IMPACT OF FLOOD/ LANDSLIDES ON BIODIVERSITY

COMMUNITY PERSPECTIVES

KERALA STATE BIODIVERSITY BOARD

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AUGUST 2018

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August 2018

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FOREWORD

Kerala is the only state in India where Biodiversity Management Committees (BMC) has been constituted in all Panchayats, Municipalities and Corporation way back in 2012. The BMCs of Kerala has also been declared as Environmental watch groups by the Government of Kerala vide GO No 04/13/Envt dated 13.05.2013. In Kerala after the devastating natural disasters of August 2018 Post Disaster Needs Assessment (PDNA) has been conducted officially by international organizations. The present report of Rapid Impact Assessment of flood/ landslides on Biodiversity focus on community perspectives of the affect on Biodiversity and Ecosystems. It is for the first time in India that such an assessment of impact of natural disasters on Biodiversity was conducted at LSG level and it is a collaborative effort of BMC and Kerala State Biodiversity Board (KSBB). More importantly each of the 187 BMCs who were involved had also outlined the major causes for such an impact as perceived by them and suggested strategies for biodiversity conservation at local level. Being a study conducted by local community all efforts has been made to incorporate practical approaches for prioritizing areas for biodiversity conservation which can be implemented at local level.

I would like to express my sincere gratitude to Hon'ble Chief Minister of Kerala for entrusting this very important task to KSBB. The whole hearted co-operation of Hon'ble Minister for Local Self Government and other functionaries of LSGD deserve special commendation. The report is the collective efforts of a large number of people and I would like to extend my gratitude to KILA for equipping the BMCs to undertake such a task, BMC members, various departments for providing required data, core committee members and district level expert committee for their valuable suggestions and Department of Environment. Last but not the least I would like to express my thanks to all my dear colleagues who prepared the state report and the district level staff of KSBB without whose hard work this would not have been possible.

Let us unite together "To ensure clean air, water and safe food" to the people of Kerala.

Dr. S.C. Joshi IFS (Retd)

Chairman

PREFACE

Between June 1 and August 18, 2018 Kerala State experienced flood and landslides which had severe impacts in all walks of life of the people and damaged livelihood assets throughout the state. The torrential rains triggered a number of landslides that devastated innumerable infrastructure facilities and washed away a vast variety of Biodiversity. The extensive havoc resulted by both flood and landslides necessitated a Post flood Impact Assessment in the state. As per the direction of the Chief Minister of Kerala, a rapid participatory assessment of the impact on Biodiversity in 187 Panchayats in 13 districts in the state was conducted. A multidisciplinary team of experts comprising 100 personals were selected for this noble cause. Apart from this, a 12 member core committee was also formed to monitor this rapid assessment. It is well eloquent to say that this is a first initiative in the country for doing such an assessment with the active involvement of State-District-BMC mechanisms through intensive trainings and survey. Various PRA tools were used to generate the data on livelihood alteration, biodiversity loss, landscape devastation, and the wash away of floral and faunal components for preparing this report. The impact on the local Biocultural diversity was also covered by this rapid assessment. Unlike other reports, this survey reflects the perceptions of the local people. The report reveals how the flood and landslides affected various landscapes, Agrobiodiversity, Species diversity and biocultural diversity of the state.

I am exceedingly grateful to all who have dedicated their valuable time and energy in assessing the impacts of flood especially the members in the core committee and Biodiversity Management Committee. I bestow my special thanks to the experts involved in this study and the elected representatives, officials from various departments, KSBB staff members and above all to the local community who shared their visions and experiences towards "Rebuilding Kerala-Post Floods". The report comprises a number of suggestions to rebuild the state from the havoc occurred due to flood and other natural calamities like cyclones etc. and to achieve the indexes towards the UN Sustainable Development Goals (SDGs).

This report will be officially submitted to the Honorable Chief Minister of Kerala during the inaugural ceremony of the State Biodiversity Congress to be held at Govt. Brennen College, Thalassery on27th January 2019 to assume the necessary actions towards the Sustainable Development of all the sectors.

Dr. V. Balakrishnan
Member Secretary

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The report of Rapid Impact Assessment of flood/ landslides on Biodiversity is a collaborative effort of Biodiversity Management Committee (BMC) and Kerala State Biodiversity Board (KSBB) with the technical inputs from a wide range of research institutes and other stakeholders. The objective of the process was to undertake a rapid assessment of the damages to ecosystem and biodiversity after the floods/ landslides and to lay the foundation for a recovery and ecosystem based reconstruction process at local level. It is for the first time in India that such an assessment of impact of natural disasters on Biodiversity was conducted at LSG level incorporating community perspectives of the affect on Biodiversity and Ecosystems. The report also outlines long term and short term strategies for environment and biodiversity inclusive sustainable development and provides recommendations for a green growth for Nava Keralam.

A joint team of 4 BMC members, 2 experts and 5 volunteers with representation from KSBB was constituted to conduct a rapid impact assessment of floods/ landslides on Biodiversity in 187 Local Self Government (LSGs) spread across 13 districts. The team visited the affected areas and data was collected in a prescribed format using Open Data Kit software. Focal group discussions were held with farmers, fishermen, tribal people, students etc. The team also conducted field visits to understand the extent and nature of damage and to record the findings in the designated format. The team also held consultations with representatives of line departments for more information and data was also compiled from other secondary sources.

SALIENT OBSERVATIONS

All the three distinct physiographic zones of Kerala the highlands, midlands and low lands (coastal plains) were affected. The worst affected districts were Wayanad (Kabini basin), Idukki (Periyar basin), Ernakulam and Thrissur (Periyar and Chalakudy basins), Alappuzha and Pathanamthitta (Pamba basin). The impacts to the natural environment differed based on the geographical location. In the hilly terrain, the major impacts are caused due to landslides. Landslides are reported in highlands in Idukki, Wayanad and Palakkad districts. The entire Kuttanad region lying in Alappuzha, and Pathanamthitta Districts (low land regions) were submerged in the flood water for 8 to 15 feet. In hilly areas the major impacts were due to combined effects of landslides and floods. The impact of landslides combined with floods may be more long lasting as any change in habitat and landscape will take more time for the species to recover. Apart from the heavy rainfall the topography, land use change and habitat degradation might also have played a major role on the intensity of floods, as it is observed that some districts which received more than 50 % of excess rain was not very severely impacted.

Landscapes	:	**771** different landscapes including riverine, forest, plantations and agricultural fields
Agricultural crops (varieties)	:	**287**
Floral diversity	:	**1053**
Faunal diversity	:	**695**

33 % of affected area are in high land region, 49% midland and 13 % low land. Landslides and floods were reported in 47% of study area while flood alone was reported in 44% of area. The impact was most severe in 27% of total study area while it was severe in 58% of area. Soil erosion was the major impact in 86 % of area. Industrial pollution is very minor at 29.9 % and is restricted to certain pockets of industrialized areas as Elloor

The most affected areas are Idukki (Periyar basin), Ernakulam and Thrissur (Periyar and Chalakudy basins), Alapuzha and Pathanamthitta (Pamba basin)., Wayanad (Kabini basin)

In Wayanad it is observed that the banks of Panamaram River & Mananthavadi River have collapsed mainly because of loss of considerable amount of natural vegetation along the river banks due to encroachments and other unsustainable land management practices in comparison to Kabini river. In Kabini river, however, natural vegetation along the river banks are not much affected whereas the other side the river bank without vegetation has eroded.

In Wayanad the local people say that the major reason for the disaster is the land use change, many marshy places and wetlands have been filled up. Small canals were constructed to drain the water from the marshy areas so that it can be made suitable for banana cultivation. This has led to drying up of marshy areas.

The major impact on the riverine ecosystem was on the places where concrete bunds have been constructed across the rivers.

A new water body has been formed at Thalappuzha under Begur Range in Thavinjal grama panchayat due to landslide. At the same time drying up of forest is also seen in such areas.

In Periyar sand bars were formed along the banks where the force of flowing water is comparatively low. Periyar and its tributaries got widened after the flood due to river bank erosion whereas its depth got reduced in low lands due to sedimentation. In some areas as Mankulam river, Idukki the depth of the river has increased.

In the Bharathapuzha river, a sandbar was created at the Ponnani estuary that has provided a semi-permanent walkway into the sea during low tide.

In Kunthipuzha river at Thathengalam near Mannarkkad at Palakkad a large sand island has been formed after flood.

Forest ecosystem has been severely affected due to landslides in Pozhuthana, Thirunelli, Mananthavadi and Thavinjal in Wayanad. Huge loss to biodiversity occurred in these region. Shola forest, evergreen forests and grass lands are also affected.

In Idukki 18 panchayats were badly affected all of them located in the ecologically sensitive areas of the Western Ghats.

Thattekad bird sanctuary, Ernakulam an important bird sanctuary of Kerala, home to 322 species of birds including long distance migratory birds, located close to the Periyar River was affected as plastic and solid wastes accumulated in the water bodies inside the sanctuary. A sandbed has appeared on a 5-km stretch from Thattekad to Kuttikal on the Periyar riverside. The sand bed has affected the movement of animals in the sanctuary. As the shrubs on the river bank were washed off in the flood, the roosting habitats of the birds may be affected.

Table 1 **Major Impact of floods/ landslides on ecosystem**

River bank erosion and collapse
Deposition of sand and sand bar formation in low lands
Change of river course
Pollution due to plastic/electronic wastes etc.
Lowering of surface water table in the neighbouring areas after the floods
Reduced depth of river bed
Landslides
Land subsidence
Collapse of hill slopes
Fissures/ Crack in Earth
Sand piping
Mud slides
Soil erosion
Changes in the colour and quality of water
Loss of riparian vegetation
Reduction in level of water in rivers immediately after floods
Deposition of alluvial, muddy, clayey soil
Increase in catch of exotic fish species such as African mushi, Sucker fish, Carps etc
Less inflow of water to river due to clogging of water channels
Inflow of estuarine water into the paddy fields
Change in pH of water

Table 2 **Major Ecosystems affected**

Periyar river
Pamba river
Chalakudy river
Kabini river
Manimala river
Achenkovil
Bharathapuzha river
Kole wetlands
Kuttanad wetlands
Hilly areas as Kurichiar Mala, Makkimala etc in Wayanad
Ranni forest division
Thattekad bird sanctuary

2. IMPACT OF FLOOD/LANDSLIDES ON SPECIES DIVERSITY

The impacts could be direct or indirect depending on habit and habitats. Most of the impacts are due to changes in the habitats, inundation for a longer period and displacement of animals during the flood. Changes have occurred in distribution patterns, all of which will have long term impact on ecological processes.

Aquatic Birds: At Thattekad Bird Sanctuary, about 30 species of water birds have been adversely affected due to habitat changes caused by flood.

Lepidoptera (Butterflies and Moths) and Odonates (Dragonflies and Damsel flies) : The early stages of butterflies, moths and odonates were subject to the detrimental effects of the floods. Moth and butterfly larval forms, normally seen in August–September period in the landscapes, were relatively lower in abundance after the rains and floods. The larval forms of odonates are aquatic and might have been washed away along with flood waters.

Amphibians and Reptiles: Tadpoles of frogs were washed away in several areas including Nelliyampathy, where they later died due to the drying up of these pools. Breeding sites of the endangered purple frog at Kootickal were completely destroyed due to landslides. Reptiles especially snakes, were displaced from their natural habitat, and found in abundance along with flood waters.

Fishes: The percentage of native species of fishes is reduced in fishermen catch. Presence of Red bellied pacu, Malaysian catfish, African mushi, Sucker catfish, Giant gourami, Carps etc. were reported from several waterbodies.

Invasive species of plants: Spread of Invasive plants such as Lantana, Mikania, and Mimosa.

Key observations

The Panamaram heronry, a small islet on the Kabini river, is covered with vegetation, predominantly with bamboo. Many avian species including the threatened white ibis, purple heron, large egret, intermediate egret, small egret, pond heron, night heron, and little cormorants breed here. During the floods the trees where the birds used to nest have been destroyed and presently the rocky bottom of the river is visible. Concrete bunds were built nearby and river has changed its course.

Sightings and killings of snakes were widely observed as floods have displaced them from their natural habitat.

Kottickal, Kottayam an Ecologically sensitive area of Western ghats was severely affected by landslide and affected the habitat of rare purple frog species.

A decline in sightings of butterflies, dragonflies, damselflies was reported widely. The floods may affect the dragonflies and damselflies as their larval stage is having aquatic habitat. They play an important ecological role as predators of mosquito larvae and other insects. It is observed that skimmers have reduced in numbers in Pathanamthitta.

A decline in clams in Vemband Lake, Pathanamthitta and Alapuzha was noted. The black clam is a keystone species in Vembanad Lake, and a source of livelihood for thousands ensuring the sustainability of ecosystem. Mass death of earthworms was reported in Wayanad

3. IMPACT OF FLOOD/LANDSLIDES ON AGROBIODIVERSITY

All three subsectors (crops, livestock, and aquaculture/fisheries) have suffered losses and damages in the flooding and landslides of 2018. Idukki, Pathanamthitta, Alappuzha and Wayanad are the most affected districts due to flooding of Pamba, Periyar, Achenkovil and Manimala and Kabini rivers. The rapid increase in the built up area has played a significant role in aggravating the impact of floods in Pampa river basin.

The major crops affected included Tubers, Spices, Banana and Rice. Hilly tracts such as Idukki and Wayanad saw large tracts of agricultural land and plantation crops wiped out due to floods and landslide. In Idukki, spice plantations were adversely affected and native varieties of Pepper, Cardamom, Tuber etc were destroyed. 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.

In many places paddy fields have been damaged due to deposition of silt, sand and muddy soil. The local people are of the opinion that recovery is not possible as the large part of the top soil has been washed off or due to landslides turned these areas unfit for cultivation. The depletion of oxygen in the soil may decrease soil microbial communities following flooding. Silt deposited by flood may add to the problem. Even the crops such as Pokkali fields which survived showed disease attacks in Ernakulam.

The districts affected by floods with inland fishing systems were Alappuzha, Ernakulum, Kottayam and Thrissur districts whereas Malappuram and Kollam districts were more affected in marine fisheries sector. There have also been significant changes in the type of fish being caught in major rivers after the floods.

***Table 3* Major Impact of flood/ landslide on Agricultural ecosystem and Agrobiodiversity**

Partial loss of local landraces of Pepper, Rice, Cassava, Tapioca, Banana etc
Top soil erosion
Impact on native breeds as Kuttanadan ducks
Deposition of sand, silt, stones, clayey soil, muddy soil etc in Agricultural fields
Loss of soil fertility
Increased acidification of soil
Deposition of solid, liquid and industrial waste in agricultural fields
Spread of invasive weeds as Barnyard grass in Wayanad
Spread of invasive species as African snail
Mass mortality of soil organisms as earthworms

Spread of exotic aquatic weeds such as Water hyacinth (Eichornia) Giant salvinia (*Salvinia molesta*) in Kuttanad region
Growth of Parthenium (*Parthenium hysterophorus*), Anathottavadi (*Mimosa diplotricha*, Venpacha (*Sphagneticola trilobata*) in fields
Profuse growth of small herbaceous weedy plant Thelkada (*Heliotropium indicum*) in kole wetlands of Alappuzha all along the paddy field posing serious problem in agriculture.
Increased incidence of diseases in Karimeen at Munroethuruthu and Vembanad-Kuttanad
Escape of exotic and ornamental fish from aquaculture farms
Washing away of exotic aquarium plants from farms
Damage to traditional agricultural/fishing implements
The panicles of rice plants, especially in pokkali rice fields became chaffy resulting in considerable reduction in yield
Early flowering of crops, decrease in fruit production of crops
Rotting of roots of tuberous crops
Increased diseases in crops such as bacterial leaf blight in paddy leading to yellowing and drying of leaves
Incidence of fungal disease in Pepper
Defoliation, Bark rotting, decrease in latex production in Rubber plantations
Increased attack by Army worms in Paddy fields in Ernakulam
Moths and Leaf cutting bees, stem borers, leaf folders and leaf webbers has shown an increasing trend after floods.

Table 4 **Major Agro ecosystems affected**

Kuttanad - Globally Important Agricultural Heritage Site
Local Agro ecosystems - 1. Chengalikodan Banana, 2. Central Travancore Jaggery, 3. Palghat Matta 4. Wayanad Scented Rice (Gandhakasal, Jeerakasala) are grown
Veemabanad Kole wetlands- A Ramsar site
Vembanad Clam fishery
Traditional Agroecosystems of Pokkali and Kole lands

Major Causes of disaster- Community perspective

- Land use change in wetlands
- Encroachments and Construction in flood plains
- Removal of river bank vegetation
- Construction activities in hill slopes
- Unscientific agricultural practices as Cultivation of Agricultural crops such as tubers on slopes leading to loosening of soil and soil erosion.
- Unscientific construction of rain water pits and ponds.
- Generally people observe that river banks having thickets of bamboo and vegetation withstood the flood.
- Unregulated levelling of hills
- Unsustainable utilization of forest produce
- Degradation of Traditional water harvesting structures
- Quarrying

Major Recommendations

- Impacted areas to be categorized and afforestation with suitable native species for slope stabilization
- Land use change should not be encouraged and that any construction activities near the river bank should be done only after conducting social and environmental audit at local level.
- For any activities near the forest a green growth policy should be adopted.
- For maintaining the pristine nature of wetlands a panchayat level water conservation policy should be adopted.
- In Gramasabha meetings biodiversity and environment conservation should be discussed and action plan developed.
- Rejuventation of small streams and tributaries- eg rejuvenation of the natural flow of Varattar prevented flooding of the adjoining areas otherwise the damage would have been much more severe.
- Agricultural schemes including those for compensation for natural disasters is being implemented based on the area under cultivation of a particular crops. The diversity in the field or the conservation value of the varieties lost are not considered.
- Special package for custodian farmers and those maintaining Agriculture diversity in fields should be considered.

Table 5 **Floral biodiversity impacted by floods/landslides.**

No	Vegetation Type	No. of Species/ Varieties
1	Water plants	29
2	Grass	57
3	Herbs	277
4	Shrubs	174
5	Climber	129
6	Trees	260
7	Agricultural crops	287
8	Traditional varieties	393
9	Locally conserved varieties	22
10	Riparian Vegetation	98

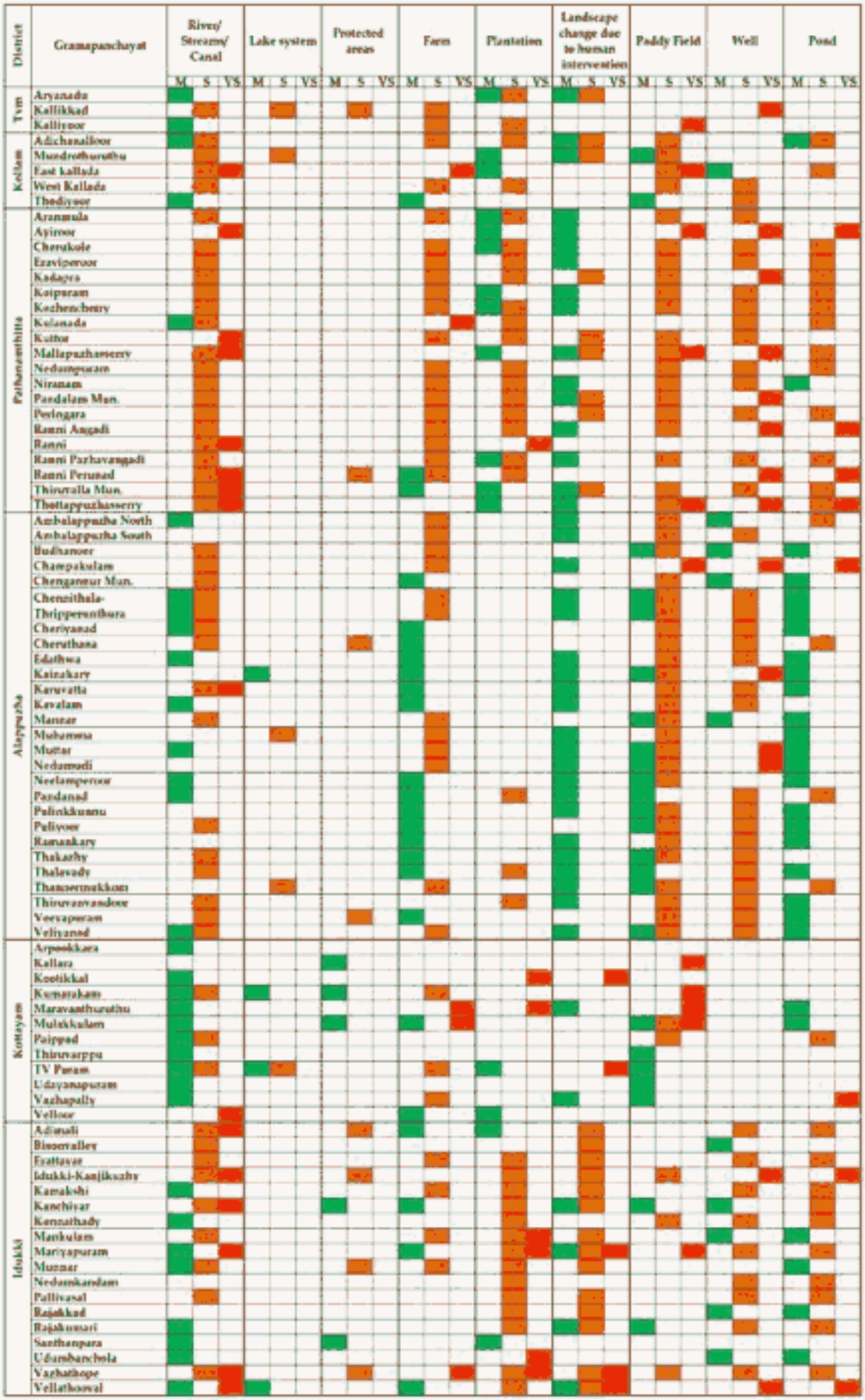
Table 6 **Faunal biodiversity of Kerala impacted by floods/landslides.**

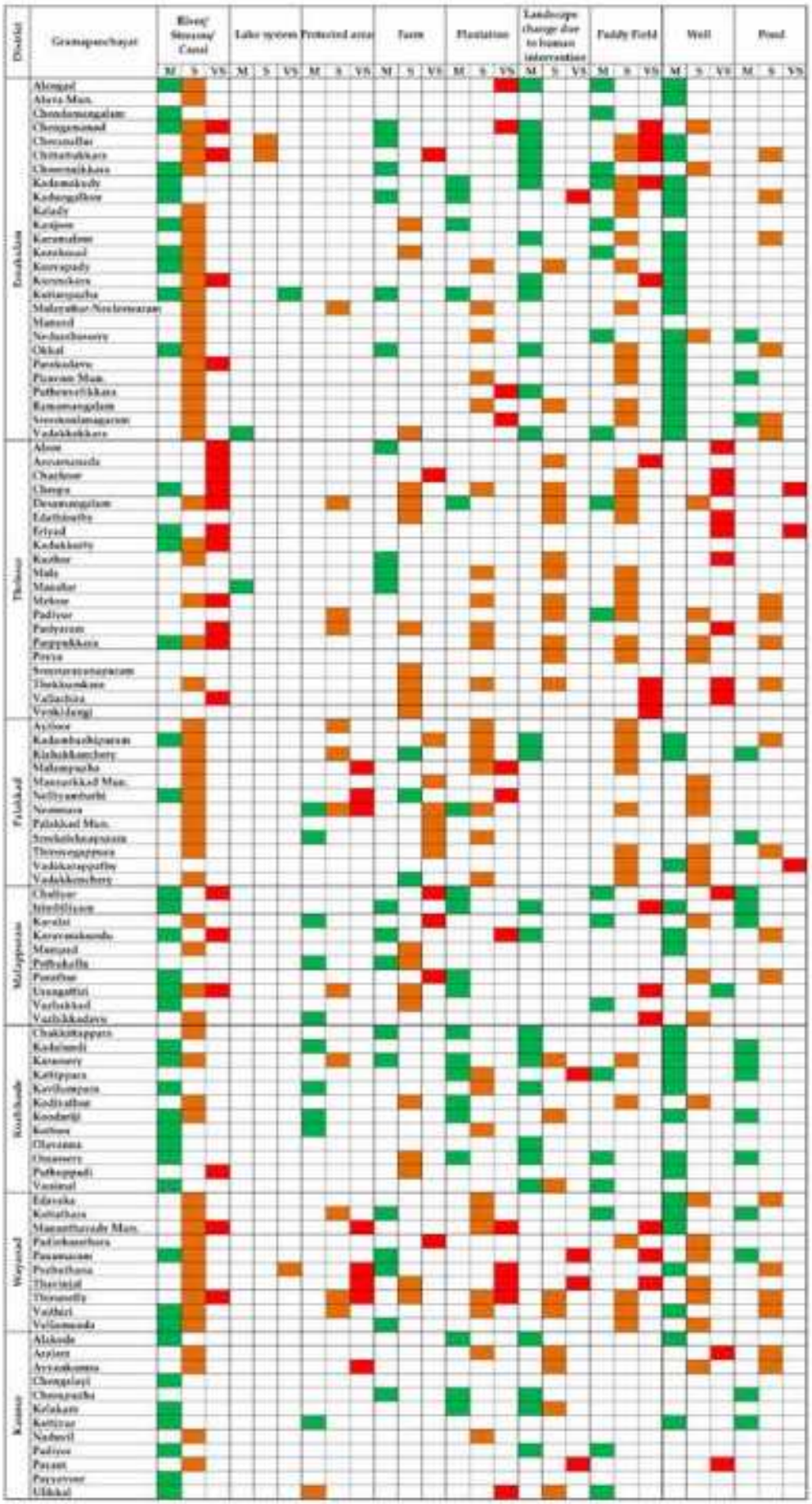
No	Fauna Type	No. of Species/ Breeds
1	Belowground Biodiversity	46
2	Amphibians	46
3	Insect	234
4	Fish	120
5	Birds	103
6	Mammals	40
7	Molluscs	25
8	Reptiles	49
9	Livestocks	34
10	Domestic Birds	20

Table 7 **Agrobiodiversity of Kerala impacted by floods/landslides**

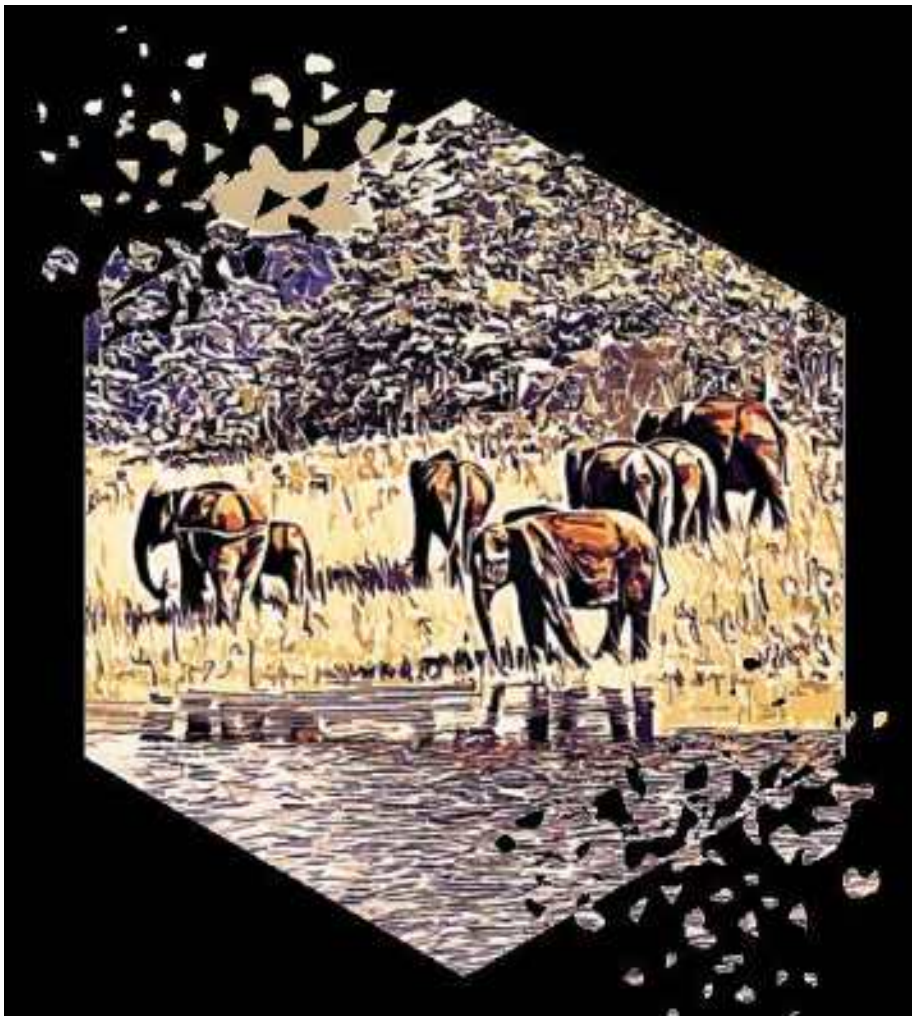
No	Agrodiversity	No of varieties
1	Ladies finger	5
2	Amaranthus	6
3	Elephant foot yam	7
4	Cashew	7
5	Arecanut	8
6	Chilly	8
7	Coconut	13
8	Colocasia	16
9	Dioscorea	16
11	Tapioca	45
12	Bitter gourd	7
13	Banana	43
14	Nutmeg	5
15	Paddy	49
16	Pepper	36
17	Brinjal	8
18	Beans	20

Table 8 Impact of natural disasters on major landscapes





M- Moderate; S- Severe; VS- Very Severe



CHAPTER 1
STATE PROFILE - BIODIVERSITY

A long coastline, stretching 580 km in length, an intricate system of backwaters along the coast, the tropical moist evergreen forests of the Western Ghats, highly undulating terrain and the tropical monsoon climate make the State a unique geographical and environmental entity. Physiographically the State comprises of highland which is between 75 – 700 m above msl (48%), midland with foothills and plains which is between 7- 75 m above msl (42%), lowlands and coastal belt which is between 0 – 7m above msl (10%).

Kerala with 1.88 % of India's landmass harbors 25.69 % of flowering plant species and 26.59% of Pteridophytes recorded in India. Herbs constitute 50.1%, shrubs 15.8 % and trees 15.08% of the total flowering plant species of the state (1). Vertebrate diversity of Kerala is represented by 1,847 species with Fishes (freshwater and marine) the most diverse group of vertebrates (905 species), followed by birds (500 species), reptiles (173 species), amphibians (151 species) and mammals (118 species)(2).

Western Ghats is recognized as one of the eight hottest hotpsots of biodiversity and 19 of the 39 serial sites inscribed on the UNESCO World Heritage List are located in Kerala. The 11309.48 km2 of forest areas, the sacred groves, the mangroves along the coast, the riparian vegetation along the river banks, Myristica swamps, lakes and ponds provide diverse ecosystems harboring a very rich diversity of plants and animals. About 28.90% of the total land area of the state is covered by forest area and are categorized as Tropical Wet Evergreen Forest, Tropical Moist Deciduous Forests, Tropical Dry Deciduous Forests, Mountain Sub Tropical Forests and Plantations. About 8.26 % of total geographical area is under PA network. The diverse physical features of Kerala have resulted in 23 agroclimatic zones.Kerala has about 1.6 lakh Ha of wetlands with coastal wetlands of 40876 Ha, out of which Vembanad-kol, Ashtamudi and Sasthamcotta wetlands have been declared as Ramsar Sites for wise use of wetlands (3).

The Kuttanad below sea level farming has been recognized as a Globally important agricultural heritage system (GIAHS). The short-neck clam (*Paphia malabarica*) fishery in the Ashtamudi Lake in Kerala has received India's first Marine Stewardship Council (MSC) certification. The certification to Ashtamudi short-neck clam fishery — only the third fishery in Asia to have received this recognition will help boost sustainable fisheries and also protect the ecosystem.

In India, Kerala has undergone highest level of urbanization in its history during 2001-2011 with an increase of 83.82% in its urban population.The density of population in Kerala has gone up to 860 persons per sq. km from a figure of 819 in 2001.Kerala has the third highest population density of all Indian States, which poses strong pressures on land use and water resources and on its fragile eco-system.

1.1 FLOOD AND LANDSLIDES OF 2018

Kerala received 2346.6mm of rainfall from 1stJune 2018 to19th August 2018 in contrast to an expected 1649.5 mm of rainfall (IMDdata) - an excess of 42 per cent. Between August 8 and August 15, each of the 14 districts of the state recorded much more than normal rainfall. The worst hit were the districts of Idukki (679 mm), Wayanad (536.8 mm), Mallapuram (447.7mm), Kozhikode (375.4 mm) and Palakkad (350 mm) each of which received rains that were much more than normal. The worst affected districts noticed were Wayanad (Kabini basin), Idukki (Periyar basin), Ernakulam and Thrissur (Periyar and Chalakudy basins), Alapuzha and Pathanamthitta (Pamba basin).

Fig 1, 2 and 3 shows the Annual average rainfall in Kerala, during 2018 and during 1924. The figures clearly shows the difference in rainfall in two major affected districts Wayanad and Idukki. During 2018 Idukki recorded a rainfall an excess of 92 % rainfall when compared to normal season, where as in Wayanad it was only 24 % excess. Palakkad also observed an increase of 75 %. Still Wayand was one of the worst affected in terms of landslide, and flood. In all the panchayats studied the general obersvation of the local people was that the impact was due to change in landuse especially the construction activites in wetlands and the gradual change in nature of the marshy lands of Wayanad.

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Fig.1. Annual Average Rainfall

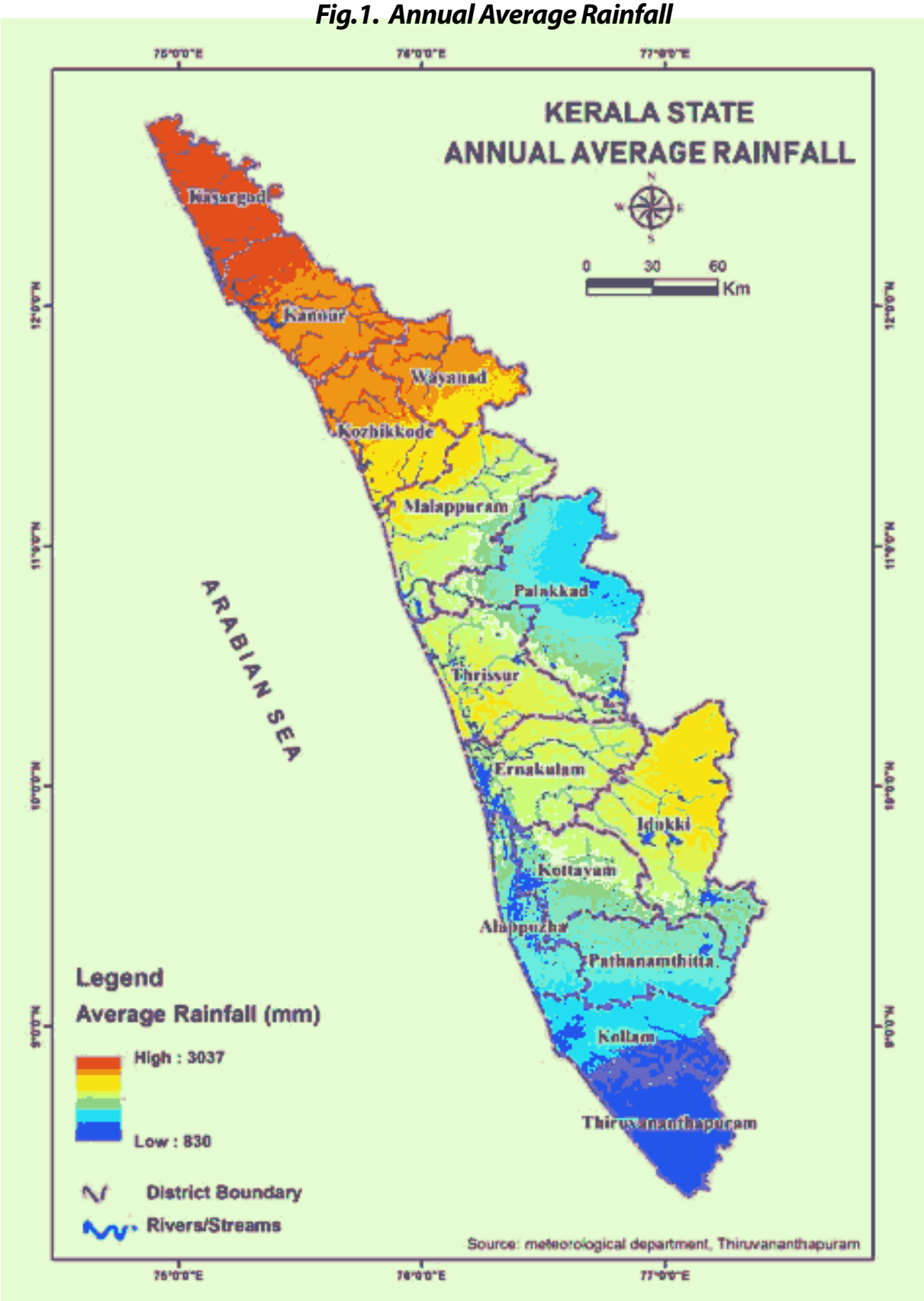


Fig.2. Average Rainfall -1924

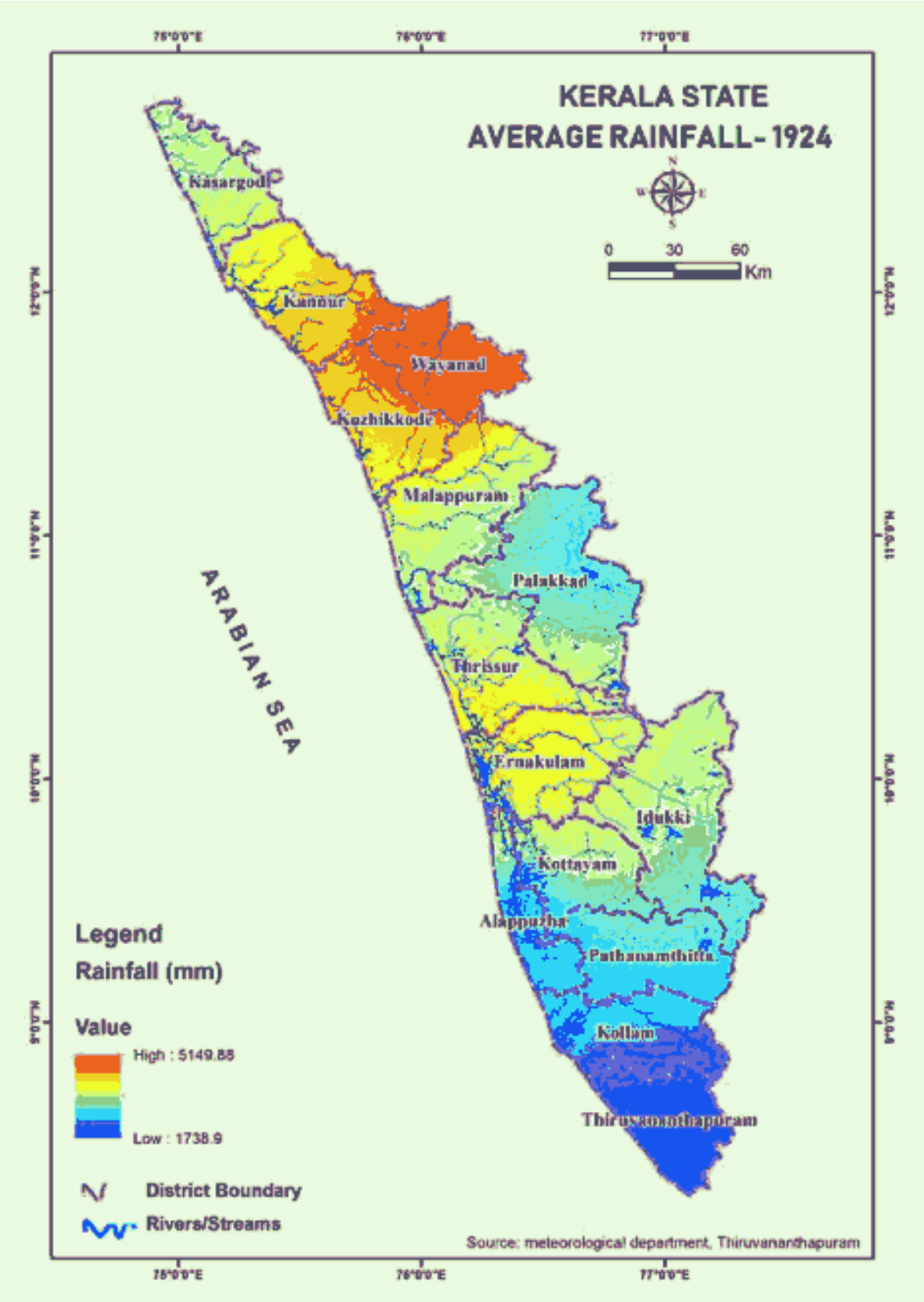
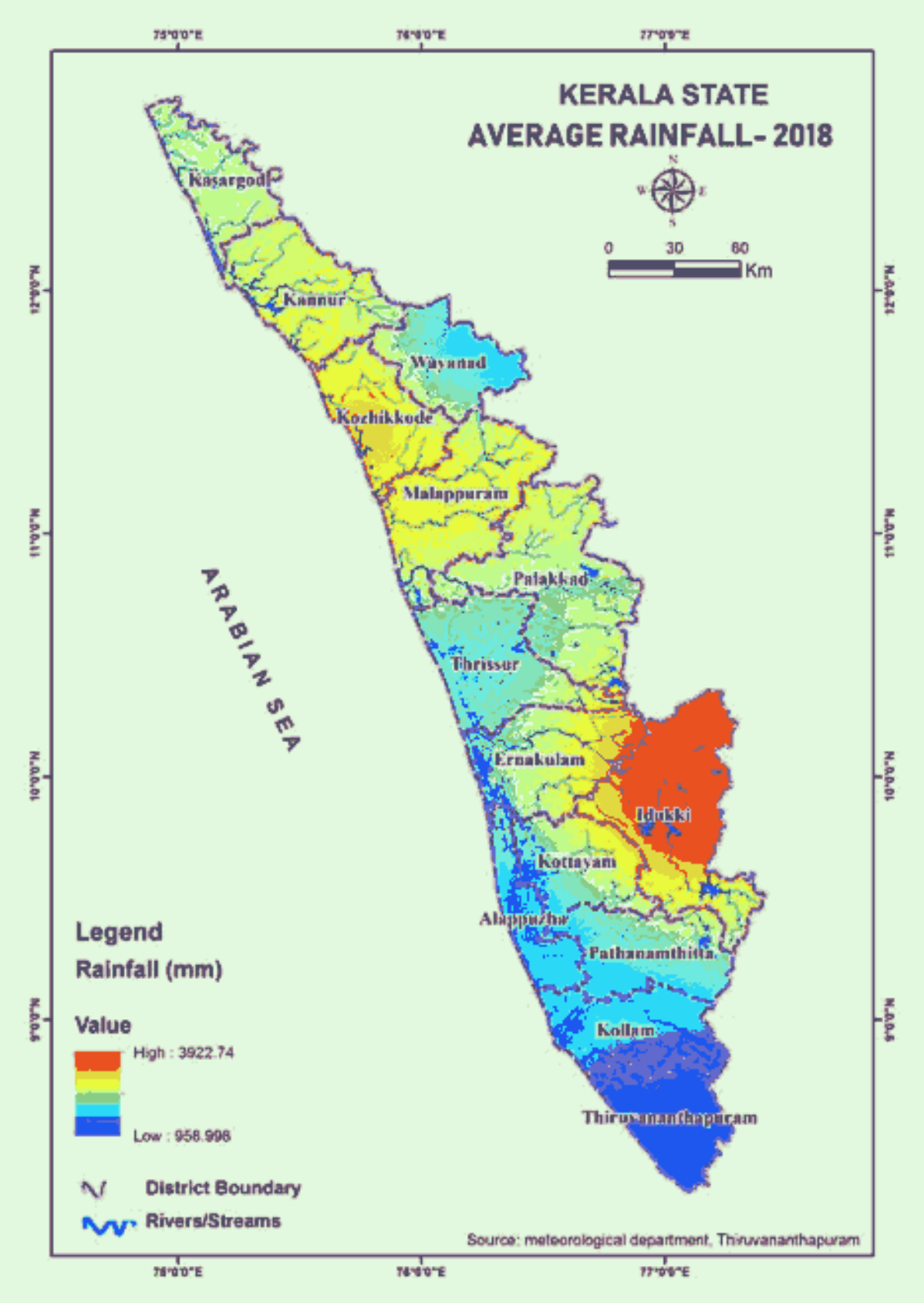


Fig. 3. Average Rainfall -2018



CHAPTER 2

METHODOLOGY OF ASSESSMENT

The report of Rapid Impact Assessment of flood/ landslides on Biodiversity is a collaborative effort of Biodiversity Management Committee and Kerala State Biodiversity Board with the technical inputs from a range of research institutes and other stakeholders. It is for the first time in India that such an assessment of impact of natural disasters on Biodiversity was conducted at LSG level incorporating community perspectives of the affect on Biodiversity and Ecosystems.

The objective of the process was to undertake a rapid assessment of the damages to ecosystem and biodiversity after the floods/ landslide and to lay the foundation for a recovery and ecosystem based reconstruction process at local level.The report also outlines long term and short term strategies for environment and biodiversity inclusive sustainable development and provides recommendations for a green growth for Nava Keralam.

2.1 ASSESSMENT PROCESS

The Biological Diversity Act is being implemented through a three tier decentralized system with National Biodiversity Authority (NBA) at National level, State Biodiversity Boards (SBBs) at provisional level and the Biodiversity Management Committees (BMCs) at local level i.e. in all the Grama Panchayats, Municipalities and Corporations. BMCs are statutory bodies at local bodies comprising of eight members constituted in accordance with the Section 41 of the Act 2002 and Section 22 of the Rules, 2004. BMCs are constituted for the purpose of promoting conservation, sustainable use and documentation of biological diversity including preservation of habitats, conservation of landraces, folk varieties and cultivars, domesticated stocks and breeds of animals and microorganisms and documentation of knowledge relating to biological diversity. In Kerala, the BMC consists of a Chairperson, Secretary and six members nominated by the local body.

A joint team of 4 BMC members, 2 experts in the field of life science and 5 volunteers along with representatives from KSBB was constituted to conduct the assessment in 187 most affected LSGs spread across all the districts of Kerala except Kasargode. A district level expert committee was constituted with representatives from Research institutes, Colleges, Universities, and Line departments. A Core committee to evaluate the results was constituted at State level.

2.2 ASSESSMENT METHODOLOGY

A state level expert meeting with representatives from all the Research Institutes, Line Departments and NGOs was conducted on 04.09.2018 to finalize the methodology to be adopted. A methodology manual for the entire process was developed in association with Kerala Institute of Local Administration. Training for the survey team was provided jointly by KILA and KSBB at Alapuzha wherein the methodology manual was introduced to the team and hands on training for conducting field survey and focal group discussions were provided.

A district level meeting to create awareness of the importance of the study and the responsibilities of the Local Self Governments was conducted under the chairmanship of the District Panchayat President with representation from Panchayats, District Planning Officer, Panchayat Deputy Director, Co-ordinators of Janakiyasoothranam, Harithakeralam mission, Suchitwa mission and other key stakeholders in all the 13 districts (Table 9). The assessment process started with a meeting chaired by BMC chairperson and attended by all the BMC members,farmers, fishermen and other stakeholders where the process of the assessment was explained. The officers from Agricultural department, Fisheries, Forest and Animal Husbandry, were invited to the meeting and requested to share data on the loss due to natural calamities in their respective sectors. (Table 10)

The team visited the affected areas and data was collected in a prescribed format using Open Data Kit software. Focal group discussions were held with farmers, fishermen, tribal people, students etc.

The team also conducted field visits to understand the extent and nature of damage and to record the findings in the designated format. The team also held consultations with representatives of line departments for more information and data was also compiled from other secondary sources collected over a 10-day period with field visits to the affected panchayats.The field visits were held to gather first-hand information on the extent of damage and to develop recovery strategies based on local needs.

Table 9 **District wise assessment time frame**

District	Dates				
	District level Meeting (12-17 October)	BMC meeting (up to 18 October)	Focal Group Discussion I (19 October)	Focal Group Discussion II (20 October)	Focal Group Discussion III (21 October)
Thiruvananthapuram	22-10-2018	12-16 October 2018	13-15 October 2018	14-18 October 2018	15-20 October 2018
Kollam	11-10-2018	12-15 October 2018	12-15 October 2018	15-18 October 2018	
Pathanamthitta	11-10-2018	12-16 October 2018	13-18 October 2018	15-19 October 2018	17-22 October 2018
Alappuzha	10-10-2018	15-17 October 2018	17-22 October 2018		21-24 October 2018
Kottayam	16-10-2018	20-29 October 2018	21-29 October 2018		
Idukki	11-10-2018	12-24 October 2018	15-25 October 2018	16-25 October 2018	17-25 October 2018
Ernakulam	12-10-2018	15-20 October 2018	16-22 October 2018	17-23 October 2018	20-24 October 2018
Thrissur	12-10-2018	13-20 October 2018	13-20 October 2018	14-21 October 2018	15-22 October 2018
Palakkad	16-10-2018	20-25 October 2018	20-25 October 2018	21-26 October 2018	
Malappuram	15-10-2018	17-23 October 2018	17-23 October 2018	20-25 October 2018	
Kozhikode	17-10-2018	15-25 October 2018	15-25 October 2018	20-27 October 2018	
Wayanad	13-10-2018	15-17 October 2018	15-17 October 2018	17-22 October 2018	
Kannur	10-10-2018	15-17 October 2018	16-19 October 2018	17-20 October 2018	18-21 October 2018

The panchayat wise data collected was compiled incorporating necessary information in consultation with technical experts. Core committee meetings were held on 25.10.2018, 06.12.2018 and 17.01.2019. This report primarily relies on the data collected from local people and their perspectives of the natural calamities, which was later collated on ecosystem/ biodiversity basis at the state level.

Table 10 **Assessment time frame**

October 5- 11	Preparation of training materials and training to study team
October 11	District Panchayat meeting
October 18	BMC meetings
October 18 - November 10	Focus group discussion and sector wise meeting with representatives of line departments and field visits
November 10 - 30	Identification of gaps in the report and collecting more information
December 1- 26	Compilation of panchayat wise reports to prepare district report at KSBB headquarters
December 26- January 20, 2019	Expert group meetings and state report preparation
January 26, 2019	Submission of state report to Government of Kerala

2.3 STUDY AREA AND ASSESSMENT SCOPE

The rapid assessment of the Impact of floods/ landslides on Ecosystem and Biodiversity due to the high rainfall during 2018 was conducted in all districts of Kerala excluding Kasargode (Fig. 7). The study area includes 182 gramapanchayats and 5 municipalities.The sectors covered in the assessment includes

1. Ecosystem diversity as Aquatic ecosystem, Forest, Sacred groves, Farms/ Plantations and Agroecosystem

2. Species diversity including flora and fauna, Agro biodiversity
3. Environment
4. Cultural heritage and Traditional knowledge if any.

The data collected using ODK software suggests that as per the respondents out of the 187 LSGs covered, physiographically 33 % of LSGs affected by flood/ landslide are in high land region, 49% midland and 13 % low land.

Fig. 4 **Terrain of Study area**
Landslides and floods were reported in 47% of study area while flood alone was reported in 44% of area

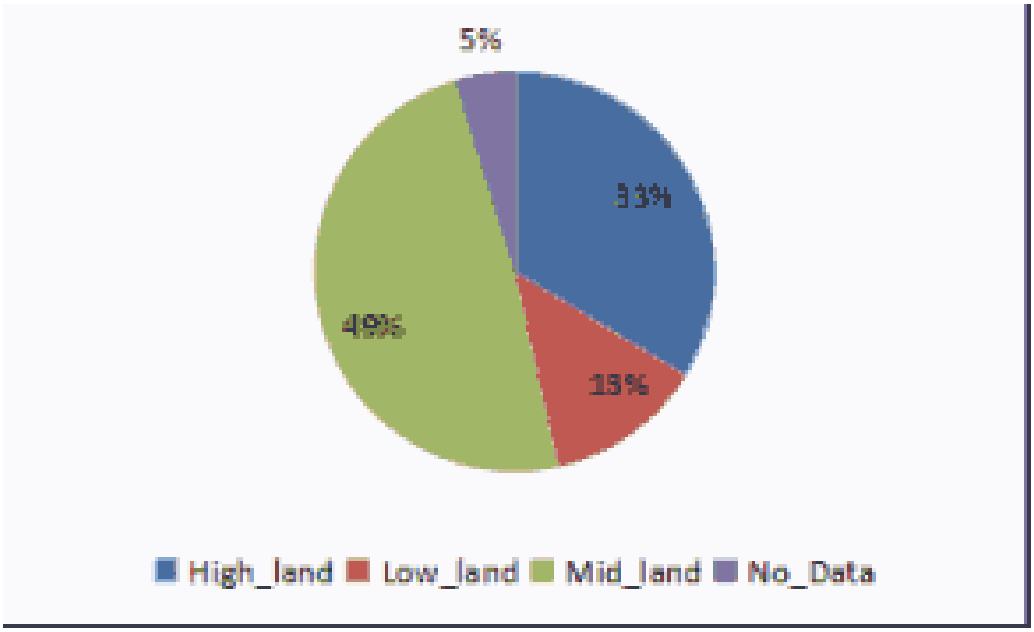


Fig. 5 **Nature of Disaster**

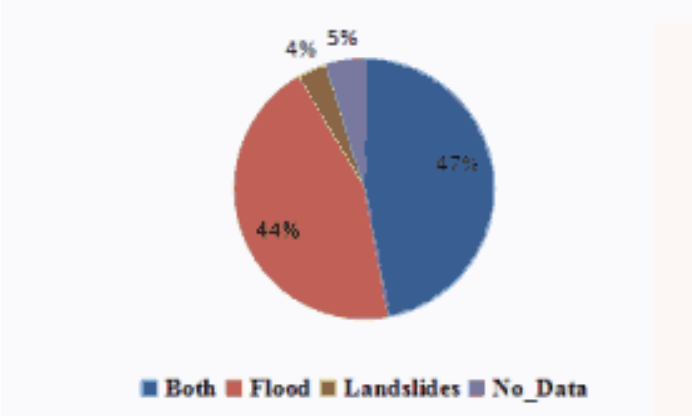


Fig.6 **Intensity of Flood**

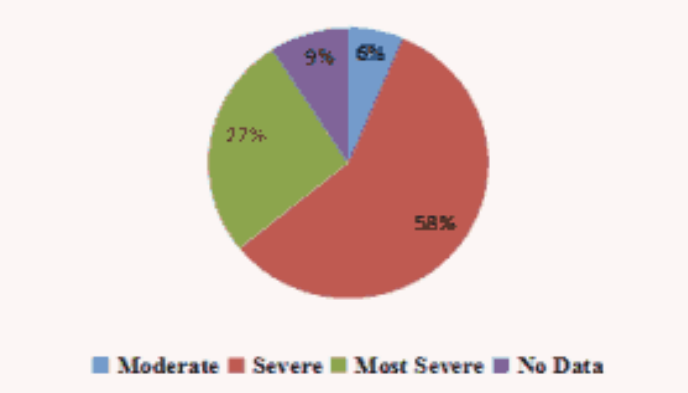
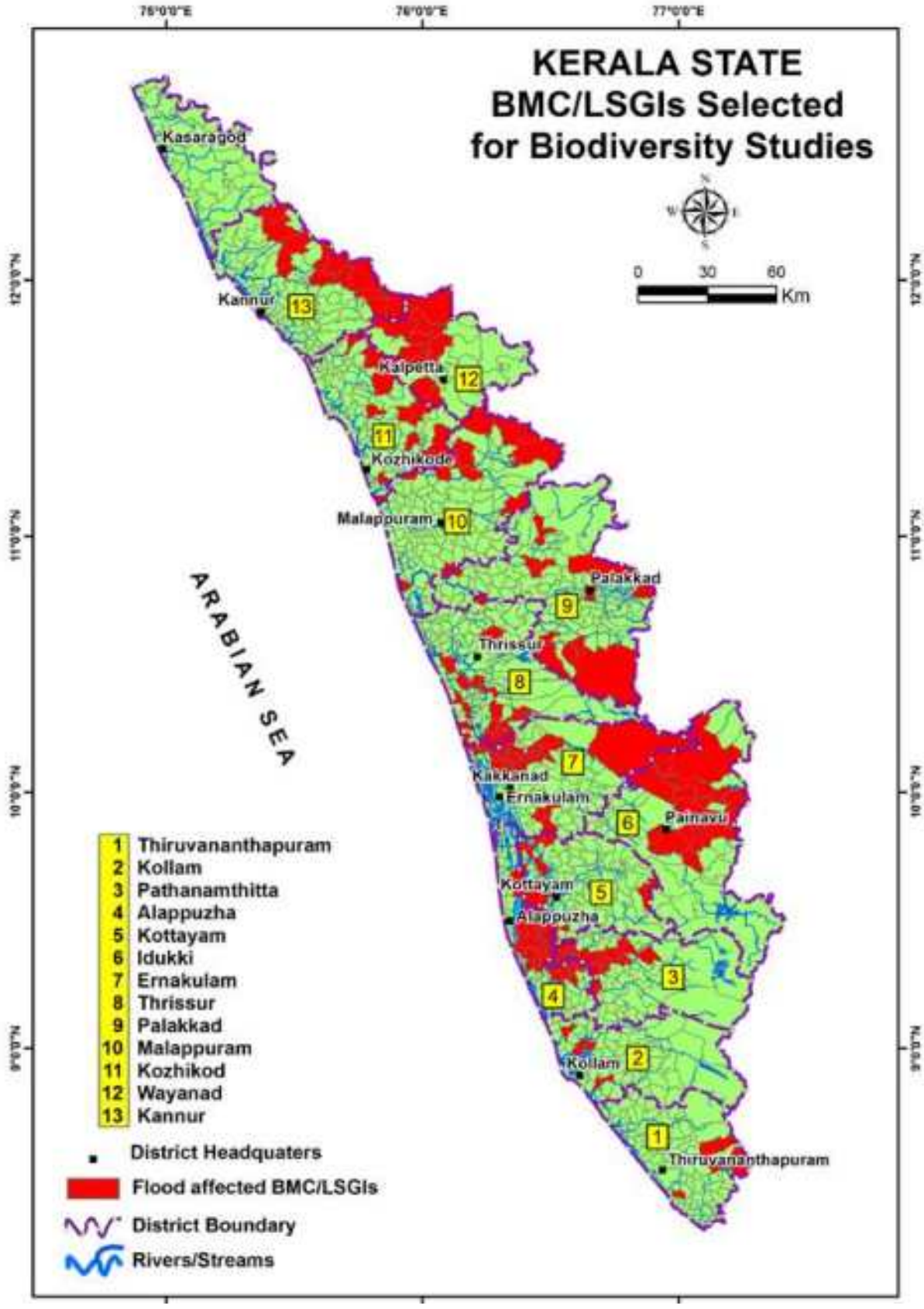


Fig.7. BMCs selected for Biodiversity Study



Agriculture, Microhabitats and Manmade structure were most severely affected. In riverine ecosystem sand deposition, silt deposition and soil erosion are the major impacts. In the case of pollution majority of the respondents identified solid waste as the major issue in 84 % of study areawhile industrial pollution is very minor at 29.9 % and is restricted to certain pockets of industrialized areas.

Fig.8 **Damage to Microhabitat, Manmade Structures, Agriculture.**

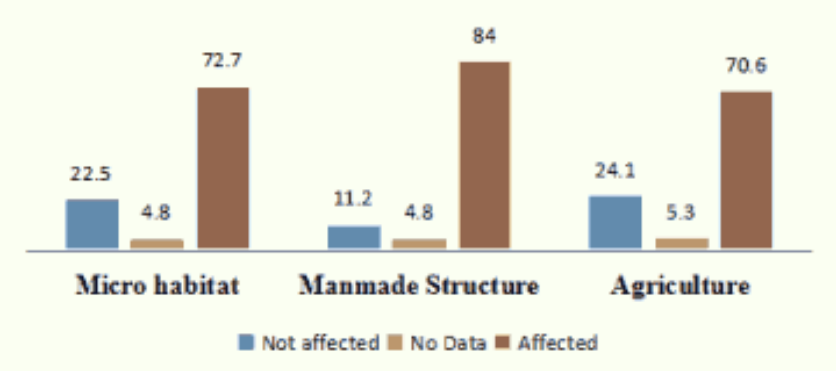


Fig.9. **Sand Deposition, Silt Deposition and Soil Erosion**

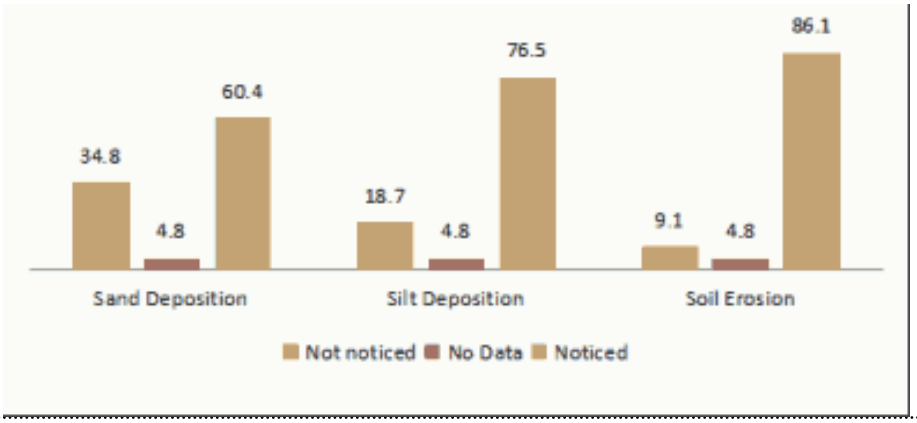
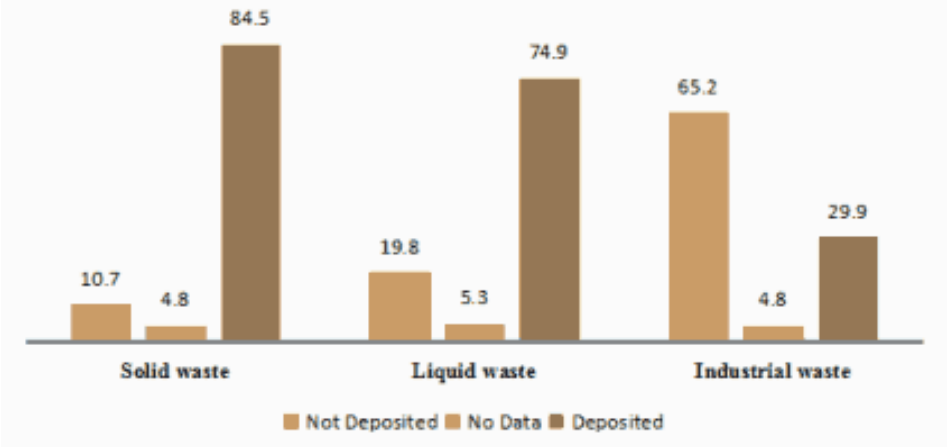


Fig.10. **Waste Deposition**



2.4 LIMITATIONS OF THE ASSESSMENT

The report is prepared based on discussions with Local Self Governments, Farmers, Fishermen, Tribal people and other knowledgeable person at local level. All efforts have been made to involve different stakeholders at LSG level in the assessment process. The focus of this assessment is to assess the scope of damage on ecosystems, biodiversity and environment based on community perspectives and does not provide a scientific study of the area. But being a study conducted by local community it has the potential to inform practical approaches for prioritizing areas for ecosystem restoration and biodiversity conservation which can be implemented at local level.

CHAPTER 3

IMPACT OF FLOOD/ LANDSLIDE ON ECOSYSTEM

3.1. STATE SCENARIO

Kerala has 41 West flowing and 3 East flowing rivers originating from Western Ghats (Fig 5) The state consist of 160.6 thousand hectares (ha) of wetlands i.e. 4.13 per cent of the state.Compared to coastal land, the high land and mid land hold very few wetlands.There are 1,593 inland wetlands with a total area of 117122 ha. The major natural Inland wetland types are River/Stream (65162 ha), Lagoons (38442 ha), and waterlogged areas (20305 ha).Kerala has 169 natural coastal wetlands with a total area of 40876 ha. The backwaters of Kerala are a unique ecosystem wherein lagoons, lakes, canals, estuaries and deltas of several rivers meet the Arabian Sea.

3.2 IMPACT OF FLOOD/ LANDSLIDE ON VARIED LANDSCAPES OF KERALA

The diverse ecosystems of Kerala including Forest areas, Plantations, Aquatic ecosytems as Riverine ecosystem, Lakes, Marshes, Ponds, Agro ecosystems as Paddy fields, farms etc have been impacted by either floods or landslides. A total of 771 different type of landscapes have been affected by the natural disasters across the state. Table 11 shows the Impact of natural disasters district wise and LSG wise on varied landscapes categorized as Medium, Severe and Most severe based on local perceptions. If the impact on biodiversity/ecosystem is 0-30 % it is medium, 31-75 % severe and above 75 % most severe. It is evident that the major impact has been on Aquatic ecosystems with the Riverine ecosystem and paddy fields the most affected in all the districts.

The major impact on Riverine ecosystem includes: (1) the erosion of the river banks (3) the erosion/ deposition of silt in river beds (4) changingcourse of river at a few locations (5) the formation of sandbars along the river (6) the fall in the surface water table in the neighboring areas after the floods.

The rivers of Kerala have been increasingly polluted from industrial and domestic waste and also from the indiscriminate use of pesticides and fertilizers in agricultural fields. In addition encroachments into the river for construction purposes, deforestation in the catchments, loss of riparian vegetation, sand mining and damming of rivers have already severly impacted the Aquatic biodiversity. In 2013 IUCN identified and validated Key Aquatic Biodiversity Areas which holds signifiant number of threatened species of conservation concern and in Kerala 25 aquatic systems have been identified as Key Biodiversity Areas of which the following have been severly impacted. A more detailed study on the impact on species of conservation concern is necessary and ugent conservation strategies are to be formulated.

Table 11: Impact of flood/landslides on Ecosystems ofKerala

District	River/streams/ Canal			Lake system			Protected areas			Farm			Plantation			Landscape changed due to human intervention			Paddy Field			Well			Pond		
	M	S	VS	M	S	VS	M	S	VS	M	S	VS	M	S	VS	M	S	VS	M	S	VS	M	S	VS	M	S	VS
Thiruvananthapuram	2	1			1			1			2		1	2		1	1				1			1			
Kollam	2	4	1		1					1	2	1	2	2		2	2		2	4	1	1	2		1	2	
Pathanamthitta	1	18	7					1		2	16	1	9	14	1	14	6			16	3		12	7	1	12	4
Alappuzha	9	14	1	1	2			2		15	11			3		20			14	24	1	4	17	4	19	4	1
Kottayam	10	3	1	2	1		3			2	3	2	2		2	2		2	5	2	4				2	1	1
Idukki	8	9	6	1			2	4		4	4	1	2	14	4	4	14	3	2	3	1	5	9	2	4	10	2
Ernakulam	11	23	4	1	2	1		1		6	3	1	4	5	4	12	2	1	8	13	5	21	3		3	6	
Thrissur	4	6	11	1				3		4	8	1	1	6			11		2	10	4		4	9		4	2
Palakkad	2	11					2	3	3		3	6	1	7	2	2				8		3	6		2	2	1
Malappuram	6	4	3				3	1		3	4	3	4		1	2			3		3	3	3	2	3	2	
Kozhikode	8	4	1				4	1		2	3		6	3		7	3	1	3	2		8	1		5		
Wayanad	3	10	2			1		3	4	4	2	1		5	4		2	2	1	4	3	5	6		2	4	
Kannur	7	4					2		1	1			3	2	1	4	4	1	2			2	1	2	2	2	
Total	73	111	37	6	7	2	16	20	8	44	61	17	35	63	19	70	45	10	42	86	26	52	64	27	44	49	11

M- Medium, S- Severe, VS- Very severe

Table 12 **Key Aquatic Biodiversity Areas affected by floods**

Key Biodiversity Area	No of Trigger Species	AZE species
Chalakuddi river	38	
Chaliar river	38	
Kabini river	48	
Bharatapuzha river	29	1
Pamba river	31	
Periyar river	36	4
Valapattanam river	14	
Vamanapuram river	20	

In 2004, Kerala State had around 3, 28,402 ha of wetlands ; it has gone down to 1, 60,590 ha in 2012, a 49 % decrease. The area under paddy cultivation was 7.53 lakh hectares during 1965 and has reduced to 1.9 lakh ha during 2014-2015 a decrease of 74.5 %. Hence apart from the heavy rainfall the topography and land use change might also have played a major role on the intensity of floods, as it is observed that some districts which received more than 50 % of excess rain was not very severly impacted. The per capita availability of water is already one of the lowest in the country and the impact on the wetlands will have great consequences on recharge of ground water in future. Table 13 and 14 shows the major rivers, streams, lakes and other natural and manmade ecosystems district wise impacted by flood/ landslide categorized based on severity of impact. The Pampa river at Alapuzha and Pathanamthitta and almost all the tributeries and streams in this district was affected by flood. At Idukki and Ernakulam Periyar river and almost all the tributaries and streams was affected by flood/ landslide.

