KERALA Integrated Water Resources Management

11 December 2018

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1. Introduction

An IWRM mission of 2 experts was mobilized for the period 28 September until 15 October 2018 with the following purpose.
The Post Disaster Needs Assessment commenced on 17th September and is scheduled to be completed within a one-month duration. Within the first week of the PDNA, the government requested to have a specific focus on issues of water conservation, water management and river basin management. This request comes with an acknowledgement that poor water resources management has contributed to the floods and landslides in the state leading to high economic losses. The government would like to address some underlying issues that caused the floods. With this objective, the government has requested the PDNA assessment team to include an analysis of the water management practices and policies and propose recommendations to improve the management including conservation of water. The identified nodal departments for water management are: the Water Resources Department - Kerala Water Authority, and the Dam Management Authority - Irrigation Department.

The objectives of the assignment were:
Contributing to the overall multi-sectoral objectives of the PDNA, the specific objectives of the Integrated Water Management Experts team is to:
• Review the water resources management practices under three broad categories: river basin management, management of water resources for irrigation and water supply, and storage and use of water for electricity generation;
• Review current policies and measures in place to manage the water resources in the state;
• Undertake an analysis of the causes of the floods and its interlinkages to water resources management, water needs and spatial planning in the state;
• Provide specific recommendations to improve water resources management practices (water safety, and water security) including policy framework and governance arrangements for management of water within the four water entities in the state government;
• Provide solutions based on international best practices for integrated management, monitoring, use and distribution of water to be implemented in short, medium and long term.

Key Deliverables of the Assignment are a chapter for the PDNA which will include the following.
- An analysis of the recent floods and its technical and governance links to river water, dam water and other water resources in the state, including eventual influences from other sectors.
- Recommendations and a range of costed and timed action plans for the establishment of integrated water resources management for the state of Kerala with specific actions to be undertaken in the short, medium and long term by the four entities which manage water resources in the state

The requested contribution to the PDNA report was submitted as a concise version of this stand alone report. After final editing of the PDNA report, some suggestions were accommodated in this 12 December 2018 report.

This more elaborate report can be used for future reference for follow up activities. It has 2 major sections focussing on Kerala water management and governance. Each section describes the context, provides an assessment as well as the potential to move forward. It provides a separate chapter on inter-sectoral linkages, followed by recommendations for immediate actions and short, medium- and long-term interventions. It concludes with the methodology used.

2. Summary

- In Kerala the concept of Integrated Water Resources Management (IWRM) is not yet adopted in its water resources management policies, planning and programmes. If comprehensive IWRM had been applied according to international standards, the impact of the floods would definitely have been less.
- IWRM is about inter-sectoral coordination based on a long-term vision on water. It should be embedded in a long-term vision laid down in Kerala's sustainable development planning.
  With this in place you can make proper plans for water safety and water security based on actual and planned land use resulting in multiple basin plans.
- IWRM plans need to be based on sufficient and reliable data, and state-of-the-art hydrological models. Quality is leading; apply concepts like Watershed Management, Room for the River, Living with Water and Eco-engineering.
- Legislation with respect to water is abundant but needs to be made more coherent and more effective. International benchmarks may inspire. Consider applying a Water Audit to all interventions.
- Set up a high-level Kerala State Water Board for coordination between related state departments, with a top expert advisory bodyl. The Board is to be supported by a secretariat in a focal ministry.

Immediate action

- Promote best practices like Room for the River, Living with Water, and Building with Nature. Build it into a communication plan with broadcasting for the general public and narrow casting to specific groups.
- Start a Hydrological Crash Program. Start collecting available data now. Compare to international standards and improve. Parallel set the requirements for the Hydrological software and use that as a benchmark for total data collection and verification. Build the hydrological model for a pilot basin.
- Prepare a master plan for the Kuttanad area. It has the attention of many and was maybe the most affected area. All aspects of IWRM are encountered there. Include upstream river basins and the coastal zone. Use the lessons learned for replication to other basins.
- Start an awareness program on Living with Water in flood prone areas at the Panchayat level. Use simple manuals and consider monitoring of land use.
- Change the culture in Kerala to make water part of the hearts and minds of the people. Link this to the communication campaign. Set up a Kerala Water Partnership as an independents entity representing the public sector, private sector, knowledge institutes and non-governmental organisations (NGOs). It can organize the dialogue and the communication, even joint research and development programs
- Costs for these immediate interventions is almost negligible compared to flood damage and wrong decisions on infrastructure investment. Seek financing now.

More recommendations on the short, medium and long term can be found in chapter 6.

3. Kerala Water Resources

3.1 General Setting Kerala Water Resources

Note: This report contributes to the Kerala Post Disaster Needs Assessment Report. For readability as a standalone report it includes general descriptions of the physical conditions of Kerala which may be a repetition of other chapters of the PDNA Report. Descriptions are taken from earlier reports notably WB/ADB Joint Rapid Damage and Needs Assessment: Kerala Floods and Landslides 2018, September 2018 and CWC Study Report Kerala Floods of August 2018, September 2018 and open sources. The data presented in the WB/ADB and CWC reports are the main basis used in the assessment, analysis and resulting recommendations. This report reviews the above information and adds observations, assessments and suggestions of the PDNA IWRM Team.

Below the general setting of Kerala is presented on issues related to Water Management. Apart from the general descriptions on the geography and climate some elaboration given to features such as climate change, salt intrusion and the coastal zone.

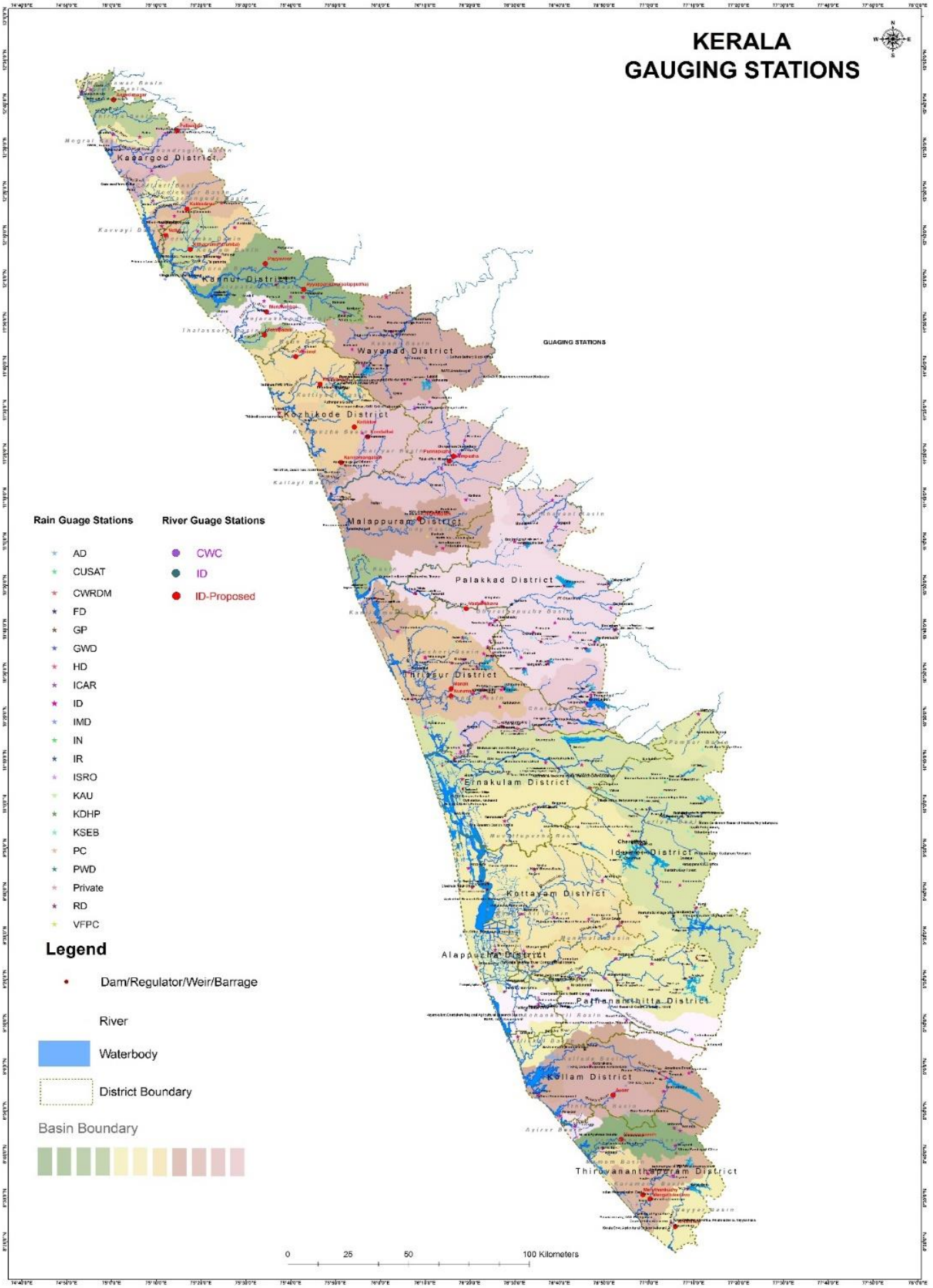
Geographical setting

Kerala, a southwestern coastal state of India, is flanked by the Arabian Sea on the west and the Western Ghats mountains on the east. The state stretches north-south along a coastline of 590 km with a varying width of 35 to 120 km. The terrain divides the State east through west into three distinct regions- hills and valleys, midland and plains and coastal region. The eastern edge, close to the Ghats, comprises steep mountains and deep valleys, covered with dense forests. The rapidly falling terrain, heavy precipitation and the narrow width of the state have given rise to numerous rivers. There are 44 rivers in the state, of which 41 originate from the Western Ghats and flow towards the west into the Arabian Sea. Only three tributaries of the river Cauvery originate in Kerala and flow east into the neighbouring States.

