of its vast employment generation potential both upstream and downstream and, second to the coir sector in providing employment among the traditional industries of the state. The handloom and coir industry in the state is concentrated in Thiruvananthapuram, Kannur, Kozhikode, Palakkad, Ernakulam, Thrissur, Kollam and Kasaragod Districts.[33]

Coired Kerala:
One-third of the villages in the State can easily be called as coir villages (Coir Board, 2001; GoK, 2009). The industry is a large earner of revenue through export and in 2013-14 coir & coir products generated about INR 1630 crore worth of foreign exchange.[1] The quantity of coir exports from Cochin port was 124,305 MT with a value of INR 374.03 crore in 2015-16.

Flood Impact

90. The loss of houses, work sheds, equipment, raw materials, finished products, coupled with a dip in the state's tourist economy has affected the lives of thousands of urban and rural households engaged in handlooms and coir. About 782 registered weavers and artisans engaged in handloom/ coir activities have lost their work sheds, raw materials, finished product stock, equipment, and tools.

33 https://www.researchgate.net/publication/281748233_HANDLOOM_INDUSTRY_IN_KERALA_A_STUDY_OF_THE_PROBLEMS_AND_CHALLENGES

Damage analysis

91. The total estimated losses across all districts is estimated to be INR 94.92 million (USD 1.36 million) including all components of supply chain in the handloom sector. Ernakulam district faced the maximum damages to the sector with 640 weavers being adversely impacted and facing damages to the tune of almost USD 1 million.

Table 34: **Sector Damages**

Subsector	Number of units affected	Workspace / warehouse / shop etc.	Looms & other equipment	Product / Input Stock losses	Others	Total estimated losses (INR Million)	Total estimated losses (USD Million)
Handloom	659	12.06	8.53	45.21	19.44	85.23	1.22
Coir	123	1.89	4.63	3.17	0.00	9.68	0.14
Total	782	13.95	13.15	48.37	19.44	94.92	1.36

Table 35: **District wise Damages**

District	Number of people affected	Workspace / warehouse / shop etc.	Looms & other equipment	Product / Input Stock losses	Others	Total estimated losses (INR Million)	Total estimated losses (USD Million)
Alappuzha	42	1.6	0.1	0.51	0	2.21	0.03
Ernakulam	640	6.63	9.58	27.96	18.69	62.86	0.9
Kannur	0	0.5	0	0	0	0.5	0.01
Kollam	3	0	0	0.23	0	0.23	0
Kottayam	25	0	2.31	1.19	0	3.5	0.05
Kozhikode	30	0	0.34	0.41	0	0.75	0.01
Malappuram	1	0.05	0.01	0.04	0	0.11	0
Palakkad	2	0.49	0	0	0	0.49	0.01
Pathanamthitta	30	3.67	0.64	11.43	0.75	16.49	0.24
Thiruvananthapuram	1	0	0	0.28	0	0.28	0
Thrissur	8	1.02	0.17	6.33	0	7.51	0.11
Total	**782**	**13.95**	**13.15**	**48.37**	**19.44**	**94.92**	**1.36**

*including co-operative societies

Immediate response

92. As the result of loss of livelihood, the government of Kerala is providing interest-free loan up to INR 0.1 million to affected people, 9% interest rate shall be paid by the state government. INR 10,000 has been transferred to all affected households and the list is publicly available. The government has also requested for skilled laborers from other states to speed up the repairing of handlooms. Since, many weavers have taken loans and lost their incomes for more than 3 months, the assessment of needs and recovery is much higher.

Reconstruction/Recovery Needs:

93. The assessment team estimates the total recovery cost to be INR 94.92 million (USD 1.36 million) for reconstruction of damaged work places, replacement / repair of loom and other equipment along with the estimated value of the lost raw material for a period of 3 months.

Resilience needs (short-medium term):

94. Producer Oriented–Market Facing: To ensure sustainability, the handloom value chain development initiative will investigate tapping the increasing demand of handloom textiles in the domestic as well as in the global market. Its strategic market-led product development program needs to be designed to enable in increasing the current wage rate of the weavers to earn a decent livelihood and ensuring work opportunity for at least 200 days in a year. Market oriented training of trainers will be introduced to engage local master weavers to further train semi-skilled weavers to respond to the demand.

95. Building an Architecture for Effective and Efficient Weaver Producer Enterprises: The State has made several investments in building the necessary architecture for ushering in second generation of transformation needed to make it a vibrant and re-vitalized engine of growth and job creation for the women, youth and the marginalized communities. In this regard, to bring about a resilient and a transformational change, investments would be needed in six areas: (a) Analytics (b) Strengthening policy / regulatory / administrative framework (c) Capacity building (d) Strengthening supply chain and access to finance (e) Market facilitation and productive alliances (f) Modernization fund.

96. Value Chain Approach: There is a need to adopt mechanisms that reflect change in the nature of engagement and types of interventions required, including multi-sectoral approaches that explore convergence of resources and roles by other departments (especially MSME, Tourism). There is a need to move from a scheme and output-based implementation strategy focusing on subsidies and public-sector institutions towards a value chain approach involving outcome-based policies and programmatic architecture focusing on capacity building investments and leveraging private sector investment. Weaver specific financial products, technological upgradation including innovation in loom design, and development of ancillary industries would need to be explored.

97. Analytics: A comprehensive assessment including components such as: (a) Baseline survey to assess status of weavers and artisans including re-engineering/pivoting cooperative societies and their needs; (b) Assessment of key government schemes, effectiveness, gaps and impact; and (c) Need assessment for strategies to improve private participation, innovative financial instrument and mechanisms to increase productivity and participation in the sector.

3.6.6 Tourism

98. Tourism accounts for 10% of the Kerala's gross domestic product (GDP)[34], with an estimated[35] share of 23.5% of the total employment in the state between 2009 and 2012. As the first Indian state to declare tourism as an industry and the first to trademark its tourism brand "Kerala – God's Own Country", Kerala has the highest[36] state expenditure on tourism in India. In 2017 alone, the state revenue (direct and indirect) from this sector was 4.77 billion USD[37]. The diverse tourism destinations in Kerala include[38] six broad categories: (1) heritage/ cultural/religious sites & events (2) backwaters (3) beaches (4) hill stations (5) eco-tourism sites like wild life sanctuaries and (6) Ayurveda/wellness-related activities.

The tourism sector in Kerala directly employs **1.4 million** people in the state and welcomed **15 million** domestic and foreign tourists in 2017 alone. Kerala also has the highest number of NRI visits in the country. The expanse and reach of the tourism sector not only has an implication on the scale of flood impact, but also on the social capital available to contribute to the rebuilding efforts.

DAMAGES AND LOSSES

99. The impact of the August 2018 floods on the tourism sector emerges in the wake of diminished tourist inflow due to the Nipah virus outbreak in May and heavy monsoon in June this year. The August-October period draws[39] a considerable segment of the annual domestic and foreign tourists, including those who attend the Onam festival celebrations and the snake & Nehru boat races in September, each year. This year, for the first time, the boat races were to be held as professional sporting leagues but had to be cancelled due to the floods. Further, 2018 had been promoted as the 'Kurinji Year' when the Neelakurinji flower was to bloom after 12 years. The Department of Tourism expected[40] over 800,000 tourist footfalls this year in the Idukki district alone, of which 100,000 were to be international tourists. Post-floods, which delayed the mass-blooming and forced the Department to shut down the park until September 20, 2018, thus the estimate has been revised to 200,000 footfalls.

100. The floods have impacted eco-tourism sites, like the Periyar National Park in Thekkady, and cultural heritage sites like the ongoing Muziris Heritage Project including disrupted access and damage to infrastructure. The backwaters, which draw[41] second largest share of tourists after cultural/heritage and religious sites, have also suffered extensive damages to infrastructure like houseboats, boat jetties and navigation canals. In addition to the immediate stalling of tourist activities, impact on the peak season of October-March is also emerging. Kerala sees a huge demand for MICE (meetings, incentives, conventions and exhibitions) activities during this period, but given that these events have a longer booking window, the hotels are witnessing cancellations in-advance.

[34] Government of Kerala (2017), Economic Review 2016
[35] ibid
[36] 1.27 % as against the national average of 0.49 %. Planning Commission (2014) State-wise/Sector-wise Annual Plan, 12-13
[37] Kerala Tourism (2017) Kerala Tourism Statistics - 2017 Highlights
[38] Ministry of Tourism (2003) 20 Year Perspective Plan for Kerala Tourism (2002-03 TO 2021-22)
[39] Tourist Statistics, Department of Tourism, Government of Kerala
[40] Discussions by JRDNA Team at the Tourism Department, Idukki district
[41] Tourist Statistics, Department of Tourism, Government of Kerala

101. The floods caused substantial damages to public, private and community-owned infrastructure in most districts, estimated at a total of INR 5,088 million (USD 72.7 million). This includes damages to hotels, jetties, navigation canals, parks, restaurants, sanctuaries and other tourist infrastructural assets. Alappuzha (INR 1,198 million), Idukki (INR 969) and Ernakulam (INR 884 million) were the most affected districts. **Error! Reference source not found.**The table below summarizes the district-wise damages to infrastructure.

Table 36: District wise estimates of damages to tourist infrastructure

District	Types of Infrastructure Damaged	Estimated damages (INR million)			Total damages	
		Public	Private	Community owned	INR million	USD million
Kasaragod		0	0	0	0	0.0
Kollam	Islands, adventure park, jetty terminal, bathing ghats	26	2	2.5	31	0.4
Kottayam	Illickal kallu destination, water parks, water sports centers, amenity centers, facilitation centers, heritage tourism zones, boat terminals, pay-and-use toilets, district office tourism department	73	334.5	10	418	6.0
Pathanamthitta	Waterfall, pilgrim shelter, tourist facilitation centre & boat landing facility, DTPC office, thiruvalla sathram, gavi destination	40	309.5	0	350	5.0
Alappuzha	Eco-park, canal banks, amenity centers, houseboat terminals, beach park, houseboats and other vessels	168	955	75	1198	17.1
Idukki	Parks, tea counties, guest houses, cultural cafes, sanctuaries and dam sites	308.5	595	65	969	13.8
Kannur	Life-saving equipment at beach	5	0	0	5	0.1
Malappuram	Eco-village, beaches, parks, town squares, signboards, waste bins and other assets	15	28	2	45	0.6
Palakkad	Parks, including folklore parks	42	104.5	3.5	150	2.1
Thiruvananthapuram	-	0	0	0	0	0.0
Ernakulum	Hotels, restaurants, houseboats, tree houses, riversides, lawns, leisure parks, fort kochi	90	650	143.5	884	12.6
Kozhikode	Beaches, boat jetties	16.5	33.5	0	50	0.7
Wayanad	Lakes, parks, caves, falls, tea estates, heritage museums, DTPC boats	225	247.5	15	488	7.0
Thrissur	Dam sites, gardens, children park	100	378	25	503	7.2
Total		**1109**	**3,637.5**	**341.5**	**5,088**	**72.7**

102. The losses in terms of income foregone is significantly higher. As per estimates, income foregone due to cancellations and reduced tourist footfalls amounts to INR 17,010 million (USD 243 million), with 19% of the tourism work-force directly impacted.

Table 37: District-wise estimates of income losses

District	Tourism Employees Affected	Estimated losses (INR million)			Total losses	
		Public	Private	Community owned	INR million	USD million
Alappuzha	10000	350	2230	125	2705	38.6
Ernakulum	25000	400	2850	0	3250	46.4
Idukki	7500	350	2230	275	2855	40.8
Kannur	1000	20	110	25	155	2.2
Kasaragod	2000	20	260	20	300	4.3
Kollam	1500	35	130	15	180	2.6
Kottayam	7500	350	2070	130	2550	36.4
Kozhikode	5000	35	115	0	150	2.1
Malappuram	1500	55	130	10	195	2.8
Palakkad	2000	85	230	15	330	4.7
Pathanamthitta	6000	85	590	70	745	10.6
Thiruvananthapuram	10000	145	560	35	740	10.6
Thrissur	6500	220	480	105	805	11.5
Wayanad	10000	275	1775	0	2050	29.3
Total	**95500**	**2425**	**13760**	**825**	**17010**	**243**

RECONSTRUCTION AND RECOVERY NEEDS

103. **Restoration, Repair and Reconstruction needs:** Reconstruction needs are estimated at is INR 6,766 million (USD 96.6) and includes reconstruction of public, private and community-owned infrastructure incorporating resilient design factors.

Table 38: District-wise estimates of reconstruction needs*

Location (District)	Asset: Hotels, Infrastructure (jetties, navigation canals etc.), Parks, Restaurants, Sanctuaries			Restoration and Reconstruction Cost for Infrastructure	
	Public	Private	Community Owned	INR million	USD million
Alappuzha	230	1310	200	1740	24.85
Ernakulum	66.6	760	0	826.6	11.8
Idukki	390	855	100	1345	19.21
Kannur	7.5	0	0	7.5	0.1
Kasaragod	0	0	0	0	0
Kollam	40	37	4	81	1.15
Kottayam	106	434.3	30	570.3	8.14
Kozhikode	22.5	61	0	83.5	1.19

Malappuram	25.6	41.4	3	70	1
Palakkad	40	188.5	5	233.5	3.33
Pathanamthitta	71	463	0	534	7.62
Thiruvananthapuram	0	0	0	0	0
Thrissur	140	495	40	675	9.64
Wayanad	262.5	315	22.5	600	8.57
TOTAL	**1401.7**	**4960.2**	**404.5**	**6766.4**	**96.66**

*****As shared by Department of Tourism, Government of Kerala. While detailed assessments are being carried out, preliminary costing has been undertaken such that for assets that have been fully damaged, 100% of the original cost of building has been accounted for and for assets that have been partially damaged, 50% of the original cost has been used.*

Recovery needs *(short term):* Immediate recovery needs will include:

- Addressing financial needs of affected sector employees, including migrants, through alternate interim livelihoods, cash-based engagement in recovery efforts etc.;
- Addressing financial needs of tourist enterprises/ restaurant owners to access insurance claims, credit, and/or tax relief;
- Debris clearance, detailed structural damage assessments and repair/rebuilding of damaged physical and environmental infrastructure;
- A basket of trust-building and marketing exercises to encourage visitors.

