A SPECIAL PACKAGE FOR POST-FLOOD KUTTANAD

Kerala State Planning Board
October 2019

GOVERNMENT OF KERALA

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GOVERNMENT OF KERALA

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MESSAGE

Kuttanad Wetland Agriculture System is unique due to the practice of rice cultivation below sea level. The Kuttanad system is a mix of fragmented agricultural landscapes. The landform comprises of *Kayalnilangal, Karinilangal* and *Karappadangal*. Kuttanad is drained by a network of rivers, canals and man made channels. The water inflow is mainly controlled by the four river systems - Meenachil, Manimala, Pampa and Achencovil which ultimately drain into Kuttanad.

In the region, the major resource for livelihood is the Vembanad lake, in various forms of reclaimed lands for paddy cultivation, fishing, tourism etc. The Swaminathan Commission Report (MSSRF report) of 2007 was a landmark in the history of Kuttanad which paved the way to have a "Kuttanad Package" with specific focus on the seven major themes of the region.

The monsoons of August 2018 struck Kuttanad drastically creating misery to the inhabitants by way of financial instabilities due to lost livelihoods. A holistic approach is essential to resurrect Kuttanad from this havoc. This report "A Special Package for Post Flood Kuttanad" is all the more significant in this context. This special package for Kuttanad will contribute to the Government's initiative to build "New Kerala" (*Navakeralam*) in the post flood scenario.

This report throws light on the implementation systems of the earlier Kuttanad Package and the assets generated. In the attempt to resurrect Kuttanad from the flood damages and to preserve its biodiversity, the report focuses on the necessity of an integrated multi departmental approach. The report covers various aspects such as - better livelihood, clean and safe drinking water, adequate sanitation, promotion of tourism etc.

The recommendations suggested in this report are innovative and I appreciate the commendable initiative of State Planning Board in this regard. I wish all success for the execution of this package which will definitely help to regain the uniqueness of Kuttanad.

Pinarayi Vijayan

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FOREWORD

Kuttanad is a region spread across the Alappuzha, Kottayam and Pathanamthitta districts in the State. It is known for its water bodies, agriculture, fisheries, its biodiversity, and great natural beauty, and it occupies a special place in Kerala's culture and consciousness. The Kuttanad Wetland Ecosystem and below-sea-level cultivation are recognised by the Food and Agriculture Organisation (FAO) as a Globally Important Agricultural Heritage System (GIAHS). It is a wetland site designated to be of international importance under the Ramsar Convention.

The Kuttanad ecosystem has been the focus of many development efforts and studies. These studies began early in the 20th century and culminated in the development plan called "Measures to Mitigate Agrarian Distress in Alappuzha and Kuttanad Wetland Ecosystem" (also known as the "Kuttanad Package") in 2007.

The tasks of area and spatial planning for Kuttanad involve the activity of different departments of Government, including those dealing with agriculture, water resources, fisheries, public works, industry, tourism and others. The development of Kuttanad has thus been of special concern to the State Planning Board. The Board began its study of Kuttanad in early 2018.

Given the topography of Kuttanad, it was one of the areas most affected by the floods of 2018. After the floods, the State Government gave the State Planning Board the task of preparing a special package for Kuttanad wetland ecosystem. In his Address to the Legislative Assembly in 2019, the Governor of Kerala stated that the State Planning Board was expected to prepare "a special package for Kuttanad Wetland Ecosystem to revitalise the overall development of the region through the development of various components and envisaging the integration of all departments."

Preparation for this report involved consultation with a very wide range of experts and stakeholders. The State Planning Board consulted representatives of farmers and fish workers, elected representatives of the people, administrators, and experts drawn from different fields, including agriculture, engineering, hydrology, fisheries, and tourism.

The report analyses the progress made under the previous Kuttanad Package after 2007. In keeping with the commitment of the 13th Five Year Plan, the report looks forward to making Kuttanad an area of sustainable environment-friendly economic growth with high levels of income generation, based on sustainable and remunerative livelihood opportunities. The application of modern science and technology, and the participation of the people and Government, are the basis for sustainability.

The report suggests that implementation of the recommendations be monitored by a Monitoring Committee. Successful implementation of the report requires inter-departmental co-ordination involving all departments concerned.

We are grateful to the Chief Minister of Kerala, Shri Pinarayi Vijayan, for his encouragement of this work.

Dr R. Ramakumar, Member, State Planning Board, is the lead author of the report. The nodal Division for the preparation of the report in the State Planning Board was the Agriculture Division. Shri S. S. Nagesh, Chief, Agriculture Division and all officers and staff of the Division participated in its preparation. The authors consulted and received detailed comments from the lead author of the 2007 report, Professor M. S. Swaminathan. They received special guidance and inputs from Dr E. J. James, Dr K. G. Padmakumar, Dr Ajayakumar Varma, Dr Srikumar Chattopadhyay, and Shri G. Venugopal, President, Alappuzha District Panchayat. All line departments, the Kerala Agricultural University, the Kerala Veterinary and Animal Sciences University, Kerala State Land Use Board, Kerala State Remote Sensing and Environment Centre, Centre for Development of Imaging Technology, and others supported this effort fully. I am grateful to all of them.

We look forward to a new road ahead for Kuttanad and its people in the years to come.