One of the striking features of the state is the continuous chain of lagoons or backwaters (kayals) existing along the coastal region. The lagoons or backwaters are connected to the sea through small openings called Azhis or Pozhis with respectively the opening being permanent or temporary. Canals link the lakes and backwaters to facilitate an uninterrupted inland water navigation system from Thiruvananthapuram to Vadakara over a distance of 450 km. The best-known backwater system in Kerala is Kuttanad with large patches of cultivated areas below sea-level. The Veli Fresh water lake system is also a unique and a vulnerable ecosystem in the state. Similar inland freshwater bodies are common in the central and southern parts of Kerala.

Climate

The climate of Kerala is tropical monsoon with seasonally excessive rainfall and hot summers. The state is having four seasons. The period of March to the end of May is the hot season. This is followed by the South West Monsoon season that continues till the end of September. From October to December is the North East Monsoon season and the months of January and February constitute the Winter season. The climate in the state is pleasant from September to February and the summer months of March to May are uncomfortable due to high temperature and humidity. The state is extremely humid due to the existence of the Arabian Sea in the west of it. The total annual rainfall in the state varies from 360 cm over the most northern parts to about 180 cm in the southern parts. The southwest monsoon is the principal rainy season when the state receives about 70-80 % of its annual rainfall.


KERALA
GAUGING STATIONS
GUAGING STATIONS
Kasaragod District
Kannur District
Wayanad District
Kozhikode District
Malappuram District
Palakkad District
Thrissur District
Ernakulam District
Idukki District
Kottayam District
Alappuzha District
Pathanamthitta District
Kollam District
Thiruvananthapuram District
Rain Guage Stations
AD
CUSAT
CWRDM
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ICAR
ID
IMD
IN
IR
ISRO
KAU
KDHP
KSEB
PC
PWD
Private
RD
VFPC
River Guage Stations
CWC
ID
ID-Proposed
Legend
Dam/Regulator/Weir/Barrage
River
Waterbody
District Boundary
Basin Boundary
0
25
50
100 Kilometers

The high intensity monsoon storms result in severe floods and heavy discharges in all the rivers. These floods are becoming more frequent and severe and are now the most common natural hazard in Kerala. Increasing flood plain occupancy and reclamation of water bodies and wetlands, less room for water, results in increasing flood damages. Riverine flooding is recurring consequent to heavy or continuous rainfall exceeding the absorptive capacity of soil and water bodies. The July 1924 floods caused by the south-west monsoon caused unprecedented flooding and loss. These floods were unusually heavy in precipitation, duration and geographic extent affecting the entire state from June end till August beginning.

Climate change (*Ref: Kerala State Action Plan on Climate Change, August 2014*)

In the first report on "Impact of climate change in four regions of the country" submitted to the Government of India by the Indian Network for Climate Change Assessment (INCCA) has been pointed out that reduced rainfall, increased atmospheric temperature and flooding due to sea level rise are the climate change scenarios for the Western Ghats and Kerala in the next 20 years. Under the projected climate change scenario, it is certain that the temperature is likely to increase by 2°C by 2050. The number of rainy days is likely to decrease along the entire Western Coast, including the Western Ghats.

In the Asia specific Observations based on IPCC Fifth assessment AR5 report it is stated that the frequency of heavy rainfall events is increasing and increase in precipitation extremes due to monsoon are very likely. Consequently, this will increase the magnitude and frequency of river floods.

It is now established that the sea level is on the rise due to global warming and the projected Sea Level Rise (SLR) along Kerala coast on a conservative estimation is about 100 to 200 mm over the next 100 years. Vulnerability to Sea Level Rise would affect the majority of coastal communities which live on sandy coasts, most of which are barrier beaches or spits. Backwater banks, islands, filtration ponds, and paddy fields are other sections of the coastal zone which are highly susceptible to Sea Level Rise.

Coastal Zone

The Coastal Zone in Kerala is the low land fringing the sea extending over 590 kilometres, with a height of less than 8m above main sea level. To protect the inland, seawalls are constructed over a length of about 340 kilometres.

The coast is prone to erosion. A recent study, *National Assessment of Shoreline Changes along Indian coast, August 2018*, prepared by the National Centre for Coastal Research has revealed that Kerala has lost almost half of its coastline to the sea in the past quarter of a century. Tidal activity and construction including dredging engulfed over 40 per cent of the coast. At the same time over 21 per cent of the Kerala coast has been recovered by accretion of fresh deposits. This seems to indicate that the coast is seeking a new natural balance to adjust to changing conditions such as human interventions.

Tidal fluctuation is different along the Kerala coast. The largest known tidal range at Kochi is 2.14 m and for Trivandrum this is 0.99 m. The Kerala coast is also vulnerable to tsunami surges.

Salt water intrusion

The short, fast-flowing, monsoon-fed rivers of Kerala often encounter salinity intrusion into their lower stretches during the summer months. When the fresh water flow reduces, two major problems are encountered in these water bodies: (i) salinity propagates more into the interior of the river and (ii) the flushing of the system becomes less effective. Both these aspects have an impact on irrigation, drinking and industrial water supply schemes, fisheries and the ecosystem situated in the downstream reaches.

The present measures for preventing salinity intrusion into the intake points of drinking water supply schemes is by the construction of temporary barrages, which prevent the flow and create ecological problems, especially concentration of pollutants upstream of the obstruction. Areas upstream of Thanneermukkom barrage in the Vembanad and Pathalam barrage in the Periyar are typical examples. (*Ref: Environmental Analysis Report for Kerala Rural Water Supply and Sanitation (KRWSS) Project May 30, 2000*)

Water Resources Development

The State has developed important water resources and irrigation systems to support various uses of water throughout the year including agriculture, domestic use, fisheries, and river transport. There are 76 dams in the State excluding 4 dams in Kerala that are managed by Tamil Nadu, and over 18,000 ponds in the state which have a combined storage capacity of 5.8 BCM. Seven of the large dams have a combined storage of 74% of the total live storage. Idukki is the largest dam with 1.46 BCM storage. Kerala State Electricity Board (KSEB) operates 58 dams with hydropower facilities and the Water Resources Department owns 16 dams for irrigating ayacut areas (ayacut: area served by an *irrigation* project such as a canal, dam or a tank) of 5,670 km^2, and 2 dams are owned by Kerala Water Authority.

In support of planning, design and implementation of water resources development projects the Kerala State Irrigation Department has a dedicated and professional organization. Basic data on river characteristics, hydrology, GIS, etc. are the domain of the Irrigation Design and Research Board of the Irrigation Department.

3.2 Observations on the Kerala Water Systems

During a two-day field visit insight was gained on various aspects of the Kerala water systems. It is based on observations made, discussions with government and other experts and people in the field.

The itinerary included the upper reach of the Pamba River up to the Kochandy Forest Check Post on the Pamba River, reportedly about 40 kilometres downstream from the Kakki Reservoir. Also, observations of the Pamba river were made at Vadasserikara and the Kalladayar River at Enath near Kottarakara). At Chengannur the middle reach of Pamba was observed at Kallisery Bridge and adjacent locations where flooding occurred. The lower part was visited at Thottapally.

The Periyar was visited near Mattupuram at the location where flooding occurred as well at Mangalapuzha and Mathanda Varma (Aluva) Bridges.

Also, the Kuttanad backwater area was explored by boat to obtain insight in the below sea level paddy cultivation and water management. The trip on the main canals encircled the Meenappally Kayal.

In addition to the field visits, meetings were held at various state government departments where professional opinions where discussed with high level officers and experts.

The following general observations are noted:

Looking at Kerala from the air or driving through it is most striking that **urbanisation** is everywhere even in the hilly areas where many scattered houses are seen. Reportedly less land is being used for low yield agriculture. Emphasis has changed to cash crops and rubber and other plantations. In the context of soil conservation and erosion protection this land use phenomena will require due consideration.

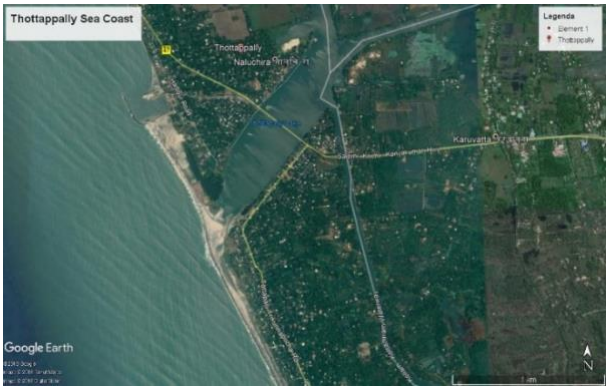
- The **upper watersheds** of the rivers do not show heavy erosion as large parts are covered by national parks and forest reserves as is the case with the upstream catchment of the Pamba River. The situation is better in the southern part than in the northern part of the state where larger patches of eroded slopes can be observed from Google Maps. Careful preservation and restoration of the upper catchment areas is an issue also in view of heavy urbanisation of Kerala. This is particularly true for hills where, due to heavy runoff, the top soil is eroded and much of the natural capacity to absorb rainwater was lost.

- The **rivers** observed have **clearly delineated main channels**. The embankments are steep and stable to a degree. It seems the rivers are stable within their bed. The full bank capacity of the rivers is, based on discussion and observation, in the order of a 1 in 10 to 25 year maximum discharge depending on the local topography. Flooding occurs with any higher river discharges. People seem to live with limited flooding, live with water, but were not prepared for an extreme flood as occurred in 1924 and 2018. This observation is relevant in planning for future flood mitigating measures with the objective of lowering the flood levels along the principles of "Room for the River".