Fig.11. Drainage Map

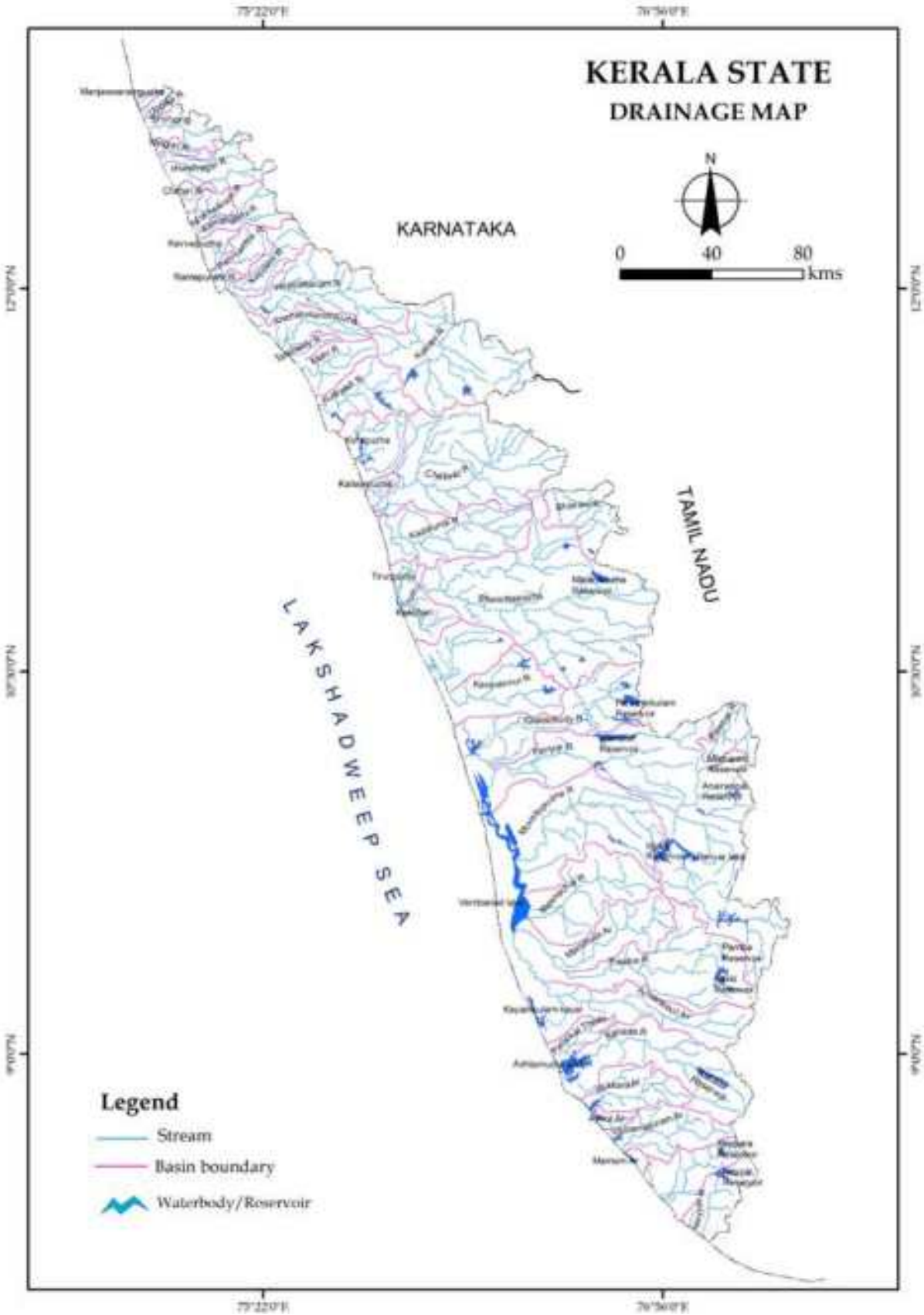


Fig.12. Achankovil River Basin

Fig.13. Bharathapuzha River Basin

Fig.14. Chaliyar River Basin

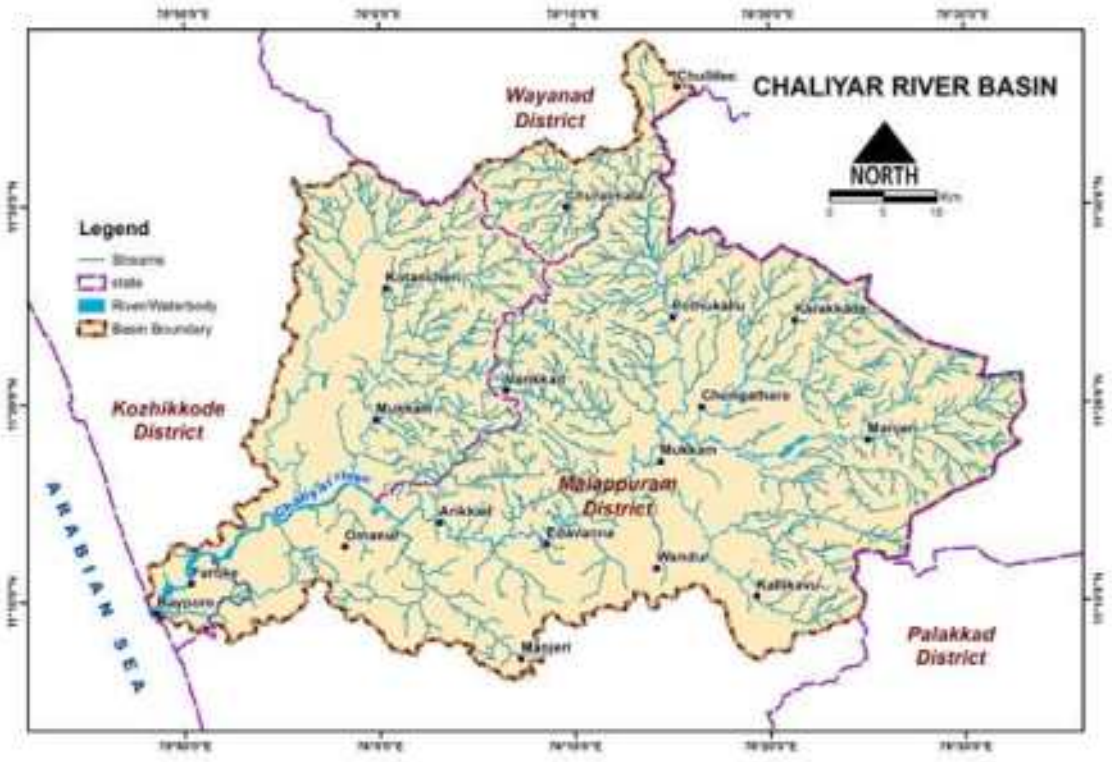


Fig.15. Karuvannur River Basin

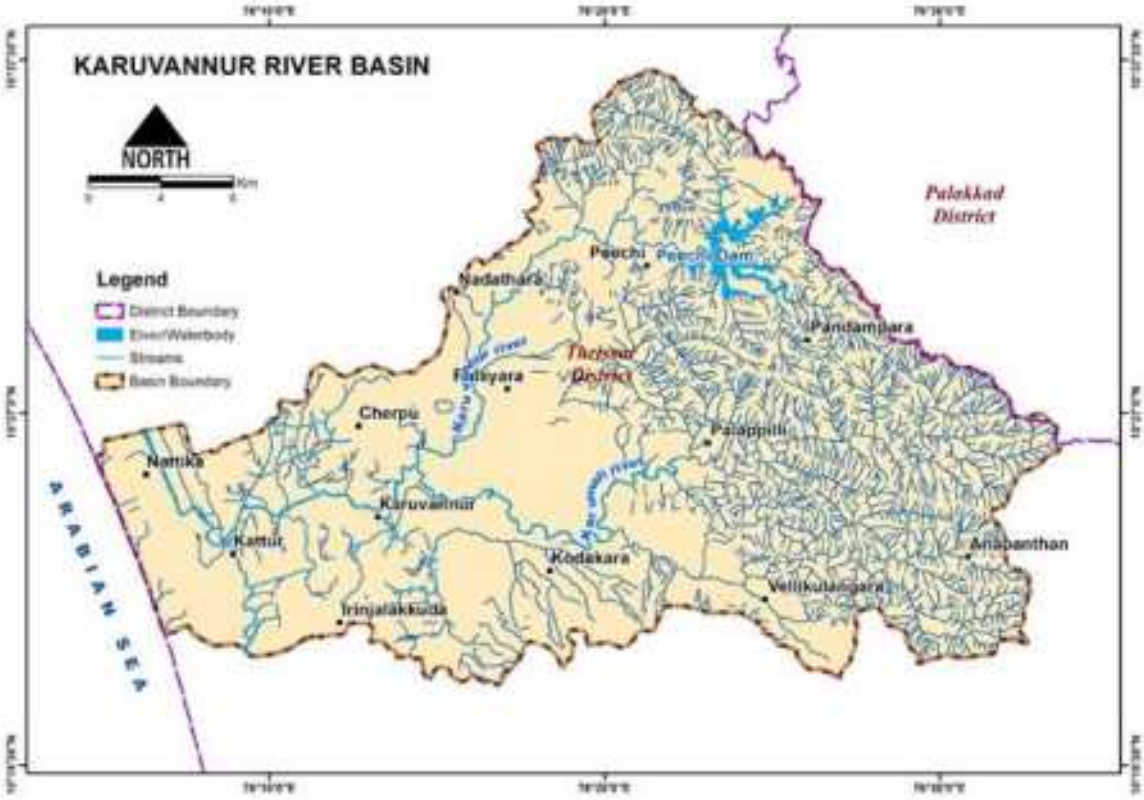


Fig.16. Manimala River Basin

Fig.17. Pampa River Basin

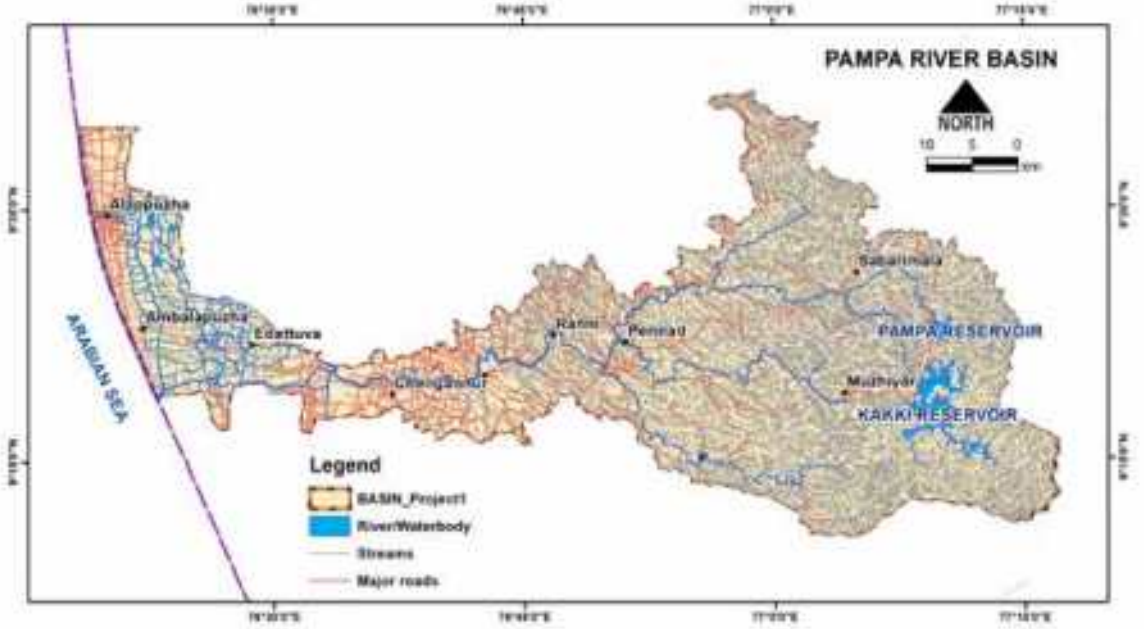


Fig.18. Periyar River Basin

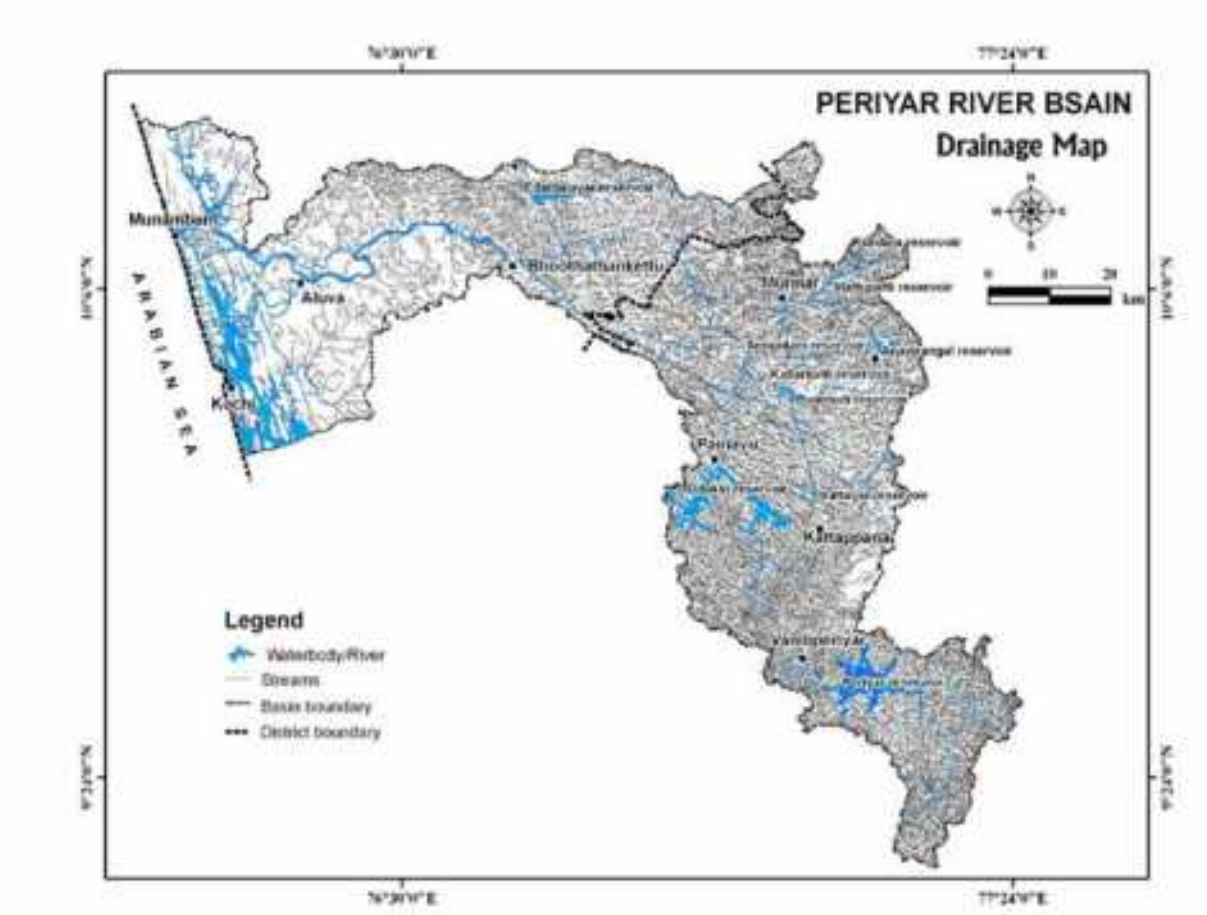


Fig.19. Chalakudy River Basin

Percentage of panchayats in the major affected river basins

S N	River basin	Percentage of panchayat in the basin
1	Achankovil	3.9
2	Pamba	17.2
3	Manimala	8.8
4	Periyar	29.06
5	Chalakudy	4.43
6	Muvattupuzha	7.38
7	Karuvannur	3.44
8	Bharatapuzha	6.89
9	Kabini	4.92
10	Valapattanam	4.92

Table 13: Impact of Flood / Landslide on Ecosystem

No.	Affected river portion	Name of River/Streams/Lake	Intensity of Flood in Grama Panchayats		
			Moderate	Severe	Very Severe
I	**Thiruvananthapuram**				
1	Main Channel	Karamana River	Aryanad		
	Tributaries	Meenankal Thodu, Keezhpaloor Thodu, Thakidiyil Thodu, Kulavarambu, Nethrathala Thodu	Aryanad & Kalliyoor		
2	Main Channel	Nerrar River		Kallikkad	
	Tributaries				
	Lake	Vellayani Lake		Kallikkad	
II	**Kollam**				
3	Main Channel	Ithikkara River		Adichanelloor	
	Tributaries	Paangad Vayalthodu, Panayarayaththodu	Adichanelloor	Adichanelloor	
4	Main Channel	Pallikkal River	Thodiyoor		
	Tributaries				
5	Main Channel	Kallada river		East Kallada,West Kallada & Manrothuruth	
	Tributaries	Perumkulam-Kalladayarthodu Kaavilkadavuthodu, Ambiyilthodu		East Kallada	East Kallada
III	**Pathanamthitta**				
6	Main Channel	Pampa River		Aranmula,Kadapra, Cherukol,Eraviperoor, Ranni, Pazhavangadi, Koipram, Kozhanchery, Ranni, Angadi, Niranam, Nedumbram, Peringara	Mallapuzhassery, Ranni-Perunad, Ayiroor, Thottapuzgassery, Ranni& Thiruvalla
	Tributaries	Kozhithode, Kolayar, Perunthenaruvi, Madathil Thodu, Maniyarthodu, Channamankal Thodu, Padappananjili		Aranmula, Kadapra, Ranni-Perunad, Cherukol, Eraviperoor,	Mallapuzhassery, Kuttoor, Thottapuzhassery

		Thodu, Thevarkadavu Thodu, Pallippadi–Kuzhimannilpadi Thodu, Perumthodu, Kanamukku–Kiliyanikkal Thodu, Puthumannuprum Thodu, Chakkappalam Thodu,Varattar, Kaithachaal, Kalkkulamthodu Mattinupuram Chaal, Thamarachaal Valiyachaal, Puliyappara Thodu Poothakkuzhi Chaal, Karumana Chaal, Peroor Chaal, Theeppuka Thodu, Panchavadithodu, Punkayil Thodu, KaithaChaal, Kalkkulam Thodu, Valiyathodu, Meenmuttupra Thodu, Edathodu, Town Thodu, Moozhikkal Thodu, Kaithodu Chaal Irappan Thodu, MechirayilValiya Thodu, Cheriya Thodu, Varattar, Ulloor Chira Thodu, Chaluvathukkal Chaal, Erappan Thodu, Varaachaal, Keezhukara Chaal, Kanjiraman Thoradath, Murukankovil Punnackamannil, Marottimukk – Pottankulam, Pulimoottil Thodu, Valiyaveettil Thodu, Thanungattil Thodu, Valiyathodu, Cheriyathodu Kolarayar, Kadalimangalam Aar Muthootkadavu Thodu, Paattapparambil Thodu, Kappiyarrisseri Thodu, Muchiyil Thodu, Morveli Thodu, Nattuthodu, Pulivelil Thodu, Valiyathodu, Muppannur – Achankovil Thode, Vettuvelil Achankovil Thodu Kulanilam – Achankovil Thode,		Koipram, Ranni-Pazhavangadi, Thottapuzhasery, Kozhanchery, Niranam, Peringara, Tyhiruvalla Municipality, Ranni, Kulanada, Ranni-Angadi, Nedumbram, Pandalam Municipality	

		Kuppannur Thode, Kurakulanji Thodu, Ealanthara Thodu, Peruvannapuram Thodu, Thevaramthodu, Mannathara Thodu, Pailakkulam Thodu, Vattakavunkalpadi–Kalayikkal Thodu, Aruvikkal Thodu, Valiyathodu Kottachaal, Mundanarithodu Valakathilthodu, Vaikkathillam Thodu, Kodenkeri Thodu, Manippuzha Thodu, Kallar Thodu, Muttar, Valiyathodu Kankuzhithodu, Kavadethuthodu Kakkattar, Nunangar, Varattar Kadalimangalam Ar, Madhurampuzha Ar, AnjilikkuzhiAr, Ammini Ar			
7	Main Channel	Achankovil river		Kadapra, Kulanada, Pandalam Municipality	
	Tributaries				
8	Main Channel	Manimala river		Kadapram, Eraviperoor, Nedumpram	Kuttoor
	Tributaries				Thiruvalla Municipality
IV	Alappuzha				
9	Main Channel	Pampa river	Ambalappuzha North	Budanoor, Chambakulam, Thiruvanvandoor, Cheruthana, Chengannur	
	Tributaries	Kuttanperror, Aramundallimala Muzhikkal Thodu, Erattappana-vaalayil Thodu, Varattar, Leading channel thodu, Chemputhodu, Korankuzhithodu		Thiruvanvandoor, Karuvatta	Karuvatta

10	Main Channel	Achankovil river	Kavalam, Neelamperoor, Veliyanad, Edathwa, Pandanad	Mannar, Veezhapuram, Chennithala-Thriperunthura, Cheriyanad, Puliyoor, Thakazhi, Thalavadi	
	Tributaries	Kuttanperror Ar, Puthanar, Kurakkalar, Uttarapalliyar, Koppayil Achankovil Thodu, Karipram Achankovil Thodu Punnakkal Thodu, Achankovilar, Muthalakuzhithodu, Thalakkerimottartharathodu, Kalikkakulam Nedumchal, Kurandichal-Ezhvanamtharathodu, Kannathranthodu, Karipolilthodu, Vallapuraedavanalthodu, Puthiyilthodu, Kaimalethuthodu, Kainakuzhithodu	Chennithala-Thriperunthura, Cheriyanad, Pandanad, Kavalam	Budhanoor, Chengannur Municipality, Mannar, Puliyoor, Veezhapuram	
11	Main Channel	Manimala River	Muttar	Veliyanad	
	Tributaries	Vandakapalli Thodu, Pulimood Uchethara Thodu			
V	Kottayam				
12	Main Channel	Mennachil River	Arpookara, Kumarakam		
	Tributaries	Ponnarthodu	Arpookara, Koottikkal		
13	Main Channel	Muvattupuzha River	Maravanthuruthu, Mulakulam, Thiruvarppu Udayanapuram, Vellur		
	Tributaries	Manathazhamthodu, Kariyar	Maravanthuruthu, TV Puram		

14	Main Channel	Manimala river	Payippad		
	Tributary	Pullakayar , Changanasserythodu, Changanasery Neelamperoorthodu, Mulakkamthuruthi Chettisserythodu, Thupramthodu, Kadampadamthodu	Vazhapilly		
VI	Idukki				
15	Main Channel	Periyar River			Kanjikuzhi, Mariyapuram, Vazhathoppu, Adimali Kanjiyar, Vellathuval
	Tributary	Deviyarpuzha, Erattayar, Muthirapuzhayar, Manjalupara, Ellikkamedu, Padukamelpara, Palakada,Thovarayar, Kalyanath, Idukkipadi, Kalthotti, Chettayiladi, Arakyanalpadi, Nallathannipuzha, Mankulampuzha, Nallathanipuzha, Panniyarpuzha, Muthirapuzha, Karikkintholam, Vimalagiri, Chattikuzhi, Chittadikkavala, Arimattompadi, Thakaramedu, Kottarampadi, Kadalakkapadi	Rajakumari, Vellathuval, Santhanpara, Kamakshi Kanjikuzhy, Udumbanchola Mariyapuram, Munnar Konnathady	Adimali, Erattayar, Biosonvalley, Munnar, Mankulam, Kanjiyar Adimali, Pallivasal Kanjikuzhy, Vazhathoppu	
VII	Ernakulam				
16	Main Channel	Periyar river		Alangad, Aluva, Okkal, Sreemulanagaram, Vadakkekara, Malayattur-Neeleswaran, Kalady, Puthenvelikkara, Nedumbassery, Cheranelloor Chengamanad,	

				Churnikkara Kunnnukara, Chittattukara Koovappadi,, Kuttampuzha Keezhmad, Kanjur Karimalur	
	Tributaries	Karikuzhipuzha, Onjithodu, Chengalthodu, Puthanthodu, Vedimarapuzha, Nadapallithodu, Kuttanpuzhanadhi, Chengalthodu, Mangathodu, Prumittathuaruvi, Ethapillithodu, Mangalapuzha, Kariyadthodu, Poopanithodu, Chavanikulamthodu, Manalvalithodu, Chaliyilthodu, Pinavurkudithodu	Kalady, Koovappady, Kuttampuzha, Kanjoor, Okkal, Changamabad	Sreemulanagaram, Ramamangalam, Kadungallur Koovappady, Kuttampuzha	Chittattukara
17	Main Channel	Muvattupuzha river		Ramamangalam, Maneed, Piravam	
	Tributaries	Ramamangalam Puzha		Ramamangalam	
18	Main Channel	Chalakudy river			Parakadavu
	Tributaries	Chalakudipuzha		Puthenvelikkara	
VIII	Thrissur				
19	Main Channel	Chalakudy river		Kadukutti, Kuzhur, Melur	Alur, Annamanada, Pariyaram
	Tributaries	Neimelilthodu	Kadukutti	Melur	
20	Main Channel	Karuvannur river	Parappurkara		Chazhur, Cherppu, Vallachira
	Tributaries	Kurumalipuzha, Pambanthodu, Poovapuzha, Arattupuzha	Cherppu	Parappurkara	
21	Main Channel	Bharathapuzha river	Desamangalam		
	Tributaries				
22	Main Channel	Periyar river	Eriyad		

	Tributaries				
23	Main Channel	Keecheri river	Thekkumkara		
	Tributaries	Vadakkancherypuzha			
IX	Palakkad				
24	Main Channel	Bharathapuzha river			
	Tributaries	Thuppunadpuzha(Karimpuzha) Dendillapuzha, Mangalampuzha, Nooradipuzha, Karaparapuzha, Kundhipuzha, Kalpathipuzha, Thuppanadpuzha, Vezhilipuzha, Pothundipuzha, Pattaruvi, Pullukadaruvi, Cherupuzha, Velampottapuzha, Sankuvarayanthodu, Kollyani, Pattimala, Ariyakodu, Neranganpara		Sreekrishnapuram, Kizhakkanchery, Nelliyampathy, Mannarkkad Municipality, Thiruvegappura, Palakkad Municipality, Vadakkanchery, Kadampazhipuram, Ayilur, Nemmara, Malampuzha	
X	Malappuram				
25	Main Channel	Bharathapuzha river	Erumbiliyam, Purathur		
	Tributaries	Thuthapuzha	Irimbiliyam		
26	Main Channel	Chaliyar river	Urgattathiri	Mambad, Vazhakkad Urgattathiri,	
	Tributaries	Kanjirapuzha, Kuravanpuzha, Karimpuzha, Cherupuzha, Kuthirapuzha, Karakodanpuzha, Punnapuzha, Kalakkanpuzha, Churapuzha, Pegaduchola	Chaliyar, Mambad, Karulai Vazhikadavu		
27	Main Channel	Thirur river	Purathur		
	Tributaries				
28	Main Channel	Kadalundi river			
	Tributories	Olipuzha, Kallanpuzha, Sulthanapuzha, Cherithodu, SSthodu,	Karuvarakundu		

		Madarithodu, Chembankaduthodu, Parasserithodu, Anathanamthodu, Manjalamcholathodu, Kallanpuzha, Mullarathodu, Kundamthodu, Manaliyampadam, Cheriyaaruvi, KallugalundaAruvi, PrayanmaduAruvi			
XI	Wayanad				
29	Main Channel	Kabini River			
	Tributories	Mananthavadipuzha, Panamarampuzha, Venniyodepuzha, Annothupuzha, Vaithiripuzha, Thalapuzha, Chirakkarathodu, Puthusseripuzha, Varampattapuzha, Karamanthodu, Narasipuzha, Cherupuzha, Kalindi, Karimkuttikalaripoykayilthodu, Vannathipuzha, Kurichyarmalathodu, Melmurithodu, Ammarathodu, Karuvanthodu, Settukkunnu, Pularithodu, Ambapuzha, Shulamkuthipuzha, Vattakundupuzha, Manathavadipuzha, Cherupuzha, Panamarampuzha	Vaithiri, Vellamunda Kottathara, Thavinjal Panamaram, Mananthavady Municipality	Thavinjal, Panamaram Kottathara, Pozhuthana Padinjarethara, Thirunelli Panamaram, Mananthavady Municipality, Edavaka	Thirunelli, Mananthavady Municipality Thavinjal, Edavaka
XII	Kozhikkod				
30	Main Channel	Kadalundi river	Kadalundi		
	Tributaries	Vadakkampattupuzha, Olipuzha, Velliyar			
31	Main Channel	Kuttiyadi river			
	Tributaries	Thottilpallampuzha, Chappanthottampuzha, Pattiyattupuzha, Oonipuzha, Ananganpuzha	Kavilumpara, Chakkittappara	Kavilumpara	

32	Main Channel	Chaliyar	Olavenna, Omassery Karassery	Kodiyathur, Karassery, Kudarinji	
	Tributaries	Eruvazhanjipuzha, Thudarapuzha, Kannappankundpuzha, Cherupuzha, Poyilingapuzha			Puthuppadi
33	Main Channel	Korapuzha river	Kottur		
	Tributaries	Ramanpuzha			
34	Main Channel	Kllayi river	Vanimel	Vanimel	
	Tributaries	Mampuzha			
35	Main Channel	Mahi river			
	Tributaries	Vanimelpuzha, Edapallithodu			
XIII	Kannur				
36	Main Channel	Valapattanam river	Chengalayi, Kottiyoor Payyavoor, Ulikkal, Padiyoor		
	Tributaries	Payyavoor River, Nuchyad River, Chennkannipuzha, Bavali, Vamchiyam river, Paisakkaripuzha, Mattarapuzha, Perattapuzha, Vellakkaithodu, NelliyodiThodu, KallenThodu, CholattuThodu, Paalchuram Thodu, KalankiThodu, Anappara Thodu, Arabi Thodu	Chengalayi, Ulikkal, Kelakam, Payyavur		
37	Main Channel	Kuppam River	Alakkode		
	Tributaries	Rayoram River	Alakkode		

Table 14 Impact of flood/ landslides on Tributaries and Streams

Panchayath	Stream Name	Moderate	Severe	Most Severe
I.WAYANAD				
Thavinjal	Varayalthodu	√		
	Andikunnuthodu, Makkimala no.6 thodu			√
Panamaram	Vaakayadthodu, ChemmiliKakkathodu, Koodammadithodu, Kannadimukkuthodu	√		
Thirunelli	Chakkunithodu, Kakkavayalthodu		√	
Edavaka	Kakkanjerithodu, Orappthodu, Pulikkadthodu,		√	
	Kammanathodu			√
Kottathara	Puzhakkamvayalthodu		√	
	Kakkanjalthodu, Kappamkollithodu, Poolakkollithodu, Karikkollithodu	√		
Pozhuthana	Edatharakadavu, Vayanankunnu, Panniyora, Koyilerithodu, Chathothuthodu, Muthirappara, Karuvanthodu	√		
	AmmaraKaivazhi, Kolothodu, Kacherippady, Ambathekkar, KurichiyarmalaAruvi, Melmuri		√	
Vaithiri	Kozhichal 12 palamathodu, Chundelvattakundu, Ayisha Plantation Mullanparathodu	√		
MananthavadiMun.	Chettappalamthodu, Payyamballithodu	√		
II.KANNUR				
Chengalayi	Vellakkaithodu	√		
Kottiyoort	Nelliyodithodu, Kallenthodu, Cholattuthodu, Paalchuramthodu	√		
Ulikkal	Kalankithodu, Anapparathodu, Arabithodu	√		
AyyankunnuPanchayat	Kliyantharathodu		√	
III.MALAPPURAM				
Chaliyar	Choorapuzha PengadChola		√	
Oorgatiri	Canals in Odakkayam area			√
Karuvarakundu	Manaliyampaadam, CheriyaAruvi, KallungalundaAruvi, ParayanmaadAruvi	√		
IV.KOZHIKODE				
Kavilumpara	Meenpattithode Kuruvanthode Aanakkulamthode	√		

Karasseri	Parathode Mathrathode	√		
Koodaranji	Thodukal	√		
V.Palakkad				
Kizhakancheri	Paattaruvi		√	
Neliyambathi	Pullukaduaruvi	√		
Malampuzha	Cherupuza, Velampottapuzha		√	
Palakkad corporation	Shanguvarayanthodu		√	
Kadambazhippuram	Kolyani, Paattimala, Ariyakode	√		
Ayiloor	Niranganpaara		√	
VI.Thrissur				
Meloor	Neymelithodu		√	
VII.Ernakulam				
Kadungalloor	Perumittatharuvi		√	
Okkal	Ethapillithodu		√	
Chengamanad	Mangalappuzha	√		
Koovappadi	Kariyadthodu, Pooppanithodu, Chavanikulamthodu, Manalvalithodu, Chaliyilthodu		√	
Kuttambuzha	Pinavoorkudithodu		√	
VIII.IDUKKI				
Kamakshi	8th mile thode, Iruttikavala-millupadithodu,Neelivayalthodu, Irukudithodu	√		
Kanjikkuzhi	Varikkamuthan, Vattompaara-plamba, Punnayal		√	
Udumbanchola	Chemmannaar	√		
Mariyapuram	Karikkintholam, Vimalagiri, Chattikkuzhi, Chittadikkavala, Arimattampadi, Thakaramedu, Kottarampadi, Kadalaykapadi	√		
Vazhathoppu	Streams in Vazhathopu		√	
Baisonvalley	Streams in Baison valley		√	
Kanjiyar	Pambadikkuzhi, Palakkad, Kozhimalapalli city		√	
Moonnar	Lakkam	√		
Konnathadi	Kannadippara, Konnathadi South	√		
Vellathooval	Mankadavu	√		
Santhanpaara	Pethetti, Cheriyaar	√		
IX.PATHANAMTHITTA				
Kadapra	Paattapparambilthodu, Kappiyarrisserithodu, Muchiyilthodu, Morvelithodu, Nattuthodu		√	
Ranni	Pulivelilthodu, Valiyathodu		√	
Kulanada	Muppannur–Achankovilthode, VettuvelilAchankovilthodu,		√	

	Kulanilam–Achankovilthode, Kuppannurthode, Kurakulanjithodu, Ealantharathodu, Peruvannapuramthodu, Thevaramthodu, Mannatharathodu			
Ranni - Angadi	Pailakkulamthodu, Vattakavunkalpadi–Kalayikkalthodu, Aruvikkalthodu, Valiyathodu		√	
Niranam	Kottachaal Mundanarithodu		√	
Nedumbram	Valakathilthodu, Vaikkathillamthodu, Kodenkerithodu, Manippuzhathodu		√	
PandalamMun.	Kallarthodu, Muttar		√	
X.ALAPPUZHA				
Budhanoor	Tributeries of River Pamba and Achankovil		√	
Mannar	Tributeries of River Pamba and Achankovil		√	
Cheriyanad	Koppayil – Achankovilthodu, Karipram – Achankovilthodu, Punnackalthodu	√		
Karuvatta	Chembuthodu, Korankuzhithodu		√	
Puliyoor	AchankovilAr – Muthalakkuzhithodu, Thalakkeri Motor tharathodu, Kaleekkakulam, Nedumchaal, Kurandichal – Ezhuvanamtharathodu		√	
Veeyapuram	Kanatharanthodu, Karippolilthodu, VallappuraEdavanalthodu, Puthiyilthodu, Kaimalethuthodu, Kainakkuzhithodu		√	
XI.KOTTAYAM				
Vazhapally	Changanasserithodu, ChanganasseriNeelamperoorthodu, MulaykkamthuruthiChettisserithodu, Thoopramthodu, Kadambadamthodu	√		
XII.THIRUVANANTHAPURAM				
Aryanad	Meenankalthodu, Keezhppaloorthodu	√		
Kalliyoor	Thakidiyilthodu, Kulavarambthodu, Nethrathalathodu	√		

Table 15 **Impact of flood/ landslide on Terrestrial Ecosystem**

Type of Ecosystem	Name of Panchayat	Name of Ecosystem	Intensity
I.WAYANAD			
Wetland	Thavinjal	Makkimala Temple	Most Severe
	Thirunelli	Thachirakolli	Moderate
		Nettara, Plamoola	Severe
	Vaithiri	AnamalaChathup, Navodaya School Chathup, Mullanpaara Chathup, Vetinerary University Chathup	Severe
Forest (Protected Area)	Thavinjal	Sooryamudi, Andikunnu 43 mile	Most Severe
	Thirunelli	Thachirakolli, Thirunelli Pothumala, Nettara	Most Severe
	Pozhuthana	Kurichyarmala, Sugandhagiri	Most Severe
	Vaithiri	Thalimala, Mullanpaaramandala	Severe
	MananthavadiMun.	Panjarakolli, Maniyankunnu, Kambamala	Most Severe
Plantation under the control of Forest Dept.	Thirunelli	Muthumari	Severe
	Pozhuthana	Sugandhagiri, 50 Ekra	Most Severe
Biodiversity rich areas	Panamaram	Kottillam	Most Severe
	Kottathara	Kottillam	Severe
Plantation (Public/Private)	Thavinjal	Makkimala Estate, Saroja Estate	Most Severe
	Thirunelli	Plamoola, Kulirmavu, Mullankolli, Kurichanmoola, Thachirakolli, Nettara	Most Severe
		Kaanancheri, Thressileri	Severe
	Edavaka	Private plantations	Severe
	Kottathara	Private plantations	Severe
	Pozhuthana	Kurichyarmala tea Estate, Ammarathotta Bhoomi	Most Severe
	Vaithiri	Thalimala, Mandamala, Anamala, Thalippuzha, Mullanpaara, Kolichal, Dairy Project	Severe
	MananthavadyMun.	Pancharakolli, Maniyankunnu, Rassalkunnu	Most Severe
		Ozhakkodi	Severe
		Plantation near riverbank, Pepper plantations	Moderate
II.KANNUR			
Forest (Protected Areas)	Kottiyoor	Kottiyoor Reserve Forest	Moderate
	Ulikkal	Anappara Forest	Severe
	Ayyankunnu	Pathipara, Kalithattumpara Ayaamkudi, Ezhamkadavu	Most Severe
Plantations under the control of forest department	Alakkode	Manjiyam plantation	Moderate
	Aralam	Aralam Farm	Severe
Plantation (Public/Private)	Cherupuzha	Cardamom plantation	Moderate
	Kelakom	Santhigiri	Moderate
	Padiyoor	Private plantation	Moderate

	Naduvil	Rubber plantation	Severe
	Ulikkal	Coconut, Aracanut, Rubber & Cashew nut plantations	Most Severe
Hilly Regions	Cherupuzha	Hills	Moderate
	Kelakam	Vendekkumchaal, Santhigiri Region, Kolithatt, Velloothi Mankulam	Moderate
	Ulikkal	Kaalanki, Kolithattu, Arabikkulam, Anappara	Severe
	Aralam	Aralam Hills	Severe
	Ayyankunnu	Paarakkamala, Mudikkayam	Severe
	Paayam	Hills	Most Severe
	Kottiyoor	Ambayathodu, Nelliyode Chappamala	Severe
III.MALAPPURAM			
Wetland	Karuvarakundu	Chirakkalkundu Chathuppu	
Forest (Protected Area)		Kalkund region (Buffer zone in Silent Valley)	
	Pothukall	Munderi Forest area, Vazhikadavu Forest Range, Kodeeri, Iruttikuthi forest	
	Oorgattiri	Neliyayi, Koreeri, Kodimbuzha regions in Odakkayam	Severe
	Vazhikkadavu	Vazhikkadavu Range, Nellikuthu Forest Station, Onnamvalavu, Kallala, Naadukanichuram, Thakarappadi, Athikurukk	Moderate
Plantation under the control of forest department	Karulayi	Forest near Karimpuzha, Cherupuzha	Moderate
Planation (Public/Private)	Irimbiliyam	Private farming	Severe
	Chaliyar	Private farming, Mooleppadam	Severe
	Karuvarakundu	Private farming (Rubber, Banana, Coconut, Aracanut, Nutmeg, Teak, Coco)	Most Severe
	Purathoor	Private farming (Nutmeg & Coconut)	Moderate
	Oorgattiri	Private farming (Coffee, Pepper, Coconut, Araecanut)	Moderate
Hilly Region	Irimbiliyam	Neelandanpaara	Moderate
	Vazhikkadavu	Quarry	Moderate
IV.KOZHIKKODE			
Wetland	Karasseri	Karasseri wetland	Moderate
Forest (Protected Areas)	Kavilumpaara	Choorani	Moderate
	Karasseri	Thottakkad Mysore Rock, Maranjati Teak plantation, Paikkadan Hill	Severe
	Koodaranji	Peedikappara, Akambuzha	Moderate
Plantations under the control of forest department	Kadalundi	Hortusmalabaricus Park	Moderate
	Puthuppadi	Kakkad VSS Area, Vanaparvam Biodiversity Park, Melekolamala	Moderate

Community Reserve	Kadalundi	Kadalundi Community Reserve	Moderate
	Kottoor	Malabar Wildlife Sanctuary	Moderate
Plantation (Public/Private)	Katteeppaara	Coconut & pepper plantation	Severe
		Rubber, Coffee, Nutmeg & Grambu plantation	Moderate
	Kavilumpaara	Rubber, Araecanut, Banana, Nutmeg, Grambu, Coco,& Coconut plantation	Severe
	Kodiyathoor	Rubber, Coffee, Pepper & Araecanut	Moderate
	Kottoor	Pathippara, Chenkotu, Kunnikkoottam	Severe
	Omasseri	Coconut, Araecanut, Rubber, Coffee, Banana & Pepper	Moderate
	Karasseri	Cashewnut, Coconut, Araecanut, Rubber, Coffee, Nutmeg, Banana & Pepper	Moderate
	Koodaranji	Rubber, Pepper, Araecanut, Nutmeg, Grambu, Coco, Coconut, Cashewnut	Moderate
	Chakkittappara	Rubber, Coconut, Pepper	Moderate
Hilly Regions	Kadalundi	Peringottukunnu, Engattirikkunnu, Vakkadavukunnu, Kottakkunnu	Moderate
	Kavilumpara	At the 5th hairpin bend of the Ghat road	Moderate
	Omasseri	Hills	Moderate
	Vanimel	Chengalppaara	Severe
	Olavanna	Chengalppaara	Moderate
	Katteeppara	Karincholamala, Chamal	Most Severe
	Karasseri	Mysoremala, Paikkadanmala, Kolakkadanmala, Parathode Elambilarisserimala	Severe
	Koodarinji	Hillsides	Severe
	Chakkittappara	3rd block to Nambyarmukku	Moderate
V.PALAKKAD			
Wetland	Kizhakkancheri	Mandhrampalli	Severe
	Kadambazhippuram	Cholappadam, Kollanipaadam	Moderate
Biodiversity rich area	Nemmara	Nelliyambathi Valley	Most Severe
Planation (Public/Private)	Sreekrishnapuram	Pooliyakkattutheruv, Veezhli	Severe
	Kizhakkancheri	Palakkuzhi, VRT, Vattappara, Uppumannu	Severe
	Nelliyambathi	Tea & Coffee Estate	Most Severe
	Malampuzha	Vettiyil Estate Elivaal	Severe
	Vadakkancheri	Moochithodi	Severe
	Kadambazhipuram	Chennampilli Thottam, Arivakkode Thottam, Pullundasseri, Puthanvilayil Thottam, Coco plantation	Severe
	Ayiloor	Banana, Nutmeg, Aracanut,	Severe

		Vegetables, Legumes & Rubber plantation	
		Coconut & Pepper plantations	Moderate
	Nemmara	Rubber plantation	Moderate
		Banana, Pepper plantations	Severe
Hilly Regions	Kizhakkancheri	Hills	Severe
	Ayiloor	Akhilumudichimala, Veezhlipotta	Severe
	Nenmara	Aathanaadkunnu, Mattayi	Severe
	Sreekrishnapuram	Mannampattapaarakkadavu	Moderate
VI.THRISSUR			
Wetland	Padiyoor	Pandinilam	Severe
Forest (Protected Area)	Pariyaram	Choolakkadavu, Mullappana, Konnakuzhi, Pandarampara, Kumbidanmudi, Pullumudi, Varadakkayam	Severe
Forest Area under the control of Forest Dept.	Desamangalam	Accasia Plantation	Severe
	Pariyaram	Konnakuzhi, Pandarampara, Mullappara teak plantation	Moderate
Ramsar Site	Manaloor	Kole region and Kolimad area	
	Padiyoor	Kole regions	Severe
Plantation (Public/Private)	Maala	Banana plantation	
	Cherpu	Banana plantation	Severe
	Desamangalam	Rubber plantation	Moderate
	Meloor	Banana, Nutmeg, Tapioca	Severe
	Parappookkara	Banana, Nutmeg, Coconut	
	Pariyaram	Nutmeg plantation	
	Thekkumbhagam	Rubber, Banana, Rubber plantations	Severe
	Vallachira	Arecanut& Coconut plantation	Moderate
Hilly Regions	Meloor	Pushpagiri	Severe
	Thekkumbhagom	Machad mala, Oorhokode hills	Most Severe
VII.ERNAKULAM			
Wetland	Alangad	Alangad wetland	Severe
	Ramamangalam	Ramamangalam wetland	Severe
	Chengamanad	Madathimoola	Severe
	Koovappadi	Vaachaal	Severe
Forest (Protected Area)	Malayattoor	Forest near Mulankuzhi	Severe
	Kuttambuzha	Malayattoor Forest Division MoonnarForet division	Moderate
Forest Area under the control of Forest Dept.	Kuttambuzha	Teak plantation of Forest Dept.	Moderate
Bird Sanctuary	Kuttambuzha	Salim Ali Bird Sactuary, Thattekkad	Severe
Planation (Public/Private)	Alangad	Alangad plantation	
	Kadungalloor	Kadungalloor plantation	
	Kadamakkudi	Eloor Factory	

	Sreemoolanagaram Puthanvelikkara	Nutmeg plantation	Most Severe
	Ramamangalam	Vanilathottam, Medicinal plants	Severe
	Malayattoor	Mahagani&Bananana plantation	Severe
	Piravam	Rubber, Teak, Pineapple	
	Nedumbasseri	Nutmeg & Rubber	Severe
	Chengamanad	Vegetable, Banana, Pepper, Nutmeg	Most Severe
	Koovappadi	Banana, Nutmeg, Coconut, Lemon, Rambootan	Severe
	Kuttambuzha	Rubber, Chooral	Moderate
	Kanjur	Banana & nutmeg	Moderate
Hilly Regions	Kuttambuzha	Sooranmudikunnu, Kanyapilly, Chemmeenkuthu, Chokkoli, Illythandumudi	Moderate
VIII.IDUKKI			
Wetland	Kamakshi	Kamakshi, Thankana	Severe
	Kanjikkuzhi	Thattakkanni	Severe
	Mariyapuram	Idukki mini dam	Moderate
	Vazhathoppu	Cheruthoni	Severe
	Kanjiyar	AyyappankovilVellilamkandam, VellilamkandamKozhimala	Moderate
	Rajakumari	Rajakumari wetland area	Moderate
Forest (Protected Area)	Kanjikkuzhi	Thattekanni Forest, Thekkanthoni, Palaplavu, Makuvallimanayathadam	Severe
	Vazhathoppu	Forest Area	Severe
	Adimali	Neryamangalam	Severe
	Kanjiyar	Anjuruli	Moderate
	Moonnar	Rajamalai Forest	Severe
	Santhanpara	Mathikettanshola National Park	Moderate
Plantation (Public/Private)	Kamakshi	Udayagiri, Kaalvari mount, Karikkinmede Tea estate, Cardamom estate, Coffee estate, Banana & Coco estate	Severe
	Kanjikkuzhi	Banana, Coffee, Nutmug, Rubber, Coco plantations	Severe
	Mariyapuram	Rubber & Pepper plantation	Most severe
	Udumbanchola	Cardamom plantation	Most Severe
	Vazhathoppu	Pepper & Coco	Most Severe
	Adimali	Cardamom plantation	Moderate
	Irattayar	Cardmom, Pepper, Rubber & Banana	Severe
	Nedumkandam	Cardamom	Severe
	Kanjiyar	Cardamom & Pepper	Severe
	Mankulam	Pepper plantation	Most Severe
	Munnar	Tea Estate	Severe
	Rajakumari	Cardamom, Pepper, Banana	Severe
	Konnathadi	Cardamom & Pepper plantation,	Severe

		Mullarikudi	
	Pallivasal	Cardamom, Pepper, Banana, Nutmug	Severe
	Vellathooval	Cardamom, Pepper, Rubber, Nutmug	Severe
	Rajakkad	Cardamom, Pepper, Banana	Severe
	Santhanpaara	Ardamom	Moderate
IX.PATHANAMTHITTA			
Wetland	Kuttoor	Kongaramali Colony	Severe
	Thiruvalla	IruvallipraRaiway Area	Severe
Forest (Protected Area)	RanniPerunadu	Konni Protected forest Bimmaram , Kappakkad, Kambakathumvala, Chelikkuzhi, Attathodu	Severe
Plantation (Public/Private)	Aranmula	Rubber estate	Moderate
		Banana plantation	Severe
	Kadapra	Banana & Vegetable plantation	Severe
	Mallappuzhasseri	Rubber plantation	Moderate
	RanniPerunad	Rubber & Banana	Severe
	Ayiroor	Rubber	Moderate
	Cherukol	Rubber	Moderate
		Banana & Vegetable	Severe
	Eraviperoor	Rubber, Banana & Vegetable	Severe
	RanniPazhavangadi	Rubber	Moderate
		Banana	Severe
	Thottapuzhasseri	Rubber	Moderate
	Ranni	Rubber, Nutmug, Rambootan, Pepper	Most Severe
	Koyipuram	Rubber	Moderate
	Kozhancheri	Rubber	Moderate
		Banana	Severe
	Kulanada	Banana & Coconut	Severe
	RanniAngadi	Banana, Rubber & Coconut	Severe
	Niranam	Banana & Coconut	Severe
	Kuttoor	Banana, Rubber & Coconut	Severe
	Nedumbram	Banana & Coconut	Severe
	Peringara	Banana & Coconut	Severe
	PandalamMun.	Agri farm, Kadaykkadu	Severe
	Thiruvalla	Rubber plantation	Moderate
Hilly Regions	Aranmula	Vallana, Malakkara	Moderate
	Cherukol	Konnaykkal, Ayikkalkunnu, Manjapramala, Thattakunnilpaara, Chakkappara, Plavunilkunnathilbhagom	Moderate
	Mallappuzhasseri	Kaippuzha, Vattamodi	Moderate
	Eraviperoor	Ayithittappara, Paarakkuzhibhagom	Moderate
	Kozhancheri	Vellaprapaara, Keezhukarapaara	Moderate
	Kuttoor	Pottanmala, Pozhiyanpaara,	Severe

		Pallimala, Mullipparamala, Kaniyampaara	
X.ALAPPUZHA			
Wetland	Karuvatta	Karuvatta wetland area	Moderate
	Ramankari	Ramankari Wetland Area	Moderate
	Pulinkunnu	Pazhakkattu, Manikyamangalam, Thattepadam, Arunoottumpadam, Ponnerivakkapadam, Wetland near Engineering Colege	Moderate
	Cheruthana	Cheruthana Wetland area	Moderate
Forest (Protected Area)	Veeyapuram	Area under the control of forest dept.	Severe
Ramsar Site	Muhamma&Thannermukkam	Vembanad Lake	Severe
Biodiversity rich areas	Muhamma	Pathiramanal	Severe
	Cheruthana	Pandi	Severe
Plantation (Public/Private)	Pandanadu	Vegetable &Nutmug plantation	Severe
	Thalavadi	Vegetable plantation	Severe
	Thiruvanvandoor	Dairy farm	Severe
XI.KOTTAYAM			
Wetland	Maravanthuruth	Maravanthuruth wetland area	Moderate
	Vazhappalli	Kottamoola, Ambazhathinadi, Paruthikkattukadavu	
Bird Sanctuary	Kumarakam	Kumarakam bird sanctuary	Moderate
Biodiversity rich areas	Mulakkulam	Kakkathuruth	Moderate
	Kallara	Kottillam	
Ramsar Site	Kumarakam& TV puram	Vembanad Lake	Moderate
Plantation (Public/Private)	Koottikkal	Pepper, Rubber & Coffee	Most Severe
	Maravanthuruth	Maravanthuruth plantation	Most Severe
	TV puram	Coconut & Pepper	Moderate
	Velloor	Veloor plantation	Moderate
Hilly Regions	Koottikkal	Hills	Severe
XII.KOLLAM			
Wetland	Manrothuruth	Nenmeni South, Pattamthuruth East, Kandramkani, Kidapram South-North, Perngalam	Severe
		Pattamthuruth West	Moderate
Ramsarsite	Manrothuruth	Manrothuruth	Severe
Plantation (Public/Private)	East Kallada	Rubber plantation	Moderate
	AdhichanelloorPanchayat	Banana & Vegetable Farming	Severe
	West Kallada	Betel Farming	Severe
Hilly Regions	Adhichanelloor	ThazhuthalaThachanthodiyilBhagam, Settlement Colony	Moderate
		Kadappathodi, Moozhiyil, Iruppuram,Vellaamathodi, ChoorapoykaPathayakkodi, Pattanikkadavu, Charuvinpuram,	Severe

		Settlement ColonyMailakkadSankaranKovil	
	Manrothuruth	Vedanchadimala	Severe
XIII.THIRUVANANTHAPURAM			
	Kalliyoor	Kireedam Palam	Severe
Plantations (Private/Public)	Kalliyoor	Tapioka plantation – (Anakkomban, Kayyalachadi, Noorumuttan)	Severe
	Aryanadu	Valiyakalinku Ela Varyankavu Ela Chothikkuzhi Ela Kokkott Ela Meenankal Ela Palekkonam Ela	Moderate
		Choozha Ela Iravoor Ela	Severe
Hilly Region	Kallikkadu	Mulapotta	Moderate

ENVIRONMENTAL IMPACT

Major environmental effects were soil erosion, silting, deposition of alluvial-sandy soil and deposition of solid, liquid and industrial waste.

Soil erosion

Due to heavy rain and flooding soil erosion occurred in the river banks. The nutrient rich topsoil which has been formed over decades were completely wiped out exposing the less fertile rocky base. The texture of soil has undergone drastic change as a result of mixing up of sand, silt, clay during flood. The pH of soil has changed. Soil nutrients leached out from cropped areas. The continuous flooding and water logging resulted in washing off the top soil and loss in soil fertility. Experts say that restoration of the soil fertility will take much more time and can be attained through mulching and organic farming. The mixing of clayey matter with soil will reduce the air spaces which could affect the water holding capacity.

Deposition of sand

Sandy soils were extensively deposited in the upper region of Pamba river, Ranni-Perunad, Ranni-Angadi and Ranni. After the flood in Maramon, Pathanamthitta the soil was completely covered with slimy mud. Almost all small plants were covered under the mud. The wet clayey top soil may also act as an impervious barrier for the percolation of rain water resulting in run off flows of rain water. This may lead to lowering of water table in the river banks and flooded areas for some time and is reported from different places.

Alluvial soil

There was a large scale deposition of alluvial soil in Aranmula, Koyipuram, Eraviperoor and Kutoor. This soil texture is fine powder and has very low aeration capacity. This soil is humus rich but due to poor aeration capacity roots of plants rotted.

Pollution

During flood there was a large scale deposition of solid and liquid waste in land and aquatic ecosystem. This includes plastic waste, damaged electronics, cloths, utensils, industrial waste, and toilet waste. This was deposited extensively in all flood affected regions. This has badly impacted the quality of water, flora and fauna of land and aquatic ecosystem. Wells in the entire flood affected regions were contaminated with pollutants.

At Ramamangalam, Nedumbasseri and Cheranalloor, Ernakulam a oily layer was seen in flood water. At Alangad , Kadamakkudi and Aluva chemical wastes from various sources including factories got mixed up with flood water and polluted soil and water bodies. At Alangad, Okkal, Sreemoolanagaram, Chengamanad, Chittattukara, Koovappadi Septic tank waste water and sewage wastes got mixed with flood water in many places and contaminated drinking water sources. At Okkal waste material from Rice mills were carried by flood water to other places

Environment pollution

It was observed that the pollution to Periyar is coming from Kuzhikandam thodu. German Technical Corporation was entrusted with the study and it was suggested that the thodu is heavily contaminated and it should be rejuvenated. The effluents allegedly released by many industries have turned the water into a deep black colour, though it can also flow red, yellow or green, depending on which chemicals flow into it. The sight of many kinds of fish lying dead on the surface of the water have now become common. Water of Periyar is contaminated with a wide range of pollutants – from persistent organic pollutants like DDT to a number of heavy metals like manganese, zinc, cadmium and mercury to excessive water nutrients like nitrates, phosphates and sulphates and NGT has observed it as one of the most toxic spots in the country.

Flood has severely hit the factories located in Edayar and Eloor areas. The chemical godowns located near the river got flooded and the chemicals got mixed up with water. Local people in the area says that clothes disintegrated, in Aluminium vessels holes were formed and steel vessels got rusted.

3.3. DISTRICT LEVEL ASSESSMENT

3.3.1 WAYANAD

3.3.1.1 DISTRICT PROFILE

Wayanad District situated at a height between 700 meters and 2100 meters above the mean sea level consist of 3 taluks Mananthavady, Sulthanbathery and Vythiri. Wayanad has an area of 2132 km ^{2}and 885.92.sq.km of area of the district is under forest. The reserve forest of the district is under three administrative divisions. Wayanad wildlife sanctuary has Muthanga, Bathery, and Tholpetty ranges. North division constitutes Mananthavady, Periya and Begur ranges, which is dominated by evergreen and moist deciduous forests. South division forms Kalpetta, Meppady and Chedeleth ranges, which is also dominated by evergreen and moist deciduous forests. The natural vegetation of Wayanad can be broadly classified into the following types: 1.Evergreen forests 2. Semi-evergreen forests 3. Moist deciduous 4. Dry deciduous 5. Grasslands and Bamboo.

3.3.1.2. THE DISASTER- FLOODS AND LANDSLIDES OF 2018

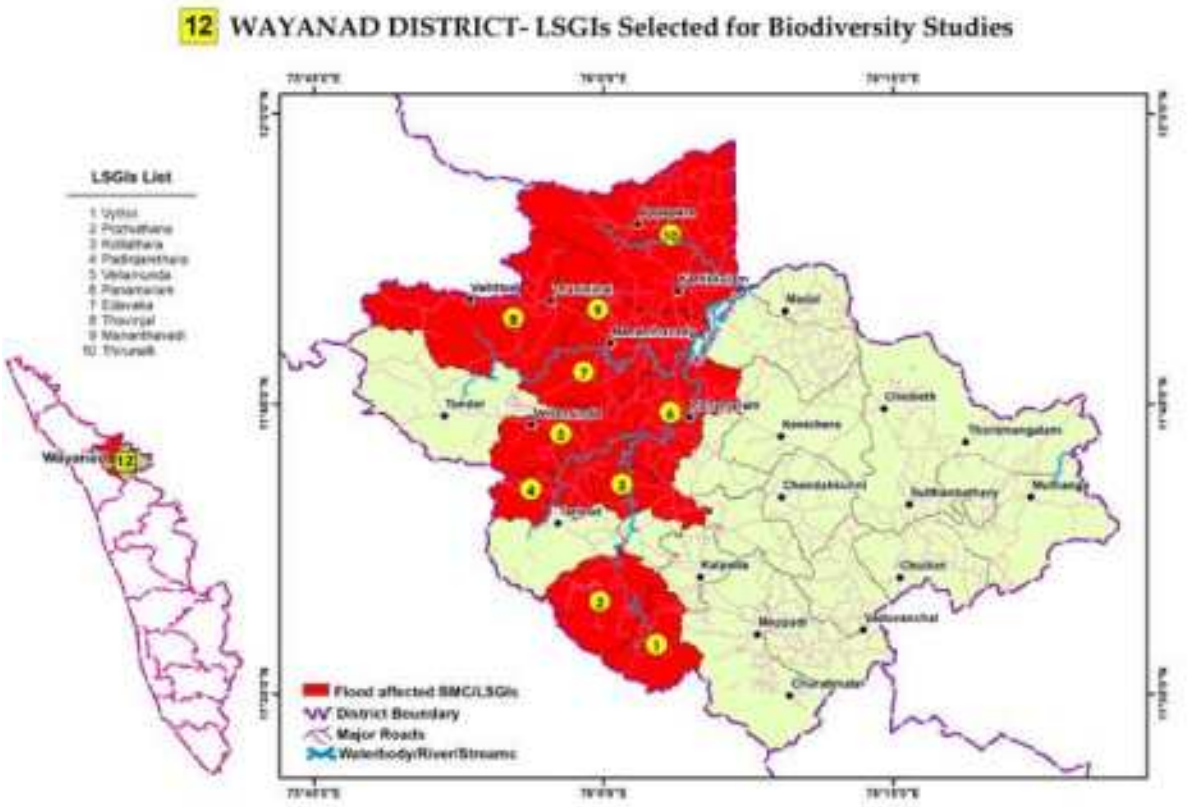
The normal rain fall in this district during 1June to 22 August is 2281.3 m.m whereas during 2018 actual rainfall from 1st June 2018 to 22 August 2018 was 2884.5 m.m which was 26 % above normal. Lakkidi, Vythiri and Meppadi are the high rainfall areas in Wayanad with Lakkidi known to be the place with the second highest rainfall in India.

3.3.1.3. STUDY AREA AND ASSESSMENT PROCESS

The district has 23 panchayats and 9 municipalities. 9 panchayats and 1 municipality of Mananthawady and Vythiri were selected for the study (Fig 20). This study was qualitative, and interpretive and sought to learn from the participants experiences of being affected by the natural disasters. According

to official sources there were 47 landslides, 155 landslips and 45 land subsidence from June 1 to August 30 and about 676 acres has been destroyed following land subsidence and landslips. The Table 16 reflects the different views of the respondents on the nature of damage to environment and biodiversity in the most affected panchayats of the district.

Fig. 20. Wayanad District- LSGs Selected for Biodiversity Study.



3.3.1.4 IMPACT OF FLOODS/ LANDSLIDES ON MAJOR ECOSYSTEMS

The most severly affected were Thavinjal, Mananthawady and Tirunelly. The Tirunelli – Kudrakote corridor is important to maintain habitat contiguity of elephant populations in the Western Ghats. The corridor connects the Brahmagiri Wildlife Sanctuary in Karnataka with the Wayanad Wildlife Sanctuary and Wayanad North Division in Kerala. Thavinjal, Mananthawady and Tirunelli are the most affected in terms of floods and landslides (Fig 21).Pozhuthana and Vythriri were most affected in terms of landslide (Fig 22).

It is to be noted that landslides were reported even from areas not classified as High Hazard Zone. Landslides are reported by local people mostly from the flood plain areas. The worst affected were Mananthawady and Tirunelly taluks. In Thavinjal the major water bodies affected included Mannathawady puzha, Thalapuzha, Chirakarathodu, Varayalthodu, and the streams of Makkimala and 20 of the 22 wards were affected by floods and landslides occurred in 10 wards. Of these Manathawadythodu, Andikunnuthodu and Makkimala are most severely affected while, Thalapuzha, Chirakarathodu, Varayalthodu are severely affected. In Tirunelli, Kabini river was most severely affected and 13 of the 17 wards were affected by floods and 9 wards by landslides.

Fig. 21. Wayanad - Drainage Map

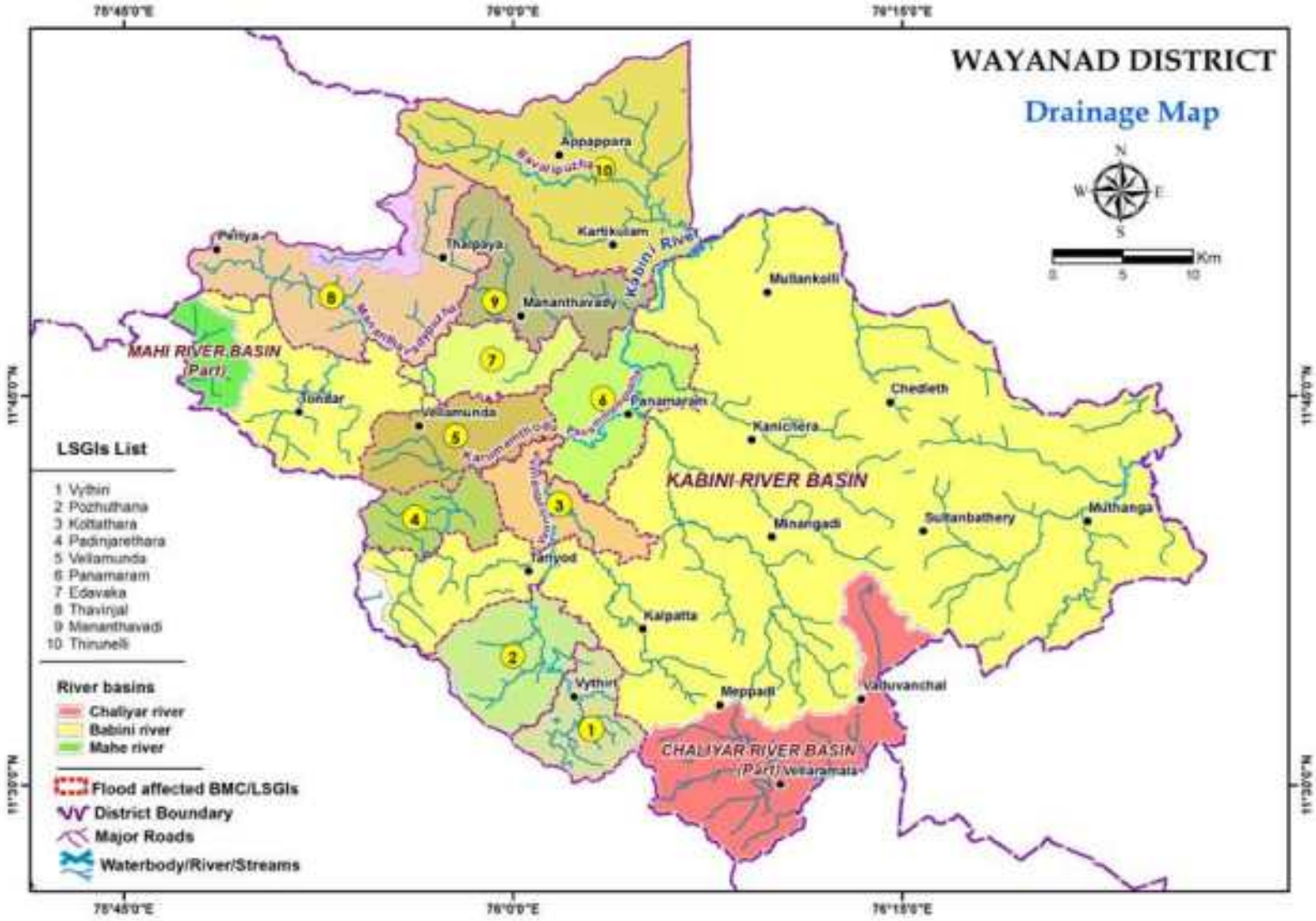


Fig. 22. Wayanad - Flood Impact Map

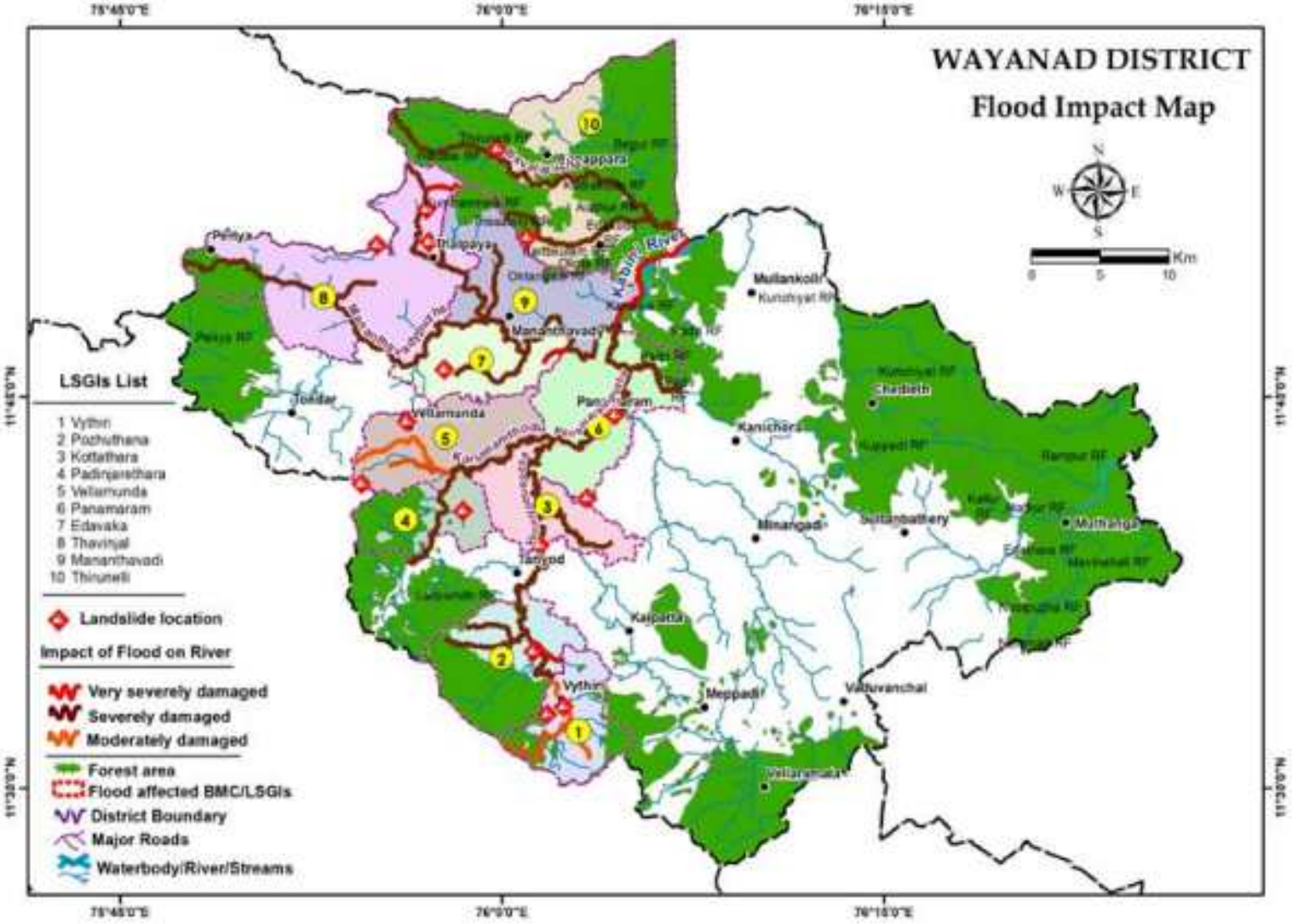


Fig. 23. Wayanad - Disaster Prone Map

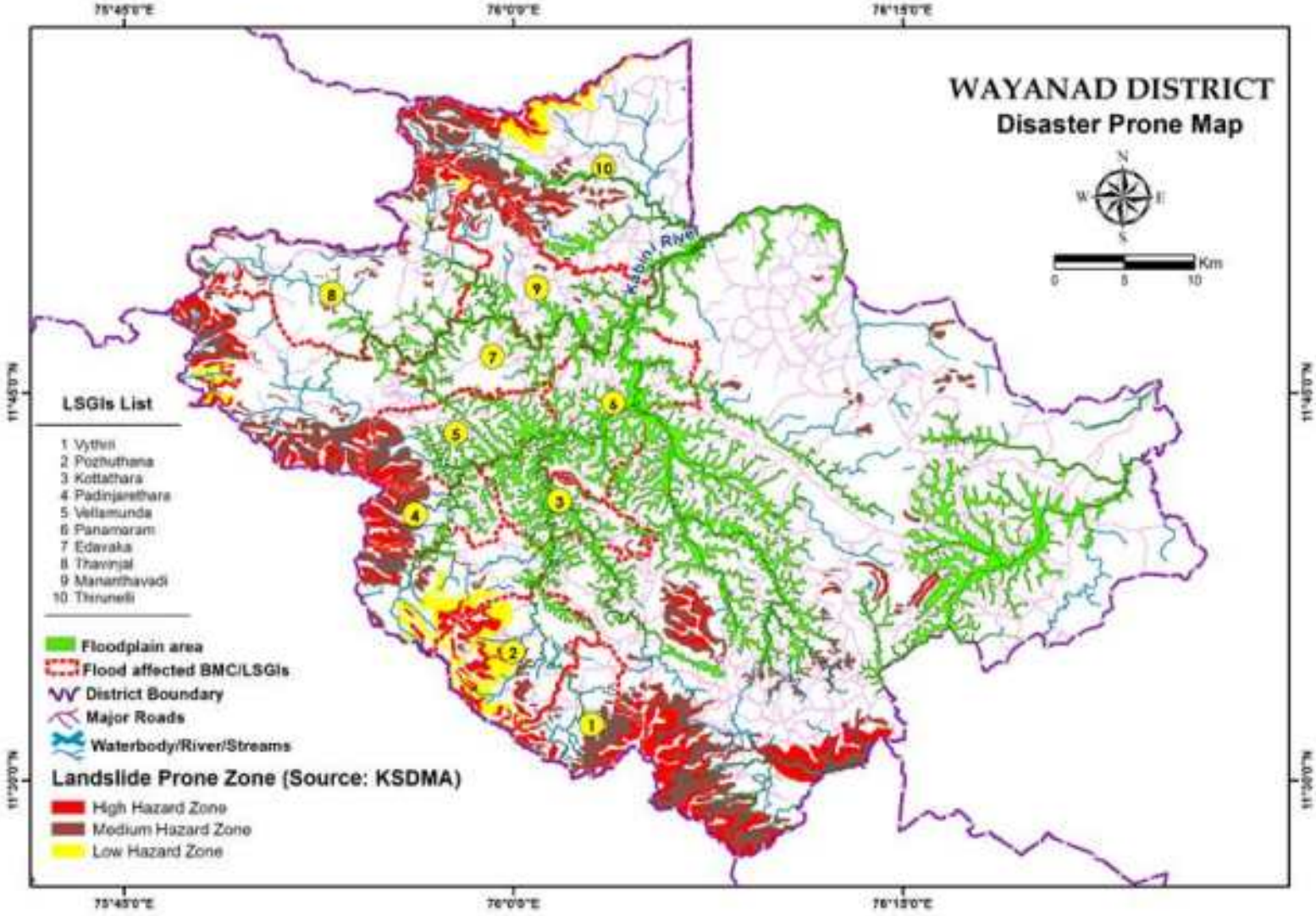


Table 16 : **Nature of Impact on Biodiversity/ Ecosystems- Wayanad**

No	Type of ecosystems	Nature of Impact
1	Riverine ecosystem	River bank erosion Loss of Riparian vegetation Deposition of soil/ mud/ boulders/ Pollution due to plastic and waste
2	Agro ecosystem	Deposition of debris in paddy fields Top Soil erosion Invasive weeds in paddy fields Rotting of crops Damage to spice plantations
3	Forest/ terrestrial ecosystem	Landslides Land subsidence Collapse of hill slopes Fissures/ Crack in Earth Sand piping Mud slides
4	Intangible heritage	Damage due to Submergence in water
5	Floral and faunal diversity	Loss of riparian vegetation Loss of nests and injury to fledglings of birds Dislocation of Reptiles from natural habitat Mass death of earthworms

The major factors which contributed to the impact of natural disasters as perceived by local people are :

Removal of river bank vegetation
Construction of check dams
Construction in flood plains by filling with soil from levelled hills thereby preventing the natural flow of water during floods
Unregulated levelling of hills
Encroachments in flood plains
Land use change in wetlands/ marshy lands
Construction activities on hill sides
Landslides occurred near the proximity of quarries in many places *eg.* In Pozhuthana a big landslide occurred very close to a quarry
Conversion of paddy fields to banana plantations

1) RIVERINE ECOSYSTEM

The Kabini River, one of the three east flowing rivers of Kerala, and its four important tributaries the Panamaram, Manathavady, Bavali and Noolpuzha drains the entire Wayanad district. Panamaram Puzha is a major tributary and is contributed by a large number of rivulets. The Panamaram river has got two major branches and joins the Mananthavady river north of Panamaram to form the Kabini river at Koodalkadavu. Mananthavady Puzha takes its origin from the northwest region of Wayanad and has 2 major tributaries, viz. Niravil Puzha and Periya Puzha. After flowing 2 kilometers from the confluence of Panamaram river, Kabini forms an island called Kuruva Island, spreading over 520 acres with diverse flora and fauna. Bavali river originates from Karimala Brahmagiri hills and is also known as Kalindhi puzha and it joins the Kabani River near the State's border. The Noolpuzha another important tributary originates from the eastern border of Wayanad and flows towards north to join the Kabani river, outside the Kerala state boundary.

According to the local people the major impact in terms of river bank collapse is found in places where human interventions have occurred such as construction of concrete structures, check dams etc across the river. Local people told that during the last few years Wayand faced acute drought and to combat this small temporary check dams has been constructed at several places mostly utilizing the soil taken from the river banks. In such places the check dams have collapsed and the banks have been eroded on a large scale. In Kabani river, near Koodlakadavu concrete check dam has been constructed which obstructs the flow of water. The bank to the right side of the check dam was eroded when flood water surged through here. The sand and soil was deposited in an area of about 10 acres of paddy land upto a height of 25 cm. The left side of the river bank has less vegetation in comparison and the impact was more here. Local people remembers that in this area years ago thick thickets of bamboo culms used to grow and later on the land was encroached and area converted for agricultural purposes.

The riparian vegetation on the banks of Mannathawady and Panamaram river is degraded due to encroachments and construction activities and the impact of flood was more on these two tributaries

Local people comments that extensive Soil erosion have occurred on the banks of these two rivers and also on the banks of the natural springs which flows into these rivers.On both sides of the river banks of Mananthawady puzha local bank erosion is noticed at specific positions. In these places native trees and bamboo clumps have been uprooted and lots of plastic and other waste materials are noticed hanging on the branches of the trees. Panamaram puzha was the worst affected.Along with flood water when the water from the dams also surged through the river the entire remaining vegetation on the banks was washed away. The Fig 23 shows the location of landslide and it can be seen that most of the landslides occurred in close proximity to rivers. Hence the major impact on riverine ecosystem is the combined affect of flood and landslides and this may impact the biodiversity severly as any change in habitat will have more long lasting impacts.

2) TERRESTRIAL ECOSYSTEM

In Mananthawadi at Pancharakolli two major landslides were noted by the people and resulting soil, rocks and uprooted small trees was swept away in the surging waters. The local people say that they heard a big sound from the forest which they thought was an earthquake and after this the water in the stream became muddy and the slopes of the hill collapsed and large amounts of soil, mud and boulders was brought down along with the flood waters. Plantations of Arecanut, Coffee, Pepper was destroyed and a mixture of soil, mud and boulders was deposited in the paddy fields, about 9 acres of paddy fields were made unsuitable for cultivation. A stream adjacent to this has been diverted from its course. Another major landslide has occurred almost adjacent to the first one and the debris material from this also was washed into the river along with dark red colored soil from the hill top. All these debris has been deposited in the fields and marshy lands downstream and this has resulted in blocking the small rivulets flowing into the main river. The locals are of the opinion that it is very difficult to restore this ecosystem.

In Mananthawady, forest areas of Pilakavu, Maniyankunnu in the valley of Thakidikunnu, landslides occurred in two phases. The 1st phase occurred in August 16 due to heavy rainfall, soil eroded and the resultant rocks, soil and uprooted small trees got entangled along with rain water. The next day due to heavy downpour another landslide occurred. The local people say that the debris shifted and slid down over an area of about 1 km and and was deposited on the paddy fields making it unfit for cultivation .

In Keshavan kolli marshy lands about 2 acres was filled with debris and the natural marshy texture of the soil has changed. In the area where the landslide occured a pond has been formed and all debris is deposited here along with dirty water. About 7 ha of thick forested areas were destroyed, the wetland nature of paddy fields and marshy land in the valley down has changed. The screwpine and rattans on the banks of the stream was uprooted and the bannana and arecanut crops in the agricultural fields were destroyed. Accoring to the local people this ecosystem cannot be restored

In Pilakavu, Russel kunnu , in an area of about 5 hectares the earth has developed deep cracks and land shifted leading to mudslide. The debris flowed into the stream Manniyankunnu thodu flowing below. This area has been extensively encroached for construction of houses. According to local people the clearing of native vegetation for construction has resulted in such a situation in this area. Large number of water harvesting pits has increased the impact of floods. In the olden days the lower part of this hill was a marshy land. Large scale land use change for cultivation of bananas occured. Canals were constructed to drain the water from the marshy area so that it can be made suitable for banana cultivation. This led to the drying of the marshy land. These marshy lands were later on filled and houses were also constructed.

Land subsidence occurred in Thirunelly, Thavinhal, Meppadi, Panamaram, Pozhuthana, and Vythiri grama panchayats and Mananthavady and Kalpetta. Land subsidence also occurred in Mananthwady municipality Varadimoola, Adivasi colony. Here it occurred in two phases, in 1st phase land subsided by about 7 feet and during the next floods by about 15 feet. The marshy land in the valley down has risen. The people of the area remembers that years back the area was marshy, during the course of time, the area dried up and for road construction and other developmental activities the hill slopes were razed. Construction activities by piling were carried out and bore wells dug. Local say that all these are responsible for land subsidence.It is widely accepted that Land subsidence generally occurs when groundwater is mined in an unplanned way.

In the Mananthawady municipality, near Ambalakunnu big fissures in the earth has developed. The local people says that this fissure is very deep and extends to the nearby hillocks and a crack is visible on the property of an individual on the other side of the hill. In the hill side a region in a semicircle shape has cracked and a gorge of one man depth was formed. Simultaneously the marshy land in the valley down has risen to about one meter.

According to the United States Geological Survey, land subsidence occurs when aquifer systems compact.Extraction of groundwater from areas prone to land subsidence may also cause adverse environmental impact on the region's ecosystem. Decline of groundwater table causes a vertical compression of sediments bearing the water.Over 100 acres in Mananthawady taluk in areas like Plamoola, Anappara, Udayagiri Kunnu, Ozhakkodi, have subsided. It is felt that it will take a long time for the land to settle. Land subsidence, or settling of land is usually attributed to loss of sub surface support.

A NEW WATER BODY

In Andikunnu, Thavinjal panchayat, Begur range jurisdiction a large area of earth has slipped. About 5 acres hill has collapsed along with several trees. The debris that fell from the sides of the hill is strewn over the forest land and the soil has blocked the flow of water in the river resulting in the formation of a water body of about 2 acres. Locals say that Red spoil has been deposited, and there is very little stones in this soil.

MAKKIMALA

1. Massive landslide occurred in Ward no 6, Makkimala Thavinjal. Red soil along with stones and rocks are deposited at a length of 100 mt and width 20 mt. Huge amount of debris was washed downstream into a rivulet which originates from Varadhoor mala. This rivulet used to flow for about 10 months in a year and was the source of water for the neighbouring people.

2. In Durga Bhagavati temple Thalapuzha, a pond of 2 ½ acres was constructed which used to be fed by small streams. On both banks of these streams in 4 locations mudslides was reported by people. About 2 acre of land was destroyed due to this and the mud got deposited in the pond resulting in the pond becoming more shallow. The mud was deposited in front of the temple and a mud bank was formed. The marshy land behind the temple near the Makkimala stream got filled with mud.

3. In Makkimala, on the top of Sooryamudikunnu local people say that 4 land slides has occured which are visible from below. They opinion that the Shola forests and grasslands of the area has been affected by this.

4. At Thalapuzha, Makkimala Muneeswaran kunnu a massive rock slide occurred on the west side and large amounts of soil, mud and stones were brought down. Above this area cracks developed on the surface of the grasslands. The locals are apprehensive of a landslide anytime. They suggest that construction activities in this ecologically fragile area is dangerous.

In Thalapuzha , Makkimala Saroja estate an abandoned tea estate, which is a biodiversity rich area with shola forests presently used for tourism purposes, in several places soil erosion has occurred and about 2 acres of land has eroded. The soil eroded from here is red in color with little stones. Nearby on the road to Saroja estate to the East also several landslides has occurred. Another rock slide was observed by the people in Thalapuzha Sivagiri kunnu. A large part of the hill has collapsed onto about 4 acres of field bringing along with it mud and soil. In Thavinjal panchahayt Kuzhakottoor near Durga Bhagavati temple in two places soil erosion has occurred. This has occured in fields and Soil has compacted and land slipped. The resulting mud slipped down and was deposited in Karimani thodu.

The Mananthavady Engineering College and its play ground wasconstructed in a valley between two hills and the land was developed using soil transported from elsewhere. The local people say that the soil was brought by using huge tipper lorries over the course of several days. But in just a single day this entire top soil which was used for filling the valley eroded and slipped and got deposited in Thalaserry road within hours.

In Tirunelly, Thachirakolly, extensive landslide in forest areas occured. Along with this the houses nearby showed cracks. A crack on the surface of the earth is visible here. This area was having good growth of grass species. Nearby as part of a NABARD project several ponds were constructed for aquaculture purposes. In Kananchery, Kurichanmala a deep fissure has developed on the Earth, about 7 acres of land was affected due to this and the tribal settlements was affected. In Pulimodoodu kunnu the earth subsided leading to a 100 mt long fissure in the earth. In Alathur also about 50mt long crack is visible . In Nettara land subsided about 12 mt down in a semi circle where as the land just below rose.

In Tirunelli Pothumala a massive landslide occured, bringing down big trees and stones and soil about 200 mt wide. About 1 km down a pond was formed. The debris flowed to about 6 km to Baveli river and surrounding paddy fields became unfit for cultivation. In Tirunelli, Tholpetty, near NSS Bargeri estate a check dam was constructed for irrigation purposes. The check dam broke and the stones and soil was washed down. People from Tirunelly also report that in Aravanazhi, nearby Thirunelli Police station due to land slide a crack has developed in Earth resulting in change of course of the river. In Muthumari forest areas in more than 6 places and in Brahmagiri in 5 places cracks has developed in earth. At Pozhuthana a natural lake Melmurithadakam was most severly affected due to landlsips.

A resident of Thrisillery, Puthan Purayil Santhosh says that in front of his house about 4 mt deep soil has eroded and shifted, and big trees were uprooted and shifted. A small stream flowing nearby has changed its course. In Thrisillery, near Panniyode check dam mud slide occured from about 8 mt height. The debris got deposited and affected the fields nearby.

In Vythiri taluk Pozhutana and Vythiri panchayat was severly affected by landslides. The 2 major landslide in this district happened in Kurichiar mala. Many of the small streams which originates from the forests were degraded due to landslides. In Pozhuthana at Sugandagiri more than 30 incidents of soil erosion was reported. In addition cracks appeared on the Earth surface at many places. Local people say that a large portion of the land is sloping and is not suitable for habitation. Large scale construction activities happened here for Veterinery College. Another place where massive landslide occured was in Pozhuthana panchayat at Ammara. Two major landslides and about 10 minor landslides occured here. A big quarry and crusher unit is operating here. Marshy lands at Sugandagiri and Pookode has been destroyed irreversibly here.

BMC meeting at Wayanad

Landslide (Pancharakolly)

New waterbody formed due to landslide (Thavinjal)

River bank erosion - Panamaram

Loss of Ochlandra sp. along Mananthavady puzha

Sand bed at Mananthavady

Melmuri - Kurichiyarmala- Pozhuthana

Kurichiyarmala - Landslide

Ozhakkodi- Mananthavady

Kurichiyarmala - Landslide

3.3.2 KANNUR

3.3.2.1. DISTRICT PROFILE

Kannur district with a geographical area of 2966 Sq.Km. can be divided into three geographical regions - highlands, midlands and lowlands. The highland region comprises mainly of mountains, the midland region, lying between the mountains and the low lands, is made up of undulating hills and valleys. The lowland comprises of rivers, deltas and seashore. The district has 71 gramapanchayats, 9 Municipalities and 1 corporation in 11 blocks. The district is blessed with 7 major rivers and 25 lakes and has a coast line of 84 km. Forest area occupies about 187 sq km and wetlands 8186 ha. Natural vegetation, except in some coastal regions, consists of different types of forests. Forests of Aralam and adjacent areas represent the only compact protected patch of vegetation belonging to the unique vegetation sub-type viz; the Dipterocarpus-Mesua-Palaquium sub-type in Kerala.The plant communities, range from mangroves to evergreen forests.