Resilience needs (medium-long term)

104. The tourism sector in Kerala mobilized rapidly post-floods, not only for supporting the rescue efforts (many house-boats were deployed for rescue and acted as relief camps) but also to initiate actions for its own recovery. Kerala tourism has rolled out a 12-point action plan to prevent losses in the forthcoming peak tourist season. This plan includes restoration of road corridors and infrastructure and initiation of several marketing strategies to attract tourists, including digital campaigns, familiarization tours for travel agents/media-persons, and campaigning for events like the champions league boat race and Kochi-Muziris Biennale. Further, Kerala's tourism industry has formed Kerala Tourism Task Force (KTTF), an independent voluntary body, to support the government state in relief and rehabilitation work.

105. Even as the tourism sector makes its foray towards **rapid** recovery to prepare for the next tourist season, it is imperative that this process be informed by disaster and climate risks – both pre-existing and those emerging from the impact of the floods. Government of Kerala has already adopted a policy of 'Responsible Tourism' and is implementing several projects towards this. The experience of the floods necessitates a reconceptualization of this policy to account for disaster and climate risks, including, but not limited to,

- risk-informed site-selection and design of hotel buildings and other infrastructure, especially in newly emerging landslide-prone areas,
- enhanced capacities of tourism and hospitality sector for disaster risk management planning, including early warning and evacuation, as well as business continuity planning,
- encouraging cultural/ heritage and religious sites to undertake disaster management planning

- enhanced capacities of tourism sector employees including bus/taxi drivers, boat operators for disaster response,
- revision of accreditation criteria for tourist enterprises to include disaster resilience, including disincentives for further risk-creation by tourist enterprises (for e.g. regulation of proposed tourism constructions contributing to the fragility of the Western Ghats),
- promoting the adoption of risk transfer mechanisms like insurance schemes, with appropriate regulatory and facilitative mechanisms,
- design of a "Resilient Kerala" branding campaign, for sharing resilience-building measures undertaken within the state for building confidence in tourists; also, as a vehicle to share knowledge about disaster and climate resilience,
- in line with the focus on experiential tourism in the Tourism Policy 2017, developing niche tourism areas like culinary tourism and spice garden tours, with a focus on promoting households and plantations/gardens severely affected by the floods
- bringing international and national artists under the auspices of the Kochi-Muziris Biennale to explore the experiences of 'living with disaster and climate risk' through art, as the theme for 2019.

106. As access to information for travelers increases, risk perception has become a key criterion for selection of tourist destinations. In this backdrop, resilience in the tourism sector is not only a moral imperative, but also an economic one for improving competitiveness of Kerala as a tourist destination.

3.7 Health

Sector Context

107. Kerala has been ranked first among states of India on the human development index. In terms of maternal and child health indicators, Kerala's achievement is commendable. However, in the past two decades, the state is passing through a phase of transition in its health sector. With a total fertility rate of 1.8, the state is an advanced stage of demographic transition with elderly population higher than most other states leading to a phenomenon called 'population aging'. Kerala is also witnessing a change in its disease profile with a marked decline in infectious diseases and a steep rise in non-communicable diseases (NCDs). According to the Global Burden of Disease study, 74.6% of total disease burden of Kerala in 2016 was attributable to NCDs. Further, the state is going through a transition in its health care delivery system with private health care system dominating curative care. However, the public health care system continues to be responsible for preventive care and a substantial portion of curative care. The public health infrastructure in the state consists of 18 general and district hospitals (DH), 7 women and child hospitals, 81 taluk level hospitals (TH), 234 community health centres (CHC), 849 primary health centres (PHC) and 5403 health sub centres (SC).

Flood Impact

108. The flood had a major impact on the health system in the state. Several health facilities including PHCs, CHCs and taluk hospitals were damaged. Further, medical equipment and furniture were destroyed in many health facilities. Contact with contaminated water had led to a spike in

cases of leptospirosis in many flood-affected areas. This has nevertheless been effectively controlled by a combination of early and effective prophylaxis and treatment and water disinfection measures. The unfolding story however is that of disruption in treatment of NCDs among flood affected patients leading to multiple complications including end organ failure. The impact of this is still being assessed.

Damage analysis

109. The damage to health infrastructure has been assessed as follows.

Table 39: District wise Damages

District	Total damaged (INR Million)	Major damages (INR Million)	Minor damages (INR Million)	Equipment Loss (INR Million)	Furniture Loss (INR Million)	Total amount (INR Million)	Total amount (USD Million)
Alappuzha	46.22	4.15	7.56	32.72	0	90.65	1.3
Ernakulam	2.71	0	35.7	11.33	0	49.74	0.71
Idukki	16	23.5	2.9	0.48	0.6	43.48	0.62
Kannur	6	0	9	0.1	0	15.1	0.22
Kollam	0	7.75	0.5	0.05	0.395	8.7	0.12
Kottayam	31.25	6	0	2.1	0	39.35	0.56
Kozhikode	3.5	0	0	4.13	2.25	9.88	0.14
Malappuram	9.2	2.3	0.95	0.76	2.22	15.43	0.22
Palakkad	8.2	0	3.45	0.14	0.1	11.89	0.17
Pathanamthitta	0	2.5	3.6	13.9	6.4	26.4	0.38
Thiruvananthapuram	0	2	0	0	0	2	0.03
Thrissur	8	11	3.7	44.57	0	67.27	0.96
Wayanad	2.5	0.6	4.05	1.1	0.515	8.77	0.13
Total	**133.58**	**59.8**	**71.41**	**111.38**	**12.48**	**388.65**	**5.55**

Immediate response

110. As part of immediate response, health services are being delivered from temporary buildings in health facilities that where totally or heavily damaged. Further, through coordinated efforts of frontline staff of the health department, state water authority and local gram panchayats, the water in wells, tanks and other water bodies has been disinfected. Resultantly, the number of leptospirosis cases have significantly gone down. The treatment of a large number of patients with NCDs was disrupted as they lost their medical records and medicines in the floods. As part of immediate response, more than 90,000 patients with diabetes, hypertension and other NCDs like cardiovascular diseases and asthma have been put on treatment regimens that are simple and deliverable at any level of health facility.

Immediate Response

111. During and in the immediate aftermath of the flooding, the GoK took steps to attenuate the impact and damage of the floods. Upstream obstructions of gates were removed. Electric supply to

the lift stations was disconnected and shutters were closed to prevent the inflow of water from the rivers. Water levels in lakes were monitored closely, and estuaries cut open to ensure free exit of flood waters into the sea. Numerous breaches of embankments, canal banks and weirs were plugged or repaired. In addition, numerous pumps were deployed to dewater critical infrastructure.

Reconstruction, Recovery and Resilience building needs

Need Analysis

112. Immediate reconstruction or repair of totally or partially damaged health facilities are crucial to restore preventive and curative health services to the citizens of flood affected areas. This would also include procurement of requisite medical equipment and furniture to make the facilities fully functional. As the disease burden of the state is predominantly comprised of NCDs, another urgent need is to be better prepared to handle NCDs during floods. Vector borne, and water borne diseases are also bound to spike during and after floods and this calls for better disease surveillance systems that capture the emergent disease patterns.

Reconstruction needs

113. Reconstruction would entail rebuilding of totally damaged health facilities and repair of those that have suffered major or minor damage. Replacement of damaged equipment and furniture will also be part of reconstruction. Reconstruction of Taluk Headquarter Hospital in Pulinkunnu in Kuttanad which has been destroyed by floods is a high priority for the state as there are no other inpatient health facilities near this highly flood prone area. The total reconstruction needs for health facilities (reconstruction, repair, equipment and furniture procurement) account for about INR 2749.95 million (USD 39.28 million). An abstract of the total cost is provided in Table 40.

Table 40: Sector Reconstruction/Recovery Needs

District	Facility Repair & Reconstruction Work	Unit	Cost for repair and reconstruction (INR Million)	Cost for Procurement of New Equipment (INR Million)	Total amount (INR Million)	Total amount (USD Million)
Alappuzha	Reconstruction of Taluka Headquarters Hospital, 1 TH, 12 PHC, 4 CHC, 13 SC, 1 other	31	1781.2	48.6	1829.8	26.14
Ernakulam	25 SC, 1 TH, 7 PHC, 1 CHC, 5 FHC	39	72.25	41	113.05	1.62
Idukki	13SC, 1 DH, 6 PHC, 2CHC, 1 FHC, 1 TH	24	60.8	17.6	78.4	1.12
Kannur	3 PHC, 2 SC, 1 Other	6	97.4	2.5	99.9	1.43
Kollam	2 PHC, 1 SC, 1 TH	4	57.8	2.3	60.1	0.86
Kottayam	3 PHC, 9 SC, 1 CHC	13	136.7	7.7	144.4	2.06
Kozhikode	2 PHC, 3 SC	5	40.35	5.1	45.45	0.65
Malappuram	3 PHC, 7 SC, 1 FHC	11	96.1	4.5	100.6	1.44
Palakkad	7SC	7	16.15	0.25	16.4	0.23
Pathanamthitta	3 PHC, 7 SC, 1 CHC, 1 DH	12	51.9	30.8	82.7	1.18
Thiruvananthapuram	Mental Health Centre	1	2.8	0	2.8	0.04

Thrissur	8 SC, 1 TH, 5 PHC, 1 FHC, 2 Others	17	67.5	87.5	155	2.21
Wayanad	1 PHC, 7 SC	8	19	2.3	21.3	0.3
Total		**178**	**2499.95**	**249.95**	**2749.9**	**39.28**

Resilience needs (medium-long term)

114. The infrastructure in all buildings that are being newly constructed to replace totally damaged buildings will have flood risk reduction measures. Other long-term measures that are planned are NCD survey to understand the disruption in treatment of NCDs among flood affected patients including complications such as end organ failure. Another long-term measure is to strengthen the disease surveillance systems such as Integrated Disease Surveillance Program (IDSP) to include inpatient data from both private and public-sector hospitals so as to equip the state to deal with any spike in disease patterns efficiently and effectively.

3.8 Irrigation and Water Resources

Sector Context

115. Kerala receives an average of 3,070 mm rainfall annually. Seventy percent of this rainfall falls during the South-West monsoon (June-September). There are 44 rivers with the total length of 3,132 km and average annual river flow of 57.6 Billion Cubic Meters (BCM), among which, only three rivers flow east and the rest flows west into the Arabian sea. With a length of 244 km, the Periyar is the longest river and the Bharatapuzha, Pamba, Chaliyar are other major rivers. The State has developed important water resources and irrigation systems to support various uses of water throughout the year including agriculture, domestic use, fisheries, and river transport. There are 76 dams in the State excluding 4 dams in Kerala that are managed by Tamil Nadu[42], and over 18,000 ponds in the state which have a combined storage capacity of 5.8 BCM. Seven of the large dams have a combined storage of 74% of the total live storage. Idukki is the largest dam with 1.46 BCM storage. Kerala State Electricity Board (KSEB) operates 58 dams with hydropower facilities and the Water Resources Department owns 16 dams for irrigating ayacut areas of 5,670 km^2, and 2 dams are owned by Kerala Water Authority.

116. The Irrigation Department is also in charge of flood protection and maintenance of the natural rivers and irrigation canals. Primary and secondary irrigation canals have a total length of over 4,500 km. The total length of river embankments, dyke, and bunds is approx. 12,500 km. The backwaters are a chain of brackish lagoons and lakes lying parallel to the coast. The Vembanad is the largest lake and has canal network with an area of 2,033 km^2. It is a Ramsar wetland and harbors paddy cultivation and fish ponds. The length of the Kerala coastline is 580 km and of which around 350 km is protected with sea walls and groynes.

Flood Impact

117. The extreme rainfall in early to mid-August 2018 caused severe flooding and landslides across the entire state, severely affecting people's lives and damaging many public and private properties.

[42] As defined by ICOLD. CWC, National Register of Large Dams, 2012

Due to above average inflow in June and July 2018, reservoirs were full and gates of 35 dams had to be opened to safely pass the large inflow[43] in August 2018. Damage and erosion to river banks occurred, irrigation canals and drains silted up, canal banks collapsed and many structures such as cross drains and gates were damaged. Inspection and approach roads to these irrigation structures were also damaged, in addition to severe damage occurred to coastal protection structures that led to salt water intrusion into the Vembanad Lake area.

118. Due to the excessive rainfall in the preceding months, years of siltation leading to reduction in the storage volume in reservoirs and lakes, the 'room-for-the-river' hotspot Vembanad lake was able to absorb only 0.6 BCM out of the 1.63 BCM inflow in August 2018. Due to existence of backflow conditions at the river mouths constraining river releases into the ocean, over 480 km^2 of land was inundated - nearly three times the normal size of monsoon flooding. The heavy rainfall also removed the top soil in the hills and upland areas leading to erosion and landslides. As a result, the hills lost much of their natural capacity to absorb rainwater. In several places in Idukki, Wayanad, Kozhikode, Pathinamthitta and Kannur districts, the topography of the land has been altered beyond recognition.

Damage Analysis

119. For this analysis, the water infrastructure is divided into three parts: flood protection, irrigation and water resources. Flood protection infrastructure refers to embankments, weirs, sluice gates and coastal flood protection of natural channels. Irrigation infrastructure refers to canals, drains and the associated hydraulic infrastructure, pumps and other equipment of artificial channels. Water resources infrastructure refers to dams, barrages, and associated infrastructure.

120. For flood protection, approximately 886 km of river banks and 103 km of coastal protection and drainage systems were severely eroded, damaged, or heavily deposited with debris. In many cases, roads and buildings adjacent to the flood protection constructions, and as associated equipment/structures like weirs, gates and dykes were also damaged.

121. Over 1,640 km of main irrigation canals, over 540 km of distributary canals, and more than 350 hydraulic structures were damaged, affecting the water supply in the command area for irrigation for the oncoming winter season.