- Regular **flooding** occurs in the low areas around the backwaters and lower river reaches. Apart from the flood discharge inflow from the rivers the reason for flooding is in particular the poor discharge capacities or blockage of discharge at the sea outlets (Azhis and Pozhis).

- Reportedly at many locations in the rivers **cross- and check dams**, both permanent and temporary, are constructed for irrigation or water supply intake. These dams are constructed without giving regard to the resulting obstruction of higher discharge and thus increasing river levels upstream which may cause unwanted flooding.

- The **drainage channel system of the Kuttanad** area including the main drain into which the four main rivers drain into the Kuttanad wetlands have poor maintenance and have to some extent silted up thus reducing their drainage discharge capacities towards the Thottappally Spillway which itself has a limited capacity of reportedly 380 m3/s.



- Manmade **interventions along the coast** such as creating small harbours by building out breakwaters have detrimental effects on the natural coast line. E.g. the Thottappally Fishing Harbour break water configuration may be the cause of silting up of the sea outlet at Thottappally and thus hampering the outflow capacity.

- Kerala has a well-established **hydrometric network** but it is not fully operational and reliable. The quality of the data can, reportedly, not always be guaranteed. Reliable topographical, hydrometric and bathymetric data are a pre-requisite for proper planning and designing of water resources development interventions as well as for the operational management of the infrastructure such as flood forecasting and preparation of dam operation protocols.

- The concept of Integrated Water Resources Management is generally known but not adopted mainly due to institutional constraints.

3.3 Extreme flooding 15 – 17 August 2018; an analysis

Kerala experienced an abnormally high rainfall from 1 June 2018 to 19 August 2018. This rainfall was about 42% above the normal. Further, the rainfall over Kerala during June, July and 1st to the 19th of August was 15%, 18% and 164% respectively, above normal. It was the worst flooding in Kerala in nearly a century.
Thirty-five dams across the state were opened to release flood runoff. All five overflow gates of the Idukki Dam were opened, for the first time in 26 years. Heavy rains in Wayanad and Idukki Districts caused severe landslides.
Water levels in several reservoirs were almost near their capacity due to continuous rainfall from 1st June. Due to heavy rainfall, the first onset of flooding occurred towards the end of July. Severe rainfall was experienced at several places from 8-9 August. Another severe spell of rainfall started from 14th August and continued till 19th August, resulting in disastrous flooding in 13 out of 14 districts. As per the IMD, it has been found that the rainfall depths recorded during the 15-17, August 2018 were comparable to the severe storm that occurred in the year 1924.
Due to this high rainfall there was an absence of appreciable storage in reservoirs upstream, along with the shrinkage of carrying capacity of lakes, rivers, and porous land. The limited capacity of Vembanad Lake and Thottappally spillway worsened the flooding in the Kuttanad region and the backwaters. Many areas were under water for more than two weeks. (Ref: JRDNA WB/ADB)

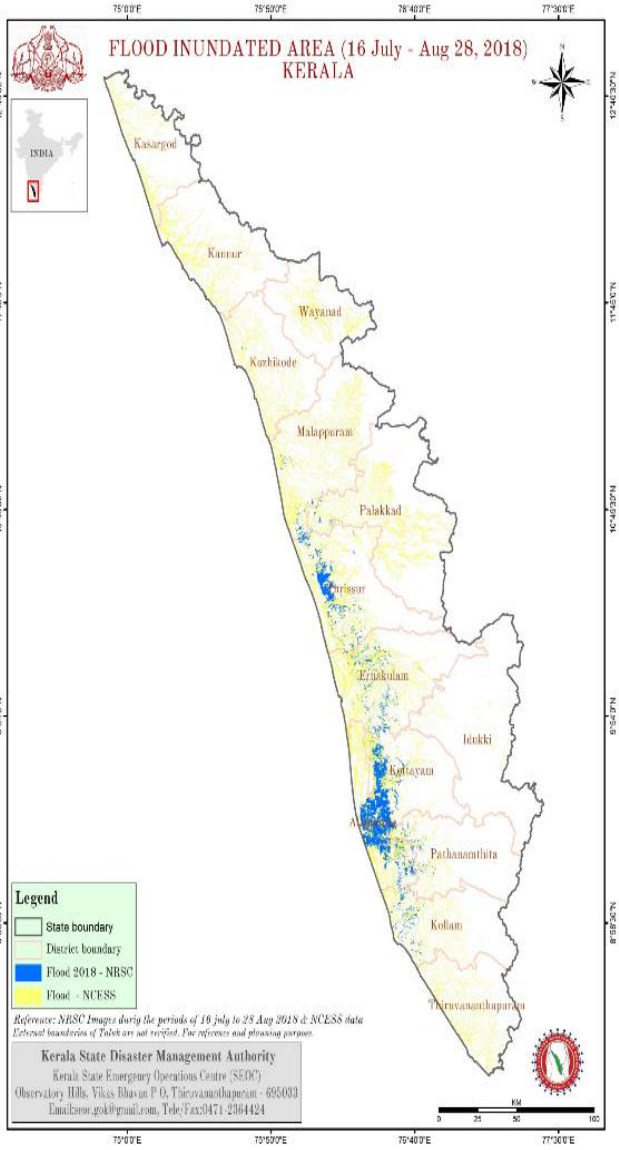
The above analysis gives in general terms a good analysis of the effects on the Kerala water systems in response to the extreme rainfall of 15 – 17 August as climax to a preceding period of heavy rains throughout June, July and particularly the first weeks of August. Of the total rainfall in the this 20 - 25 % came down in the three days from 15 – 17 August.

The CWC report on the Kerala Floods of August 2018 gives a thorough hydrological analysis of the effects of the heavy rainfall on the Periyar, Pamba, combined Pamba – Manimala – Meenachil – Achenkovil all draining into the Kuttanad wetlands, Chalakudi, Bharathepuzha and the Kabini basins. Reference can be made to this report for detailed insight.

Based on the CWC report an analysis of the flood disaster is presented with focus on the Bharathepuzha, Chalakudy and Periyar rivers and the Kuttanad water body with inflow from the Muvattupuzha, Meenachil, Manimala, Pamba and Achenkovil rivers.

The Flood Inundation Map (Figure 5 of the WB/ADB JRDNA report) shows that the majority of the flooded area occurred in the areas around the backwaters and the lower reaches of the rivers where river bank heights were lower and adjacent flat areas became water logged with exceptional levels up to 1 – 2 metres.

In the middle and upper reaches water logging was less although damage has occurred where strong currents and flood discharges, in excess of full bank flow, surprised the people and damaged housing, trees and crops close to the river banks.



With respect to the outflow from the Malampuzha dam it is stated that that "*during 8-9, August 2018 the total inflow into the reservoir was about 97 MCM against the release of 48 MCM. During 8-9, August 2018, the reservoir absorbed about 49 MCM of flood water and thus resulting less flooding in downstream area. During 15-17, August 2018 the total inflow into the reservoir was about 53 MCM against the release of 66 MCM, hence the released volume was about 13 MCM more than the inflow, which is insignificant in comparison to estimated runoff of 1510 MCM from the basin."* This holds true for the flooding in the lower reach of the Bharathepuzha. This is not directly true for the discharge at locations immediately downstream such as Palakkad city which is located close to the dam. Here the hydrograph at Palakkad should be compared with outflow from the reservoir to see how dam operation actually influenced the local flood flow.

Landslides occurred inland from the rivers and are independent from the high flood levels in the river. They happened mainly due to soils being soaked and soil piping and human interventions such as road construction and housing. Reportedly no major river bank slides occurred confirming the general stability of the river banks. In the lower reaches of the rivers some bank erosion has been reported but too a limited extend.

The largest areas flooded were those adjacent to the backwaters along the coast. Also, normally flood free areas within these wetlands were to a large extent flooded. It can be stated, given the extremely heavy rainfall, flooding of those areas and areas along the lower parts of the river was unavoidable given the characteristics and the physical condition of the water systems. The outlets to the sea whether natural Azhis and Pozhis or controlled, such as at the Thottappally Spillway and Thanneermukkam barrage, do not have the capacity to evacuate the high flood flows from the rivers, as they occurred, into the sea. The excess water gathered in the low-lying areas. As the flood was exceptional the flood levels were as well and far above as experienced by the people for the 1/10 to 1/25 year flood events. Along the Kerala coast the situation was aggravated by the Perigean spring tide, a high tide occurring only three or four times a year, for the period August 11-15, 2018 and sustained strong onshore winds resulting in abnormal high sea levels further hampering river outflow to the sea.

As per the CWC report the overall drainage capacity to the sea of the Kuttanad water body is far below the original capacity of the structures and the drainage canals/rivers draining towards them. Siltation of these canals together with an overall poor state of maintenance has drastically reduced their capacities. Even with lesser floods, water logging of built up areas occur although people seem to live with the water and like a small flood for flushing out the polluted canals.

A proper operation of the major dams in the upper catchments of the Periya, Chalakudy and Pamba rivers respectively the Idukki, Mallaperiyar, Parambikulam and Kakki dams would have had only a minimal add-on effect on the flood levels in their lower reaches and the backwaters and on the duration of waterlogging. Of course, protocols should be adhered to and not only include operational rules for optimizing power generation, irrigation supply and safe guarding of the dam but include operational rules for downstream flood protection when heavy rains occur and environmental flow during periods of drought. Optimizing dam releases for downstream flood protection will in any case allow for alleviation of extreme peak flows immediately downstream of the dam and thus reduce damages caused. Controlled releases from the dams, being located hundred plus kilometres upstream from the wetlands, will have little effect on the flood levels in the lower reaches especially when the sea outflow is hampered.
Small reservoirs will always have some flood shaving effect. The larger the reservoir capacity, as compared to the flood volume from the reservoir's upper catchment, flood control operational rules become more effective for the downstream reaches.
Increased bed resistance in the rivers by blockages in the middle and upper reaches by check dams, bunds and poor maintenance will shave off the peak of the floods and, effectively, slow down the inflow into the backwater areas providing more time for sea outflow and to some extent reduce the flood levels. The river obstructions in the middle and upper reaches will give locally increased flood levels. Further analysis may indicate whether this has caused flood damage at, and upstream of, these locations or was experienced as manageable. In the latter case no "Room for the River" measures will then be required.