The Kattampally wetland area located in Chirakkal, Narath, Kolachery, Munderyand Kuttyattoor panchayats and Puzhathi and Elayavur areas of the Kannur Corporation is a Biodiversity rich area. The area is identified as an Important Bird Area (IBA) by the Indian Bird Conservation Network (IBCN) and Birdlife International. Kattampally is the most important area in species diversity as well as richness of birds, as more than 18,000 birds have been seen in this wetland area. Kattampally is also the feeding ground for a number of waterbirds nesting at various heronries in Kannur district. Once a large swamp on the floodplains of the Valapattanam river with reed beds and mangrove vegetation, Kattampally has been facing ecological problems as the mangroves in the area have almost disappeared.

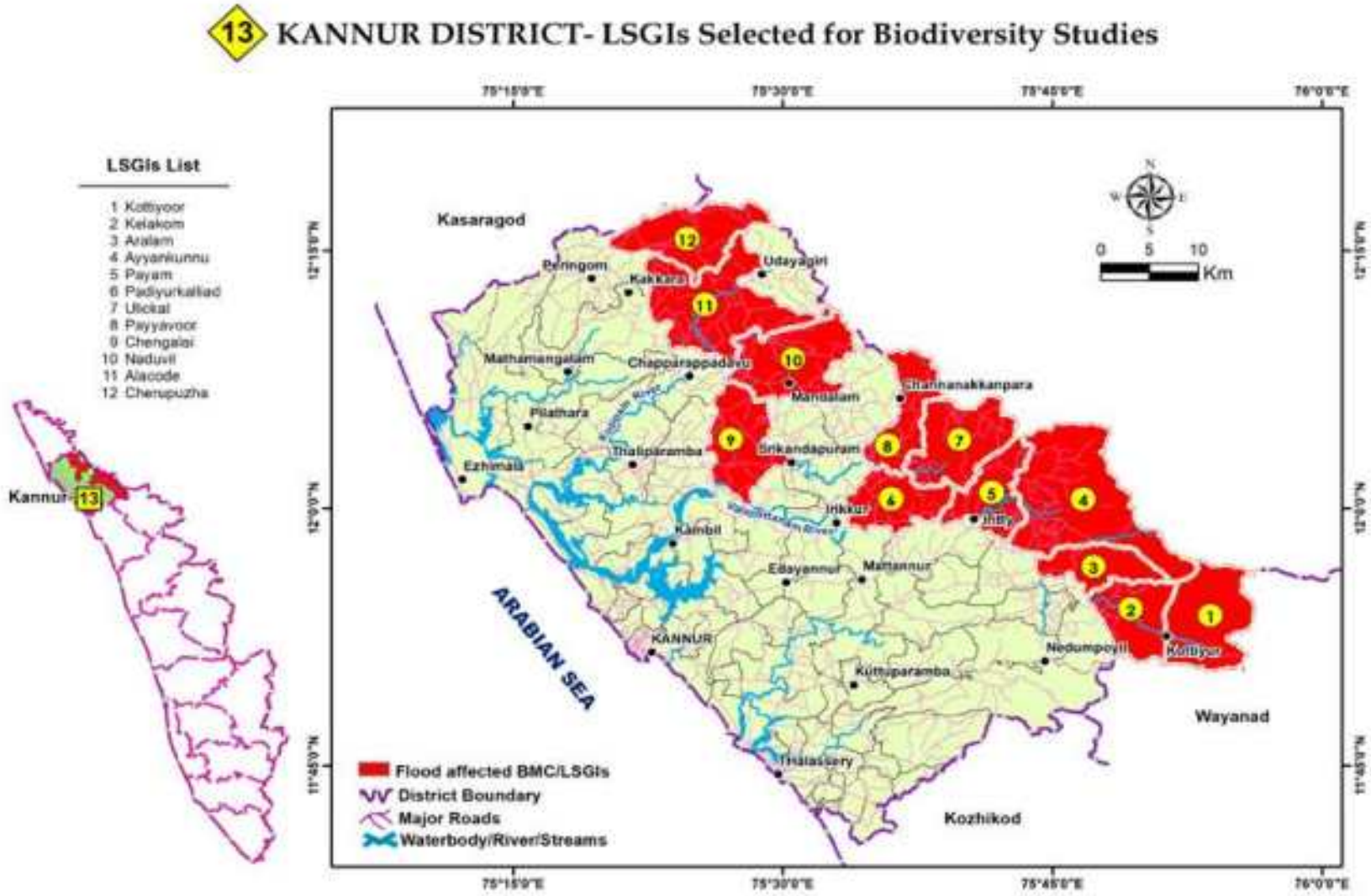
3.3.2.2. THE DISASTER- FLOODS AND LANDSLIDES OF 2018

The average rain fall in this district from 1 June to 22 August is 2333.2 whereas during 2018 actual rainfall was 2573.3 which was 10 % above average. The district mainly suffers from natural disasters such as flood, drought, sea erosion, landslides etc. Landslide is a common phenomenon in the highland regions of the district especially during Monsoon season. The reason for local floods found in the low lying areas of coastal region, especially in the northern part of the district, is poor drainage condition mainly due to the geography of the region. Some parts of the sea areas are below sea level and the flooded water from the rain stay there. Soil erosion and silting of river beds added to the problem.

3.3.2.3 STUDY ARAE AND ASSESSMENT PROCESS

At Kannur 12 panchayats were selected for the study (Fig 24). Most of the panchayats fall in the Valapattanam river basin.

Fig. 24. Kannur District- LSGs Selected for Biodiversity Study.



3.3.2.4. IMPACT OF FLOOD/ LANDSLIDES ON MAJOR ECOSYSTEMS

The major rivers of the district are Perumba, Kuppam, Valapattanam, Thalassery, Mahi and Ancharakandy which originates in the highlands of Western Ghats and drain in to the sea. Cheenkannipuzha the major tributary originates from the upper reaches of Brahmagiris and flows down the forests of Aralam, before draining into Valapattanam River. The sanctuary forms the watershed area of Cheenkannipuzha and Iriittipuzha. The main tributaries of Valapattanam River are Varapuzha and Aralam puzha.

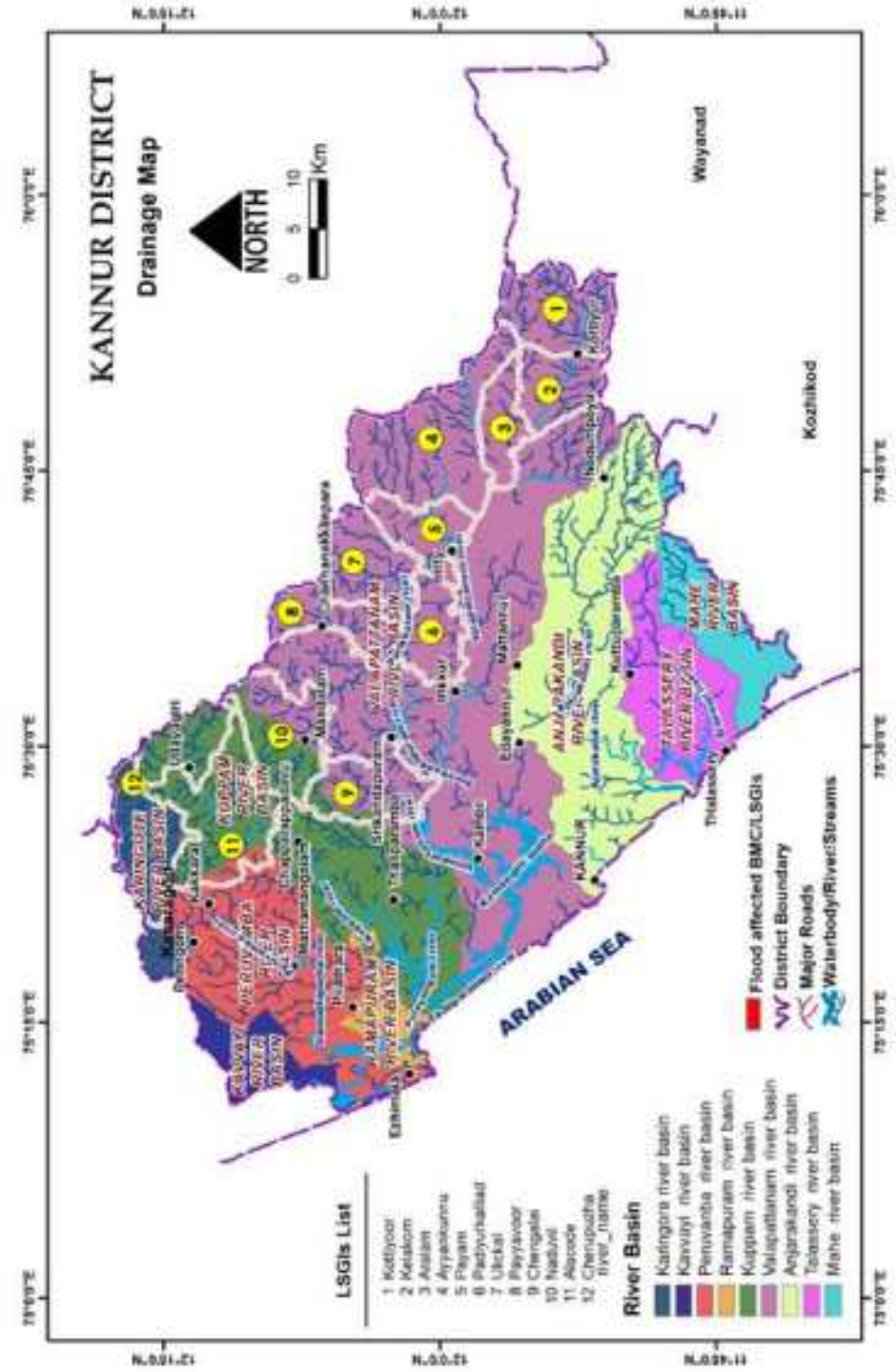


Fig. 25. Kannur District- Drainage Map

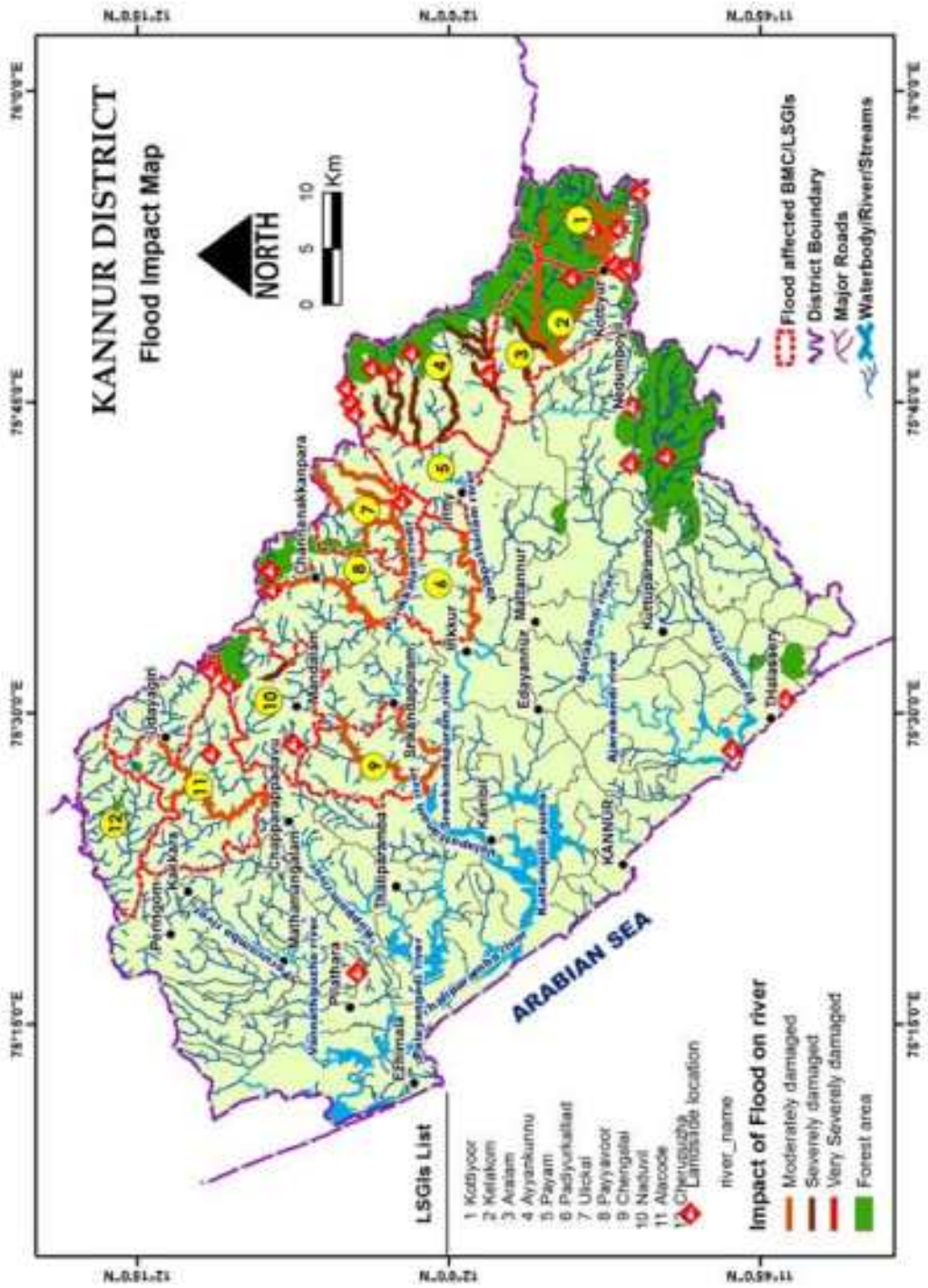
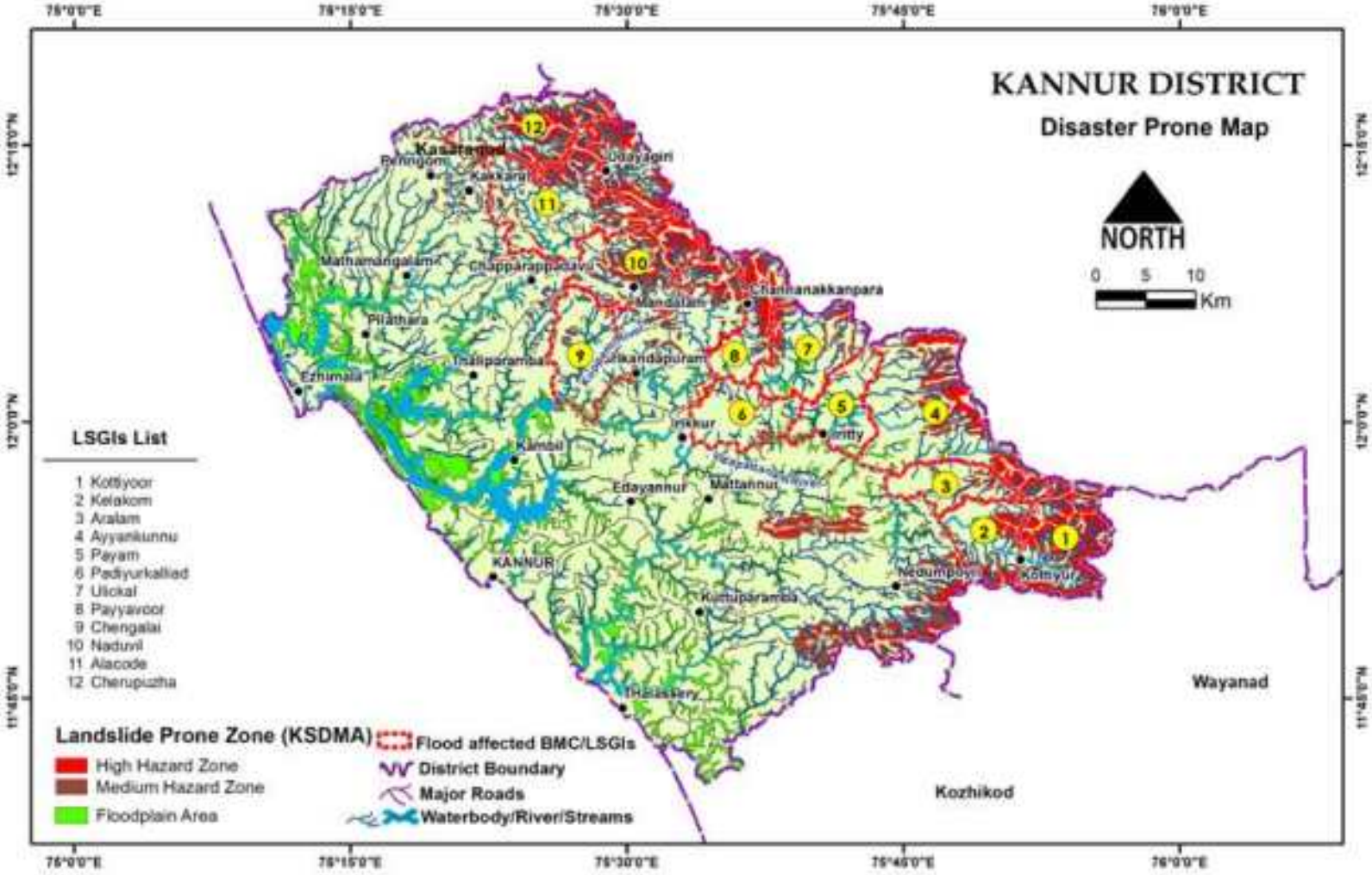


Fig. 26. Kannur District- Flood impact map

Fig. 27. Kannur District- Disaster prone map



Soil erosion
Riverine vegetation loss
Loss of soil from river bed
River bank erosion
Drying up of river immediately after flood eg. Bavali river
Change in soil texture, deposition of soil in some places
Decrease in depth and Increase in width of Varapuzha river at Payam
Formation of sand bars in Varapuzha river at Payam
Change in course of river at Aralam and Payyavoor
Deposition of rocks and debris from landslides
Major Causes
Unsustainable construction activities in slopes using heavy machines
Unsustainable utilization of forest produce
Unscientific agricultural practices
Degradation of Traditional water harvesting structures and vegetation as bamboos, small trees
Removal of small stones from stream beds for construction of channels
Rock stone quarrying
Felling of big trees with wide root system
Decreased Water retention capacity of soil

RIVERINE VEGETATION

Valapattanam river was moderately affected at Chengalayi, Kottiyoor, Payyavoor, Ulikkal, Padiyoor. Ayyankunnu and Aralam villages in the Iritty taluk were worst affected by the floods as the water level in the Valapattanam river and its tributary rose in the upstream. The Valapattanam River originates in the western slopes of the Brahmagiri Hills, Western Ghats. All the rivers upper tributary catchments are covered with evergreen forest and Shola grasslands which are degraded in some areas. The river then flows through townships, paddy fields and rubber and cashew plantations before reaching the lower reaches, backwaters and estuary which it shares with the Kuppam and Peruvamba river. At Alakode, flood water in Kuppam river resulted in rising of water upto 1. 5 mt, while Cheenkanni puzha was severely affected due to Landslide at Aralam and silt was deposited.. Varapuzha was seriuosly impacted at Payam due to floods and soil erosion. Valapattanam river is a key biodiversity area with 14 trigger species. The riverine ecosystem of Cheenkanni puzha at Aralam, Barapuzha at Ayankunnu, Valapattanam river at Kottiyoor, Payyavoor and Ulikkal were affected.

The Valapattanam river ecosystem was very seriously affected at Naduvil due to landslide, leading to soil erosion from the river bed, loss of river side riparian vegetation. The major impact as perceived by the community is the drying up of the river immediately after the floods. They are of the view that this may be caused due to the loss of river bed soil and the resultant decreased water retaining capacity of soil. Barapuzha river was severely impacted at Ayyankunnu due to floods and landslides, here also the drying of river after floods was reported by the local people.


BMC meeting at Kannur


Alakkode-Rayoram


Naduvil-Mavumchal


Payyavoor


Ayyankunnu
Randamkadavu


kottiyur ambayathodu


Ayyankunnu-Edappuzha


Kolithattu, Ulikkal GP


Payyavoor - Chathirambuzha

One of the worst hit areas is Ulikkal. Nuchiyad puzha, Mattara puzha, Peratta puzha was moderately affected due to landslides and flood. As a result the soil from the river bed was washed off, the water level of the river has gone down and the people say that iron content in water has increased. The local people say that there is an increase in incidence of landslides reported from Ulikkal as the number of stone crushers and quarries has increased over the years. In Ulikkal due to landslides soil was washed off from the streams of Kalanki, Anapara, Arabi thodu. Metal pieces from the quarries were

The riverine ecosystem of the tributary Vembuzha at Aralam was severely impacted due to soil erosion and the river changed its course. At Ayyankunnu due to floods and heavy rock slide river was severely affected and after the floods the river dried up. At Kottiyoor, Bavali puzha was moderately affected due to landlsides and the rocks and boulders got deposited in the river. Local people are in the opinion that the width of the river increased by 5-10 mts and immediately after the rains the river dried up.

2) TERRESTRIAL ECOSYSTEMS

In Kottiyoor, Nelliyodi thodu, Kallen thodu, Cholattu thodu, Palchuram thodu were affected due to landslides. Cracks have appeared on the Earth near Kottiyoor which are 300-400 mt long and during heavy rain there is chance of landslides again. Wells at Aralam, Alakodu, Kottiyoor was moderately affected. The drinking water sources at Ayyankunnu, was affected as 35 wells were completely damaged where as at Payam 4 wells were completely damaged and cannot be recovered.

Major part of Kannur district comes under midland region with numerous hills and stretches of laterite capped hillocks. At Alakkod Manjium plantations were established in an area which was a natural habiat for grass and local people attributes this land use change as one of the reasons for the floods.

The district disaster management plan for Kannur has identified the vulnerable areas in the district which includes 29 vulnerable villages. The present study focussed on 12 panchayats of Kannur out of which 8 including Kottiyoor, Ayyankunnu, Aralam, Payyavoor, Padiyoor, Kelakam and Naduvil was impacted by landslides / floods. In addition to these it is observed that four panchayats namely Payam, Cherupuzha, Chengalayi, Ulikkal was affected during the recent floods and landslides. During the floods of 2018 Payam was one of the worst hit areas due to floods and soil erosion.In forest areas of Ayankunnu, Kottiyoor and Ulikkal forest areas were affected due to landslides and the rocks and boulders resulted in massive uprooting of trees and loss of fertile top soil.

Among the panchayaths Mayyil, Sreekandapuram, Irikkur, Malappattam and Padiyoor are characterised with intensive mining activity. Aralam, ward no 3,4, 5 was most severely affected due to landslides and soil erosion, and it is reported to be very difficult to rejuvenate this areas according to local people. At Ayyankunnu, Parakamala was severely affected due to landslides and soil erosion. At Payam very serious impact on the delicate hill ecosystem are found due to the collapse of the hill slopes and appearance of cracks on Earth

Hilly areas of Kalanki, Kolithattu of Ulikkal was very seriously damaged due to landslides and deep gorges filled with boulders has been formed in this area and local people say that it is not possible to recover this area. Payyavoor, Kanhirakkolli, Mattara, Kalanki and Nellikkutty are areas where quarrying has developed as a major economic activity. One of the most significant features is the wide distribution of laterites. Laterites in the block are the extension of laterite sheet from North Wayanad which is the southern tip of the Deccan plateau. In the panchayaths of Ulikkal and Payyavoor mining is not a significant economic activity. But quarrying of gneiss and charnockites are most common in some of the hill slopes. There are 35 mines in the panchayath found mainly in Ulikkal, Vattyamthode, Angadisserithattu, Arabithattu and Kolithattu. One of the most dangerous impacts of laterite mining here is the ever increasing loss of topsoil from the hilltops.

3.3.3. MALAPPURAM

3.3.3.1 DISTRICT PROFILE

Geographically, this district is classified in to Coastal, Plains and Hilly areas. Chaliyar, Bharathapuzha, Kadalundipuzha, Thiroor puzha, Kunthipuzha etc. are the major rivers flowing through the district. Canoly plot, situated in Nilambur area, the world's first man made teak plantation is in this district. Cholanaikkar, the primitive tribal groups inhabits the Karulai region in Malappuram district. New Amarambalam reserve forest lies in the Nilambur forest region of the district. Silent valley national park, Nilgiri biosphere reserve, a biodiversity important area is also part of this district. The forest tract from Pandiar-Punnapuzha in the North to Cherupuzha in the South is treated as the Karimpuzha valley, which constitutes the eastern portion of Chaliyar basin. The forests in the upper catchment of Chaliyar are part of the New Amarambalam Reserve lying within Nilambur South division and form the core zone of the Nilgiri Biosphere Reserve. The New Amarambalam Valley is ranked second to Silent Valley in its biodiversity index.

3.3.3.2 THE DISASTER- FLOODS AND LANDSLIDES OF 2018

The average rain fall in this district for 1 June to 22 August is 1761.9 mm whereas during 2018 the actual rainfall was 2637.2mm which was 50 % above average.

3.3.3.3. STUDY AREA

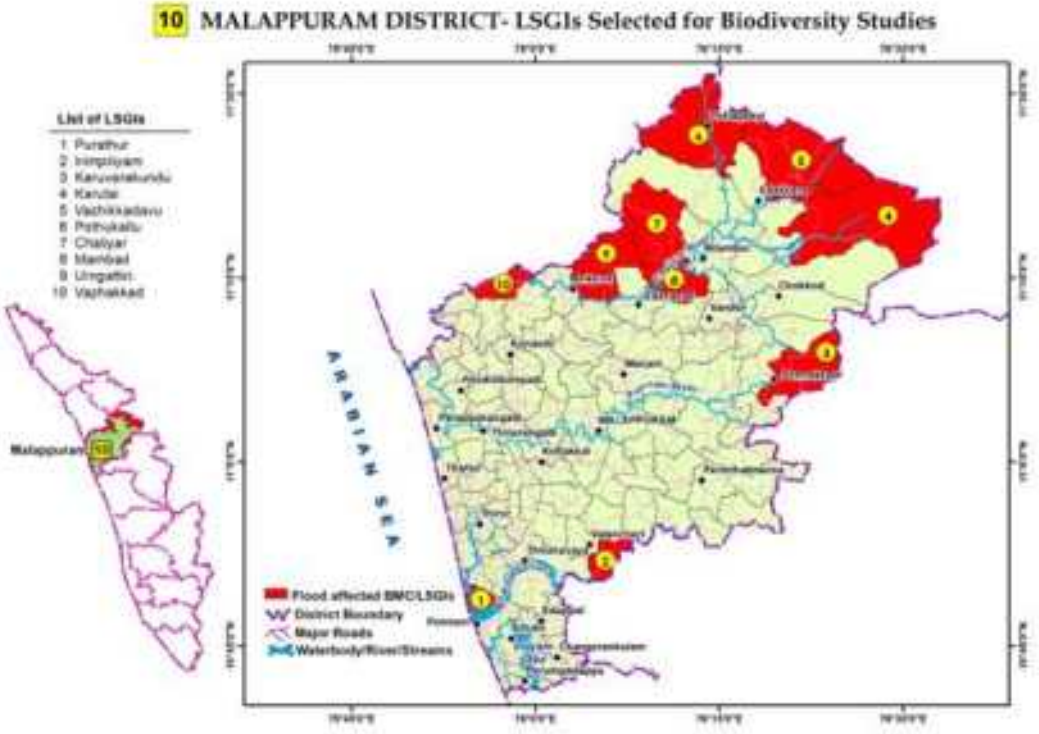
Ten most affected panchayats were selected for the study

Table 17 Ten most affected panchayats - Thrissur.

No:	Grama Panchayath	Flood/ landslide/ Both	Impact of Flood/ Landslide
1	Chaliyar	Both	High
2	Irimbiliyam	Flood	Medium
3	Karulayi	Both	High
4	Karuvarakundu	Both	High

5	Mampad	Flood	Medium
6	Pothukallu	Flood	Medium
7	Purathur	Flood	Medium
8	Urngattiri	Flood	Medium
9	Vazhakkadu	Flood	Medium
10	Vazhikkadavu	Both	High

Fig. 28. Malappuram District - LSGs Selected for Biodiversity Study.



3.3.3.4 IMPACT OF FLOODS/ LANDSLIDES ON MAJOR ECOSYSTEMS

1) RIVERINE ECOSYSTEM

River Chaliyar

Known in the lower reaches as the Beypore river, Chaliyar is one of northern Kerala's important rivers. It originates in the Ilambalari hills in Gudalur taluk of Nilgiri district in Tamil Nadu and flows through New Amarambalam Hills in Kerala. The Chalipuzha, Cherupuzha, Punnapuzha, Pandiyar, Karimpuzha, Vadapurampuzha, Iruvanjipuzha and Iruthilpuzha are its important tributaries. The Chaliyar river flows through Nilambur, Mambad, Edavanna, Areecode, Vazhakkad in Malappuram district and Feroke in Kozhikode district before it joins the sea near Beypore. The flood affected Chaliyar, Mampad, Oorngattiri and Vazhakkad panchayath.

In Chaliyar, the flood heavily affected the biodiversity of the area. Impact on river shore and soil erosion due to flood affected the tributaries like Kaanjirapuzha and Kuruvan puzha. Landslides and landslips that happened in the forest resulted in a massive flow of water and rocks in to the river. In some areas the water rose to a level of 2.5 meters above ground level, causing the submergence of herbs, shrubs and small animals. At Mambad of 19 wards in 15 wards flood/ landslide occured, but in 3 wards the landslide was severe. Due to landslides rocks and boulders were washed down the Chaliyar river and water rose almost upto 8 mt height. Small streams called Choora puzha, Pengadchola were affected. At Vazhakkadu massive soil erosion occured at many places, and at Parasserikutti area, Mukkorackal sand bars of 1-2 mt height was formed. At Edakadavu a sand bar of 65 mt length and 4 mt height was formed.

Bharatapuzha

Bharatapuzha originates in the eastern slopes of Anamalai mountains in Tamil Nadu, some of the river's tributaries are Gayatripuzha, Kannadipuzha, Kalppathipuzha, Thoothapuzha. Bharatapuzha comprises one of the sixteen catchments in the southern Western Ghats that has the highest species richness and endemism of freshwater taxa including fish, mollusc, and odonates. **Thuthapuzha the main tributary of Bharatapuzha was flooded and water rose upto 2 1/2 mt, the river banks collapsed and river changed its course at Irimbiliyam and many depressions were formed in the river bed. Local people say that floods coupled with unregulated sand mining has led to the formation of such depressions.**

Kunthipuzha

The Kunthipuzha River flows through the Silent Valley National Park, and is a tributary of the river Thuthapuzha, which is in turn one of the main tributaries of the Bharathapuzha River.

Fig. 29. Malappuram District - Drainage Map

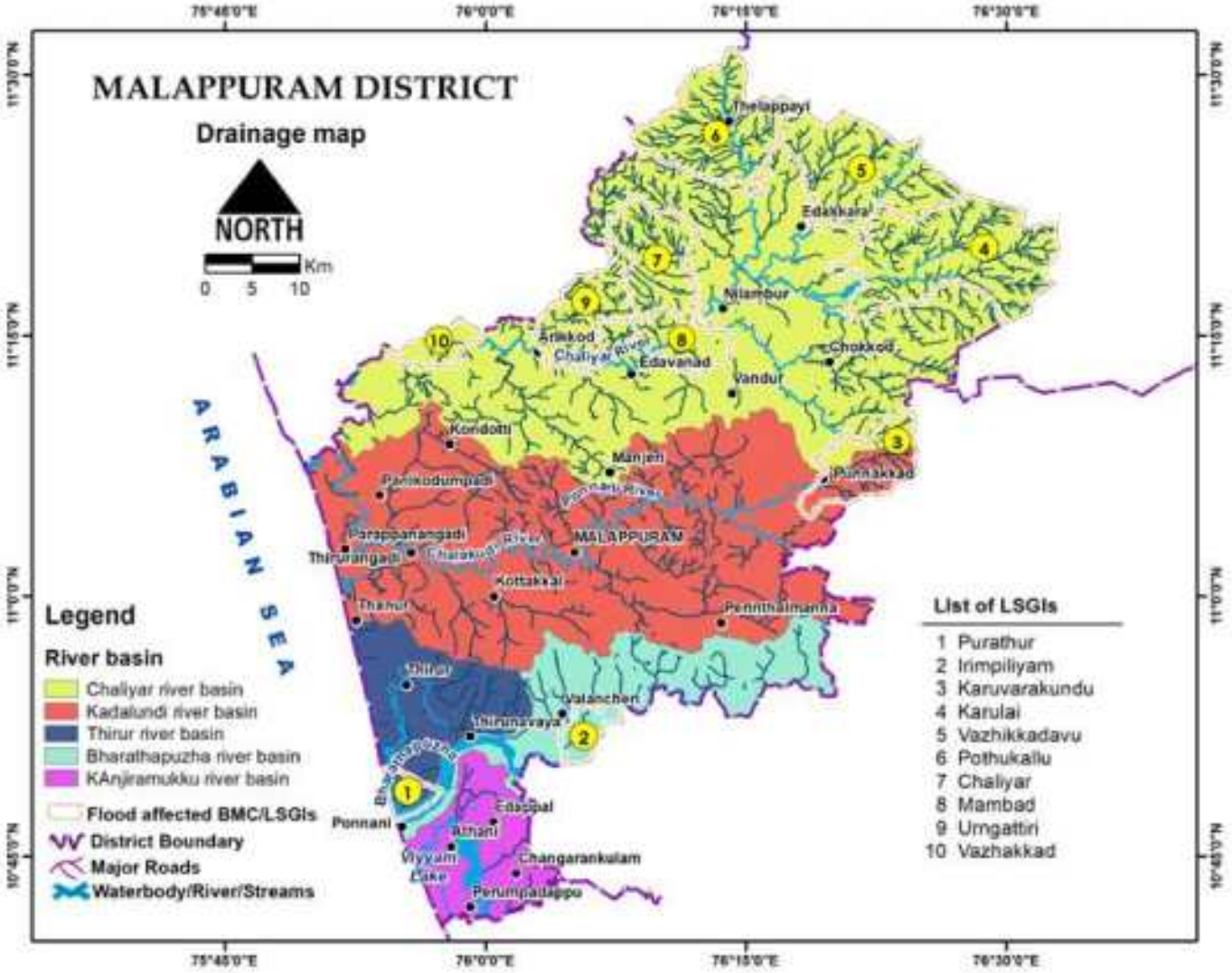


Fig. 30. Malappuram District - Flood impact map

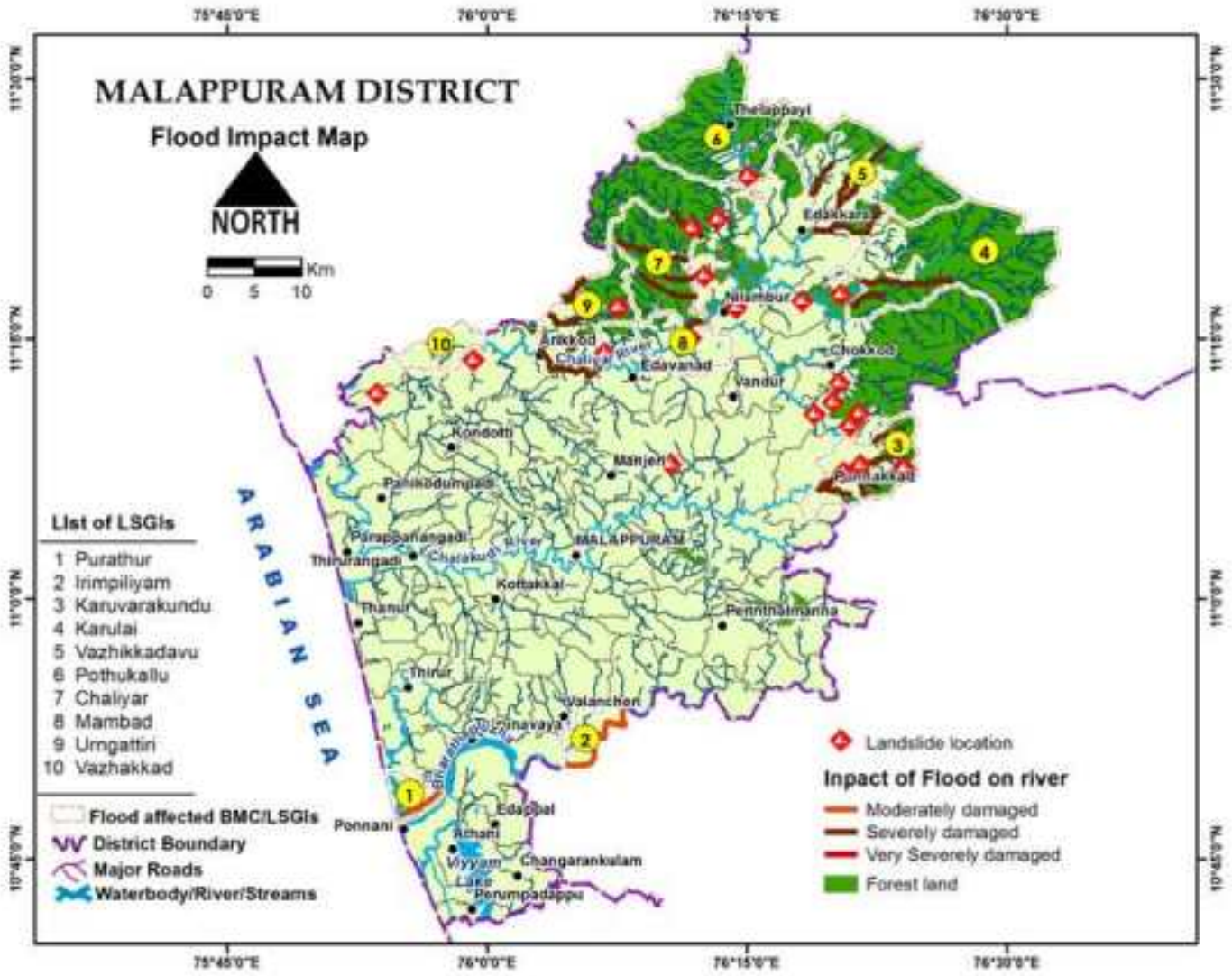
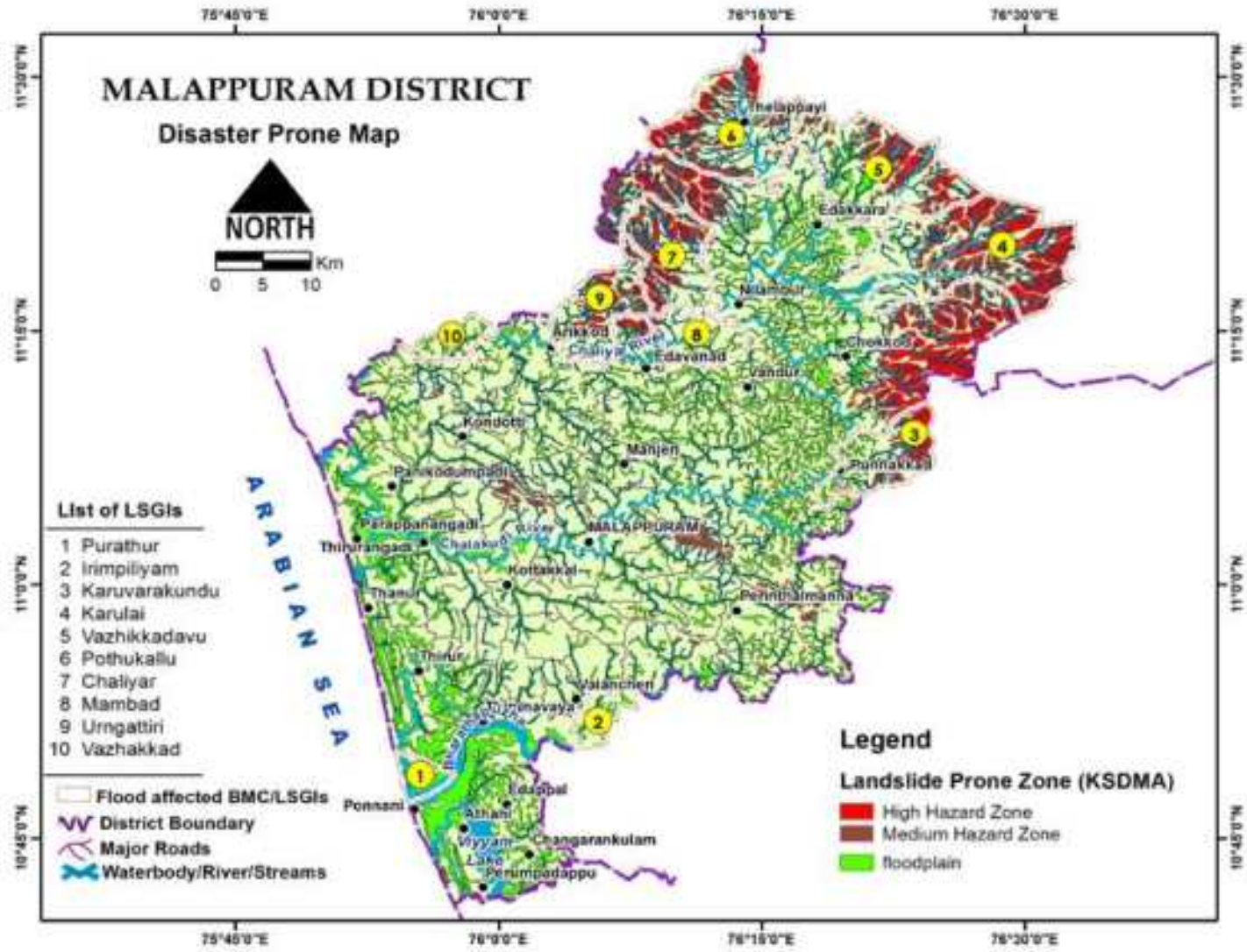


Fig. 31. Malappuram District - Disaster prone map



Karuvarakundu was one of the affected areas and the tributaries as Olipuzha, Kallanpouzha, Sulthanpuzha, Cherithodu, Madari thodu, Chembankadu thodu, Parasseri thodu overflowed and Olipuzha changes its course. Soil erosion occurred at many places on the banks, sand bars were formed, in some areas due to the deposition of stones and mud the streams changed its course.

The wet lands at Ponani, Maranchery, Purathur areas were badly affected because of the natural calamity. At Ponnani a new island-like area developed along the beach. At Urnagattiri two small streams has been completely degraded due to landslides and flood.

2) TERRESTRIAL ECOSYSTEM

The major forest area of the district is concentrated in Nilambur and Wandoor blocks and Melattur region. There are no remarkable damage reported from the forest areas of Nilambur South Division. At the same time, major land slides occurred at Pullengode, Chengode, Nenmini, Arakkuparambu, Adakkakundu, Cheri, Manjalamchola& Manaliyampadam in Karuvarakundu Forest Station of Kalikavu Forest Range. Landslides also occured in Nilambur North Division at Odakkayam, Vettilakolly, Palakayam, Kakkadampoyil, Moleppadam Area, Aadyanpara Area

The ecological impact at Chaliyar, Karulai, Karuvarakund and Vazhikkadavu are high compared to Irimbiliyam, Mampad, Pothukkallu, Purathur and Urngattiri. Soil erosion occurred in Chaliyar, Irimbliyam, Karuvarakundu and Karulai Panchayaths. The soil and water from hilly areas deposited in the lower regions resulted in the changes in the soil color and texture. In Irimbliyam, the soil color changed from brown to red. The soil fertility is lost and the soil became dry. Of the total 17 wards of this panchayat 13 wards were affected by floods and landslides and soil erosion occured in 2 wards. Due to heavy rainfall at Neelandanpara soil erosion occured.

At Chaliyar Kuravanpuzha which originates from Vellarimala flowed changing its course for about 2 km, and the vegetation in the path of the river was completely destroyed, big rocks and boulders were deposited in the area changing the natural habitat of this area. At Punchakolli, Vazhikkadavu a crack has appeared on the Earth surface. Landslides were also reported from Urnagattiri from forest areas. The grasslands and rocks at Nelliyayi was damaged due to landslides

Local people say that construction activities in hilly areas using huge machines is one of the cause for landslides and soil erosion. Encroachments in the river banks and construction of check dams obstructing the natural course of the river leads to erosion of river banks. People suggest that land use change should not be encouraged and that any construction activities near the river bank should be done only after conducting EIA.

At Urnagattiri people observe that land use change such as the spread of Rubber plantations, filling up of paddy fields, filling up of naural rivulets etc has enhanced the impact of floods. They recommend that for any activities near the forest a green growth policy should be adopted. It was suggested that for maintaining the pristine nature of wetlands a panchayat level water conservation policy should be adopted. In Gramasabha meetings biodiversity and environment conservation should be discussed and action plan developed.

3.3.4 KOZHIKODE

3.3.4.1. DISTRICT PROFILE

Kozhikode district is bounded by Kannur district in the north, in the east by Wayand, South by Malapuram and Arabian Sea in the West. All the four taluks of the district are spread over three regions the sandy coastal belt, the rocky highlands formed by the hilly portions of the Western Ghats and the lateritic midland. Of the total area of 2344 sq.kms, the sandy coastal belt is 362.85 sq.kms, lateritic midlands 1343.50 sq.kms and rocky highlands 637.65 sq.kms.The highland region accounts for 26.80 per cent and the lowland region for 15.55 per cent of the total area of the district.

Many rivers which originate from Western Ghats which is located along the eastern part of the district run along the outer reaches of Calicut city, namely Chaliyar, Kallyai, Korapuzha, Poonoor Puzha and Iravanjhi Puzha. Among these Kallayi puzha has its origin in Cherikkulathur village. This river is connected to Chaliyar on the south of the Kozhikode city by a manmade canal. Kallai River has been most important with respect to cultural and historic perspective of Kozhikode.

Another important river the Korapuzha is formed by the joining of Agalapuzha with the Punnurpuzha, which empties in to Arabian Sea at Elathur. Canoly Canal was built in 1848. This canal connects the Korapuzha River in the north to Kallayi River in the south. This canal was made to function as a drain to reduce flood in monsoon and also for navigation. This canal passes alongside a system of mangrove patches, wetlands and small forest patches. Mangroves ecosystem which is highly valued ecosystem in terms of ecosystem services provided especially for shoreline protection. This very unique ecosystem has been highly endangered in terms of sand deposit due to anthropological impact in upstream of many rivers and streams. Kadalundi – Vallikkunnu Community reserve the only community reserve in the State is located in this district.

3.3.4.2. THE DISASTER - FLOODS/ LANDSLIDES OF 2018

The district experienced a rainfall of 2898 mm during the period 1 July to 31 August 218, an excess of 29 % from the noraml rainfall of 2250.4 mm. Many regions of the district suffered due to landslides and flash floods.

3.3.4.3. STUDY AREA AND ASSESSMENT METHODOLOGY

The study area included 12 gramapanchayats most of which are located in Chaliyar river basin. In Kerala, landslides commonly occur in localised areas of the Western Ghats region where the slope is steep and the soil is over saturated as a result of prolonged rainfall. 26.80 per cent of the Kozhikode district falls under this category and hence these areas are prone to landslides.

3.3.4.4. IMPACT ON AQUATIC ECOSYSTEMS

Much of the fresh water habitat of both flowing and static in nature has been partially or completely destroyed. The reason for the same is that the stagnant water sources like ponds have been completely filled up with the mud and rocks from the landslide. The impacts of flood on rivers are many folds and these have been a common phenomenon in almost all of the districts of the state. The major impact was on Puthupadi where due to landslides the Kanappankundu Puzha changed its course and large amounts of soil, and debris were deposited. At Karasseri in marshy lands dust and sludge from quarries and materials from M Sand manufaturing units were deposited.

Fig. 32. Kozhikod District - LSGs Selected for Biodiversity Study.

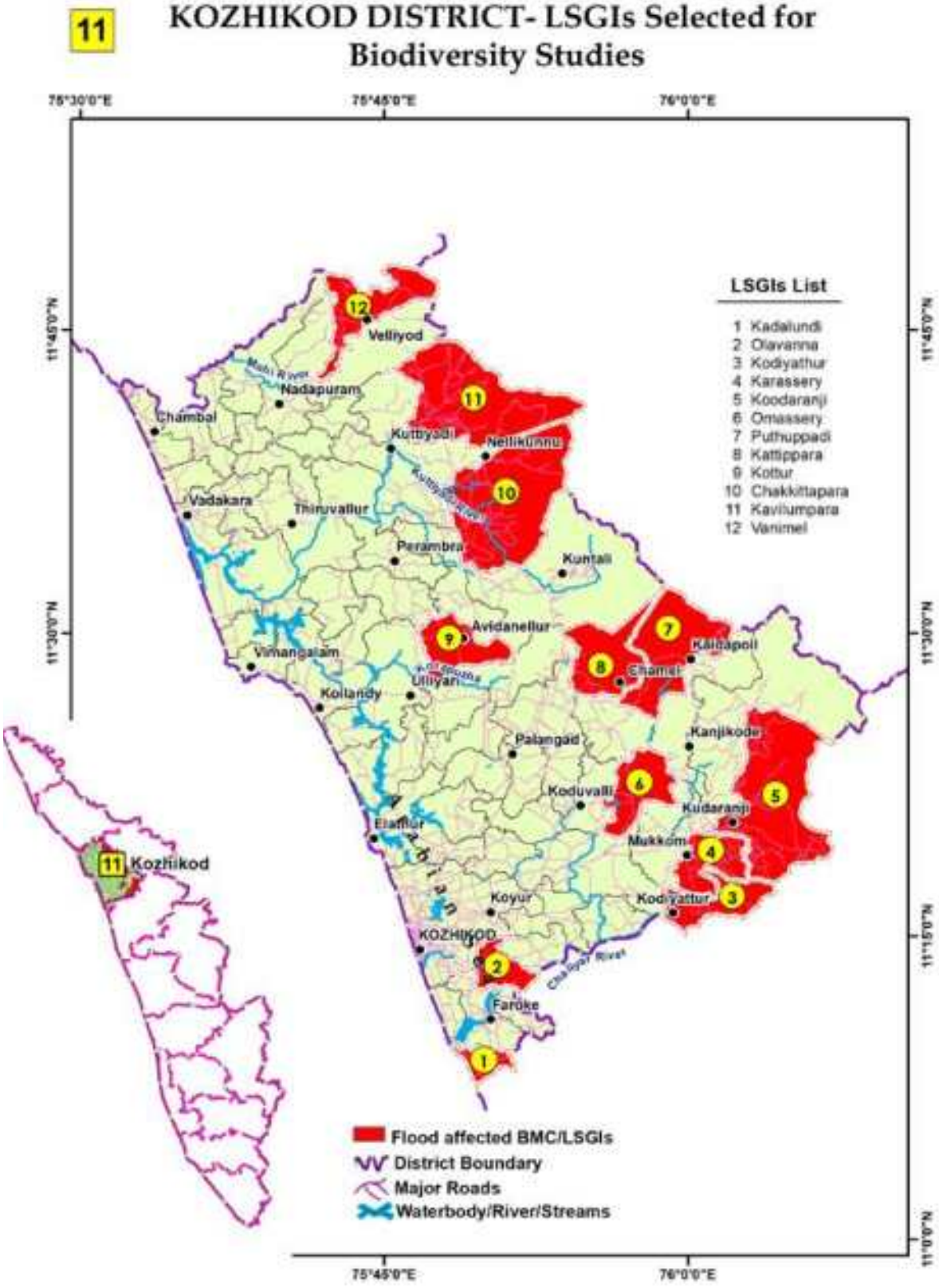


Fig. 33. Kozhikod District - Drainage Map

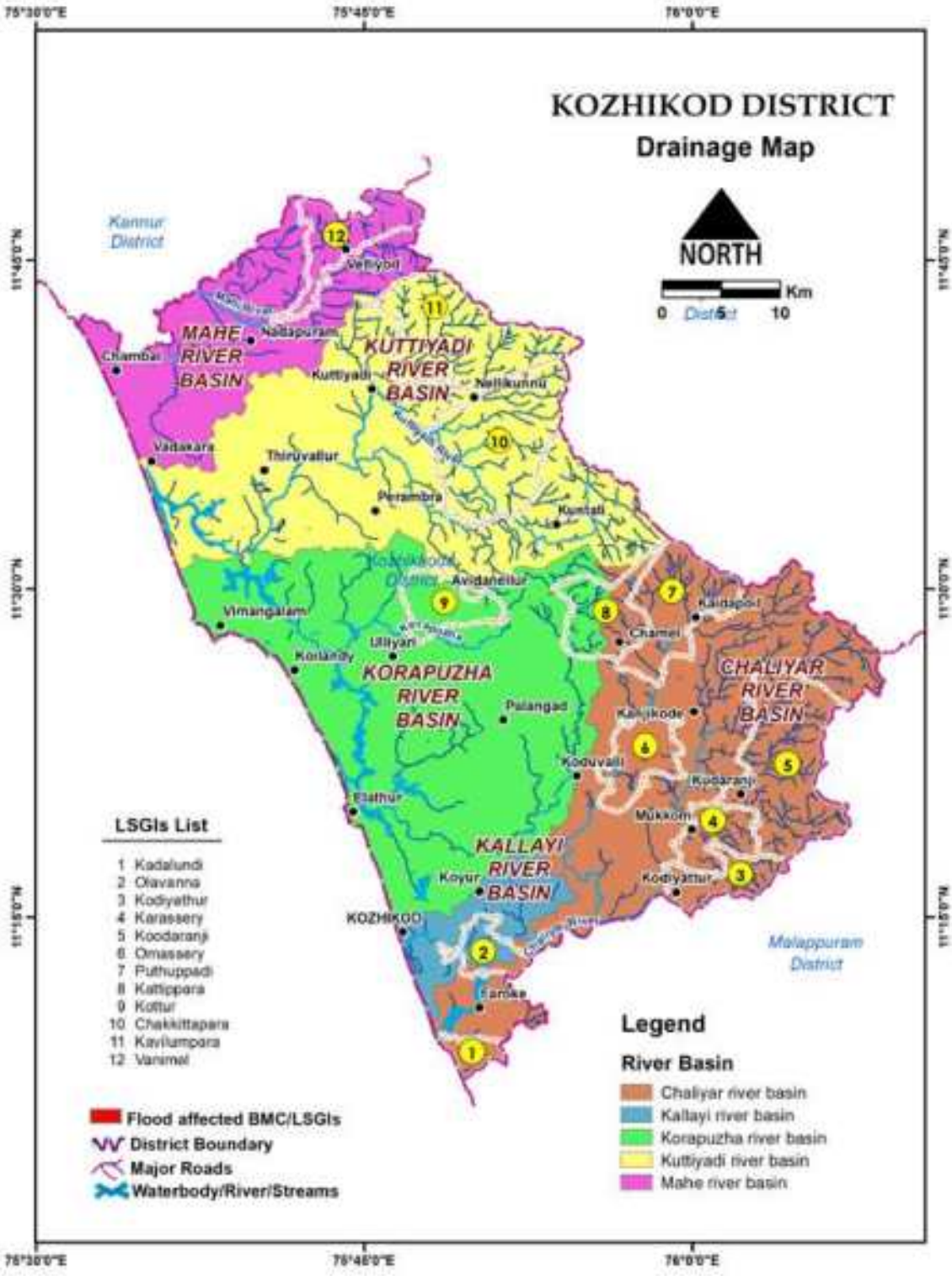


Fig. 34. Kozhikod District - Flood impact map

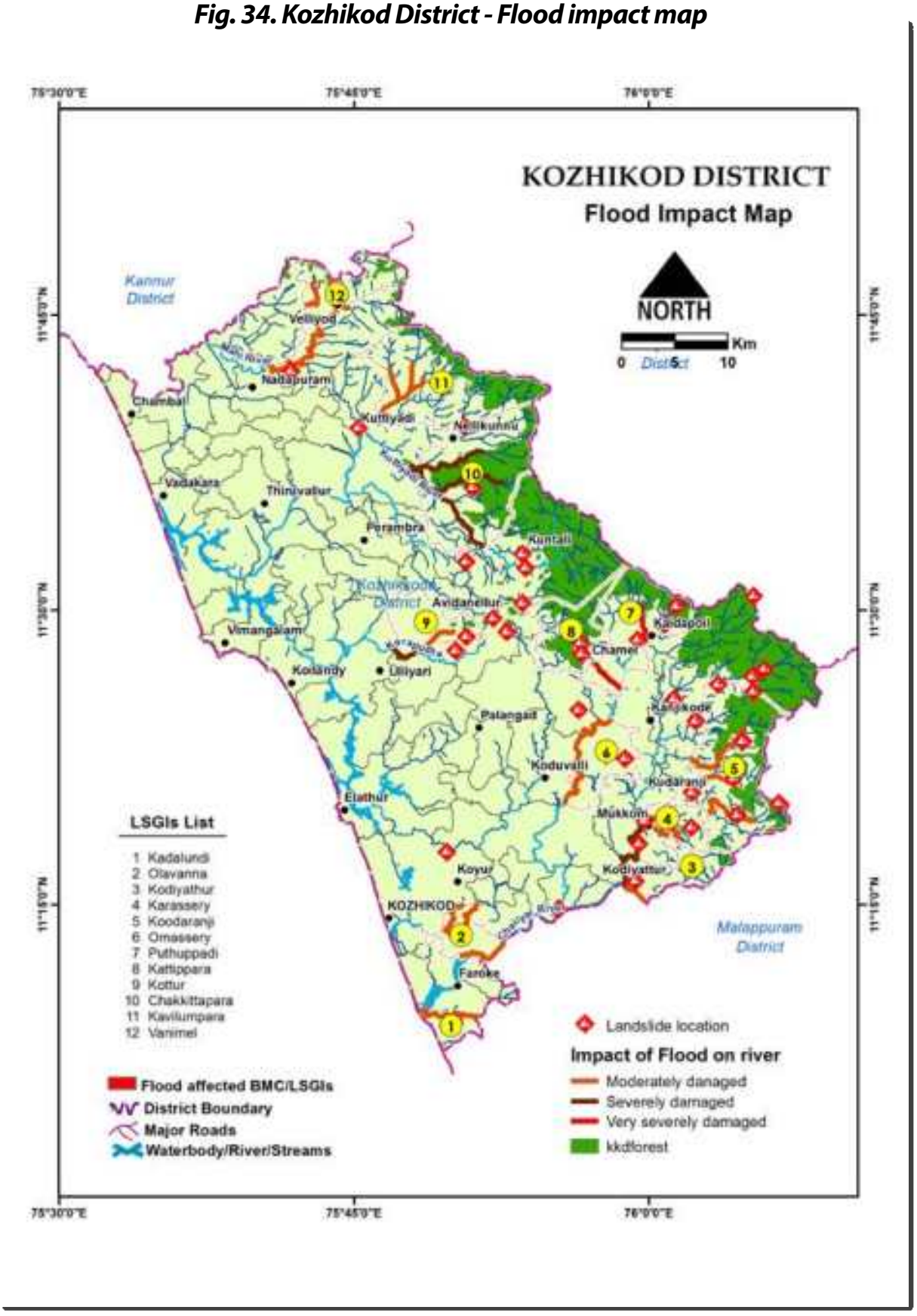
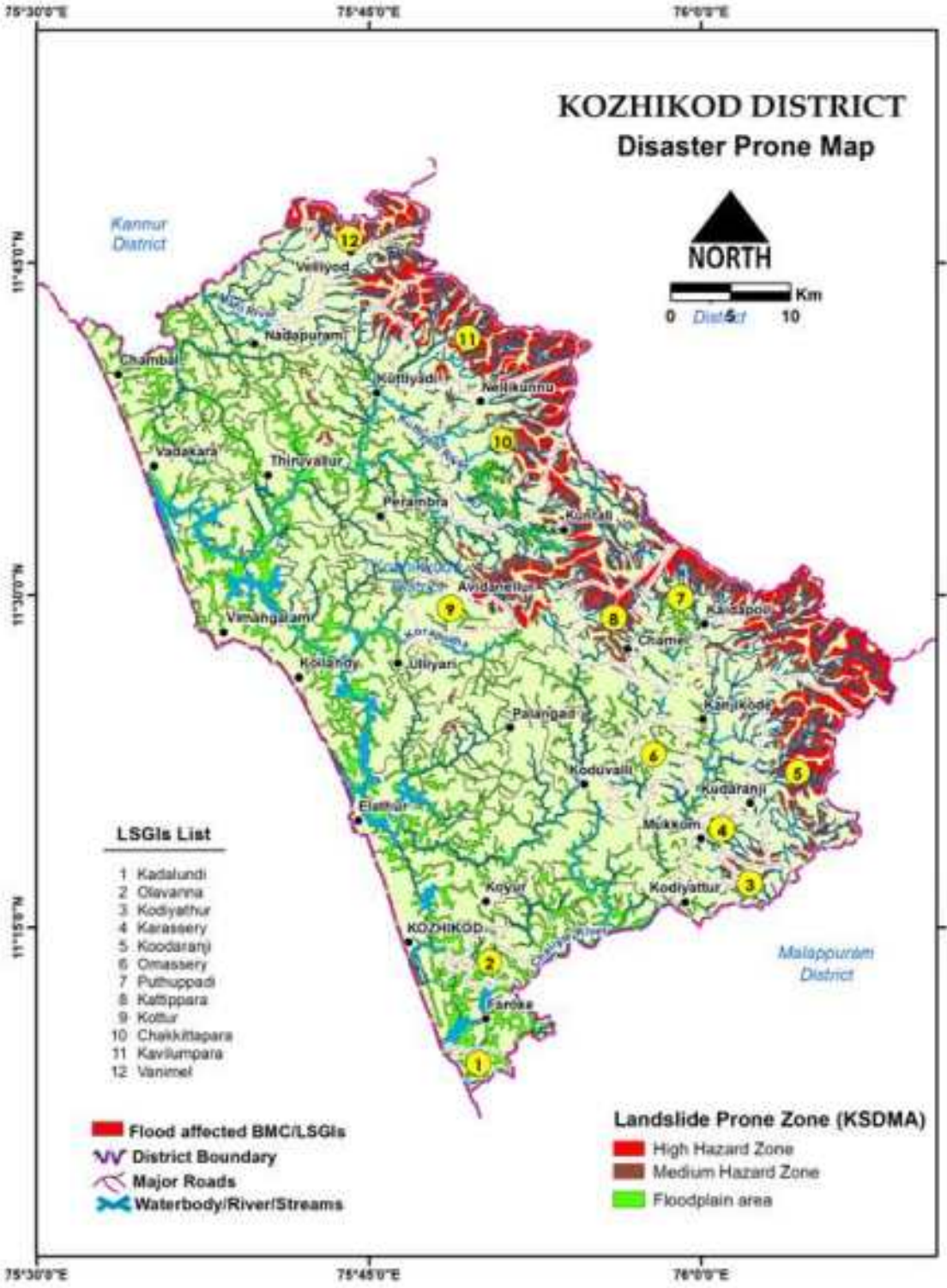


Fig. 35. Kozhikod District - Disaster prone map



The district faced flash flood which washed of much of its river banks, which increased the width of the rivers. This has been largely because of the anthropological activities that made changes to the banks of river substituting its natural vegetation. The flash floods washed away the long deposits of sand and other natural forms. This increased the depth of the rivers. This has been noted at Thudarappuzha at Puthuppa.

At certain places depth of the river decreased. Thisphenomenon has also been noted in certain rivers were the sand washed away from high altitudes of the river have been deposited in the lower portions of the river which has lead to the decrease in depth of the river. This phenomenon has been noted in lower portion of Chaliyar River at Kodiyathoor, Karasseri, Koodarnji and in Iruvazhanjippuzha at Kodiyathoor.

> Local people says that all the small streams should be conserved. The encroachments in Chattankaithodu, Mattumalthodu, Poolakachirathodu, Chembayithodu, Kudapuram thodu should be removed. Quarrying should not be allowed in areas where there is chance of landslides areas. In Kadalundi peope say that the width of many of the streams has reduced and it should be restored.

Though there is a increase in depth and width of the river at many places throughout the course of rivers, and in certain places the decrease in depth there has been noted a decrease in water level of many of the rivers when compared to previous years. This would be largely for the fact that there is no natural barriers that keep the water from emptying in to the sea. Normally when a stream or river passed through it course, it faces many barriers like natural vegetation which slows down its flow and also much of the water are absorbed by the humus rich soil that allows a slow release of water. But when these natural barriers are washed away by flash floods the water flows free with very less absorption and is emptied in to the sea.

Fertile Alluvium soil are also deposited in the bank of Chaliyar and in paddy fields and this could be very helpful to increase the fertility of the fields which could aid cultivation. Another impact that the flood has caused to wetland is the deposition of sand and formation of sand bed in wetlands. This has been reported in many areas in Kozhikode district such as Kottoor, Olavanna, Omasseri, Puthuppadi. In much of these areas sand beds have been formed in wetlands and paddy fields to a height of about 1 meter and it has also been reported to an area up to 1.5 Acres. This has changed the texture of soil in much of the wetlands. The fertility and water holding capacity of the wetlands have been reduced. The plastics and other non degradable materials that has been dumped in to river and lakes have been thrown off to the wetlands which has been entangled in wetlands which has made it difficult in managing these waste.

2) TERRESTRIAL ECOSYSTEM

Landslides have been reported from many areas in the high lands of Kozhikode district. Places like Kavilumpara, Karasseri, Koodaranji, Puthuppadi, Kottoor, Omasseri Vanimel and Katteeppara had more than one landslides reported. The impacts of these landslides have been of many folds.. Landslide had happened in more than 20 places in 1985. It is worth to note that after quarrying started at Karasseri village in 2005, landslides had been frequent and repeated year after year. 13 large landslides were reported in 2018. It is also interesting to note that because of the increasing anthropogenic activity, since 1990's, more number of landslides have been reported. At Karasseri landlsides occured in 1988 and 1991, landslides were reported in Sambra and Perumbula also respectively. Another major area was Chakkittapara where Ooni puzha, Anaghan puzha etc was impacted due to soil erosion and sand bar formation. At kottoor also soil erosion occured and the impact has been severe at Kattipara, Karincola mala and upto 3 mt soil has eroded, rocks crumbled. Local people say that unscientific construction activities and quarrying is repsonsible and it is very difficult to recover. At hill slopes at Koodarinji also the impact was severe.

KADALUNDI – VALLIKKUNNU COMMUNITY RESERVE

Kadalundi – Vallikkunnu Community reserve is a bird sanctuary spread over 154 hectares of area in Kadalundi village of Kozhikode district and Vallikkunnu Village of Malapuram district. Different species of mangroves are present in this area. The habitat created by the sand bed, mangroves, crisscrossing small canals, large wetlands and coconut plantations is acting as both breeding ground as well as wintering ground for many migratory birds, butterflies, dragonflies, reptiles and amphibians etc. About 326 plant species, 9 mangrove varieties, 15 mammals, 23 reptile species, 7 species of frogs, 12 species of fishes and 135 species of birds has been reported from this area.

The reserve has been facing challenges with respect to the drying of mangrove plants since last decade. This has been largely due to the accumulation of sand. The breathing roots of mangroves are increasingly covered by sand by the recent floods; this has accelerated the drying of mangroves. With the soil texture changing from muddy, clay to more sandy it will lose it water retaining capacity, this will reduce the soil microbes and polycheates that the birds depend on as food, and will have an impact on the migratory birds in future which will bring about drastic ecological changes.

The impact on soil texture: The landslides have brought about changes in the characteristic of soil in many areas. In some places the rocks have been crushed and the sand from these crushed rocks have been washed down. This has changed the soil texture and made the soil less fertile. The top soil has been completely removed and washed away and the soil remaining is devoid of humus and other organic matter.

In Kozhikode district the landslide has played a major role than flood. Silt deposition of 2-4 cm was reported in low land areas due to flood where as in highlands the landslide had deposited 10 or 100 times soil to the area compared to low lands. A mixture of plants, trees, and soil from powdered rocks etc. were deposited in the place of topsoil which was washed away. Other than natural processes, the process like the anthropogenic activities such as quarries and small dam constructions etc. adds more to it. In Panchayaths like Karasseri, where quarries are functioning, the deposited soil contains small rock powder. The characteristic of soil is different in different areas where landslides happened. A detailed study is needed to identify the changes and their ecological significance.

3.3.5. PALAKKAD

3.3.5.1. DISTRICT PROFILE

Palakkad with a total area of 4,480 km2 is the largest district in Kerala. The district opens the state to the rest of the country through the Palakkad Gap with a width of 32 to 40 Kms. The district is one of the main granaries of Kerala and its economy is primarily agricultural. The district is also the land of Palmyrahs.

The climate of this district is slightly different from the rest of the State, as it is influenced by the presence of Palakkad gap. The district has a tropical climate, with an oppressive hot season and fairly assured seasonal rainfall.About one third of land is covered by forests. Based on the physical features, the district is divided into two, viz., the mountainous highlands and the undulating midlands. The highland has high mountains, deep valleys with tropical forest of various types. These are mostly seen concentrated on the northern and southern parts of the district on either side of the Palghat

Gap. Most parts of the district fall in the midland region except the Nelliampathy-Parambikulam area in the Chittur taluk in the south and Attappadi-Malampuzha area in the north, which are hilly and fall in the highland region.Evergreen forests are limited and deciduous forests dominate. Vast areas of teak plantations exist in the Nelliampathy and Walayar region. Dense forest are mainly found in Mannarkkad and Chittur blocks of the district.The Attappady valley is occupiedby three tribal groups vizIrular, Kurumbar, Mudugar. The Parambikkulam and adjoining area have Muthuvans, Eravallars, Malamalasar, Malasar and Kadars.

The district is blessed with many small and medium rivers, which are tributaries of the BharathapuzhaRiver.The four main tributaries are Gayatripuzha, Kannadipuzha, Kalpathypuzha and Thuthapuzha.Bharathapuzha is one of the richest among the State's rivers in terms of fish diversitywith three species endemic to the river. The Kunthipuzha stream of the Thoothapuzha tributary flowing through the Silent Valley National Park has very high conservation value, as two endemic species are restricted to this stream.

3.3.5.2. THE DISASTER- FLOODS AND LANDSLIDES OF 2018

As per the IMD records, 73% increase in rainfall from 1321.7 mm to 2285.6 mm was recorded in Palakkad during the period from 1 June 2018 to 22 August 2018, which is next only to Idukki which is the highest.

3.3.5.3. STUDY AREA AND ASSESSMENT METHODOLOGY

The study area selected for quick assessment of flood impact in Palakkad district included 10 Gramapanchayaths and 2 Municipalities which were most seriously affected by floods. They are as follows: Nelliyampathy, Wadakkancherry, Sreekrishnapuram, Malampuzha, Ayiloor, Kizhakkancherry, Thiruvegappuram, Vadakarapathy, Nemmara, Kadampazhippuram, Mannarkkad Municipality and Palakkad Municipality. Initially, Attappady area was not included in the area considering the remoteness and inaccessibility of the area for quick assessment. Subsequently, details of biodiversity loss in respect of the above areas were also gathered from various stake holders and included in the report.

Study Group: Students from the 8 educational institutions of the district participated in the survey. **They are :** 1.Ideal College, Cherplasserry 2. Mahatma College, Karimba 3. SN College, Alathur 4. MES Kalladi College, Mannarkkad 5.VTB College, Sreekrishnapuram 6.ITI Malampuzha 7.Government Arts and Science College, Kozhinjampara 8.Government College, Chittur.Four Biodiversity Management Committee (BMC) members from each panchayath with the technical guidance from two selected field experts also participated in data collection. Data collected manually through questionnaire and with the help of ODK software were verified through discussion with the focal groups and subject experts before compiling them for the preparation of the report.

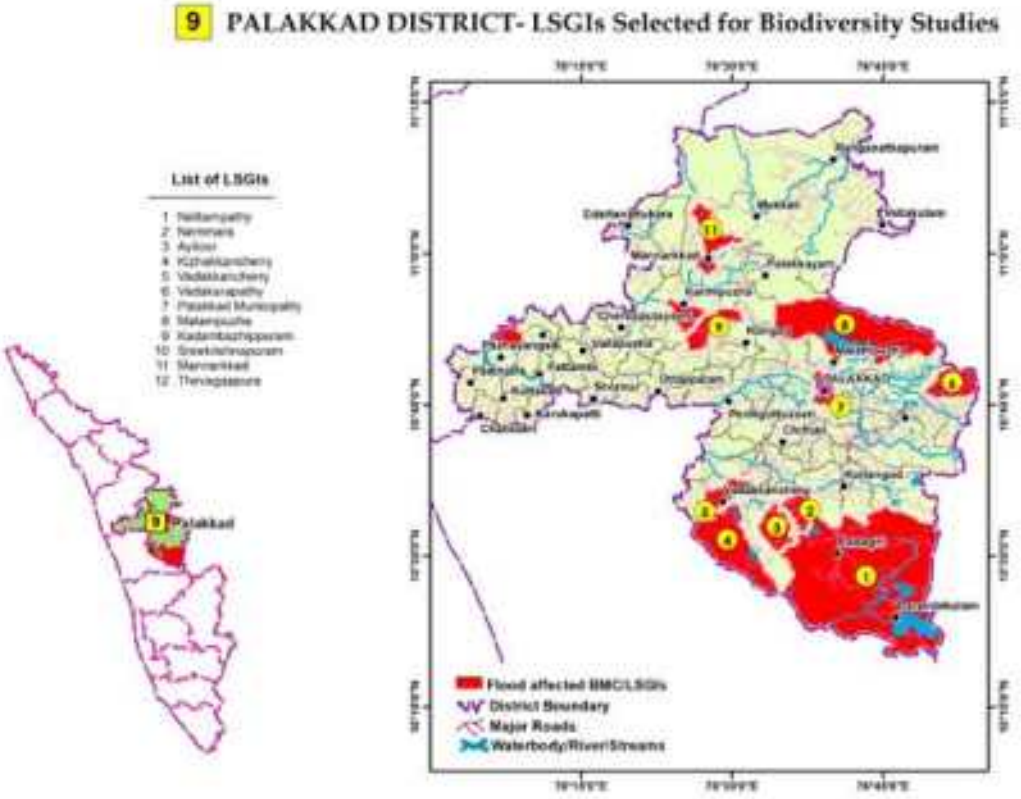
45 FGD were conducted and 293 people were interviewed. 43 people from Tribal people in Nelliyampathi including Kadar community from Cherunelli, Malasar tribal communities from Pullookadu, Brookland were also interviewed.

3.3.5.4. IMPACT OF FLOODS/ LANDSLIDES ON MAJOR ECOSYSTEMS

Many parts of Olavakode, Kalpathy, Chandra Nagar, Jain Medu and KunnathoorMedu were inundated in heavy rains. Landslips were reported from Kava, Parappana and Elival, hilly regions forming part of the catchment area of Kerala's largest irrigation dam Malampuzha. Massive landslides have taken place at Nelliyampathy hills. Bharathapuzha's tributaries Mangalam, Ayiloor, Gayathri, Mokkai, Kalpathy and Walayar were in spate and water flowed heavily in the otherwise dry Bharathapuzha. The damage caused was wide spread, causing harm to not only to human life, but also to the diversity

of flora and fauna and the ecosystems in which they prevailed.Almost all the residential areas in Palakkad municipality which were built by reclaiming paddy fields were submerged in water, while the outer regions of the town and the district were almost unaffected by the flooding.

Fig. 36. Palakkad District - LSGs Selected for Biodiversity Study.