122. With respect to water resources, most damage occurred in smaller storage systems like minor dams and storage ponds. No damage has been reported to large and medium dams. Nearly 200 storage ponds and 70 minor dams were damaged. Several gates are now non-operational or are experiencing severe leakage due to damage to parts of the structures. Approach roads leading to dams, site offices, and residential areas are heavily damaged. The physical damage to flood protection, irrigation and water resources infrastructure is summarized in the below.

[43] https://www.thehindu.com/news/national/kerala/severe-storm-occurrences-caused-floods-cwc-report/article24917702.ece

Table 41: Physical damages in irrigation and water resources sector

Sector	Item	Unit	Quantity
Flood protection	Bunds	km	886
	Regulators etc.	No	42
	Weirs / Check dams	No	142
	Coastal protection, drainage systems	km	103
	Others (e.g., dykes)	No	76
Irrigation	Canals	km	1,642
	Distributaries (distribution channels)	km	543
	Structures (sluice gates, weirs, pump, intake well, etc.)	No	357
	Canal side access/ inspection roads	km	50
	Other (e.g., lift stations)	No	248
Water Resources	Storage ponds and tanks	No	192
	Major Dams *	No	0
	Medium Dams *	No	0
	Minor Dams	No	70
	Operating systems, monitoring, and gaging systems	No	27
	Others (buildings, etc.) Nos.	No	75

* May needs further technical investigations

Reconstruction, Recovery and Resilience building needs

123. **Recovery Needs:** Investments required in response to the flood emergency have been identified for flood protection, irrigation and water resources. These include repair of damaged and breached: river banks, tank bunds, ponds, coastal protection structures, irrigation and drainage canals; and approach roads to dams and canals; as well as removal of silt/debris deposits. The winter irrigation season is commencing in January therefore, all damaged irrigation and drainage canals and structures should be repaired on priority.

124. Installation of real time monitoring of major rivers and water storage structures should also be undertaken on priority. Surveys, designs and studies for re-modelling and repairs of water resources infrastructure need to be carried out within a one-two year period to allow commencement of planning of long-term interventions. In addition, the following multi-district efforts are also identified as short & medium-term needs. The total cost of Water Sector Recovery works is USD211.9 million is given in Table 42.

Table 42: **Irrigation and Water Resources Sector Short & Mid-Term Recovery Needs**

No	District	Flood Protection (INR Million)	Irrigation (INR Million)	Water Resources (INR Million)	Study and Planning (INR Million)	Short & Mid-Term Total	
						INR (Million)	USD Million
1	Alappuzha	3,248	68	121.8	0	3,438.00	49.1
2	Ernakulam	613	274	132.8	0	1,020.10	14.6
3	Idukki	663	51	25.9	0	740.4	10.6
4	Kannur	263	114	0	0	376.5	5.4
5	Kasaragod	81	1	0	0	82.2	1.2
6	Kollam	163	35	3.6	0	201.8	2.9
7	Kottayam	404	72	27.5	0	502.8	7.2
8	Kozhikode	887	202	0.8	0	1,089.70	15.6
9	Malappuram	481	11	0.2	0	492.9	7
10	Palakkad	236	410	140	0	785.7	11.2
11	Pathanamthitta	810	202	53.4	0	1,065.10	15.2
12	Thiruvananthapuram	748	29	0	0	777.7	11.1
13	Thrissur	846	394	90.3	0	1,329.90	19
14	Wayanad	181	97	2.5	0	280.3	4
15	Multi-district	2,000	300	0	350	2,650.0	37.9
	Total	**11,624**	**2,260**	**5,98.8**	**350**	**14,833**	**211.9**

125. *Hydromet and Flood Modeling* -The 2018 flood event confirmed the importance of flood forecasting with the use of real time water resources monitoring information for generating warnings, planning evacuations, and other related decisions. In addition, flood modeling (impact forecasting) should be conducted to prepare inundation mapping, flood zoning, and flood contour maps to avoid settlement in flood zones. Conducting bathymetry and river cross sections surveys is also critical for developing accurate modeling, to understand river conveyance/carriage capacity for high flow conditions, especially with dam discharges during the August 2018. The verified flood modeling should be further used to plan, evaluate, and design flood protection measures. This activity should be done in a close coordination with the ongoing interventions under National Hydrology Project (NHP).

126. *Mechanical Works* – The 2018 flood event caused significant damages to the mechanical equipment and structures. The mechanical wing of the department needs additional budgetary allocations to manage the increased number of services, operations and maintenance requirements.

127. *Technical Studies and Master Planning* – There are several potential flood protection, irrigation, and water resources projects that would strengthen flood resiliency in the flood affected areas across the state and they are listed in the following section. To better cost, verify the importance and proper sizing of projects, technical studies and master planning need to be conducted in short to mid-term period.

128. **Resilience needs:** Three areas are identified to strengthen long-term resilience of the water resources and irrigation sector based on the site visits and discussion with district and state

governments, which includes but not limited to 1) Canal Erosion and Sedimentation Management, 2) Dam and Barrages Operations, and 3) Coastal Zone Management, among others.

129. The State developed the following activities that are aligned with the identified long-term needs. Pricing for each activity is not provided as approximate cost can only be identified after proper technical studies and master planning are completed during in the short to mid-term period.

- *Additional Flood Protection and Coastal Zone Management:* Upon completion of flood modelling, verification and generation of flood maps, the flood models can be used to identify and design necessary flood protection measures such as additional storages, river training, embankments, etc. Major types of work that the State identified include river and thodu[44] rejuvenation, storages including ponds and dams, lift stations, regulators, and flood bunds. Coastal zone erosion management is another long-term activity required, considering the severity and extent of the coastal damages caused by the August 2018 floods. Similarly, the Pampa area development plan prepared by Travancore Devasom Board should be updated considering the impacts of the floods before commencement of any reconstruction in the area.
- *Irrigation Project to Strengthening Flood Resiliency:* The August 2018 flood revealed that canal banks and cross-drainage systems including regulators, weirs, and lift stations need additional strengthening to resist high flow conditions, as any canal breach can slow down dewatering after flooding and increase damages in agriculture and fisheries. There was a case where barrage gates were too old to open during high flood conditions. Therefore, dams and barrages also need technical investigations to identify upgradation needs of gating structures and other instrumentation, in coordination with the ongoing Dam Rehabilitation and Improvement Project (DRIP) program.
- *Kuttanadu Flood Control Works:* To strengthen flood resiliency in Kuttanadu region, renovation and extension of Alappuzha-Chenganassery Canal and modernization of Thottappally Spillway were identified as long-term priorities. Master planning of the Kuttanadu region needs to be initiated and feasibility of multi-sectoral interventions be prepared to guide systematic planning and implementation of development activities in the area.

130. Most of the identified areas have been included under NHP or DRIP Project, so close coordination with these national level projects is critical when preparing these long-term activities.

3.9 Power

Sector Context

131. Kerala generates power from four sources - hydro power, thermal power, wind power and solar power. Of these, hydel and thermal are the dominant mode of power generations. Kerala State Electricity Board Limited (KSEB Ltd), a government company incorporated on 14 January 2011 under the Companies Act, 1956, which started its operations as an independent company with effect from 1 November 2013, is responsible for Generation, Transmission and Distribution in the state. For administrative convenience, the distribution area of KSEB Ltd is divided in to different regions. Presently, there are four regions viz. South, Central. North and North Malabar. The Generation Strategic Business Unit under KSEB operates and maintains 37 hydroelectric generating stations, 2 thermal power plants, a wind farm at Kanjikode and few non-conventional stations spread across the state, with a total installed capacity of 2,234 MW. Renovation, modernization and up-rating of the

[44] Small water channels

old hydroelectric projects which have surpassed their useful life are also being carried out by this wing.

Flood Impact

132. KSEB Ltd sustained losses in all fronts viz. Generation, Transmission, Distribution and by way of loss of revenue due to loss of load. Five major hydro generation stations and fourteen small hydel stations were affected due to the flood and subsequent landslide. 22 substations were flooded, damaging the control system. 10 Power Transformers were submerged; many transmission towers were toppled; 10 major transmission corridors became dysfunctional due to the flooding. Massive flood has hit the Distribution infra badly. Power Distribution in 300 odd Electrical Sections in seven Districts were shattered. More than 1700 Distribution Transformers were either submerged or damaged. More than 10,000 Distribution Substations were switched off to avoid mishaps. Feeding from 16,158 Distribution Transformers were affected. Service to 25.60 Lakh consumers were disrupted in the calamity.

Damage Analysis

133. It is estimated that to restore normalcy in power Distribution, over 1,700 Distribution Transformer Stations and about 5,300 km distribution lines will have to be reconstructed. More than 100,0000 damaged poles also require replacement. It is estimated that 300,000 Singe Phase energy meters and about 50,000 Three Phase energy meter are damaged due to submergence and need replacement. In addition, new governor, Excitation system, SCADA, control panel, excitation system, Relay & control panels also need replacement.

Immediate response

134. GoK, using its own resources, have started providing immediate short-term repair of energy access, clearance of debris, temporary connection etc. Most of the restoration works were done with the immediate intent of restoring the supply to the consumers without insisting on standard procedures and practices, as a temporary measure, sometimes by extending supply with the help of weatherproof wire, sometimes without connecting meters and in many cases by bringing in prewired essential supply points. Back-feeding from distant areas have been resorted to in many cases. A major portion of the flooded transformers with considerably decreased residual life (due to weakened insulation) have been put back into service after reconditioning as a temporary measure. These transformers will have to be replaced at the earliest. Energy meters have been bypassed in many cases and connection restored with the existing faulty meters in others. A large number of transformers and meters will therefore be required. There are a lot of houses where the wiring circuits were damaged and found unsafe, and where essential supply points were given from prewired kits.

Reconstruction, Recovery and Resilience building needs

Need Analysis

135. The needs are based on the lessons learnt from historical experiences of 'building back better' that inform the design of a comprehensive recovery framework in Kerala. The framework would set the groundwork as a way forward to improve the resilience of state infrastructure and its communities for future natural disasters. Based on the needs assessment, overall distribution sector

would need to be significantly reconstructed along with major generation and transmission corridors. Additionally, to enhance disaster resilience, technological interventions are suggested. Overall reconstruction cost in generation, transmission and distribution sectors are tabulated as below:

Table 43: Sector Reconstruction/Recovery Needs

Activity	Typology for reconstruction/recovery	Reconstruction/Recovery	
		INR million	USD million
Generation	Civil works, Excitation system, SCADA, Control Panel	**808.50**	**11.6**
Distribution	Poles, Distribution Transformers, Meters, Weatherproof cables, ELCBs.	**2424.51**	**34.8**
Transmissions	Power Transformers, Conductors, Disc Insulators, Circuit breakers, Lightning Arrestors.	**297.71**	**4.3**
Total		**3,530.72**	**50.7**

Recovery Needs

136. Medium to short term recovery strategy should focus on improving the planning, design, construction and operation and maintenance practices to embrace 'synonymous with technology' principles, particularly in the areas with distribution and flooding risks. The state must start evolving newer transmission technology areas.

Resilience needs

137. KSEB Ltd has decided that the re-building activity will not be a business as usual but will follow the principle of building back better. It is recommended to implement technology solutions e.g. (i) Use of distribution poles higher than maximum flood limits firmly grouted on a solid foundation, (ii) Application of SCADA based Flood prediction system, (iii) Climate proofing of Distribution transformers, (iv) use of multi circuit towers, and (v) Dam improvement technologies.

Recovery Road Map

Short to Medium Term (Estimated amount USD50 million)

- Restoration of supply to consumers on war footing.
- Back feeding from distant areas.
- Sourcing of equipment for continuity of connections.

Medium to Long Term (build back better)

- Long Term Transmission Plan
- Disaster Resilient construction to ensure supply redundancy.
- Strengthening of Power evacuation system with focus of enhancing reliability of power supply blended with loss reductions.
- Extending Smart meter service to remote areas.

- Technology based Dam Management inter alia silting aspects.
- Application of SCADA/Climate based flood prediction system.

3.10 Natural Environment and Biodiversity

Sector Context

138. The state of Kerala is flanked by the Western Ghats - one of the 25 global biodiversity hotspots - and the Arabian sea. The tropical evergreen forests on the Western Ghats, the highly undulating terrain, the tropical monsoon climate and the long coastline has an intricate system of backwaters along the coast that make Kerala a unique geographical and environmental entity. Amid the right productive and biodiversity rich ecosystems, urban and rural areas of the state are interspersed as a rural-urban continuum.

139. The Kerala Forest Department is broadly organized into Territorial, Wildlife and Social Forestry wings. The total area under the administrative control is about 11,310 sq. km which is about 29% of the total state land. Of these, 24.26% constitute protected areas and 75.75% constitute Reserved Forests. There are fourteen wildlife sanctuaries, six national parks, two tiger reserves, two UNESCO-recognized biosphere reserves (Nilgiri and Agasthyamalai) shared with neighboring states, reserved forests, vested forests and ecologically fragile lands. These are home to protected and endangered species like the Indian Sloth-Bear, Lion-Tailed Macaque, Indian Bison, Bengal Tiger and Nilgiri Tahr. Kerala is also well-known for its exotic and rare species of flora and fauna.

140. There are 44 rivers and, of these, 41 flow westward as the terrain changes from the hills to the coast and the sea. All these rivers are rainfed and tend to have little or no flow during the summer months. Kerala is also endowed with several wetlands located within the forests and in the plains (including the coasts). Of these, there are three Ramsar sites - Sasthamkotta Lake, Asthamudi and Vembanad Kole Wetlands. There are also mangroves in a few of the coastal districts of which the northern district of Kannur has almost 80% of the State's mangroves.

141. Outside of these declared eco-sensitive areas and forests, Kerala's natural environment is unique as it is gifted with varying soil profile, rich vegetation, distinct agro-climatic zones, vibrant climate, dynamic hydrology, distinct geological domains and terrains and different mineral deposits. Therefore, economic development – agriculture, industrial, infrastructure, urban, rural, tourism and – will have to be embedded in this rich natural environment. The two-way interaction, i.e. economic development depends on the natural environment and the natural environment must bear the impacts of economic development, is significant and pronounced in the Kerala context given its narrow land strip and dense population.