In summary: The accumulation of several simultaneous and unique phenomena resulted in extreme floods. Extreme rainfall, immediate runoff, low flood storage capacity in the reservoirs, poor drainage capacity of canals and sea outlets and high spring tides came all together.

3.4 Kerala Water Management

3.4.1 Integrated Water Resources Management

In Kerala the concept of Integrated Water Resources Management (IWRM) and its related concept of Integrated River Basin Management is well known and appreciated but, as yet, not adopted in its water resources management policies, planning and programmes.

IWRM emphasises cross-disciplinary coordination of water, land and related resources in a river basin, watershed or catchment to achieve long-term sustainability. IWRM highlights the importance of ecosystem function in the long term, and reminds us that an integration of policies, decisions and costs are necessary across a multitude of sectors.

Integrated Water Resources Management aims to break the inter-sectoral barriers to establish a holistic framework for coordination. It brings together all stakeholders involved in the use of the river basin resources and together develop an agreed set of policies and strategies to achieve a balanced approach to land, water, and natural resource management. It helps us understand that we can find best practice river management in many activities—from community use, safeguarding the environment, economics, urban planning or business management. And, it puts the focus back onto achieving healthy river ecosystems with wide-ranging benefits for all communities, economies and biological processes within it.

Integrated Water Resources Management has its focus on different uses of interdependent finite water resources. High irrigation demands and polluted drainage flows from agriculture mean less freshwater for drinking or industrial use; contaminated municipal and industrial wastewater pollutes rivers and threatens ecosystems; if water must be left in a river to protect fisheries and ecosystems, less can be diverted to grow crops. There are plenty more examples of the basic theme that unregulated use of scarce water resources is wasteful and inherently unsustainable.

In this report recommendations and a range of costed and timed action plans will be presented on the establishment of integrated water resources planning for the State of Kerala.

3.4.2 Practical concepts for Kerala river basin planning

In the previous chapters the main issues of Kerala's river basin management are discussed of which the most pressing are:

- Cross-Sectoral coordination in policy development, planning, and implementation of water related infrastructure. This issue will be dealt with in Chapter 2 of this report on institutional development.
- Upper catchment soil conservation and erosion protection
- River channel management in view of uncoordinated construction of permanent and temporary check dams and bunds for irrigation and domestic water supply.
- Poor state of repair of canal embankments (bunds) and silted-up and polluted drainage canals.
- Sub-optimal operational conditions and state of repair of weirs, barrages, and spillways.
- Sub-optimal protocols, and adherence to them, for dam operations without e.g. balanced consideration for downstream water demand, environmental flow, flood protection, and power generation.
- Poor management of coastal river outlets.
- Sub-optimal polder management in e.g. the Kuttanad area.
- Lack of validated hydrological, bathymetric, topographical, land-use and remote sensing data and related models.

Due to these issues the river systems do not function well with as a result difficulty in managing irrigation and domestic water supply during periods of drought, water management of impoldered paddy fields and kayals and finally increase in flood risks across the basins. As all issues are interrelated the concept of IWRM needs to be adopted and implemented.

To understand the inter relations, a river basin plan needs to be developed incorporating all above aspects. In the first instance the plan needs alternative development scenarios to be developed and agreed upon. From these scenarios a preferred scenario with a long-term vision and related objectives is to be derived which will need political/administrative support before proceeding with planning. The required detail of the development scenarios depends on the complexity of the administrative/political discussion. Once a long-term vision is agreed upon the plan can be worked out and may consist of various interventions for the short, middle and longer term which together achieve the objectives of the long-term vision.

In carrying out basin planning for Kerala's rivers use can be made of internationally accepted good practices and technical concepts. Some of these good practices are elaborated on in the following.

Hydrological Crash Programme

Before embarking on the planning exercise an absolute prerequisite will be a reliable set of data on which to base the technical components of the Basin Planning, such as hydrological modelling, to improve the behaviour of the river under different circumstances and to be used in the development of different scenarios. Without having the data in order no proper calibration of the models can take place: rubbish in gives rubbish out!

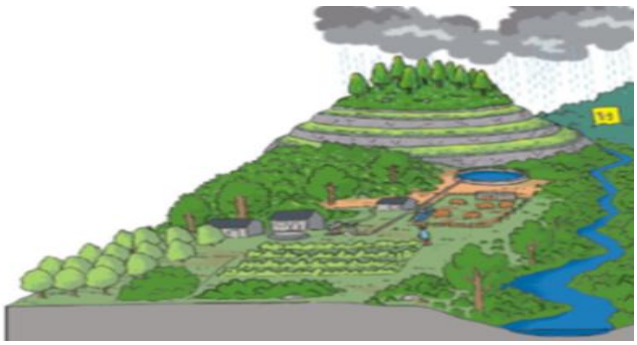
It is to be considered to immediately embark on a Hydrological Crash Programme in which all relevant data are collected, digitalized and where needed thoroughly validated. Possibly the National Hydrological Programme (NHP) can assist and contribute.

The exercise should in the first instance take not more than six months. Parallel, basin modelling can take place. The developed models can be calibrated once reliable data becomes available. These models will become decision support tools in which different scenarios or alternative measures can be simulated to enable fact-based decisions at higher administrative/political levels.

The crash programme should also include a component on data needed for coastal zone management and engineering.

Integrated Watershed Management in the Hilly area and upper sub-catchments

The upper catchments of the rivers are for certain areas well managed as they are designated forest reserves or national parks. When this is not the case the upper watersheds are used for up-hill agriculture, plantations of rubber trees, pineapples, tea plants, etc. To ensure good water absorption and water holding conditions of the upper soil, rigorous soil conservation, and erosion protection measures need to be taken.



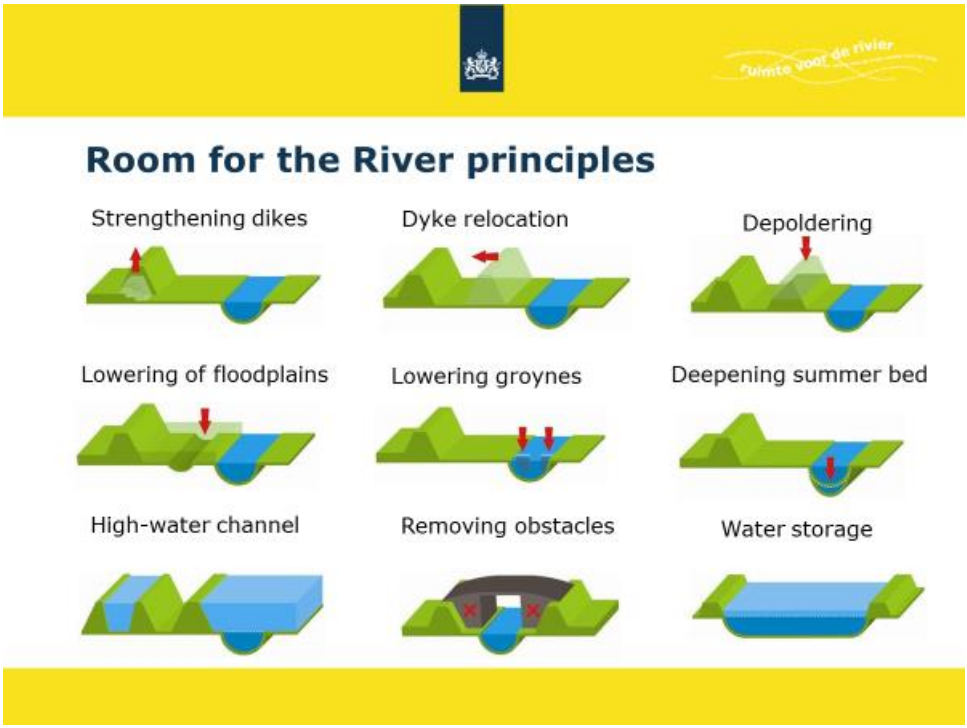
An international best practice for managing the smaller upper catchment of rivers and streams is Integrated Watershed Management (IWM) with objectives to improve farmer's livelihoods and sustainable estate management to protect the environment in often highly degraded watersheds in the hilly regions by promoting an integrated and replicable model of sustainable rural development. Through a participatory design process at panchayat level, activities can be packaged into an integrated set of interventions. i) Soil and water conservation: physical investments for soil and water conservation primarily of public interest including minimum capital farmland, sediment retention structures, afforestation and vegetative cover, and village infrastructure such as water supply facilities. ii) Livelihood improvement: physical investments designed to improve the income of farmers including terracing of slope land, horticulture and fruit and nut trees, grasslands, livestock development, irrigation and drainage and renewable energy supply. iii) Coordination and support services will ensure the participatory design process with inclusion of vulnerable groups, the quality implementation of activities under the first two components, the right institutional setting for sustainable operation and maintenance of project activities, the mitigation of environmental and social risks, and monitoring and evaluation.

Neyyar River Sea Outlet

from Poovar Backwater

Mitigation of flood risks – 'Room for the River'

Flood risk management is building on two components to mitigate flood risk damage (Flood risk damage = Risk of flooding x Resulting damage).