Sand deposition in banana plantation at Mayapara, Malampuzha

Fig. 37. Palakkad District - Drainage map

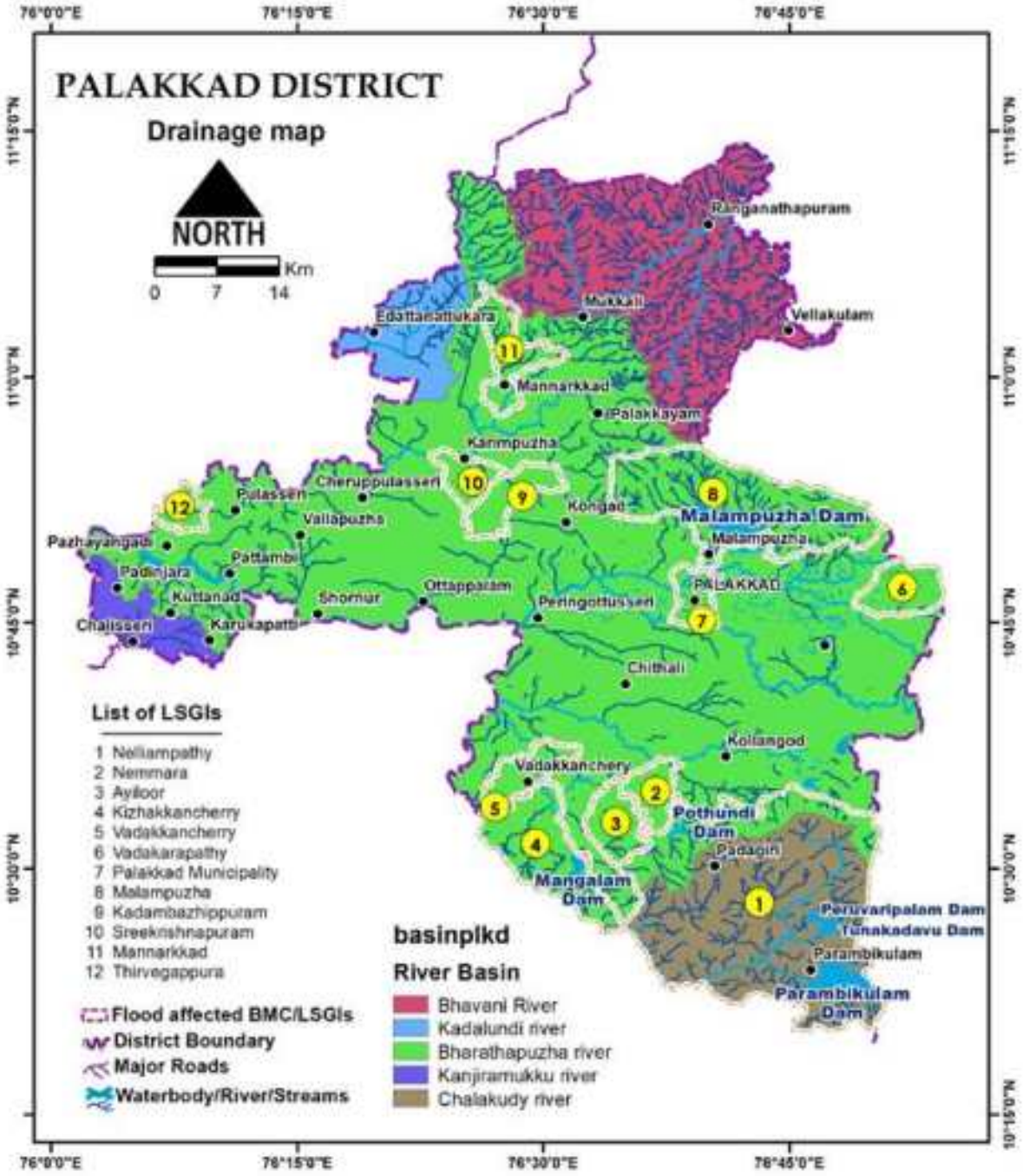


Fig. 38. Palakkad District - Flood impact map

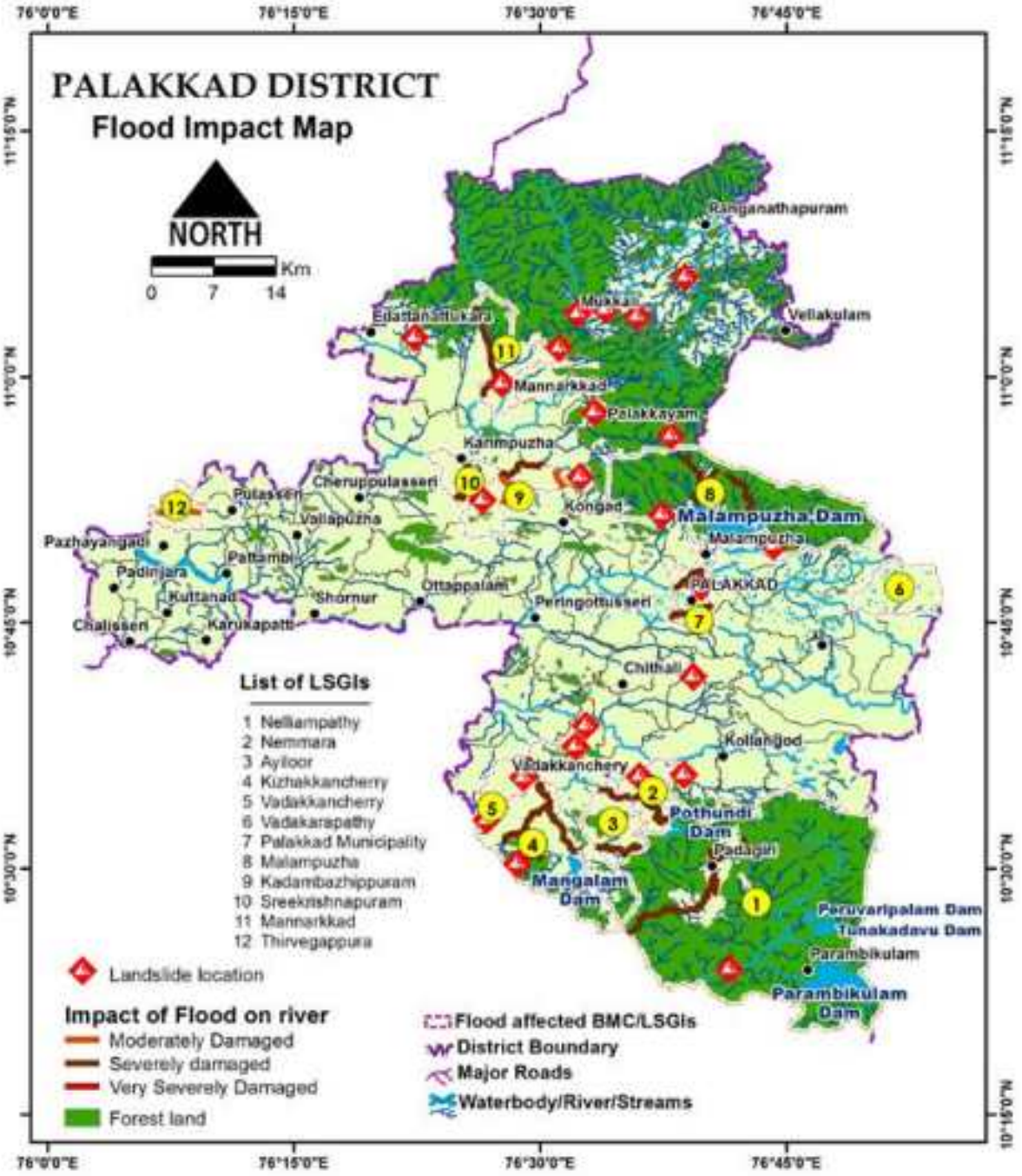


Fig. 39. Palakkad District - Disaster prone map

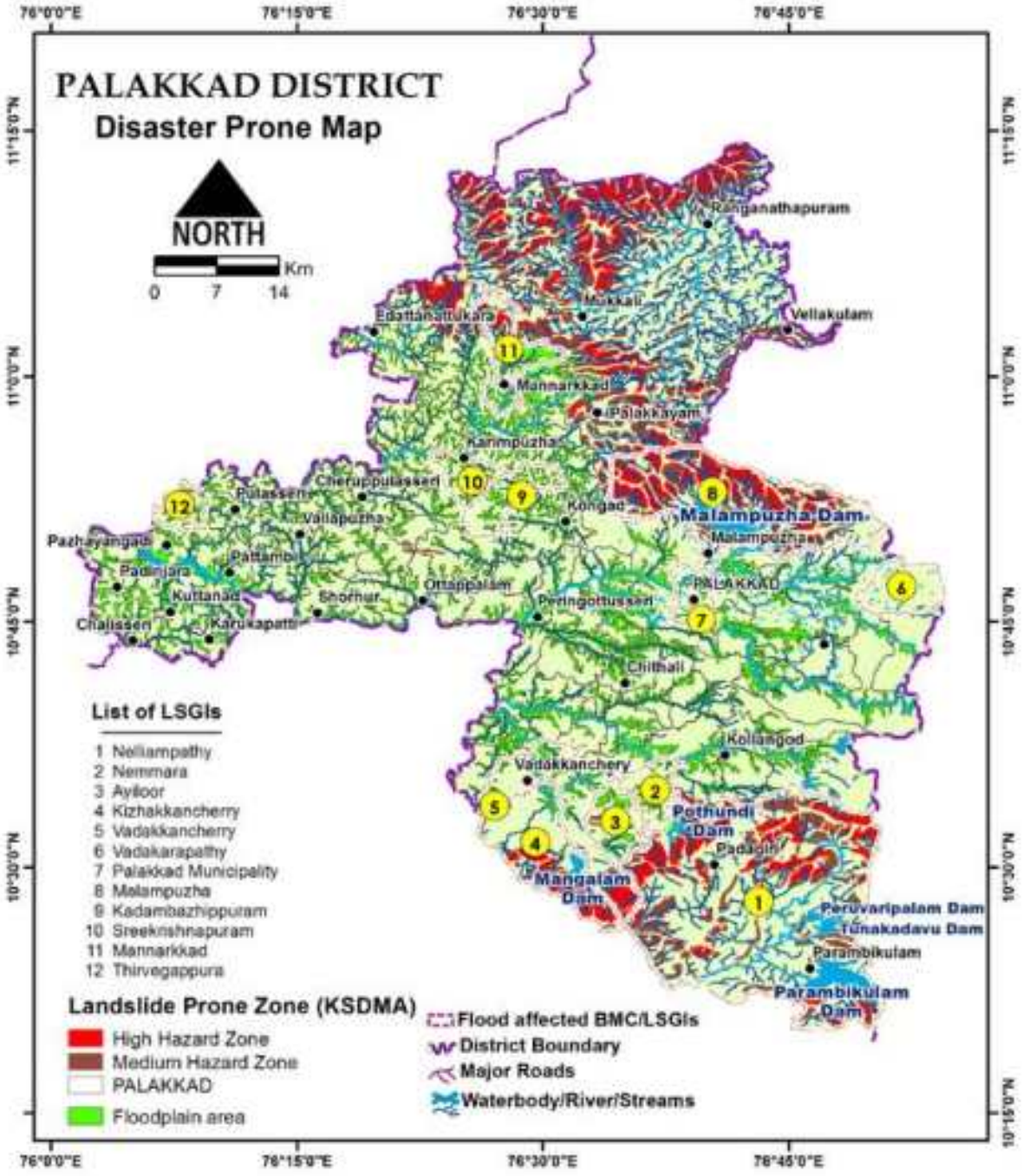


Table 18: Impact of flood on Biodiversity/ Ecosystems- PALAKKAD

Sl no	Type of Ecosystem	Nature of Impact
1	Riverine Ecosystem	Removal of sediments from riverbed leading to river deepening. Accumulation of Waste materials in the rivers Loss of Riparian vegetation Change in course of rivers
2	Agro ecosystem	Sand and silt were deposited in paddy fields. Paddy land became uncultivable due to deposition of mud which became a hard layer on dryng. The flood water damaged the bunds which regulated the water level in paddy fields Increased incidence of diseases in crops
3	Wetlands	Soil structure weakened Natural flow of water reduced
4	Forests/Sanctuaries/ Terrestrial ecosystems	Loss of nutrient rich topsoil Landslides causing extensive damage Damage to Check dams in forests Soil piping, landslides and land subsidence

1) RIVERINE ECOSYSTEM

The main rivers that flow through the district are the Bharathapuzhaalso known as 'Nila' and Bhavanipuzha. The important tributaries of Bharathapuzha are Gayatri puzha, Kannadi puzha, Korayar and Thuthapuzha. Bhavani River and Siruvani River also passes through Palakkad.
Afterreceding of the flood waters, the river shores of Bharathapuzha had developed good deposits of white coloured sand downstream in theLakkidi portion. The above locations formerly supported heavy bush growth all along the river beds which was washed away during the flow of the flood and in lieu deposited thick sands in extensive length and breadth of the bank. Close to that area in Mannannur, in a paddy field after the flood waters residedwhite sand was deposited.

Ottappalam stream has breached during the rain and in Njarakode area about 100 acre paddy field has been inundated. Cultivation was done here along the encroached banks of the stream.The area has been covered with 3 feet deep sand and mud.In Pattambi area near the bridge, formerly unauthorized sand mining was rampant. After the floods the river beds are seen with good deposit of almost 4 feet thick sand, which presents a panoramic view.

In Agali area, Bhavaniriver changed its course and people of Anakkara and Kappur were isolated. In MamparamKakkathara area, Yakkarariver also changed its course. Thoothapuzha has also changed its course causingextensive damages to the agricultural sector in Vilayur and Thiruvegapura area.

A new island was formed in the river Kunthipuzha at Pulinchode in Thathengalam after the recent flood. The river, which had changed its course, created an area similar to a beach.The sandy island is attracting visitors not only from Palakkad district but also from neighbouring districts.

Wells which were used mainly for drinking purpose and for irrigating crops were severely affected by flood and landslide. Subsidence of wells occurred due to soil piping in Nelliyampathy and Kadambazhippuram, Many wells became filled with mud and silt and sand causing change in taste of drinking water

2) TERRESTRIAL ECOSYSTEMS

In Karadiyode hill near Mannarkkad, fissures developed on Earth surface. As against the normal landslide, fissures have been formed in about 2km length here. In and around Karadiyode hill landslides occurred in 15 locations. Apart from that in Koombanmala, landslide has occurred in multiple locations. The slush deposited at the agricultural land following the landslide has formed into thick concrete like material leaving cultivation impossible.At Uppumannu in Kizhakkancherry Panchayat also fissures developed in the land.

In Nelliyampathy, forest area was most severely damaged due to landslide, soil piping and land subsidence. In Kizhakkanchery, Ayiloor and Nemmara panchayaths, forest area was severely affected where the top soil along with vegetation was lost. In Silent Valley National Park, the suspension bridge at Sairandhri was washed away.

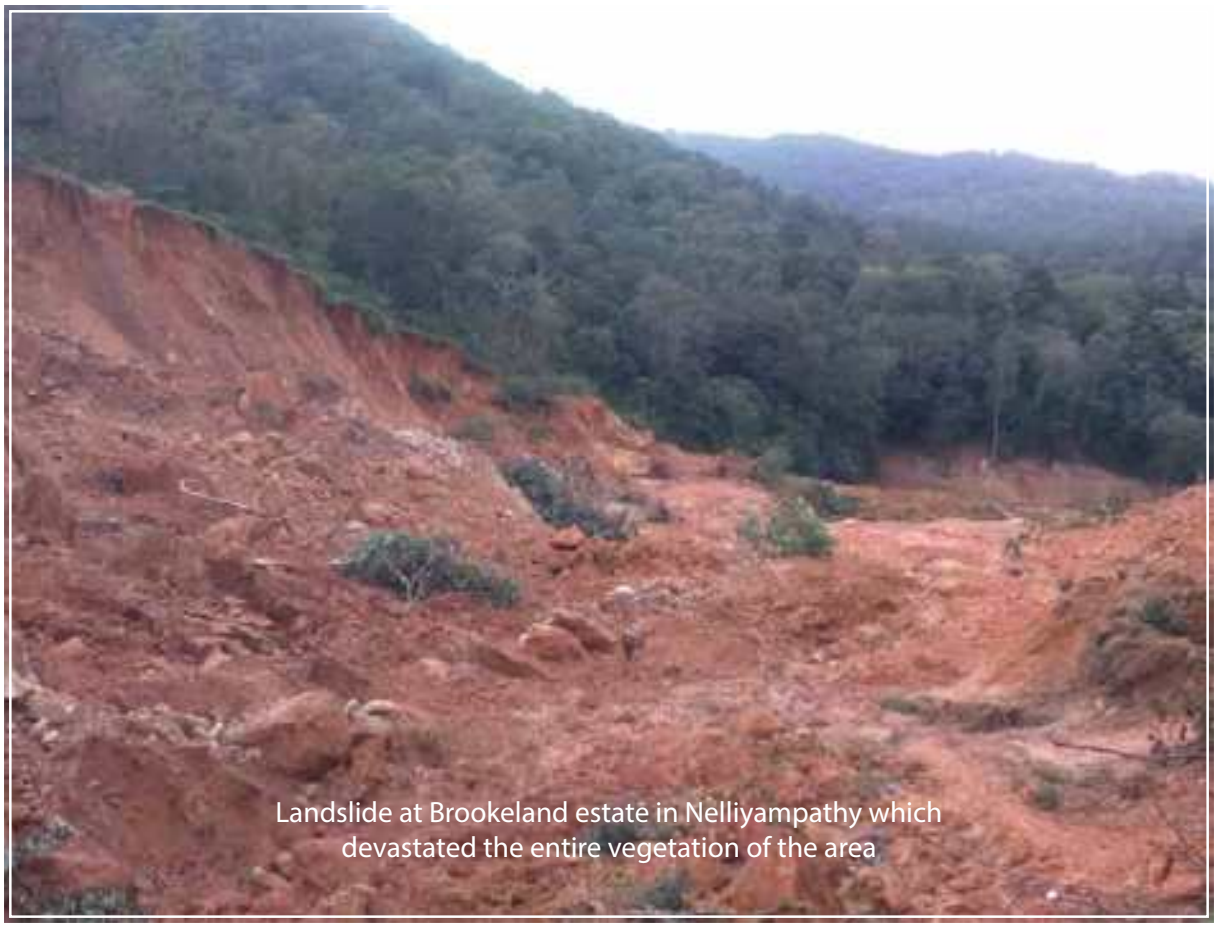
Nelliampathy area witnessed 17 major landslides and numerous landslips. The Minampara - Anamada road to Nelliaymapathi was blocked due to landslide.
Rain wreaked havoc in major private plantations of the hills, such as Anamada,Periashola, Rosary, Biatris, Oriaental, Karappara, Pakuthippalam, Chandramala and Brook Land. These areas used to be forested areas but later on the trees were cut down and converted to tea plantations. Many roads connecting the plantations were also constructed. Extensive landslides and land slips occured in this area, and all the debris was brought down and deposited in the Anamada road. In Nenmara Avanadu mala massive landslide occured. In Silent valley, due to landslides and mudslide the road from Panthamthodu to Sirandri was damaged. In Meppadi more than 30 instances of soil erosion was reported. In Manarcaud forest area also many trees were uprooted.

In the forestry sector, in Manankkad, Nemmara and Palakkad forest division several landslides occurred. Local people say that in Vavoli Chattakkallu Panampully portion of Vizhumala a landslide accompanied by a huge sound was heard. Hearing the sound, the inhabitants below the hill ran away and narrowly escaped. The entire vegetation in this area was damaged. Landslides and landslips along Mannarkkad – Attappadi road kept Attappadi area isolated for few days.

Table 19 Impact of flood on Protected forests-Palakkad

Name of Forest	LSG	Extent of damage	Nature of damage
Palakkuzhi Vattappara	Kizhakkancherry	Severe Severe	Land slide resulted in loss of top soil along with the vegetation. Streams changed its course.
Brookeland (1)	Nelliyampathi	Most severe	Land subsidence made the area uninhabitable Severe loss of vegetation including trees.
Brookeland (2)	Nelliyampathi	Most severe	Destruction of forest Soil piping continuing which is an indication of future land slides
Nooradi- Padagiri	Nelliyampathi	Most severe	Soil piping. Plants and small animals destroyed
Anamada ward Vazhakkundu, Kattilappara	Nelliyampathi	Most severe	Landslide caused severe destruction of forest. Bisons were found dead.
Kottayankadu (100 ha)	Nelliyampathi	Most severe	Land slide, land subsidence, soil piping causing severe destruction of forest
Karappara	Nelliyampathi	Most severe	Land slide, land subsidence caused severe destruction of forest
Nooradi Hill top	Nelliyampathi	Most severe	Land slide, land subsidence caused severe destruction of forest
Koonampalam	Nelliyampathi	Most severe	Land slide, land subsidence , siltation of river resulted in severe loss of aquatic biodiversity
Kaikatti Thampuran kunnu Kunduchola,	Nelliyampathi	Most severe	Land slide, land subsidence caused severe destruction of forest. Large trees uprooted
Cherunelli,	Nelliyampathi	Most severe	Land slide, land subsidence caused severe destruction of forest
Seetharkundu	Nelliyampathi	Most severe	Land slide, land subsidence, soil piping caused severe destruction of forest
Kundu chola	Nelliyampathi	Most severe	A new river has been formed. Land slide, land subsidence caused severe destruction of forest .Large trees uprooted
Akamalavaram, Elival	Malampuzha	Most severe	Land slide and land subsidence. Forest trees (40 nos.) uprooted.
Mayappara	Malampuzha	Very Severe	Flood and landslide caused severe soil erosion . Teak plants dried off , latex production in rubber was reduced
Niranganpara	Ayiloor	Severe	Landslide, Trees uprooted
Manalur Challa	Ayiloor	Severe	Land subsidence caused destruction of forest.
Cheeramada	Ayiloor	Severe	Landslide, boulders and sand deposits changed soil structure
Kundra chola	Nemmara	Severe	Land slide destroyed forest. Trees uprooted, micro habitats affected.
Koduvalppara	Nemmara	Mild	Mild landslide only

Land slide in Athanad, Nemmara wiped out the flora and fauna in its course



Landslide at Brookeland estate in Nelliyampathy which devastated the entire vegetation of the area

Sand deposition in banana plantation at Mayapara, Malampuzha

Gully formed in kerampara in Vadakarapathy consequent to breach of bund and flash flood causing complete loss of vegetation

Coconut plantation in a low lying area at Kerampara in Vadakarapathy severely affected due to water stagnation after floodt

It has been observed that 500 hectares of Brookeland(1) of Nelliyampathi became uninhabitable after landslide and land subsidence caused severe destruction in the area . In Brookeland(2), soil piping was found to continue even during the period of this survey indicating that the area is prone to future land slides.

Forest plantations of Mayappara in Malambuzha were most severely affected by land slide, flood and soil erosion. Teak trees got dried up and latex production in rubber reduced. In Kizhakkancherry, fissures were formed on hillsides and the flow of water through these fissures made the hills more weak and prone to mud slide. In Akhilumudichimala in Ayiloor, water bodieswere newly formed. In Athanad hill in Nemmara, top soil was lost due to land slide. Mannampatta rocks in Sreekrishnapuram were slightly affected. In the mountain slopes of Mattayi in Nemmara fissures were formed. Soil piping in Pothupara in Nelliyampathy and Kottayankadu were very severe and Tea estates were destroyed. In Pulayampara, river overflowed which later got filled up with debris. In Mazhuveenakundu in Malampuzha, land slide resulted in fissures on the earth.

Seetharkundu chola in Nelliyampathi faced very severe destruction due to landslide. Large trees, and shrubs were wiped off from the area.

3.3.6. THRISSUR

3.3.6.1. DISTRICT PROFILE

Thrissur district lies in the central part of Kerala, and is divided into 5 taluks- Talappilly, Thrissur, Chavakkad, Kodungallur and Mukundapuram. These taluks are further divided into 16 development blocks, and 88 gramapanchayats. There are 6 Municipalities Thrissur, Chalakudy, Kodungallur, Irinjalakuda, Kunnamkulam, Chavakkad and Guruvayur. Topographically the district has three regions high land, mid land and low land. All these three regions are found in the Thrissur and Mukundapuramtaluks. Talappilly taluk consists of both high land and mid land regions, while Chavakkad and Kodungallurtaluks lie in low land regions. High land has mountain ranges with thick forests. The entire forest area of the district is covered by Thrissur Forest Division, Peechi Wild Life Division, Chalakudy Forest Division and Vazhachal Forest Division. The district has moist deciduous evergreen and semievergreen forests. Thrissur District has three Wildlife Sanctuaries (WLS) namely PeechiVazhani WLS, Chimmony WLS and Chulannur Peafowl Sanctuary at Chulannur, border region of Thrissur and Palakkad Districts.

In Thrissur District, there are six Rivers flowing towards Arabian Sea. The main rivers in the district are Bharathapuzha, and its tributary Gayathripuzha, Karuvannur River and its tributaries, Manali and Kurumali River, Chalakudipuzha, Kecheri River (Wadakkanchery River), Periyar River, PuzhakkalPuzha. The riparian vegetation along the Chalakudy River system offers a unique ecosystem, which serves as a link between the varied habitats at lower and higher elevations. Healthy riparian zones maintain the channel form and serve as important filters of light, nutrient and sediment which provide habitat for fish and other riverine organisms. The riparian forests of the Chalakudy River have revealed the existence of a thick riparian vegetation of more than 10 m width for a distance of 10.5 km downstream from Poringalkoothu, covering an area of 58.5 ha. Out of this, 26.4 ha lie within the Vazhachal area, including three large islands densely covered by riparian forests.

3.3.6.2 THE DISASTER- FLOODS/LANDSLIDES OF 2018

The normal rainfall in the district from 1June to 21 August is 1824.2 mm , but during 2018 actual rain fall was 2077.6 mm, that is 14% of excess rainfall.

3.3.6.3. STUDY AREA AND ASSESSMENT PROCESS

The study area in Trichur district included twenty gramapanchayaths, subsequently a rapid study was conducted at Athirapally also.

Table 20: The study area in Trichur district

Sl.no	GramaPanchayath	Flood/ landslide/ Both	No of people who participated in focal discussions	Impact of Flood/ Landslide
1	Aloor	Flood	48	High
2	Annamanada	Flood	47	High
3	Chazhoor	Flood	22	High
4	Cherpu	Flood	49	HIgh
5	Desamangalam	Both	24	High
6	Edathiruthy	Flood	49	Medium
7	Eriyad	Flood	27	Medium
8	Kadukkutty	Flood	49	High
9	Kuzhur	Flood	24	High
10	Mala	Flood	36	Low
11	Manalur	Flood	32	Medium
12	Meloor	Both	18	HIgh
13	Padiyur	Flood	32	Medium
14	Pariyaram	Both	32	High
15	Parppukkara	Flood	48	Low
16	Poyya	Flood	18	Medium
17	Sreenarayanapuram	Flood	39	Low
18	Thekkumkara	Both	26	High
19	Vallachira	Flood	28	Low
20	Venkidangu	Flood	43	Medium

Fig. 40. Thrissur District -- LSGs Selected for Biodiversity Study.

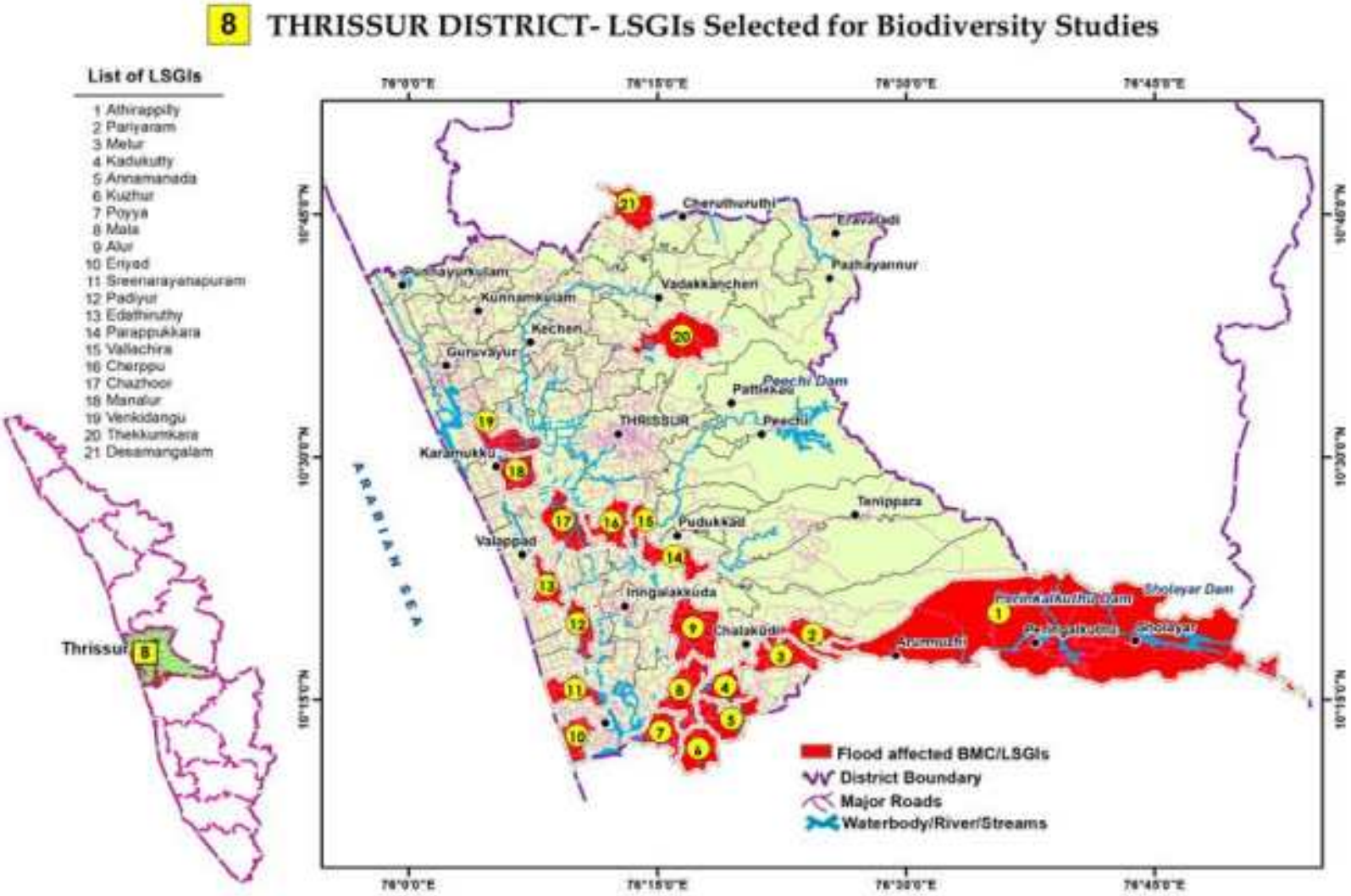


Fig. 41. Thrissur District -- Drainage Map.

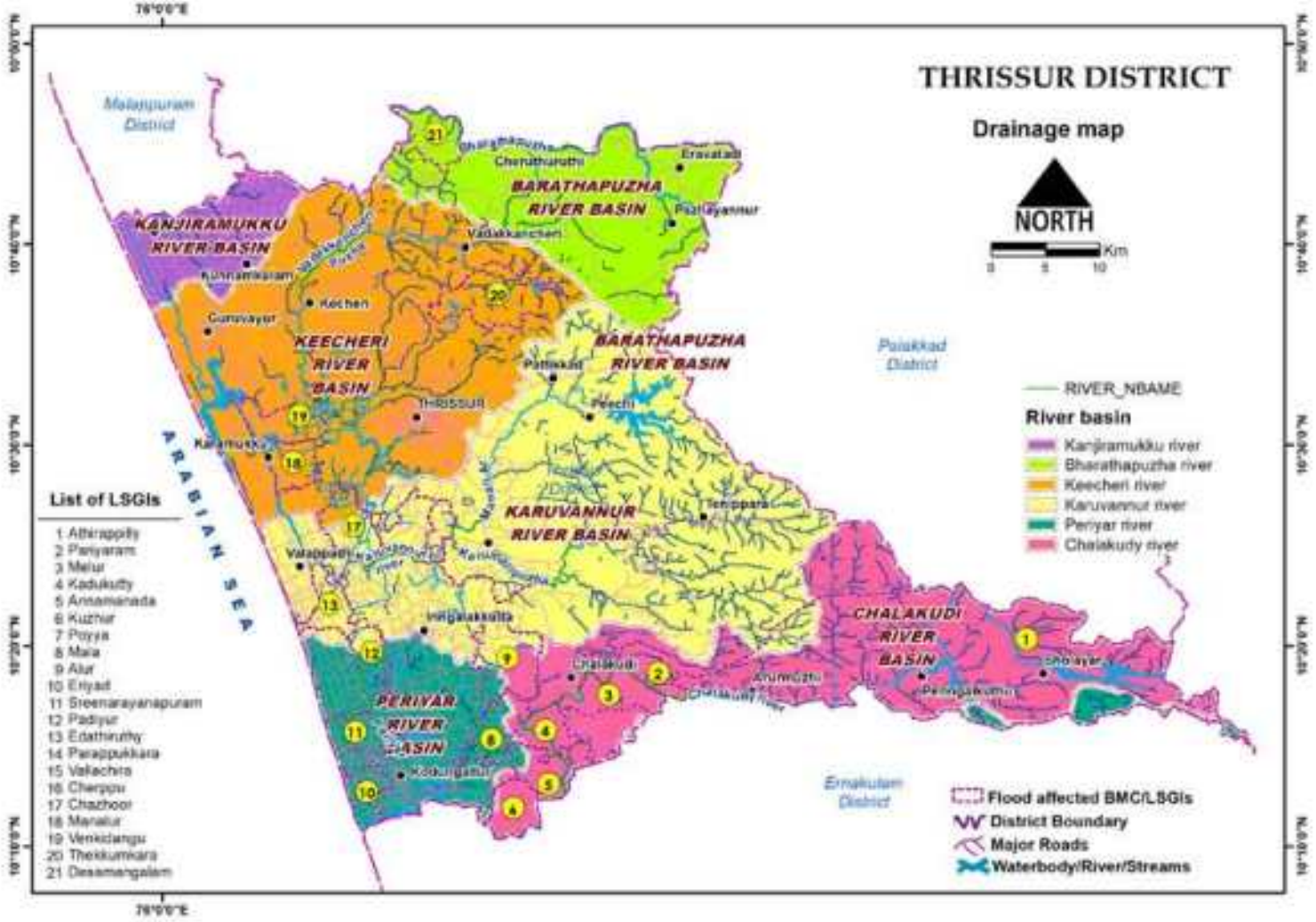


Fig. 42. Thrissur District -- Flood impact map.

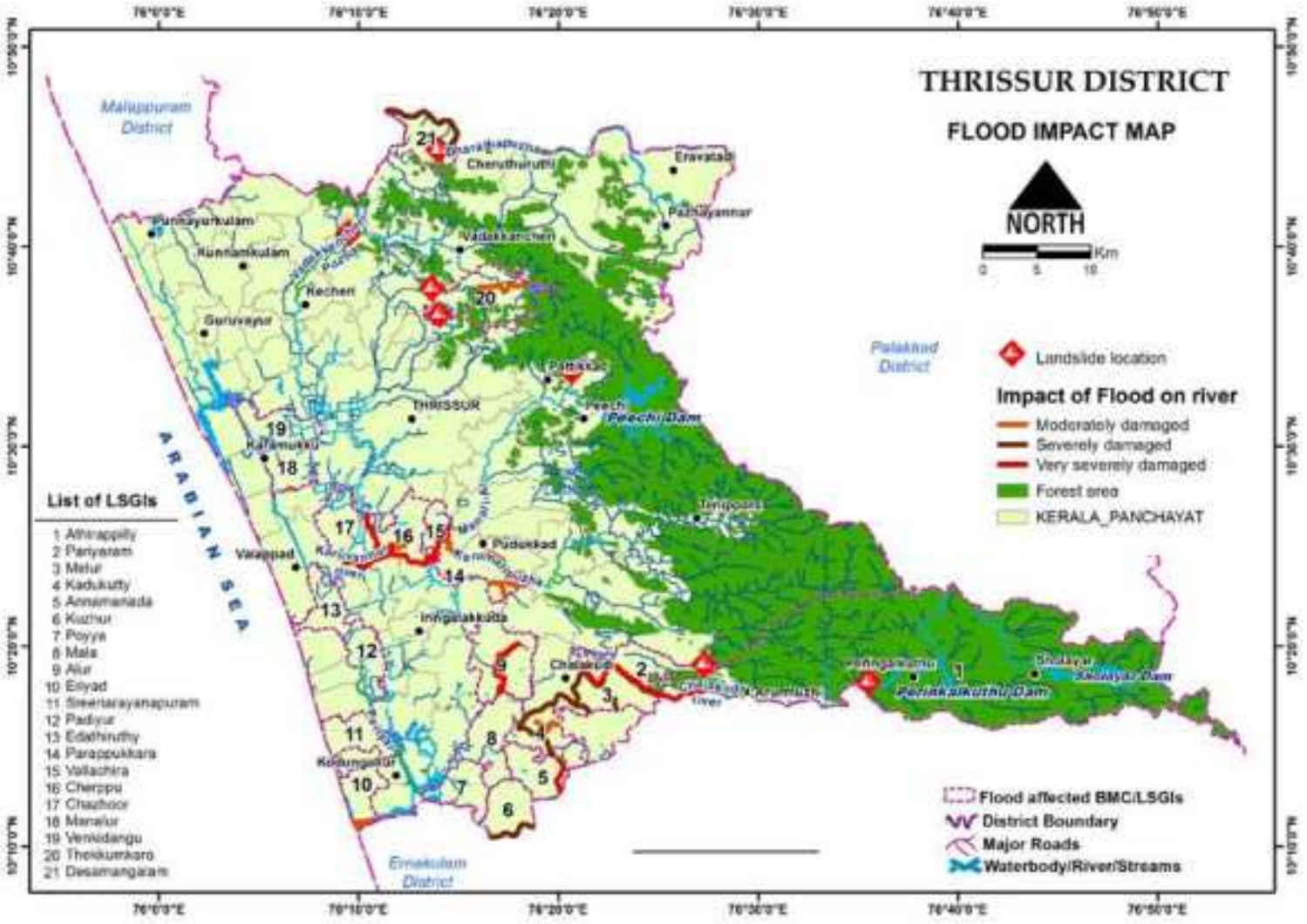
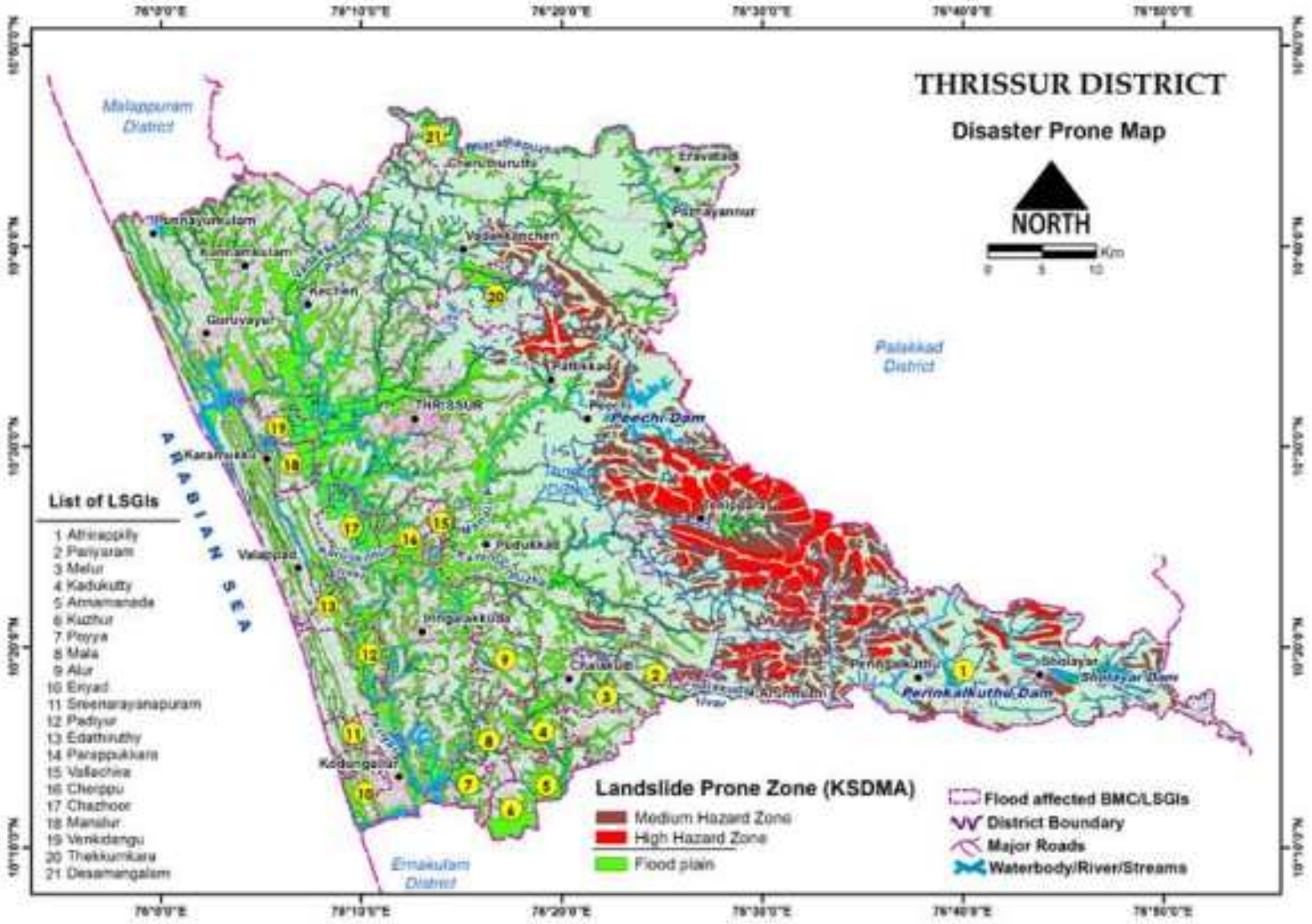


Fig. 43. Thrissur District -- Disaster prone map.



3.3.6.4. IMPACT OF FLOODS/ LANDSLIDE ON MAJOR ECOSYSTEMS

The flood caused vast devastation in more than 50 percentage of the district. According to National Centre for Earth Science Studies report on 2010, the flood prone area in the district is nearly 690 Km2 , nearly 22.65 % of the total area. Nearly 109 Km2 area (3.56% of the total area) are highly susceptible to landslide prone areas and nearly 218 Km2 (7.5% of the total area) are in low susceptible areas.In the mid and lowland areas the average height of water level rose to nearly three meters. Twenty panchayaths in the districts were affected by flood whereas in four panchayats both flood and landslide occured. The water level rose upto 3 mt in many areas in the district.The river banks eroded and riparian vegetation was lost, the width of the rivers increased in many places. Chalakudypuzha and Kurumalipuzha changed course in many places. After floods, the river bed of Chalakudypuzha dried .The landslide and land slip areas mainly occured in hilly areas and forest regions in the district.

1) RIVERINE ECOSYSTEM

The heavy rain in Parambikulam, Upper Sholayar, Lower sholayar, Peringalkuthu dams and catchment areas and the heavy landslides in the forest, resulted in rising of water level of Chalakkudy river. The Panchayaths like Aloor, Annamanada, Kaadukutti, Kuzoor ,Meloor and Pariyaram on the banks of the river were affected. The Kole landin the district was completed submerged and it affected the Manalur, Venkitangu, Mullassery, Anthikkad Panchayaths. As per the official documents the district

has reported nearly 25 landslidesand 8 landslips during flood in August, 2018.Chalakudy, Kodaseri, Melur, Koratti, Kadukutti, Pariyaram, Athrirapally, Mala, Alloor, Kuzhoor, Annamanda, Poya was affected due to flash floods.

The Karuvenoor river changed its course and caused damages in Arattupuzha, Pellisery, Oorakam, Ettumana, Cherpu, Alappad, Sashathamkadavu, Pullu, Anthiikkad, Nedupuzha, Aranattukara, Chettupuzha, Arimbur etc. Venkitangu, Mullassery, Arimbur and Anthikkadpanchayaths were affected severly. At Kadukutti sand was deposited and depth of river decreased. At Cherupu big trees which used to be roosting ground for bats was uprooted when Karuvanoor puzha overflowed. The main rivers of Bharatapuzha, Chalakudypuzha, Karuvannurpuzha, Kecheripuzha, Periyar, Puizhackalpuzha were affected. In addition the tributariesManlipuzh, Kurumalipuzha was flooded. Kurumalipuzha overflowed affected Padiyoor, Poomangalam, Puthanchira, Vennakaloor. Aratupuzha changed its course at Parapookara and flowed affecting Cherpu, Vallachira, Arimboor, Chazhoor. In Kadukutti panchayat the natural ecosystem of Vynthala lake got restored. The place was highly polluted and filled with debris but after the floods all the debris was washed away. Bharatapuzha was severly affected at Desamangalam. Chalakudy puzha was very severly affected at Pariyaram. Aratupuzha changed its course at Parappookara and was very severly affected, river bank eroded. At Machadumala strong soil erosion occured and the water streams got blocked and the stagnant water created pressure and massive landslides occured.

The floods damaged concrete dams and other hardy structures. But in many places Kayarbhoovasthram made with Coir, Grass and Soil withstood the flood. The second biggest Kayarbhoovasthram at Kodungaloor, Perthodinkara was not destroyed. One year back on both banks of Perunthodu KayarBhoovasthram was laid. It withstood the floods even though it was submerged in water for almost 4 days.

In the district soil has eroded extensively. It is told that the 50 cm of top soil is fertile, in forest areas the top soil is fertile in more depth. But due to floods the different types of soil got mixed up. A particluar type of soil is not visible. Alluvial soil, Malayooramannu, Vettukalmannu all got mixed together.

IMPACT ON FOREST ECOSYSTEM

In August, heavy rain inside the forest resulted in heavy landslides and landslips in Pariyaram, Aanakkayam, Machad forest areas and the vegetation of the area was affected. Soil piping was observed in Varantharpally panchayat.A massive landslide occurred in Vadakancherry Kuranchery. At Pariyaram in Choolakadavu, Mullapana, Konnakuzhi, Pandarampara, Kumbidanmudi massive landslides occured and mud and stones was deposited and affected biodiversity.

3.3.7. ERNAKULAM

3.3.7.1. DISTRICT PROFILE

Ernakulam district occupies the Central part of Kerala state and has High lands, Midlands and Coastal areas. There are seven taluks in the district. The entire taluks of Kochi and Parur and major parts of Kanayannur fall under the coastal plain. All the other taluks except the north-eastern parts of Kunnathunad taluk fall under the mid land area. The high land belt of the district is the Malayattoor reserve forest in Koovappady block, which covers about 9% of the area of the district

The Coastal belt is dotted with a host of islands ranging from largest Vypin islands of length 27 km to, smaller islands like Mulavukad, Vallarpadam, and Wellingdon Island etc. The western coast of Vypin has the longest beach in Kochi namely, the Cherai Beach. The northern tip of Vypin (Munambam) has the largest fishing harbour in Kochi namely, the Munambam Fishing Harbour. Vypin is home for harbour related industrial establishments like, the SPM project of the Kochi Refineries, and the Puthuvyp LNG Terminal. The sea along the entire coast of the district and the backwaters abound in fish of various kinds.

Wetlands forms 10.41% of the total geographical area of the district. Kerala's longest River, Periyarflows through all the taluks except Muvattupuzha. The Muvattupuzha River and a branch of Chalakkudy River also flow through the district. The major wetland area identified in Ernakulam district is the Vembanad wetland, is fed by five rivers and is the largest estuarine system in western coastal wetland system. The wetlands support rich bird population which visits the area for breeding and feeding. Other wetlands in Ernakulam district include Kodungallur kayal andVarappuzha kayal and are two other backwaters adjoining the Vembanad Lake. TheKodungallur kayal is found north of Paravoor taluk and extends to the Trichurdistrict. The Varapuzha kayal lies south of the Paravoor taluk and the Periyar riverdrains into it. Scattered patches of mangroves are found in Vypin, Vallarpadam, Malippuram, and Mangalavanam in the north zone and Kumbalam, Panangad, Chellanam, Puthuvypu and Kumbalangi in the south. The district has several Sacred Groves, Iringol kavu, one of the largest sacred grove in Kerala having an extent of about 16 Ha is located in Perumbavoor of Ernakulam District.

3.3.7.2 THE DISASTER- FLOODS/LANDSLIDES OF 2018

The normal rainfall in the district is 1680.4 mm, but from 1June to 21 August 2018 the actual rain fall during the period was 2477.8 mm, anexcess 47%.

3.3.7.3. STUDY AREA AND ASSESSMENT METHODOLOGY

Ernakulam was among the most affected districts to reel under torrential rains and overflowing rivers during August 2018. With heavy rain lashing the district continuously, many parts of Ernakulam have been flooded. The rise in water level in Periyar had a major impact on the flood situation of the district.The impact of the heavy rain and the resultant flooding was mostly felt in the eastern parts of the district.

3.3.7.4. IMPACT OF FLOODS/ LANDSLIDES ON MAJOR ECOSYSTEMS

The wetlands present in Alangad, Ramamangalam, Chengamanad, Koovappadi were seriously affected by flood. Large quantities of silt and sandgot deposited in these wetlands thereby changing physical characteristics of the soil and water. The accumulation of wastes in the wetlands was also observed in these areas. The acidity of water has increased in the wetlands.The change in physical and chemical characteristics of the wetlands will affect the micro and macro organisms associated with this ecosystem.In general, the mangrove area of the district were less affected by flood and was found to withstand the impact of flood.In Chittattukara and Vadakkekkara, the mangrove area present in two Wards controlled the water flow and prevented soil erosion upto a certain extend. Rhizophora, Avicennia sp. are mainly present in these mangrove areas.

Fig. 44. Ernakulam District -- LSGs Selected for Biodiversity Study.

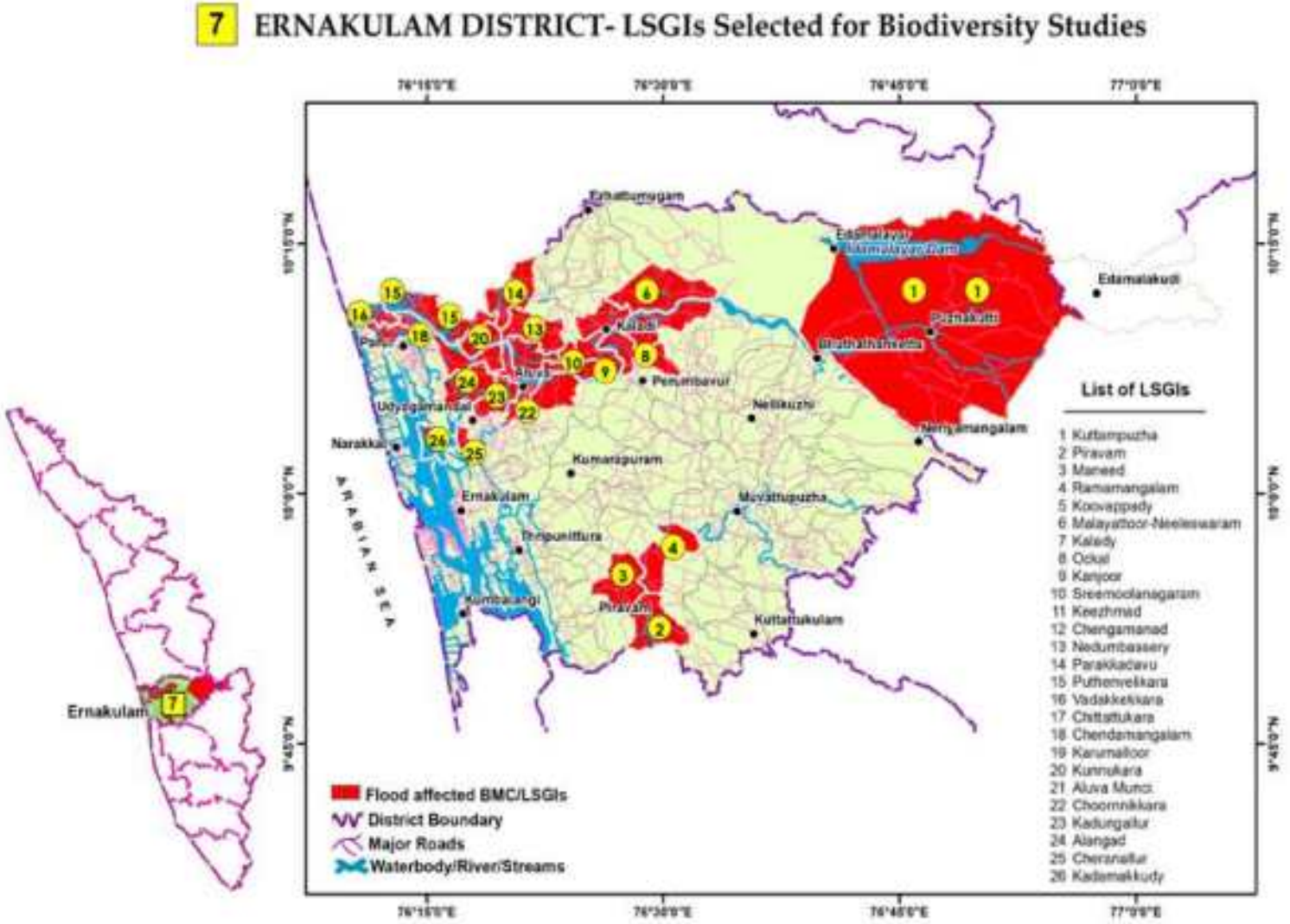


Table 21: **Impact of flood on Ecosystems -Ernakulam**

Sl No	Type of Ecosystem	Nature of Impact
1.	Riverine Ecosystem	The colour, acidity, turbidity of river water changed Rivers wollahs emaceb and wider due to deposition of silt and waste materials in large quantities. Severe erosion of riverbanks. Shrinkage of canals with reduced water flow. Riparian vegetation severely affected Aquatic weeds washed off from river.
2.	Agro ecosystem	Sand and silt was deposited in paddy fields. Paddy land became uncultivable due to deposition of waste material in large quantities. The flood water damaged the bunds which regulated the water level in paddy fields Irrigation canals were damaged by flood The panicles of the standing crop has become chaffy
3.	Wetlands	Deposition of silt and sand in the wetlands Accumulation of wastes Increase in acidity of water
4.	Mangroves	Mangroves were found to withstand the impact of flood. Mangroves prevented soil erosion up to a certain extent.
5.	Sacred groves	Mud deposition in large quantities Plants dried up completely. Huge trees uprooted in the flood. Termites were completely wiped out
6.	Backwaters	Pollution due to deposition of plastic wastes and bio wastes Deposition of sand mud and silt Thin oily layer above water leading to reduced light penetration Grasses and small plants dried
7.	Forests/Sanctuaries/ Terrestrial ecosystems	The nutrient rich topsoil was completely wiped out exposing the less fertile rocky base. The structure, texture of soil changed due to mixing up of sand, silt, clay. The pH of soil changed Soil nutrients leached out from cropped areas. Landslides causing extensive damage Damage to Check dams in forests Accumulation of Plastic wastes and slush Soil piping leading to land subsidence

1) RIVERINE ECOSYSTEM:

The flood had a devastating effect on the fresh water ecosystem of the district. Periyar river swelled up due to incessant rains. The resultant flood caused severe destruction in 19 out of 26 LSG's included in the study namely Alangad, Aluva, Okkal, Sreemoolanagaram, Vadakkekkara, Malayattoor-Neeleswaram, Kalady, Puthenvelikkara, Nedumbasseri, Cheranallur, Chengamanad, Choornikkara, Kunnukara, Chittattukara, Koovappady, Kuttambuzha and Keezhmadu .

The whirlpool formed where Periyar river meets Aryampara became wider and strong during flood. The color and smell of water changed and an oily layer above water was found. In many places at Aluva due to deposition of mud in periyar the river bank rose. At Piravam, along with flood water silt was deposited in Muvattupuzhaar and river bed rose. On the banks large scale deposition ofsand occurred.

Chalakudy river is home to a large number of fish varieties and studies have identified 104 fish species from it. Considering the fish diversity supported by the river, the National Bureau of Fish Genetics Resources, Lucknow, has recommended that the upstream areas of the river should be declared as a fish sanctuary.The overflown Chalakkudy river lashed in Parakkadavu panchayath where water level rose upto 10-12 feet and caused extreme damage. A lot of wastes accumulated after flood. There is considerable reduction in availability of small fishes. Karikuzhi, Ramamangalam , Vedimara and Kuttambuzha are the major tributaries . Perumittath stream, Onji, Puthen thodu, Nadappalli thodu, Chengal , Manga , ethappilli , Mangalappuzha, Kariyad , Pooppani , Chavanikulam , Manalvali, Chaliyil , Pinavoorkudi are the canals found in this district. The color of water changed in Chalakkudi puzha and Vedimarapuzha.

Karikuzhi Puzha at Alangad used to have turbid water after flood the water became clear, during the flood the river changed its course. But the river bank was eroded and the breadth of river increased whereas the depth decreased. Aquatic plants were washed off.

Majority of the canals such as Kariyad , Pooppani , Chavanikulam , Manalvali, Chaliyil shrinked with reduced water flow. Ramamangalam river water became acidic. Aquatic plants were completely destroyed.Ethappilli canal which was a fresh water source of Okkal Panchayath was severely affected. Fishes were found dead and floated up in Vedimarapuzha.

At Aluva near Parunthu ranchi island large quantities of sand was deposited. At Kuttivanam 1 mt high sand bar was been formed in Periyar. Okkal was one of the worst hit places and in this thuruthu 1 1/2 mt height, 200 mt long and 100 mt wide sand bars were formed. The soil here became blackish and the nature of the soil has changed and has become like a marshy palce. At Sreemoola nagaram also sand bars has been formed. At Vadakekkara sand was deposited and during low tide it is possible to cross the estuary by walking. In many places the soil has become more darker and the smell has also changed. In many places in Malayattoor extensive soil erosion has occured and channels has been formed and in some places sand has been deposited.

In Ernakulam District, there are approximately 5000 ponds (Source: Wetland Envis Cenre , Kerala) and flood has affected most of them in its course. The sides of ponds eroded and solid wastes and silt got deposited. In Kadungalloor and Piravom colour of pond water changed and water level became low. The aquatic plants such as Salvinia were removed completely from the ponds of Piravom whereas in Sreemoolanagaram, Salvinia accumulated in ponds in large quantities. At Nedumbassery the well water developed yellow color with a metallic taste. Wells which were drained out for cleaning were found to have layer of mud at the bottom.

Fig. 45. Ernakulam District -- Drainage map

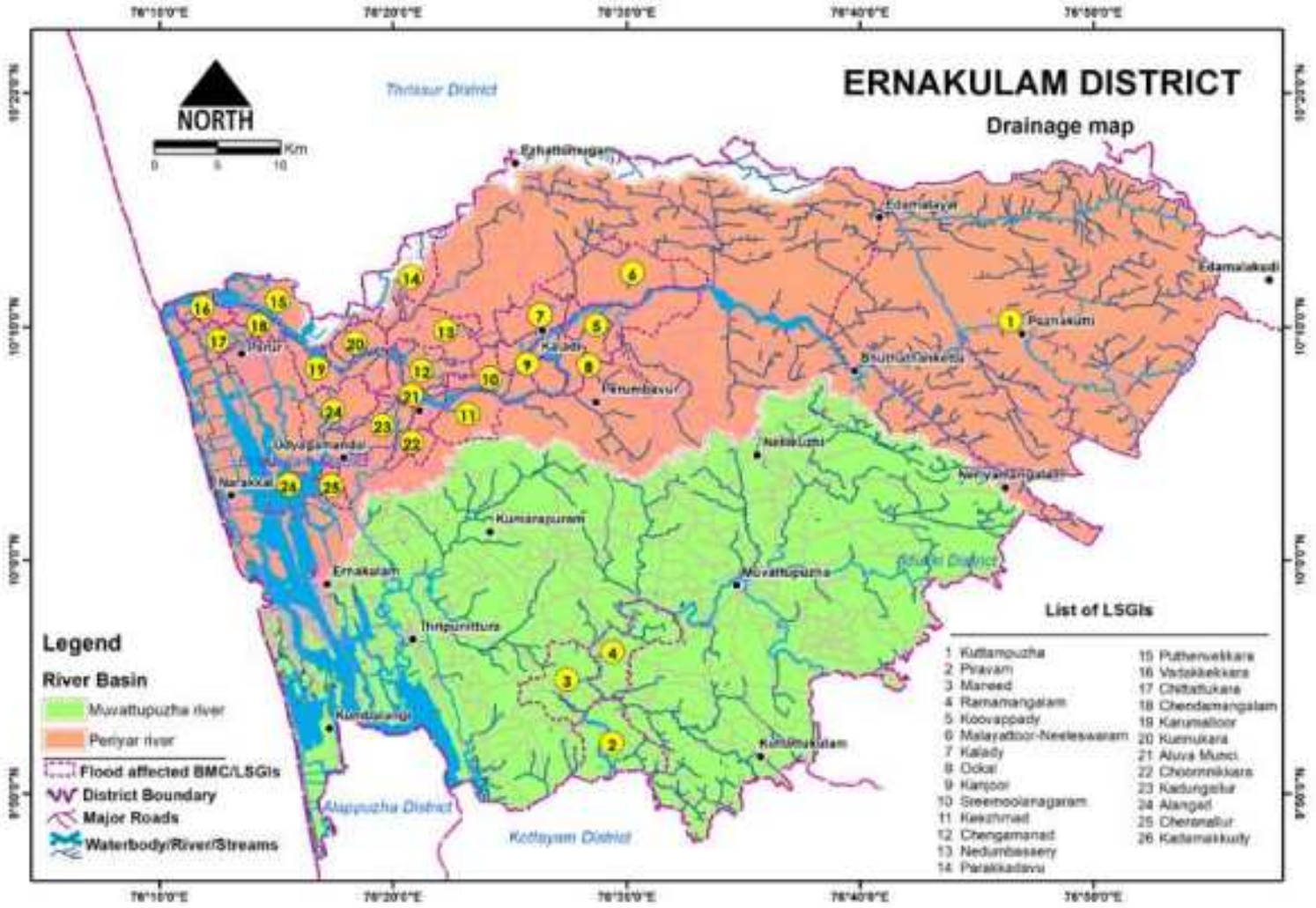


Fig. 46. Ernakulam District - Flood impact map

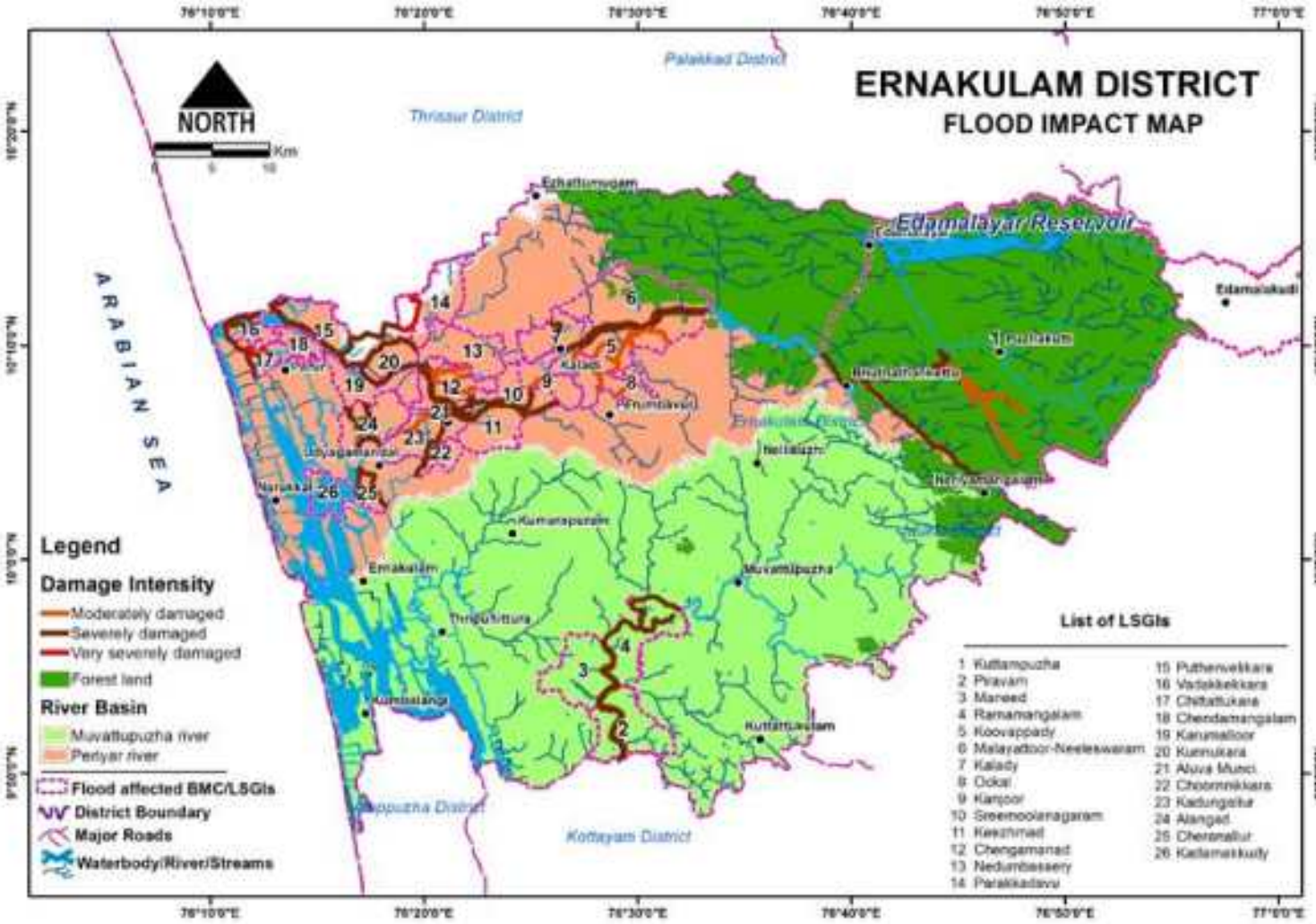
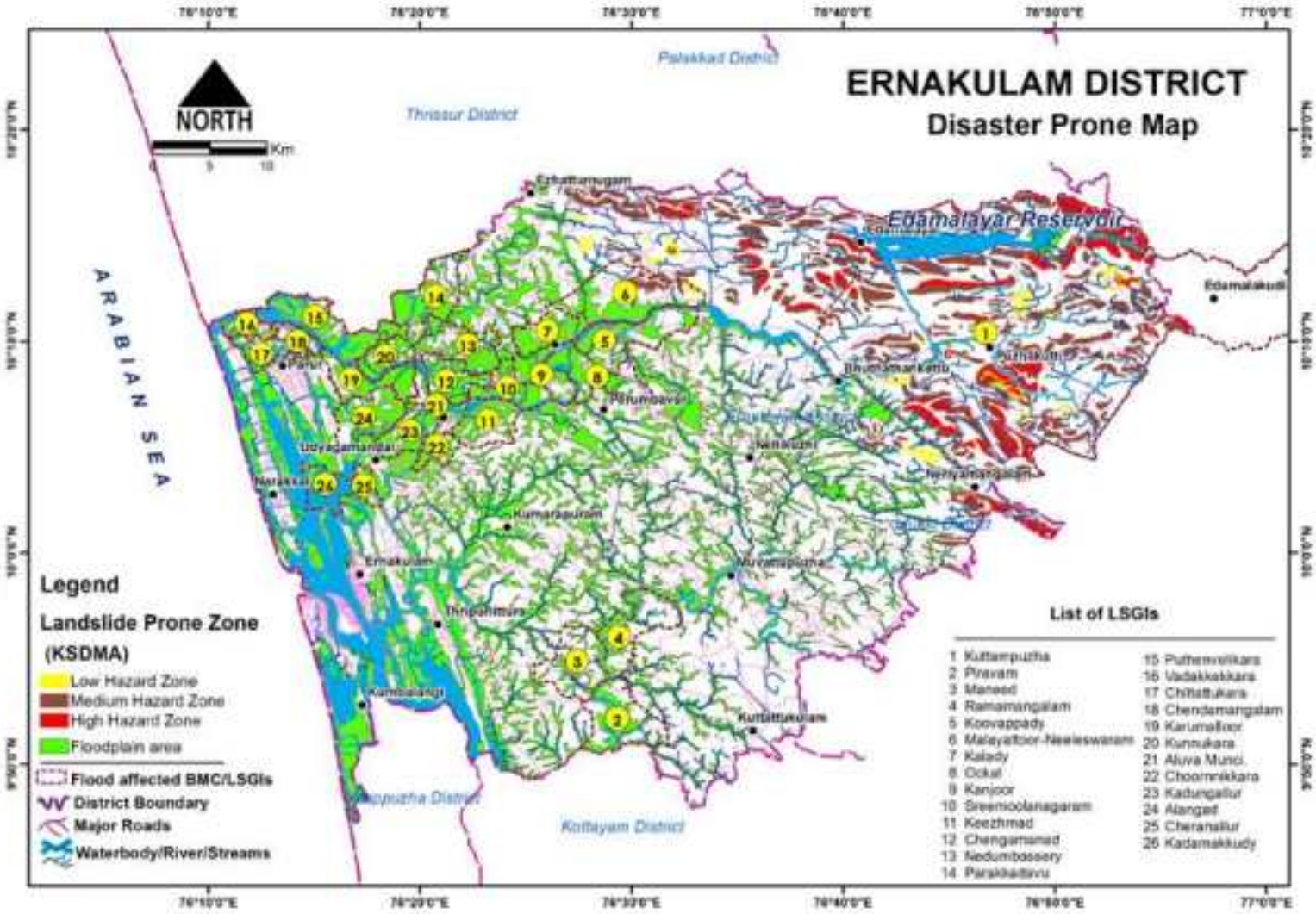


Fig. 47. Ernakulam District - Disaster prone map



During the flood the Cochin International Airport which is situated close to Periyar river was completely inundated and was shut down. Sand deposition occurred in large scale in Chengal Thodu. When the airport was built, a creek, the Chengal Thodu, that served as a distributary from the river and three irrigation canals that provide water to nearby paddy fields were realigned to make space for the runway. The natural flow of water was interrupted for providing facility for Nedumbassery airport and buildings were constructed by conversion of paddy lands. Chengal Thodu connects Periyar to other rivers. The residents of the area feels that the diversion of the natural canal contributed to the flooding of the area.

2) TERESTRIAL ECOSYSTEMS

The protected forest areas in Mulankuzhi of Malayattoor was seriously affected by flood. In Kuttambuzha, protected forest areas and Teak plantations faced only mild damage due to floods.

Landslides and flash floods have caused widespread deforestation and land erosion inside the forests. Several trees were uprooted while roads and bridges were washed away by flash flood.Soil erosion and mud slides occurred in 6 wards of Kuttambuzha . Thala vecha para tribal colony in Kallerimannu was affected. Landslide occured in Valiyaknasseri mala wiping out the entire flora and fauna which prevailed there

THATTEKAD BIRD SANCTUARY

Dr. Salim Ali Bird Sanctuary at Thattekkad was severely affected by flood due to flooding of Periyar and Kuttambuzha rivers. There are several water bodies inside the sanctuary and eleven out of 14 check dams in the sanctuary were destroyed by flood, plastic waste and sediments accumulated in the lakes and waterbodies inside the sanctuary. Deposition of mud and silt has resulted in decreased water depth and disrupted the aquatic ecosystem. Some of the animals protected in cages, including king cobras, pythons, porcupines, peacocks and tortoises were released. 26 avian species and 51 fish species were severely affected by flood.

Thattekad annually witnesses the arrival of water and forest birds. Ornithologist R Sugathan said the flood is likely to affect it. "Around 322 species of birds arrive at Thattekad, while across Kerala, around 523 species reach the same time," he said. A sandbed has appeared on a 5-km stretch from Thattekad to Kuttikal on the Periyar riverside. The sand bed cannot be manually removed. The shrubs on the river bank were washed off in the flood, the wetland nature of the area has changed due to deposition of san and the situation will affect the survival of water birds in the long run".

The uninhabited Parunthuranji Island in the Periyar river is rich in vegetation and used mainly as a grazing ground for cattle, many of which are taken there in boats when they are young. Flood has completely submerged the island from where cattle were rescued by the owners. Large quantity of sand from Periyar got deposited in this island thus changing the soil structure and causing loss of rich vegetation. The area of this island is gradually reducing over the years due to soil erosion.

Islands : Sathar island in Vadakkekkara is rich in plant diversity and is the natural breeding site of many fishes. The groyne (pulimuttu) protecting the eastern side of Sathar island from sea erosion was damaged during flood . It is a cause of serious concern as the destruction of the groyne poses threat to the existence of the island itself. Flood water of more than 6 feet height created havoc in this island Agricultural implements, fishing nets, fishing boats and canoes were lost. Cage fish culture was destroyed completely. Shrimp farm of 50 acres was seriously affected resulting in loss of shrimp in large quantities along with the flood water. Considerable reduction in the availability of marine fishes in the western side of Sathar island was reported by the local people who claimed that the fishes were available in plenty before flood, However the silt deposits proved beneficial to the island as evidenced by the rapid growth of vegetation in this area.

According to local people 'Kettuvalippatham' is a peculiar phenomenon seen in this island where the sea will not imbibe the drained out water for 4 days adjoining Karkidaka vavu. The flood occurred during the same time, hence caused much damage in the island as the water drained into the sea at a much lower pace. Elder people say this phenomenon happened in 1924 flood also.

Sacred Groves : Out of the 20 sacred groves in 11 LSG's of the study area, Panayam Kavu, Punnasseriputtukavu in Kadungalloor were severely affected by flood. Mud deposition in large quantities occurred and the plants dried up completely. A number of huge trees in Thelathuruthi kavu in Kunnukara Panchayath and a large False Hemp Tree in sacred grove in Ramamangalam Gramapanchayath Thottathikavu was uprooted in the flood.

In Sreemoolam panchayat Best farmer award winner Hari who is also an exporter of ornamental fish says that in his farm 113 species of fish Gold fish, Guppy, Platy, Abel fish, Sucker, Black molly, Tiger Barb, Oscar, Koicarp, Silver arona, Catfish, Giant Gourami, Zebra fish, Eel fish, Fighter fish, Sword tail was cultivated. After floods only 43 species are remaining. In the same place thee farm of Thomas Chacko who used to grow ornamental plants for sale such as Acorus, Asoori, Redmint, Vallisneria, Ludwigia, Cabomba, Angulia, Mexican grass, Amazon grass etc. was affected and many exotic plants were released in the natural ecosystem

Flood has seriously affected majority of farms in the district. Vegetable cultivation in State Seed Farm, Okkal, Goat, Pig and poultry farm in Cheranalloor. In Madathimoola farm at Chengamanad, Cattle mortality due to Foot and Mouth disease occurred. The ponds in fish farms at Choornikkara, Chittattukara and Kuttambuzha became filled with aquatic weeds and Kanjoor cattle farm and Poultry farm was destroyed in flood . Cage culture of oysters in Kottuvallikkadu in Vadakkekkara was washed out along with flood water. Hundreds of Cages lost including fishes like Kalanji, Karimeen, Valodi, Moda, Kalava, Vatta, and Chembally lost from more than 1000 cages due to over flooding in Puthenvelikkara

Aluva Sri Mahadeva Temple, Aluva Municipality

60 year old Banyan tree uprooted due to flood in Sreemoolanagaram, Ernakulam

Landslide at Kuttambuzha

Survived termite mount

Landslide - Maneed panchayat

Fish farming - Chittattukara

3.3.8. IDUKKI

3.3.8.1 DISTRICT - OVERVIEW

Idukki district consists of eight taluks namely, Thodupuzha, Devikulam, Idukki, Udumbanchola, Nedumkandam, Ilamdesham, Idukki and Peerumedu. It also consists of 8 block panchayaths, 52 gramapanchayaths and 2 muncipalities. On November 1, 2010, a separate Panchayath was created for administering Edamalakkudy and it became the first tribal panchayath of the state. This is the second largest district in Kerala with a land area of 4476 sq km (11% of total area of the State). Most part of Idukki district comes under the Western Ghats biodiversity hot spot and hence more than 50% of the land in the district falls under protected forest. Elimala, known for cardamom plantation is situated in Kattappana block panchayath of Udumbanchola thaluk. The famous Neelakurinji (Strobilanthes kunthiana) which blooms once in 12 years, Eravikulam National Park which supports the largest population of Nilgiri tahr in the world, Periyar Tiger Reserve are also situated in Idukki district.

Idukki district has a unique geography compared to other districts except to that of Wayanad. 97% of the land is covered with forests and hills. Marayoor which is famous for its natural sandal forest is located here. Around 14 peaks which are higher than 2000 masl is found here. Anamudi, which is the highest peak in Western Ghats and the renowned Meeshapulimala are located in Munnar Panchayath. Due to its mixed geography, the land is not suitable for traditional cultivation methods and cultivars found elsewhere in the state, but typical for Tea, coffee, cardamom, pepper, rubber, coco, clove, nutmeg etc and for the same reason these are the main cultivars here.

3.3.8.2. STUDY AREA

In Idukki the study mainly concentrated on 18 panchayats. About 60 focal group discussions were held and 450 people participated in this, of which 283 were men and 167 were women. The participants were from a wide range of stakeholders including farmers, tribals and elderly persons.

3.3.8.2 THE DISASTER- FLOODS/LANDSLIDES OF 2018

The normal rainfall in the district is 1851.7 mm , but from 1 June to 21 August 2018, the data shows that, the actual rain fall recorded is 3555.5mm, a 92 % of excess rainfall occurred in the district. In Idukki 278 major landslides and 1800 mudslides has been officially reported. This mudslides and landslide together account for 340 hectors of land. The flash floods, mudslides and land slide had a terrific impact on the biodiversity of one of the most biodiversity rich districts of the State. The current report is limited to the general public's perception of the biodiversity loss, habitat change and the aftermath of the impact.

It to be noted that almost all municipalities and grama panchayath of the district has been affected by flood in a way or other. The two municipalities and all 52 villages have been affected by these natural disasters very badly.

3.3.8.3 IMPACT OF NATURAL DISASTERS ON MAJOR ECOSYSTEM

Almost 80% of the district is drained by Periyar River, which is the largest river in Kerala which originates at the southeastern border of the district. Mullayar, Panniyar, Puyankuttiyar, Perinjamkuttar and Muthirapuzhayar are the important tributaries of Periyar.

Fig. 48. Idukki District -- LSGs Selected for Biodiversity Study.