Impacts

142. Broadly, the impacts to the natural environment differ based on their geographical location. In the hilly terrain, the major impacts are in the forests and eco-sensitive areas, which have been caused due to landslides. Some of these landslides are 3-4 km in length and 20-30m average in width. Here the impacts include the loss of tree and soil, partial or complete damage to forest infrastructure

such as eco-tourism facilities, buildings, roads and fencing. Furthermore, in selected areas, nurseries and wetlands have been silted. However, the impacts on the biodiversity – both species and ecosystems – have not yet been scientifically studied. Additionally, in selected forest areas, tribal populations living within the forests have also been displaced and relocated to other erstwhile pristine forest areas.

143. In the midlands and plains / coastal areas, environmental assets have been impacted. Due to the flooding, wetlands have received sizeable quantities of wastes – accumulation of weeds, garbage, mud / silt, debris, sewage, sullage and other pollutants (Refer separate chapter on debris management) - that has changed the organic composition of the water bodies. Of these, the Vembanad Kole is recognized to have suffered the largest impacts. However, the overall impacts on the wetlands have not yet been studied. The midlands / plains have also received the rich top soil run-off from the highlands. Wherever accumulated, the local community is already collecting and using the rich top soil to cater to their current needs.

144. The river ecosystems were considerably damaged. The natural assets of the river that have been impacted are: (1) The rocks in the river bed (in the hilly areas close to the landslide locations, (2) the erosion / deepening of the river, (3) the fall in both the surface and the adjoining sub-surface water table along selected river stretches, (4) the changing course of the river in a few locations, and (5) the formation of sandbanks along the river.

145. Along the coast, there were temporary impacts on the beaches and surrounding areas due the flooding caused by the high tide that prevented the draining of the rainwater into the sea. At the outfall of the Bharathapuzha river, a sandbar was created at the Ponnani estuary that has provided a semi-permanent walkway into the sea during low tide. Having become a tourist attraction, this newly formed sandbar has the potential to cause secondary impacts and requires proper oversight / management.

146. With economic development dependent on the natural environment, there are inevitable, difficult questions regarding whether its nature of development has worsened the impacts of floods and landslides on the people of Kerala. The worsening of impacts due to errant development is obvious in certain instances, i.e. having human habitats immediately adjoining the river banks or even within the river itself as has been the case in selected locations. However, further scientific studies are required in order to establish a cause-effect relationship between the features of the natural environment and the extent of impacts due to errant / unsustainable development practices.

Restoration and Recovery

Needs

147. On forests and eco-sensitive areas, restoration of the damage to the natural assets and the associated infrastructure in the forests have been estimated wherever feasible. However, it is important to reiterate that this is only a preliminary estimate and is likely to change as more data becomes available. Moreover, the restoration needs for the biodiversity, wetlands and mangroves will have to be done only after the impacts are fully assessed. The restoration costs identified so far are included in the following table:

Table 44: Restoration of damage to forests by district

No.	Districts	Costs (INR Millions)	Cost (USD Million)
A	**District Wise Break-up**		
1	Alappuzha	0.25	0
2	Ernakulam	30.5	0.44
3	Idukki	90.19	1.29
4	Kannur	12.56	0.18
5	Kasaragod	0	0
6	Kollam	5	0.07
7	Kottayam	2.7	0.04
8	Kozhikode	5.18	0.07
9	Malappuram	77.3	1.1
10	Palakkad	122.07	1.74
11	Pathanamthitta	130.05	1.86
12	Thiruvananthapuram	0	0
13	Thrissur	233.15	3.33
14	Wayanad	113.03	1.61
B	**Other Restoration**		
Vembanad Kol		3000.00	42.86
Other Eco-sensitive areas (all other districts)		700.00	10.00
Kerala Forest Development Corporation Ltd.		23.49	0.34
Total		**4545.46**	**64.94**

Table 45: Restoration of damage to forests by type of damage

Sector / Data Heads	Costs (INR Millions)	Costs (USD Millions)
Forests area		
Damage to Nurseries	9.31	0.13
Landslides within Forest areas	241.07	3.44
Forest infrastructure	371.25	5.30
Habitat improvement works	132.64	1.89
Wetlands & mangroves-related		-
Damage to wetlands	1.95	0.03
Damage to mangroves	-	-
Biodiversity-related		-
Damage to enlisted and other protected areas	-	-
Other Losses	65.75	0.94
Vembanad Kol	3,000.00	42.86
Other Eco-sensitive areas (all other districts)	700.00	10.00
Kerala Forest Development Corporation Ltd.	23.49	0.34
Total	**4545.46**	**64.94**

Note: The above costs pertaining to eco-sensitive areas restoration are provisional as impacts to biodiversity, mangroves and wetlands are in the process of being estimated.

148. On the broader subject of preserving the natural environment in the context of economic development, there were four areas that were identified as the broad needs: (1) restoring river eco-

systems, (2) improving land use planning around eco-sensitive areas and forests in specific, and other areas due to its physical characteristics; (3) preventing landslides in sensitive slopes and (4) disposing of waste and debris generated due to the floods and landslides in a safe, environmentally responsible manner (Refer separate chapter on debris management).

Recommended Strategies and Actions

149. Recommended strategies and actions include technical studies, short-term and medium-term initiatives:

Technical studies

- **Wetlands and Mangroves:** Scientific studies should be done to determine the impacts on wetlands. Of importance, the Vembanad Kol – a Ramsar site – has to be studied as it is recognized to have received waste from the four adjoining districts during the floods. Similar impacts study should be done for the wetlands in the coastal region and for those in the forests that have been impacted. While mangroves may have had a positive role in terms of absorbing the shock, these should also be selectively studied.
- **Biodiversity**: The Kerala State Biodiversity Board (KSBB) has proposed to do a rapid assessment of the biodiversity impacts starting October 2018. This assessment will be done with the support of the State Biodiversity Management Committees already established in the local panchayats. In 13 affected districts, 186 panchayats / committees have been identified and a team of volunteers / experts are being established. This assessment will cover the impacts on species and ecosystems and will also examine traditional knowledge to document their utility and effectiveness, if any. In addition to the collective expertise within the state, this assessment should also draw from best practices from national / international experiences.
- **Identifying strategies to restore the natural environment**: In locations outside the forests and eco-sensitive areas, background studies should be done to determine whether and how economic development has worsened the impacts due to floods and landslides. As the nature and scale of impacts extend across the state, a few severely affected locations should be identified and analyzed. This should be across various typologies, such as (1) along the periphery of forests and eco-sensitive areas, (2) steep slopes that are in use for agricultural plantations and (3) commercial and residential development in the immediate vicinity of the river banks. Using the findings of these studies, strategies to restore the natural environment should be drafted, consulted with the stakeholders and recommendations finalized using a collective & integrated approach. This should be urgently undertaken as the strategies identified therein are particularly relevant to the “Build Back Better” theme.

Short-term actions

- **Restoration related to forest and other eco-sensitive areas**: Restoration of all identified damages and those to be identified through the technical studies.
- **Landslides in forest areas – an integrated approach**: There are slope protection initiatives being done by the Forest Department (forest areas), Department of Soil Survey and Soil Conservation (watershed development), Department of Local-Self Government, and Public Works Department (road infrastructure works). An integrated approach should be developed for the forest areas using the collective expertise, which should also include best practices from national /

international experiences. Proof-of-concepts pilots should be designed and implemented in order to evolve such an integrated approach.

- **Restoration of the Vembanad Kol:** As a follow-up to the technical study, multiple activities should be implemented to restore this wetland. This includes de-weeding, desilting, rebuilding the bunds, shore stabilization activities, removal of waste, and segregation & disposal of the waste.
- **Implementing strategies to restore the natural environment along the river banks**: Identified as a part of the technical studies, the strategies should be implemented in a phased-manner. These should necessarily include the implementation of land use strategies to regulate commercial and residential development along the river banks, which has emerged as priority during these floods and landslides.

Medium-term actions

- **Implementing strategies in the periphery of forests and eco-sensitive areas:** A detailed and scientific vulnerability mapping in a spatial platform should be done in the periphery of forests and eco-sensitive areas. Developing land use policy and plans from such a vulnerability analysis and, accordingly, aligning the rebuilding activities so that the human-induced development impacts do not aggravate those related to extreme disaster events in the future.
- **Systematic strengthening and implementing strategies to restore the natural environment**: Having initiated the implementation of such strategies, it is important to constantly monitor and strengthen their effectiveness. Based on that, proactive strategies should evolve, approved and implemented as a systematic means of climate proofing economic development in Kerala.

3.11 Cultural Heritage

Sector Context

150. The state of Kerala has a unique and diverse culture molded by international traders, conquerors, travelers, colonists and the royal administrators. The 3000-year history of maritime activities, interactions with 30 other countries and the various religions that set foot in Kerala through trade have contributed to priceless cultural exchange that took place between the state and various other countries. Layers of history created by the traders like Portuguese, Dutch and English along with the interactions between the various ethnic communities that have made Kerala their home have sculpted the way of life of people here, the major indicators of the same being architecture, festivals, arts, sculpture, food, painting, customs and traditions, woodwork and handicrafts etc. In the context of Kerala, these expressions of the way of life, better defined as 'Cultural heritage' have always drawn immense international attention. The rich natural and architectural heritage of the place along with the intangible heritage associated with the communities make Kerala one of the top tourist destinations in India. The cultural heritage that captures the attention of the tourists ranges from architecture to art forms, festivals to traditions and dresses to cuisines. The culture of Kerala is something that must be experienced.

Flood Impact

151. The floods have caused considerable damage to some of the culturally rich sites in Kerala. While the information on the number of built heritage components affected due to flood and the nature and extent of damage due to the same is highly incomplete, the assessments carried out by

local organizations like the Aranmula Heritage Trust and international organizations like ICOMOS reveal that there is extensive loss and destruction to the 'traditional knowledge systems' stretching across the central and southern part of the state. These indigenous systems were acquired by the local communities through the interaction with the nature and natural components. The uniqueness of these systems has helped attain a geographical indication tag (GI tag) for most of them. Apart from being the most recognizable historical markers of the respective regions these gravely affected traditional knowledge systems are major drivers of tourism. They contribute significantly to the tourism industry. The damage of these systems is expected to cause considerable impact on the tourism revenue.

152. With an exhaustive list of 179 cultural properties under the Department of State archaeology and 28 cultural properties under the Archaeological Survey of India, the government of Kerala has been able to capture the most valuable tangible-built heritage within the geographic region. Apart from these the artefacts and data on art, culture, architecture and natural history are preserved in museums of history and heritage under the Archaeological Survey of India (1 no.), Dept. of State Archaeology (12 nos.) and District Tourism Promotion Council (1 no.). There are also a few private museums in the state which showcase artefacts and folklores.

153. A comprehensive understanding and interpretation of the rich cultural heritage of Kerala classifies it better into movable heritage (artefacts like art paintings, furniture, wall paintings/murals, palm leaf scriptures called 'thaliyolas', books, costumes of traditional art forms etc.), immovable heritage (single buildings/clusters) and intangible heritage (all kinds of traditional knowledge systems). The rich history and traditions, distinct architecture, traditional art forms and community-based art/crafts set in a unique landscape make the state one of the most sorted tourist destinations in India.

154. The data collection and damage assessment in sector has been conducted with help of the government departments (ASI and Dept. of Archaeology), Department of Tourism, Kerala Heritage Rescue Initiative (launched by ICOMOS), Paliyam Heritage Trust, INTACH, local experts in heritage, value systems, environment and related subjects, journalists, local affected community/ community representatives, NGOs involved in the rescue activities, and social activists.

Damage analysis

155. Damage to the artefacts in the museums has occurred more in the central part of Kerala where manuscripts and palm leaf scriptures were submerged under water for more than two days. While the Paliyam Dutch palace Museum (in Ernakulam district) records damage of 30 palm leaf scriptures and 330 artefacts (paintings, bronze and wooden utensils, elephant tusks, swords, coins etc.) the Sree Shankara University of Sanskrit records damage of a large collection of books, paintings and traditional costumes of 'Koodiyattam', one of India's oldest living theatrical traditions (Sanskrit theatre) which is also in the representative list of UNESCO's intangible cultural heritage.

Figure 9: Movable Heritage: Retrieving artefacts (palm leaf scriptures called 'Thaliyolas') at Paliyam Dutch palace museum

Source: Kerala heritage rescue initiative (initiated by ICOMOS)

156. A few of the glaring common damages to artefacts include water stains and discoloration due to accumulation of mud and silt. In addition to this there was growth of fungus and mold on the manuscripts. The metal artefacts were soiled, and deposits were there on the surface of porous artefacts. While above is the status of the artefacts that have already been classified and recorded, a sizeable number of artefacts damaged/ washed away by the flood are privately owned and remains unrecorded. The important artefacts in the private collection include paintings, murals, originals of important historic documents etc. Private collection of scriptures written on specially processed palm leaves known as 'Thaliyolas', research papers on historical/political events, literature and such other rare and vital documents were either washed away or damaged by silt. Floods have also damaged traditional knowledge sources. The ancient system of ayurvedic medicine which has its historical roots in Kerala has obtained the status of an alternative system of medicine on a global basis. Rare manuscripts and palm leaf scriptures on Ayurveda and medicinal plants, yet another category coming under the private collection have been damaged by floods.

157. Moderate damages have also been recorded in the historic structures that house the museums while the exhibit display cases (most of which have historic value) also have suffered severe damage. A 90 - 100 percent loss of the electrical installations that supports the system has been recorded in such buildings.

158. Though a rapid assessment of the immovable heritage (listed by the ASI and State Archaeology) qualifies the damages recorded visually to be moderately significant/less significant, the chances of major or minor structural damages in any of these structures cannot be totally ruled

out since the result of the various actions during the flood in combination might impact the structure and make it vulnerable in future.