- Ensure absorption and holding of water in the upper catchment areas of the river. This can be achieved by building multipurpose storage reservoir and adopting IWM as explained above.
- Adopt the principles of 'Room for the River'. The objective of this principle is to lower flood water levels in the rivers to reduce the flood risk. The above figure shows the possible interventions to achieve this objective.

When translating this to Kerala conditions it may involve:

- Strengthening or increasing crest heights of embankments and bunds;
- Outward Shifting of embankments or bunds or digging off river embankments to increase channel/canal wet areas;
- Removing of lower bunds which protect flood plains to allow free flow through flood plains with as much as possible clean-up of trees and brushes and removal of housing and sheds;
- Lowering of the flood plains or flat areas next to the river;
- Removal of check dams and cross-bunds and other obstacles;
- Dredging out the river and canal beds;
- Create flood by-pass using already low-lying areas or old river beds e.g. those old river beds used by the recent flood waters next to the main river channels;
- Create retention areas by linking lakes, irrigation canals or dedicated kayals to temporary store water.

Preventive damage control is done by having a strict licencing policy for building in flood prone areas which also needs to be adhered to. As Kerala sees a rapid urbanisation and pressure on availability of building plots the concept of 'living with water' may be adopted for those who accept a calculated risk and build accordingly.

The Netherlands ‘Room for the River’ project had as an qually important objective: ecological conservation and restoration. When planning any intervention, it needs to be accompanied by a proper Environmental and Social Impact Assessment (EISA) including required mitigating measures to avoid environmental deterioration. For the Basin Plans this may be at a strategic level (SESIA).

Integrated Coastal Zone Management

ICZM is a dynamic, multidisciplinary and iterative process to promote sustainable management of coastal zones. ICZM seeks, over the long-term, to balance environmental, economic, social, cultural and recreational objectives, all within the limits set by natural dynamics. 'Integrated' in ICZM refers to the integration of objectives and also to the integration of the many instruments needed to meet these objectives. It means integration of all relevant policy areas, sectors, and levels of administration. It means integration of the terrestrial and marine components of the target territory, in both time and space. (*Definition of ICZM by European Commission*)

On the technical side state of the art morphological models are available to analyse and predict coastal morphological processes such as coastal erosion or accretion. For Kerala this is relevant in engineering sustainable sea outlets where needed.

Living with water

In flood prone areas water logging of built-up land cannot always be avoided. As people are under certain conditions comfortable with this fact, the concept of ‘living with water’ can be adopted in developing long term vision scenarios for these areas. Apart from technical measures such as building of multi-storeyed housing to allow a safe place for the household during floods and mounts to where cattle can be evacuated, soft measures apply such as enhancing awareness of the risks and early warning and communication.

In Kerala living with water is to some extent brought into practice in the Vembanad lake system and Kuttanad. The encroachments of housing on the bunds can also be looked upon as positive as people apparently accept the regular flooding, within limits, of their plots; they live with the water. In future Kuttanad development this feature can be used to try to improve on the conditions to stimulate flood safe housing (e.g. on poles) and build out mounts from the bunds or reclaim land from the kayals or provide increased flood safety using higher embankments.

Living with water is also practiced for eco-tourism where houseboats in the kayals are popular holiday dwellings. Adapted waterfront development on or close to the water may give tourist a living with water experience.

In living with water, it should be made clear that the people need to accept the risk that extreme flood levels may, occasionally, occur and housing needs to be adapted to these possible circumstances. Due consideration needs to be given to the water, sanitation, and hygiene (WASH) aspects in the developments.

Building with nature

Building with nature is a concept where natural phenomena are leveraged to cope with climate change risks, such as floods, waves and sea-level- rise (SLR). It is also called 'eco-engineering'.

An oyster reef to protect the coast, mangroves or willows in front of the dyke. Slowly but surely, a new insight is gaining ground: hard civil engineering interventions by themselves are not a panacea. Nature seems willing to help us to keep the upper hand over the advancing waves and rising sea levels and provides us with new sources of food and income.

For Kerala BwN/Eco-engineering could be an option worth studying for coastal protection, bund and embankment protection against wave attacks from fast tourist boats, natural by-passes in the river to enlarge the river's discharge capacity and thus keep flood water levels lower, etc.

Flood risk management
Flood control aims at preventing human casualties and limiting the material damage. Extreme floods cannot be prevented. Investment in reduction of flood risks is like an insurance premium. The amount of the premium depends on the risk level one wants to insure against. Flood risk damage = flood risk x flood damage. Areas with potentially high socio-economic damage could be protected against flood occurrences of once in 50 -100 years (or more), this however at a cost (high premium). Rural areas with few people could receive less protection with also lower investments (low premium).

3.5 Kuttanad wetlands

The Kuttanad water system was one of the areas most effected by the flood of August 2014. The flooding occurred mainly in the lower part of the Meenachil basin and the areas southwards toward the lower reaches of the Pamba river, the Kuttanad wetlands (polder) area and the lands adjacent to the southern part of the Vembanad lake system. The main reason for the excessive flooding was the limited capacity of the outflow to the sea. In the various assessments, formal and informal, Kuttanad receives due attention and has priority to plan for improved water management including flood damage mitigation.

The Kuttanad wetlands extend from the South part of Vembanad lake of which the outflow is controlled by the Taneermukkum Barrage (main purpose is avoidance of salt intrusion), the polder areas in and adjacent to the lake and the polder areas south of the lake with as approximate southern boundary the Pamba river and outlet canal controlled by the Thottappally Spillway (designed for blocking salt water intrusion and discharging of flood waters).

Kerala's coastal area is, apart from the climate, in many ways similar to the coastal area of The Netherlands. Both have a straight coastline running from north to south with (originally) natural sea barriers with levels of 5 – 10 meters above main sea level (msl). In Kerala they constitute of stable deposits with built-on settlements whilst in the Netherlands there are sand dunes. On the seaside sandy beaches are predominant which in both situations are prone to coastal erosion. All along and behind the higher coastline one finds natural backwaters. In Kerala they are called kayal.

The Kuttanad is an impoldered back water used for below msl paddy cultivation. The Vembanad lake system is the largest kayal. The Kayamkulam Kayal and Ashtamudi Lake are other examples in Kerala. In the Netherlands most of the backwaters are impoldered to allow for agricultural, urban, and industrial development. Polder development is characterized by a system of main canals with water levels at approximately msl or below. The canals typically run within embankments or dikes and are used as buffers for supply of irrigation water or for pumped water from lower lying polders. In Kuttanad these polders are mainly paddy fields. The canals also act as drainage for the whole polder system, achieved by free flow towards the sea or by using pumps.

To gain a quick understanding of the Kuttanad water management as it was around 1990, it is recommended to look at a film on the Kuttanad Water Balance Study Project which can be found using the following link: https://youtu.be/Z-wH-EujcTE Kuttanad - Water Balance Study Project (Indo-Dutch). The study presents recommendations for improvement of the water management of Kuttanad. Only to a very limited extent the recommendations had a follow up in actual improvement and construction of new water management infrastructure.

Since 1990 the situation in the Kuttanad area has drastically changed not alone by encroachment of housing on the canal bunds which is now everywhere. Canals and water management structures are suffering from poor maintenance. Any new improvement plan will have to deal with this next to the environmental deterioration due to fertilisers and pesticides which took place over the years resulting in abundant uncontrolled growth of water hyacinth. In addition to flood damage mitigation. Tourism, fisheries and ecological aspects for wetland improvement must be considered.

An important component is coastal zone management with specific coastal engineering for sustained sea outlets for flood drainage out of the area. Options like Building with Nature may well be applicable. To improve the water management in Kuttanad a study must be undertaken to plan rehabilitation of the water system using state-of-the-art concepts in polder development and coastal zone management.

A good starting point would be a review of the Kuttanad Water Balance Study. A prerequisite for any further study would be the update of existing data and collection of new data on topography, polder infrastructure, hydrology, coastal bathymetry, and ecology. The methodology and tools developed for Kuttanad as a pilot area can also be applied in other Kerala river basins.
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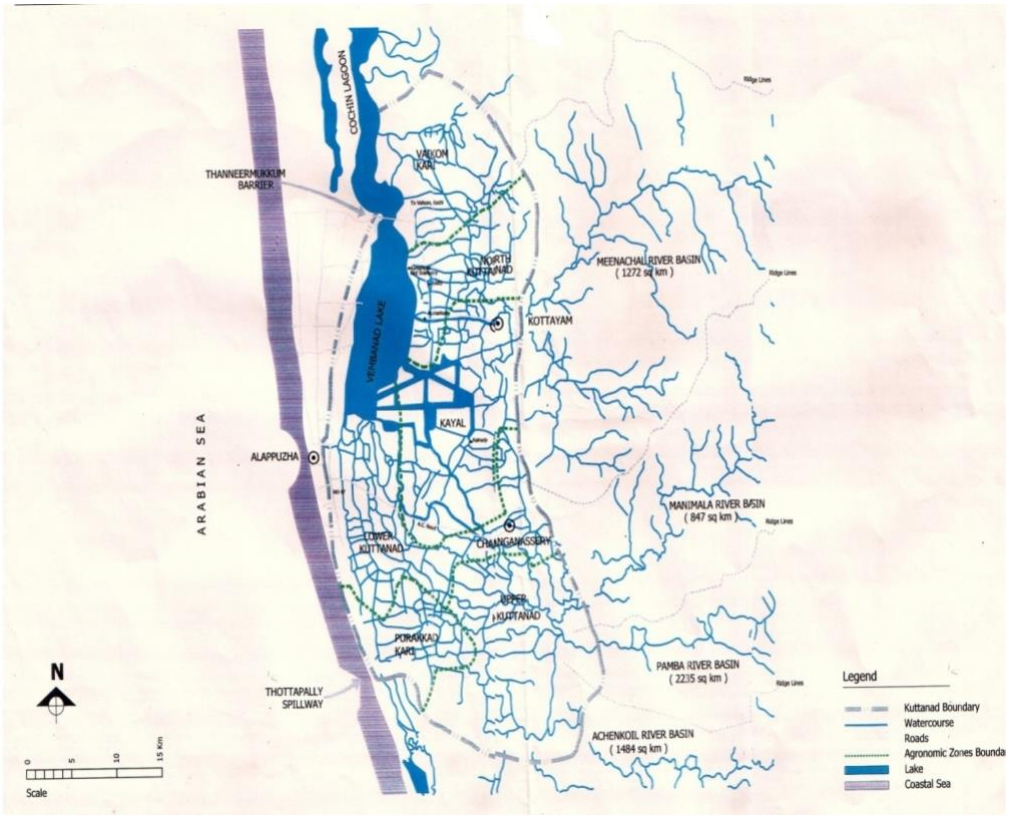


CWC Fig.10: Index map of Kuttanad/ Vembanad Lake

4. Kerala Governance

IWRM is considered part and parcel of integrated spatial planning encompassing both urban and rural development. IWRM planning has to fit into formal spatial plans enacted in law.