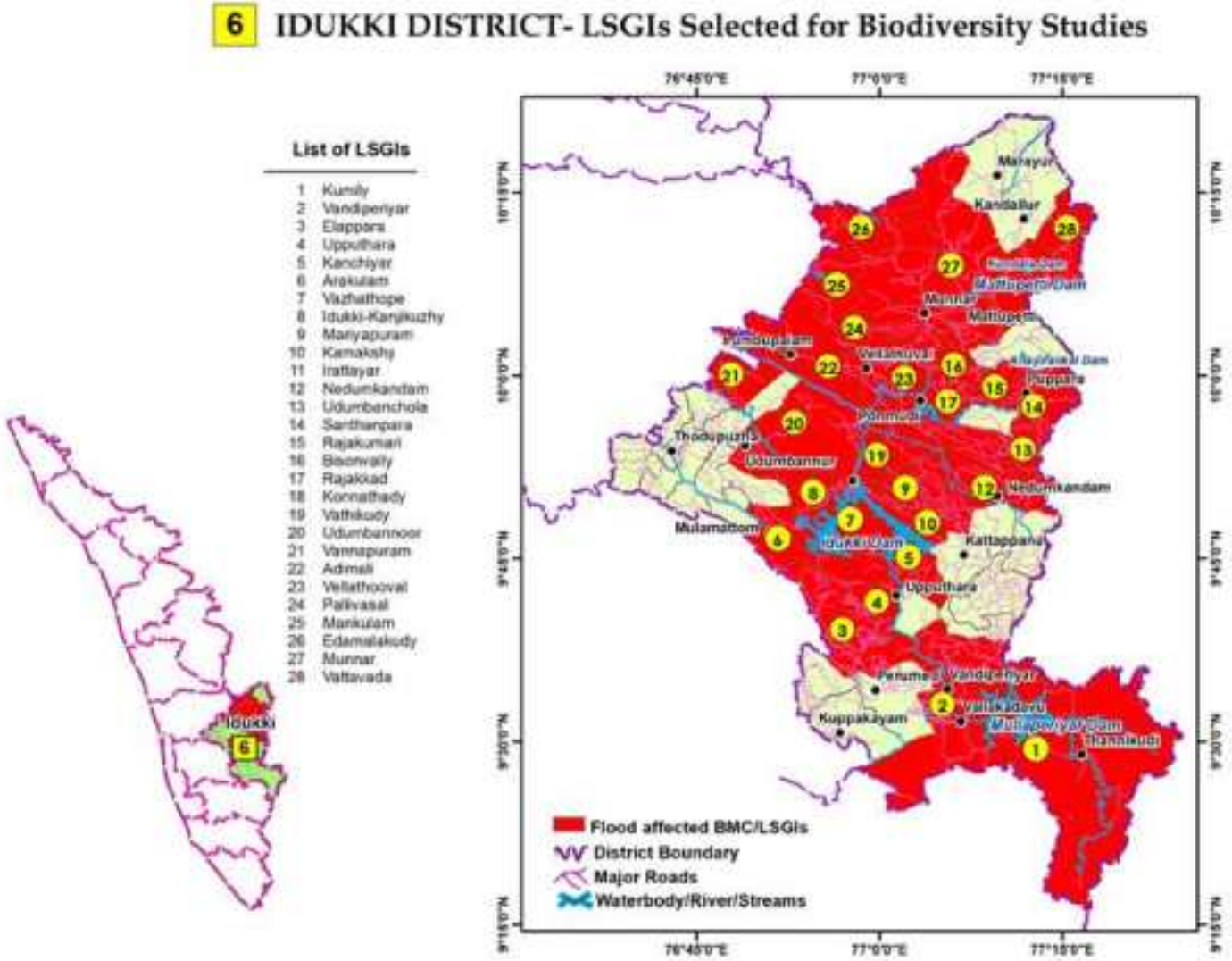


Fig. 49. Idukki District -- Drainage map

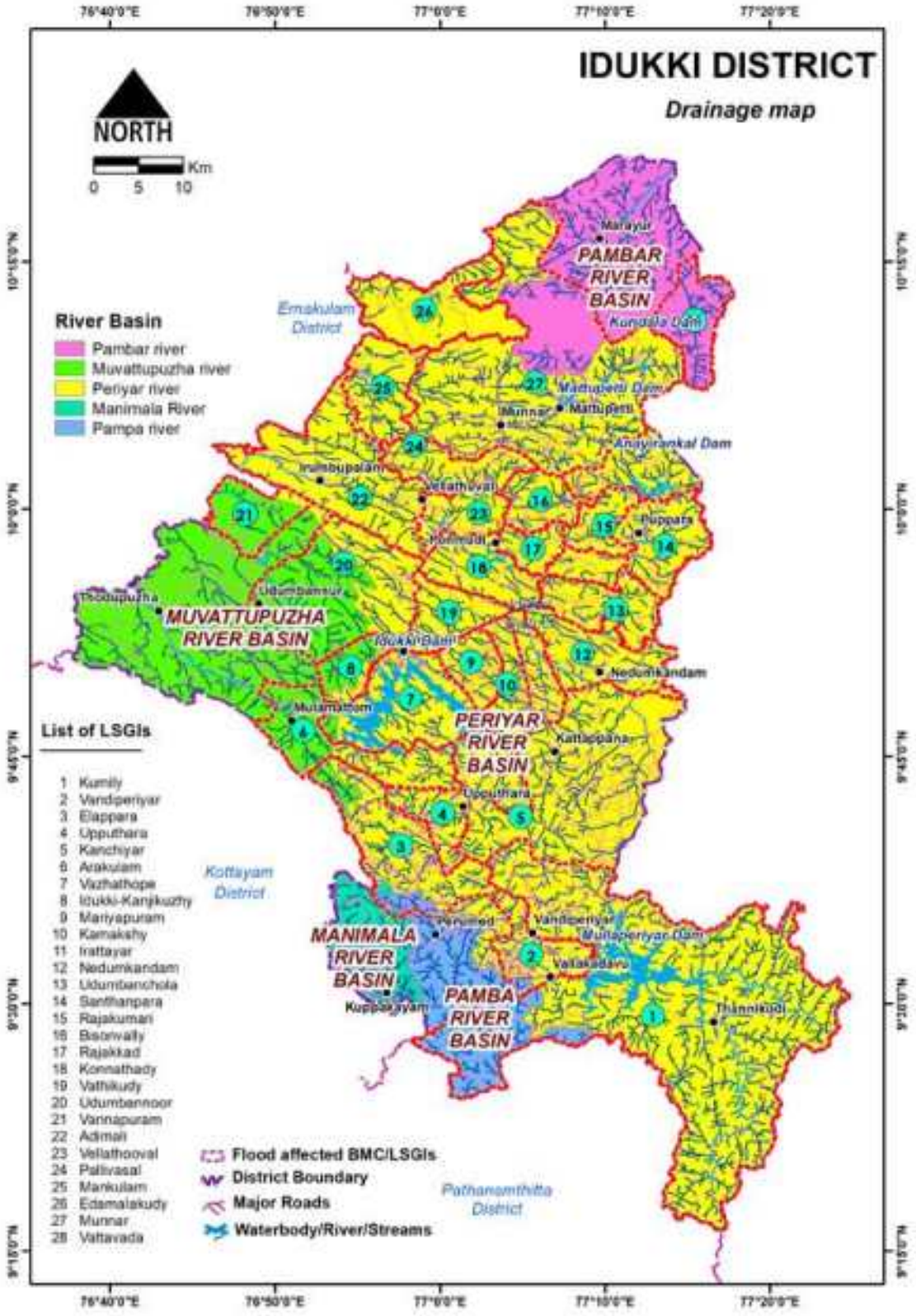


Fig. 50. Idukki District -- Flood impact map

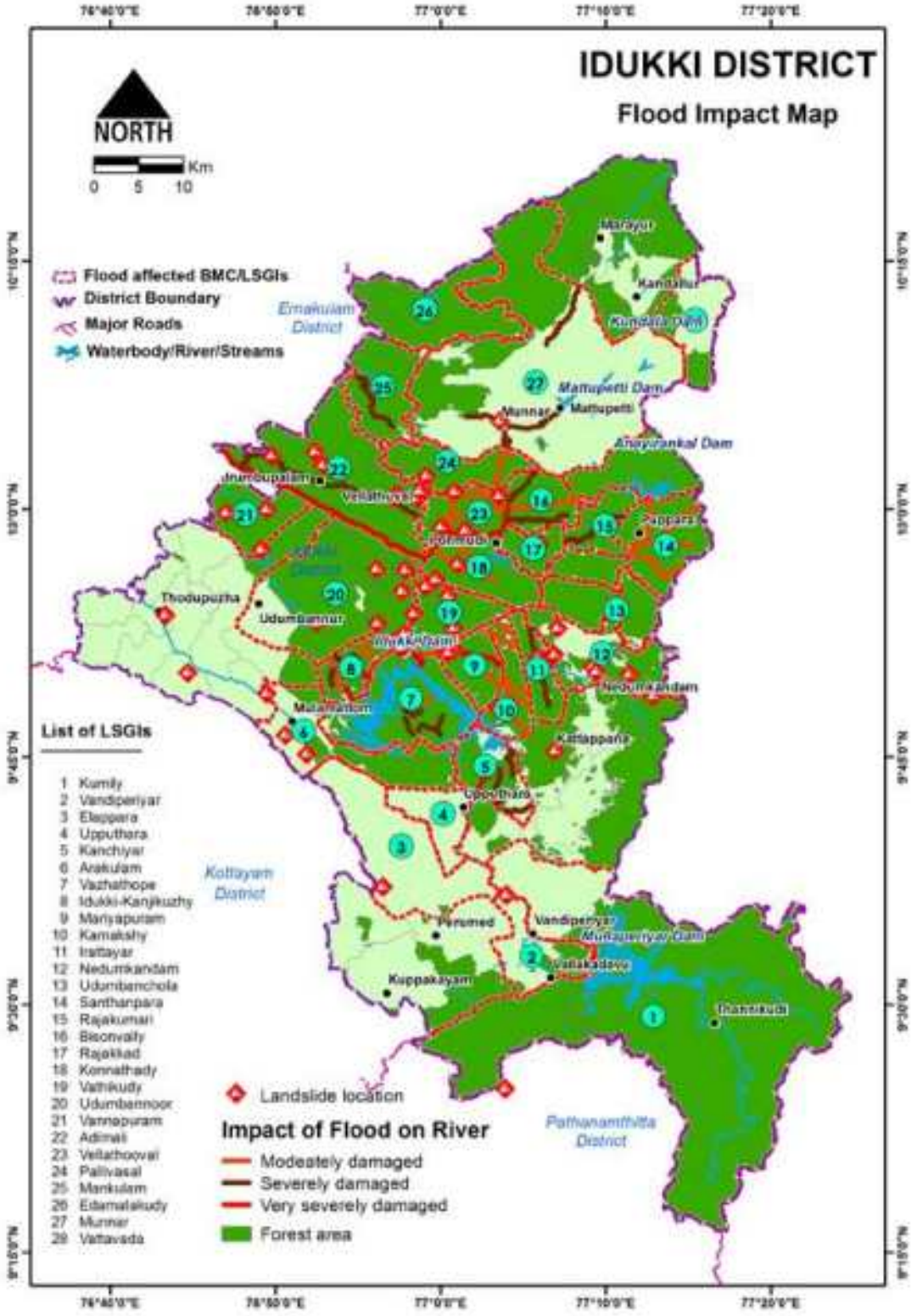
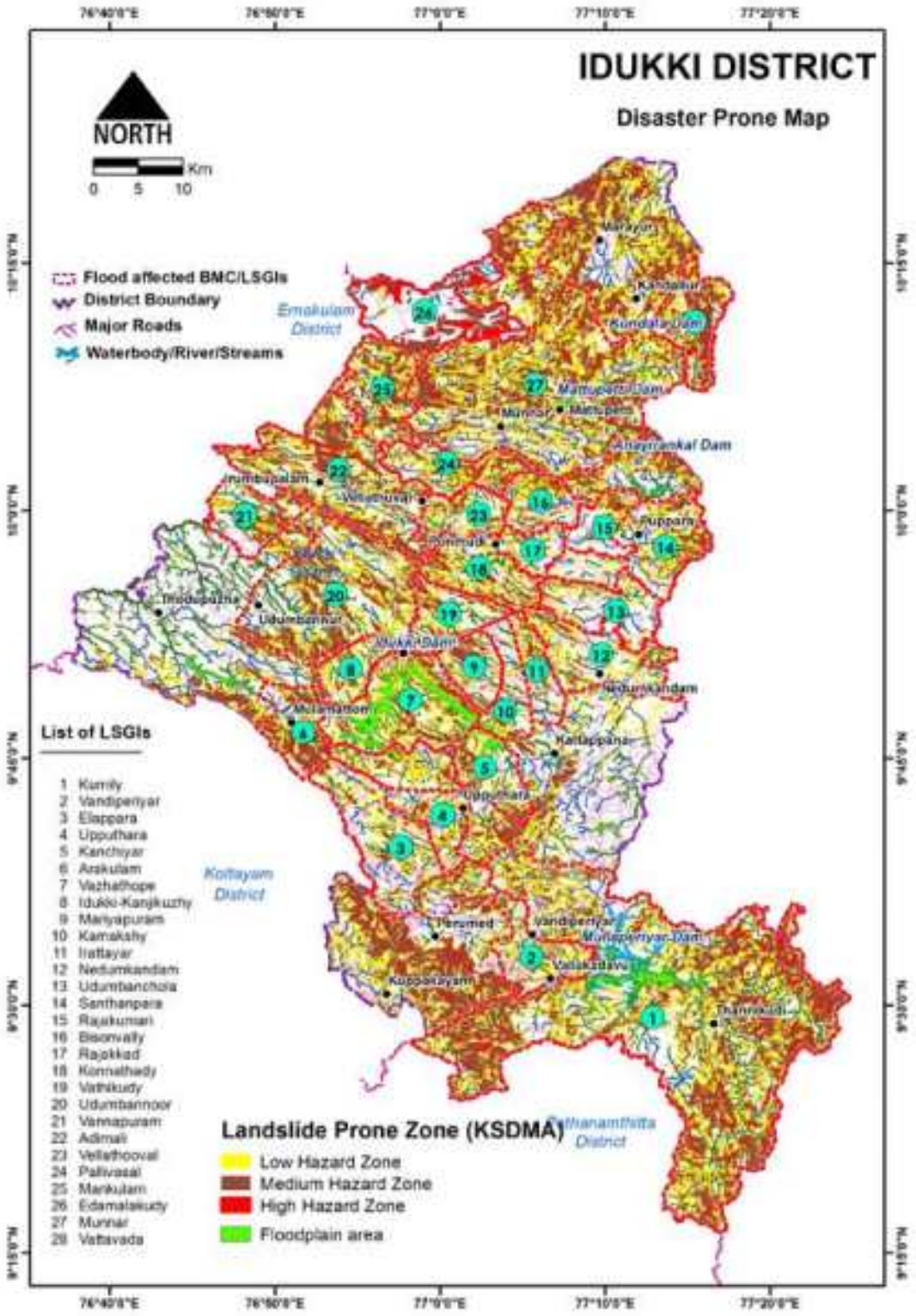


Fig. 51. Idukki District -- Disaster prone map



1) RIVERINE ECOSYSTEM

One of the important observations is that river banks have collapsed in multiple places and that much of the collapse have been directly linked to anthropogenic activities. The human interventions of upgrading river banks by removing natural riparian vegetations and other floral groups have lead to drastic erosion of river banks. The construction of unscientific and unauthorized water catchment areas and checkdams in multiple places have lead to a temporary hold of vast water sources which in time collapsed releasing water at a increased rate leading to more catastrophic destructions further downstream.

The areas downstream like Vallakadavu, Vandiperiyar, Upputhara and Chappath has been severly effected by flood and could have accounted to loss in floral and faunal biodiversity loss.The most severely affected included Vazhathopu, Mariyapuram, Kanjukuzhi, Munnar and Adimali. In these places river bank on both sides of Periyar was severely impacted. The major impact of landslides and soil erosion was observed in Munnar, Konnathadi, Kanjikuzhi, Vazhathopu, Arakulam, Udumbanoor, Vannapuram,. In addition floods severely impacted Vandiperiyar and Thodupuzha also. In these places water rose almost upto 5 mt. At Vellathooval the river changes its course.

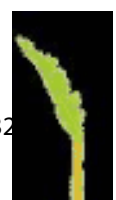
At Bison Valley Muthirapuzhayar was very severely impacted and the local people say that it very difficult to recover this. The depth of river increased and width also increased . The elderly people of the area says that the impact was much more severe than during the floods of 1924.

Almost the entire stretch of Periyar River passing through Vazhathoppu, Kanjikuzhi, Konnathadi, Mariyapuram and Admiali have been eroded. It's reported that 3 to 5M of river bank has been eroded and washed away. This has lead the removal of vegetation from the river side's and river banks are left exposed with rocks. This has lead to widening of the river, with no vegetation to protect the banks of river the river banks are more vulnerable for now.

In some places like Vandiperiyar, kanchiyar, Adimali, Vellathooval, Upputhara and Vathukudi the river has changes in its course of flow. It has also been reported that the depth of rivers have increased in these places. The reason for the same can be accounted for erosion of sand and other debris that were settled down the river bottom over the years. Though the water level seems to be decreased after the flood, this was many because of the increase in depth of the river on account of soil/sand erosion.

The river banks of Periyar was very severely affected and in some places as Vazhathopu, Kanjikuzhi, Konnathadi, Adimali, Mariyapuram only stones are there presently and the entire riparian vegetation has been washed of. At Thattekanni on both banks of Periyar a 1 km long stretch of sand bar has been formed.

The major tributaries of Deviyaar , Erattayar, Mutharipuzhayaar, Nallathanni, Mankulam puzha, Muthira puzha, Panniyaar has been severly impacted at Mankulam, Munnar, Pallivassal, Vellathooval, Santhanpara etc.



Apart from the natural ponds and other stagnant water bodies, There are multiple Reservoirs, mini dams and checkdams in Idukki district, that are build for multiple purpose according to the need of mankind. In the awake of recent flood, in the district the water level of these water bodies have been reduced due to the deposition of mud, sand, rocks and other organic debris. In certain places there has also been reported change in PH of water. The water holding capacity of these stagnant sources has been reduced. It is to be noted that these sources are the one that recharges the ground water table and hence reduction in the carrying capacity of these could impact the water table of the District.

The water in these hills plains come to these stagnant water bodies through many tiny streams and rivers. The presence of stone and other substratum along with vegetation and roots complexes slows down fast streams and allows recharging of ground water table in the due course. Erosion of the sides of these streams affected the process, and the infiltration of water to ground is highly This reduced intake of water would surely have its impact on water table and this in turn would result in a much depleted water table that could lead for scarcity of water in the future.






3.3.9. PATHANAMTHITTA

3.3.9.1. DISTRICT PROFILE

PathanamthittaDistrict, is situated on the slopes of the Western Ghats and stretches to the low-lying rice fields bordering Alappuzha District. Pathanamthitta has one district panchayat, 8 block panchayat, 4 municipalities and 53 gramapanchayats. Forest covers more than half of the total area of the district. District consists of three natural divisions viz, the lowlands, midlands and highlands. The topography of the district is highly undulating with hills and valleys. The vegetation is divided into 3 categories such as lowland vegetation, midland vegetation and upland vegetation. The Flora presents a systematic account of a total of 1249 species with 260 species which are endemic. A total of 90 wild relatives of cultivated crop plants have been collected from here.

Three main rivers Pamba, Manimala and Achenkovil are flowing through the district. The district has rich tradition and culture. The snake boat race associated with the Parthasarathy temple in Aranmula, largest Christian meet of Asia at Maramon, Chrukolpuzha Hindu religious convention are held at the sand banks of holy river Pamba. Agriculture is the main occupation of the people and cultivate tuber crops, spices and plantation crops in addition inland fishing are also a major source of livelihood.

3.3.9.2 THE DISASTER- FLOODS/LANDSLIDES OF 2018

The average rainfall during 1 June to 31 August in the district is 1357.5 mm but durng 2018 it was1968 mm which is 45% above normal. The district was one among the worst affected by the flood in the state. 25 out of 57 gramapanchayts in the district was severely affected by flood and was selected for the study

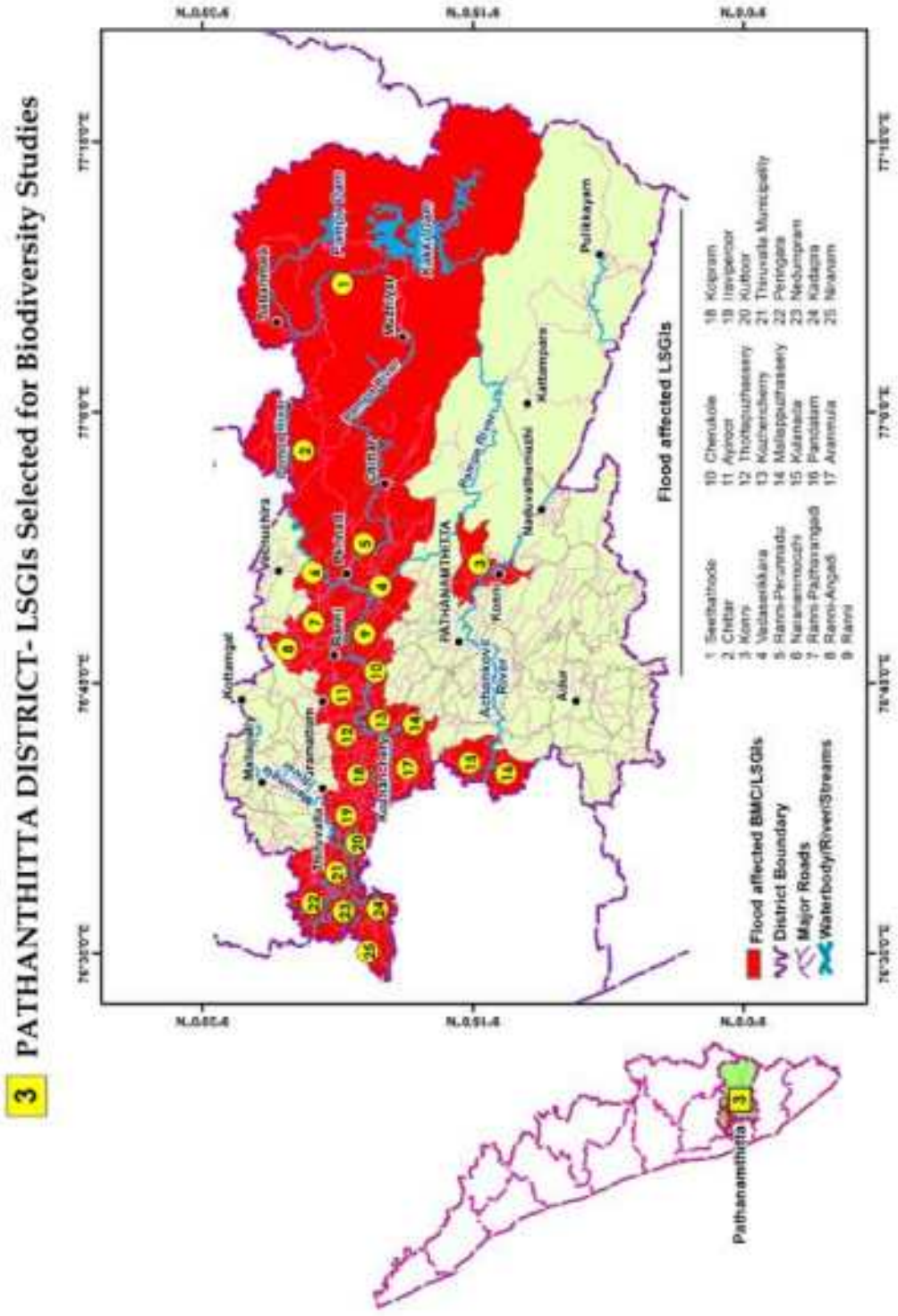


Fig. 52. Pathanamthitta District -- LSGs Selected for Biodiversity Study.

Fig. 53. Pathanamthitta District -- Drainage map

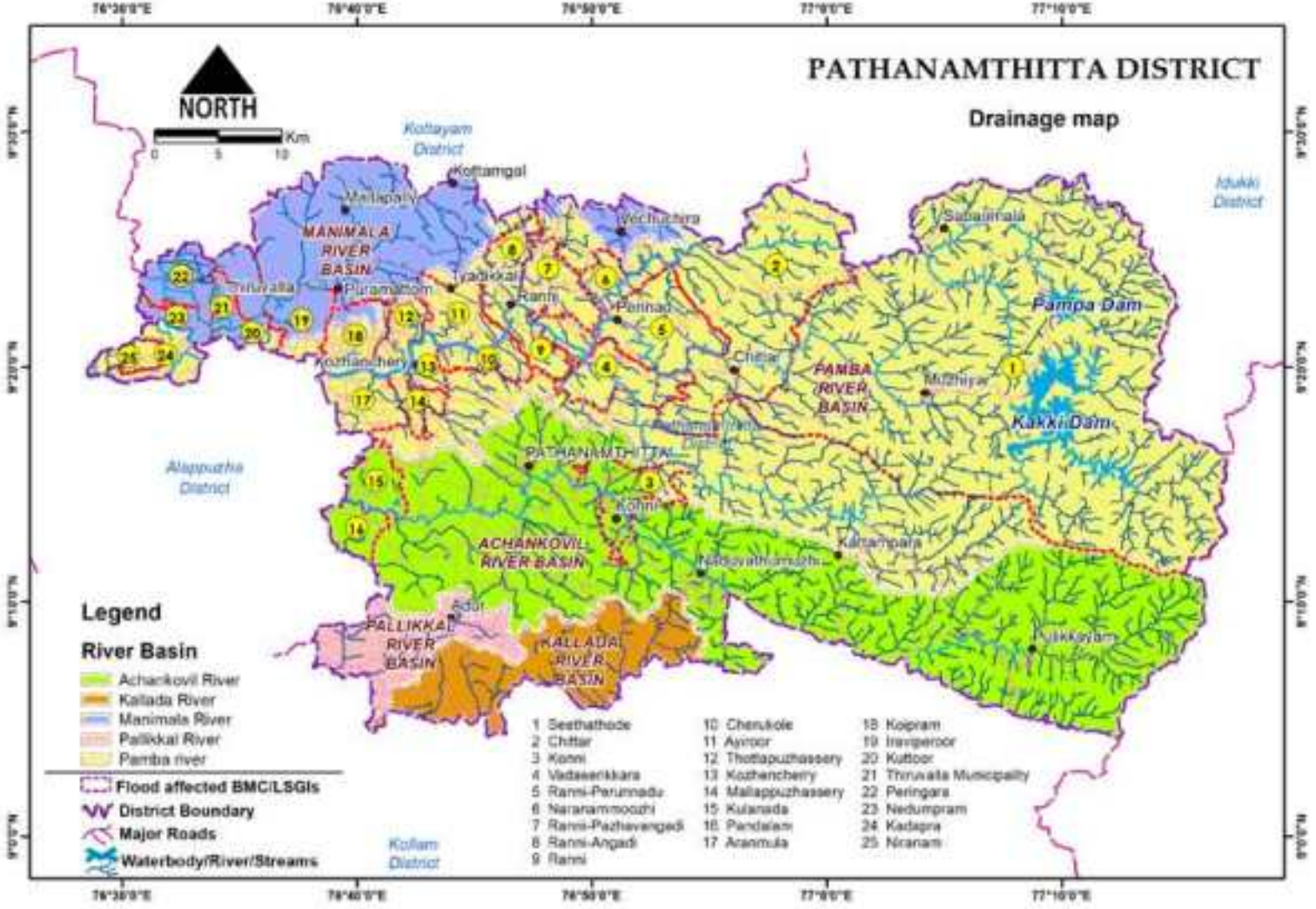


Fig. 54. Pathanamthitta District -- Flood impact map.

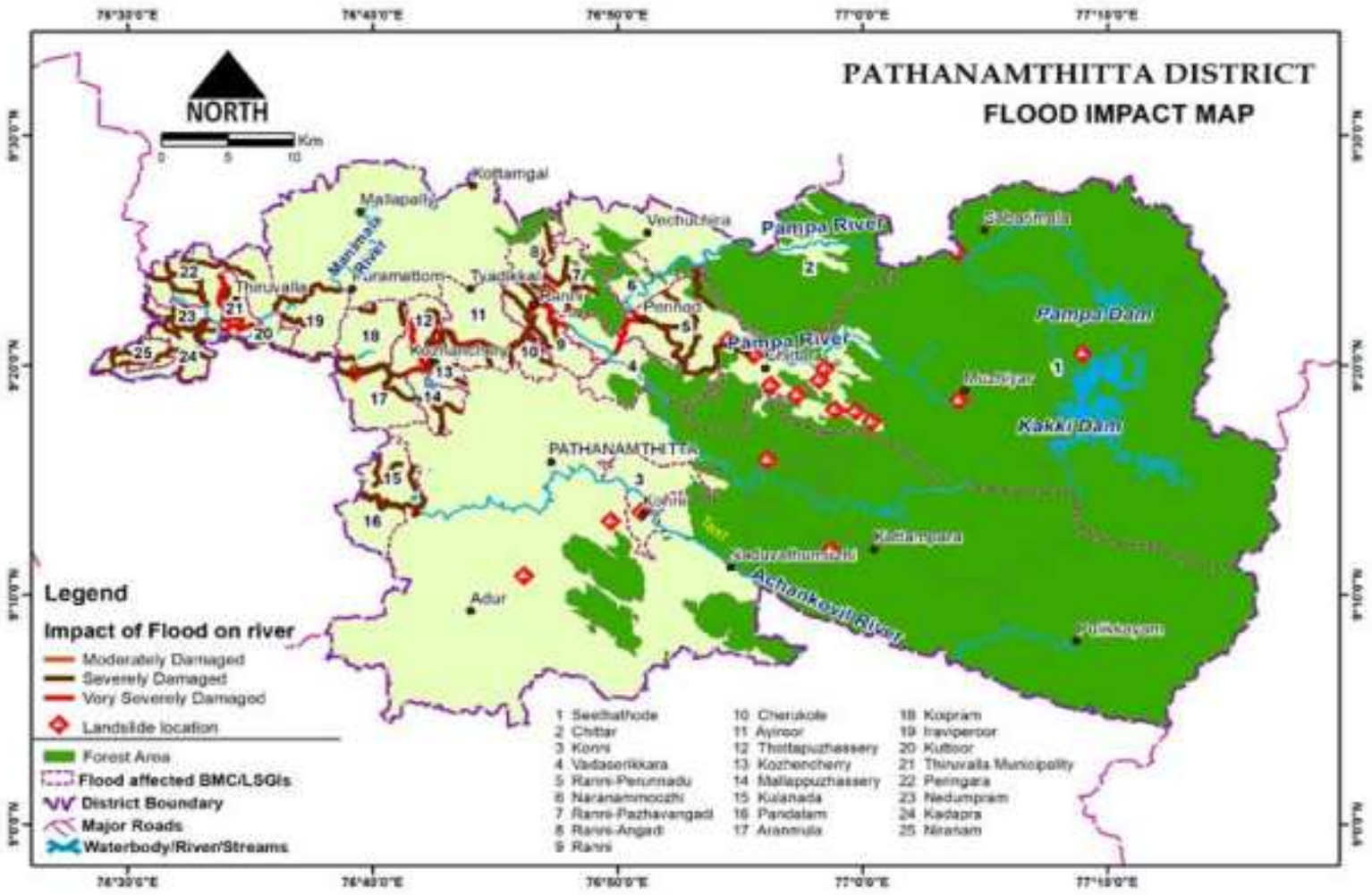
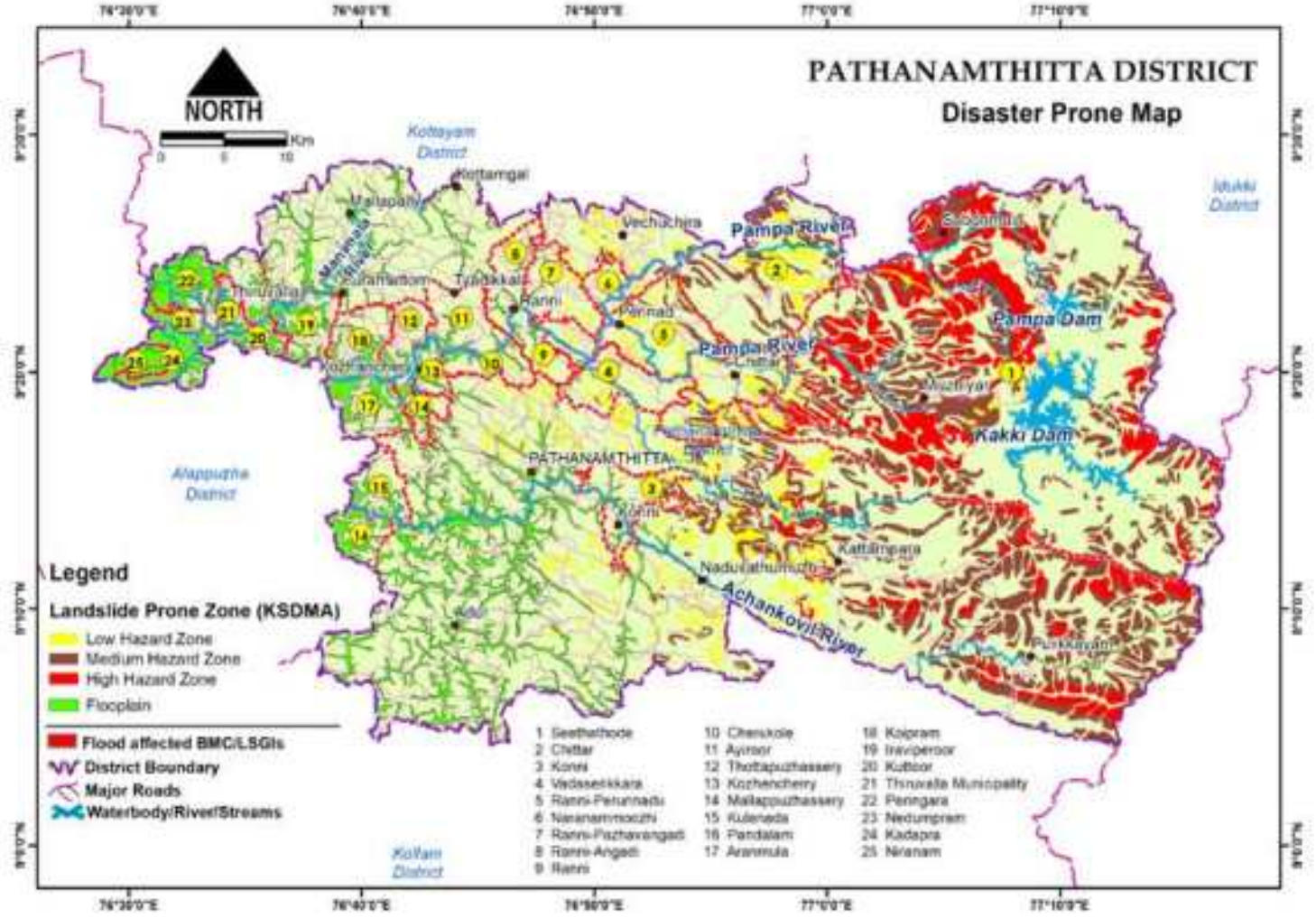


Fig. 55. Pathanamthitta District -- Disaster prone map.



3.3.9.4. IMPACT OF FLOOD ON ECOSYSTEMS

Three important rivers flow through Pathanamthitta district. These rivers originate from various mountains of Western Ghats mountain ranges. The Pamba (176 km) is the third largest river in Kerala originates from Pulichimala and drains into Vembanad Lake. The Achenkovil river (128 km) originates from Pasukidamedu and Manimala river (90 km) originates from Thattamalai Hills. In addition to that many tributaries and small streams enrich the rivers with water. Tributaries of Pamba such as Kakkattar, Nunangar and Varattar; the flood plain of both Pamba and Manimala rivers are important small rivers in this region. Western part of the district lies in the Upper Kuttanad area and this region is enriched with many ponds and wet lands. The floods has caused severe damage to all kind of ecosystem such as fresh water ecosystem, agrobiodiversity, forest ecosystem and caused a huge loss in flora and fauna in this region. The flood severly affected the Pampa and Manimala rivers at Pathanamthitta. Landslide was mainly located near the Pampa river basin.

1) AQUATIC ECOSYSTEM

Pamba river

Pamba is the third largest and one of the holy rivers in Kerala. Sabarimala, one of the national pilgrim centre lies in the Pamba valley in this district. The river cuts across a diverse array of ecosystem settings from montane temperate grass lands through moist deciduous and evergreen forests to a mangrove lined estuary. It flows through Pathanamthitta and Alappuzha district.

Flood in river Pamba and its tributaries severely affected 21 gramapanchayats such as Ranni-Perunadu, Chittar, Seethathode, Vadasserikara, Naranammoozhy, Ranni, Ranni-Angadi, Ranni-Pazhavangadi, Kozhenjeri, Mallapuzhasseri, Thottapuzhasseri, Aranmula, Koyipram, Ayiroor Eraviperoor, Kuttoor, Kadapra, Thiruvalla, Niranam, Nedubram and Peringara through which it flow. All these GP's were severely affected due to the overflow of water from Pamba river during flood. The level of water rose up to 15 meters in upper region of Pamba in Ranni-Perunadu GP; 10 -12 meters in Ranni, Ranni-Angadi, Ranni-Pazhavangadi GP's; 6 -9 meters in Kozhenjeri, Mallapuzhasseri, Thottapuzhasseri, Aranmula, Koyipram, Ayiroor, Kuttoor, Eraviperoor GP's and 3 -5 meters in lower

pH of water reduced to acidic

After flood pH of the wells, ponds and rivers decreased to 4.2 and became acidic. And the pH ranged from 4.3 to 5.2 in almost all flooded regions in the district. This was noticed in all the flooded region of Pamba, Manimala and Achenkovil rivers

IMPACT ON RIPARIAN VEGETATION AND ENVIRONMENTAL IMPACTS

River Pamba was flooded two times during 2018 ie, before and after August 13. Water level rose up to 10 meter from river bed. River banks collapsed and soil erosion took place in all the 17 GP's through which Pamba flow. All along the river bank sand bars were developed extending up to 25 to 100 meters in length and 1 to 2 meter height from river bed. The worst affected areas were Ranni-Perunadu, Ranni, Ranni Angadi GP's which lie in the upper region of the river (High range area) and Pandalam (Achenkovil river), Mallapuzhasseri, Thottapuzhasseri, Koyipram, Aranmula, Eraviperoor, Kuttoor, Niranam and Kadapra in mid land region. The major issues in the GP's lying in the mid land area such as Kozhenjeri, Mallapuzhasseri, Thottapuzhasseri, Koyipram, Aranmula and Eraviperoor is the deposition of alluvial and muddy/clayey soil all along the riverine area. This soil had poor aeration capacity and due to this, herbaceous plants along the riparian zone started decaying. The impact of Pamba was most severe in Ranni-Perunadu, Aranmula, Koyipram, Mallapuzzhasseri, Kuttoor and Kadapra. In Ranni-Perunad, Pamba river changed its course and sand bars were formed in the river banks. River bank was extensively eroded in Ayiroor and Cherukol where the river was most severely affected. In Cherukol the river banks eroded extensively and resulted in loss of herbaceous medicinal plants. In Ranni-Perunad and Thottapuzhaserry the river bed rose due to deposition of silt. At Ranni-Perunadu the riparian vegetation such as Aattuvanchi, Aattuchampa, Vaka, Edampiri-valampiri, Therakam, Atthi and many herbaceous and shrubby plants decayed. Achenkovil river was severely affected at Kulanada and Pandalam Municipality area. River banks collapsed and soil erosion took place. Many riparian plants was washed off in flood water and lost. Manimala Ar was severely affected at Kadapra, Eraviperoor, Kuttoor, Nedumbram,Niranam and Thiruvalla. At Varattar extensive river bank erosion occurred and a large pool (lake) formed at Thaimaravumkara in Kuttoor GP

IMPACT OF FLOOD ON VARATTAR –FLOOD PLAIN OF PAMBA AND MANIMALA RIVERS

Varattar is a tributary of Pamba connecting Manimala river and is a natural flood plain of both rivers, carrying water from both sides. Recently a massive public movement spearheaded the rejuvenation of this dead river. The riverine ecosystem was degraded mainly due to encroachments and construction of causeways obstructing the natural flow of water. During flood, water inflow from both rivers caused severe flooding all along the Varattar river basin. River banks collapsed. Sand and alluvial soil was deposited in riverbed resulting in decreased depth of the river. Many herbaceous medicinal plants, shrubs and small trees were washed away due to mud slide and soil erosion. There are about 95 plant species reported from riparian zone of Varattar. Agricultural crops such as coffee, nutmeg, pepper, rubber and banana, and tuber crops cultivated in the river basin were also damaged and lost in flood. But local people say that the rejuvenation of the natural flow of Varattar prevented flooding of the adjoining areas and the damage would have been otherwise more severe. At Thaimaravumakara, in Kuttoor GP, a new pond was formed at the junction of Varattar and Kadalimangalam Ar due to flood.

IMPACT OF FLOOD ON INVASIVE SPECIES OF AQUATIC PLANTS IN PAMBA RIVER

Sri. N. Sukumaran Nair, Chairman, Pamba Parirekshana Samithi, says, flood has badly affected the natural ecosystem of Pamba river. Sand, silt and alluvial soil was deposited extensively on river bed, bank and nearby agricultural fields Deposition of sand and silt caused resluted in a decrease in depth of river. He says that, after flood river water became acidic affecting the endemic fishes and other aquatic organisms. In addition to that he reported that invasive aquatic plants such as Cabomba and Kulavazha, were displaced from upper regions of Pamba river and deposited in lower regions of the river and flood plains. After flood presence of Cabomba is widely noticed in Varattar, a tributary and flood plain of both Pamba and Manimala rivers. Measures should be taken to check this, he says.

Wet lands and ponds are critical part of fresh water ecosystem areas lie in the Kuttanad region such as Niranam, Kadapra, Nedumpram, Peringara, Kuttoor GP's is rich in wetlands and ponds Vast areas of paddy lands, wet lands, rivers, streams and ponds were infested with aquatic weeds In addition weeds were dumped into agricultural fields posing a serious menace to the farmers. Sand, silt and muddy soil along with all kind of pollutants including effluents from industrial firms were deposited widely in all flood affected regions causing damage to the prevailing natural ecosystem. One example is the leakage of bathroom cleaning products from an industrial firm, at Aranmula. Extensive algal blooms and eutrophication of the ponds at Eraviperoor, Kuttoor, Cherukol, Ayiroor etc is reported by local people. After the floods the water level in the ponds has gone down and the water has become muddy. The water in the wells has become unfit for drinking.

2. TERRESTRIAL ECOSYSTEM

Incessant and intensive rain caused soil erosion and landslides in mountain regions. There was a series land slide reported from Ranni-Perunadu, Chittar and Seethathode Gramapanchayts in Pathanamthitta district. Of these, 5 landslides occurred in Rajampara forest division in Ranni-Perunadu GP; 3 in Kappakkad and 2 in Bimmaram tribal settlement (Malaipandaram). Here vast areas of land eroded and many forest trees, plantation crops and crops cultivated by tribals were damaged. 18 landslides occurred in forest areas of Chittar and Seethathode GP's. Most of these were occurred near inhabited area and some in deep forest area. Among these 4 landslides was occurred near Sabarigiri Hydroelectric project; Panniyar, Meenkuzhy, Vayyattupuzha and 22nd Block area, caused severe damage to the ecosystem and biodiversity of this region. Large quantity of soil, rocks, forest trees, medicinal shrubs, herbs, native crops of tribal communities eroded in runoff water. Drained water and solid materials from all these landslides came to Kakkattar, a major tributary of Pamba which resulted in more flooding in Pamba river.Most of these landslides occurred in forest fringes ie, near plantation or agricultural fields. Due to clearing of shrubby vegetation in forest fringes for agricultural purposes the soil became loose and these areas became more prone to soil erosion and landslide during intense rainy season.

Pandhalam Municipality

Aranmula












Ranni-Perunadu-Pumba

SABARIMALA-PAMBA: NATIONAL PILGRIM CENTRE

The national pilgrim centre, Sabarimala, is situated on the banks of holy river Pamba. Flood affected Pamba valley. Here, the river diverged from its normal course and damaged all the buildings at Pamba-Thriveni. Extensive landslide and soil erosion also occurred in river banks and caused a huge loss in riparian vegetation.

3.3.10. ALAPPUZHA

3.3.10.1. DISTRICT PROFILE

Geographically the district includes both costal and midland area. Alappuzha is enriched with backwaters, rivers, wetlands and ponds. Major rivers flowing through the district are Pamba, Manimala and Achenkovil. Snake boat race is a significant traditional event in Alappuzha and number of boat races are conducted in this region. The district is a well known tourist destination in India due to the presence Vembanad lake, the largest back water in Kerala. Vembanad back water covers about 2/3 of the district. The district is also known for its coir factories, most of the coir factories are situated in and around Alappuzha. Part of Kuttanad, the rice bowl of Kerala, lie in this district.

Pamba, the third longest river in Kerala is formed by several streams originating from Peerumedu plateau in Idukki district. After flowing through Pathanamthitta district it enters Alappuzha district at Chengannur and flows through Pandanad, Veeyapuram, Thakazhy, and Champakulam through a distance of about 117 km in the district and plunges into Vembanad lake through several branches such as Pallathuruthi Ar, Nedumudi Ar, Muttar and Pookaitha Ar. Major tributaries are Kakkiar, Nunangar, Kakkattar and Kallar which are in Pathanamthitta district.

3.3.10.2. THE DISASTER- FLOOD/LANDSLIDES OF 2018

The average rainfall during the period 1 June to 22 August for the district is 1380.6mm but during 2018 the rainfall was 1784 mm which is 29 % above average

3.3.10.3 IMPACT OF FLOOD ON ECOSYSTEM

Due to the presence of many rivers, streams, wet lands, ponds canals the district is highly prone to flooding. All the three major rivers were over flooded and discharged the water into Vembanad lake. The flood was triggered by a sudden rise in water level in Pamba river following the opening of shutters of Kakki, Anathodu and KochuPamba reservoirs, which are part of the Sabarigiri hydroelectric project in Pathanamthitta district. Inflow of water from all these rivers caused severe flooding in 27 out of 73 gramapanchayts. The water that gushed from the rivers filled Vembanadlake and flooded most of low lying areas in the region. In flood, Chengannur, Kuttanad and Ambalapuzha taluks were completely isolate. Kuttanad region witnessed the worst flood in the century.

1) RIVERINE ECOSYSTEM

Pamba, Manimala and Achenkovil are the major rivers flowing through the district. Flood in Pamba caused severe damages in 17 gramapanchayats through which it flows. Flood caused extensive

damages to the river bank and riverine vegetation in the upper part of the district, Chengannur taluk. Water rose up to 5-8 meter in height here. Soil erosion occurred all along the river bank. The Pamba-Achenkovil river affected Budhanoor, Mannar, Veeyapuram, Chambakulam, Thiruvanvandoor severely. Due to soil erosion and runoff velocity of water, most of riparian vegetations was washed away. There is large scale deposition of silt and sand in river bed and shore and this caused in decrease in the depth of the river. Native fishes were washed off in flood and after flood the population seems to be decreased in number. Most of the aquatic weeds washed away. Water became polluted and colour changed. After flood new species or exotic fishes are abundantly found in river.

The river Achenkovil enters Alappuzha district at Venmony. The river passes through Cheriyanad, Puliyoor and Chengannur villages, enters Mavelikkara Taluk at Chennithala, flows through Thriperumthura and Pallippad villages and joins Pamba at Veeyapuram.

Flood in Achenkovil river caused severe damages to the biodiversity and ecosystems of 8 gramapanchatyats through which it flow. Landslides occurred all along river bank and the depth of the river reduced due to vast deposition of silt and sand in river bed. Large scale deposition of solid waste including plastic, electronic and cloths were noticed all along the river and water became polluted.

MANIMALA RIVER

The river enters the district at Thalavady village in Kuttanad taluk and passes through Edathua and Champakulam village and joins Pamba river at Muttar. Flood in Manimala river caused extensive damages in 5 gramapanchayats; Edathua, Thiruvanvandoor, Champakulam, Muttar, Thalavady and villages of Manimala, Kaviyoor and , Kallooppara that lies in the course of river. Landslide and soil erosion occurred all along the river bank in the upper part of the river. Due to the inflow water from Manimala river, low lying areas like Champakkulam and Thiruvanvandoor in Upper Kuttanad was severely flooded. There are many tributaries, canals and streams in Alappuzha. Important tributaries are Pookaithayar, Varattar, Kuttamperror Ar, Kuraykkalar, Puthanar, Utharapalliyar etc. Inflow of water from rivers (cumulative effect) caused severe damage to all these ecosystems and caused habitat loss and loss/damage of flora, fauna and aquatic ecosystem.

IMPACT OF FLOOD ON WET LANDS : VEMBANAD LAKE -RAMASAR SITE -FLOODED

Vembanad lake system is the largest estuarine-lagoon system in Kerala. The lake consists of a complex system of backwaters, marshes, mangroves and canal systems and extends to Ernakulam district and Vaikom-Kumarakom in Kottayam district. Because of its ecological importance lake was designated as Ramsar site for wise use of wetlands. Six perennial rivers, which originate from the Western Ghats drain into the lake before joining the Arabian Sea. They are Achenkoil (128 km), Pamba (176 km), Manimala (90 km), Meenachil (78 km), and Muvattuppuzha (121 km) which join at southern arm of the lake and a branch of Periyar (244 km) which joins at the northern arm in Kochi.

Vembanad has a unique environmental habitat which supports rich and diverse species of flora and fauna. Both freshwater and saline water species are present in this tropical estuary, faunal diversity includes a large variety of fishes, prawns, clams, reptiles and birds. This ecosystem supports the third largest population of waterfowl in India. Numerous species of resident and migratory birds are found visiting this area for breeding and feeding.

All the three major rivers that flow through Alappuzha district Pamba, Manimala and Achenkovil, discharge its water into Vembanad lake. Water gushed into the low lying areas as wetlands, paddy fields and agricultural fields and caused severe damages to the crop and ecosystem. New exotic

and invasive species of fishes such as African mushi, Red bellied Piranah, were abundantly found in Vembanad lake after flood. This is a threat to the native endemic aquatic species of animals. Availability of fresh water mussels were also reduced after flood. Lake is filled with more aquatic weeds, solid wastes like plastics, electronics and cloths causing severe pollution.

The Vembanad backwaters in Kerala is a tourism destination where foreign and Indian tourists cruise on houseboat and the annual tourist inflow is much above the carrying capacity of the Lake. It is estimated that there are about 1000 house boats here. This has led to the pollution of the water with leakage of fuels from the house boat. The local people say that this affects the fish catch of the lake. The fishery of Vemaband lake consists of crab, clam, various varieties of prawns, and many fish species including the famous pearl spot. In 2007, the MS Swaminathan Research Foundation, in their report titled Measures to mitigate the agrarian distress in Alappuzha and Kuttanad wetland ecosystem sounded a warning. "The changed ecology is believed to have led to the loss of about 23 species of fishes, prevented migration of about 13 other species, led to the decline of 33 percent of bird population, [and] brought in new predatory bird species like Neerkozhi."

The depth of the river has decreased and due to floods the polluted water was washed off and the local people say that fish is more tasty and bigger in size. But local people say that the catch of Karimeen is very less now. The flood has also affected the clam fishery due to deposition of silt.

Alappuzha has a number of ponds, most them are used for fish farming. All ponds in the flood affected Gramapanchayats were flooded with overflowing water from rivers and canals and became polluted and damaged. All wells in the flood affected regions were contaminated with flood water and polluted. Solid and liquids waste were dumped in wells and water became unfit for drinking and the area faces serious drinking water scarcity.

NEW SPECIES OF FISHES -ECOLOGICAL IMPLICATIONS OF FLOOD ON VEMBANAD LAKE

After receding of flood water from kole lands / paddy fields, there is profuse growth of small herbaceous weedy plant Thelkada (*Heliotropium indicum*) all along the paddy field posing serious problem in agriculture. Similarly after flood, there is an abundance of new back water fish species such as Vatta (Malabar trevally) (*Caranngoides malabaricus*) Manthal (Common sole) (*Sole sole*) in Vembanad and allied areas. Abundant growth and distribution of aquatic weeds also a major problem in Vembanad allied wet lands. But local fishermen says that aquatic weed provided a breeding site for fish.

Water entered the forest and timber depot to the height of 6 feet and herbaceous medicinal plants, shrubs, small animals, soil living organism were swept away in the surging flood waters and lost. Major trees present in the forests are Teak *(Tectona grandis)* Mahagony (Swetenia mahogony) Anjili *(Artocarpus hirsutus)* etc. Trees were not affected much by the flood but soil erosion occurred and flood dumped large quantity of plastic wastes in the forest area thus raising many ecological problems.

Herbaceous medicinal plants such as Mukkutti (Biophytum sensitivum) karukappullu (Cynadon dactylon), kurunthotty (Sida cordifolia) shrubs such as arali (Nerium oleander) chethi (Ixora coccinea) trees such as kanjiram (Strychnos nuxvomica) elanji (Mimusops elenji) etc were uprooted out. Large trees such as anjili (Artocarpus hirsutus) Ezhilampala (Alstonia scholaris) etc were withstand the flood.

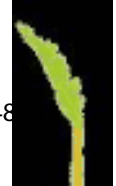


Fig. 56. Alappuzha District -- LSGs Selected for Biodiversity Study.

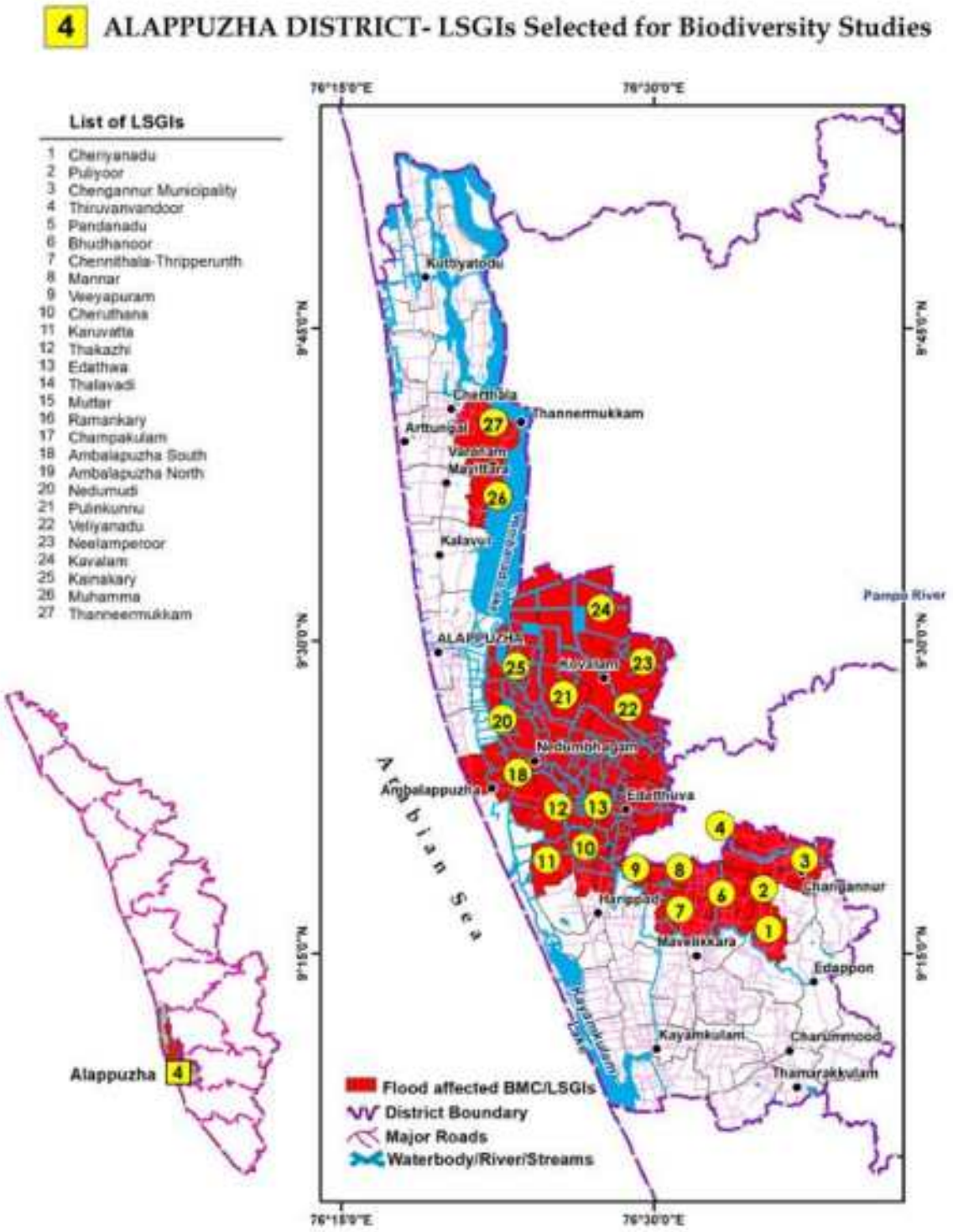


Fig. 57. Alappuzha District -- Drainage map.

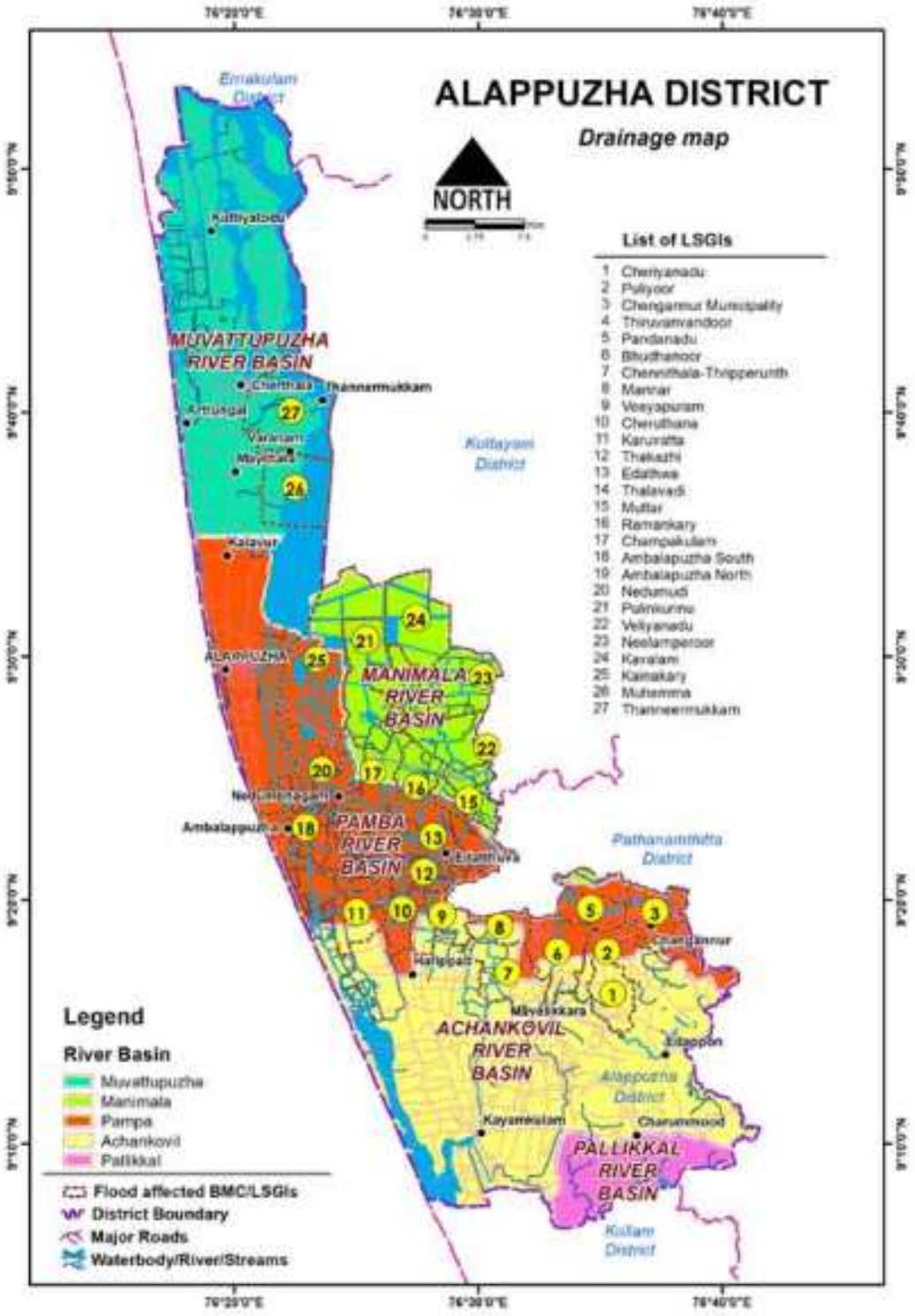


Fig. 58. Alappuzha District -- Flood impact map.

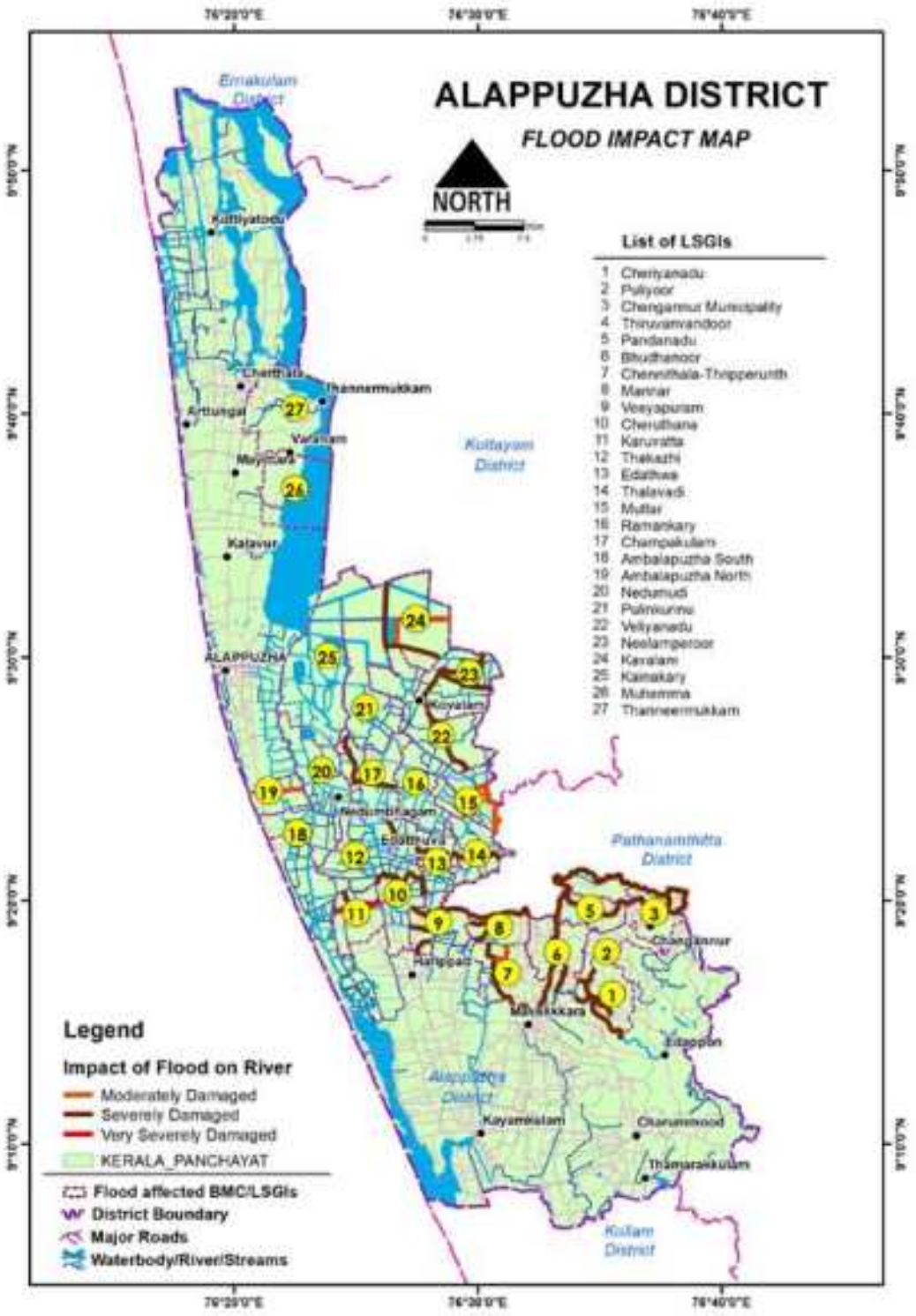
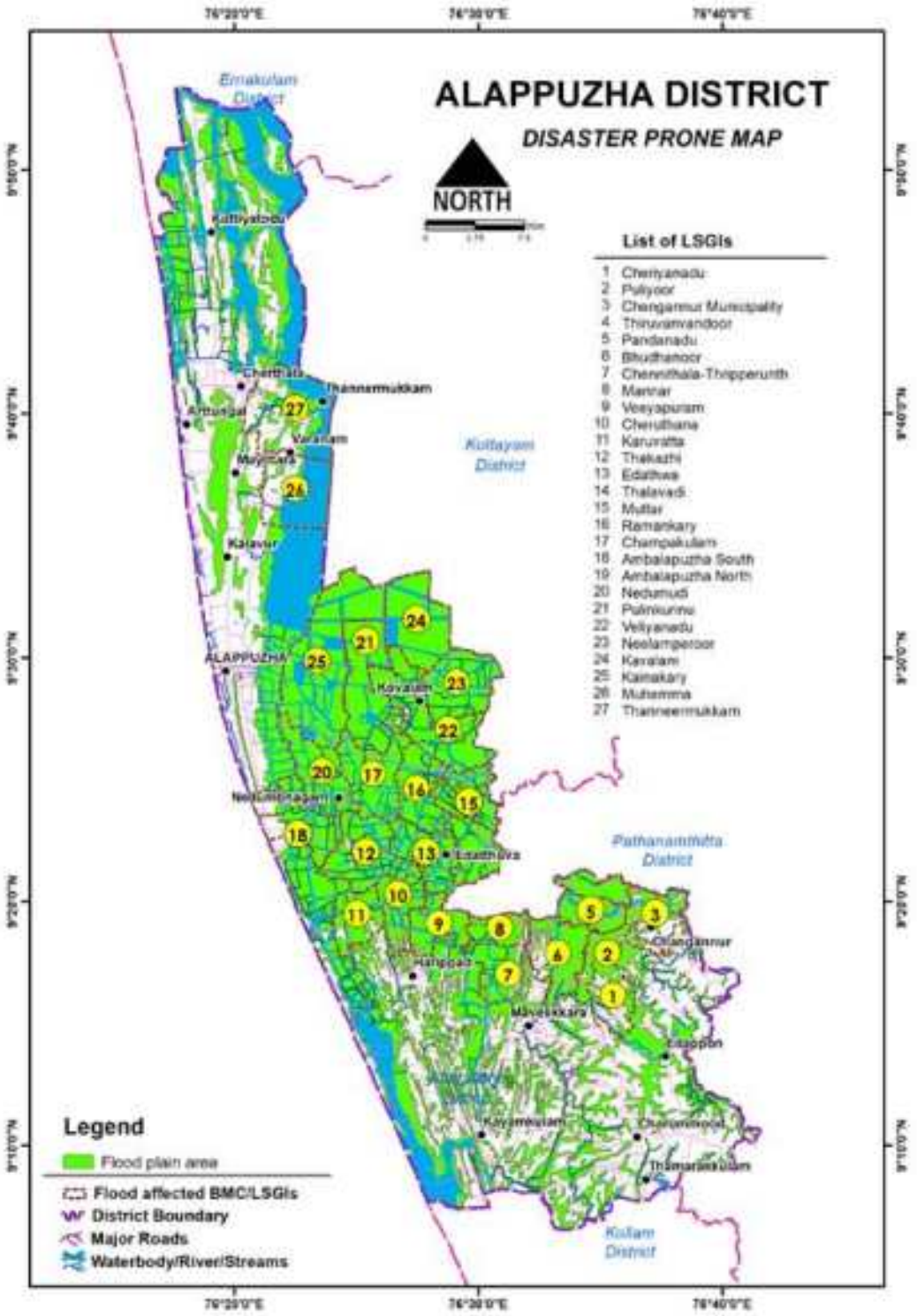


Fig. 59. Alappuzha District -- Disaster prone map.



3.3.11. KOTTAYAM

3.3.11.1. DISTRICT PROFILE

Kottayam can be divided as highland, midland and lowland, the bulk being constituted by midland regions. The important rivers of the District are the Meenachil, Muvattupuzha and Manimala.

3.3.11.2. THE DISASTER- FLOOD/LANDSLIDES OF 2018

The average rainfall during 1 June to 22 August in the district is 1531.1mm but during 2018 it was 2307 mm which was an excess of 51%.

3.3.11.3. STUDY AREA AND ASSESSMENT METHODOLOGY

The study on impact assessment of flood on biodiversity was conducted in severely affected twelve GramaPanchayats in Kottayam district, viz, Arpookkara, Kallara, Koottickal, Kumarakom, Maravanthuruthu, Mulakulam2, Payippad, Thiruvarppu, T.V. Puram, Udayanapuram,Vazhappally and Velloor.

3.3.11.4. IMPACT OF FLOOD/LANDSLIDES ON ECOSYSTEM
1) RIVERINE ECOSYSTEM

The main affected rivers are Meenachil River, Muvattupuzha River and Pampa River. The Meenachil River flowing through Arpookkara and Kumarakom region was affected. Mud deposition occurred in rivers and streams and plastic wastes got accumulated in the river. Muvattupuzha River is flowing through Mulakkkulam, Thiruvarppu, Udayanapuram and Velloor Panchayats, where the water became more turbid and depth decreased due to siltation. In Udayanapuram flow of water decreased due to the formation of sand bars to a height of 2.5 feet. In Velloor siltation occurred and the depth of river decreased. Sand bars was formed in the river bank in about 1.5 acres of area.The Pampa River overflowed at Payippad region and nearby paddy fields, ponds, wells and canals were flooded.

Pullakayar a tributary of Manimalayar flows through Koottickal and was affected due to landslide. At certain regions river bank collapsed and plastic wastes got tangled in the branches of riparian trees. Liquid wastes from rubber factory enhanced the rate of pollution and fishes died.

Mannathazham canal in Maravanthuruthu has been affected by landslide. The sand deposited in the bed of canalappeared in orange colour and water holding capacity of soil decreased due to siltation. Sand bars was formed in many regions, siltation occurred 20-30 cm in thickness and soil was eroded along the banks. Reeds helped to overcome soil erosion to an extent. Kariyar, a tributary of Muvattupuzha River in T.V. Puram became turbid and depth increased due to mud banking. People says that the taste of water changed to sour. Depth of river decreased in 5 canals in Vazhappally Panchayats due to mud deposition.

Fig. 60. Kottayam District -- LSGs Selected for Biodiversity Study.

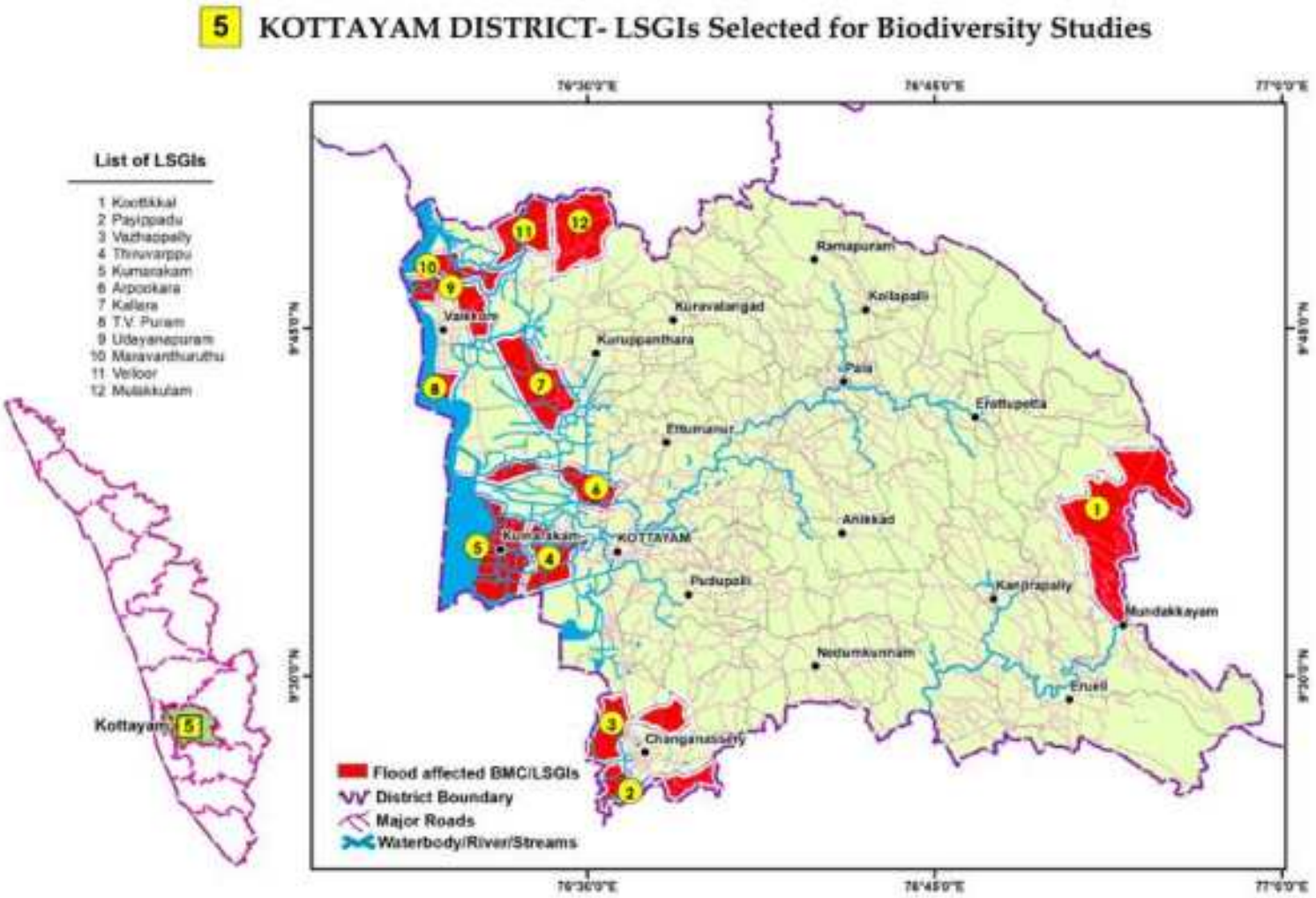


Fig. 61. Kottayam District -- Drainage map

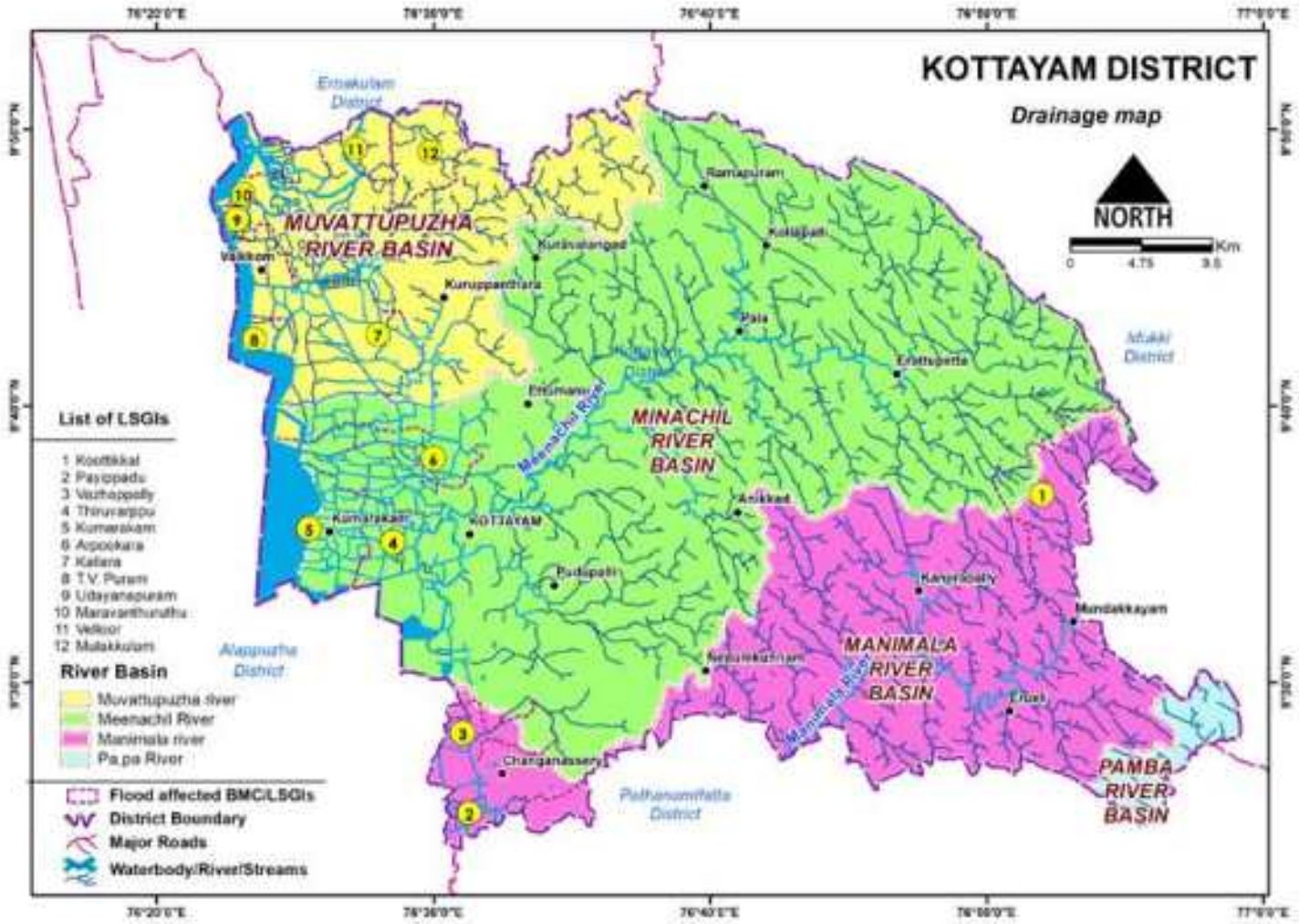


Fig. 62. Kottayam District -- Flood impact map.

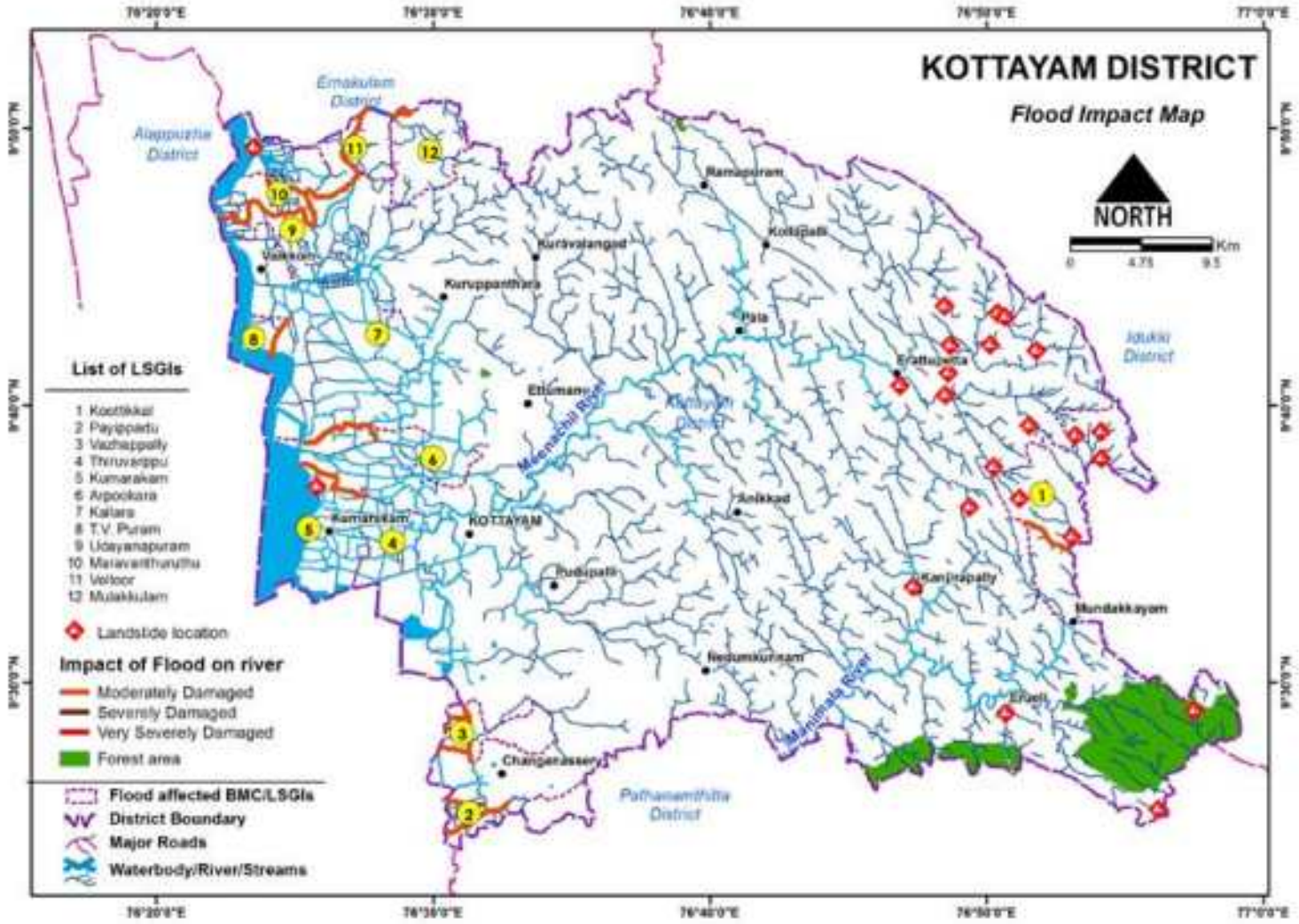
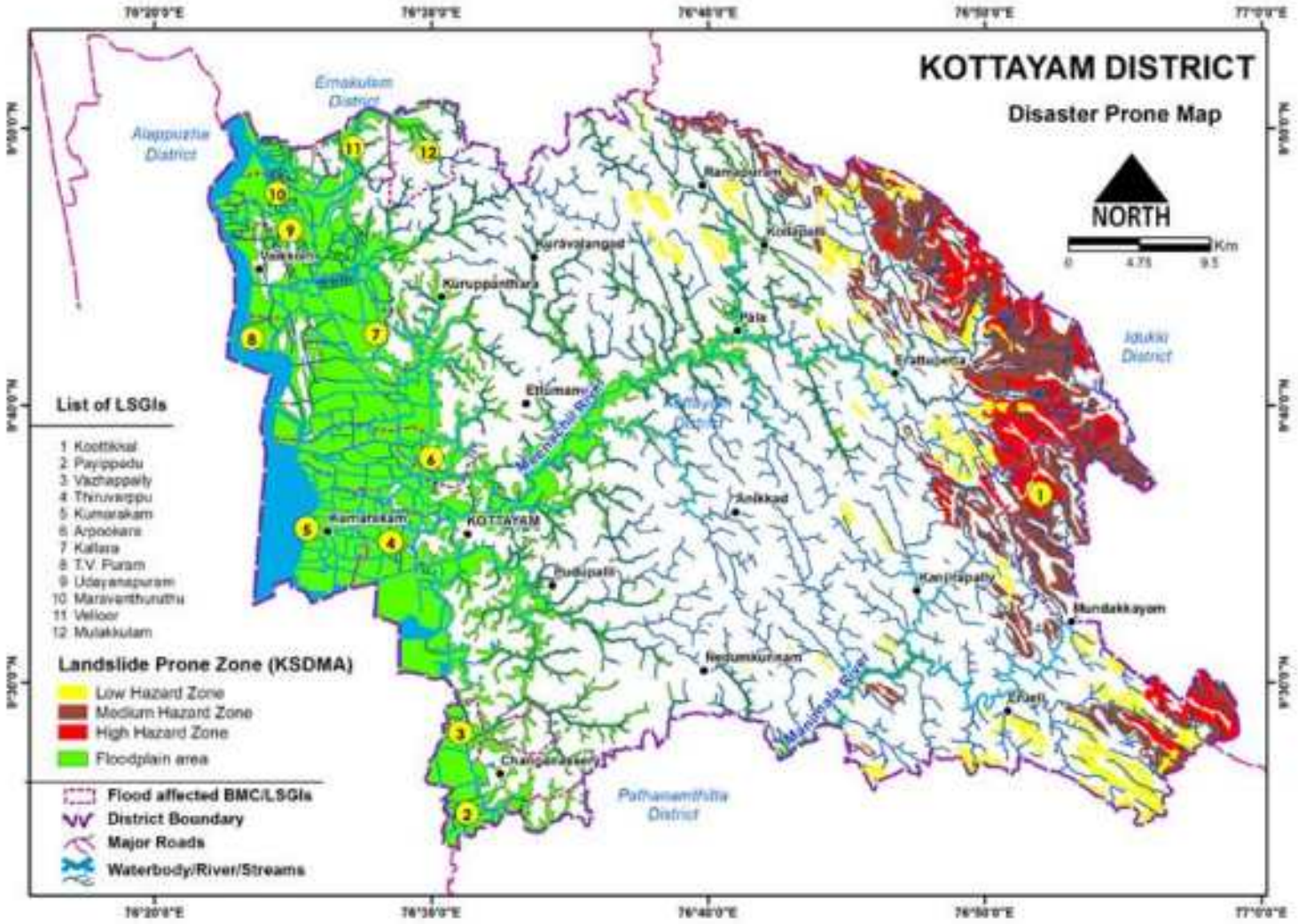


Fig. 63. Kottayam District -- Disaster prone map.