Figure 10: Immovable Heritage: Aluva palace, guest house under Dept. of Tourism

Figure 11: Immovable Heritage: Pallymanna Temple, (ASI Protected Monument) Trissur District

159. It is important to note that there are unidentified and unrecorded damage struck privately owned traditional houses (individual and clusters) and religious structures spread out in Ernakulam, Malappuram, Pathanamthitta and Alappuzha districts. The total destruction of the 300-year-old Vishnu temple and 3 traditional houses of the Chandrashekharapuram agrahaaram (Tamil Brahmin settlement, Palakkad district) need special mention in this context.

Figure 12: Immovable Heritage: Structures in Chandrashekharapuram Agraharam, Palakkad district

Figure 13: Immovable Heritage: Paliyam Shiva temple, Paliyam, Ernakulam district

Figure 14: Immovable Heritage: Narasimhamoorthy temple (ASI protected monument), Pathanamthitta

160. Structural issues have been officially recorded for two of the listed structures falling under the archaeological and religious categories of the ASI and Dept. of State Archaeology respectively.

161. Damage assessment of the traditional knowledge systems/indigenous systems that contribute to the major part of the intangible cultural heritage of the state shows that there is a total/ partial loss of raw materials and finished goods in the handloom sector, mirror manufacturing sector and the traditional agricultural farming sector.

Figure 15: Intangible Cultural Heritage: Chendamangalam handicrafts (Traditional knowledge system)

Source: 'Save the Loom' initiative, https://www.savetheloom.org

Figure 16: Intangible Cultural Heritage: Pokkali paddy cultivation, traditional farming technique, Ernakulam district (Traditional knowledge system)

Figure 17: Intangible Cultural Heritage: Aranmula mirror manufacturing, Pathanamthitta district (Traditional knowledge system)

Figure 18: Intangible Cultural Heritage: Kole wetlands, traditional community farming technique (traditional knowledge system), Trissur district

Figure 19: Intangible Cultural Heritage: Aranmula Snake boat/palliyodam, Pathanamthitta district (traditional knowledge system)

162. The infrastructure (machines and equipment) which immensely contribute to the effective operation of the intangible heritage sector has been severely affected due to floods. A special mention of the badly affected Chinese fishing nets (Cheena vala), a traditional fishing technique in Ernakulam district needs to be made in this context. Despite being a cultural symbol of Kerala and a very popular tourist attraction, this value system is fast disappearing. Total/ partial loss of finished goods also has been noted in most of the identified knowledge systems. All the above factors have severely affected the value systems and the local community at large. The sectors have almost come to a standstill.

Figure 20: Intangible Cultural Heritage: Chinese fishing nets, traditional fishing technique, Ernakulam district (Traditional knowledge system)

163. Though loss of natural heritage within the state is being recorded by the government in a larger scale as part of 'loss of biodiversity', a large number of sites/circuits under this category remain unrecorded. Some of the badly affected natural heritage sites are Munnar (Idukki district) and Nelliampathy (Palakkad district). It is anticipated that other districts like Wayanad, Malappuram, Palakkad, Kozhikode and Kannur might have huge loss of natural heritage. Rivers which bring life and livelihoods to the people on their banks form a major part of cultural heritage of Kerala. The sacred land-water interface generated by river Pamba in Pathanamthitta district is one of the most flood affected stretches in Kerala. This spiritual heritage circuit includes the famous Sabarimala temple, site for Maramon convention (the largest Christian gathering in Asia) and 'Sathrakkadavu' of Aranmula boat race, all three sites being situated on the banks of river Pamba. The above sacred circuit ends at the most affected area of Alappuzha district- the Kuttanad region- better known as the 'granary of Kerala' which is mainly famous for the traditional farming technique.

Immediate response

164. The Archaeological Survey of India has completed a damage assessment exercise of the 28 listed structures under them. The assessment of the 179 structures under the State Dept. of Archaeology is on-going. The Kerala Heritage Rescue Initiative was launched by International Council on Monuments and Sites (ICOMOS) to assess damage to rich cultural and built heritage sites in Kerala due to floods. The Paliyam Heritage Trust with the support of ICCROM (International Centre for the Study of the Preservation and Restoration of Cultural Property) and ICOMOS are also taking a stock on the extent of damages. INTACH, Kochi chapter has been actively involved in identifying the impacted (unlisted) built heritage and community-based crafts in and around Ernakulam district. Several educational institutions in the state and Indian Institute of Architects (Thiruvananthapuram,

Kochi and Calicut chapters) are mapping the all the affected areas including the heritage sector. Several NGOs are raising funds to support the affected craft communities. A campaign for saving the Chendamangalam handicraft and craftsmen called 'Save the loom' initiated by a group of people who are into the film industry has attracted public attention. An expert team under the Kerala State Biodiversity Board is assessing the biodiversity loss in the state.

Reconstruction, Recovery and Resilience building needs

Need analysis

165. There is an immediate need for comprehensive identification, recording and damage analysis of the damaged/ lost movable, immovable and intangible cultural heritage. The identification of the damaged components within the state shall be irrespective of whether they are listed under the Central government/ State government or not. Identifications needs to be followed by a systematic recording of damage caused due to flood. This shall be an exhaustive district wise study so as to make a complete database of the flood affected cultural components.

Reconstruction and Recovery needs

166. The cost of reconstruction of the tangible heritage and revival of the intangible has been calculated at the estimated value of damages plus 20 % to build back better through the use of high quality building materials. The cost of recovery includes the professional services provided by technical experts to the concerned organization (Govt/non govt) and any other support for the preservation of tangible and intangible cultural heritage.

Table 46: Estimated Recovery Needs

District	Movable Heritage (INR millions)		Immovable Heritage (INR millions)		Intangible Cultural Heritage (Traditional Knowledge Systems) (INR millions)				Needs in Public Sector (INR millions)	Needs in Private Sector (INR millions)
	Artefacts	Infrastructure	Built Infrastructure	Articulation/ Murals	Raw Materials	Finished Goods	Machine/ Equipment	Built Infrastructur		
Alappuzha				10					10	0
Ernakulam	50	43.5	40	20	100	100	70	50	122.3	351.2
Palakkad			70						0	70
Pathanamthitta					10	10	10	20	0	50
Thrissur			30		200				160	70
Wayanad			40						40	0
Total	**50**	**43.5**	**180**	**30**	**310**	**110**	**80**	**70**		
Total in INR Millions					**873.5**				**332.3**	**541.2**
Total in USD Millions					**12.5**				**4.7**	**7.8**

- The recovery cost has been calculated at the estimated value of damages plus 20 % to build back better through the use of high quality building materials (as specified by the architectural/material conservationist) and equipment.

- The damage/loss data heritage has been provided by the affected societies/concerned institutions/heritage trusts/government.

Recovery strategy

167. The damaged artefacts being prime possessions of great historic and archaeological value the most pressing and immediate need is the recovery, repair and preservation of the same. The short-term strategy to conserve them shall be to repair the damaged artefacts using scientific techniques. The long-term strategy of conserving the artefacts shall be to carry out a detailed documentation using recognized standards and to catalogue the artefacts to organize the museum collections in a better manner. A computerized data base shall be created to manage the artefacts. The private collectors also shall carry out a similar exercise of documenting the collection and preparing a data base. Recovery of artefacts is a specialized task for which conservators are required to manage the recovery work. Training programmes shall be required to support the development of additional workers for the artefact recovery. As a mitigation measure, it would be advisable to shift the valuable museum collections to the upper floor if there is a provision for the same.

168. The immediate need in the conservation of the affected immovable heritage/ built heritage (single/cluster) is to inventory the affected structures in all districts, carry out a condition mapping and a structural assessment as per requirement. This would feed data into the preparation of a database required to collate baseline information on each affected site, ranging from its exact location details, including GPS data to photographic documentation, historic information, a brief description of damage suffered and a detailed needs assessment to support restoration planning. The long-term strategy shall be to prepare a register with an exhaustive list of tangible built heritage in each district and create an information database for the tangible cultural heritage of the state of Kerala. This shall be a major step taken to conserve the valuable tangible cultural components within the state.

169. The badly affected intangible value systems that falls into the category of 'traditional knowledge system's need immediate attention. The short-term strategies to revive the value systems shall majorly focus on revitalizing the economy of the community. Damaged equipment and machines need to be repaired and the ones beyond repair need to be replaced by new ones instantly to revive the value system. The damaged/ lost built infrastructure which forms a significant component of the indigenous system need to be rebuilt without which the sector cannot operate. The long-term strategy shall be to identify and prepare a list of intangible heritage of the state. This shall later on become part of the main register which has the list of tangible cultural heritage.

Resilience needs

170. It is imperative that a well-formed strategy need to be adopted to reduce the future risk s to cultural heritage. These strategies shall also help for a better appreciation of the value of the cultural assets and effective conservation of the same within the state.

- Regular monitoring and maintenance measures need to be adopted for cultural heritage assets-both tangible and intangible.

- Samples of post disaster damage assessment forms need to be prepared and kept so that timely and accurate estimation of damage and losses for cultural heritage is recorded in case of a calamity.
- Forming a rapid response team for heritage consisting of architects, engineers, conservators, historians, archaeologists and all those who are concerned about heritage.
- It needs to be assured that there is proper communication between the owners of cultural properties and the rapid response team for heritage at times of disaster.
- It is important to set up a platform for emergency response to the cultural heritage during challenging circumstances

CHAPTER 4. DEBRIS/WASTE MANAGEMENT

Quantity of Debris / Waste Generated

1. Large quantity of waste was generated due to the floods and landslides in Kerala. While a significant part of this waste is debris, notable quantity of biodegradable waste was also generated. It is however, difficult to estimate the actual quantity of waste and its characteristics. Sections below provides a broad estimate of waste generated during floods / landslides, broad strategies and approximate cost estimates for immediate and medium-term management of waste.

Non-biodegradable debris / wastes

2. Spoilt household items - mattresses, pillows, utensils & books, plastic goods, furniture, clothes, books and electronic items – constitute a significant part of the debris / waste generated. These household wastes were mixed with muck / mud / silt. The waste was spread across the streets, inside homes and strewn everywhere in the towns / cities, nearby river banks and canals and beaches. The generated debris / waste was collected within their jurisdiction by the respective corporations, municipalities and gram panchayats (Local Self Governments – LSG) with support from the service providers in the initial phase of relief activities. The debris / waste collected was decentralized and data was not collated at the state level, hence estimation of actual quantities is difficult at this stage. Based on the discussions with local agencies, it is estimated that about 300 tons waste could have been collected in each affected district in the initial phase and about 2700 tons of waste from all nine affected districts.

3. Subsequently, the state agency, Clean Kerala Company Limited (CKCL), was called to support and streamline waste collection. In this phase, CKCL, collected about 6,405 tons of non-biodegradable waste across the state up to September 23, 2018. This is likely to be the major quantity of debris / waste. Both this waste and the waste collected by the LSGs was disposed in the various low-lying areas and some abandoned quarries.

4. Further, about 7923 tons of waste was collected from Ernakulam and Thrissur districts and disposed at Brahmapuram dump yard and at the landfill operated by Kerala Enviro Infrastructure Limited, Kochi. Based on the above, it is assessed that about 17,000 tons of debris generated due to the floods, has already been collected and disposed by various agencies of Government of Kerala (GOK), by September 23, 2018. As summarized in the table below, about 4,586 tons of waste remains to be collected and GOK plans to collect this waste by the first week of October 2018. Overall, about 21,614 tons of non-biodegradable waste was generated in the state due to floods.

Table 47: Debris/ waste generated due to floods& landslides in the most affected districts *(tons)*

District	Collected by LSG *(2)*	Collected by Clean Kerala (Till Sep 23) *(3)*	Disposed at Brahmapuram & KEIL (Till Sep 23) *(4)*	*Waste to be collected (5)*	Total *Estimate (6)*
Alappuzha	300	700	210	182	1,392
Ernakulam	300	2400	4920	1464	9,084
Kottayam	300	50	15	435	800
Kozhikode	300	96	29	375	800
Malappuram	300	5	2	493	800
Palakkad	300	28	8	464	800
Pathanamthitta	300	1650	495	429	2,874
Thrissur	300	849	2055	581	3,785
Wayanad	300	627	189	163	1,279
Total:	**2,700**	**6,405**	**7,923**	**4,586**	**21,614**

Notes / Assumptions:
Column 2: Waste collected in the initial phase by LSGs and estimated at 300 tons per district
Column 3: Actual waste collected by Clean Kerala Company Ltd, up to September 23, 2018
Column 4: Estimated at 30% of what Clean Kerala collected and disposed at KEIL. This assumption is based on the actual debris / waste received at the landfill operated by KEIL Further, waste disposed by Ernakulam and Thrissur districts directly at Brahmapuram dump yard near Ernakulam, have also been added.
Column 5: Estimated at 20% (based on discussions) of waste collected till September 23. A total of 500 tons has been considered for Districts which have not sent, in the earlier phases.

5. The following three aspects have been considered, to arrive at the cost incurred for the collection, transportation and disposal of non-biodegradable waste.

- **Costs incurred by the LSGs**: As a part of the Haritha Mission, each LSG received funds for collecting the waste in their jurisdiction and bringing to a common waste transfer point to enable subsequent collection. This was incurred soon after the floods and landslides. It is estimated that about INR 3.00 million could have been allocated for each affected district and at a total of INR 27.00 million or USD 0.39 million, for this purpose.
- **Costs incurred by the service provider / CKCL**: For collecting and transporting the debris / waste from the transfer point to the segregating/ sorting center or the final disposal location, about INR 4 million per 1,000 tons, was paid by CKCL. Based on this assumption, the total cost for transporting the total debris/ waste generated due to floods is estimated as INR 86.50 million or USD 1.24 million.
- **Costs incurred at the point of disposal (for waste estimated in columns 3, 4 and 5 of table above):** Based on cost information collected from KEIL (INR 2,000 per ton) and assuming only 50% of the non-biodegradable reaches disposal site, it is estimated that about INR 21.61 million or USD 0.31 million, is spent / required for the disposal of non-biodegradable waste generated.