4.1 Context

State Government structure

In broad terms the state government comprises of the Governor, Chief Minister, Council of Ministers, Legislative Assembly and Secretaries (Chief Secretary, Additional Chief Secretaries and Secretaries) heading 20 departments, with some 100 directorates out which some 25 may be considered of immediate relevance to IWRM. No cross-cutting arrangements were observed.

Besides government departments, the activities of the government of Kerala is spread over several other government Institutions such as Commissions, Autonomous Bodies, Cultural Institutions, Public Enterprises, Welfare Fund Boards, Co-operative Organisations, Development Authorities, Universities etc.

In addition, there are 4 missions. The Haritha Keralam is an Umbrella Mission envisages pollution-free water sources, revival of water sources, water conservation, eco-friendly and sustainable waste management, as well as enhancing organic farming

There are 1200 local governments in Kerala, which includes 941 Grama Panchayats, 152 Block Panchayats, 14 District Panchayats, 77 Taluks, 87 Municipalities and 6 Municipal Corporations. Kerala's experience with local self-government has been distinct in three important ways and is more developed than elsewhere: financial devolution. the part played by local bodies in formulating and implementing Plans and the extent of people's participation in development planning

The Water Resources Department takes the administrative level decisions of the Line/Subordinate Departments. Its political head is the Minister and the administrative head is the additional Chief Secretary.

The mission and vision are to ensure that the right of access to water for all citizens is transformed into reality. This can only be achieved by ensuring that the demands for drinking water, agriculture, power generation and industry are appropriately addressed in the context of the physical, environmental and social background of the State. At the same time, to ensure that this vital resource will be sustainable for future generations to come.

The activities of the Water Resources Department are rooted in the State's Water Policy. A massive exercise has been launched aiming at strengthening and restructuring of Kerala Water Authority, thereby reorienting it into a "Customer Friendly" and competitive organization. A priority-based approach is applied for selection, implementation and commissioning of new projects. Great importance has been attached to the timely completion of projects.

The department has the following sections**:**

1. Irrigation Department
2. Kerala Water Authority
3. Ground Water Department
4. Jalanidhi (Rural Water Supply and Sanitation)
5. (Irrigation) Command Area Development Authority (CADA)
6. Kerala Irrigation and Infrastructure Development Corporation

In addition, there are several Agencies such as the Kerala Disaster Management Agency

At the national level there is the Central Water Commission, which is a premier Technical Organization in the field of water resources and is presently attached to the Ministry of Water Resources, River Development and Ganga Rejuvenation. It deals with initiating, coordinating and furthering in consultation with state governments concerned, schemes for flood control, irrigation, navigation, drinking water supply and water power development. When required it may undertake investigations, construction and execution of any such schemes required. It has a regional office in Coimbatore, Tamil Nadu. In Kerala there is no State Water Commission. most tasks are entrusted to the Department Water Resources and in particular its Irrigation Department. It is being considered to enhance it's mandate and become the focal ministry for integrated water resources management. At least, the willingness is there in some quarters.

A separate observation is that, based on the infrastructures visited, there is a general lack of maintenance, probably due to the same shortage of funding for O&M as in other sectors, in particular Water Supply & Sanitation. During extreme events one can not expect the infrastructure to operate at it's full capacity.

4.2 Assessment

Acceptance of IWRM as cross-cutting is gaining momentum. As Kerala is a federal state with a well-educated population, it should be able to manage its own resources in an autonomous way. There are only 6 shared rivers with the State of Tamil Nadu, which are of minor importance and can be dealt with between the 2 states

Kerala has a strong government which gives **autonomy to lower levels** of government and in particular districts and panchayats. At the district level the local experts usually deal with operation and maintenance of smaller schemes.

There is **multitude of government entities** that one way or another deal with water related activities. They are not all of the same importance in IWRM. Therefore, we distinguish 3 rings. The **1st ring** will deal with IWRM on a daily basis, the **2nd ring** frequently, the **3rd ring** occasionally. The Department Water Resources is the most conversant with IWRM. Immediately related are the Irrigation Department, sections Groundwater and hydrographic Survey Wing (1st ring). Also related are Agriculture Development and Farmer's welfare, Environment and Climate Change, Fisheries, Harbour engineering, Public Works, Mining and Geology, Soil Survey and Conservation, Surveys and Land Records, Town and Country Planning and Water Transport (2nd ring). More remotely related are i.e. education, which could be part of a 3rd ring related to IWRM. There are no obvious coordination arrangements yet between the different directorates, apart from the first ring. Key persons recognize that this requires action.

The **mandates** of Department Water Resources and the Department Irrigation currently cover a lot of what is required for Water Resources Management. On the other hand i.e. the Energy Department manages the dams for electricity production. For irrigation purposes, the flow of these dams is considered sufficient. Nevertheless, there is much scope for improved coordination between different sectors, which, to date, is considered not easy. For a river basin systems approach this cross-sectoral coordination is crucial to optimize a more robust system. This will require a shift in culture and possibly legislation. On the other hand, well educated people in the government and civil society have a good grasp of what is required. Also, many laws and regulations are said to be in place but have not always become effective. There is quite some experience with local autonomy at the lower levels of government and a well-developed network of Community Service Organizations to build on. Apparently, there is sufficient **absorption capacity** for further developing a river basin systems approach.

Awareness, capacity building and operationalization. Broadly comparing IWRM in Kerala with reference countries, there is much still to gained. Awareness and expertise on IWRM and a systems-based approach is available. But it is limited and scattered and needs to be linked. Knowledge on IWRM is available among senior government officials and among less senior staff that still have to make a career. Especially the latter needs to be unlocked. Several key players at the government state level are aware of the importance of IWRM but do not yet have an overall common understanding. Given the awareness at the top and with individuals lower in the organization, it should be possible to train people soon to incorporate a common IWRM approach in their tasks. One could start soon with a **2 day workshop** among key stakeholders.
In the **private sector** and with **knowledge institutes** there is expertise on IWRM which could well be tapped into. Also, individuals in civil society understand the importance of IWRM. It was noted that there are different interpretations of IWRM depending on the sectoral background. It would strengthen cooperation and partnerships to enhance common understanding of IWRM with coherent and consistent training programs.

Decision making on interventions in the river basins is often based on sectoral priority rather than an overall integrated plan. Planning is done meticulously but implementation is often missing. The impact on other stakeholders is not always taken into account. Checks and balances on changing land use may be improved with inspiration from international practice. Not available is a tool like a **Water Audit** that can be applied as a proven effective check on all spatial plans and its amendments as to the impact on the overall water system.

Still to be explored is the potential to tap into the Kerala **diaspora**. . Contacts with the Kerala community in the Netherlands, confirm that there is international standard expertise available and committed to contributing. It is assumed that this expertise and commitment is available in other countries as well and is worthwhile tapping into.

The relatively new Kerala Disaster Management Agency has proven to be capable of dealing with complex issues related to IWRM. Staff is aware of and champions the future application of international best practices for adequate river basin management in Kerala including flood prevention, management and relief. Close cooperation between the department Water Resources and this Agency, even informal, has the potential to convince decision makers on immediate steps forward.

Especially **districts and panchayats** are empowered to a serious level of autonomy. This study has not been able to verify the local capabilities. There is no doubt about resilience after the disaster, but it appears as though disaster preparedness was not developed to its full extent. In terms of water management related issues, tasks are limited to small schemes, operation & maintenance. The capability is doubtful as to how to deal with IWRM without training and provision of tools. Other PDNA reports and consultation with CSOs reveal a solid base for local commitment to build on.

Informants point out that there is an abundance of **legislation**. It is not yet clear to what extent available laws strengthen one another or are contradicting. According to most informers enforcement remains a big problem. In particular land use planning, administration and permitting can be a tool to ensure that human interventions are controlled.

The team was informed about an existing **Centre for Water Resources Development and Management** , but it could not be visited to assess its role and effectiveness. It is an autonomous R & D institution in the water sector established by the Government of Kerala, under its Science and Technology Policy in February 1978. The Centre was amalgamated with the Kerala State Council for Science, Technology and Environment (KSCSTE) in its Silver Jubilee Year-2003. The centre has contributed to the scientific hydrologic studies and water management in the region.

4.3 Potential

There is a sufficient base for the introduction of IWRM. But in needs to be embedded in the governance system. At this moment there is a **momentum** to promote IWRM and put it on the political map and link it to any future spatial planning and physical development. To use this momentum and structure the potential for IWRM, the following may be considered.