VEMBANAD LAKE -RAMSAR SITE AT KUMARAKOM– MANGROVES SHOWS REPLENISHED GROWTH!!

Mangroves like Sonneratiacaseolaris, Bruguieragymnorrhiza, Annonaglabra, Excoecariaagallochaand grasses on the bank of lake like Panicumrepens, Leersiahexanbra, Ischaemumtravancorense, Cyperussps. shows replenished growth after flood.

Marshes in Maravanthuruthu and 67 acres of marshy land in Vazhappally region wasaffected. Ferns growing in marshes areas shows replenished growth after flood in Maravanthuruthu.

2) TERRESTRIAL ECOSYSTEM

In Kakkathuruthu heronry in Mulakkulam Panchayat, population of crows were found to be increased after flood.Kuttikkadu kavu in T.V. Puram was severely affected.Kumarakom Agriculture Research Centre and Karshika Vinjan Kendra were severely affected.

From five acres of fish farms, about 26,000 fish fingerlings of Rohu, Catla, Grass carp and Thelapia; about 1000 indigenous fish fingerlings of karimeen (Etroplus suratensis) and manjakoori (Horabagrus brachysoma) escaped.
Crops like snake gourd, bitter gourd, ash gourd, cucumber cultivated in 5 acres of land were completely lost. Planting materials of tapioca, amorphophallus, etc. of 2 acres land were lost. Other planting materials like Kudampuli (Garcenia) – 5000, Nutmeg– 1000, Mavu – 6050, Jack fruit tree – 1500 & Coconut – 2000 were also lost. Phosphorus content of soil decreased and acidity increased.

In Koottickal region, strong landslides occured. Landslip occured at Kodungayil and Mealethadom area. Kerala State Biodiversity Board had earlier conduced a study on the mining operations of the Valyantha watershed area of Kootickal Village by considering the environmental, geological and biological setting of the area stated that the functioning of quarries and crusher units in the ecologically sensitive steep hill slopes of Kodangu and Valyantha micro-watershed need to be stopped and proper ameliorative measures taken for the eco-restoration.

Kottayam, Udayanapuram field


Landslide at Koottikkal GP


Trees uprooted, Maravanthuruthu

3.3.12. KOLLAM

3.3.12.1 DISTRICT PROFILE

The district is composed of two revenue divisions viz. Kollam and Punalur with three taluks each under them and the district has 69 Panchayat, 1 Corporation and 4 Municipalities.

3.3.12.2 THE DISASTER- FLOODS/LANDLSIDES OF 2018

The average rainfall in the district during the period 1 June to 22 August is 1038.9 mm but during 2018 it was 1579.3 mm, 52 % above normal.

3.3.12.3. STUDY AREA AND ASSESSMENT METHODOLOGY

The study on impact assessment of flood on biodiversity was conducted in five GramaPanchayats in Kollam district which was severely affected, viz, Adichanalloor, East Kallada, Munroethuruthu, Thodiyur and West Kallada.

3.3.12.4. IMPACT ON ECOSYSTEM:

Ithikkara River, Kallada River and Pallikkal River are the major rivers affected in the district due to flood and landslide. Small marshy areas in Katramkani, Kadapram- Perungalam and Pattamthuruthu West were also damaged severely. Ashtamudi Lake was severely affected due to mud deposition, accumulation of plastic wastes, etc and local people say that water has become more saline.In Adichanallooor 2 ponds were severely affected and their sidewalls got damaged. In East Kallada, a fish farming pond was flooded and fish ready for harvest like Cutla and Rohu were completely lost. In Adichanalloor, small hillocks was very severely due to landslide and soil erosion and they cannot be rejuvenated.

1) AQUATIC ECOSYSTEM:-

The banks of Ithikkara River in Adichanalloor Panchayat collapsed and width of the river has been increased. Large amount of solid wastes and plastic wastes was deposited in the river. In addition to this, two streams (Pangodevayalthodu and Panayaraththodu) in the Panchayat deviated form its course.

The Kallada river system was severely affected in West Kallada, East Kallada and Munroethuruthu Panchayats. In West Kallada the damage was mainly due to flood and landslide whereas in Munroethuruthu it was due to flood. In East Kallada the width of the river increased and soil erosion occured along the banks of the river. Both solid waste and plastic waste accumulated in the river.

In West Kallada damage occurred due to landslides the severity of damage is very high and it will take time to rejuvenate. The river bank collapsed and liquid and solid wastes accumulated. Large amount of silt was deposited and sand bars were formed. Three tributaries of KalladaRiver such as Perumkulam-Kalladathodu, Kavilkadavuthodu and Ampiyilthoduwere were severely damaged. In Perumkulam-Kalladayarthodu, silt was deposited, water became more turbid and pH increased to 8. When compared to Ithikkara and Kallada Rivers the severity of the damage is less in Pallikkal River. The river flows through ThodiyurPanchyat. Siltation and soil erosion occurred in small scale along its bank. Wastes from nearby Milk factory reached the river and other plastic wastes also came along with flooded water and got deposited in nearby wetlands and fields along with mud.

Fig. 64. Kollam District-- LSGs Selected for Biodiversity Study.

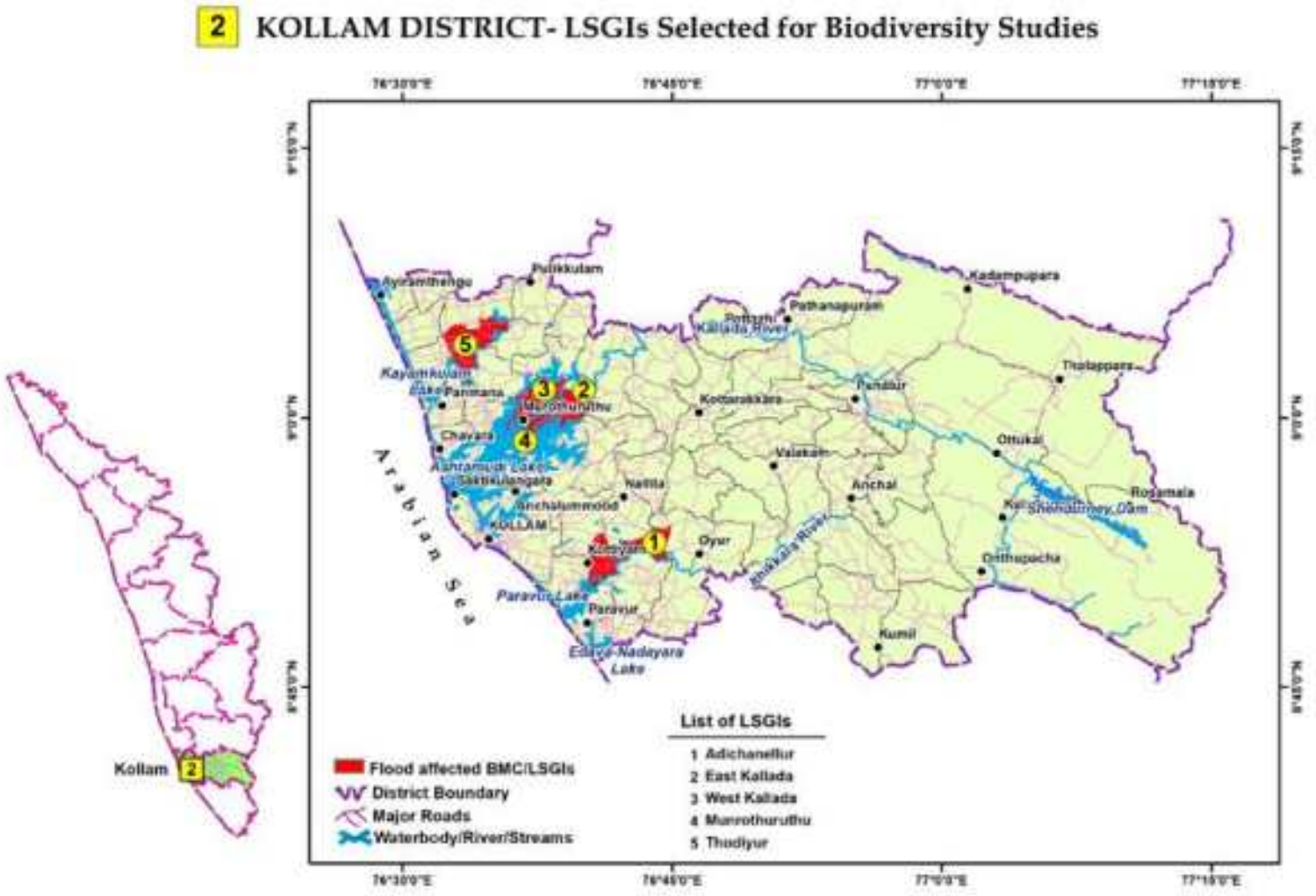


Fig. 65. Kollam District - Drainage map.

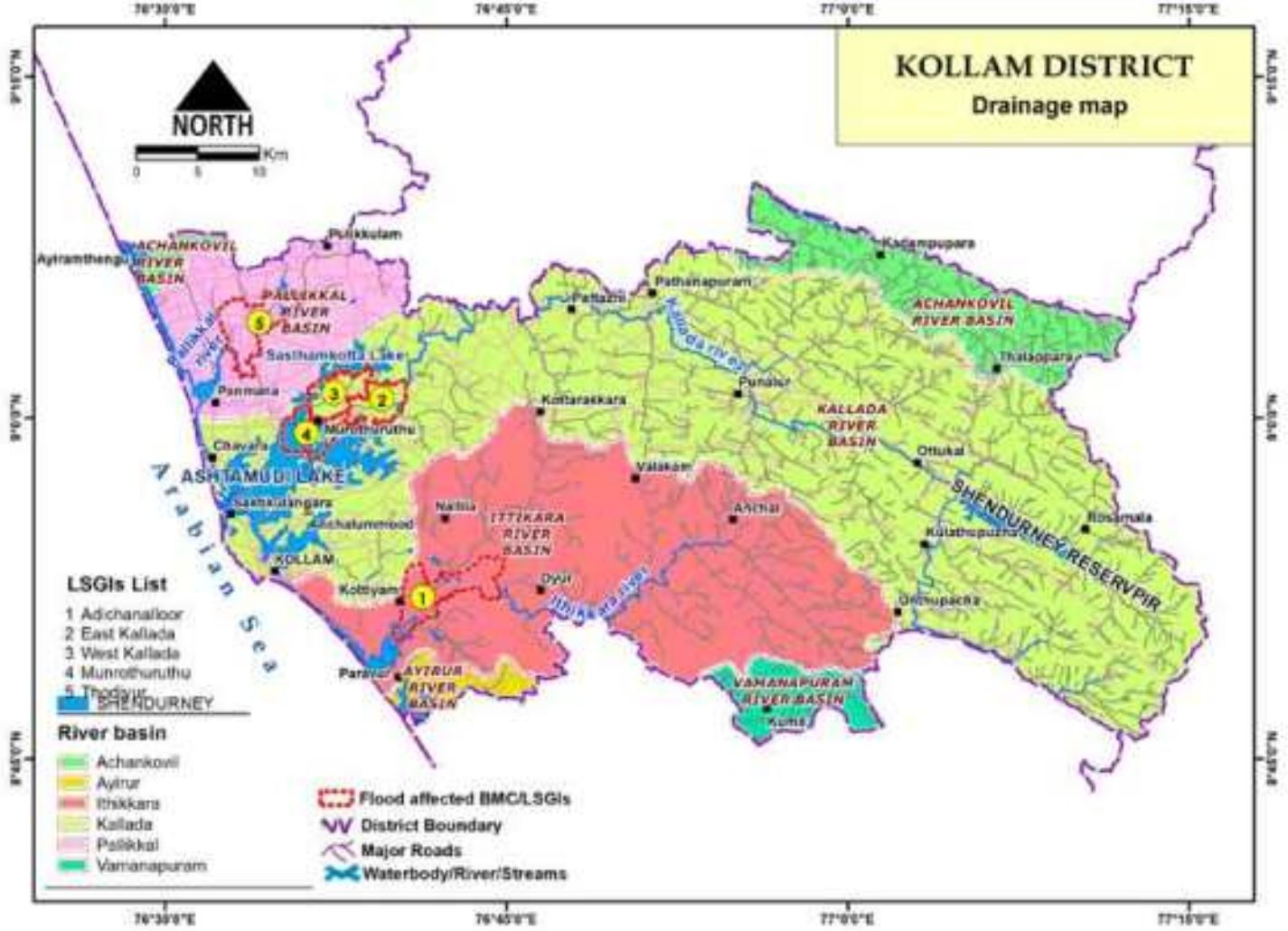


Fig. 66. Kollam District - Flood impact map.

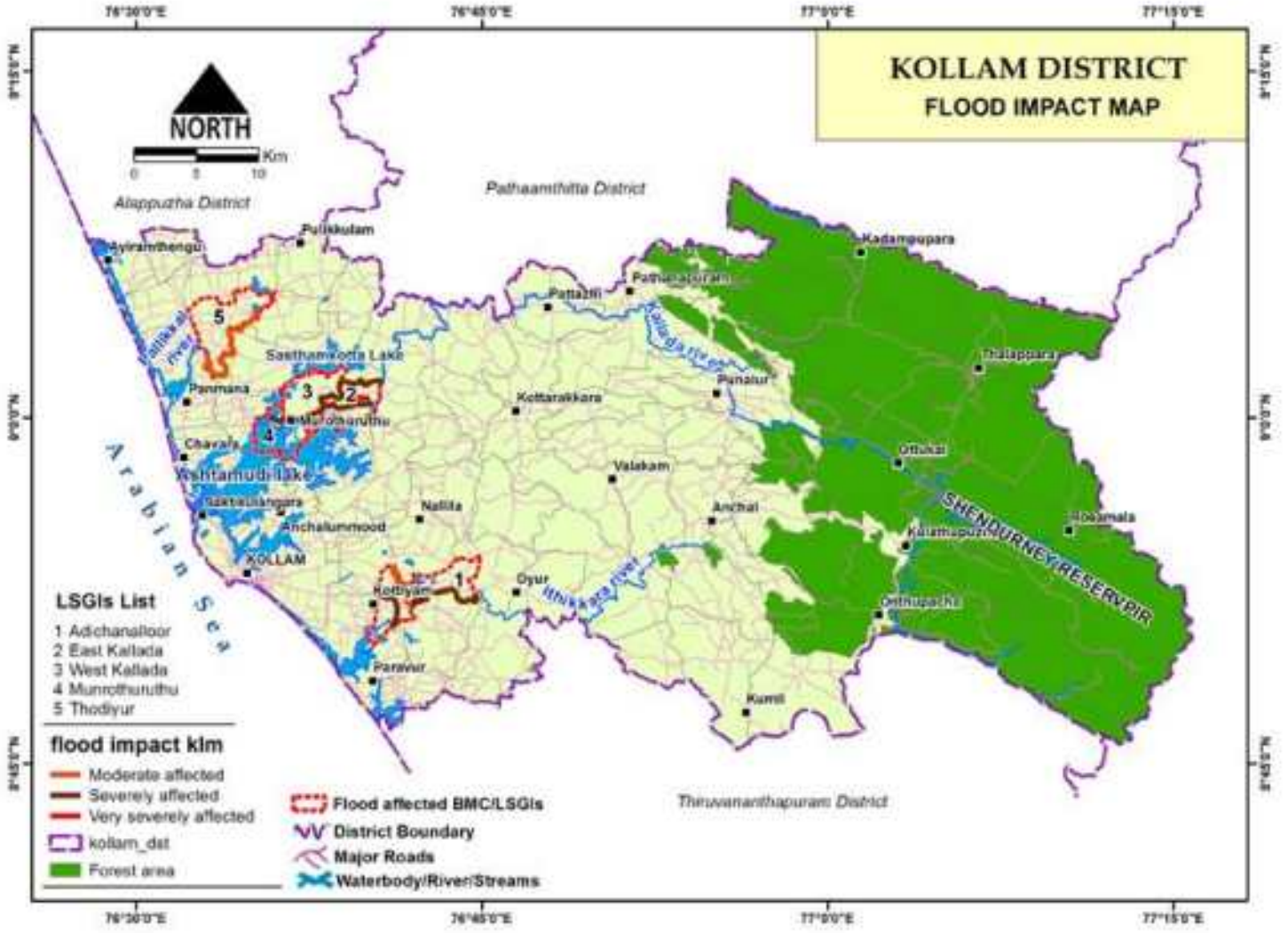
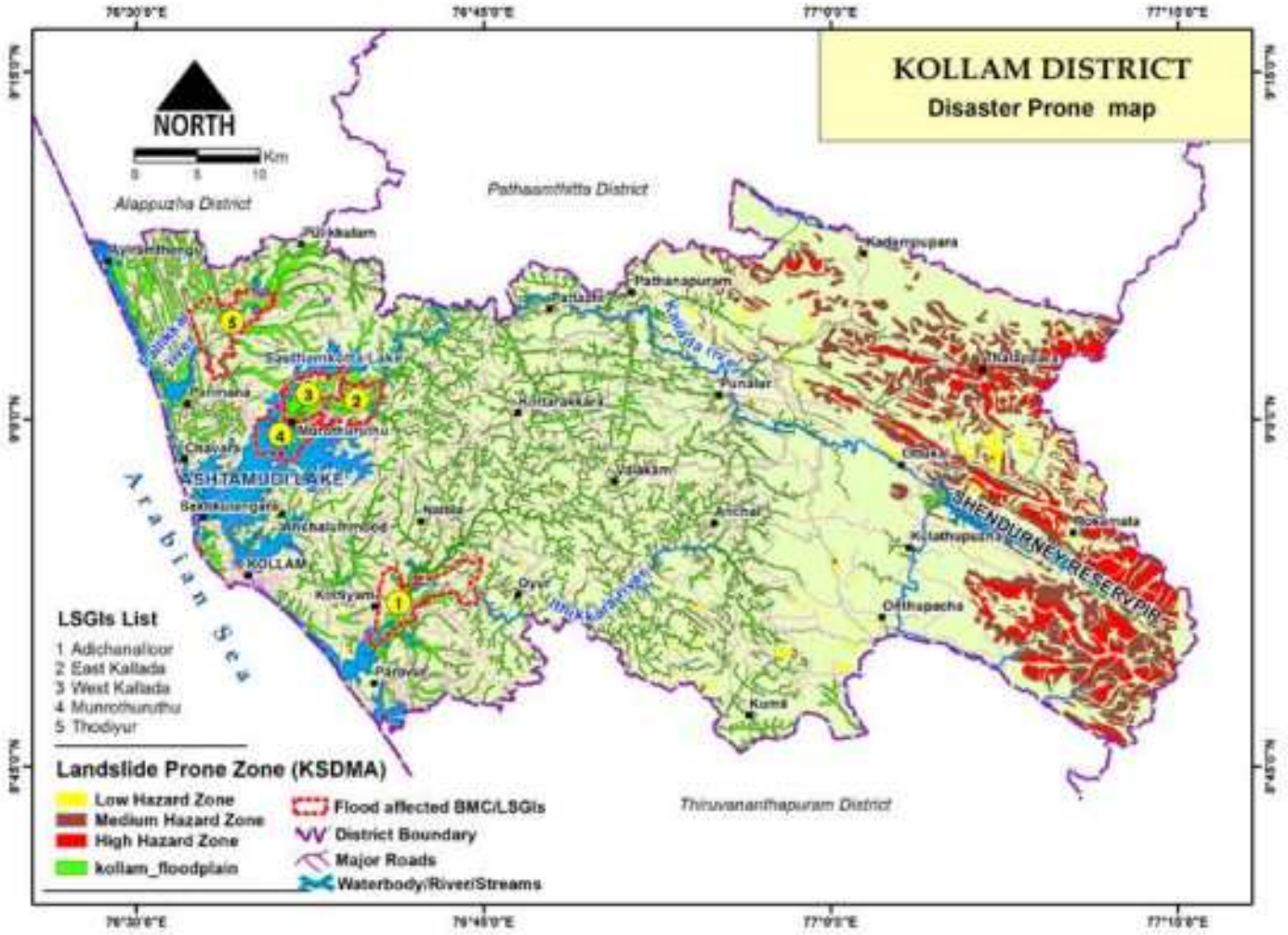


Fig. 67. Kollam District - Disaster prone map.



Vedankollimala, Manrothuruth

Munroe Island, locally known as Mundrothuruth, is an amalgamation of eight small islands in Ashtamudy backwater located at the confluence of Ashtamudi Lake and the Kallada River, in Kollam district. Munroe Island has a geographical area of 13.4sq.km. Over 70 percent of the panchayat is the delta formed by the Kallada river and the people mostly depend on prawn farming. Most of the islands are permanently inundated to an extent of over 1.25 metres in the last few years. In olden days when floods occurred in Kalladayar soil used to get deposited and people used to demarcate the area. Construction of a dam at Thenmala, upstream of Kalladariver prevented the delta accumulation on the islands. Munroe Thuruthu is reported to be sinking because of the rise in water level due to global warming or the tectonic movement. During the floods which occurred after August 13th all the 13 wards of the island were severly affected. In Munroethuruthu, the river bank collapsed and silt was deposited along the bank in about 10 acres area. Sand bars was formed in almost all wards in the Panchayat. Plastic wastes was deposited in land along with mud at the time of flood. Water rose to more than 1 mt in all the wards of this panchayat. Mud slide was also reported in Perungalam and Villimangalam which was the most severely affected. In Villimangalam- Mulachandanavayal muddy soil was deposited. In the marshy land of Nenmeni Pattamthuruthu east Perungalam massive amount of alluvial soil and mud was deposited. After the floods due to the deposition of mud particularly in ward no 10 and 13 species of prawns, clams, barnacles etc was destroyed. In Perungalamsand bars were formed. In Vedan chadi hills one side of the hill collapsed and the debris fell into Ashtamudi kayal. Among coconut and banana plantations a weed Wedilia trilobata is extensively found after floods. The catch of Etroplus, Mugil etc was reduced. The fishes were found to have Epizootic ulcerative syndrome. After the flood the soil color and texture changed and it becam sandy and dark colored. Ward no 1,9,12, 13 had some areas with mangroves which helped to control the floods to a limited extent. Marshes in Muroethuruthu like Nenmenithekku and Pattamthuruthu East having an area of 1 acre each have been severely damaged due to mud deposition, siltation and bank collapse.

3.3.13. THIRUVANANTHAPURAM

3.3.13.1. DISTRICT PROFILE

Thiruvananthapuram district is nourished by rivers like Neyyar, Karamana, Mamom, Vamanapuram, Ayiroor and Ithikkara. In addition to these rivers, the district hosts many backwater systems like Akkulam - Veli, Kadinamkulam, Kozhithottam, Anchuthengu, Kappil, Akathumuri and Edava - Nadayarakayals. Among the 3 fresh water lakes of Kerala, Vellayanilake is situated in Thiruvananthapuram district. The Vellayani Lake is a unique fresh water system and its catchment area is coming under the jurisdictions of Pallichal, Kalliyoor and VenganoorGramapanchayats and Thiruvananthapuram Corporation.

3.3.13.2. THE DISASTER- FLOODS/LANDLSIDES OF 2018

The average rainfall during 1 June to 22 August is 672.1 mm but during 2018 it was 966.7 mm which was an excess of 44%. In Thiruvananthapuram District three LSGs were selected for Biodiversity Studies

3.3.13.3. IMPACT ON ECOSYSTEMS:

When compared to other districts, the severity of disaster – flood and landslide is very less. Of the affected area severely affected 3 GramaPanchayatsviz, Aryanad, Kallikkad and Kalliyoor has been selected for the study. Of these GramaPanchayats, Aryanad and Kallikkad lies on the banks of River Karamana and Neyyar respectively, while in Kalliyoor the most affected aquatic ecosystem is the Vellayani Lake. It is reported that landslide occured in Mulapotta hills in Kallikkad

1) AQUATIC ECOSYSTEMS

Neyyar and Karamana Rivers and Vellayani Lake are the major affected ecosystems in the district. Neyyar and its tributaries were severely affected due to flood when compared to Karamana River. In Aryanad, the banks of River Karamana collapsed along with riparian vegetation and thus width of river increased. Similarly banks of two major canals of Aryanad such as Meenangal and Keezhpaloor canals also collapsed due to flood. Likewise bank erosion occurred in Thakidiyil and Kulavarambu-Nethrathala canals in Kalliyoor. Due to landslide 3 wells in Aryanad were severely affected and subsided completely.

NEYYAR RIVER BASIN

The Neyyar River is the southern-most river of Kerala State. It emerges from Agastya hills at about 1865m above MSL and debouches into Arabian Sea after flowing a distance of 56 Km. The main tributaries of the Neyyar are Chit Ar, Kall Ar, Karavali Ar, Mull Ar, Aruvukod Thodu, Maruthur Thodu, Edamalai Thodu and Talakke thodu.

In Kallikkad, the River Nayyar flows through 5km stretch and it is severely affected due to flood and landslide. The river bank has been eroded around 1 km stretch. In most of the region, width of the river increased and depth decreased as the river bank eroded.

VELLAYANI LAKE:

Vellayani Lake is one of the three rain-fed freshwater lakes in Kerala, with the potential to become the major water sources for Thiruvananthapuram Corporation and adjoining Grama panchayats. It is the largest fresh water lake in Thiruvananthapuram district, and its catchment area is coming under the jurisdictions of Pallichal, Kalliyur and Venganur Grama panchayats and Thiruvananthapuram Corporation. The Vellayani Lake in Kalliyoor was severely affected due to flood. The water became turbid and the depth decreased due to mud deposition.

Theviyarkunnu, Karamanayar

Fig. 68. Thiruvananathapuram District - LSGs Selected for Biodiversity Study.

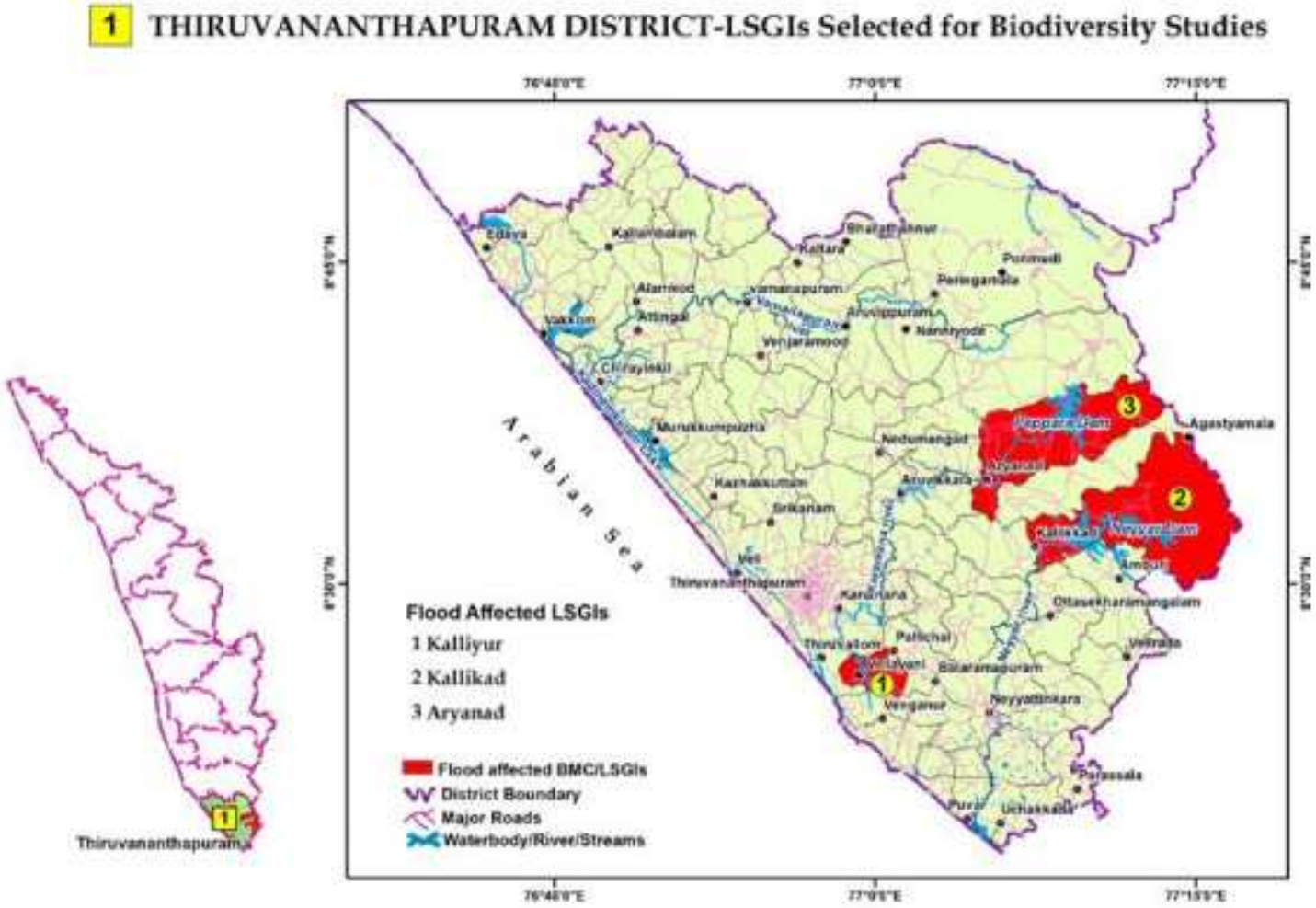


Fig. 69. Thiruvananathapuram District - Drainage map.

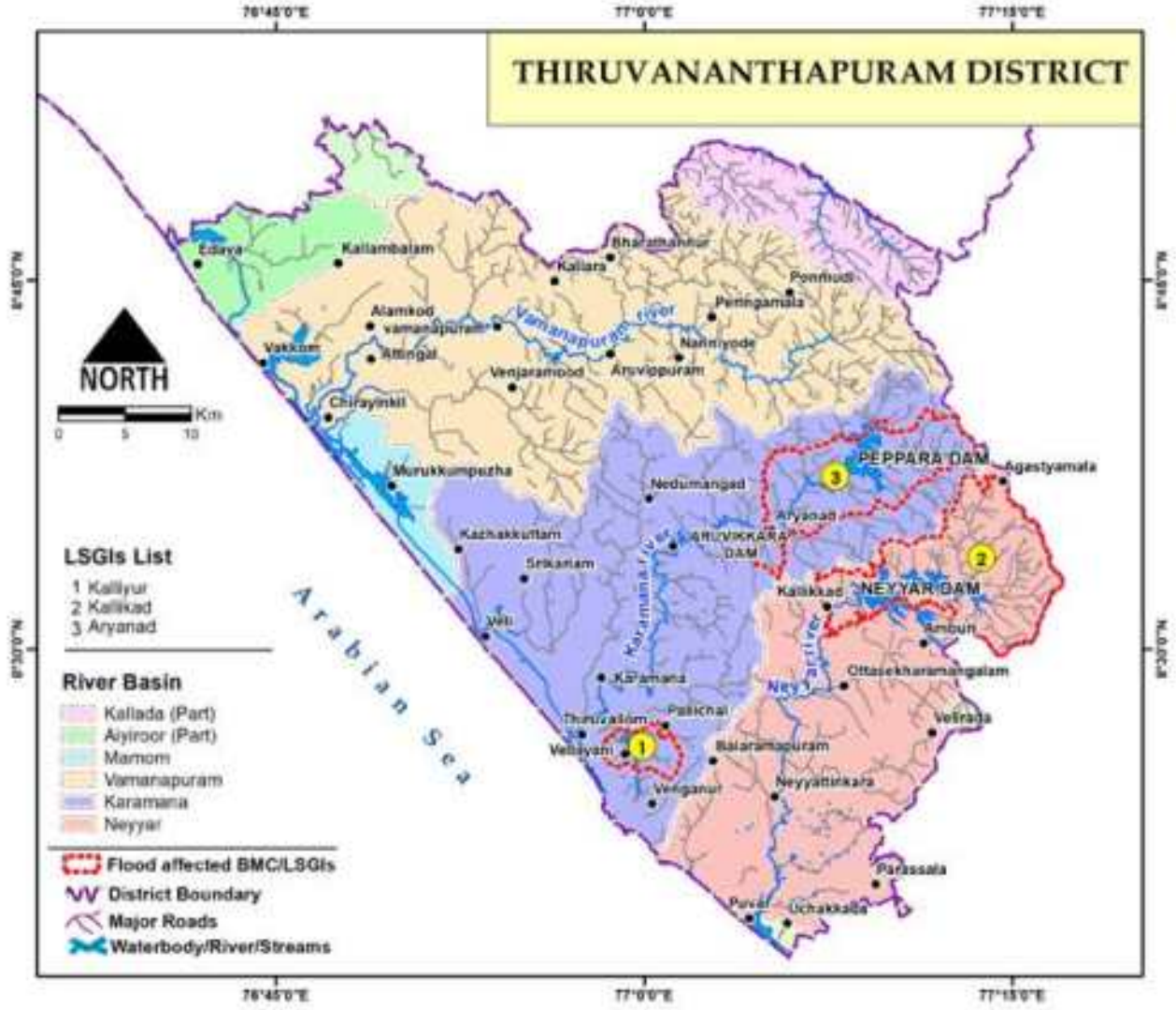


Fig. 70. Thiruvananathapuram District - Flood impact map.

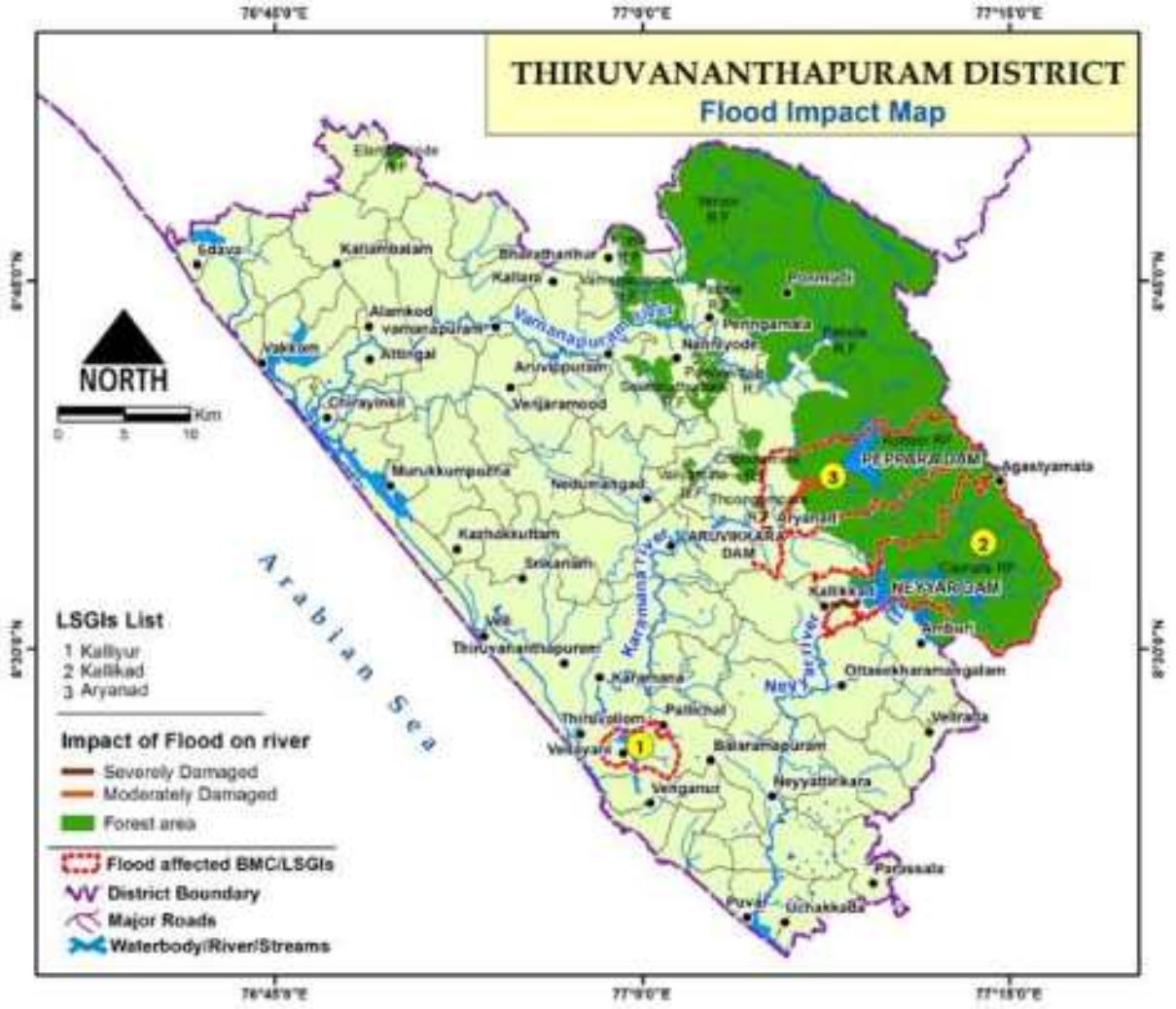
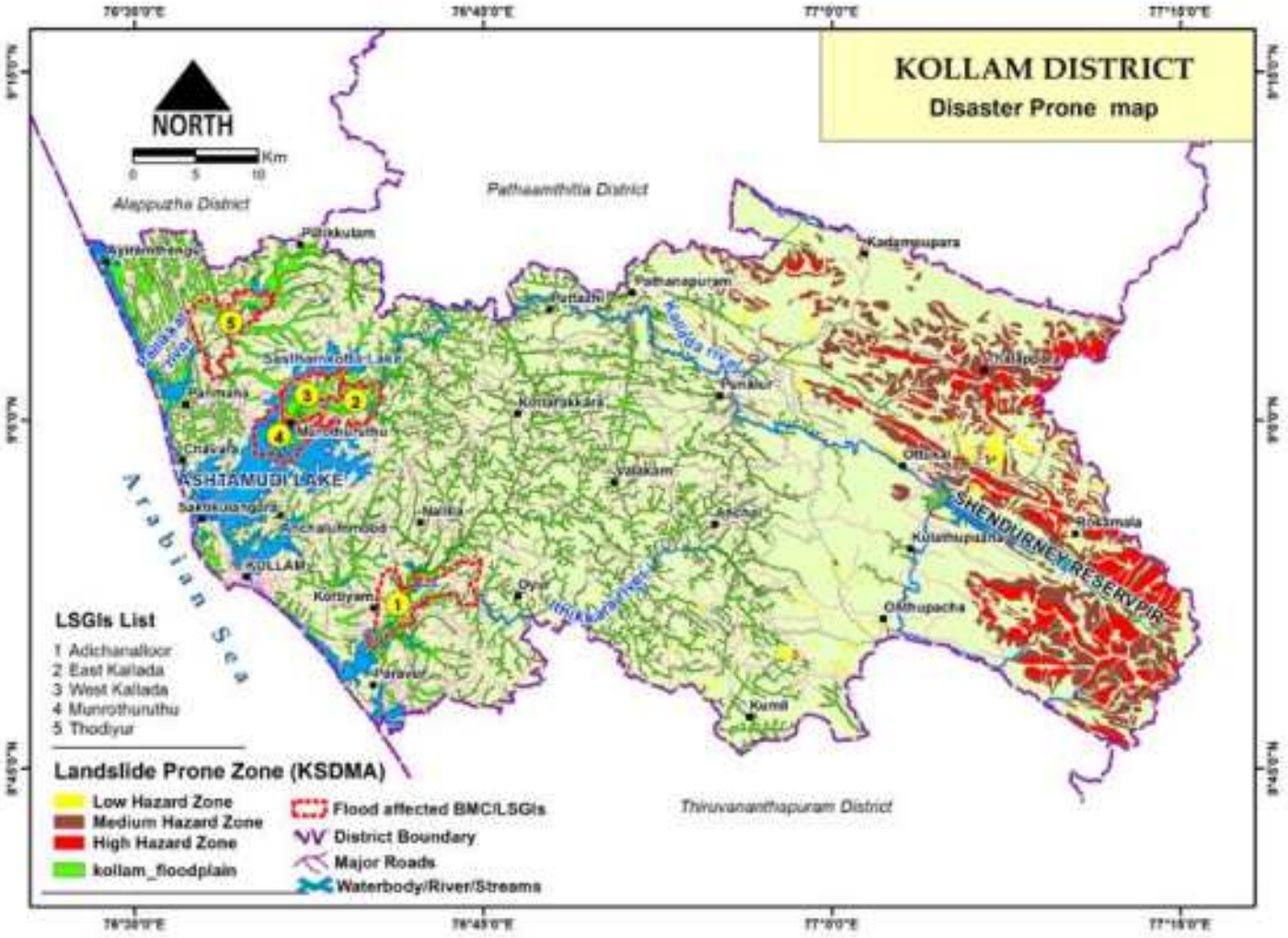


Fig. 71. Thiruvananathapuram District - Disaster prone map.




Kokotela

CHAPTER 4

AGROBIODIVERSITY OF KERALA

4.1 AGROBIOIVERSITY- STATE SCENARIO

Agricultural diversity ensures the resistance of species against diseases, pests or climate change. This genetic pool is the basis of all crop breeding programmes for ensuring food security. Kerala's 23 diverse agroecological units are ideal for the cultivation of a wide variety of crops, including cereals, pulses, fruits, vegetables, tubers, spices, oilseeds, plantation crops and medicinal plants. The state's freshwater resources comprise rivers, ponds, paddy fields, reservoirs, tanks and irrigation tanks. In India eighteen agro-biodiversity hotspots has been identified and the Travancore/ Malabar area of Kerala has been identified as an agro- biodiversity hotspot.

A large number of agriculturally important plants, 142 crop plants belonging to 104 genera and 43 families are grown in Kerala. They belong to 5/10 categories fruits & nuts, beverages & stimulants, spices, coconut, rubber, and staple food crops. These are grown for both domestic use and commercial purposes. The top 10 crop plants of the State are coconut, rubber, paddy, black pepper, banana, arecanut, jack, cassava, mango, and coffee. A number of accessions of Paddy, Pepper and Tubers are being conserved in Kerala.

In Kerala a wide range of local landraces of paddy is available showing variability for different characters such as duration (long, medium and short), grain size (big, medium and slender), season, landscape (lowland, upland and marshy land) etc. The area under paddy cultivation has decreased drastically by 35.8 % in 2013-2014 when compared to 2002-2003. The area under paddy production of local varieties has reduced drastically from 19.23 % of total area in 2002-2003 to 6.45 % in 2011-2012. In Kerala Rice covers a wide array of ecological niches and about 2000 local land races are grown in different agro climatic regions of Kerala including resistant varieties to biotic and abiotic stresses, with ability to adapt to drought or floods, quality attributes like medicinal value, aroma and resistance to diseases. In Wayanad alone during 2002, farmers cultivated 20 different indigenous rice varieties, with Gandhakasala, Veliyan, Thondi and Chomala being the most popular ones. 10 years later, the diversity of traditional varieties had decreased by about 30 percent, whereas the range of modern rice varieties available had increased from 1 to 14 high yielding varieties. High genetic diversity exists within the pokkali varieties viz., Pallippurampokkali, Kuzhippallipokkali and Vettikkalpokkali. Other saline resistant varieties include Cheruviruppu, Chettiviruppu, Kuruka and Anakodan. Varieties like Orumundakan, Eravapandy, Orpandy , Orkayama etc. are photosensitive and are grown during the second crop season. Kuthiruvithu, Kochumundon and Mundon are the saline tolerant varieties of the Kaipad system. Traditional varieties viz., Mundakan, Karamundakan, Karimundakan, Vellamundakan, Athikkirazhimundakan and Oarumundakan are photosensitive tall indica varieties possessing tolerance to salinity. Traditional cultivars namely Kuthiru, Orkayama, Mundon, Kandorkutty, Orpandy, Odiyan are tolerant to low and medium salinity and have been cultivated in various kaipad fields in Kerala. These varieties are no longer under cultivation widely.

Table 22 Impact of flood/landslide on Agroecosystem

Sl.No.	Panchayat	Name of Paddy Field	Flood Intensity
I. Wayanad			
1	Thavinjal	Shivagirikunnuvayal	Most Severe
2	Vellamunda	Varambattapaadam	Severe
3	Padinjarathara	Chembakachal, Cheryamkolli, Kurumani	Severe
4	Panamaram	Kalluvayal, Chandanakolli, Manalkadavu, Kellomkadavu	most severe
5	Thiruneli	PuthiyoorBavali, Aalathoor	Severe
		Ammani, Thrichilleri, PanavalliPuzhakkaracolony,Thirunelli, Pothumoola, Manikkolli	Moderate
6	Edavaka	Kakkanjeripaadam, Mukkathuvayal,Nanjothu, Orappuvayal, Chovvapadam	Severe
7	Kottathara	Venniyodu, Vandiyambatta, Cherakathu, Palappoyil, Karikutti, Poovachulli, Kaappamkolli, Paalukara, Mayladi, Karikolli, Puzhakkanvayal, Kakkanjal, Kottathara, Ozhuvanjeri, Moolavayal, Kallabetti, Vittiyori, Mandalamvayal	Moderate
8	Pozhuthana	Aanothu, Paniyara, Athimoola	Moderate
9	Vythiri	Pookodedairy paadam	Severe
10	ManathavadyMunciplity	Koodalkadavuto Chaligadha	Severe
		Varattimoolapadam, Vemompaadam, Illathuvayal	Moderate
II. Kannur			
1	Padiyoor	Padiyoorpaddy field	Moderate
2	Ulikkal	Kokkad paddy field, Ulikkalpaddy field	Moderate
III. Malappuram			
1	Irmbiliyam	Irmbiliyampaddy field	Severe
2	Chaliyar	Perumbathoor, Mayiladi, Koramkode, Akambadam Erinji, Mangad	Severe
3	Karulayi	Cheerappaadam, Maruthangad Chettikarindhar	Severe
4	Oorgattiri	Maithra paddy field	Severe
5	Vaazhakkad	Vaazhakkadpaddy field	Severe

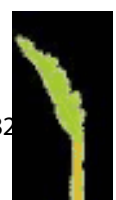
6	Vazhikkadvu	Vazhikkadvupaddy field	Severe
IV. Kozhikod			
1	Katteeppaara	Kalvari	Moderate
2	Kodiyathoor	Kaaratpaadam	Severe
3	Omasseri	Ayyattuthuruthi paddy field	Moderate
4	Vanimel	Verkadavu paddy field	Moderate
5	Karasseri	Kakkadanpaadam, Koovappara paddy field, Akkottuchal, Maathra, Kuttiparambu, Pannimukku, Thannipoyil	Severe
6	Kadalundi	Pidippazhi, Chalippaadam, Vadakkumbad	Moderate
V. Palakkad			
1	Vadakarapathi	Vadakarapathipaddy	Severe
2	Kizhakancheri	Punnappadam, Karappadam, Kalavappadam	Severe
3	Thiruvegapura	Jalam	Severe
4	Malambuzha	Kadukkamkunnu	Severe
5	Vadakkanjeri	Palayam	Severe
6	Kadambazhippuram	Cholappaadam, Chembalpaadam, Vellapokkpaadam, Kannadipaadam, Pottanamkurrisiipaadam, Vaalamkalithapaadam	Severe
7	Ayiloor	Ayiloorpaddy field	Severe
8	Nenmara	Nenmara paddy field	Severe
VI. Thrissur			
1	Annamanada	Venipaadam, KarikattuchaalKolepaadam	Most severe
2	Maala	Chakkaparambu paddy field	Severe
3	Chazoor	Pullu, Aalapaatu, Purathoor	Severe
4	Cherppu	Jublieethevarpadavu, Perunkulampadavu, Aalikkapadavu, Chennamtharishupadavu	Moderate
5	Deshamangalam	Desamangalam paddy field	Severe
6	Edathuruthi	Manianthazham, Edathuruthi, Payyannoor	Severe
7	Meloor	Naymeli paddyfield	Severe
8	Padiyoor	Punjaareas	Most severe

9	Parapookara	Kuttaadampanthaloor, Thottipaal, Rappaal, Nedumbaal	Severe
10	Poyya	Pokkali paddy field	Severe
11	Thekkumkara	Punnam paddyfield, Manalipaadam /Kelipaadam	Most severe
12	Vallachira	Mandepaadam	Severe
13	Venkidangu	Kizhakekarimbaadam, Padinjarekarimbaadam, Thekkekonjira, Vadakekonjira, Kolepadavu, Elamuthakolepadavu, Kanneerkayalpaddy field	Severe
VII. Ernakulam			
1	Alangad	Alangadpaddy field	Severe
2	Kadungalloor	Elappadam	Most Severe
		Punchapadam	Severe
3	Kadamakkudy	Kadamakkudy paddy field	Severe
4	Chendamangalam	Chendamangalam paddy field	Moderate
5	Koovappadi	Padikkalappaara,Kurachilakkod	Severe
6	Okkal	Okkal paddy field	Severe
7	Sreemoolanagaram	Sreemoolanagaram paddy field	Severe
8	Vadakkekkara	Vadakkekkara paddy field	Not affected
9	Piravom	Kakkad, Kalamboor, Attutheeram paddy field	Severe
10	Parakkadavu	Parakkadavu paddy field	Severe
11	Ramamangalam	Mamalasserithazhathekkad , Padinjaremanamel paddy field, Padathuthaazham paddy field, Padiyethu paddy filed	Severe
12	Malayattoor	Malayattoor paddy filed	Severe
13	Kalady	Kalady paddy filed	Severe
14	Nedumbasseri	Mallisseri paddy filed	Severe
15	Chengamanad	Thuruth,Kaprasseri paddy filed	Most Severe
16	Choornikara	Choornikkara paddy filed	Severe
17	Kunnukara	Kunnukara paddy filed	Most severe
18	Keezhmad	Thulapadam	Not affected
19	Kanjoor	Kanjoor paddy field	Severe
20	Karumaloor	East Veliyathunadpaddy field	Severe
21	Chittattukara	Pokkali paddy field	Severe

22	Cheranalloor	Pokkali paddy field	Severe
23	Kadamakkudi	Pokkali paddy field	Severe
VIII. Idukki			
1	Kanjikkuzhi	Makkuvalli	Severe
2	Mariyapuram	Kochukarimbankuthirakallu	Most severe
3	Vazhathoppu	Vazhathopu paddy field	Severe
4	Kanjiyar	Attappalli	Moderate
5	Rajakumari	Nadummattam	Moderate
6	Konnathadi	Parathodu	Severe
IX. Pathanamthitta			
1	Aranmula	Aranmulapunja, Lakavelipunja, Maalakkaraadichil, Mundakanpaddy field, Neervilakom paddy field, Kurichimuttam paddy field, Kattatt paddy field, Kottaperumthod paddy field, Iruthimalapadam, Kidangannurpunja	Severe
2	Mallappuzhasseri	Aranmulapunja, Mundakanpaddy field, Kottaykad paddy field, Munduthalla paddy field, Punaykkad paddy field	Severe
		Puthiyidathu paddy field, Kannamparambil paddy field	Most Severe
3	Kadapra	Ayyankonari, Chennangaripaddy field, Kakkepadam, Morbalipadam, Attuvallampadam, Nattuthodupaadam	Severe
4	Ayiroor	Puthiyakavupaddy field, Ayiroor paddy field, Idappavoorpaddy field	Most Severe
5	Cherukol	Chakkittayil, Thevarkadu, Meppadamela, Katturela, Kiliyanikkal, Samaramukku, Kuzhimannil,PuthumannuVayalathalapaddy field	Severe
6	Eraviperoor	Padathupalam, Komekeri , Kaithachal, MarayankalliChennath, Theeppuka, Aavanipunja, ThanappalliNedumbalapunja, Karumatha, Panamoodu paddy field	Severe
7	RanniPazhavangadi	Madathumpadi, Chellakkad,	Severe

		Mandhamaruthi, Makkappuzha	
8	Thottapuzhasseri	Padeethrappadi	Severe
		Nedumbrayarpunja, Kandanpadavam paddy field, Kudandha paddy field	Most severe
9	Koyipram	Thrikkanapuram paddy field, Nukathalapadam, Chathanpara paddy field, Koipramkrishibhavan paddy field, Kallingalpadam	Severe
10	Kozhancheri	Potholi paddy field, Nilamel paddy field, Valiyakalayil paddy field, Idayodi paddy field, Thekkemala paddy field, Thanungatilpadam	Severe
11	RanniAngadi	Poovanmalapaadam, Ettichuvadpaadam, Varavoorpaadam, Pullaprampadam	Severe
12	Niranam	Edayodichembu paddy field, Niranathuthadampaadam, Ayyankonari paddy field	Severe
13	Kuttoor	Kothaviroothipaadam, Thiruvamanapuram, Ettukadavupunja, Njakkandampaadam, Venpalapadam, Odakkulampaadam	Severe
14	Nedumbram	Payyankeripaadam, Idakkeripaadam, Kidayilpunja, Koyppallilpaadam	Severe
15	Peringara	Vengalpaadam, Mepralpaadam, Chathangaripaadam	Severe
16	PandalamMun.	Karingalipunja, Chittilappalam, Manjinamkulam, Sasthampadipaadam	Severe
17	Thiruvalla	Meenthalavayal, Kavarayil, Neelakkuzhipaadam, Thirumulapadam, Muthootvelipadam, Puthankeri, Kosavanodi, Paruthikkatveli	Severe
X.	**Alappuzha**		
1	Ambalappuzha North	Ottavelipaadam,Kappamvelipaadam,Naalupaadam,Kattukonampaadam,Koladikkavu,Nanekattupaadam,Kochuparakkadavu	Severe
2	Budhanoor	Budhanoorpaddy field	Moderate

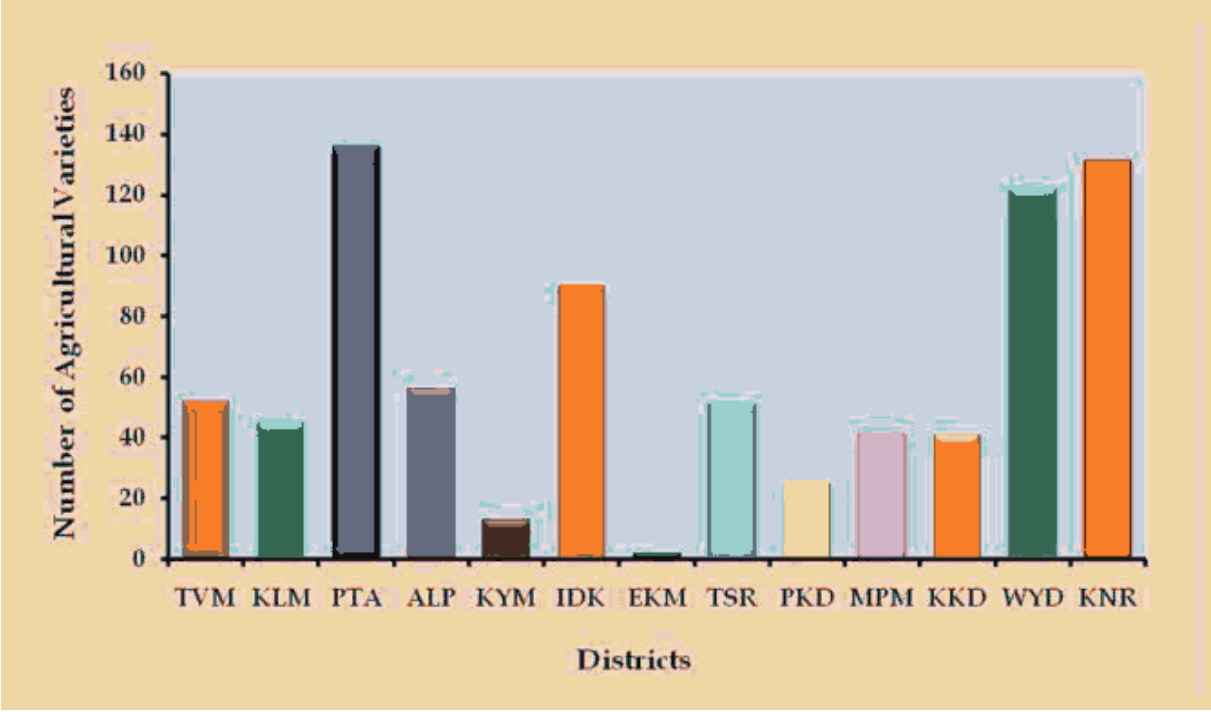
3	Mannar	Mannar paddy field	Moderate
4	Chambakkulam	Chambakkulampaddy field	Severe
5	ChengannurMun.	ChengannurMun. paddy field	Moderate
6	ChennithalaThripperumthura	Orippoo, Irippoopaddy fields	Moderate
7	Cheriyanad	Mambra, PambanamChaal, Karippurampuncha	Severe
8	Edathua	Edathua paddy field	Severe
9	Kainakari	Kuppappuram,Cherukali Lake, Aarupanku, Valiyathuruthparuthivalavu, Meenappalli, Thekkevavakkad,VadakkeVavakkad, Kadukayya, Somathuram, Iruvanam, Puthenthuram, Edappally, Kanakasseri, C Block,Rani, Chithira, Marthandam	Severe
10	Karuvatta	Ezhavankari East, Ezhvankari West, Uluvam - Maravakkulam, Manthara - Meenchal,Thettikkulam, Chalunkal,Njandiyezham, Vezhankari - Ullumbikkari, Vellamkeri,Edayilekkuzhi, Koppara, Thevarottu	Severe
11	Kavalam	Kavalampaddy pields	Severe
12	Muttar	Kavalampaddy fields	Severe
13	Neelamperoor	Neelamperoorpaddy fields	Severe
14	Nedumudi	Chirakkupuram, Kadachal, Moolappallikaadan	Severe
15	Pandanad	East prayar, Kiliyamthara, Padanilam, KeezhVanmazi, Velloorpuravupuncha	Severe
16	Pulinkunnu	Maniyankaripaddy field, Chirackapaddy field, Velliprackalpaddy field	Moderate
17	Puliyoor	Padanilam, Vadavupurampaddy fields	Moderate
18	Ramankari	Ramankaripaddy fields	Severe
19	Thakazhi	Thakazhipaddy fields	Severe
20	Thalavady	Thalavadypaddy fields	Severe
21	Thannermukkam	Kakkathuruthupaadam, PothyMangalampaadam	Severe



22	Thiruvanvandoor	Koladaqthusseri, Umayattukara, Attakkuzhi, Thiruvanvandoor, Eramallikkara	Severe
23	Veeyapuram	Karippolipaadam,Kanatharanpaadam,Mattathupaadam, Karippaadam,MuppayikkerilMuttumpaadam,PavadiPurakkerilpaadam,VettiPuthukkeripaadam, Chekkamayikkeripaadam	Severe
24	Veliyanad	Punchappaadangal	Moderate
25	Cheruthana	Karingalpaadam, Keerangeri, Theveri paddy field	Severe
26	Ambalapuzha South	Kattakkuzhi paddy field, Pulikkal paddy field, Karangalithara paddy field, Mooleppadam, Panchitharapaddy field	Severe
XI.	**Kottayam**		
1	Kallara	Kallarapaddy field	Most Severe
2	Mulakkulam	Kochuthuruth, Kakkathuruth, Mulakkulam, Idayattu	Severe
3	Payippadu	Payippadu paddy field	
4	Thiruvarppu	Thiruvarppu paddy field	
5	Udayanapuram	Udayanapuram paddy field	
6	Vazhappalli	Kadambadam paddy field, Thuppram paddy fiel, Parekadavu paddy field, Thundikkadavu, Arisrakkal, Ambazhathanadi, Kavunadathottayi, Eerathara, Pattithanam, Aanjilikudipaadam, Thekkeottetti, VadakkeOttetti, Chembupaadam, Chembu mini Pulinamkunnu	
7	Maravanthuruth	Maravanthuruth paddy field	Severe
8	TV Puram	TV Puram paddy field	Severe
XII.	**Kollam**		
1	Thodiyoor	Aryanpadam, Kuttiyilpaadam Karoorpadam	Moderate
2	Adhichanelloor	Kummalloorpaadam, Kattachalela, Kaithakkuzhiela, Thazhuthalaela	Severe
3	East Kallada	Muttaara, Madathuvayalela, Perumkulamela, Unnikkulamela Mankattvayal,Navunkara paddy field,Veranoorela, Kuravanchalela, Chembupadam, Chittumalachira	Severe Most Severe

		Mundakappadam	
4	Manrothuruth	Villimangalam, Mulachanthanavayal	Severe
5	West Kallada	Idiyattipuramela (Njavara, Mundakan) ChakkulamCherikkuzhi, Nannumpuram (Mundakan, Prathyasa)	Severe
XIII. Thiruvananthapuram			
1	Kalliyoor	Punchakkari, Chundukari	Most Severe

Fig. 72. Impact on Arobiodiversity- District -wise.



4.3 DISTRICT WISE IMPACT ASSESSMENT

4.3.1. WAYANAD

4.3.1. 1. AGROBIODIVERSITY SCENARIO OF WAYANAD

The Peoples Biodiversity Register of Wayanad records the cultivation of about 100 varieties of Rice during olden days. In Tirunelli PBR about 50 varieties of Paddy were reported to be cultivated in olden days. It includes drought tolerant and short duration varieties like Kalladiyaryan, Thonooran thondi, Urunikaima, Scented varieties like Kayama and Mullankayama, medium to long duration varieties like Gandhakasala, Jeerkasala, flood tolerant varieties like Chettuveliayan. medicinal rice like Njavara, Chennellu, Rekthasali. Disease resistant varieties as Vallichuri both bran and bran less varieties are reported. Bran varieties are suggested to be more resistant. Many of these varieties provide several kinds of insurance against crop failure to the farmers.The tribal communities in Wayanad eat edible roots, tubers and rhizomes of 24 wild plant species/varieties. About 21 different types of Dioscorea are present in Wayanad district of Kerala.

The traditional rice genetic diversity of the district has now been narrowed down to less than 20 varieties. Gandhakasala and Jeerakasala rice are two varieties of scented rice cultivated widely in Wayanad. They are certified as Farmers' Varieties under the provisions of the Protection of Plant Varieties and Farmers' Rights Authority, Ministry of Agriculture, Government of India. Both Jeerakasala rice and Gandhakasala rice have been registered with the Geographical Indications (GI) registry of Government of India in 2010. It was the agro-ecological conditions, the methods of organic cultivation, traditional genetic make-up of cultivars, and unique processing technologies that has produced the specific aroma and flavor of Jeerakasala and Gandhakasala rice varieties.

4.3.1.2. IMPACT OF FLOODS/ LANDSLIDE ON AGROBIODIVERSITY

The floods and landslides has caused extensive damage to the paddy fields. In addition to the loss of crops the damage to the wetland ecosystem of Wayanad will have more lasting impact. In many places the local people are of the opinion that it is very difficult to recover the natural state of the land.

Gandhakasala and Jeerakasala cultivation in Thavinjal , Padinjarathara, Panamaram, Thirunelli, Edavaka, Manathanvady municipality has been affected. Near Palvelicham and Kuruva on the left banks of the river the paddy fields were ploughed and kept ready for sowing of seeds when floods occurred and the locals say that the entire top soil which has been loosened was washed off and the land has been converted into fallow land and can be made fit for cultivation only if it is filled with fertile soil. Kallamballam punja fields has been badly damaged.

A major impact on Agricultural fields is the spread of wild invasive species as Barnyard grass in many Paddy fields in Wayanad after floods. Even though it was reported before also from Wayanad, after floods it has spread and has became uncontrollable. As it is similar to paddy in habit while de weeding it cannot be identified, only when it grows and seed sets it can be identified. This will lead to less productivity and revenue loss to farmers.

At Thavinjal, Sivagirikunnu vayal was very severely affected by landslides and has been filled by mud and gravel and is unfit for cultivation. At Tirunelli also landslides has affected the agricultural fields. At Puthiyoor Bhavali, Pothumala, Alathur areas paddy fields were submerged in water and mud and gravel has been deposited. According to farmers it is almost impossible to recover these area and make it suitable for cultivation.

At Panamaram block, silt deposition occurred heavily in paddy and tuber crops fields (lowlands) and caused appreciable damage. Table 1 and Fig 1 lists the varieties of Agricultural crops damaged partially during the floods. These include several varieties as Rakthasali, Chennelu, Mullan Kayama Thondi, Vallichoori, and different varieties of Tapioca as Neerali kappa, Chulli kappa, Vella kappa, Ambakadan, and Dioscorea such as Inchi kachil, Neel kachil, Kutti kachil, Cheru mullan, Nari mullan etc. The Rakthashali is a natural red rice variant with red husk & grain that have high medicinal value. It is rich in antioxidants, calcium, zinc, iron, and other minerals. It is useful food for the persons who have allergies & skin ailments, uterus related problems, gastro intestinal problems, liver, kidney, and nerve disorders.

Shri Shaji N. M, Mananthawady, Wayanad district, the recipient of the UNDP- India Biodiversity Award 2018 in individual category for conservation of domesticated species and Genome savior award winner is a conserver of tuber crops mainly."I have a collection of 200 edible tuber species, including the rarest ones, besides herbs and medicinal plants on my four-acre land," he says. Wild tubers like 'ari kizhangu', 'nana kizhangu', ' neelakoova' and 'kaattumanjal' are grown in this farm. Tubers like 'aana kachil', 'panni kaachil' and rare varieties like 'karinthal' and 'chorian kizhangu' are to be found in his farm. The flood has caused damage to 10 varieties of Colocasia, 13 varieties of Dioscorea, 8 varieties of Ginger, 8 varieties of Cassava, 17 varieties of Capsicum, 19 varieties of Paddy in his field.He laments that while Agricultural schemes including those for compensation for natural disasters is being implemented only the area under cultivation of a particular crops is considered. The diversity in the field or the conservation value of the varieties lost are not considered. He says that special package for custodian farmers and those maintaining Agriculture diversity in fields should be considered.

Shri Shaji conserves numerous varieties of Greater yam, Colocasia, Sweet Potato, Tapioca, Elephant foot yam, Arrow Root, Chinese Potato, Lesser yam and other crops such as Turmeric, vegetables, medicinal plant and orchid native type species. In tuber crops viz. Greater yam and Elephant foot yam, he has used innovative methods of conservation, storage techniques and planting techniques. In his field flood caused extensive damage to several rare varieties of tubers, vegetables, rice varieties etc, in addition to domesticated species of animals, honey bees, and fish culture (Table 23)

Table.23 List of traditional varieties conserved by Shri. Shaji N.M. affected by flood.

Sl. No	Variety
1	Cherukizhangu
2	Nanakizhangu
3	Mullankizhungu
4	Cheruchembu
5	Paalchembu
6	Nanachembu
7	Thamarakannan
8	Aattukannan
9	Cheerachembu
10	Kappachembu
11	Pindalanchembu
12	Karindhal
13	Pottukannan
14	Undakachil
15	Pannikkachil
16	Neelakkachil
17	Africankachil
18	Kuttikkachil
19	Irachikachil
20	Vazhanakizhangu
21	Adathappu
22	Cherumullan
23	Narimullan
24	Kappakachil
25	Vazhavadakkan
26	Vellakkachil
27	Pullathikizhangu
28	Narokizhangu
29	Areekizhangu
30	Nurokizhangu
31	Kothakizhangu
32	Mudavanni
33	Naadan inji
34	Chumanna inji
35	Karutha inji
36	Indonasian inji
37	Thailand inji
38	Chukkumaran
39	Himachil
40	Rigodi
41	Kasthoorimanjal

Sl. No	Variety
42	Malamanjal
43	Koova
44	Kacholam
45	Naadan chena
46	Neychena
47	Kattuchena
48	Ethakappa
49	Kandharipadappan
50	Sugar free kappa (Neeralikappa)
51	Pathinettkappa
52	Chullikkappa
53	Divan
54	Malabarikappa
55	Vellakappa
56	Nadan koorkka
57	Neelan koorkka
58	Nadan madhurakizhangu
59	Pressure cheera
60	Palmuthukku
61	Cherukandhari
62	Vellakandhari
63	Undakkandhari
64	Neelamulak
65	Mottumulak
66	Krishnamulak
67	Malimulak
68	Neelankandhari
69	Baji mulaka
70	Bhoojalaki mulak
71	Injimulak
72	Kammal mulak
73	Capsicum
74	Karnnampotti
75	Nadan beans
76	Karkoondhal payar
77	Nadan paval
78	Kattupaval
79	Undapaval
80	Kuttipayar
81	Nadan Vazhuthana
82	Cheera vazhuthana

83	Nadan Mathan
84	Vellari
85	Nadan vazha
86	Njali
87	Nadan nendra
88	Kattuvazha
89	Cheruthen
90	Kuttithen
91	Gandhakasala
92	Jeerakasala
93	Thondi
94	Mullan kayamma
95	Rakthasali
96	Kunkumasali
97	Palthondi
98	Thonnuramthondi
99	Kanaka
100	Chembakam

101	Chennell
102	Red Jasmine
103	Navara
104	Veliyan
105	Krishna kamodh
106	Chettu veliyan
107	Chenthadi
108	Puzhamathi
109	Kaari
110	Koori
111	Vatton
112	Aral
113	Vazhakkavarayan
114	Nadan kozhi
115	Karikila
116	Kappirikozhi
117	Karinkozhi

Farm of Shri. Shaji N.M.

4.3. 2 KANNUR

4.3.2.1 AGRICULTURE SCENARIO

Paddy, coconut, pepper, cashew, tapioca and arecanut grow abundantly in this area, along with plantation crops like rubber. In Kannur the impact of Floods/ Landslides on Agriculture was not much severe. The most affected panchayats were Padiyoor and Ulickal. At Naduvil panchayat Rubber plantations were impacted due to drought like conditions after floods and loss of fertile top soil. At Cherupuzha vegetables and tubers even after sprouting is becoming yellow and crops are lost.

4.3.2.2 IMPACT OF FLOODS/ LANDSLIDES ON AGROBIODIVERSITY

Agricultural fields were partially damaged at Ulikkal. The crops affected include Coconut, Arecanut, Cashew, Rubber plantations. The major impact on Agrodiversity was the loss of banana plantations, where 11 varieties of banana including a rare variety kallu vazha was partially damaged . Kallu vazha is a medicinal banana used for treatment of kidney stone and urinary retentions. Floods also affected pepper cultivation and 9 varieties of pepper were partially damaged including Kallu valli, perumkodi etc, 11 varieties of Cassava, 7 varieties of Colocasia and 7 varieties of Dioscorea.

Biju Narayanan, a mechanical engineer turned farmer from Ulickal in Kannur cultivates 33 varieties of pepper. He says that he has a total of 33 varieties of pepper – both bush pepper and vine pepper at his farm at Ulickal. He has collected varieties from different parts in Kerala, Karnataka and Tamil Nadu.The seven acres farm at Ulickal is an experimental and demonstration plot for him. Manjamunda variety, one of the 33 varieties he cultivates, gives good productivity. Flood has damaged the pepper vines in his farm but generally he observes that Manjamunda variety is much more resistant to diseases and to climate change.

Apart from collecting and cultivating different varieties of pepper, he also likes experimenting in cultivation methods and he has several observations from his past experience. He said he is also experimenting with multi-level integrated cropping pattern in his farm to get maximum productivity from the land. For this, he has preferred Kuttiadi variety of coconut (around 40-ft-high) for the first level in his multi-level cropping pattern. Mr Biju Narayan says that " Many local landraces of Cashew trees bear fruits 3 times a year but not all branches flowers at the same time. Different branches give yield at different time. As an experiment plantains (poovan) were planted in between cashew trees. But it is noticed that when the plantain leaves touch the branch of cashew tree ,that specific branch will not give any yield and later it dries off. So it was decided to plant traditional variety of pepper and it is noticed that there is an increase in the yield of pepper. Initially traditional varieties of pepper as Panniyor, Karimunda were planted . Later on different varieties of pepper was collected from different places all over Kerala and planted and thus a Pepper garden was started. Malabar XL

is a rare variety , which is said to be used as anti cancerous material. Manjamunda is a variety which gives yield every year even though yield is less compared to Panniyor . Panniyor will give high yield but only in alternate year. They had found that 100 kg of green pepper gives 33 kg of dry pepper in case of Panniyor , at the same time 100 kg of Manjamunda will give almost 41 kg of dry pepper. They used Sheemakonna (Gliricidia) and Jackfruit for trailing Pepper vines. During the first year pepper plant will reach a height of 2 feet in sheemakonna and 6 feet during the second year. By that time the Jack fruit will also grow and the pepper will climb up the Jackfruit sapling. The advantage of this according to him is that the pepper plant will not climb too high and hence is easily accessible.

Table 24: **Pepper varieties grown in the field of custodian farmer - Mr Biju Narayan**

Panniyoor 1 to 8* Siyon mundi, Sakthi, Shrikara, Narayakodi*, Wayanadan*, Chumala,	Manjamunda, Kairali, Girimunda, Shubakara Panchami, Vellanambar, Kotta nadan	Vijay Arakulam munda*, Coorg XL Karimunda*, Thekkan, Neelimundi*, Manjamunda*	Kausukan, Thevam, MalabarXL, Pournami, Perumkodi*, Vairamuthu,

*(*Due to flood and landslides some areas of his farm was affected. The affected varieties are marked in asterix)*

4.3.3 MALAPPURAM

Agriculture is the mainstay of the population, involving 75 per cent of the people, directly or indirectly. The main crops raised are Paddy, Coconut, Tapioca, Areca nut, Cashew nut, Banana, Rubber, Pulses, Ginger, Pepper and Betel vine.The major loss in the agro field was in Banana crop. Coconut, Arecanut, Rubber, Paddy, Vegetables, Ginger, Turmeric Tapioca, Pepper.

4.3.4 KOZHIKODE

It is noted that the high ranges of the Kozhikode district where landslides and landslips have occurred have brought down many of the cultivar varieties of cash crops like coffee, cardamom, pepper, cinnamon and rubber. The flood has brought loss to crops in lower land like Paddy, Banana, and Tapioca etc. After the flood an increased attack of Phytophthora pest to coconut and an increasing loss of coconut prior to ripening was observed by farmers. Rubber plants show wilting of leafs and reduced quality and quantity of latex. The paddy fields at Karasseri was affected due to deposition of mud and slurry from quarries.

4.3.5. PALAKKAD

4.3.5.1. AGRICULTURE SCENARIO OF DISTRICT

Agro ecosystems of Palakkad include Paddy fields, Monoculture plantations of Arecanut, Banana, Coconut, Rubber and mixed crop systems. Palakkad is considered as the Rice bowl of the state and contributes a major production of rice in the state. Palakkadan Matta rice received the Geographical Indication Registry of Intellectual Property India right under the Geographical Indication of Goods (Registration and Protection) Act, 1999 in November, 2007. Under the registry, there are 10 varieties of Palakkadan Matta, which are now being considered as the popular Palakkadan Matta rice variety. They are: Aryan, Aruvakkari, Chitteni, Chenkazhama, Chettadi, Thavalakanna, Eruppu, Poochamban, Vattan Jyothy and Kunjukunj. Registration is given to the Palakkadan Matta Farmers Producer Company Ltd . Mangoes, banana and plantains are the important fresh fruits cultivated in the district. Arecanut and sesamom are the other cash crops of this district. Cashewnut is mostly cultivated in Ottapalam and Mannarghat taluks. Coffee is grown in the Nelliyampathy hills of Chittur taluk and parts of Alathur taluk. Tea plantations are located in Nelliyampathy hills and Sholayar hills. Nelliampathy is famous for oranges. Rubber is also grown in Mannarghat, Ottapalam and parts of Alathur taluk. The other crops in this district are pepper grown in Mannarkkad block, jowar and ragi in Chittur block, chillies, pulses, sweet potato, tapioca and coconut in Trithala, Pattambi and Ottapalam blocks.Apart from Virippu, Mundakan and Puncha, there are other systems like "Koottumundakan" which are raised in the district. Live stock population includes cattle, sheep, buffaloes, goats and other livestock .