Overall, the total cost of managing non-biodegradable waste is estimated at INR 135.11 million or USD 1.93 million.

6. As noted earlier, the non-biodegradables include items such as plastics and electronic items, which have residual or salvage value. These are separated at the sorting / segregating centers by the

service providers and sent for recovery/ recycling at no additional cost to the GOK. The rest of the biodegradables are taken to the open dump yards or the only engineered landfill of the state. Thus, other than the cost of transportation to the sorting / segregating centers and disposal, no other costs are incurred by GOK for debris / waste management.

Biodegradable wastes

7. Biodegradable waste such as organic matter, trees and other vegetative material generated due to the floods was mixed with the debris/ non-biodegradable waste discussed in section 4.1.1 above. However, wastes comprising carcasses of animals and birds killed also form as an important part of the biodegradable waste generated during the floods. This waste was collected and transported to burial sites of cities, towns and villages in the vicinity with the help of the service providers. The total quantity of this waste however, is difficult to estimate and confirm. While, it is estimated that about 256 tons of biodegradable waste was generated Kozhikode District, no such estimates are available for other districts. Using estimates of Kozhikode district as an indicator, it is estimated that about 2,500-3,000 tons of biodegradable waste is generated in the nine severely affected districts. As highlighted above, this waste has been disposed at the burial grounds of the respective areas / localities and hence no further actions are anticipated for the management of these wastes.

Hazardous wastes

8. Hazardous waste material includes, common household items such as electronic goods, batteries, etc. and waste from industrial units or hospitals. As part of the damage need assessment, no incidents of hazardous waste generation were reported. Discussions with the engineered landfill, KEIL at Kochi also indicated that that no significant quantities of hazardous wastes were found in the debris / waste received for disposal. Similarly, the bio-medical waste continues to be sent to the Palakkad disposal facility as per the current, and no incidents of biomedical wastes generation due to the floods & landslides was reported. Hence, it is assumed that, except mixing of some substances with the debris, no substantial / large quantity of hazardous waste is generated due to the floods.

Relief and Recovery

Needs analysis

9. In the immediate aftermath and as a part of the relief operations, a number of initiatives were taken by GOK to collect, transport and dispose the accumulated debris / waste. The Government had set-up a control room under the Department of Local Self-Government too coordinate the debris / waste management. Further, there were voluntary initiatives of the local community, the business / corporate volunteers (engineers and IT professionals) and the Kerala Police along with the support of professional trade associations.

10. All these efforts are being further strengthened and streamlined in terms of having debris / waste transported and disposed in different phases / drives. The state-based company, CKCL, has been entrusted with the responsibility of collecting and transporting debris/ waste to the segregation centers and point of final disposal. Through the Suchitha Mission and Haritha Keralam, several good practices are also being shared with the corporations, municipalities and gram panchayats.

11. As noted in section above, the state continues to focus speedy removal of removal of the remaining debris/ waste (about 4586 tons) to the segregating/ sorting centers and the final disposal points. This is targeted to be completed by October 1st week. After this, the immediate issue of waste removal from the flood affected areas and transportation would have been addressed. This is can be considered as the immediate relief measure. The next steps hence would be to move to the next phase of recovery in the short term and initiate medium / long term strategies for future disasters. These are described in the following sections.

Recovery Strategies

Short-term Actions

- Review the practices at waste collection centers and disposal / dumping sites and implement measures to avoid / minimize impacts of soil, ground water and surface water pollution and other environmental issues (if any).

  Following the completion of the ongoing debris/ waste collection, transportation and disposal, it is recommended to have an independent state-level team (s) conduct field visits and a review of practices and issues at associated with waste collection and disposal sites to ensure that the transfer and disposal of wastes undertaken has been effectively done. Findings of this review, corrective and preventive actions identified, should be implemented. These could include, improving waste segregation and reuse / recycling practices at collection centers; implementation of containment measures such as leachate collection and top / lateral containment measures at the disposal / dump sites, as needed.

- Identify, collect, transport, segregate, and dispose waste from left over areas (if any) including water bodies, back waters, river mouths, sea beaches, etc.

  While the waste from cities / towns/ villages / habitations has been removed, significant quantity of waste accumulated in sensitive areas such as water bodies, back waters, river mouths, sea beaches, also needs immediate attention. This should be the next focus of GOK to ensure that the impacts on natural resources is minimized /mitigated. In addition, this will help faster revival of tourist inflow, that is seriously affected by the floods.

- Establish guide lines for the collection and disposal of waste from the reconstruction of houses / structures

  Reconstruction/ restoration of affected houses affected due to the floods is expected to be another major source of waste generation in the recovery phase. To address this issue, it is important that specific strategies and guidelines are developed for collection of this waste and its disposal.

Medium Term Strategies

- Develop strategies for the management of Debris / waste during extreme floods / disasters

  Based on the experience of managing waste / debris during floods and localized strategies adopted by various agencies, it is important that strategies for management waste in extreme flood situations prepared in advance. As a start, an experience-sharing workshop involving Haritha Keralam, Suchitwa Mission, Clean Kerala Company Limited and selected key service providers should be conducted to collect the first-hand information of the challenges faced and the enabling measures adopted.

- Develop standard operating procedures for collection, transportation and disposal of waste / debris, hazardous waste, biodegradable waste, recyclables, etc. shall be developed. This shall include, roles and responsibilities of each agency from common public, LSG to state level. This could include a common / general part, and a district-specific part that will provide particular information on the service providers, these guidelines should be developed in English and Malayalam. This should be a part of the overall strengthening of Disaster Management Preparedness and Response procedures.
- Using these guidelines, the capacity building programs should be administered prior to the monsoons each year through the Department of Local Self-Governments and its training institute, Kerala Institute of Local Administration (KILA). This should be a part of the overall strengthening of Disaster Management Preparedness initiatives that the state conducts annually.
- Identify potential locations for temporary storage or transfer stations of waste, possible disposal sites, reuse / recycling centers, e-waste processing facilities, etc. map / geo-reference them, and ensure that this information is available for all stakeholders
- Identify specific technical and capacity building needs, vehicles, implements and infrastructure needs such as mobile shredders, compactors, vehicles to operate in flood waters, etc.

Long Term Strategies

12. With large volumes of waste disposed at the only landfill site in the state, dependence neighboring states for e-waste and other waste disposal, it is imperative that, a long-term waste management strategy be developed for Kerala, that identifies the need for the following facilities.

(i) upgradation of existing and / or development of new regional facilities for solid waste landfills,
(ii) development of regional facility for Paver Blocks / C&D processing,
(iii) plastic recycling units
(iv) e-waste processing facilities, and
(v) additional hazardous waste disposal,

13. With the state's economic growth and development, these in addition helping future flood situations, will also help overall waste management scenario in the state. These should necessarily have to be decentralized and regional facilities to reduce the haulage distances from their respective points of waste generation. All these facilities can be developed with participation from private sector, so that both technical and financial resources are mobilized for the development and operation.

Relief and Recovery Costs

14. A broad estimate of implementing the above relief and recovery costs is summarized below. It is however, important note that these are based on approximate quantities waste presented above and the generic measures suggested in 4.2 above. These shall be revised substantially, based on the accurate information and the chosen mitigation measures to address the issue.

Table 48: Block cost of R&R Measures for Waste Management

R&R Action	*Approximate Cost INR million*	*Approximate Cost USD million*	Remarks
Short-term			
1. Mitigation / Management measures at Dumping Sites	200	2.9	INR 10 million each for 20 sites
2. collection and disposal of accumulated waste from water bodies / River mouths	300	4.3	INR 30 million for 10 sites
3. Guidelines and infrastructure for collection and disposal of debris from reconstruction houses	75	1.1	10000 tons at INR 7500 / ton
Sub-Total Short-term Measures	**575**	**8.3**	
Medium-term Strategies			
1. Development of strategies, SOPs and Capacity Building	50	0.7	Lumpsum
2. Procurement of Vehicles& Implements	100	1.4	INR 10 million / district
Sub-Total Medium-term Strategies	**150**	**2.1**	
Long-term Strategies			
1.Development of Long-term Waste Management strategy	20	0.3	
2. Development of common waste management infrastructure	1000	14.3	
Total Cost of R&R Actions	**1745**	**25**	

CHAPTER 5: SOCIAL IMPACT AND RECOVERY STRATEGY

Impact of Floods on Socially Vulnerable Groups- Sector Wise Analysis

1. Disaster impacts are generally greater on vulnerable sections of the society. Floods have rendered poor and marginal homeless in addition to loss of household assets and livelihoods, straining their already limited resources. This reduces the capacity of vulnerable sections to overcome from impacts of disasters owing to their poor endowments. It can result into mass migration, psycho social impacts, high crime and suicides and sexual abuse of women and children, all of which further push vulnerable people into destitution. It is therefore critical that the differential impacts of floods on vulnerable sections are properly assessed and they are provided with additional short and long-term support to better deal with these difficult situations.

5.1 Livelihoods

Agriculture/ horticulture/livestock

2. The livelihood loss is a major social impact of the floods and landslides by way of loss of land, crops, and farming equipment etc. Most of the affected population includes small and marginal farmers, agrarian or casual labourers. The farm labour predominantly consists of women mainly working in plantation crops like tea, coffee, rubber plantations. Among the tribes, more than 55% work are agricultural labourers and large number of these are women. Large number of women farmers practicing group farming under Kudumbashree program have also been impacted by the floods.

3. The tribes, women, and SCs, constitute the majority affected in the farming sector due to immediate and long-term work losses and related wage losses. The farmers will need to invest in reclaiming of lands lost under landslides and need investments for restoring the top soil, farming equipment, and cash assistance to meet immediate to medium term income losses.

4. As an immediate measure, the farm labour needs work opportunities and cash and material assistance. The farm labour can be given first opportunity in relief and restoration works and can be provided training in masonry, electrical, plumbing works. The small and marginal farmers, should be provided concessions on farm loans, besides providing cash and material assistance for reviving the agriculture. Several of the on-going welfare programs meant for these sections should be ensured their implementation.

SMEs/tourism

5. Tourism plays important role in economic development in the state Kerala. It contributes nearly 10% of the state's GDP. Majority of the towns and cities of the plains and the hills are popular tourist destinations or gateways to other tourism spots. Total tourist arrival to Kerala during the year 2017 is around 15 million USD. The sector witnesses' active participation of the private sector and the local host communities and is a major source of employment. With the impact on tourism, the livelihood of the population dependent on tourism is severely affected. Although data is still being compiled, discussion with the government departments and interactions with local people during field visits revealed that the tourist destinations have seen major cancellations due to the floods and

this year the tourist footfall is expected to fall sharply as compared to the previous years. This is likely to impact large number of poor households whose livelihoods was dependent to tourism.

6. The Micro, Small and Medium Enterprises (MSME) sector has emerged as a vibrant and dynamic sector in Kerala. There are 23.79 lakh SMEs which employs 44.64 lakh employees. During the floods, the SMEs have also been impacted and many small and medium enterprises were washed away. Most of the affected SMEs are largely engaged in the manufacture of food products, coir, wooden furniture, saw mills, cement concrete products, tailoring unit, curry powders etc. Many of these SMEs were run by women entrepreneurs who have faced losses either due to forced closure of their units during floods or damage to their properties. For instance, there is huge loss to MSMEs in Pathanamthitta district which includes loss of building, machinery, raw materials and finished products apart from huge loss of workers man days.

5.2 Housing

7. Tribal, differently abled, SC, female headed households are more likely to face severest impact of loss of houses because of poverty and lack of availability of resources to build houses. About 21,737 houses were destroyed and 104,636 houses were partially damaged due to floods. Many structures have become unsafe for living as major cracks have developed and there could be chances of further damage in the coming rains as many of the buildings are either originally located on the slopes or are now located on the edge of the slopes after the landslides.

8. Among the districts, the tribal population is more affected in five districts, viz. Wayanad (18.55% STs to total population), Idukki (5.04%), Palakkad (1.74%), Kasaragod (3.75%), Kannur (1.64%) (2011 census). While there is no precise data available, it is likely that many affected belong to these sections as they are living in more disaster-prone area. In the severely affected districts, many SC colonies are also impacted where structures were either fully affected and collapsed or partially affected making them unfit for use. The affected households also include many women headed households. There were many informal settlers including on public lands and made a dwelling for living purposes, mainly working as farm labourers or cattle shepherds. The loss as per the social category and vulnerability has not been quantified due to a lack of relevant available data at the time of this report. The affected families have been accommodated in relief camps. They were provided with food and health facilities and cash assistance.

5.3 Rural/Urban Infrastructure, Water and Sanitation

9. With equal distribution of population between rural and urban, Kerala has witnessed substantial impacts and losses due to floods and inundation both in rural and urban areas. The accessibility to health care facilities, educational institution, markets, tourist locations has become a challenge after the floods due to damaged road network. Many water pumping stations have also been damaged in rural and urban areas.

10. Many rural colonies, which are in low lying areas, including those where SC and ST colonies/communities lived were inundated during floods for many days resulting in

contamination of groundwater. In Kerala, majority of the households have pit/septic toilets (on-plot Sanitation), which has become a major source in contamination of groundwater during floods. Many of these colonies do not have water supply and thus access to drinking water and water for domestic use has become a challenge, particularly for women who take care of water needs for the families.

Reconstruction, Recovery and Resilience building needs for Socially Vulnerable Population

11. The following approaches are suggested for recovery and to improve resilience of socially vulnerable population to natural disasters.