The **Chief Minister's office** is the administrative level responsible for coordinating cross-sectoral development planning and implementation. With the **Chief Secretary** also being the secretary to the **Council of Ministers**, the necessary input for a balanced political decision making can be affected.

The concept of a legally constituted **Kerala State Water Board**, could be used as a point on the horizon to aim at. International examples can be used as benchmarks for Kerala. Its mandate would be to coordinate all water issues in Kerala. Specific issues may remain with specific departments, but the overall coordination and mandate to balance interests and prepare for political decision making is with the Board. The preferred option is to have such a Board attached to the Chief Minister's office. Its members are the secretaries of the most relevant departments. **An Advisory Panel** of top experts can provide top level reflection and advise and create public support. The Kerala State Water Board should be supported by a strong secretariat embedded in a focal ministry.

The Kerala State Water Board should strive for basic water safety and security to be well financed separate from the annual budget to guarantee continued funding regardless of changing administrations. (i.e. the "Water Infrastructure Fund" in the Netherlands)

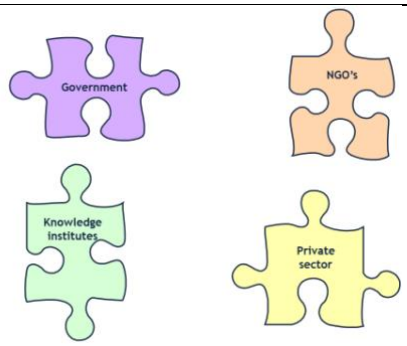
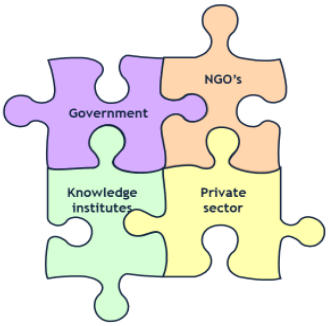
The Chief Secretary is the government administrative function where all the cross-sectoral elements of IWRM come together. Until a full Kerala State Water Board is formally established, day to day coordination can start now with an inter-departmental **Water Working Group** that can be attached to the Chief Secretary's office. Its members are the relevant secretaries and should convene at least twice a month. It needs a supporting mechanism to make coordination operational. The Water Working Group would be well advised by a provisional top expert Advisory Panel comprising representatives with excellent reputation from government, private sector, academia and CSOs. The **focal Department** is likely to be Water Resources which could start with Memoranda of Cooperation with the first ring stakeholders to ensure balanced arrangements to gain political backing. Such memoranda should be accompanied by bilateral Standard Operation Procedures. The Department Water Resources will provide a technical secretariat to the Water Working Group. The Water Working Group can report monthly to the Chief Secretary and quarterly to the Council of Ministers.

There is support for a review on existing water related **legislation**. The tool of a **Water Audit**, required to check and approve interventions on their impact on the water system, would be an operational mechanism for each development in rural and urban areas. A Water Audit should be done before issuing licenses. The impact should also be assessed properly in Environmental Impact Assessments attached to development plans. The Kerala Water Board could use the Water Audit as an operational tool.

Partnerships in Kerala with its well-educated population and with the current post disaster momentum may be well positioned to start a culture change in water management. There appears to be no platform yet where professionals can meet from the public and private sector. There is the India Water Partnership. Its effectiveness is still limited when compared with other countries. It looks attractive to set up a Kerala Water Partnership. It will be an independent entity supported by its stakeholders. It could become a platform for dialogue between all relevant stakeholders in the water sector, Public, Private, Knowledge institutes and NGOs. Start dialogue groups for specific interest groups like water supply, irrigation, etc. with a special focus group on integrated water resources management to create coherence.

Develop common interest programs on capacity development, research, advocacy. The Global Water Partnership may well support such a KWP, since the GWP has IWRM as its mission. It can also provide an IWRM toolbox. Linking up may kick start the process.

Potentially organized by the KWP, Kerala may celebrate an annual International Water Day each March.

Partnerships between Government Agencies, NGOs, Knowledge Institutes, and Private Actors is Key	
	

Community participation is well developed. Kerala has a strong network of Civil Society Organizations that often work complementary to the government. Also, resilience and self-help are strong. The collective efforts during and immediately after the floods have proven that there is a huge potential to address water management at the grass roots level. CSO can contribute in and take responsibility for awareness development/training, monitoring, enforcement by exposure and advocacy/feed back to the government, private sector and knowledge institutes. This can have a tremendous impact if the full power of communities is mobilized in on-plot retention, neighbourhood planning and implementation, maintenance of channels, reporting on waste dumping and pollution. The CSO can thus safeguard the interests of the community where the government cannot and should not reach. The potential of the Haritha Keralam mission can be further explored covering household level segregation and safe disposal of waste, rejuvenation of tanks, ponds, streams and rivers, promoting organic agriculture. The Mahatma Gandhi National Rural Employment Scheme may serve well here to combine IWRM and employment generation. Attention for the gender angle and its impact may be supported by the Kudambahree Community networks.

Unfortunate is the **encroachment** over the past decades on bunds and river banks that are known to be flood prone and may hamper maintenance. Often this is government owned land where no developments are allowed. Resettlement may be hard, but the concept of Living with Water may well be applied here. Future encroachment is to be stopped unless planned and the principles of Living with Water are adhered to meticulously. Next to formal land use planning and enforcement, officials at **district and panchayat level** can play an important role, supported by community efforts. **Flood risk** may be reduced but not completely avoided. Communities have to designate safe places to flee to with shelter, water, food, power and communication facilities. This can be organized at the community level.

Communication is key to effective partnerships. Transparency and accountability are core, requiring protocols for information sharing. An even broader communication strategy is recommended as an essential part of an IWRM approach. It should be set up and become operational with the start of the IWRM approach even at the planning stage of a pilot basin.

5. Inter-sectoral links

IWRM is cross-sectoral. In the assessments and recommendations throughout the PDNA report many links can be seen with IWRM.

- **Environment**
  Soil erosion and forest area, riverine impacts, water contamination and biodiversity are the environmental issues directly related to upper catchment soil and water conservation and erosion protection to be approached through integrated watershed management interventions in the hill and midland zones of the river basins. Dam operation rules need to consider release of environmental flows for year-round sustained riverine eco-systems. When looking at "Room for the River", giving more room or space to the water to flow through at higher discharges, this can well go together with ecological restoration in the widened river reaches and in river by-passes and thus contributing to a 'green Kerala'.
- **Employment and Livelihood**
  Within IWRM there are ample opportunities for MG-NREGS jobs. Eco-restoration works are mentioned. Also, at panchayat level jobs can be created in taking up the first watershed management infrastructural works on creek and small streams building small check dams or cleaning out where waterlogging is a danger.
- **Agriculture, fisheries and livestock**
  Long term risk mitigation through maintenance of natural flow of rivers, prevention of soil degradation and improving soil health and integrated flood resilience approach are cross linking components in the crop recovery strategy. IWRM planning always considers fisheries to be balanced with requirements from other water users. It is sometimes a challenge but there are ample opportunities for co-habitation in a profitable way for all users (fisherman, paddy farmers, tourist entrepreneurs, wetlands). A proposed Vembanad Development Authority should not be seen independent from a future institutional setting for the planning for the Kuttanad Water Body as a whole, including the extensive Vembanad lake system.
- **Housing, Land and Settlements**
  The recommendations for proper land use level in the Coastal, Midland, Hill zones with Kuttanad a special zone will very much need to go together with demarcating land reservations in e.g. flood plains or old river beds for "Room for the River" measures. Reservations to be placed on these lands with prohibition of any build-up. Flood risk maps are to be part of overall hazard zoning.
- **Disaster Risk Reduction**
  Insight in the behaviour of a river basin, which comes with IWRM, and tools such as hydrological models and flood risk mapping can be used in the design of flood risk awareness for strengthening of disaster preparedness and response.
- **Health and nutrition**
  Ensuring clean and healthy rivers and the ensuring of clean water to all users is to be seen as a main contributor to preventive health care.
- **Local Governance**
  Forecasting and Early warning systems for river floods for better preparedness needed for last mile connectivity will be contributed to by IWRM tools such as hydrological models of the water systems. Involving panchayats in local IWRM actions would be a most effective way on spreading the concept and make people more comfortable in enjoying and respecting water whilst "Living with Water".
- **WASH**
  WASH will always be part of IWRM with water supply having a direct relation with its water source. Proper sanitation and effective waste management are prerequisites to keep clean and healthy water resources.
- **Gender and social inclusion, cultural heritage, education and child protection**
  These are cross-cutting aspects against which an Integrated River Basin Plan needs to be judged with respect to good governance, social responsibility and capacity building.

6. Recommendations

This report accommodates the desire of the Kerala government to give recommendations over the short, medium and long term. But in addition, they requested recommendations that could immediately be followed up.

Immediate

- Use the current momentum and get commitment at the State level that a system based IRWM approach is adopted, to ensure that administrators and civil servants have the political support.
- Organize a 2-3 days IWRM workshop with stakeholders, sharing the notions of this report and seeking comments and commitments on applicability in Kerala of integrated watershed management, 'Room for the River' principles, 'Living with Water' and eco-engineering.
- Start collection, digitalizing and validation of all relevant hydrological, topographical, bathymetric and remote sensing data in preparation of and as a prerequisite for a Hydrological Crash Programme.
- Enforcement on land use and licensing for flood prone areas, both at the state and Panchayat level.
- Start Village level campaigns to "Live with Water" at the neighbourhood level, including improvement of basic flood and drainage infrastructure, accompanied by a communication campaign. Link with national and local missions' programs/schemes.
- Start village and district level training in Integrated Watershed Management to restore good water absorption and erosion protection in the upper watershed.
- Prepare a TOR and start initial Kerala implementation of a Hydrological Crash Programme.
- Prepare a TOR for and start initial local implementation of a comparative study on IWRM legislation
- Formulate a TOR for a Masterplan for Kuttanad basin.
- Seek financing at state and national level as well as potential for international support. Link up with NHP.