4.3.5.2. IMPACT OF NATURAL DISASTERS ON AGRICULTURE AND ALLIED SECTOR

The Padasekarams of Vadakarappathi, Kizhakkancheri, Thiruvegappuram, Malampuzha, Wadakkanchery, Kadambazhippuram, Ayiloor and Nemmara was severely affected in the floods. In respect of agricultural lands, the extent of area silted is about 895 hectares which became unproductive and an extent of 952 hectare become uncultivable due to landslides, landslips, formation of gullies, etc. A total of 451 wells were filled with filthy water which requires to be chlorinated. The PBR records the cultivation of several cultivars in the past as Cheruponnaryan, Cherumanikazhama, Velutha Aryan, Chettadi, Chenkazhama, Karuthyeni, Parambuvettan, Kunjikunji , Chemban, Kasthurikazhama, Pookkula kazhama, Thanjavoor kazhama, Kannamodan, Arupathamkutti, Kazhama, Undakazhama Vetteri, Uruniyankazhama, Veluthiri kazhama, Vellakkoli, Vrishchikapandi, Arikkalari etc to name a few some of which were suitable for mundakan and some for virippu cultivation. But majority of these cultivars are no longer used by farmers. A major impact of these natural disaster will be the loss of genetic resources of these already dwindling cultivars due to ecosystem change and impact on soil health.

In rice fields in Sreekrishnapuram due to the deposition of a mixture of mud and alluvial soil, after the floods the water content dried up resulting in the formation of a paste like soil which is unfit for cultivation. Invasive alien species were found to flourish in areas such as Agali and Kottathara, in the post flood situation. The plant species such as Parthenium, Anathottavadi Venpacha were found to increase after flood.

The Poultry farms in Sreekrishnapuram, Kizhakkancherry, Manthrampallam, Kozhukkalli, Mannarcaud, Thiruvegappuram, Nemmara and pig farm at Palakkad Municipality were severely affected by flood. The entire birds reared in poultry farms died and several pigs also were lost. From the fish farms at Moolamcode in Kizhakkanchery, Thiruvegappuram and Kadambazhippuram fish stock were washed off to waterbodies. In the Orange & Vegetable farm (50 ha) in Pulayampara in Nelliyampathi it is observed that there was decrease in fruit production after flood. Fodder crops was also slightly affected in Wadkkancherry.There are several private estates in Palakkad where rubber, coffee, pepper, banana, nutmeg, coconut, arecanut, tea, cocoa etc are cultivated and flood caused severe damage to most of them resulting in crop loss.

HUMAN INTERFERENCE AGGRAVATED FLOOD IMPACT

The unscientific construction of bunds without proper planning, encroachment of rivers etc has added to the havoc caused by flood. The four bunds in Nelliyampathi which were constructed along the waterway obstructed the flow of water and an area of 500 ha was affected causing very severe loss of aquatic flora and fauna. "Check dams in the Bharathapuzha such as the ones in Mannanur and Edathara in Parli have caused untold damage to the mud banks, destroying acres of mud banks and crops. The unscientific construction of the dams has led to the rivers changing course and destroying private property andcausing ecological damage," said environmentalist K K Devadas. In Wadakkanchery large scale encroachment in Bharatapuzha has made the river shallow. Almost all the residentialareas in Palakkad municipality which were built by reclaiming paddy fields were submerged in water.

4.3.6 THRISSUR

4.3.6.1. AGRICULTURE SCENARIO

Paddy cultivation is by far the largest agricultural practice pursued by a major section of the people. They lie 0.5 to 2.0 metres below the msl and are water logged during the major part of the year. During monsoon months the entire area is covered with fresh water. When the monsoons recede by November, the level of fresh water falls and sea water tends to get in. The entry of sea water is prevented to a certain extent by the construction of bunds at Enamavu, Mulayam. Next to paddy, tapioca forms the chief food crop. Coconut and Areca nut are the other most important crops grown in the district. A large variety of fruit trees are also grown in the district.

4.3.6.2. IMPACT OF FLOOD ON AGRICULTURE

Flood affected the agrobiodversity of the district. The major impact on biodiversity was on Banana varieties.

Kole wetlands : The *Kole* wetlands lie between the Chalakudy river in Thrissur district and Bharathapuzha river in Malappuram district. It is a part of the unique Vembanad-kole wet land ecosystem in Kerala and a Ramsar site. Karuvannur River divides the Thrissur kole land into North and South kole, Kecheri River drain the kole lands and finally discharges into the Arabian Sea. The flood water from the rivers used to bring enormous quantities of nutrient rich alluvium, which gets deposited in the kole lands. These wetlands get submerged in the monsoon and cultivation is carried out in the summer months when water levels are low. In olden days the kole lands were reclaimed from kayal area by putting up temporary earthen bunds and cultivation of rice were done during summer period from December to May. In olden days coconut leaves and bamboo was used for making bunds and mud from the fields was used to strengthen the bunds.

KOLE WETLANDS- A RAMSAR SITE FOR WISE USE OF WETLANDS

Thrissur kole lands are unique wetlands that acts as a natural drainage system for Thrissur city and Thrissur district. Earlier only long stemmed traditional varieties of Paddy like kuttadan, chembavu, cheera etc. were cultivated. Flood affected the soil fertility, depositing large amount of muddy soil, silt and debris in the ecosystem and after flood the area became dry and will require huge efforts to reclaim the area. A recent bird survey conducted in kole fields by Kerala Agriculture University sighted rare species of migratory birds like Daurian starling and Peregrine falcon. An increase in population of Greater flamingoes was also observed. The presence of rare birds is now considered a sign of climate change. Recently the kole wetlands are increasingly being left fallow or are being filled up for construction purposes, all of which has aggravated the flood situation in Thrissur district. This land use change will also have profound influence on the wetland dependent species.

Traditional fishing implements such as Koodu, Vanchivala , Cheenavala, Petti, Para, Kuruthi, Ottal were lost in Aloor, Kuzhoor, Manaloor, Cherupu,. Poya, Sreenarayana puram etc and this affected the livelihood of fishermen.

Padasekarams at Parapookara, Poya was extensively filled for developmental activities. At Poya alone about 500 hec of kole lands were filled and this has added to the impact of floods. The local people say that the acidic nature of kole fields has increased. At Annamanada, Desamangalam, Padiyoor also the impact was very severe due to deposition of silt. At Edathuruthi paddy fields were affected severly and extensive damage to the paddy cultivar Kodiyan occurred. At Kaneerkayal padasekaram, Vengidangu saline water entered into the paddy fields affecting the agro- ecosystem.

In Thrissur the major impact on Agrodiversity was on Paddy fields and Banana plantations. The flood has affected the unique variety Changalikodan banana variety.Native cattle breeds like vechur, were affected by the flood and the Government vechur cow conservation farm in Chalakkudy was completely washed away during flood.

In Athirapally, Thumboormuzhi a massive landslide occurred which affected the Cattle farm of Veterinary college and the Vechur cows being reared here was lost. From the farm Malabari and Attapady black goats were also lost. Doctors says that the survived cows show diseases as swollen udder, skin diseases and respiratory problems

BIO FENCE- WITHSTAND FLOODS

Mr Unnikrishnan a resident of Mankuttipadam has a 6 acre farm in Mattathoor near Kodali padam near the banks of Vennikulangara valia thodu. To prevent soil erosion of the banks a bio fence (jaiva veli) was constructed with bamboos. The fence was created using 12 feet long bamboo stumps planted two and half feet deep in four rows and tied and covered with nets. The bamboo clumps were planted 2 feet apart. He says that even though concrete bunds collapsed due to the force of flood water this bio fence survived. According to him after the floods the strength of bio fence increased as mud and roots of plants got deposited in between nets and made it more strong. It also prevented the plastics and other debris from entering into the fields also.

CHANGALIKODAN- GEOGRAPHICAL INDICATOR BANANA VARIETY

Changalikodan Nendran Banana or famously known as Changalikodan is a banana variety cultivated in Chengazhikodu village of Thrissur District in Kerala state of India. It is grown in Erumapetty, Wadakkancherry, Mundoor, Kaiparambu, Desamangalam and Thayyur of Thrissur District. It is the *Kaazhchakula* to the presiding deity of the Guruvayoor *Sree Krishna Temple*. The average bunch bears 20 to 25 fruits per hand. Changalikodan got Geographical indication registration from the Geographical Indications Registry, Chennai. The Chengalikodan Banana Growers' Association, Erumapetty, was given the registration. Flood affected the cultivation of the variety in many panchayaths.

INVASIVE PLANTS A MAJOR THREAT TO TERRESTRIAL ECOSYSTEM

Invasive plants are one of the major menace to our ecosystem. Kerala State Biodiversity Board earlier in a study has reported that nearly eight nine species of invasive species are spread in Kerala. Flood became a tool for the spread of invasive species to non disturbed regions. Many species reported in hilly regions, spread to the mid and low land regions. The rapid spread of Giant African snail after flood is an alarming situation in Kerala. *Mikania micrantha, Mimosa diplotricha, Parthenium hysterophorus, Sphagneticola trilobata* and *Chromolaena odorata* are the major invasive species in Kerala. These plants can survive in any climatic conditions in Kerala.

4.3.7. ERNAKULAM

4.3.7.1. AGRICULTRE SCENARIO OF DISTRICT

The district is having a unique system of paddy cultivation known as Pokkali, wherein saline resistant paddy and prawn are organically cultivated alternatively in fields having standing water with zero inputs. The brand Pokkali has received a GI tag. Ernakulam district is the largest producer of nutmeg and pineapple in the state. Rubber is the most cultivated plantation crop in the district. The sea along the entire coast of the district and the backwaters abound in fish of various kinds and offer

opportunities for both marine and inland fisheries. Activities allied to agriculture such as diary, poultry, piggery and fishery also play a very important role in the economy of the district.

4.3.7.2. IMPACT OF FLOOD ON AGRO ECOSYSTEM

In Ernakulam district, flood had a devastating effect on agricultural ecosystem especially the paddy. The flood had directly and indirectly influenced the flora and fauna living in association with this ecosystem. In Alangad, upland rice (var: Jaya) and Jyothi variety were completely lost. In Kadungallur Elappadam(15 acres) and Punchappadam (30 cents) became uncultivable due to deposition of waste material in large quantitites. In Kadamakkudi, the bunds of paddy field were destroyed and silt got deposited in the field. Paddy fields of Koovappadi was completely lost. In Okkal in Chelamattam, 35 hectares of paddy crop was lost. In Sreemoolanagaram, variety Chettuva and in Parakkadavu, variety Ponmani were completely lost. Padiyedath padasekharam was affected due to accumulation of wastes.

In Ramamangalam, Mamalassery Thazhathekkadu padasekharam, 5 acres of paddy crop was lost. In Malayattoor, on one side of paddy field the plants dried up whereas the other side they survived. Out of 64 hectares of paddy cultivated, 80% were lost due to flood. In Kalady Jyothi, Ponmani varieties cultivated were lost due to deposition of silt. In Choornikkara, the crop dried off due to deposition of silt. In Mallisseri Nelpadam of Nedumbassery cultivated with varieties Jaya and Uma, the panicles became chaffy causing heavy yield loss. In Chengamanad Thuruth Kaprasseri Nelpadam, East Veliyathunad Nelpadam and Nelpadam in Kunnukara, paddy crop was severely affected. Kanjoor Rice mills was severely affected by flood and the Paddy stock in the mill became useless.
Piravam Kakkad padasekaram was damaged due to deposition of sand and stones and silt. Kakkad padam was filled with stones, sand and silt brought by flood water and has become uncultivable. The irrigation canal was damaged during flood hence paddy cultivation could not be taken up in this area without irrigation facility.The paddy field of 2 Hectares in Chendamangalam Devaswam Padam was not affected by flood.

Vegetable cultivation in State Seed Farm, Okkal, Goat , Pig and poultry farm in Cheranalloor were affected. In Madathimoola farm at Chengamanad, Cattle mortality due to Foot and Mouth disease occurred. The ponds in fish farms at Choornikkara, Chittattukara and Kuttambuzha became filled with aquatic weeds and Kanjoor cattle farm and Poultry farm was destroyed in flood . Cage culture of oysters in Kottuvallikkadu in Vadakkekkara was washed out along with flood water. Hundreds of Cages were lost including fishes like Kalanji, Karimeen, Valodi, Moda, Kalava, Vatta, and Chembally due to flooding.

Private farms at Alangad, Kadungalloor were destroyed due to flood. Nutmeg plantations in Puthenvelikkara and Sreemoolanagaram were most seriously affected where all the trees dried out.150 vanilla plants were lost from the Vanilla plantation garden of Ramamangalam whereas 75% loss was reported in Medicinal plants garden. In Malayattoor, several Mahagony trees toppled down in Mahagony plantation, more than 1000 nendran banana were lost. In Piravom Rubber, Teak and Pineapple plantations faced serious loss due to flood. Rubber trees were uprooted in the heavy winds. All the teak plants dried out. Pineapple garden faced very serious loss with plants affected with rotting.

In Nedumbassery, Rubber and Nutmeg plantations were seriously affected. Similarly in Chengamanad, Pepper, Nutmeg, Banana, and Vegetable cultivation faced serious loss whereas in Koovappady Coconut, Nutmeg, Rambuttan and Citrus gardens were affected. In Kuttambuzha, Rubber plantations became infected with disease causing extensive defoliation and bark rotting which resulted in considerable reduction of latex production.Bamboo garden was not affected seriously. In Kanjoor, Banana and Nutmeg gardens were affected due to deposition of mud and solid wastes.

In Sreemoolam panchayat Best farmer award winner Mr Hari who is also an exporter of ornamental fish says that he cultivates 113 species of fish in his farm which includes popular varieties as Gold fish, Guppy, Platyy, Abel fish, Sucker, Black molly, Tiger Barb, Oscar, Koicarp, Silver arona, Catfish, Giant Gourami, Zebra fish, Eel fish, Fighter fish, Sword tail. After floods only 43 species are remaining. In the same place Thomas Chacko who used to grow aquatic plants for sale such as Acorus, Asoori, Redmint, Pogostyle, Penodu, Vallisneria, Ludwegia, Cabomba, Angulia, Sigma, Mansilly, Mexican grass, Amazon grass etc also reports the loss of his crops. This is a matter of grave concern as the introduction of such exotic and ornamental fish and aquatic plants in the natural ecosystem will affect the native biodiversity of the region.

SPECIALIZED ECOSYSTEM: POKKALI LANDS

Pokkali lands are known after the renowned pokkali rice cultivar which is internationally accepted as gene donor for salt tolerance in rice.The integration of rice and prawn rotationally with the change in the field water salinity augurs well with the system of nature. Aquatic and semi- aquatic weeds occur in the pokkali fields in plenty during crop season. They get dried and decayed in the off - season, ie during March to May. Fourteen species of aquatic weeds were recorded from the pokkali fields. 57 fish species belonging to 29 families and 9 orders have been identified from the Pokkali fields.

There used to be some 25,000 hectares of Pokkali fields a few decades ago, but now the extent is down to roughly 9,000 hectares. There was about 4,000 hectares of paddy fields under pokkali cultivation in Ernakulam district, alone. Some areas like Kumbalangi, Udayamperoor, Cheranalloor, Chellanam, Eloor, Kadamkudi, Varapuzha, Edavanakaddu, Moolampally and Puthuvype of Ernakulam District are mostly marshy and waterlogged and suitable for cultivation.

POKKALI FIELDS SURVIVE AT KADAMAKKUDI

In Ernakulam local farmers says that the depth of Pokkali fields has decreased due to deposition of mud/ silt. Pokkali areas of Kadamakkudi were only mderately affected by flood, but incidence of leaf disease has become wide spread after flood. Only the newly sown fields were affected.

In Cheranalloor, Pokkali cultivation is mostly confined to Kurangotta island where 50 % loss has been estimated by farmers. Panicles became chaffy causing much reduction in yield. In Chittattukara and Karumalur also, Pokkali cultivation was only moderately affected by flood.

The inhabitants of 17 colony tribal area in Kuttambuzha practice “Panchaprana krishi” where 5 species of cereal and millets are cultivated which includes Rice(Thiruvalan), Maize , Foxtail millet (Chama) , Little millet (Thina), Ragi (Pullu) all of which was completely lost in flood.

Majority of agricultural crops including Pepper Nutmeg, Peas, Tapioca, Amorphophallus, Diascorea, Colocasia, Bottle Gourd, Pumpkin, Ashgourd, Bhindi, Tomato, Amaranthus, Ridge gourd, Banana, Betelvine, Ginger, Turmeric, Pineapple, Panniyur 1 and Karimunda Pepper varieties, Nendran, Pineapple, Rubber, Rekthasali Rice were lost completely during flood. Palayamkodan Banana were found to survive flood. Neerkodan Kappa was destroyed completely. In Pokkali Rice varieties Vyttila 5, Vyttila 4 , Vyttila 2 (Cheruvirippu), the leaves were found to dry up after floods. The panicles became chaffy. Usually Pokkali rice was found to withstand waterlogged condition and floods, but during 2018 flood, the crop was severely affected.

RISE IN PEST POPULATION AFTER FLOOD

Army worms are spotted more in the fields after flood which feed on entire plant causing complete destruction. This caterpillar being a polyphagous pest and voracious feeder will certainly pose threat to agricultural crops, hence integrated pest management measures are required to be adopted on a community basis.

The population of Moths and Leaf cutting bees has shown an increasing trend after floods. Some of the crop pests such as stem borers, leaf folders and leaf webbers have also increased in numbers. Local people reported that a new type ofinsect which sucks the sap from papaya has been noticed after floods. This require further intervention from concerned authorities. The population ofAfrican snail has also increased which can become a menace to households and crops

Majority of agricultural crops including Pepper Nutmeg, Peas, Tapioca, Amorphophallus, Diascorea, Colocasia, Bottle Gourd, Pumpkin, Ashgourd, Bhindi, Tomato, Amaranthus, Ridge gourd, Banana, Betelvine, Ginger, Turmeric, Pineapple, Panniyur 1 and Karimunda Pepper varieties, Nendran, Pineapple, Rubber, Rekthasali Rice were lost completely during flood. Palayamkodan Banana were found to survive flood. Neerkodan Kappa was destroyed completely. In Pokkali Rice varieties Vyttila 5, Vyttila 4 , Vyttila 2 (Cheruvirippu), the leaves were found to dry up after floods. The panicles became chaffy. Usually Pokkali rice was found to withstand waterlogged condition and floods, but during 2018 flood, the crop was severely affected.

The flood mainly affected the herbaceous plants and the Grasses, Darbha grass and Karuka grass were lost completely during flood, but was observed that their regrowth occurred faster after flood. People observed significant physiological changes in some plant species after the flood. Early flowering has been noticed in Cassia (*Cassia fistula*) and Mango (*Mangifera indica*). Star fruit (*Averrhoea carambola*) flowered profusely after flood. Palmyra palm were also found to produce more fruits after flood.

The Traditional Agricultural implements such as thoomba, mazhu and fishing equipments such as Chinese fishing nets (Cheena vala), Meen kettu, Vanchi, Choondavala, oonni vala, neettuvala, ottal were completely lost in Alangad, Kadamakkudi, Sreemoolanagaram,Vadakkekkara, Ramamangalam, Parakkadavu, Cheranallur, and Kunnukara panchayaths.

4.3.8. IDUKKI

IMPACT ON AGROBIODIVERSITY

It has been reported that 18 panchayaths have been widely affected by flood with respect to agrobiodiversity loss. The major crops affected are Pepper, Cardamom, Cocoa, Clove, Nutmeg, Coffee, Tea, Banana, Rubber and Tapioca. The major impact was on Cardamom and Pepper plantations. The PBR of Edamalakudy the only tribal Panchayath of the state records the cultivation of local landraces of Pepper, legumes etc. The pachayath was also affected by flood and landslides but the quantitative assessment of the same has not yet been done. KSBB had also earlier conducted studies on the traditional knowledge of the tribals of Idukki District. These included tribals areas in Kanchiyar, Udumbanchola, Munnar, Vandipiriyar, Marayur, Vattavada, Arakkulam, Udumbanoor, Edamalakkudi,

Peerumedu, Upputhara, Ayyappan Kovil and Kumali panchayats in Idukki District. The panchayaths in Kanchiyar, Udumbanchola and Munnar villages are included in the study on the impact of natural calamities.

In Kanchiyar there are 7 tribal settlements. Cardamom, coffee, cocoa and betel are the important plantations here. Banana plantations were completely lost in Kozhimala. But no damages have been reported from other settlements. There are reports of loss of many rubber trees and Cocoa tree that have been uprooted by winds that accompanied the heavy rains. Udumbanchola have 7 tribal settlements. Pepper, coffee, cardamom and cocoa are the important plantations. In thinkakkadu colony, 40 cent of cardamom plantations were completely lost and 40 cent of land is stated as unfit for habitation due to land slides and mudslides and partially because of huge cracks that have developed in Earth. No major damage has been recorded in Lakkammuthuvan settlement of Munnar Panchayat. They mainly cultivate pepper and vegetables. Ragi crops like ragi, maize, and street pepper are no longer cultivated.

CHR (CARDAMOM HILL RESERVE)

In the study area, the Rajakkad, Rajkumari, Satanpara, Udumbanchola and Nedumkandam are parts of the CHR. Here, mainly cardamom and pepper are grown. In the CHR panchayats, cardamom plantations are majorly found in Rajkumari, Satanpara, Udumbanchola and Rajakkad panchayaths. Local people say that more than 350 acres of cardamom has been completely destroyed in 15 places. Almost 300 acres of cardamom were washed down due to landslides in about 75 spots and almost 600 acres of cardamom destroyed partially due heavy rains and floods. The cardamom varieities include Njallani, Palakodi, Kannivazhutha, PV1, PV2 and Malabar.

PEPPER

In CHR areas, Pepper plantations are mainly found in Udumbanchola, Rajakkad, Rajkumari, Santhanpara and according to local people about 180 acre of pepper plantations were completely destroyed in 20 places due to landslides and another 125 acre of plantations were destroyed in 225 spots. Due to heavy rain and flood, the yellowing of leaves of the black pepper was also noted in these areas. The pepper varieties include Panniyoor 1-7, Karimunda, Jeerakamundi, Neelamundi, Kottanadan, Vattamundi, Thekkan.

UNUSUAL FLOWERING AND FRUITING OF TREES

This phenomenon has been reported throughout the Idukki district. There has and been report of unusual flowering and fruiting of trees. The Mango tree flowering commences by November-December and the harvesting starts by March-April. It was interesting to note that the much of the Mango tree started flowering soon after the flood and much prior to the winter season when the flowering is to occur. The fruits are much mature by November and ready for harvest in a month. The same was noted for Neem trees. Early flowering and fruiting or the non seasonal flowering and fruiting will have a major impact on the ecological cycle. Many of the insects and organism that depend on the flowering and fruiting of these trees will be affected. There is high chance of food shortage for them, which would have an impact on its population structure and density. On the other hand much of the pollination and dispersal that are done in the hands of much of the insects and birds will not occur. Studies also suggest that flowering and fruiting of trees in non seasonal cycle will have an impact on the nutritional value of the fruit. Studies have already reported on the impact of climate change in reducing the nutritional values of the many cultivars.

4.3.9. PATHANAMTHITTA

4.3.9.1 ` AGRICULTURE SCENARIO OF DISTRICT

Rubber is the most important crop as the hilly terrain with high humidity makes the region suitable for rubber plantations. Paddy is the most important crop cultivated in the wet lands. Tapioca and pulses are the other important dry land crops. Other major crops are coconut, banana, pepper and ginger. In certain areas cashew, pineapple, sugarcane, cocoa and other tree spices are cultivated.

4.3.9.2. IMPACT ON AGROBIODIVERSITY

Flood have severely affected and devastated all the crops and agro-biodiversity of this region. Muddy soil and silt was extensively deposited in fields and the fields where made unfit for cultivation. The situation is very serious at Mallapuzhasseri and at Ayiroor mud was deposited and the fields got filled up and has become unfit for cultivation. At Kaviyoorpunja fields, Thiruvalla the top soil was completely lost and can be recovered only with great difficulty.

IMPACT OF FLOOD ON PLANTS -PHENOLOGICAL CHANGES OBSERVED

Dr. Thomas P Thomas, Professor Dept of Botany St. Thomas College, Kozhnjeri reported that, after flood some phenological changes were observed in some crop plants at Maramon, Thiruvalla. Exotic species like Mangosteen and Durian are commonly cultivated in the area adjacent to river. The regular flowering season is from January to February and fruits will mature by June-July during Monsoon rains. After the floods, some of the Mangosteen and Durian in the area flowered. Upon personal enquiry, many farmers reported this untimely flowering in their homestead also. The flowering was not copious as in January-February. Non-flowered Mangosteen followed the routine pattern of producing new leaves and new branches. These branches normally produce flowers in January- February. Durian also flowered during September-October

AGRICULTURE IN TRIBAL AREAS

On Agust 15, 2018; a series of landslide occurred in Rajampara forest division (9th ward of Ranni-Perunadu GP). This forest was vested in Konni reserve forest. The inhabitants of this area belonged to Malapandaram and Malakurrava tribal communities. Crops such as tapioca, ginger, sweet potato, wild turmeric cultivated by these tribal communities were lost in land slide and soil erosion. Kolinchi is a major crop cultivated by both the communities in Bimmaram colony. These were lost in runoff water due to the landslide. Crops of Sweet potato (chuvanna thandan madhura kizhangu) another native variety grown by the tribal community in this region was also damaged in land slide. In addition to that, a member of Malapandaram tribal community says that wild tubers like Nooronkizhangu, staple food of tribal community was damaged in landslide, soil erosion along with runoff water.

TUBER CROPS

Tuber crops as tapioca, elephant foot yam, taro, yams, sweet potato and other minor (wild) tuber crops are cultivated in upland and low land fields and also in homestead garden and backyard of kitchen etc. This includes many native tuber varieties also. Pathanamthitta district is the hub of

production of seed material for tuber crops such as elephant foot yams, taro, tannia etc. Heavy rain and flood resulted in rotting and decay of tuber crops. Compared to greater yams, minor yams like Dioscorea, Taro was completely damaged in flood water. Corms and tubers decayed and rotted and vines dried up. Farmers said that this was also due to the deposition of alluvial/muddy soil which has poor aeration capacity. Due to this farmers are facing a serious problem like the shortage of planting material/seed for the next cropping season.

The worst affected areas are in upper Kuttanad area such as Niranam, Nedumpuram, Peringara, Kadapra and Kuttoor where a complete loss of cassava crops occured. Other severely affected GP's include Ranni, Ranni-Pazhavangadi, Aranmula, Kozhenjeri, Ayiroor, Thottapuzhasseri, Koipram, Pandalam and Eraviperoor. Here also the crops were devastated due to submergence for long days. Out of the total area under cassava cultivation, the affected area comes to approximately 9.1% where as for the rest of the tuber crops, the affected area was around 25%.

PULLADAN KAPPA - ORGANIC CASSAVA

Pullad, is a village in Koyipuram Gramapanchayat in Pathanamthitta district well known for the high quality organic cassava, namely ' Pulladan Kappa'. This is a native variety cultivated since ancient times in this region. This organic cassava is priced high in the markets of central Kerala region and has a high demand in the state and abroad. This was cultivated in all regions of Koyipuram GP and grow best in laterite soil. The highest culinary quality of the tubers can be attributed to the cumulative effect of soil and organic farming practices adopted.
Biju, Vettukunnil, Pullad, a tapioca farmer say that large number of cassava fields were waterlogged for more than a week. There are 17 varieties of tapioca cultivated in this region. Among this 4 are native varieties; Pulladan kappa, Onthakadan kappa, Parakkodan kappa, karuthathandan kappa are cultivated in certain specific areas only. Cassava is considered as a climate resilient crop which withstands drought and high temperate situations, but do not withstand water logging to any extent. In extensive areas of affected GP's, tapioca stem completely withered and root system was completely damaged and tubers were rotten due to the submergence and water logging.

It is noted that Palayamkodan variety withstood the flood to some extent compared to other 21plantain varieties in the entire flood affected GP's.

Rice (Paddy)Rice is the most important food crop grown in the state. Flood has completely destroyed paddy cultivation in Niranam GP and PandalamMuncipality area. At the time of first flood ie, before August 13, paddy cultivation was present only in Niranam GP, which lie in the Upper Kuttanad area. 'Uma' variety was cultivated in 250 ha area. Whole paddy fields were fully submerged in water for more than 2 weeks and entire crop was destroyed in flood.

Navara Rice *(Oryzasativa)* This rice has many medicinal properties and has an important place in the Ayurvedic system of treatment. It is used alone or in combination with other medicinal herbs to treat diseases like cancer, polio, snake bite and diabetes. Navara rice is used in 'Navarakizhi' in traditional medicine for curing neuromuscular diseases and rheumatism.

Flood affected 1 acre of Navara rice farm, located in Kadakkad agricultural farm in Pandalam Municipality area. Rice fields were near to the Achenkovil river. Rice fields were fully submerged due to the inflow of water from the river.

CENTRAL TRAVANCORE JAGGERY- GI REGISTERATION

Central Travancore Jaggery comprises of jaggery prepared from the sugarcane grown in the riverbanks and nearby places of, Manimala, Pampa, Achenkovil and Meenachil rivers of Kottayam and Pathanamthitta districts and Chengannur taluk in Alappuzha district of Kerala. The soil of the river banks of the region, where sugarcane is cultivated gets inundated during the South - West and North - East monsoons and hence is rich in organic matter due to the sedimentation of fresh silt from the flood waters. The soil type is riverine alluvium and is unique in having slightly acidic pH. The uniqueness of Central Travancore Jaggery is that it is very sweet, have good taste, appealing colour, adopt organic methods for processing and do not have the salty taste of jiggery produced from sugarcanes cultivated in the alkaline soils. Sugarcane is cultivated Upper Kuttanad area especially in Manimala –Varattar river basin in Thiruvanvandoor and Pandanad GP. The sugarcane varieties cultivated in this area are Madhuri and Madhurima. About 10 ha of both crop varieties were devastated in flood. All these farms were fully submerged with flood water for more than 2 weeks. Due to continuous water logging and deposition silt and muddy soil over the plants, the entire crop was rotten and lost.

Rubber Pathanamthitta is the third largest producer of natural rubber in the state. Rubber is one of the major plantation crops in the high land area of Pathanamthitta. It is cultivated in the entire flood affected areas except the one lie in Upper Kuttanad area. There were small to large scale growers and is one of the major incomes of the middle class people in this region. Flood caused extensive damages to the rubber plants and plantations in Pamba, Manimala and Achenkoyil banks. In addition to that there are large scale deposition of silt and sandy soil in the fields.

Pepper, Ginger, Turmeric and **Nutmeg** Incessant rain and flood caused serious damage to the spice crops in entire flood affected gramapanchayats in Pathanamthitta. Farmers said that excessive rain have washed off the pepper (Piper nigrum) spikes. There are 13 pepper varieties cultivated in this region. Ginger (Zingiber officinale) and Turmeric (Curcuma longa) was affected. Farmers says that the main reason for loss of plant is due to the deposition of silt and muddy soil, which has poor aeration capacity causing withering of the crops.

NUTMEG THE MOST AFFECTED SPICE CROP

Nutmeg (Myristica fragrans) another important spice cash crop was badly affected by the flood. Most of the plantations were located near the river banks and wet lands. Farmer says that due to the deposition of mud and silt having poor aeration capacity rotting and decay of root system occured.

COFFEE AND COCO

The unprecedented rain has resulted in devastation of coffee and coco plantations in certain GP's affected with flood. Most prominent damage was noticed in tribal dwelling areas of Ranni-Perunadu GP. Coca (*Theobroma cacao*) and coffee (*Coffea arabica*) plants have been uprooted in vast areas due to landslide and soil erosion. These were the major agricultural crops cultivated by the Malapandaram tribal community at Attathodu in Pamba river valley near Sabarimala. Fruit bearing plants were uprooted and washed off along with runoff water.

4.3.10. ALAPPUZHA

4.3.10.1. AGRICULTURAL SCENARIO:

The major crops cultivated in the district are Rice, Tapioca and Coconut. Paddy is the main agricultural crop cultivated in most part of the district and Alapuzha is the major producer of rice in the state. The Kuttanad farming below sea level farming system is the only system in India that practices rice cultivation below sea level and is recognized as Globally important Agriculture Heritage System.This system practiced for over 150 years is unique as it contributes to the conservation of biodiversity. Kuttanad wetland zone includes Ampalapuzha and parts of Karthikappally, Chertallai, Mavelikara taluks of Alappuzha district; Chengannur and Thiruvalla taluks of Pathanamthitta district and parts of Changanasseny, Kottayam and Vaikom taluks of Kottayam districtand is mainly the deltaic zone of Achenkovil, Pampa, Manimala and Meenachil. In the past, the marshy soil in this zone was regularly enriched by deposits of nutrient rich soil through the river systems of the region in the monsoon season. The clayey paddy soil in the area remained highly fertile and very suitable for paddy cultivation. But land use changes has led to changes in the regular ecological replenishment of the soil systems of Kuttanad.

Other livestock such as goat, rabbit, duck, and poultry also contribute to the livelihoods of people. Kuttanad has highest number of ducks in the State. Duck farming is also constrained with non-availability of paddy fields for foraging. Coconut plantations in Alappuzha is badly affected with coconut root wilt, particularly in the Onattukara region. In the inland fisheries sector The Vembanad Lake and associated water body has several endemic species of fishes like Pearl spot (karimeen; Etroplus suratensis) crabs and clams and the giant freshwater prawn (Aattu konju; Macrobrachium rosenbergii).

4.3.10.2. IMPACT OF NATURAL DISASTERS ON AGRICULTURE AND ALLIED SECTOR

Due to the incessant rain and flood all paddy fields in the flood affected areas were submerged with flood water for long days. The major crops affected includes Paddy, Tubers, Spices, Sugarcane and Vegetables. Invasive aquatic weeds are posing a serious threat to wet lands and Vembanad lake. Due to the force of flood water aquatic weeds such Kulavazha, Cabomba were washed off from

upper parts of the river, streams and ponds and reached in Vembanad kole lands and fish farms and polluted the natural ecosystem. Farmers say that this is a serious problem in agricultural farms.

KUTTANAD-WETLAND ECOSYSTEM

Kuttanad is one among the unique wetland ecosystem in India. Agriculture and Inland Fisheries are the major land/water use practises of Kuttand. There are a large number of paddy fields in this region - Kuttanad kole lands. Only a small area had rice cultivation at the time of flood. But inflow of water from Pamba, Achenkovil, Manimala and Meenechil rivers caused severe flooding and extensive damage in lower Kuttanad region. Kainakari, Nedumudy, Gramapanchayats are worst affected areas in this region. Due to the force of flood water, bunds made for controlling water inflow were damaged and destroyed. This caused more flooding in these regions. All most all inhabited areas were flooded and submerged for more than 2 weeks. Water rose up to 1 to 2 meter in height. Most of the upland agricultural crops, medicinal herbs, shrubs and small trees were decayed and lost due to long time submergence with water. Due to flood large amounts of silt, mud and debris got deposited in the paddy fields. In some areas fertile top soil got eroded and the field became unfertile.

IMPACT OF FLOOD ON KUTTANAD PADDY FIELDS- GLOBALLY IMPORTANT AGRICULTURAL HERITAGE SYSTEM (GIAHS)

PBR of Alapuzha region records the cultivation of 45 varieties of Paddy of many of which are not available at present. Certain paddy polders (Padasekharam) at Ambalapuzha, Edathua, Champakkulam, Thanneermukkom, Ramankari and Thiruvanvandoor gramapanchayats were completely destroyed in flood. It is noticed that silt and sand was deposited all over the paddy fields. Solid wastes such plastic, electronic and cloths were also deposited in large areas of paddy fields which became highly polluted. After flood water receded paddy crops decayed.

FAO has declared this as a Globally important agricultural heritage system (GIAHS) and as per the GIAHS norms, there should be proper documentation of the traditional knowledge of below sea level paddy cultivation in the zone. The region requires appropriate conservation programs to preserve the associated aquatic biodiversity in the wetlands. In the ancient cultivation program, there were no permanent bunds around the polders. Cheap and locally available materials like coconut leaves, twigs of trees, straw, shrubs, reeds and clay were used for mud-bunding to create polders in the waterlogged wetlands. After the mud-bund construction, large water wheels (chakram) were used to de-water the fields. Caterpillars of the harmful insects were collected using a particular type of basket sweep (puzhukkotta or pookkotta) and destroyed. Farming operations were entirely related to the local water cycle.

Taller variety viz. Champavu, Pookula chempavu, Karuthachara, Attikarai, Chettuvirippu etc. were some of the popular varieties of seeds used. Mechanization fastened the 'Kayal' reclamations and changed the entire face of paddy cultivation in Kuttanad and the local varieties which were tall variety with long panicles are no longer cultivated. Native rice varieties such as Chitteni nadan, Vallaryan, Kunnukulappan, Rekthasaali, Arupathamkuruva, Krishnakamod and Karutha Njavara, cultivation in Thalavady gramapanchayat was affected in flood.

After receding of flood water from kole lands and paddy fields, there is profuse growth of small herbaceous weedy plant Thelkada (Heliotropium indicum) all along the paddy field posing serious problem in agriculture.

MADA KUTI' (BUND)- NATURAL AND ECOFRIENDLY PRACTICE OF WATER CONTROL SYSTEM AND ITS BENEFITS

People of Kuttanad says that in olden times during rice cultivation 'mada kuti' (bund) used to be done for conserving the water in paddy fields. Formerly the practice followed was clay from the Vembanad lake was scooped up to layer the farmlands for strengthening the margins of farmlands. Bund construction started with the formation of a double corridor around the proposed area using pieces of coconut trees driven deep into the waterbed. Either side of it is then fenced with bamboo screen. Inside these screens are filled with sand, clay, twigs and garbage. Now these bunds are replaced by concrete bunds.Local community say that this kind of unnatural construction lead to raising of the water level and flooding.

IMPACT OF FLOOD ON KUTTANAD FARMING

The paddy varieties of Kuttanad affected due to floods

GP	Rice varieties
Ambalapuzha North	Uma
Edathua	Uma
Champakkulam	Chembavu, Njavara, Cheera, Chettivirivu, Kolappala, Emikuruka, Cherukuruka, Jeerakachembavu
Ramankari	Uma, Oorikari, Puthukari
Thanneermukkom	Uma
Thiruvnvandoor	Uma, Jyothi

Aquatic flora and fauna also affected very badly. Aquatic weed such as Kulavazha (E*ichornea crassipes*), Cobomba (*Cabomba caroliniana*), Kappapayal (*Pistia stratiotes*), Ambal (*Nymphaea sp*) African payal (Salvinia molesta) kattuthaalu (Colocasia sp.) etc were washed off in flood water. All kind solid waste were deposited in large quantities all over the wet lands.

IMPACT ON AQUATIC WEEDS

Flood water washed off aquatic weed Mullan payal (Cabomba caroliniana).Local people say that locally this used to be a spawning ground for fish. Cabomba is a common aquarium plant introduced in natural ecosystem accidently and is widely known as one of the worst invasive weeds. Cabomba stem breaks easily and parts are capable of spreading and reproduction. The spread of these invasive species along the Aranmula stretch of Pampa has already started creating problems to the riverine ecology. It has also spread in Vembanad Lake as the salinity of Vembanad lake has been reduced.

LOSS OF TRADITIONAL FISHING AND AGRICULTURAL IMPLEMENTS

Traditional fishing equipments such as Udakkuvala, Thettal, Veesuvala, Perum koodu, Ottal, Choonda, Vallam, Vala, Muppalli etc were extensively damaged and lost in flood in Thakazhi, Kainagiri, Chambakulam etc.

In Kuttanad area after monsoon season water in paddy fields was pumped out to nearby lake or pond by mechanical methods. Earlier times this was done with giant water wheels but nowdays water is pumped out generally into the surrounded lake or the canals made outside with special pump called petti and para, driven by oil engines or electric motors in each padasekharam. Flood water has damaged these machines widely all over the Lower Kuttanad region such as Ramankari, Kainakari, Champakulam and Nedumudi.

Banana/Plantain: Among other major crops, banana was the worst hit by the flood in all flood affected gramapanchayts of Alappuzha district. Major banana varieties cultivated in the region are Eathan, Palayamkodan, Njalippovan and Chenkadali Due to water logging for more than two weeks, the root system of banana plants were damaged and crop was damaged. Approximately 50000 banana plants were lost in flood. The most severely affected area is the GPs lying in Upper Kuttanad area.

Coconut: Coconut is grown in homestead and also as plantations in this area. Small coconut trees aging 1 to 4 years of all coconut varieties withered and got damaged in flood. This was due to submergence of the plants in water for long days and deposition of silt and muddy soil over the plants. This was observed in all flood affected area.
Vegetable crops These plants were submerged for more than a week and was completely decayed and lost. Vegetables such as bitter guard, tomato, ladies finger, amaranthus, capsicum , papaya etc were decayed.

Tuber crops: Tuber crops such as tapioca, greater yam, lesser yams, taro are extensively damaged and lost in flood affected area. Due to the submergence and water logging for many days, corms and tubers were decayed and rotten. Farmers said that this was also due to the deposition of muddy soil which has poor aeration capacity there by all these crops plants decayed.

INLAND FISHERIES - ALIEN FISH- A THREAT TO NATIVE SPECIES

Intense rain had a significant effect on fish farming sector in the flooded area.Local fishermen say that the overall fish catch in Vembanad lake-Kuttanad wet lands increased after flood. Almost 30% of the fishes caught post-flood days were exotic species that would have comedown either from private aqua farms or reservoirs.Fisher men say that the catch of many local species of fresh water fishes from rivers has reduced. Local people speculated that these may be washed away in flood water. They include widely available local fishes, such as Varal, Pallathi, Paral, Karimeen etc.

EXOTIC FISH IN NATURAL ECOSYSTEMS

There were many fish farms in all the flood affected areas in Alappuzha. Heavy losses occurred in fish farms. Fishes from hatcheries and private farms escaped or was washed off in flood water. This includes commercially valuable fishes such as Pearl spot, Catla-catla, Tilapia, GIFT etc. Red bellied pacu, African cat fish, Mosambique tilapia and Assam wala were the exotic species dominant in catch. Indian exotics like Catla, Rohu and Mrigal which are normally found in local farms were also in catch. Red belly is the most popular fish breed in Kerala. It is native of south America and it is farmed in Kuttanad area. Other

fishes and leaves near the river banks are the feed for this fish. Local fish breeds will face a major threat as these fishes will feed on fish eggs too.

African Mushi, is another threat to the local fishes. Though African catfishes are banned in Kerala, it is farmed in many parts of Kerala including Kuttanad. Sucker catfish, Three spot gourami and similar aquarium fishes were also spotted. These fishes will eat eggs of local fish breeds. Fishermen also mentioned the presence of aquarium exotics, namely three spot gourami and moon gourami. All these species pose a serious threat to the indigenous fish and freshwater ecosystem.

IMPACT OF FLOOD ON PEARL SPOT- THE STATE FISH

Water salinity affects the fish directly or indirectly through generating changes in the ecological factors and production of food organisms. A change in salinity affects the survival and growth of fish. Pear spot, one of the indigenous and most valuable fish in Kerala. Due its economic importance it is farmed extensively throughout Kerala. It is one of the major native fish in Vembanad-Kuttanad wetland system.

Local fishermen from these regions say that, after flood the pearl spots in Vembanad-Kuttanad seems to have zootopic diseases, warts on its body. They claim that this may due to the decrease in salinity of estuary due to the inflow of flood water to the lake. The silt deposition has changed the ecosystem of Vembanad lake and has impacted the. clam fishery of Alapuzha. The local people say that clams are smaller in size when compared to before.

The Vembanad backwaters in Kerala is a tourism destination where foreign and Indian tourists cruise on houseboat and the annual tourist inflow is much above the carrying capacity of the Lake. It is estimated that there is about 1000 house boats here. This has led to the pollution of the water with leakage of fuels from the house boat. The local people say that this affects the fish catch of the lake. The depth of the river has decreased and due to floods the polluted water was washed off and the local people say that fish is more tasty now.

The fishery of Vembanad lake consists of crab, clams, various varieties of prawns, and many fish species including the famous pearl spot. In 2007, the MS Swaminathan Research Foundation, in their report titled Measures to mitigate the agrarian distress in Alappuzha and Kuttanad wetland ecosystem sounded a warning. "The changed ecology is believed to have led to the loss of about 23 species of fishes, prevented migration of about 13 other species, led to the decline of 33 percent of bird population, [and] brought in new predatory bird species like Neerkozhi."

4.3.11. KOTTAYAM

4.3.11.1. IMPACT ON AGROBIODIVERSITY

Paddy fields – are very severely affected in Kallara Panchayat. Acidity of the field increased and soil appeared rust in colour on surface. People says that due to acidity the seeds sowed after flood also are not growing in such fields. Other paddy fields in Maravanthuruthu, Mulakkulam, Payippad, Thiruvarppu, Udayanapuram and Vazhappally were also flooded with water and crops were lost and siltation occurred. In Mulakkulam, silt has been deposited in paddy fields and the water became

turbid. In Udayanapuram, light coffee brown coloured silt has been deposited in fields and the soil became hard and capacity of water to percolate decreased. In Payippad water became sour to taste, turbidity increased and mud has been deposited.

Pepper cultivation, Rubber and Coffee plantations were severely damaged in Koottickal due to landslide. In Maravanthuruthu and Velloor, Nutmeg plantations were severely affected due to flood and nutmeg plants completely dried. In addition to this vegetables like lady's finger, kasthuri venda, ash gourd, tubers like chena, chembu, vellakachil, tapioca, etc. were also lost.
Due to flood defoliation of Rubber plants took place, rate of lactation decreased and growth became stunted in Mulakkulam.

Production Units of Alappuzha Coir has been severely affected in 14 wards of Maravanthuruthu. About 85 quintal coir has been lost from individuals and societies.

INDIGENOUS FISHES WERE DECREASED!!

Indigenous fish varieties like karimeen, pallathi, vala, vayambu, vatta, kanni, thuppalukudiyan, paral, kanijan, vazhakka varayan, chillan, kallemuytti/ kalladamutti, kooral, planjil, manalaryan, aarakan, kari, kola, konchu etc. in Vembanadu lake and Meenachil river got diminished drastically. People says that the escaped fish species like rohu, catla, grass carp, koorivala,etc. from fish farms might be the reason for decreasing the number of indigenous varieties of fishes.

Fishes like rohu, catla, koori, vala, etc. escaped from fish farms in Payippad. In T.V. Puram, about 40,000 red belly fishes weighing 500 gm each escaped from a farm. In Vazhappally about 10,000 fingerlings of catla, rohu, grasscarp, about 5000 numbers of kalladamutti, kari, varaal, etc. escaped from fish farms.

AGROBIODIVERSITY LOSS IN UPPER KUTTANAD REGION

A special type of habitat in Arpookkara known as '**Chekka**', where coconuts are being cultivated sustained well even though the whole region remained flooded for days

The upper Kuttanad agricultural ecosystems in Kallara and Kumarakom region were severely damaged. Acidity in field has raised. Bunds were destroyed and canals changed its course in Kumarakom. The soil in the field appears slightly yellowish orange in colour due to siltation in Maravanthuruthu. Local people say that after the Thaneermukkam bund was constructed in 1976, large scale changes in biodiversity and the natural ecosytem occured.

A species known as Chuttenthal has been severely affected in Koottickal due to landslide. The *Malayaraya* tribe residing in the region depends on this plant for their livelihood. They used its leaves for making brooms.

4.3.12. KOLLAM

4.3.12.1. AGRICULTURE SCENARIO OF DISTRICT

Paddy, coconut, rubber, pepper, banana, tapioca, mango and cashew are some of the extensively cultivated crops in this district. Area under cultivation of paddy is more in the mid land area of the district. The coastal areas of the district, though having more land area suitable for paddy, are left fallow by the farmers due to non profitability of cultivation

4.3.12.2. IMPACT ON AGROBIODIVERSITY

In East Kallada, 5.5. Acres of integrated farm has been damaged due to overflow of water from Kallada River and crops which were ready for harvesting like banana (Ethan, Chenkadali, Robusta), vegetables (Cow pea, Bitter gourd, Lady's finger), etc. were lost. In Adchanalloor about 22 acres of fields has been severely affected and crops like Mundakan rice, vegetables like Cow pea, Bitter guard and Snake guard, Banana, Tapioca, etc. has been damaged. In West Kallada, about 20 ha of fields were severely affected due to overflow of water from Kallada River. About 36 ha of cultivable paddy fields became completely flooded with water and 20 ha became unsuitable for cultivation. After the disaster water holding capacity of the soil decreased.

Banana varieties such as nendran, palayankodan, mondhan, njalipoovan, chenkadali, etc were severely affected and the land became unsuitable for cultivation. In East Kallada, more than 200 acres of fields has been affected severely due to overflow of water from Kallada River through canals. Cultivated rice varieties -Pattambi, Uma, Cheradi etc. in the field decayed and dried.

Table 25 Impact on Agrobiodiversity of Kollam

Sl.No.	Species Name	Number of varieties
1	Coconut	4
2	Cassava	5
3	Banana	6

MUNROETHURUTHU- A SINKING ISLAND

After the floods due to the deposition of mud particularly in Ward no 10 and 13 prawns, clams, barnacles etc was destroyed. In Perungalam sand bars were formed. Fish farms of Karimeen, Thirutha, Poomeen was destroyed.Among coconut and banana plantations a weed Wedilia trilobata is extensively found after floods. The catch of Etroplus, Mugil, was reduced and was found to be diseased.

ASHTAMUDI LAKE

Ashtamudi lake, a Ramsar wetland of international importance recived the first Marine Stewardship Council-certified fishery in India. It supports the livelihoods of around 3000 fisherfolk involved in collection, cleaning processing and trading clams..The Lake has been severely affected due to mud deposition, accumulation of plastic wastes,

4.3.13TRIVANDRUM

4.3.13.1. AGRICULTURE SCENARIO OF DISTRICT

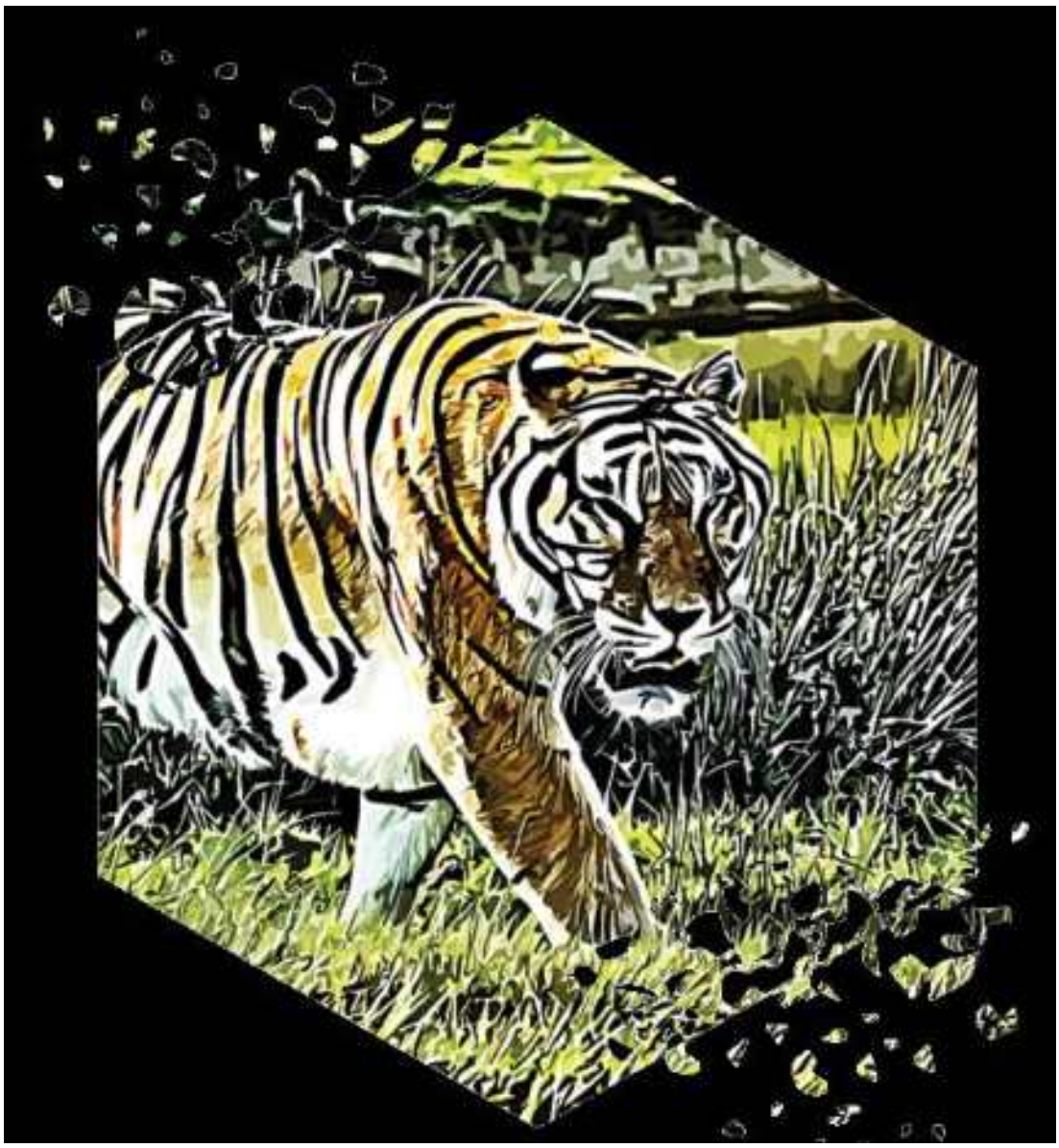
In Trivandrum the study area includes 3 panchayats Aryanad, Kallikadu, Kalliyoor. The Vellayani Lake lies in the southern most outskirt of Thiruvananthapuram Corporation and its catchment area is coming under the jurisdictions of Pallichal, Kalliyur and Venganur Grama panchayats and Thiruvananthapuram Corporation. The lowland and the flood plains areas around the lake is used for the cultivation of paddy.

4.3.13.2. IMPACT OF FLOODS ON AGROBIODIVERSITY

About 58 ha of paddy fields (Pandarakkari and Chundukari) near Vellayani Lake became unfit for cultivation due to flood. While in Aryanad about 30 acres of crop fields has been destroyed where tapioca, banana and vegetables were cultivated. It is also noticed that wastes from nearby quarry reached the crop field in Aryanad and crops like tapioca and banana were severely damaged. In the district 12 varieties of tapioca and 10 varieties of Banana was moderately affected during the floods In Kallikkad a fish farm and a fish pond have been affected severely and about 1800 fishes were escaped or lost. In Kalliyoor both poultry and goat farms have been damaged severely and 3 goats and 37 poultry have been lost.

Fish hatchery at Neyyar Dam (under Fisheries Dept.) has been flooded and lakhs of fish fingerlings has been lost. (Mrugal – 10.5lakh; Cutla- 3.5 lakh; Cutla fingerlings – 0.5 lakh, Rohu fingerlings – 0.5 lakh, Grass carp – 0.2 lakh). In addition ornamental fish as Angel Gold, Gourami, Shark, Moly, Guppi also escaped.

Alien fishes may alter the aquatic ecosystem by changing water quality and also cause the extinction of native fishes by predation (destroying the eggs, larvae, and adults), damaging the aquatic vegetation and competing for the food resources. Besides, alien fish species may hybridize with indigenous species in the wild, diluting the wild genetic stock .Population of African Mushi increased in Neyyar River and associated canals after floods which will badly affect the indigenous fishes.The nocturnal predatory fish feeds primarily on living, as well as dead, animal matter including fish, invertebrates, and small birds. Its ability to survive in shallow mud for long periods of time and its high tolerance for poorly oxygenated water gives it an advantage over other native species.



CHAPATER 5

IMPACT ON SPECIES DIVERSITY:

5.1. IMPACT OF FLOOD/LANDSLIDES ON FLORA/FAUNA

This chapter deals with an impact assessment of floral and faunal diversity of the flood affected areas of various districts of Kerala. These informations have been recorded according to the community point of view of the respected Grama Panchayath, Municpality and Corporation. Based on the study the impacts are catagorised as direct, indirect and immediate depending on the habit and habitats of the flora and fauna. Most of the impacts are due to changes in the habitats, inundation for a longer period, and washing away by the torrential rain. Changes have occurred in distribution patterns, all of which will have long term impact on ecological processes. In other hand the impacts of climate change and the changes in habitats affected certain wetland-related species, such as birds, fishes, reptiles and amphibians. Butterflies are considered as indicators of ecosystem change and are used to predict various environmental alterations. They are specific in ecological requirements such as temperature, humidity and their food plants and egg-laying habitats were affected. Since butterflies are the important pollinator components of an ecosystem, any effect on them would lead to disruption in pollinator relationships. The amphibians are the best other known ecological indicators, because of their moist permeable skin, dual mode of life and multiple habitat preference. Flash floods don't give time for animals to relocate and as a result, they often get washed away. When the natural habitat for wild animals is lost, it lead to competition for food and exposure to new types of prey and affect the population. In case of floral diversity the major impact was on undergrowth.

5.1. 1. IMPACT ON FLORAL DIVERSITY

In Pathanamthitta district, flood severely affected the plants growing in the riparian and adjacent land near all the rivers. This happened all along the Pamba river bank from Pamba valley to Niranam in Upper Kuttanad area. Severe impact was on herbaceous medicinal plants including Kurunthotty (Sida ulnifolia), Valliuzhinja (Cardiospermum halicacabum), Kayyonni (Eclipta alba), Nilappana (Curculigo orchioides) Anachuvady (Elephantopus scaber) Chakkarakolli (Gymnema sylvestre), Mukkutti (Biophytum sensitivum) Paadathaali (Cyclea peltata) etc. Number of shrubs and trees were also lost due to the landslide along the river bank. Shrubs include Edampiri-valampiri (Helicteres isora) Paanal (Glycosmis pentaphylla) Ottaveran (Clerodendrum infortunatum) Amalpori (Chassalia curviflora) Kundalappala (Tabernae montana alternifolia) etc. Many fruit trees growing along the river bank were also uprooted and damaged in landslide. Fruit trees include Ayaniplavu (Artocarpus hirsutus) Thengu (Cocos nucifera) Kudampuli (Garcinia gummi-gutta) Mavu (Mangifera indica) Mangostein (Garcinia mangostane), Rambootan (Nephelium lappaceum) etc. Other tree plants or cash crops uprooted or damaged in flood are Athi (Ficus racemosa) Rubber (Hevea braziliensis) Jaathi (Myristica fragrans) Coco (Theobroma cacao) Coffee (Coffea arabica) etc. Flood badly impacted lower plants such as Pteridophytes and Bryophytes (Appendix). It is obseved that certain lichens found on tree trunks withered just after flood.

Abundant growth of some specific weed plants on flood affected area

It is noticed that there is a profuse growth of certain specific weed plants in almost all wetlands and nearby places in flood affected region. Plants such as Manalcheera (Alternanthera bettzickiana), Anathottavady (Mimosa diplotricha), Koonikorappullu (Cyperus cyperinus) kurunthotty (Sida rhomifolia) are prominent among them. It seems, wetlands and paddy fields were completely covered with Koonikorappullu. Similarly Manalcheera, Anathottavady and Kurunthotty plants profusely grow in all agricultural fields, posing a serious threat to the crops.

Flood severely affected the riparian vegetation in Alapuzha. In the flood water, river

Banks eroded extensively and most of the herbaceous medicinal plants such as kurunthotty (Sida alnifolia), Ramacham,(Chrysopogon zizanioides) Balikaruka (Cynodon dactylon); shrubs such as Panal (Glycosmis pentaphylla), Yellow bamboo (Bambusa vulgaris), Erikku (Calotropis gigantea), and trees such as Punna (Calophyllum inophyllum), etc were rooted out and washed away. Trees and shrubs grown on river bank and lake shore are affected by flood. Some of them are rooted out in the force of flood water and lost. Trees such as Athi (Ficus racemosa) Plavu (Artocarpus heterophyllus) Marotti (Hydnocarpus pentandra) Mullupazham (Ziziphus jujuba), Adakka (Areca catechu), Aryaveppu (Azadirachta indica) Vellila (Mussaenda frondosa) etc were decayed. Climbers such as Shanghupuspaam (Clitoria ternatea), Thazhuthama (Boerhavia diffusa) etc were also lost in flood. (Appendix).

Loss of Herbs, Shrubs &Trees

In Kottayam district population of aquatic plant species like Kudapayal (Pistia stratiotes) Salvinia (Salvinia molesta) Azolla, (Azolla caroliniana) Kulavazha, (Eichhornia crassipes) Mullan payal (Cabomba caroliniana), etc were considerably reduced. Herbs like Nilapana (Curculigo orchioides), Poovamkurunthal (Cyanthillium cinereum), Kudangal (Centella asiatica), Kallurukki (Scoparia dulcis) Cherula (Aerva lanata) Muyalcheviyan (Emilia sonchifolia), etc. were lost at the time of flood. The vegetation is recovering slowly in places affected by floods .

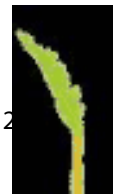
Ochlandra travancorica and Ochlandra Wightii (Eetta) withstand the flood

Ochlandra travancorica is reffered to an endemic bamboo of Western Ghats. The plant material is wildly used in cottage industries to make mats, baskets and also used for thatching the roof of the traditional huts of Tribal communities of Kerala. Selling the baskets and mats they are generating income and it supports the livelihood of socially and economically weaker sections of the society. It is noted that, all most all reed plants sustained the flood. Landslide or mudslides were comparitively less in riverbank/place there which they grow. This was noticed on all riverine area in upper part of Pamba, Ranni-Perunadu Grama Panchayath (GP). This is a suitable material for natural fencing to prevent mudslide/landslide or soil erosion along river banks.

Riparian Vegetation of Chalakkudy, Thrissur

A massive loss of vegetation in the riparian area of Chalakkudy River was recorded. According to the survey, nearly forty eight plants in the Chalakkudy river area were washed out. This include number of climbers, grass, herbs, shrubs and Trees species. Different forests like Tropical wet evergreen forests, Tropical semi-evergreen forests, Tropical moist deciduous forests and Plantations are found in the district. During the August 2018, heavy rain inside the forest resulted in heavy landslides and landslips in Pariyaram, Aanakkayam, Machad forest areas leading to the loss of entire vegetation. Heavy landslide occured in Machad region and all the plants in the area were destroyed or affected due to landslide. The Kechery River originates from the Machad hills flowing westwards and joins the backwaters of Chettuvai. A portion of a hill on the Machad forest range came down in a landslide destroying the vegetation. The commonly distributed invasive species here are Dhritharashtrapacha (Mikania micrantha) and Anathottavadi (Mimosa diplotricha).

Chitteenthal (*Phoenix pusilla*) A species known as Chittenthal has been severely affected in Koottickal GP due to landslide. The Malayaraya tribe residing in this locality depends on this plant for their livelihood. They used its leaves for making brooms and fruits are edible.



Riparian vegetation of Kabani

Riparian vegetation of Kabani, Wayanad and its tributaries are associated with a defined riparian flora of 24 species. Along the banks of streams dense thickets of Ochlandra and Pandanus species are common. Trees like Lophopetalum wightianum, Syzygium cumini, Syzygium heyneanum, Hydnocarpus pentandra, Neolamarckia cadamba, Madhuca neriifolia, Vepris bilocularis, Diospyros malabarica, Calophyllum apetalum, Diospyros paniculata, Ochreinauclea missionis, Hopea ponga, Pongamia pinnata, Salix tetrasperma, Vateria indica, etc. are common along the banks of this river. Rotula aquatica, Homonoia riparia, etc. are the common shrubs in the area. The survey indicates that bamboo vegetation on the banks of these rivers has been destroyed extensively. The small herbs and shrubs on the banks was affected, small trees are found uprooted. The right bank of Kabini River is still having natural vegetation cover and hence the right banks did not erode much in the floods in comparison to left bank.

The tree species like Diospyros malabarica,, Calophyllum inophyllum, Poeciloneuron indicum, Garcinia gummi gutta, Pongamia pinnata, Ficus racemosa, Elaeocarpus tuberculatus, Syzygium cumini, Ochlandra travancorica found impacted are usually found on the banks are riparian zone trees characterized by their affinity to water and tolerance to saturated conditions. The presence of invasive species like Lantana camara, chromolaena odorata etc are also found. Local people are of the opinion that one of the beneficial affects is the washing away of aquatic weeds in the flood. Accoding to the local inhabitant's places where the native vegetation exist river banks were not much affected. They say that many species which used to be found frequently in marshy places are not sighted anymore. Many years ago in Meenchal the landscape was having lots of wetlands and marshy lands and during rainy season the people used to commute through boats. In these marshes even Elephant used to sink according to them. But now the entire area has been filled up and the land has lost its natural marshy nature leading to the disappearance of many aquatic species.

The impact of such magnitude as mentioned above on the riverine ecosytem and the resulting impact on endangered species and species with narrow range distribution has to be studies in detail.

In Idukki the erosion of 3 to 5M of river bank on the sides of Periyar have resulted in commendable loss of floral diversity. It needs to be noted that these areas are well known for its floral biodiversity, and much of the ecosystem can be classified as forest ecosystem. Many of the flora species that can be classified as endemic and endangered would have been washed away with the river bank erosion. Apart from the erosion the loss of floral diversity for long term water logging cannot be ruled out.

Nilakkurinji *(Strobilanthes kunthianus)* Devikulam, Munnar, Kanthallur, Vattavada, Bisionvalley and Chinnakanal are the panchayats that are famous for endangered and endemic flowering plant the Nilakkurinji (Strobilanthes kunthianus). About 2% the kurinji plants were destroyed due to floods and landslides. At certain places flowering process was delayed due to heavy rains. In addition, the flowering was not consistent due to adverse weather conditions. The flowers were soaked in water due to the consistent rain and flood and hence much of them were decayed and did not remain for long. In places were massive landslide had occurred there was a complete removal of the top soil and much of the plants had gone along with the topsoil.

Jasminum angustifolium, Vanda sp, and endangered plants like "Vathakkodi" (Cayratia trifolia) and "Naykuruna" (Mucuna pruriens) were seriously affected by landslides and soil erosions.

The natural calamity that happened in these regions had a great impact on invasive species like "African payal" (Salvinia auriculata), as much of these have been washed downstream reducing its concentration in a particular area. But the flood has helped in the dispersal of Salvinia auriculata to many water bodies were it has not been previously reported.

"Comunist pachha" Chromolaena odorata is a weed that has been spread widely in state of Idukki and much common than any native species. Much of the species have been eroded off with the top soil, as a result of the landslides and mudslide.

In Thiruvananthapuram, Vellayani lake located in the Kalliyoor Gramapanchayath, aquatic plants such as Lotus (Nelumbo nucifera), Aambal (Nymphaea nouchali), Neyyambal (Nymphoides indica), Vazhapadathi

(Commeleena difusa), Pannalchedi (Ferns), Chemeen chedi, was lost. Since 1953 onwards the lake was used for the cultivation of lotus flowers for the Sree Padmanabha swamy temple for conducting various ritual functions. The collection of lotus leaves and flowers is a source of livelihood for many people living in this area.

Bamboo, Pandanus sp., Aquatic Rotula, Cannon ball tree, Jamun, Reeds like Phragmites australis, Desmotachya bipinnata, trees like Kadam and Aattuvanchi etc. effectively survived in the flood.

In Puthenvelikkara, Ernakulam a traditional variety of Rice similar to Pokkali named "Kuttadan" suitable for water stagnated areas was cultivated in earlier times. Kuttadan is a tall variety which grows to a height of 5 feet and there is no attack from pest. Farmers recollects that Kuttadan grows as water in the field increases, it will stand above the water. As water recedes, it will fall and will touch the ground, new plant will come from this point where it touches the ground. Yield is less for this variety, but taste is very good. Once cultivated, there is no need for sowing seeds for another 5 years. This variety no longer exists in this area.

5.1. 2. IMPACT ON FAUNAL DIVERSITY

INSECTS

The flood had many fold impact on the insect population. There are chances that the ecological transition of the streams, lakes and ponds would have an adverse impact on insects and its larval forms. The availability of food and wash down of the larval forms would have led to a density change. What impact these would have on ecology need further studies. Certain butterfly species are seen lesser in number as the aftermath of flood. Some odonates species that are seen in high altitude have been reported from lower altitude, the reason for the same can be accounted for larval wash down. The population of some odonata species has also been effected.

At Ernakulam in general, people have noticed a decrease in the population of insects such as Wasps, Butterflies, Ants, Odonates, Spiders, House flies and termites. But the population of Moths and Leaf cutting bees has shown an increasing trend after floods. Some of the crop pests such as stem borers, leaf folders and leaf webbers have also increased in numbers. Local people reported that a new type of insect which sucks the sap from papaya has been noticed after floods.

At Chekalthode area the number of honeybees was reported to be less. This is likely to impact the pollination of several plants including cultivated crops. There has been considerable reduction in the population of fire flies and Grass hoppers too.

In Attappady area of Palghat district, availability of honey has become limited as the honey combs fell off during the heavy rains and were destroyed. It also led to the massive destruction of eggs and larvae of honey bees and as a result, their population has drastically reduced. This will have a negative impact on the pollination of several floral species of the area.

At Kottayam population of mosquitoes, dragonflies and honey bees has increased.

In Pathanamthitta a large Millipede (Perumal atta) (*Phyllogonostreptus nigrolabiatus*) was reported from Ranni-Pazhavangadi Gramapanchayath. This was found only in forest area and suspected to be washed along with flood water.

At Ernakulam Cotton leafworm (*Spodoptera litura*) are spotted more after flood which voraciously feed on entire plant causing complete destruction.

3 NEW SPECIES OF ANTS FROM VARATTAR RIVER BASIN – REDUCED THEIR NUMBER AFTER FLOOD

Recently 3 new species of ants were discovered in Varattar river bank by Dr. Abhilash, Asst. Professor of Botany, Christian College Chengannur. These ants were normally found in North Indian states such as Haryana and Himachal Pradesh. This was the first finding of its presence in Kerala by his team. He says that, after flood there was a decrease in their number and speculated that these were washed off along with flood water or lost their natural habitat in deluge.

CRUSTACEANS

In Chenkalthod the Crustaceans, Garden Snails, Soft shell clams, Crabs, Shell fish were found in reduced numbers after flood. Shelled organisms like Chiromantes sp. have also been reported to be sighted lesser in number. In Eranakulam district, according to the local people, there is considerable reduction in the population of Crabs, Prawns, Oysters, Mussels, Giant mud crabs and Giant tiger prawns.

INVASIVE SPECIES- GREAT AFRICAN SNAIL POPULATION ON THE RISE

The population of Giant African Snail has increased in flood affected areas of Ranni-Angadi Gramapanchayat at Pathanamthitta and Ernakulam. These snails were listed as one of the top 100 most damaging invasive species in the world. Local people says that before flood their population was negligible but after flood, it has been dispersed to all regions and neighbouring areas of the GP. These snails are known to cause massive damage to agricultural and horticultural crops, as they feed voraciously on more than 500 different kinds of plants. Given that they are hermaphrodites, they lay 300 to 500 eggs at a time which provides a higher chance of invasion.

BUTTERFLIES

At Patthanamthitta flood resulted in habitat loss to butterflies, honeybees and dragonflies. There was an extensive damage to the banks of all the three major rivers and streams due to landslide and soil erosion. Most of riparian plants were washed off in flood. Local farmer say that honey bee colonies were totally washed off from river banks at Thottapuzhasseri GP. In addition to that local community says, due to habitat loss and unavailability of nectar plants after flood, it seems butterflies and honeybees are less in number or vanished from riverside (eg. Common Indian crow (അരളിശലഭം) Euploea core), Common Grass yellow (മഞ്ഞപാപ്പാത്തി Eurema hecabe), Blue tiger (നീലക്കടുവ Tirumala limniace) etc.

In Chenkalthod area, lepidopterans such as butterfly Blue mormon (Papilio polymnestor), Common mormon (Papilio polytes) are seen in large number in contradiction to reports from other areas.
At Cherupuzha, Kannur, The early stages of Butterflies, Moths and Odonates are subject to the detrimental effects of floods. Moths and butterfly larval forms seen during July- August - September are very much reduced in population size. This will affect the flowering and seed set of annual crops.

ODONATES

In the post flood survey conducted at Silent Valley National Park by Indian dragon fly society 82 species including 14 new ones were identified. Rare species such as Saffron Reedtail (കുങ്കുമ നിഴൽതുമ്പി, Indosticta deccanensis), Forest Spreadwing (കാട്ടുചേരാചിറകൻ, Lestes dorothea), Plain Sinuate Clubtail (ചതുരവാലൻ കടുവ, Burmagomphus laidlawi), Pigmy Clubtail (കടുവാച്ചിന്നൻ, Microgomphus souteri), Nilgiri Clawtail (നീലഗിരി നഖവാലൻ, Onychogomphus nilgiriensis), Travancore Daggerhead (തെക്കൻ കോമരം, Idionyx travancorensis), Giant Clubtail (പെരുവാലൻ ISph, Megalogomphus hannyngtoni), Lesser Blue Wing (കരിനീലച്ചിറകൻ, Rhyothemis triangularis) were found. It was also observed that there is considerable reduction in the number of Damselflies. According to Sri. V. Balachandran, Secretary, Indian dragon fly society & survey co-ordinator, the flood has washed out the larvae of these odonates from the streams; hence there is a notable reduction in population.

At Chenkalthod area damsel flies such as Stream Glory (പീലിതുമ്പി, Neurobasis chinensis), Blue-Banded Longtail (Acp-hn Xp-¼n, Archibasis oscillans), Clear-Winged Forest Glory (ചെറിയ തണൽ തുമ്പി,Vestalis gracilis) etc are seen in large numbers after flood. This may be to the fact that larval form of these species have been washed down in large numbers to the lower altitude planes like Chenkalthod area from where these larvae have emerged. It has also to be noted that when these species are found in large numbers in Chenkalthod which may not be its natural habitat, its survival chances are lesser when compared to the places from where they are washed down from. The numbering of wandering gliders (തുലാത്തുമ്പി, Pantala flavescens) has also been reported lesser in number.

At Padiyoor, Kannur some dragonflies which used to be seen in common like, Common Clubtail (നാട്ടുകടുവ, Ictinogomphus rapax), Pale-spotted Emperor (മരതക രാജൻ, Anax guttatus), Rufous-Backed Marsh Hawk (തവിട്ടു വെണ്ണീറൻ, Brachydiplax chalybea) is not seen now. Its believed that the larvae and eggs of these species may be lost during the floods.

At Payam, Kannur also population of dragon flies like Stream Glory (പീലിതുമ്പി, Neurobasis chinensis), Stream Ruby(നീർമാണിക്കൻ, Heliocypha bisignata), Saffron-Faced Grass Dart (ചെമ്മുഖപ്പുത്താലി, Pseudagrion rubriceps), Malabar Torrent Dart (ചെങ്കറുപ്പൻ അരുവിയൻ, Euphaea fraseri), River Heliodor (തവളക്കണ്ണൻ, Libellago lineata), Common Clubtail (നാട്ടുകടുവ, Ictinogomphus rapax), Pale-spotted Emperor (മരതക രാജൻ Anax guttatus), Rufous-Backed Marsh Hawk (തവിട്ടു വെണ്ണീറൻ, Brachydiplax chalybea) has considerable decline in Population. At Payyavoor, Kannur some dragon flies like Stream Glory (പീലിതുമ്പി, Neurobasis chinensis), Stream Ruby (നീർമാണിക്കൻ, Heliocypha bisignata), Malabar Torrent Dart (ചെങ്കറുപ്പൻ അരുവിയൻ, Euphaea fraseri), Blue-Banded Longtail (അരുവി തുമ്പി, Archibasis oscillans), River Heliodor (തവളക്കണ്ണൻ Libellago indica) Common Clubtail (നാട്ടുകടുവ, Ictinogomphus rapax), Blue Grass Dart (നാട്ടു പൂത്താലി, Pseudagrion microcephalum) Rufous-Backed Marsh Hawk (തവിട്ടു വെണ്ണീറൻ, Brachydiplax chalybea), Tricoloured Marsh Hawk (ത്രിവർണ്ണൻ വ്യാളി, Orthetrum luzonicum), Yellow-Tailed Ashy Skimmer (പുള്ളിവാലൻ, Potamarcha congener) are not seen nowadays.

SOIL DWELLING ORGANISMS

In many flooded regions like Pandalam, Kuttoor and Eraviperoor etc. large number of earthworms were found to be dead.

At Ernakulam earthworms were severely affected by floods which were found to die in large numbers. Centipedes, Scorpions, and caterpillars were not much affected. Earthworms were found to come out of their burrows to the surface of soil in large numbers majority of which were later found to be dead. People correlate this aspect to the disruption of soil structure due to large scale sedimentation of fine particles such as silt and clay in the soil during flood making it more compact and less aerated.
Heavy rain and flood caused extensive damage to the Achenkovil river and riverine ecosystem. According to Dr, Sanal Kumar, Professor and Head of Department of Zoology, NSS College Pandalam, there was large scale depletion of species such as soil Microarthropdes; Collembolans- wing less soil insects and isopodes, the first level decomposers in the soil. These organisms enhance soil fertility. He says that this was due to the change in the pH of water. Depletion of these organisms from the soil is mainly due to the erosion of top soil and change pH of the water during flood. After flood pH of the water became acidic (4.2-5.0). He also reported that Mayfly nymph (Rhithrogena germanica) and Dragonfly larvae is totally absent in Achankovil river after flood. These are all environmental pollution indicators

At Palakkad in the case of soil inhabitants, large reduction in the population of earth worms was observed after flood. Reduction in population of Millipedes, Centipedes, Ants and crickets were also noticed after flood. The flood which resulted in change in the soil structure and composition by way of loss of top soil, deposition of mud, silt, clay, accumulation of wastes etc could have caused harm to the living environment of soil dwelling organisms. The loss of flora, fauna and micro organisms from a particular location which impede the food chain and disrupt ecological balance could also form a factor for reduction in population.

At Cherupuzha, Kannur top soil of up to 3 inch deep was washed off. Many water sources and small streams were affected due to deposition of mud and debris and lowering of water

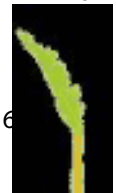


table. Due to changes in soil structure mass mortality of earthworms is a major cause of concern as this will directly affect the fertility of soil which is already adversely affected by the washing away of top fertile soil.

BIRDS

Though, birds are one of the major ecological indicators and highly migratory in behaviour. The direct impact of flood would be limited when compared to other faunal groups. One of the major reasons for the same is the areal behaviour of the birds, and their preferred nesting place etc. Flooded months do not coincide with the breeding or nesting season of majority of birds, hence the flood might have had limited impact on them. Secondly the natural disaster took place in a non migratory season hence the impact of the natural calamities would be limited to resident species, which are much more adapted to the monsoon.

The fresh water lake of Vellayani and the paddy fields of Punchakkari in Trivandrum district is an abode for indigenous and migratory birds. In a previous study conducted about 140 species of bird were recorded alone in Vellayani Lake. A study conducted by Kerala state Biodiversity board alone identified 81 species including three near threatened species. Though many of the species of these birds come under least concerned species category in IUCN, the population trend of many are declining and further more need to be re-accessed with respect to the declining population. In this context the habitat destruction of about 5Sq. Km area due to flood might have affected the inhabitations for both native and migratory birds at Kireedampalam in Kalliyoor, Thiruvananthapuram.