Tribes/SCs:

12. A considerable part of the affected population belongs to scheduled tribe and schedule caste which include fishermen, community residing inside the forests, local labourers etc., who are socially and economically vulnerable. Many of these families are either residing in low lying areas or in hilly areas which are more prone to any natural calamity. During the flood, there has been a severe impact on the houses, livelihood and allied infrastructure (like boats, fishing nets etc.) of these families. The residential structures of many of these families have been fully or partially impacted due to the flood. The livelihood has also been severely affected for those who are generating their income through any commercial activity in backwater, coastal and hilly areas. Being economically weak, they already have relatively poor living and sanitary facilities, low skill levels, limited access to credit and markets, and face social exclusion. Their economic and social condition will be further marginalized. Proper planning and socially inclusive government policies will help them to restore their livelihood. In the short term, based on the assessment of the loss of livelihood and houses of the ST and SC households, they need to be provided with financial support to restore their houses wherever possible and some assistance to initiate their livelihood activities. The homeless need to be given proper shelter and food supplies at very low rates till the time houses are built for them.

Recovery and Resilience Needs

- Priority to be given in allocation of houses along with amenities like electricity, water supply, sanitation facilities and access roads
- Participatory planning to be ensured in selection of sites and relocation of the affected SC & ST families
- Relocation sites should be close to their original habitations if they are safe to live
- Participatory planning for the cluster and housing design and ensuring the homogeneity for retaining the social fabric
- Financial assistance to be provided who want to rebuild or repair their houses on their own

Women:

13. The loss of shelter and livelihoods due to flood in the state have disproportionately affected women which includes old, destitute and single women, women responsible for managing their families, daily laborers, and tribal women with restricted livelihood options. Lack of access due to damaged roads and loss of agriculture adversely impacts the livelihood of women. Coupled with it, the loss of domesticated animals, like chicken and milch animals in floods cause loss of income to women as animal husbandry is normally practiced by women.

14. Further, the added responsibility of fetching drinking water and taking preventive measures for the family health during and immediately after the floods adds to the drudgery of the women in such circumstances. Women also find it difficult to locate places for defecation as toilet facilities become unusable due to flooding. The loss of shelter also compromises their privacy and security needs in the affected villages. There could be exacerbation of gender-based violence (GBV) due to loss of houses and livelihood making women more vulnerable to exploitation.

15. In Kerala, several income-generating activities were undertaken by women groups in affected districts under government sponsored schemes like Kudumbashree, Society for Assistance to Fishermen etc. Under these schemes, women (both individual and in groups) were involved in commercial activities like farming, tailoring, food processing unit, coconut product, book binding etc. The agricultural lands and units for these commercial activities were severely impacted during the floods, thus incurring huge losses to women who are already economically and socially vulnerable. Thousands of agricultural workers and those working in NREGA, most of which are women have become jobless due to the floods.

16. As an immediate measure, affected women would need psychosocial support and counselling on a consistent basis to help them cope with the situation and losses. Awareness generation campaign will have to be launched on issues of safety and security of women and GBV to avoid such instances in the camps and other areas where the flood affected have taken shelter. In districts like Wayanad, Palakkad and Idukki which have incidence of trafficking of women from the neighbouring states, anti-trafficking awareness generation campaigns are required as disasters may create situations of enhanced trafficking of women & children. Some organizations like Kudumbashree has started provided awareness against trafficking in certain flood affected areas.

17. Further, measures would need to be taken by the government to help the women in building their shelters, restoring livelihood through alternate means and additional financial support to set up SMEs and MSMEs. Skill training of women in trades which have marketability and those skills which would be needed in the flood rehabilitation work would need to be given to enable these affected women to get jobs.

18. Though, women are the most likely to be more affected by floods, their concerns are least likely to be addressed. Women are mostly not present where disaster related planning is done and therefore their interests are often poorly represented. There is a need for integration of gender, women and child issues into disaster research & planning and designing of DRR programs.

Recovery and Resilience Needs

- Study on 'Impacts, issues and resilience needs of women' to be conducted.
- Financial assistance for women micro entrepreneurs and women farmers
- Providing sanitation facilities and kits including sanitary pads, soaps, etc. in the camps and after return to their homes.
- Ensuring provision of nearby water supply facilities and cleaning of wells on regular basis
- Providing better sanitation facilities by making the toilets with septic tanks to avoid contamination of ground water.

- Community counselling on issues of safety and security of women and GBV in the camps and other areas.
- Restoration of road network particularly in hilly terrains to ensure that the major facilities as needed by the affected population are accessible for livelihood, education and other needs.
- Imparting disaster risk coping skills for women and children in disaster prone areas

Children

19. Heavy rains have damaged the shelter, schools and incurred losses in terms of children's study materials which have disrupted their learning process. Many children have lost their parents due to land- slides and floods. Because of floods, Anganwadi and school buildings have been damaged. Natural disasters also create situations of exploitation of children in poor families, including sexual abuse. Immediate measures including running of schools in alternate buildings, health care checks ups, psycho social counselling, awareness generation on preventing exploitation of children etc. would be required in relief camps as well as in the other flood affected areas.

Recovery and Resilience Needs

- Study on 'Impacts, issues and recovery needs of children who have become orphans.
- Make shift schools need to be provided during the reconstruction period.
- Free distribution of study materials in schools.

Differently Abled and Aged Population:

20. Differently abled lost assistive devices like wheel chair, walker, hearing aid, artificial limb etc. due to floods and landslides. Kerala has large size of aged population and those especially in the poorer sections have been greatly impacted by the floods due to the physical injuries, lack of housing & sanitation facilities, food, health care and dislocation. Many of them have lost livelihood as well. The state government is carrying out a household survey to estimate the number of differently abled and aged population, and transgender population which has been impacted by the floods including the psycho social aspects. Relief measures specific to the needs of the aged and differently abled population are required for the food, shelter, health care and livelihood.

Recovery and Resilience Needs

- Interventions targeting vulnerable older persons- health care, housing & food, relocation and preparedness for any future natural disasters
- Distribution of assistive devices like wheel chair, walker, hearing aid, artificial limb etc.
- Providing shelter homes for aged and differently abled persons who have become homeless.
- In long run, programs for skill building and employment generation for the differently abled will have to be initiated.

Cost Estimates

Sr No	Activity	Tentative budget	
		INR (in Million)	USD (in Million)
1	Study of 'Impacts, Issues and Resilience Needs of Women Impacted by Floods in Kerala'	5	0.07
2	Study of 'Impacts and Recovery Needs of Children who have become Orphans due to Floods in Kerala'	3	0.04
3	Study of Recovery and Employment Generation of the Migrant Workers in Kerala	5	0.07
4	Program for supporting vulnerable older persons impacted by floods- health care, housing & food, relocation and preparedness for future natural disasters including imparting coping skills and awareness generation	105	1.50
	Total	**113**	**1.68**

CHAPTER 6: RECOMMENDATIONS FOR RESILIENT RECOVERY

1. This chapter summarizes JRDNA's recommendations for achieving resilient recovery in each sector using 'Building Back Better' approaches and promote the practices of risk-informed development planning in Kerala's context. These recommendations can inform the recovery framework in Kerala and set the groundwork to improve the resilience of state infrastructure and its communities. The table below summarizes the key needs with details specified in the relevant sectors.

Table 47: Summary of Recommendations for Resilient Recovery

Housing
• Set up Authorities to protect Kuttanad Backwaters, Kole Lands, Highlands and other such ecologically fragile and disaster vulnerable regions with a mandate including building bye laws, land use planning, tourism and other infrastructure. • Undertake Revise Panchayat Building Rules including Panchayat level land use planning • Set up a Construction and Demolition Waste recycling plants as per the national guidelines.
Public Buildings
• Adopt higher standards for infrastructure design to make it resilient to climate change and other hazards • Hazard zoning to inform siting/placement of public building and allied infrastructure • Undertake maintenance and protection measures in a timely manner for existing buildings and formal procedure for safety inspection/audit of buildings, replacement programme for buildings which have topped the service life and are structurally deficient/deterrent to public health. • Develop new protection guidelines / standards for public buildings / critical facilities. • Determine select public buildings as emergency facility and undertake structural and non-structural mitigation measures (example: elevating structural and non-structural elements in police station, emergency shelters, fire station, health centre above the flood level; floodproofing) • Protect and build redundancy measures in public buildings/critical facilities, and ensure the buildings are accessible and operable during and following most hazard events.
Transport
• Site Specific Climate Adaptations based on flood and landslide hazard vulnerability assessment i.e. flood maps, landslide zonation based on geological and geomorphological studies and super-imposed micro climate data. • Adopting "Life cycle cost" approach and "Environmentally Optimized Design" measures to rehabilitation and reconstruction of road pavement i.e. long-life pavement, rigid pavements, semi-rigid pavements, soil stabilization, use of NRMB and other local materials. • Retrofit CD structures with downstream erosion protection (e.g. aprons). • Design new CD structures using latest flood and hydrological data with climate projections. • Packaged landslide protection works: Combination of Gabions, Breast wall, other slope protection using bio-engineering measures (e.g. geo-grids with grass sodding/rip-raps) and improve coverage of road side plantations. • Augment contracting capacity in the state with specific capacity building measures, targeted outreach program to contractors in the neighboring states, setting up an equipment pooling and leasing arrangement.

Urban Infrastructure
• Urban Infrastructure: The long-term reconstruction needs for urban infrastructure include measures to build resilient and sustainable infrastructure supported by: (i) zonation of areas vulnerable to various hazards and climate change effects; and incorporating appropriate measures in town planning standards and processes[45]; (ii) development of technical guidelines and specifications for creation and maintenance of infrastructure; (iii) capacity building of local bodies; (iv) introduction of policies to relocate vulnerable settlements/houses/buildings from risk prone zones to safe zones based on the outcomes of hazard mapping. • Establish a system of solid waste management for all local bodies as per SWM Rules 2016 • Invest in disaster resilient wastewater facilities (including existing septic tanks/ soak pits), sanitation, septage management arrangements. • Water supply: KWA needs to initiate auditing of its assets from climate change perspective to ensure that the designs of all ongoing and proposed works be built with resilient measures based on the lessons learned. Shifting of sources to sustainable locations such as reservoirs and interlinking of strategically important schemes should be considered on a long-term perspective. Expansion of pipe water coverage with service connection, reduction in non-revenue water, automation of systems for better disaster management should also be included in its long-term priorities. A Technical Assistance program may be started for KWA for planning and development of detailed designs incorporating disaster resilient features.
Rural Infrastructure
• Disaster Risk Reduction measures: Extensive capacity building of the engineering cadre of local bodies is required for incorporating improved designs as a disaster risk reduction measures for roads and other rural infrastructure to mitigate the risks of future risks. Some of the high-risk water supply components that were damaged during the floods should be redesigned to address risks from similar disasters and enhance reliability of supply. The works mainly include increasing floor height of pump houses and locating transformers to safe locations. • Reduction of dependency on water from Open-wells: KWA currently utilizes only 46% (1,150 MLD) as against an installed capacity of 2,500 MLD for water supply in the state[46]. KWA should expand its network of new connections in the vulnerable areas, for optimum utilization of the spare capacity, thereby reducing dependency on open wells or tube wells by individual households and other essential services in the rural areas. • Technical Assistance: Water Resources Department should undertake a climate risk analysis of all existing and new water supply schemes, map risks and identify actions for enhancing resilience against recurring floods and droughts in the state (USD 2 million) and implement recommendations for remedial actions building climate resilient infrastructure. • Long term (beyond 5 years): The state should make investments of about INR 16,794 million (USD 240 million) to provide piped water supply to households in the flood affected rural areas to enhance resilience of the population from future disasters.
Livelihoods
Agriculture: • Shift to agroecological approach (23 agroecological units) with climate-smart elements and farm investments tailored to the specific agroecological conditions • Land restoration: Combine land restoration measures with package of nutrients and soil ameliorants to restore soil fertility • Low-lands / Mid-lands: Integrated investments in Kuttanad and Kole wetlands including environment-friendly bunding, channel deepening, integration with animal husbandry and cage culture

[45] Includes revision of building and construction standards of urban and rural infrastructure incorporating climate resilient features, with procedures and processes for auditing compliance

46 Source: Water Sector Study Report, December 2017

- Hill regions: Multi-institutional studies led by geologists, plantation and disaster to map vulnerabilities in hill districts; replantation needs to combine crops with shallow root systems and crops with deep root systems
- Crop insurance: Invest in improving awareness and uptake of crop insurance among farmers to improve resilience

Livestock:

- Promote better animal management techniques for improved productivity: Promote preventive care, improved nutrition including protein bypass supplements and CO3 grass and disease management to double yield and increase incomes.
- Promote indigenous breeds: 94% crossbred varieties in Kerala. Re-introduce disease-resistant indigenous cattle breeds in specific areas; Invest in branding and promotion of A2 milk
- Improve awareness of livestock insurance: Livestock insurance schemes need to be promoted and farmers encouraged to access these schemes for improved resilience.
- Assessments / studies to improve knowledge-base and planning: Disease mapping in a GIS framework, Fodder requirement mapping, and development of block level fodder development; Development of drug delivery protocols etc.

Fisheries:

- Strengthening value chains: Creating/improving necessary facilities in landing centers. Providing drying platforms and cold chain facilities, proper weighing and packaging facilities, transport facilities and marketing linkages to the fishing communities.
- Aquaculture revival: Existing hatcheries, ponds, nurseries, fish farms need to be strengthened and few new units needs to be built. Ornamental fish culture units and fish seed rearing units need to be rehabilitated.
- Promote inland fisheries: More flood-resilient systems/management can be considered in inland fisheries which is currently underutilized.
- Basic resilient infrastructure for fishermen settlements such as drainage systems, internal roads, healthcare centers, drinking water facilities needs to be provided.
- Invasive and alien species like red bellied pacu, Alligator gar, others; shows the need for strict clearance requirements and policies to control and monitor and alien fauna and flora
- Policies and actions to minimize deposition of excess nutrients, fertilizers, pesticides, heavy metals, debris, weeds sediments which degrade aquatic habitats, lower water quality, reduce coastal / wetland production.