Short term (0-2 year)

- Prepare dam operation protocols including balanced operational rules for optimizing power generation, irrigation supply, safe guarding of the dam, flood protection when heavy rains occur and release of environmental flow during droughts.
- Improve operation and maintenance supported by sufficient budget allocation.
- Start with simple guidelines that could be tested and embedded later in existing legislation.
- Set up a provisional Water Working Group with a technical secretariat to enhance cooperation between stakeholders. Link it to a focal department (DWR).
- Start with Memorandum of Cooperation between the Department Water Resources and most relevant stakeholders and accompany with Standard Operating Procedures.
- Cooperate with universities that claim to have their own data sets and models.
- Set up a Kerala Water Partnership.
- Analyse the educational capacity in Kerala as to the potential to develop IWRM training. programs. Link up with national and international knowledge centres.
- Start implementation of a Hydrological Crash Programme.
- Start a comparative study on IWRM legislation.
- Start a Masterplan for Kuttanad water body.
- Start capacity building on coastal zone management and coastal/marine engineering.
- Seek financing at state and national level with potential for international support. Link up with NHP.

Medium term (2-5 years)

- Revise existing legislation to support IWRM, remove overlaps and shortcomings that need to be addressed. Present best practices from India and abroad as alternatives to choose from.
- Approve, finance and implement Kuttanad master plan for a pilot IWRM and realize institutional changes to get it approved, implemented and enforced. Use experiences in the pilot for the other basins, based on available expertise developed in the meantime.
- Consider upgrading the Water Working Group to a "Kerala Water Resources Committee", well mandated and supported by adequate legislation. Use international examples as benchmarks.
- Evaluate enforcement effectiveness.
- Prepare decision makers for scenario based and adaptive planning.
- Embark on the preparation of comprehensive River Basin Planning. Consideration is to be given to long term scenarios for administrative/political discussion on the preferred long-term vision in respect of water resources management on which consists political consensus.
- Analyse the educational capacity in Kerala as to the potential to develop IWRM training programs at college, academic and post-graduate level.
- Allow for benchmark visits for key stakeholders to encounter best IWRM practices in several countries to allow for inspiration to create a system that suits Kerala.

Long term (more than 5 years)

- Expand the Kuttanad example to other basins.
- Solidify water safety and water security in long term legislation
- Build towards a budget arrangement to allow for constant operation & maintenance as well as upgrading of the system as scenarios unfold over time with overall development in Kerala.
- Evaluate every 5 years the performance of the technical and institutional infrastructure.

7. Immediate follow up, Cost and Actors

7.1 Follow up

- Start a comparative study into IWRM related legislation in Kerala. Start immediately with a team of Kerala experts, complemented with experts form the diaspora. Add an expert with proven international experience in a matured IWRM environment. Explore the possibilities to broaden the mandate of the Department Water Resources
- Organize within 2 months a team of Indian and international experts to formulate a TOR for a Basin Management Plan. Focus on the Kuttanad area and incorporate the basins of the rivers flowing into the area
- Organize rapid funding from Kerala, India (NHP?), and international sources for both initiatives.
- Kerala and in particular the Department Water Resources to be in the lead

7.2 Cost and Actors

No estimate is made of damage and immediate recovery costs since this covered to a large extent by the other PDNA reports and the JRDNA report. Only cost for the immediate follow up and priority actions are indicated. Further costing is considered part of follow up activities

Immediate follow Up and actors:

- Workshop: Routine budget (Ch. Secretary's office together with DWR)
- Initial data collection and modelling: Routine budget (DWR)
- Enforcement: Routine budget (Department Land Use and Districts/Panchayats)
- Village level campaign (DWR, CSOs, Panchayats)
- TOR formulation plus guidance to upgrade databases: US$ 50.000 (Chief Secretary and DWR)
- TOR formulation plus comparative study IWRM legal environment: US$ 75.000(Chief Secretary with DWR with Legal Dept.)
- TOR formulation plus master plan "Kuttanad basin": US$ 2 – 3.000.000 (Chief Secretary and DWR)
- TOR formulation plus Hydrological Crash Program: US$ 750.000 DWR)
- Seek financing: Routine budget (Coordination with Chief Secretary)

8. Methodology

- The international experts brought in their personal experience from countries around the world, in particular in Asia as well as India. Also the Netherlands experience with the delta plan and Room for the River program as well as access to innovation hubs in the Netherlands.
- Reading newspaper articles, checking open sources.
- Reports (especially JRDNA and CWC) and data sets available prior to their departure and provided in Kerala.
- Use was made of the expertise available in the Netherlands with the Kerala diaspora.
- The UNDP/PDNA office provided excellent support in arranging strategic appointments and logistics, including field visits.
- Input from the other PDNA teams was taken into account where relevant
- Already at an early stage, it became obvious that many phenomena in Kerala are not unique and matching problems with international best practices soon indicated the way forward.
- The initial scope for the way forward was tested in several meetings,
- The 1st draft report was distributed and comments invited. Based on further meetings and verification of support for the outcome, the comments the report was refined.

Kerala rebuilding cost put at ₹27,000 cr

The Hindu. Friday, October 12

Draft report prepared with the support of 11 UN agencies presented to Chief Secretary

SPECIAL CORRESPONDENT
THIRUVANANTHAPURAM

The draft Post Disaster Need Assessment (PDNA) on Kerala floods, prepared with the support of 11 UN agencies, estimates that the State may need about ₹27,000 crore for the Nava Keralam project within the next five years.

The study has found that the highest amount would be needed for rebuilding roads (₹8,554 crore), followed by housing (₹5,659 crore), agriculture, fisheries and livestock (₹4,499 crore), livelihood (₹3,903 crore), irrigation (₹1,484 crore) and water and sanitation (₹1,331 crore).

The report has several suggestions to make Kerala the first green State in India with eco-sensitive and risk informed approach. The report gave several high ticket innovations and global examples to build back better Kerala, a statement said.

A first for India

The report was presented to Chief Secretary Tom Jose by acting UN Resident Coordinator and WHO India Chief Henk Bekedam and PDNA State coordinator and Fisheries Director Venkatesepathy here on Thursday. This is for the first time that a PDNA report has been prepared in India by the UN.

Agencies involved

The UN agencies involved in its preparation included UNDP, UNICEF, UN WOMEN, WFP, UNFPA, WHO, ILO, FAO, UNEP and European Union.

The team had two integrated water resource management experts from Netherlands.

The UN PDNA coordinator Rita Missal, UN State team leader Job Zachariah, water experts from Netherlands Simon Warmerdam and Paul Van Meel were present when the report was handed over to the Chief Secretary.

Acting UN Resident Coordinator and WHO India Chief Henk Bekedam presenting the draft Post Disaster Need Assessment on Kerala floods to Chief Secretary Tom Jose in Thiruvananthapuram on Thursday.

Norms for housing for flood-hit issued

SPECIAL CORRESPONDENT
THIRUVANANTHAPURAM

The government has issued guidelines for measures to be adopted by District Collectors in identifying land to house flood victims who lost their land and dwellings in the recent floods.

A government order (GO) issued by the Disaster Management Department directs the Collectors to relocate people from environmentally fragile areas to safer locations.

Families with the resources to purchase land will be allowed to do so and provided with financial assistance subject to certain conditions.

The Collectors have been asked to identify land to rehabilitate financially backward families. Unused land belonging to government departments, public sector institutions or unproductive plantations and that earmarked for projects that have since failed to take off can be considered, as well as property donated to the government.

Plots of 3 to 5 cents

The officials have been instructed to provide assistance for construction of houses after dividing the available land into plots of three to five cents.

The GO recommends the construction of multi-storey apartments in areas where the demand for housing outstrips the availability of land.

It also moots the adoption of modern technology for fast completion of projects. Beneficiaries are to be consulted on the projects.

The Collectors have also been asked to purchase land if no other option is available.

However, the land should not be environmentally fragile or flood prone.

Authority denies allegation on dam mismanagement

Says CWC had examined details of rainfall and discharge

SPECIAL CORRESPONDENT
KOCHI

- Presents its case before the High Court
- Says dams served as a controlling mechanism to contain flood situation

The Kerala Dam Safety Authority on Thursday informed the Kerala High Court that the allegation that the August flood was caused by improper management of water level in dams was absolutely untenable and unsustainable.

In an affidavit, K.H. Shamsudeen, member secretary, said the dams served as an effective controlling mechanism for containing the flood situation.

Pivotal role for dams

In fact, the Central Water Commission (CWC) had examined the details of the rainfall and discharge from the dams during the relevant period and concluded that the dams in the State had, in fact, reduced the intensity of the flood following the controlled release of water.

Flow neutralisation

It was beyond dispute that the management of the quantity of water was more or less under control till August 14, 2018 when unexpected and unprecedented rainfall necessitated neutralisation of inflow of water for securing the safety of the dams.

The affidavit pointed out that the unprecedented flooding at Chengannur, Thiruvalla, and Pala had been attributed to the Achencoil, Manimala, and Meenachil rivers that did not have any dam.

No wilful inaction

The report said all the dams were managed efficiently to contain water to the most safest level. The safety and security of the dams were maintained. There was no wilful inaction on the part of the authority in preventing the flood situation.

The flood was comparable in its severity and depth to the flood of July 1924.

The affidavit was filed in response to a writ petition filed by T.G. Mohan Das seeking a directive to the Central Water Commission to conduct an investigation into the alleged mismanagement in regulating the outlaw of water in proportion to the inflow of water.