Water birds such as Egret (small and large egrets) and herons were not much affected by flood. There were two bird nesting places near Pandalam -Muttar region. This was an intensely flooded area. But even after flood, local people say, there is an abundance of egrets and herons in this region. This may be because of the availability of food sources after receding flood water.

THATTEKKAD BIRD SANCTUARY

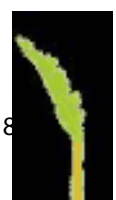
The scenario is bit different in Midland ecosystem such as in Thattekkad bird sanctuary. The Thattekkad bird sanctuary is the first bird sanctuary of the state that was established in the year 1983. Thattekkad as it literally means is a flat forest, the region is characterised by dense tropical evergreen low land forest nested between braches of Periyar River. The Sanctuary is known for its rich bird diversity. Dr. Salim Ali, the bird man of India describes the sanctuary as "the richest bird habitat on Penisular India". The sanctuary is home to both forest birds as well as water birds. It is known that Thattekkad bird sanctuary is an abode for almost 322 species of birds. Among the 322 species, 160 are strict migrants and of this 17% are international migrants.

WATER BIRDS OF THATTEKAD BIRD SANCTUARY

The data from ebird for whole of Kerala for the post flooded months September to November 2018 were compared with that of the same in the previous year (2017). 379 species were documented in 2017 when compared to 369 in 2018. There has been some species that is found new in 2018 compared to 2017 and while it's also to be noted that some species found in 2017 missing in 2018. The table for comparison is given below. The migratory season has not been subjected to analysis in the current study and hence cannot be commented up on.

Table 26 Water Birds of Thattekad Bird Sanctuary

No	Common name	2017	2018
1	Lesser Whistling-Duck		
2	Knob-billed Duck		
3	Cotton Pygmy-Goose		
4	Garganey		
5	Northern Shoveler		
6	Gadwall		
7	Indian Spot-billed Duck		
8	Northern Pintail		
9	Green-winged Teal		
10	Indian Peafowl		
11	Red Spurfowl		
12	Rain Quail		
13	Jungle Bush-Quail		
14	Painted Bush-Quail		
15	Grey Francolin		
16	Grey Junglefowl		
17	Greater Flamingo		
18	Little Grebe		
19	Rock Pigeon		
20	Nilgiri Wood-Pigeon		
21	Oriental Turtle-Dove		
22	Red Collared-Dove		
23	Spotted Dove		
24	Laughing Dove		
25	Asian Emerald Dove		
26	Orange-breasted Pigeon		
27	Grey-fronted Green-Pigeon		
28	Yellow-footed Pigeon		
29	Green Imperial-Pigeon		
30	Mountain Imperial-Pigeon		
31	Greater Coucal		
32	Lesser Coucal		
33	Sirkeer Malkoha		
34	Blue-faced Malkoha		
35	Pied Cuckoo		
36	Asian Koel		
37	Banded Bay Cuckoo		
38	Grey-bellied Cuckoo		
39	Fork-tailed Drongo-Cuckoo		
40	Common Hawk-Cuckoo		
41	Indian Cuckoo		
42	Common Cuckoo		
43	Sri Lanka Frogmouth		
44	Great Eared-Nightjar		
45	Jungle Nightjar		
46	Jerdon's Nightjar		
47	Indian Nightjar		
48	Savanna Nightjar		
49	White-rumped Needletail		
50	Brown-backed Needletail		
51	Indian Swiftlet		
52	Alpine Swift		
53	Little Swift		
54	Asian Palm-Swift		
55	Crested Treeswift		
56	Eurasian Moorhen		
57	Eurasian Coot		
58	Grey-headed Swamphen		
59	Watercock		
60	White-breasted Waterhen		
61	Slaty-legged Crake		
62	Ruddy-breasted Crake		
63	Baillon's Crake		
64	Indian Thick-knee		
65	Great Thick-knee		
66	Black-winged Stilt		
67	Eurasian Oystercatcher		
68	Black-bellied Plover		
69	Pacific Golden-Plover		
70	Yellow-wattled Lapwing		



71	Grey-headed Lapwing		
72	Red-wattled Lapwing		
73	Lesser Sand-Plover		
74	Greater Sand-Plover		
75	Caspian Plover		
76	Kentish Plover		
77	Common Ringed Plover		
78	Little Ringed Plover		
79	Greater Painted-Snipe		
80	Pheasant-tailed Jacana		
81	Bronze-winged Jacana		
82	Whimbrel		
83	Eurasian Curlew		
84	Bar-tailed Godwit		
85	Black-tailed Godwit		
86	Ruddy Turnstone		
87	Great Knot		
88	Red Knot		
89	Ruff		
90	Broad-billed Sandpiper		
91	Curlew Sandpiper		
92	Temminck's Stint		
93	Long-toed Stint		
94	Sanderling		
95	Dunlin		
96	Little Stint		
97	Pectoral Sandpiper		
98	Common Snipe		
99	Pin-tailed Snipe		
100	Terek Sandpiper		
101	Common Sandpiper		
102	Green Sandpiper		
103	Spotted Redshank		
104	Common Greenshank		
105	Marsh Sandpiper		
106	Wood Sandpiper		
107	Common Redshank		
108	Barred Buttonquail		
109	Crab-Plover		
110	Small Pratincole		
111	Pomarine Jaeger		
112	Parasitic Jaeger		

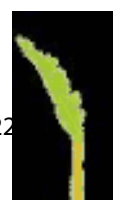
113	Long-tailed Jaeger		
114	Slender-billed Gull		
115	Black-headed Gull		
116	Brown-headed Gull		
117	Pallas's Gull		
118	Lesser Black-backed Gull		
119	Lesser Noddy		
120	Bridled Tern		
121	Little Tern		
122	Gull-billed Tern		
123	Caspian Tern		
124	White-winged Tern		
125	Whiskered Tern		
126	Common Tern		
127	River Tern		
128	Great Crested Tern		
129	Sandwich Tern		
130	Lesser Crested Tern		
131	Red-billed Tropicbird		
132	Wilson's Storm-Petrel		
133	Swinhoe's Storm-Petrel		
134	Flesh-footed Shearwater		
135	Asian Openbill		
136	Woolly-necked Stork		
137	White Stork		
138	Painted Stork		
139	Lesser Frigatebird		
140	Masked Booby		
141	Oriental Darter		
142	Little Cormorant		
143	Great Cormorant		
144	Indian Cormorant		
145	Spot-billed Pelican		
146	Yellow Bittern		
147	Cinnamon Bittern		
148	Black Bittern		
149	Grey Heron		
150	Purple Heron		
151	Great Egret		
152	Intermediate Egret		
153	Little Egret		

154	Western Reef-Heron		
155	Cattle Egret		
156	Indian Pond-Heron		
157	Striated Heron		
158	Black-crowned Night-Heron		
159	Glossy Ibis		
160	Black-headed Ibis		
161	Eurasian Spoonbill		
162	Osprey		
163	Black-winged Kite		
164	Oriental Honey-buzzard		
165	Red-headed Vulture		
166	White-rumped Vulture		
167	Black Baza		
168	Crested Serpent-Eagle		
169	Short-toed Snake-Eagle		
170	Crested Hawk-Eagle		
171	Legge's Hawk-Eagle		
172	Rufous-bellied Eagle		
173	Black Eagle		
174	Indian Spotted Eagle		
175	Greater Spotted Eagle		
176	Booted Eagle		
177	Bonelli's Eagle		
178	White-eyed Buzzard		
179	Pallid Harrier		
180	Eurasian Marsh-Harrier		
181	Crested Goshawk		
182	Shikra		
183	Besra		
	Eurasian Sparrowhawk		
184	Black Kite		
185	Brahminy Kite		
186	White-bellied Sea-Eagle		
187	Lesser Fish-Eagle		
188	Common Buzzard		
189	Barn Owl		
190	Sri Lanka Bay-Owl		

191	Indian Scops-Owl		
192	Oriental Scops-Owl		
193	Spot-bellied Eagle-Owl		
194	Brown Fish-Owl		
195	Jungle Owlet		
196	Spotted Owlet		
197	Mottled Wood-Owl		
198	Brown Wood-Owl		
199	Brown Hawk-Owl		
200	Malabar Trogon		
201	Eurasian Hoopoe		
202	Great Hornbill		
203	Indian Grey Hornbill		
204	Malabar Grey Hornbill		
205	Malabar Pied-Hornbill		
206	Common Kingfisher		
207	Blue-eared Kingfisher		
208	Black-backed Dwarf-Kingfisher		
209	Stork-billed Kingfisher		
210	White-throated Kingfisher		
211	Black-capped Kingfisher		
212	Pied Kingfisher		
213	Blue-bearded Bee-eater		
214	Green Bee-eater		
215	Blue-cheeked Bee-eater		
216	Blue-tailed Bee-eater		
217	Chestnut-headed Bee-eater		
218	European Roller		
219	Indian Roller		
220	Oriental Dollarbird		
221	Malabar Barbet		
222	Coppersmith Barbet		
223	Brown-headed Barbet		
224	White-cheeked Barbet		
225	Speckled Piculet		
226	Heart-spotted Woodpecker		

227	Brown-capped Pygmy Woodpecker		
228	Yellow-crowned Woodpecker		
229	Greater Flameback		
230	Rufous Woodpecker		
231	Common Flameback		
232	Black-rumped Flameback		
233	Lesser Yellownape		
234	Streak-throated Woodpecker		
235	White-bellied Woodpecker		
236	Eurasian Kestrel		
237	Red-necked Falcon		
238	Peregrine Falcon		
239	Rose-ringed Parakeet		
240	Plum-headed Parakeet		
241	Malabar Parakeet		
242	Vernal Hanging-Parrot		
243	Indian Pitta		
244	Malabar Woodshrike		
245	Common Woodshrike		
246	Bar-winged Flycatcher-shrike		
247	Ashy Woodswallow		
248	Common Iora		
249	Small Minivet		
250	Orange Minivet		
251	Large Cuckooshrike		
252	Black-headed Cuckooshrike		
253	Brown Shrike		
254	Bay-backed Shrike		
255	Long-tailed Shrike		
256	Indian Golden Oriole		
257	Black-naped Oriole		
258	Black-hooded Oriole		
259	Black Drongo		
260	Ashy Drongo		
261	White-bellied Drongo		
262	Bronzed Drongo		
263	Hair-crested Drongo		
264	Greater Racket-tailed Drongo		
265	White-browed Fantail		
266	Black-naped Monarch		
267	Indian Paradise-Flycatcher		
268	Rufous Treepie		
269	White-bellied Treepie		
270	House Crow		
271	Large-billed Crow		
272	Ashy-crowned Sparrow-Lark		
273	Jerdon's Bushlark		
274	Sykes's Short-toed Lark		
275	Oriental Skylark		
276	Malabar Lark		
277	Bank Swallow		
278	Dusky Crag-Martin		
279	Barn Swallow		
280	Wire-tailed Swallow		
281	Hill Swallow		
282	Red-rumped Swallow		
	Streak-throated Swallow		
283	Grey-headed Canary-Flycatcher		
284	Cinereous Tit		
285	Indian Yellow Tit		
286	Velvet-fronted Nuthatch		
287	Grey-headed Bulbul		
288	Flame-throated Bulbul		
289	Red-vented Bulbul		
290	Red-whiskered Bulbul		
291	White-browed Bulbul		
292	Yellow-browed Bulbul		
293	Square-tailed Bulbul		
294	Tickell's Leaf Warbler		
295	Tytler's Leaf Warbler		
296	Green Warbler		
297	Greenish Warbler		

298	Large-billed Leaf Warbler		
299	Western Crowned Warbler		
300	Thick-billed Warbler		
301	Booted Warbler		
302	Sykes's Warbler		
303	Paddyfield Warbler		
304	Blyth's Reed Warbler		
305	Clamorous Reed Warbler		
306	Broad-tailed Grassbird		
307	Pallas's Grasshopper-Warbler		
308	Bristled Grassbird		
309	Common Tailorbird		
310	Grey-breasted Prinia		
311	Jungle Prinia		
312	Ashy Prinia		
313	Plain Prinia		
314	Zitting Cisticola		
315	Golden-headed Cisticola		
316	Yellow-eyed Babbler		
317	Hume's Whitethroat		
318	Eastern Orphean Warbler		
319	Oriental White-eye		
320	Tawny-bellied Babbler		
321	Dark-fronted Babbler		
322	Indian Scimitar-Babbler		
323	Puff-throated Babbler		
324	Brown-cheeked Fulvetta		
325	Large Grey Babbler		
326	Rufous Babbler		
327	Jungle Babbler		
328	Yellow-billed Babbler		
329	Wynaad Laughingthrush		
330	Palani Laughingthrush		
331	Asian Fairy-bluebird		
332	Asian Brown Flycatcher		
333	Brown-breasted Flycatcher		
334	Indian Robin		
335	Oriental Magpie-Robin		
336	White-rumped Shama		
337	Nilgiri Sholakili		
338	White-bellied Sholakili		
339	White-bellied Blue Flycatcher		
340	Blue-throated Flycatcher		
341	Tickell's Blue Flycatcher		
342	Nilgiri Flycatcher		
343	Verditer Flycatcher		
344	Indian Blue Robin		
345	Malabar Whistling-Thrush		
346	Black-and-orange Flycatcher		
347	Rusty-tailed Flycatcher		
348	Taiga Flycatcher		
349	Blue-capped Rock-Thrush		
350	Blue Rock-Thrush		
351	Pied Bushchat		
352	Orange-headed Thrush		
353	Desert Wheatear		
354	Isabelline Wheatear		
355	Indian Blackbird		
356	Southern Hill Myna		
357	Rosy Starling		
358	Daurian Starling		
359	Brahminy Starling		
360	Chestnut-tailed Starling		
361	Malabar Starling		
362	Common Myna		
363	Jungle Myna		
364	Jerdon's Leafbird		
365	Golden-fronted Leafbird		
366	Thick-billed Flowerpecker		



367	Pale-billed Flowerpecker		
368	Nilgiri Flowerpecker		
369	Purple-rumped Sunbird		
370	Crimson-backed Sunbird		
371	Purple Sunbird		
372	Long-billed Sunbird		
373	Little Spiderhunter		
374	Forest Wagtail		
375	Grey Wagtail		
376	Western Yellow Wagtail		
377	Citrine Wagtail		
378	White-browed Wagtail		
379	White Wagtail		
380	Richard's Pipit		
381	Paddyfield Pipit		
382	Blyth's Pipit		
383	Tawny Pipit		
384	Nilgiri Pipit		
385	Olive-backed Pipit		
386	Common Rosefinch		
387	Black-headed Bunting		
388	Red-headed Bunting		
389	Grey-necked Bunting		
390	House Sparrow		
391	Chestnut-shouldered Petronia		
392	Streaked Weaver		
393	Baya Weaver		
394	Red Avadavat		
395	Indian Silverbill		
396	White-rumped Munia		
397	Black-throated Munia		
398	Scaly-breasted Munia		
399	Tricolored Munia		
	Total	379	369

IMPACT OF FLOODS AT THATTEKAD BIRD SANCTUARY

As the Sanctuary is nested within the banks of the Periyar, it was affected by flood badly. The sanctuary was flooded and as a result, plastic waste, silt and sand got accumulated in much of the ponds, lake and marshy wetlands of the Sanctuary. Much of the damage done to the aquatic ecosystem was irreparable. Dr Sugathan R says that "A sandbed has appeared on a 5-km stretch from Thattekad to Kuttikal on the sides of Periyar river. This was the most preferred place for migratory water birds. The conversion of this marshy wetland to sand bed has drastically reduced the number of wetland birds to these areas. 32 species of water birds have been greatly affected by the changes brought out by the flood. In certain species of water birds like Whiskered tern only few numbers have been sighted in the current migratory season compared to previous years". Wetland birds prefers marshy wetlands as these are good source of polychaetes, earth worms, other invertebrate and lower vertebrates which are the much preferred food for most of the water birds. As these wetlands are converted to sand beds the food sources for water birds are depleted which reduces bird activity in these areas. It's noted that certain ponds within the sanctuary were completely covered by sand and silt, out of the 14 check dams 11 were completely destroyed by flood. Under these scenarios, it should be understood that in long run this would have an ecological imbalance of a bigger magnitude capable of bigger ecological destruction.

Table 27 List of Birds affected by flood in Thattekkad Bird Sanctuary.

Sl no.	Common Name
1	Little Grebe
2	Large cormorant
3	Indian cormorant
4	Little cormorant
5	Darter (oriental darter)
6	Grey Heron
7	Purple Heron
8	Little Green Heron
9	Pond Heron
10	Cattle Egret
11	Large Egret
12	Smaller Egret
13	Little Egret
14	Night Heron
15	Open bill stork
16	White necked stork
17	Pintail duck
18	Spot bill duck
19	Lesser pied king fisher
20	Common king fisher
21	Strok billed king fisher
22	White breasted king fisher
23	Chesnut bittern
24	Malaya or Tiger bittern
25	Yellow bittern
26	Black bittern

KARINGALIPUNCHA-HEAVEN OF BIRD IN PANDALAM

Karingalipuncha is a wetland in Muttar region of Pandalam Municipality area habitat for around 1200 birds belonging to 33 species. These wet lands were once paddy polders and later it became swampy and water logged area. It is a flood plain of Achenkovil river. Flood did not have much impact on the area however silt and sand and alluvial soil got extensively deposited and was polluted by solid and liquid wastes and the change of habitat might affect waterbirds.

At Alapuzha, birds were the least affected group by flood. Kuttanad kole lands were the centre of migratory birds. Local people say that there was no change in the number and diversity of any kind of bird species after flood.

At Palakkad severe reduction in avian population has been noticed by people during the post flood situation. Local people listed out 27 bird species which they sighted less after flood. This includes several species listed in IUCN as vulnerable, least concern. In areas adjacent to Malampuzha dam, Mangalam dam, Kanjirampuzha dam etc the population of birds has decreased.

ROOSTING OF BIRDS AFFECTED

In Thiruvegappuram, trees on river banks and paddy field boundaries were the roosting sites of large number of birds. After flood, a considerable reduction in the number of birds in these sites has been noticed by the local people. The survey conducted for quick assessment of impact of flood, it was found that there is considerable reduction in population of 15 species of birds after flood.

The Panamaram heronry is a small natural islet that covers approximately one acre formed in the area where small streams as Cherupuzha joins with the Panamaram river. Vegetation of the heronry is dominated by Bambusa spp, small trees and ground is covered with grass, weeds and bushes. A total of 9 species has been reported to breed in the heronry viz. Little Cormorant (Phalacrocorax niger), Little Egret (Egretta garzetta), Great Egret (Casmerodius albus), Intermediate Egret (Mesophoyx intermedia), Cattle Egret (Bubulcus ibis), Indian Pond Heron (Ardeola grayii), Black-Crowned Night Heron (Nycticorax nycticorax), Purple Heron (Ardea purpurea) and Near Threatened Black-headed Ibis (Threskiornis melanocephalus). More than 500 nests have been recorded from this area. In Panamaram, the breeding of the birds coincides with the onset of South West monsoon between the ends of May to October. The Panamaram river flood plain area as well as the nearby paddy fields is the major foraging areas of the heronry birds. Near the Panamaram heronry a check dam was constructed.

The survey suggests that even before the rains the river banks were eroding due to the unscientific construction of a check dam. And this problem was aggravated by the floods leading to soil erosion on the left side of bank. The eroded soil was deposited near the check dam leading to the diversion of the course of river.

Panamaram heronry is the largest traditional mixed-species heronry in Wayanad district and support the breeding of 9 species of birds. This heronry support the biggest single breeding population of Black-headed Ibis in the state. Locals report that a portion of the islet has collapsed and is washed off. The islet has become less wide and the small trees has dried up. The floods destroyed the habitat of the birds and destroyed the eggs and nest and killed the fledglings. One interesting observation by the local community is that the bamboo clumps survived. Worldwide it has been observed that Bamboo clumps can act as a natural buffer and prevent soil erosions due to floods.

FISH

In terms of faunal diversity Kabini river is identified as a Key Biodiversity Area by IUCN, with trigger species. Recently new species of fish has been identified from Kabini river which includes edible Pristolepis pentacantha (Aattuchemballi). This new species of fish is edible, tastes similar to Karimeen or the Pearl Spotted fish and could also be used as an ornamental fish. Scientists recently have discovered a new species of fish from a secluded stream draining into the Kabini river located between Periya and Boys Town. Barbodes carnaticus, Puntius wynaadensis, Labeo ariza, Labeo potail, Garra gotyla stenorhynchus, Balitora mysorensis, Nemacheilus semiarmatus, Mystus cavasius, M. punctatus, Clarias dussumieri, Glyptothorax madraspatanus are the endangered species of fish found in Kabini. Notoptems notptems, Hypselobarbus curmuca, Puntius conchonius, Esomus danricus, Bhavania australis, Channa striata, Lebistes reticulatus, Pristozepis marginata, Psuedambassis ranga are the vulnerable species found on Kabini. Puntius melanostigma, Amblypharyngodon mola are critically endangered. Due to its restricted distribution and severe population declines (up to 80%) in the last decade, Neolissochilus wynaadensis has been listed as 'Critically Endangered' in the IUCN Red List of Threatened Species. N. wynaadensis prefers fast flowing upland streams and rivers where they occur in both rocky pools as well as riffles.

A study conducted on the fish diversity of Vellayani Lake revealed 42 species (as listed below) of which 4 species were near threatened (Ompok bimaculatus, Wallago attu, Clarias dussumieri, Oreochromis mossambicus) and two were found to be Vulnerable (Hyporhamphus xanthopterus and Pseudosphromenus dayi). But for now the flood has not much harmed the fish diversity but the impact on ecosystem might affect their population in long run.

In Kallikkad, the River Neyyar flows through 5km stretch and it is severely affected due to flood and landslide. The river bank has been eroded around 1 km stretch. In most of the region, width of the river increased and depth decreased as the river bank eroded. About 1823 fish farms in Kallikkad were affected severely due to flood and fishes were lost/ escaped from such fish farms/ hatcheries which might have entered the Neyyar River. The local fishermen says that catch of African Mushi has increased in Neyyar River and associated canals which will badly affect the indigenous fishes.
Impact of flood on fresh water fishes and diversity

In addition that there are many private fish hatcheries and farms including Govt. Fish Seed Farm, Pannivelichira, Mallapuzhasseri GP in the flood affected GP's. These were badly affected with flood and exotic edible and ornamental fishes escaped and leached off from ponds and fish farms along with flood water. Local community says that now these species are abundantly found in all fresh water ecosystems in the region. This includes commercially valuable fishes such as Pearl spot, Catla-catla, Thilapia, GIFT, etc.

EXOTIC -ALIEN FISHES IN NATURAL ECOSYSTEM AFTER FLOOD

The catastrophic flood caused widespread release of several alien fish species grown in private farms into natural ecosystem such as rivers, ponds and wetlands posing a threat to the endemic aquatic

ecosystem and biodiversity. This includes predatory species such as Red bellied Piranha, African catfish, Gourami, Koi Carp etc. Local people say that they got catch of such species from Kuttoor and Eraviperoor GP's after flood.

INVASIVE/EXOTIC FISHES IN VEMBANAD AND ALLIED WET LANDS- ALAPUZHA

There are many private fish farms all over the Kuttanad region. Most of them were rearing exotic farm fishes such as Tilapia, Gourami, Mrigal, Carp etc. During flood all these ponds were flooded and exotic fishes leaked out to the natural ecosystem. Local fisher men say that they have good catch of such fishes after flood from all regions of Vembanad and allied lakes. They also say that these fishes may be a threat to the native fishes.

STATUS OF THE FISH ENCOUNTERED IN PERIYAR LAKE-STREAM SYSTEM- IDUKKI

The previous studies reports 54 species belonging to six orders and 19 families from Periyar. But the BMC report after the floods in Periyar, found far less species. It is to be noted that the monsoon is breeding period for fishes, though the flood may wash away certain high altitudinal species and may be that would have an impact on its diversity and density. But all those species that are relatively in midland would have very less direct impact. But since the monsoon coincides with the breeding period of fishes, the flood would have its impact on them. The erosion of river banks and the lack of vegetation could have an adverse effect on the fish fringes and fingerlings; they would be more exposed to predators with no vegetation to hide them. The lack of diversity in the current study may be not a direct reflection of the actual diversity present but largely because of lack of proper sampling strategies.

At Ernakulam A considerable reduction has been noticed in the availability of more than 15 fish species from water bodies after flood. On the contrary, Cat fish, Nutter fish Arowana, Gaurami, Sucker fish, Climbing perch, Mud fish, Carps, Mrigal, Giant snake head are found in more numbers. In Thattekkad Bird sanctuary, 52 fish species has been reported to be affected by flood. The presence of Red Belly, Tilapia, Rohu, and African cat fish are also found in several water bodies. Fisher folk expressed their concern about the presence of such banned carnivorous fishes in river ecosystems which may result in the wipe out of population of the native fishes. They are found in aquatic ecosystem of Chendamnagalam, Chittatukara, Vadakekkara, Cheranelloor, Kadamakudi.

Table 28 List of fishes affected by flood in Thattekkad bird sanctuary.

Anguilla bengalensis	Rasbora dandia
Anguilla bicolor	Tor khudree
Barilius canarensis	Osteobrama bakeri
Barilius gatensis	Barbodes sarana subnasutus
Salmophasia boopis	Hypselobarbus curmuca
Amblypharyngodon melettinus	Osteochilichthys longidorsalis
Gara stenorhynchus	Garra stenorhynchus
Puntius mahecola	Horabagrus annandalei
Puntius arulius	Heteropneustes fossilis
Puntius denisonii	Xenentodon cancila
Puntius dorsalis	Aplocheilus lineatus
Puntius fasciatus	Mastacembelus armatus
Puntius filamentosus	L.malabaricus
Puntius assimilis	Parambassis dayi
Puntius muvattupuzhensis	Parambassis thomassi
Puntius punctatus	Pristolepis marginata
Puntius vittatus	Etroplus maculatus
Garra surendranathanii	Oreochromis mossambicus
Bhavania australis	Glossogobius giuris
Mesonoemacheilus guentheri	Pseudosphromenus cupanus
Mesonoemacheilus triangularis	Channa gachua
Lepidocephalus thermalis	Channa marulius
Mystus ocutatus	Channa striata
Batasio travancoria	Tetraodon travancoricus
Ompok bimaculatus	Osteochilichthys longidorsalis

At Thrissur the local people reported that the fish availability in the area became scarce and fish diversity became poor. The flood affected the other river ecosystem like Karuvannoor, Araattupuzha, Manali and Kurumali river. The flood severely affected ten fish species in the chalakkudy river ecosystem.

At Palakkad local people noticed reduction in availability of fish species such as Catla, Paral, Varal, Kolan Kotti and Kadu after flood.

AMPHIBIANS

Amphibians are best known biological indicators. A considerable part of Kerala State is situated in high altitudes of Western Ghat which is a biodiversity hot spot. There is a high degree of Amphibians endemism in Western Ghats. The flooded months coincide with the breeding period of much of the amphibians of Kerala. Amphibians occupy variety of niches from different ground habitat to Grasses, Herbs, shrubs and tree tops. Amphibians lay eggs and the fertilisation is external. For the same reason there is a high chance that the flood has impacted the population of much of the amphibian species. *Indirana* genus is represented by forest floor frogs; these frogs are special to the fact that they lay their eggs on rock surfaces and the tadpole metamorphosis on vertical rock surfaces with thin film of water. There is a high chance that much of these tadpole and eggs may be washed down. As, much of the frogs can collapse with even minute change in temperature, the survival of such wash down is

negligible. The bush frogs would also been effected for the fact that they lay their eggs on trees and shrubs and in Rahacophorids that lay eggs on overhanging vegetation of streams, rivers and lakes has a higher chance of washed down by flash flood. Incomplete metamorphosis and weaker frog lets of bush frogs are highly vulnerable to the flood and natural calamities. The flooded stagnant water bodies and the deposit of sand and silt would changes the ecology of these water bodies, which reduce the food and aquatic vegetation, which are hiding space for tadpoles that survive in water, this would have caused high mortality rate in tadpole. It should be noted in such scenarios that amphibians are one of the most impacted when it comes to the impact on fauna.

In lower attitudes like Padiyoor the population of frogs like *Euphlyctis hexadactylus*, F*ejervarya rufescens, Hoplobatrachus tigerinus, Fejervarya brevipalmata, Rhacophorus malabaricus, Polypedates sp., Raorchestes sp* has shown considerable reduction.

REPTILES

Kerala part of Southern part of Western Ghats is home to many endemic species of reptiles, much of the endemic species are limited to few sq km2.The impact of reptiles require a long time study, as much of the species that are ground dwelling and flash floods and landslides would have made high alteration to their habitat and prey base. There could definitely have a larger impact on their population and species distribution. The sex determination and many other factors are dependent on temperature, hence understanding the impact of flood requires cautious studies concentrating on each species. Many of the species could have been washed down hill, which would have been a much less preferable habitat of this species.

Reptiles such as Skinks, Calotes, Monitor lizard, Oriental garden lizard were reduced in numbers after flood. Snakes were spotted more after flood. In the forest area of Malayattoor, near riversides, Pythons were seen. In the interior forest area of Mulankuzhi young ones of king cobra were sighted. New sightings in Pathanathitta after flood

Travancore Tortoise (Indotestudo travancorica): A rare species endemic to Western Ghats which is categorised as vulnerable by IUCN red list was washed along with flood water and found in midland regions of Pathanamthitta at Thiruvalla Muncipality area.

Monitor Lizard (Udumbu) -Varanus: Local people spotted large number of monitor lizards in Kuttoor and Thiruvalla region of Pathanamthitta. These are normally found in forest area. Local says that these were found only in small numbers before flood.

At Palakkad the population of many species of snakes such as Rat snake, Cobra, Viper, Green vine snake were found to be very less. Tree lizards, Skinks, Monitor lizards were also seen in less numbers after flood. However, people observed more numbers of Water snakes, South Indian rock agamas after flood. At Pathanamthitta many snakes were also displaced from the habitat. Local people say that after receding flood water, remains of dead snakes were found in flooded areas. At Kannur among reptiles flying lizard, Common Keeled Skink, Termite Hill Gecko and Bengal Monitor is disappearing due to reduction in their population size.

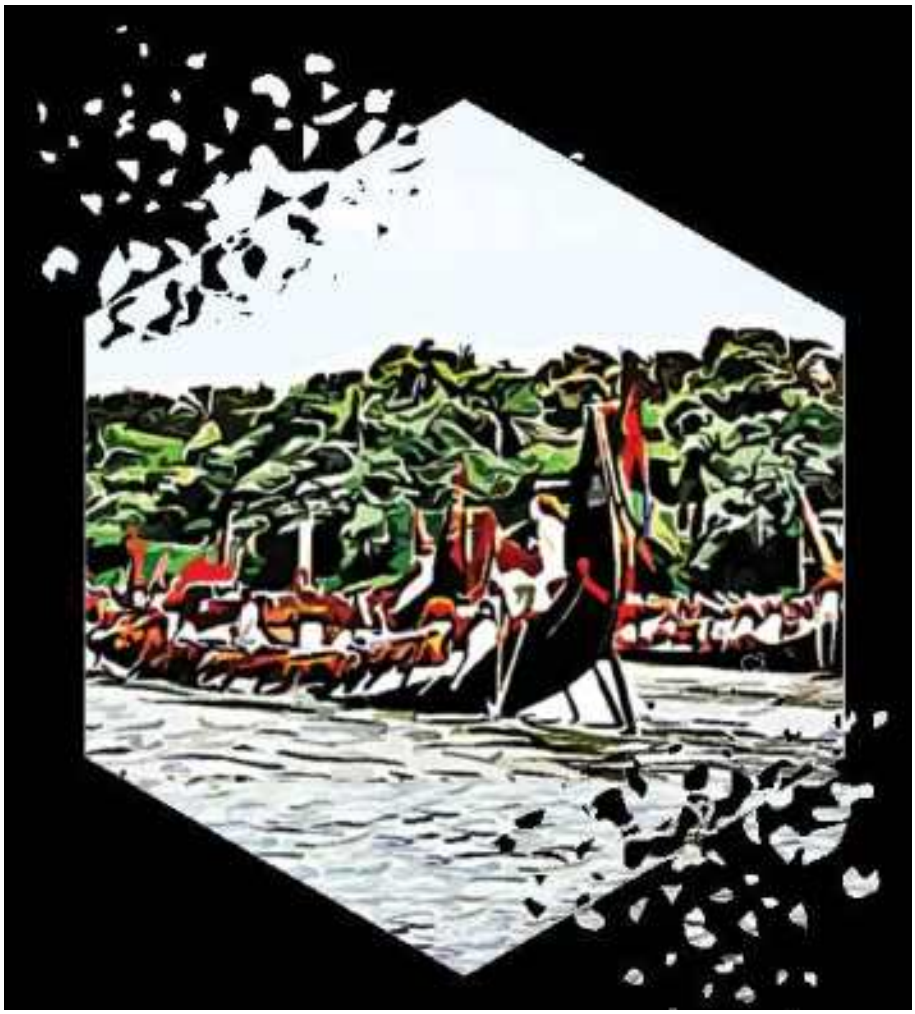
MAMMALS

The effect of flood on mammals have not much been noticed, except for the loss of domestic cattle, goats and dogs. Much of these have been drowned to death in flood. As for the wild mammals, there has not been a noticeable effect of flood in wildlife; this is largely because of the fact that much greater efforts and long term studies are required to study the impact of flood on them. The state as a whole has lost three elephants, one gaur and one tiger. The death of the tiger has been reported from Periyar Tiger Reserve in Idukki which is home to 35 to 40 tiger. It is also reported in Idukki that the movement or migration of elephants to certain part of Idukki has limited or stopped. The reasons for the same have not yet been identified.

DOMESTICATED ANIMALS

At Pathanamthitta Thousands of domesticated animals and birds including cow, sheep, dogs, cats, poultry (hen, duck) etc. lost their lives in flood in all flood affected GP's in Pathanamthitta. These include native breeds of cows, goat and ducks. Farmers say that after receding the water, bloated animal carcasses are seen all over the water bodies and farm yards. A total 40 goat died in flood. Among this 30 are Malabari native breed. A duck farm at Niranam was affected by floods, where Kuttanadan breeds such as Kakki, Chara and Chemballi were grown.

At Ernakulam Rabbits died during floods and people observed that there was reduction in number of Indian flying fox due to flood .The dogs which survived the flood were found to get infected with diseases, Bats were not much affected by floods and they survived. Indigenous cattle varieties such as Vechur cow, Vadakara Dwarf, Kasaragode dwarf, Malanad Jitha etc were taken away by flood water. Thalassery kozhi, naked neck, and local varieties of poultry died in large numbers due to flood. Population of 14 Mammals including Bats, Bandicoots, pigs, Palm civets were also reduced. Common Vampire bats and Pea fowls associated with Moshath Kavu in Kadambazhipuram were slightly affected by flood.



CHAPTER 6
CULTURAL HERITAGE

Kerala is a land of cultural heritage and across the state several artefacts, historically important areas, worshipping places and traditional crafts were impacted due to the floods.

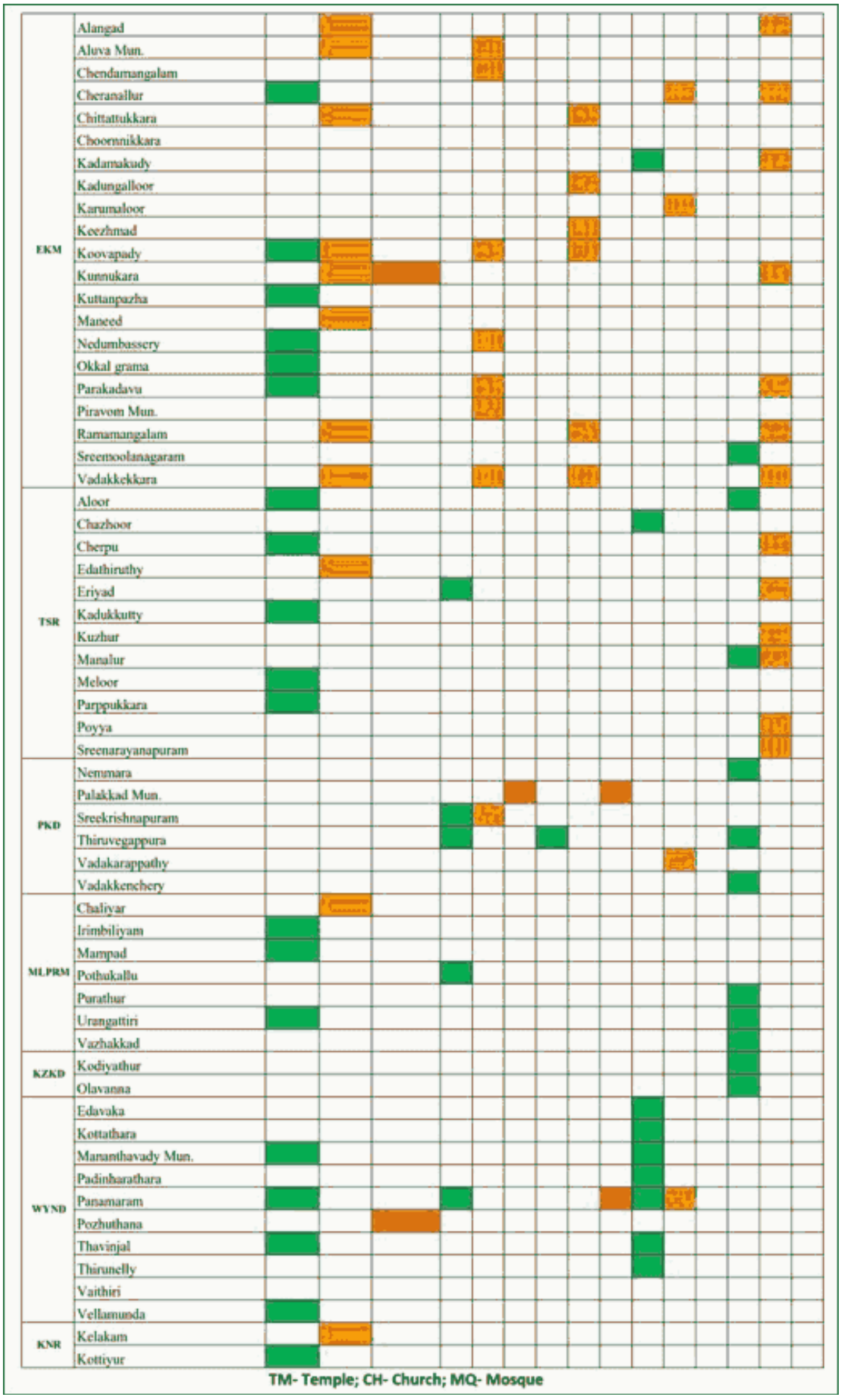
The encryption on the walls of Oottupura of the Puthiyakavu temple in Vadakkekkara shows that the rise in water level during 1924 floods were 10 inch less than 2018 floods. Local people says that in older days, houses had wooden roof tops (Thattu) where people sheltered themselves in times of need. During 1924 floods water reached upto these roof tops. The 1961 flood was comparatively of lesser extent, but people remember the scarcity of food they faced after flood. There were many people who completely depended on tuber crops such as tapioca for food.

Some famous practises being followed for centuries were postponed such as the the famous Boat race. Some museums and manuscripts were also damaged. The cancellation of rituals, festivities, due to the floods had a significant effect on the morale of the community involved.

Aranmula kannadi, Chendamangalam handloom weaving and Kuthupally saree weaving in Pathanamthitta, Ernakulam, and Thrissur districts respectively were the worst affected among traditional craft-forms.

Table 29 Impact of floods on Cultural Heritage

District	Gramapanchayat	Places of worship			Historic places			Cultural Heritage			GI			Traditional Fishery/Agricultu		
		M	S	VS	M	S	VS	M	S	VS	M	S	VS	M	S	VS
TVM	Kalliyoor Panchayat															
KLM	East kallada	TM														
PTA	Aranmula	TM/CH	TM													
	Ayiroor		TM													
	Cherukole	TM/CH/MC														
	Eraviperoor	TM/CH														
	Kadapra		TM/CH													
	Koipuram	TM/CH														
	Kozhencherry	TM														
	Kulanada															
	Kuttor		TM/CH/MC													
	Mallapuzhasserry	TM														
	Nedumpuram															
	Niranam	TM/CH														
	Pandalam Mun.															
	Peringara															
	Ranni Angadi	TM														
	Ranni	TM/CH														
	Ranni Pazhavangadi	TM/CH														
	Ranni Perunad	TM/CC														
	Thiruvalla Mun.															
	Thottappuzhasserry	TM/CH														
ALP	Ambalappuzha North	TM														
	Ambalappuzha South	TM														
	Budhanoor	TM														
	Champakulam	TM														
	Chengannur Mun.															
	Chennithala-Thripperunthura															
	Cheriyanad															
	Cheruthana	TM														
	Edathwa	CH														
	Kainakary															
	Karuvatta															
	Kavalam	TM														
	Mannar															
	Muhamma															
	Muttar	TM														
	Nedumudi	TM														
	Neelamperoor															
	Pandanad	TM														
	Pulinkkunnu															
	Puliyoor															
	Ramankary	TM														
	Thakazhy	TM,CH														
	Thalavady		TM													
	Thannermukkom	TM														
	Thiruvanvandoor															
	Veeyapuram	TM,CH,MC														
	Veliyanad	TM,CH														
Kktm	Arpookkara															
	Kootikkal															
	Kumarakam															
	Maravanthuruthu															
	Mulakkulam															
	Thiruvarppu															
	TV Puram															
	Udayanapuram															
	Vazhapally															
IDK	Adimali															
	Idukki-Kanjikuzhy															
	Kamakshi															
	Kanchiyar															
	Mariyapuram															
	Munnar															
	Rajakkad															
	Rajakumari															
	Vazhathope															


EKM
Alangad
Aluva Mun.
Chendamangalam
Cheranallur
Chittattukkara
Choornnikkara
Kadamakudy
Kadungalloor
Karumaloor
Keezhmad
Koovapady
Kunnukara
Kuttanpazha
Maneed
Nedumbassery
Okkal grama
Parakadavu
Piravom Mun.
Ramamangalam
Sreemoolanagaram
Vadakkekkara
TSR
Aloor
Chazhoor
Cherpu
Edathiruthy
Eriyad
Kadukkutty
Kuzhur
Manalur
Meloor
Parppukkara
Poyya
Sreenarayanapuram
PKD
Nemmara
Palakkad Mun.
Sreekrishnapuram
Thiruvegappura
Vadakarappathy
Vadakkenchery
MLPRM
Chaliyar
Irimbiliyam
Mampad
Pothukallu
Purathur
Urangattiri
Vazhakkad
KZKD
Kodiyathur
Olavanna
WYND
Edavaka
Kottathara
Mananthavady Mun.
Padinharathara
Panamaram
Pozhuthana
Thavinjal
Thirunelly
Vaithiri
Vellamunda
KNR
Kelakam
Kottiyur
TM- Temple; CH- Church; MQ- Mosque

6.1. IMPACT ON/OR LOSS OF CULTURAL HERITAGE

Snake boat- 'Palliyodam'

Aranmula is famous for snake boat race held during Onam festival of Parthasarathy temple. 'Vallasadya' a traditional ritual feast is conducted at the temple during this time. For this people from nearby areas come by large boats called 'Thiruvonathoni' (snake boat) made with the wood of Ayaniplavu (Artocarpus hirsutus)). These are known as 'Palliyodam'. Of the 51 snake boats, 30 have been damaged, among which two are almost completely destroyed. Flood affected these boats; some of them were washed away for a long distance and was damaged. Two boats or 'Palliyodam' which was severely damaged in flood are Thekkemuri Palliyodam and Kizhakkemuri Palliyodam, both from Mallapuzhasseri GP. Around 10 Palliyodams (snake boat) are there in Chengannur and Thiruvanvandoor gramapanchayats which are nearer to this temple. Flood severely affected these regions and caused severe damages to all these Palliyodams. At Pandanad 10 Snake boats were damaged

ARCHAEOLOGICAL SPECIMENS OF 10-15TH CENTURY DISCOVERED AFTER FLOOD AT ARANMULA

Just after flood in Pamba in Aranmula, large number of archaeological specimens was excavated from Edayaranmula-Anjilummood river basin. It is estimated that these were made between 10-15th century. Archaeologists says this is an evidence of the presence an ancient civilization that has flourished in Pamba valley.

'ARANMULA KANNADI'- HERITAGE OF KERALA (ARANMULA MIRROR)

Aranmula Kannadi, which has received Geographical Indication (GI) tag is a special kind of handmade mirror formulated by polishing bell metal plate until it shines (metal mirror). This is made by mixing lead and copper in a particular ratio. Members of 7 families with traditional skilled artisanship were engaged in the manufacture of this mirror and they keep the manufacturing procedure a secret. About 25 such craft-centre units have been destroyed in this district due to the flooding. The existing moulds and the raw material for making moulds to cast the mirrors were severely damaged and have become unusable.

A special kind of clayey soil collected from wetlands of Pamba-Aranmula river basin is used in making the mould for metal mirror. During flood all these wet lands were extensively deposited with alluvial and muddy soil. Now this community faces the non availability of this special kind of soil and that affected the production of Aranmula Kannadi and their livelihood. In addition to that large number of products and related raw materials were washed away in the flood.

Handlooms: Chendamangalam is known for their GI certified handloom products. The cluster consists of five societies with more than 600 weavers. The floods in Kerala have destroyed all their looms, yarns and raw material. They have lost finished textile products, traditional weaving instruments and a huge stock of thread and dye units in the deluge This cluster, which has been awarded the prestigious GI tag, is now trying very hard to resurrect itself back to life. Groups of students at Cochin Univ and other philanthrophists washed these clothes , disinfected them and used them to make Chekutti dolls and cloth bags. A symbol of rejuvenation.

ALEPPEY COIR - GEOGRAPHICAL INDEX

Alleppey is famous throughout the world for its production of coir and coir products had received Geographical Indication status "Alleppey Coir" in 2007. The easy availability of raw materials and existence of backwaters and canals suitable for the retting of green husk and accessibility of transportation are the main factors for the development of this industry. Traditional uses of the coir fiber include rope and twine, brooms and brushes, doormats, rugs, mattresses and other upholstery, often in the form of rubberized coir pads.

There are two varieties of coir Brown coir and White coir. Brown coir is harvested from fully ripened coconuts. It is thick, strong and has high abrasion resistance. It is typically used in mats, brushes and sacking. White coir fibres are harvested from the coconuts before they are ripe. These fibres are white or light brown in color and are smoother and finer, but also weaker. They are generally spun to make yarn that is used in mats or rope. Some of the cottage industrial centres near Vembanad lake were submerged in flood water and machineries and coir products were damaged and lost.

Production Units of Alappuzha Coir has been severely affected in 14 wards of Maravanthuruthu, Kottayam. About 85 quintal coir has been lost from individuals and societies.

CHEKKUTTY DOLLS: SYMBOL OF SURVIVAL AND HOPE (CHENDAMANGALAM HANDLOOM)

Chekkutty , a tiny handmade doll made out of soiled and damaged fabric has become a symbol of survival and hope for a group of weavers, whose dreams and livelihood were washed away by the floods last month in Kerala. Demands are now pouring in from across the globe for these dolls. weavers

SHRAMAM: AN ATTEMPT OF COMPASSION

Shramam is a student initiative from Cochin University of Science and Technology working for Women Empowerment (Exhibition and sales of cloth bags made by women clusters of flood-ravaged Chendamangalam.

6.2. IMPACT OF FLOODS ON HISTORICAL PLACES

Monuments of Poykayil Kumara Gurudevan at Eraviperoor; monuments erected for the memorial of arrival of Thoma Sleeha on AD 52 at Niranamon; monument of Kannassa poets at Niranam are the historical places severely affected with flood.

The Advaitashramama at Aluva was flooded. The Kuttamassery yuvajana vayanasala in Keezhmadu Gramapanchayath which has found a place in history for the visit of Prime Minister Pandit Jawahar lal Nehru along with his family was completely submerged in flood water, and old and valuable books were irrecoverably lost.

At Ernakulam historically important Paliyam kovilakam was badly affected. 30 old palm leaf manuscript describing plants used in Ayurveda was damaged. Ancient Palm leaf engravings on Tantra, Manthra and medicine which were more than 200 years old preserved in Palakkappally Anandamana in Ramamangalam Panchayath were irrecoverably lost.

6.3. IMPACT OF FLOOD ON CULTURAL CENTRES

Pathanamthitta district is known as the 'Pilgrim Capital of Kerala'. Rain and flood badly affected the temples and heritage of Pathanamthitta. Incessant rain and flood affected 82 worshiping places including many temples, churches and mosques in all 25 flood affected GP's of Pathanamthitta.
Maramon Convention and Chrukolpuzha Hindu religious meet

Asia's largest Christian meet and World's largest Hindu meet were held at sandy shores of Pamba river at Maramon and Chrukolpuzha respectively. During flood these areas were extensively deposited with mud and alluvial soil and submerged for longer periods. Flood affected the functioning these religious conventions very badly.

HERITAGE CENTRE - ARANMULA

Aranmula- Parthasaradhy temple is one of the important heritage centre in Kerala.It is located in the left bank of Holy river Pamba, in Mallapuzhasseri GP. Inflow of water from river Pamba caused flooding in temple and surrounded area. 15 out of 18 steps of the temple were submerged with flood water and mild damages occurred in temple walls.

Flood caused mild somewhere with severe damages to the temples and churches in flood affected regions of Alappuzha. Many of them submerged for many days with flood water. The mud and silt carried by the flood water deposited on these places and artworks, carvings, paintings etc were damaged.

In Wayanad Floods have also impacted man made cultural heritage centres as Kurichyar mala mosque and sixth mile muslim mosque in Pozhuthana both of which has been badly damaged. In Thavinjal panchayat the old St John C SI church was partially damaged when huge quantities of soil fell on the church. The nearby hill side was levelled for construction purposes from top using machines and this has led to the soil erosion and resulted in damage to this old church.

At Alangad , Ernakulam in Thiruvalloor Siva Temple the age old mural paintings were damaged and the colors are fading.

The ritualistically important Siva peedham in the temple which was a part of Pazhoor Balippura was broken and got covered by sand.

The Jew Synagogue and the remains of the Vypeekotta Seminary built by the Portuguese and preserved as a historic monument were damaged.

In Chendamangalam, cracks were formed in the wall having ancient scripts of the local language "vattezhuthu.

6.4. IMPACT OF FLOODS ON TRADITIONAL FISHING GEARS AND AGRICULTURAL IMPLEMENTS

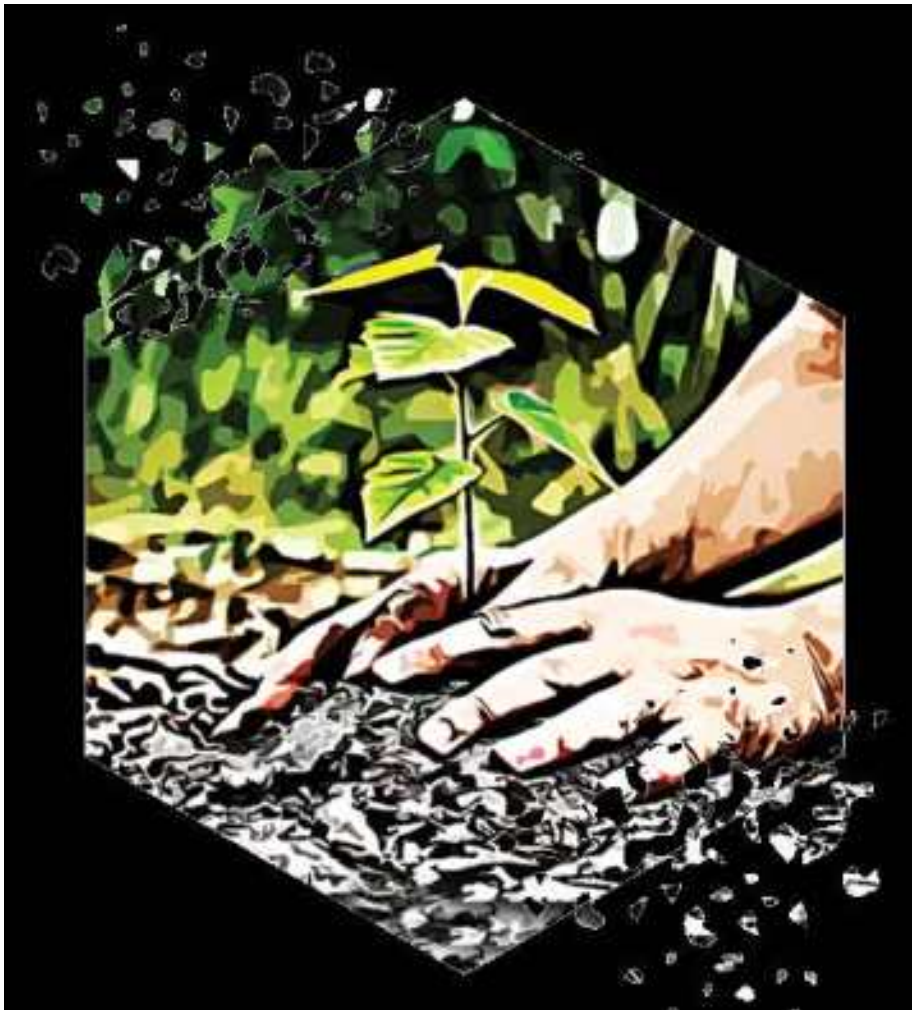
In Ernakulam the fishing community is facing the brunts of the calamity and are in the path of survival. The Traditional Agricultural implements such as thoomba, mazhu and fishing equipments such as Chinese fishing nets (Cheena vala), Meen kettu, Vanchi, Choondavala, oonni vala, neettuvala, ottal were completely lost in Alangad, Kadamakkudi, Sreemoolanagaram, , Vadakkekkara, Ramamangalam, Parakkadavu, Cheranallur, and Kunnukara panchayaths.

LOSS OF TRADITIONAL FISHING AND AGRICULTURAL IMPLEMENTS

Traditional fishing equipments such as Udakkuvala, Thettal, Veesuvala, Perum koodu, Ottal, Choonda, Vallam, Vala, Muppalli etc were extensively damaged and lost in flood in Thakazhi, Kainagiri, Chambakulam at Alapuzha etc.

In Kuttanad area farming below sea level farming system after monsoon season paddy fields water was pumping out to nearby lake or pond by mechanical methods. Earlier times this was done with giant water wheels but nowdays water is pumped out generally into the surrounded lake or the canals made outside with special pump called petti and para, driven by oil engines or electric motors in each padasekharam. Flood water has damaged these machines widely all over the Lower Kuttanad region such as Ramankari, Kainakari, Champakulam and Nedumudi.

At Thrissur Traditional fishing implements such as Koodu, Vanchivala , Cheenavala, Petti, Para, Kuruthi, Ottal were lost in Aloor, Kuzhoor, Manaloor, Cherupu,. Poya, Sreenarayana puram etc and this affected the livelihood of fishermen.



CHAPTER 7

BIODIVERSITY FOR CLIMATE RESILIENT NAVAKERALAM

Major recommendations for Biodiversity Conservation for Climate Resilient NavaKeralam based on quick community based assessment

Biological diversity is the basis for life itself and plays an important role in providing ecosystem services such as clean water, clean air as well as services such as pollination, regulation of pests and diseases etc. Biodiversity and ecosystem services contribute directly to human well-being and development priorities. Biodiversity is the critical foundation for sustainable development and human well-being by providing natural resources including food, fiber, fuel, and medicinal plants. Ecosystem resilience to climate change depends on biodiversity. But unfortunately as the impact of biodiversity loss is long term and is not usually noticed or felt in normal conditions on day to day basis remedial measures and fund allocation for it are often not considered while formulating sectoral plans.

Kerala provides a geographical and ecologically circumscribed but complex mosaic of land where the development-environment link is getting neglected and disrupted. The environmental systems here are very fragile because of the inherent nature of geography, climatic conditions and ecological characteristics. The geographic settings of the state are much different from other states and the life line of the state is the rivers. The complex interconnections between forests in the mountains, rivers and the ocean maintain the dynamism of life in the state, besides providing long term assets for sustainable development. The natural inclination of the land towards the sea and lesser average width of state compared to other states of India demands careful land use planning, especially along the 44 river basins of Kerala. Further the population density of the state is also more along the coastal plains and along the river basins. Watersheds and floodplains of rivers are therefore of particularly strategic importance for the state.

Over the years the state has lost much of its green cover due to changes in land use patterns, building and road construction in the hills and unsustainable tourism practices harmful to the state's ecosystem and biodiversity. The recent episode of flood has demonstrated that scientific management of its lands and waterbodies in general and hilly areas and rivers and its flood plains in particular, are highly relevant from the sustainable developmental perspectives, through the process of rebuilding Kerala- Navakeralam. While envisaging the whole process of rebuilding Kerala, an ecosystem approach is therefore all the more important, with a stronger focus on healthy rivers and richer biodiversity.

Sustainable consumption and Production

As Mr Braulio, Executive secretary to Convention on Biological Diversity, the UN multilateral treaty to which India is a party explains "With the fight against biodiversity loss, we invest in people, their lives and their wellbeing."NITI Aayog's comprehensive national strategy for Sustainable development also states that biodiversity conservation and maintenance of healthy habitats for wild life have to be aligned with sustainability goals. In the light of this the focus of Rebuild Kerala should be to promote Sustainable consumption and production. The Environment White Paper approved by the State Government is committed to design an environment friendly economic system for clean water, soil, air and biodiversity and to formulate Action Plans and implement them with people's participation.

Ministry of Environment and Forests along with National Biodiversity Authority (NBA) has developed 12 National Biodiversity Targets and Action Plan (NBAP) for India to be achieved by 2010. Besides these targets, all the Sate Government departments are involved in achieving United Nations Sustainable Development Goals (SDGs) set for 2030;

some of which are similar to National Biodiversity targets. Due to these international and national commitments through SDGs and NBTs which are to be achieved by various departments of Government, there is an urgent need for the state to have Kerala specific land use policy and develop necessary institutions to achieve the above mandates/goals to prevent occurrence of large scale calamities in future. The Kerala State Biodiversity Board (KSBB) is a statutory advisory body of Government of Kerala with the primary mandate of conservation of biodiversity, sustainable use, and equitable sharing of the benefits arising out of utilization of biological resources. Biodiversity conservation requires cross sectoral strategies to protect biodiversity and KSBB has identified 28 organizations including Departments of State Governments such as Fisheries, Forests, Agriculture, Livestock and Animal Husbandry, Mining, Education, Local-level institutions etc directly or indirectly implementing schemes with positive or negative impacts on biodiversity.

Major Recommendations of Quick Assessment Survey

After the recent floods, the Government of Kerala, especially Hon'ble Chief Minister, proposed to conduct a community based quick assessment study by Kerala State Biodiversity Board (KSBB) on the impact of flood on the biodiversity of the state. Accordingly KSBB with the help of 187 BMCs carried out a quick assessment of impact of flood in 13 districts of Kerala. Meanwhile, an international team consisting of United Nations Organization and European Union had also conducted a study on the impact of flood and suggested four pronged strategy for post flood rebuilding Kerala programme under Resilient Kerala initiative of Navakerala Mission. These four pronged strategies also called pillers are:

Pillar 1: Integrated water resources management (IWRM)

Pillar 2: Eco-sensitive and risk-informed approaches to land use and settlements

Pillar 3: Inclusive and people centred approach

Pillar 4: Knowledge, innovation, and technology

The recommendations made to the State Government by Kerala State Biodiversity Board are therefore aligned with the above mentioned four pillars. The major recommendations are:

1. Institutional structure for cross sectoral strategies to conserve biodiversity

1. Constitute a **State level Steering Committee of Biodiversity** with Chief Secretary as Chairman and Secretaries of all associated departments as members to provide guidelines and coordination for holistic integration of functioning of all related departments and statutory bodies/ Authorities constituted under various related Central and State Acts and Rules to achieve SDGs and NBTs.
2. Designate **District level Forest officers** for implementing Biodiversity Act 2002 especially for implementing regulatory functions.
3. Constitution of an **Integrated River and Lake Management Authority** to manage holistically the River Basin and Lakes with community participation considering the entire basin as a single ecological unit. Implementation of a basin-wide master plan linking all LSG in upstream, and downstream zones within next 6 months.
4. Development of a network of trained officials " The Virtual Biodiversity Cadre" by identifying two officials, **who have knowledge to deal with biodiversity and environ-**

ment in each of the 28 biodiversity related line department/ institution for developing concerned departments policies and schemes in consonance with biodiversity conservation.

2. Policy Initiatives and policy reforms recommended

1. KSBB had proposed a draft Land use policy during 2010 including associated policy like organic policy with emphasis on land use for clean environment, water, soil and food which may be modified by Land use board and adopted as an overarching policy for all type of land use in the state.

2. Presently Kerala State Action Plan on Climate Change does not ensure consideration of Biodiversity conservation aspects in the Action plan of different sectors. It must be ensured that action plan of all sectors incorporates Biodiversity conservation in their sectoral schemes.

3. Organic Kerala Mission to be included as part of Nava Keralam to implement the Organic farming policy, strategy and action plan to maintain diversity of beneficial insects and soil health. Presently Agriculture development policy 2015 does not provide much incentive for the conservation and sustainable use of indigenous varieties as well as its marketing. It is strongly recommended that

    a. The farmers should be encouraged through incentives and other means for producing indigenous varieties of different crops.

    b. The existing market channels like Haritha market as well as new market avenues need to be developed for procuring the indigenous varieties at appropriate rates for providing farmers ready market without delay as their shelf life may be limited.

4. Stringent implementation of the Kerala Conservation of Paddy Land and Wetland Act, 2008 and amendments, to ensure that Paddy lands are conserved and managed as wetlands for ground water recharge and biodiversity conservation.
5. MOEF has identified 18 areas as Important Coastal and Marine Biodiversity Areas in Kerala. So far in Kerala only one site Kadalundi- Vallikkunu is declared as Community reserve. It is recommended that conservation of important coastal and marine biodiversity areas as Community-Based Marine Protected sites may be taken up.
6. Presence of exotic species like Red bellied pacu, Arapima and Alligator gar in the catch after the floods shows the need for strict implementation of the existing policies to control and monitor exotic species and aquarium flora. Implementation of the Kerala Inland Fisheries and Aquaculture Act, in order to prevent farming of banned exotic species
7. Appropriate policy for strict quarantine and biosecurity measures for any exotic species brought to the state may be developed. It is recommended to develop state database on Aquatic Invasive Alien species and quarantine and management strategies for control the spread of IAS.
8. Regulate or prohibit the use of fishing crafts and gear, which are deemed as destructive to biodiversity. Bycatch reduction methods should be made mandatory to reduce the catch of non-targeted species.
9. Expanding the scope of Minimum Legal size for commercially exploited marine bio resources.

10. Strict regulation of tourist boats in backwaters based on carrying capacity studies and strict regulations for waste management by tourism department.
11. For people centred approach to biodiversity conservation, biodiversity rich areas outside protected areas may be identified and notified as Biodiversity Heritage Sites (BHSs)
12. Notification of species on verge of extinction under Section 38 of Biodiversity Act and a stronger focus on point endemics (species limited to a single locality).

3. Financing biodiversity conservation

1. It is recommended that Local Self Government Department must make certain fixed percentage allocation out of Panchayat plan fund for Biodiversity and Environment conservation.
2. The River Management Fund accrued through sand mining revenue to be used mainly for eco-restoration of the river and river banks instead of utilizing it for construction purposes
3. A fixed amount of sectoral schemes of Agriculture and allied sectors to be utilized for conservation of biodiversity, native varieties and breeds etc.
4. The possibilities for international funding for climate resilience, including REDD plus, green climate fund and funding of GEF may be better explored.

4. Recovery and Resilience strategies

4. 1. Aquatic ecosystem (Integrated water resource management)

The major recovery needs identified in the action plan proposed by majority of BMCs are

(1) restoring natural river ecosystems and riparian vegetation along the banks,

(2) protecting river banks from soil erosion

(3) land use planning especially in hill slopes, wetlands, flood plains

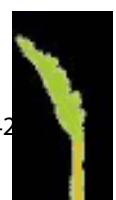
(3) disposing of silt, sand and debris deposited due to the floods and landslides

4) Species recovery programmes by suitably augmenting native species

Restoring natural river ecosystems

1. The River banks of Pampa, Periyar, Kabani, Bharatapuzha, Chalakudy and Manimala faced bank erosion and siltation following floods and landslides. To build resilience of the ecosystem it is necessary to support the restoration of degraded river banks and buffer zones. River Basin level plans should be prepared through participatory process in a priority basis at areas affected severely and implemented in a phased manner with suitable watershed measures, eco – restoration of catchments and water recharging.

The study demonstrates the role of riparian vegetation in preventing river bank erosion and hence massive eco-restoration programmes in the catchments of rivers and lakes through conservation of riparian vegetation and planting of suitable species is recommended. Riparian management should be taken up by BMCs, through a Green army comprising of LSGs, VSS, and local NGOs.



2. Upstream river basin management with a focus on the conservation of forests, downstream management in the mid and lowlands with sustainable Agricultural practices with a focus on multi-cropping and integrated farming has to be developed. This should be integrated with a coastal zone management with afforestation by mangroves and creation of a green buffer zone in the coastal zone.

3. A massive **Kerala State Wetland Restoration Programme** may be launched, which include cleaning up of rivers, ponds and lakes with full participation of people. Removal of sand deposited in rivers and river banks should be undertaken only after holistic studies throughout the river basin with regard to its impact on Biodiversity and its cascading affects downstream is undertaken.

4. Coastal Bioshield belt with community participation.

Sea walls have been constructed in as much as 310 km of coast (53% of coast) resulting in Artificial coast. These artificial coasts are eroding coasts. The overall erosion characteristics of Kerala is 63.02 % (Sum of high + medium + low + artificial). Vegetative and mangrove afforestation with community participation must be taken up at sites requiring eco restoration

Land use planning

1. A large variety of freshwater fish regularly migrates as a group, swimming against the flow in rivers, and enters the flooded fields mainly to breed. The monsoon flood cycle and the seasonal inundation of floodplains of rivers are critical factors determining the survival of many species of freshwater fishes. This life cycle of aquatic species has been affected by the large scale conversion of wetlands and encroachments into flood plains which should be regulated.
2. A Kerala State Wetland Register may be prepared for each Panchayath under the leadership of the Biodiversity Management Committee and put in public domain. Wetlands in the State may be prioritized on the basis of their biodiversity, economic and cultural values for long-term conservation.

4.2 Non forest terrestrial landscapes (Inclusive and People centered approach)

The survey suggests that landslides have occurred in areas not identified as landslide prone also, some of the landslides occurred on the fringes of forests and other hill slopes subjected to human interventions, construction activities and check dams etc. Quarrying in some areas was also suggested as one of the reasons for landslides. Landslides in the Kurichiar Mala in Wayanad is one of the most affected areas.

The widespread flooding in urban and semi-urban areas of Kerala has reaffirmed the importance of urban planning. Cities in many cases harbour great biodiversity, managed and maintained by citizens. In Kerala many areas are conserved in rural and urban areas as Sacred groves most of which has withstood the floods.

Slope stabilization in Hilly areas

1. For landslide prevention on slopes a comprehensive assessment of the region, identification of the type of plants suited for sloping areas, and planting the right mix of native species is necessary, which can be taken up by LSGs/ BMCs.
2. Sustainable groundwater management plan based on groundwater potential and estimated rate of land subsidence of different areas, to minimise the adverse environmental impacts of groundwater development.

Urban landscapes

Promotion of ex situ conservation of RET/ endemic species in rural and urban public places and wastelands

Development of sustainable cities by promoting urban green areas, vertical gardens etc through residents association.

Agro ecosystems

The floods and landslides have resulted in widespread loss of local landraces of crops as Paddy, Pepper, Colocassia, Cassava, Banana etc. It has also affected the farms of custodian farmers in Wayanad, Kannur, Idukki etc. More importantly the major impact on Agroecosystem is the impact on soil, loss of soil fertility, spread of invasive weeds. etc .

The present survey suggests that the major recovery needs will be that since the floods occurred while the paddy fields were kept ready for sowing most of the top soil was washed off and sand was deposited. Topsoil erosion caused due to rains and deposition of silt/sand in paddy fields, has resulted in changes to its physical and chemical properties, water logging, and anaerobic conditions. All the surviving plants show symptoms of nutrient deficiency. It is widely reported that, after the flood, earth worms died in large numbers in various areas of Idukki district. Also due to the heavy soil erosion the farm lands lost its water absorption capacity. There is very low moisture retention in the soil, which is reflected in wilting of the plants during sunny days soon after the floods along with drastic lowering of water levels in wells. The damage to the soil structure, loss of soil fertility, loss of soil dwelling organisms as earthworms, advent of crop diseases, and the proliferation of weeds can have long term effects.

Hence in Agricultural sector the major short term and medium term recovery needs to be taken up by Agriculture department includes restoration of agricultural land through leveling / desilting / reclamation. Land restoration measures need to be supplemented by nutrients and soil ameliorants to counter increase in soil acidity due to washing away of topsoil.

Resilience Building needs.

In addition to these short term measures the resilience of the sector needs to be build up in the long term. The major resilience building needs should be oriented to meet the Aichi Biodiversity Targets and National Biodiversity Targets. Aichi Biodiversity Target 13 and Sustainable Development Goal 2 lays down that by 2020, the genetic diversity of cultivated plants and (farmed and domesticated animals) of wild relatives is maintained, and strategies have been developed and implemented for minimizing genetic erosion and safeguarding their genetic diversity. The development of a strategic approach to integrate adaptation to climate change into agriculture through maintenance of Agro bio-diversity is necessary.

The following long term resilience building needs for Mainstreaming biodiversity for Sustainable Agriculture are recommended in Agriculture and allied sector :

1. **The present study points out the continuous loss of diversity of Agricultural crops earlier used by farmers as also the local flood tolerant landraces grown in Pokkali and Kole fields. Kerala has been delineated into 23 agro-climatic zones based on agro ecological conditions including soil, climate, terrain and water. In view of this it is recommended that an Agro ecological approach to the agricultural sector with climate-resilient locally adapted cropping pattern is to be adopted as also suggested by Planning Commission.**

2. Ensure seed sovereignty of the farmers by ensuring supply of locally suitable seeds in each agro-climatic zone. The seeds of many local landraces and farmers varieties are no longer available. Hence BMCs should take up identification of custodian famers and creating a network of traditional farmers which will enable ensuring supply of cultivars. BMCs can also support Community seed bank in each Agro climatic zone for ensuring seed supply.

> Community gene banks has been successfully promoted by FAO in Andhra Pradesh where drought resistant crops such as millets, sorghum, beans, bajra, jowar, cowpea, grams, cereals and other local varieties were collected, especially traditional ones, and stored at village level. This has enabled to restore marginal lands to cultivation and minimize the risk of total failure in case of disease and to prevent malnutrition in rural areas. Such concepts can be introduced by BMC throughout the state, to begin with initially in Tribal areas of Attapady and Wayanad to conserve the genetic diversity of crops and their wild relatives and also to address the problems of malnutrition due to limited food basket in tribal area.

3. **Ex situ conservation of indigenous varieties in Diversity blocks:**

   Ex situ conservation of Agricultural diversity in each district by establishing Agro diversity gardens or diversity blocks will serve to conserve the genetic diversity of crops and create awareness and showcase the rich diversity of food crops for future generations. Such diversity blocks can be maintained by LSG/BMC with active participation of custodian farmers.

> One such successful initiative is The Rice Diversity Block at Panavelly Wayanad maintained by Thanal Agro Ecology Centre as part of the Save our Rice Campaign. Indigenous Rice Diversity Blocks are fields that maintain the various varieties of paddy across years, either as a collective effort. It conserve 219 indigenous varieties of paddy and is visited by hundreds of farmers and scientists, it has become an inspiration for farmers to conserve indigenous varieties of seeds. The Save our Rice campaign has facilitated the maintenance of many RDBs across six states – Kerala, Tamil Nadu, Karnataka, West Bengal, Chattisgarh and Jharkhand. Together, these RDBs conserve more than 1,000 indigenous varieties, which over 30,000 farmers have adopted. Many of these varieties also compete well with the HYVs, show a better resistance to pests and diseases, stress tolerance properties and are adapted to local climatic conditions

4. **Integrated home garden development** The homesteads of Kerala were often explained as centers of tropical biodiversity similar to tropical forest ecosystem and one of the most productive unit of land. The BMC can facilitate development of linkages with custodian farmers and promote model homesteads in each Panchayat.

   It has been proven that native breeds of cattle like the Vechur, High range Dwarf and Kasaragod Dwarf, goat breeds like Malabari and Attapadi Black, Chicken breeds like Naked neck and Thalasseri, Duck breeds like Chara and Chempalli can better with-

stand heat and water scarcity compared to exotic breeds. Further, these native breeds require less feed and management and are more resistant to diseases. Increased farm productivity by integrated and sustainable use of local crop and livestock diversity with attention to under-utilized crops and breeds should be promoted.

A major impact of the floods and landslides has been the loss of soil biota and pollinators. To sustain these life sustaining elements, BMCs along with Haritha Keralam mission and other local level organization should take up programmes of organic agricultural practises to spearhead an organic revolution in Kerala.

5. Capacity building and Awareness

i. Capacity building of the working group on Biodiversity, Environment, Climate change and Disaster management to perform Environmental auditing of all developmental schemes being implemented at local level

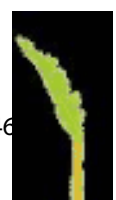
ii. Capacity building for strengthening BMCs for formulation of Local Action Plan for Biodiversity and their implementation and monitoring at panchayat level.

iii. Capacity building of MNREGS for clearing exotic/ invasive species

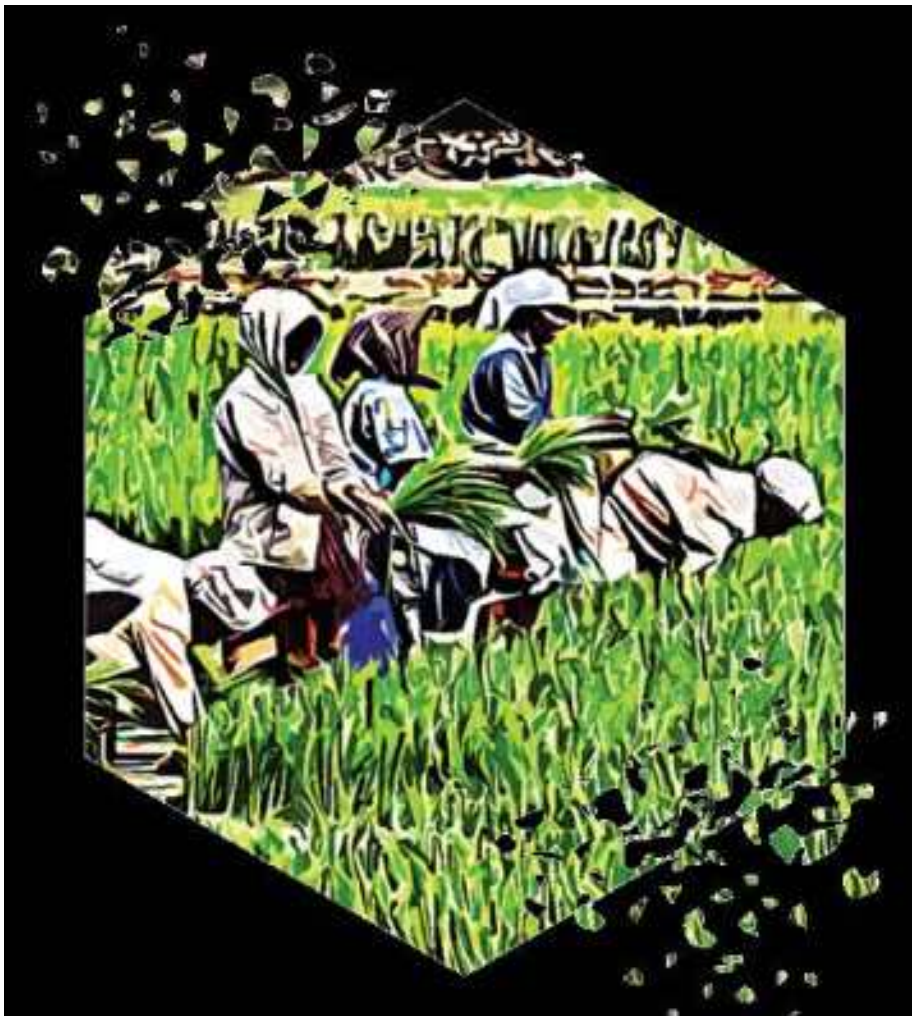
6. Knowledge, Technology and Research studies

The following Knowledge gaps have to be addressed to Mainstream Biodiversity in Governance.

1. Mapping of flood prone areas along the river banks and develop strategies to prevent hazards due to flooding.
2. Develop a database of Agro biodiversity based on Agro ecological zones- This database will be the basis for genetic resource to be used for hybrization programmes and will serve as the base document for planning for agriculture at LSG level
3. Studies on the trade off due to conversion of monoculture plantations to mixed species planted forest.
4. Develop database of traded bioresources including both terrestrial and aquatic bioresources, volume of extraction, estimation of sustainable yield and develop sustainable harvesting protocols for priority species
5. After Cyclonic Okhi, 400 kg of ghost nets were collected from two different locations in the Vizhinjam seabed in just 90 minutes. Ghost nets usually traps and kill marine species. Biodegradable nets can be explored to avoid ghost fishing and it also minimizes the pollution of plastics in the coastal/marine environment.
6. A database on the pet traders to be maintained and illegal trade to be regulated.The species enlisted as Endangered, Critically Endangered, Near Threatened should be excluded from trading.
7. Pollution in Vembanad and other backwater due to tourism much beyond the carrying capacity affects the biodiversity. Introduction of green technologies for powering Tourist boats by non-conventional energy and fitted with green toilets.
8. Status Report of the Biodiversity of Kerala should be brought out periodically by consolidating the information from various sources



9. Since fresh water resources are one of the most degraded, a Status of Environment Report for Rivers of Kerala is to be brought out. KSBB had conducted a Riverine monitoring program during 2010 through participatory process. It is proposed that regular financial support for monitoring of biodiversity of wetlands should be allocated.
10. Regular monitoring of Rare, Endangered and Threatened (RET) species and critical habitats, coastal marine habitat lost (mangroves, sand dunes, mud-flats, etc.) assessing their status and range of distribution and, identifying potential habitats for protection. Red data book for Kerala to be developed. Periodic assessment and distribution maps of threatened and endemic species of threatened species
11. A database of ex situ collections and conservatories of flora and fauna in the State need to be developed.
12. Urban biodiversity indexing and Regular monitoring of urban vegetation with involvement of voluntary organisations is necessary
13. Promotion of Citizen science involvement in biodiversity monitoring, documentation and conservation.



APPENDIX

List of Tables

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