MSMEs:

- Supporting and strengthening NHGs: Many Kudumbashree members have lost their livelihoods as well as homes. Providing integrated assistance packages to quickly to meet their immediate needs and aid recovery of economic activities
- Building Financial Resilience: Innovative financial menu options that are specifically tailored to meet business requirements of nano / micro entrepreneurs and ease credit burden need to be developed.
- Risk assessment for disaster preparedness: Risk assessment of nano / micro / small enterprises needs to be carried out and appropriate infrastructure upgradations taken up
- End-to-end value chain support: End-to-end value chain support including capacity building, backward and forward linkages, packaging, branding and other business development services needs to be provided, particularly to nano/ micro / Kudumbashree enterprises

Handloom and Coir:

- Rebuilding essential infrastructure: Reconstruction of damaged work places, replacement / repair of loom and other equipment along with providing raw material at subsidized rates.
- Producer Oriented–Market Facing: Strategic market-led product development program need to be designed to enable in increasing the current wage rate of the weavers.
- Adopting innovative mechanisms: Weaver specific financial products and technological up gradation would need to be explored with innovation in loom design and ancillary industries.

Tourism:

- Facilitate financial recovery of both employees and owners: alternate interim livelihoods, remunerative engagement in recovery; credit facilities, tax relief, expedited processing of insurance claims
- Ensure all reconstruction is risk-informed: site-selection and design of all new construction and restoration efforts based on a detailed risk analysis exercise
- Initiate Disaster Risk Management within Tourism Sector: Accreditation criteria, contingency and business continuity planning by tourist enterprises, enhanced capacities of tourism employees like drivers/boat operators for disaster response
- Brand 'Resilient Kerala': Multi-pronged communication strategy to restore confidence of travelers but also to use this social capital of travelers/artists/NRIs to contribute to Kerala's recovery/ raise awareness about resilience measures

Heath

- The infrastructure in all buildings that are being newly constructed to replace totally damaged buildings will have flood risk reduction measures. Other long-term measures that are planned are NCD survey to understand the disruption in treatment of NCDs among flood affected patients including complications such as end organ failure. Another long-term measure is to strengthen the disease surveillance systems such as Integrated Disease Surveillance Program (IDSP) to include inpatient data from both private and public-sector hospitals to equip the state to deal with any spike in disease patterns efficiently and effectively.

Irrigation and Water Resources

- Additional Flood Protection and Coastal Zone Management: After the flood model is verified and flood maps were generated, the flood model can be used to identify necessary flood protection measures such as additional storages, river training, and embankments. Major types of work that the State identified include river and thodu rejuvenation, storages including ponds and dams, lift stations, regulators, and flood bunds. Coastal zone erosion management is another long-term activity required for long-term considering the severity and extent of the coastal damages caused by the August 2018 floods.
- Irrigation Project to Strengthening Flood Resiliency: The August 2018 flood revealed that canal banks and cross-drainage system would need more strength to resist high flow conditions because any canal breach can slow down dewatering after flooding and increase damages in agriculture and fisheries. Dam and barrages also need technical investigations to identify upgrade needs of gating structures and instruments. There was a case where barrage gates were too old to open during the flood conditions.
- Kuttanadu Flood Control Works: To strengthen flood resiliency in Kuttanadu region, renovation and extension of Alappuzha-Chenganassery Canal and modernization of Thottappally Spillway were identified as long-term priorities. Master planning for the Kuttanadu region needs to be prepared and feasibility of such major activities established before implementing.

Power/Energy

- KSEB Ltd has decided that the re-building activity will not be a business as usual but will follow the principle of building back better. It is recommended to implement technology solutions e.g. (i) Use of distribution poles higher than maximum flood limits firmly grouted on a solid foundation, (ii) Application of SCADA based Flood prediction system, (iii) Climate proofing of Distribution transformers, (iv) use of multi circuit towers, and (v) Dam improvement technologies.
- Long Term Transmission Plan
- Disaster Resilient construction to ensure supply redundancy.
- Strengthening of Power evacuation system with focus of enhancing reliability of power supply blended with loss reductions.
- Extending Smart meter service to remote areas.

- Technology based Dam Management inter alia silting aspects.
- Application of SCADA/Climate based flood prediction system.

Environment and biodiversity

- Improved land use plans and their implementation: A detailed and scientific vulnerability mapping in a spatial platform should be done in the periphery of forests and eco-sensitive areas. Developing land use policy and plans from such a vulnerability analysis and, accordingly, aligning the rebuilding activities so that the human-induced development impacts do not aggravate those related to extreme disaster events in the future.
- Disaster Management Plans and facilities for forest areas aimed mainly at wildlife and tribal communities. This include support mechanism for deranged wildlife during disasters. Also integrate mechanisms to support estates and plantation workers in case of emergencies.
- Each of the 44 rivers flowing within the state have been adversely affected. There are selected river stretches where the natural assets have been impacted significantly whereas there are others that are less so. Studies should be initiated to identify these stretches and to assess the extent of damage.

Cultural Heritage

- It is imperative that a well-formed strategy need to be adopted to reduce the future risk s to cultural heritage. These strategies shall also help for a better appreciation of the value of the cultural assets and effective conservation of the same within the state.
- Regular monitoring and maintenance measures need to be adopted for cultural heritage assets- both tangible and intangible.
- Samples of post disaster damage assessment forms need to be prepared and kept so that timely and accurate estimation of damage and losses for cultural heritage is recorded in case of a calamity.
- Forming a rapid response team for heritage consisting of architects, engineers, conservators, historians, archaeologists and all those who are concerned about heritage.
- It needs to be assured that there is proper communication between the owners of cultural properties and the rapid response team for heritage at times of disaster.
- It is important to set up a platform for emergency response to the cultural heritage during challenging circumstances

CHAPTER 7: THE WAY FORWARD TOWARDS DISASTER RESILIENCE

1. The severe impact and suffering caused by the 2018 floods and landslides in Kerala has reiterated the importance of enhancing disaster preparedness, investing in risk-informed development planning and, above all, building disaster resilient communities and institutions. The GoK's efficient management of the rescue and relief operations and expeditious restoration of basic services and connectivity can be attributed to the state's disaster preparedness and response capabilities. Despite being severely impacted by the floods and landslides, the people of Kerala have shown remarkable resilience in the face of adversity. The affected communities and civil society played a vital role in aiding the rescue and relief operations.

2. The state of Kerala has made significant advances in establishing an institutional set-up for disaster risk management. The Kerala State Disaster Management Authority (KSDMA), established in 2007 under the Disaster Management Act 2005, has fulfilled its mandate over the years in promoting awareness on disaster risks faced by the State and building scientific evidence-base to support risk-informed development planning. For example, after a scientific study, soil piping[47] has been recognized as a state-specific disaster and certain private losses due to soil piping are considered eligible for compensation under the state law. For disaster response, Kerala SDRF and the Civil Defence Institute at Thrissur which has been established with the assistance of GoI. In terms for financing, the guidelines are in place for Flexi-funds, that enables 10% of the CSS schemes budget to undertake disaster mitigation/restoration activities.

3. The KSDMA has developed the Kerala State Disaster Management Plan (KSDMP) in 2016 that duly illustrates the natural and manmade disaster risks that state is prone to and identifies critical facilities and population at varying degree of vulnerability. KSDMA classifies around 2.8 million people in 5,619 sq.km to be exposed to landslide risk and a 7.8 million people, almost a quarter of the state's population, as exposed to floods in 6,790 sq.km. Haphazard reclamation and settlement in floodplain areas has further increased the flood vulnerability in Kerala. The impact of the floods and landslides this monsoon has corroborated these estimates and has also served as a strong reminder to the state, government and people, to take concrete measures to reduce the vulnerability of assets, lives and livelihoods to these risks.

4. This chapter outlines several recommendations for strengthening disaster resilience of Kerala based on the findings of the JRDNA under each sector and detailed interactions with GoK and other stakeholders. The recommendations largely correspond to the priority actions or risks already identified in the KSDMP, but the scale of the floods and growing disaster exposure calls for urgent programming and implementation of these priority actions.

[47] The "Soil piping", also known as "tunnel erosion" is the subsurface erosion of soil by percolating waters to produce pipe-like conduits below ground especially in non-lithified earth materials. In Kerala except Thiruvananthapuram, Kollam and Alappuzha all other districts reported the occurrence of soil piping affected soils.

Risk Identification and Technical Studies

- Detailed vulnerability assessment of important infrastructure and assets to site-specific hazards.
- Promote use of hazard risk information in land-use planning and zoning regulations, Conduct disaster risk impact assessments as part of the planning process before the construction of critical infrastructure.
- Conduct morphology studies in major rivers and improve dam reservoir management and updating of rules as necessary.

Risk Governance

- Amendment of building by-laws and land-use regulations and standards for basic services in view of the recent flooding extent and landslide/land subsidence events.
- Update the floodplain zoning with stronger techno-legal regime
- A land use policy shall be evolved out of the vulnerability analysis incorporating socio-economic parameters. The rebuilding activities shall be only based on the land use policy thus involved.
- Improving compliance of all new critical infrastructure projects to safer standards and specifications
- Relocate the habitations in most vulnerable locations to safe locations
- Formulation of Emergency Action Plan and O&M Manuals for Dams to facilitate improved dam management
- Formulation of Emergency action plan to minimize damage to basic services such as public water supply.

Mitigation Infrastructure and Measures

- Construction of multi-purpose emergency shelters and improved access to such shelters that are handed over to the communities with corpus fund for operation and maintenance.
- Agriculture: Contingency crop planning to deal with climate variations, ensure sustainable livelihoods in areas of recurrent climate risks by promoting supplementary income generation, Education: Incorporate DRR modules into the school curriculum, construct all new schools located in hazard-prone areas to higher standards of hazard resilience.
- Health: Conduct vulnerability assessment of hospitals in hazard-prone areas, promote hazard resilient construction of new hospitals, implement disaster preparedness plans for hospitals.
- Flood mitigation options may be considered comprising major works such as large diversion channels. These needs to be evaluated in terms of their hydraulic efficacy in delivering the required degree of flood mitigation.
- Structural flood mitigation measures such as provision of additional spillway capacity at Dams.

Landslides Management Strategy

- An integrated approach involving land use planning, good land management practices in cropping, grazing and forestry, careful road construction, terracing and other contour-aligned practices in fields and plantations, and participation of local communities.

- Deploy ground-penetrating radars for monitoring landslide and land slip susceptibility
- Improved landslide monitoring, zoning and cadastral-level (1:4000) risk maps to inform site-specific mitigation and relocation plans
- Monitoring of the land movement, water table and surface runoff etc. are required before any engineering solutions on landslide risk management. Lowering the water table, reducing surface runoff is required apart from soil nailing, retaining walls etc.
- Soil and land use, reforestation should be targeted at high risk areas that can result in a large reduction in landslide incidence and sediment yield. Lowering the water table, reducing surface runoff using plants that can absorb water and using plants to bind the soils with its root systems are the main functions of the potential plants and other interventions that are required for landslide mitigation.

Urban resilience

5. The widespread flooding in urban and semi-urban areas of Kerala has reaffirmed the importance of risk-informed urban planning, flood zone regulation and compliance, and resilient urban infrastructure. In India, urban flood risks have historically increased due to unplanned development and anthropogenic changes in river hydrology and morphology. Cities expanded to both banks of the river, constricting the floodplains, where construction of embankments further constrained the natural flow and resulted in siltation of river beds. Inadequate storm water drainage and filling of traditional water storage reservoirs have increased the pluvial flood risks. With rapid urbanization, people and enterprises including their assets are increasingly concentrated in cities and highly dependent on critical infrastructure systems, industries, and supply chains for their well-being and economic activities. Natural and manmade disruptions to these highly dependent and interconnected systems can have a catastrophic impact on a city's ability to meet the most basic needs of its citizens and to sustain its economy. In terms of building urban resilience in Kerala, the following specific interventions may be considered by the state government:

- Revising the urban planning norms to make the hazard mapping and zoning mandatory as a part of the city master plans and further to improve the systems at the local government level for ensuring compliance with the planning norms and guidelines.
- Developing building codes, standards and design guidelines for climate resilient municipal infrastructure, and ensuring proper enforcement for all the physical construction works to improve the quality of infrastructure being developed for municipal services.
- Specific and targeted support to cities in coastal zone and river basin areas for proactive disaster management, emergency response and recovery operations.

Financial Resilience

- Promote effective disaster risk insurance and credit schemes to compensate for agricultural related damage and losses to livelihoods due to natural hazards.
- Innovative value capture financing techniques like TDR, land pooling etc. need to be resorted. The Town & Country Planning Act, 2016 provides for such methods, however subordinate legislations detailing out these provisions are needed urgently.

Addressing the Climate Vulnerability

6. The Kerala State Climate Action Plan (2014), highlights the state's dependence on natural resources as a primary driver of its economy. Further, the plan acknowledges climate vulnerabilities to the following sectors: Agriculture, Animal Husbandry, Fisheries and Coastal Resources, Forest and Biodiversity, Water Resources, Health, Energy, Urban Front and Transportation, and Tourism. It also states that of the 14 districts, the districts of Alappuzha, Palaghat and hilly districts of Wayanad and Idukki are climate change hotspots (coincidentally these districts have been most impacted due to the monsoons and landslides of 2018). Hence, underscoring the need for urgent attention and action. In this regard, the current calamity provides an opportunity for relooking at some of the legacy policies that have driven development in the state. Therefore, there may be a need to look at cross-cutting policies that will address these challenges. Some example of such initiatives could be

- Eco-retrofitting of all existing major public infrastructure/facilities such as Airport, sewage farms, industries etc. (Short to Medium term) This also includes planning siting decisions for major sensitive support infrastructure (for e.g.: large scale solar panels deployment at ground level; considering the possible environmental externalities and safety issues during events like floods).
- Declaration of eco-disaster hotspots where all development would follow long term plan prepared based on carrying capacity / ecological aspects and disaster proneness.
- Reviewing and revising both the district and urban master plans (wherever approved or in the process) in the light of the climate change and disaster vulnerability.
- In the coastal areas, the CRZ regulations are relevant both along the coast and along the rivers to the extent that there are tidal influences extend. There are 17 out of 44 rivers wherein the CRZ regulations are applicable. Reviewing and revising (as necessary) the CRZ maps that were prepared in 2011 as a part of the CZMP. Integrating its requirements with the district and urban master plans as a part of the revision process.