V K Ramachandran
Vice-Chairperson
Kerala State Planning Board
Thiruvananthapuram, 1 October, 2019

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INTRODUCTION

The Kuttanad region of Kerala is a *Globally Important Agricultural Heritage System (GIAHS)*, as declared by the Food and Agriculture Organization (FAO). The key feature of Kuttanad is the cultivation of paddy at 1 m to 2 m below sea level in wetlands formed by draining delta swamps in brackish waters. Such cultivation of paddy is shaped by the specific system of fresh and saline water flow in the region. From the East, the Vembanad Lake in Kuttanad is at the receiving end of five of Kerala's major rivers: Pamba, Achankovil, Meenachil, Manimala and Muvattupuzha. From the West, Kuttanad receives the inflow of saline water from the Arabian Sea. In the north, the Thanneermukkam salt-barrage regulates the inflow of salt water into Kuttanad. In the south, the Thottappally Spillway helps the outflow of monsoon water into the Arabian Sea. Within these conditions, paddy is cultivated in polders, coconut is grown in garden lands, ducks are reared in water-logged areas and fisher-families harvest special species of fish. More recently, the region is also an acclaimed tourism destination.

Kuttanad is one of the few regions in India where paddy is cultivated below sea level. Over more than 150 years, farmers in this region have developed and mastered the technique of below sea level cultivation of paddy. This unique system in Kuttanad has many similarities with the Dutch polder system, which is also recognised as a GIAHS by the FAO.

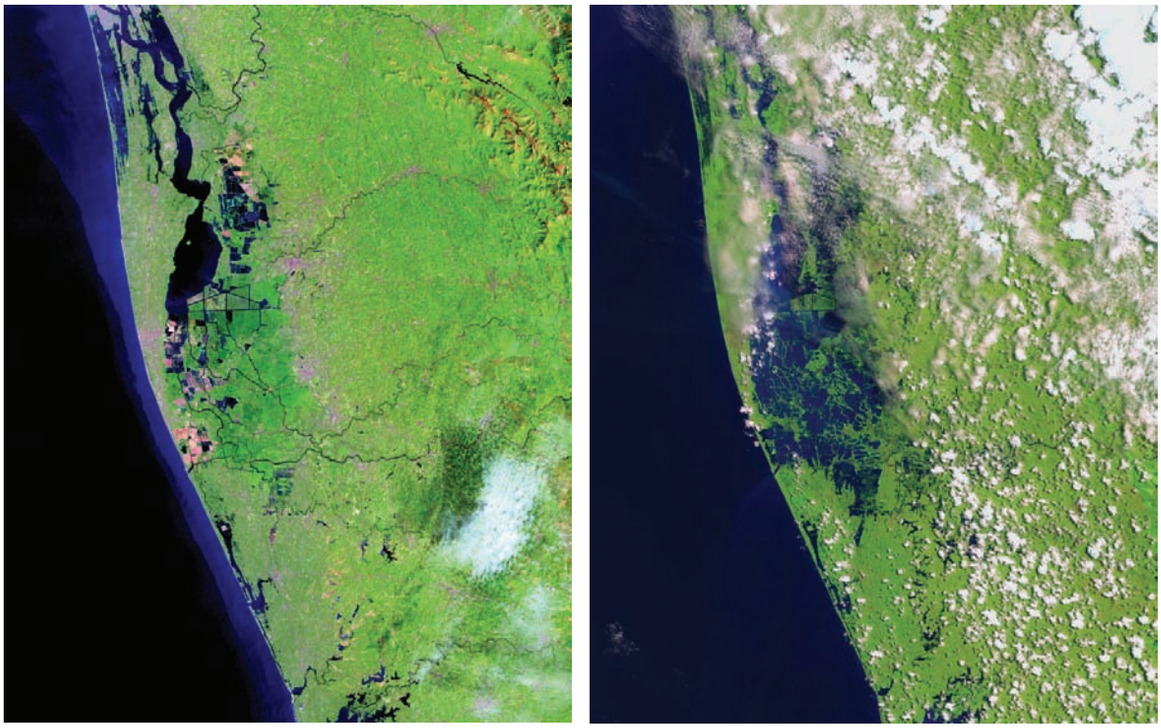
During the floods of June, July and August 2018 in Kerala, the Kuttanad region was acutely affected. Lying 1 to 2 metre below mean sea level, Kuttanad has always been highly flood prone. Every year, during the monsoons, some part of this region is flooded. Data show that floods generally occur with varying intensities at a recurrence interval of 2, 5, 10, 25, 50 and 100 years. The flood of August 2018 was a once in 100 years phenomenon, or of 1 per cent probability. The rivers of Meenachil, Pamba, Manimala and Achankovil, which debouch into the Vembanad Lake and Kuttanad as a whole, originate in the Idukki district. Idukki experienced "large excess" rainfall between 1st June and 22nd August 2018, which was a 92 per cent departure from the normal rainfall. Runoff generated from these four rivers during the rains between 15th and 17th August 2018 was about 1.63 bcm, as against the 0.6 bcm carrying capacity of the Vembanad Lake (see **Table 1**). The remaining quantity of about 1 bcm of runoff created a rise in the water level in the Vembanad Lake and the adjoining areas. Flood height rose to 8.46 m on the 16th August 2018 at Malakkara on the Pamba river (CWC, 2018). This was 0.46 m higher than the "high flood level" (HFL) at Malakkara of 8 m.

Table 1 *River discharge between 15th and 17th August, 2018, selected rivers, Kerala*

Name of River	Catchment Area (km²)	Depth of rainfall (15th-17th Aug) (in mm)	Runoff (15th-17th Aug) (in MCM)	Runoff in 3 days as % of total annual runoff
Meenachil	820	437	268	11.4
Pamba & Manimala	2656	517	1030	15.9
Achankovil	1359	329	336	14.7
Total/weighted average	**4835**	**451**	**1634**	**14.7**

Source: CWC (2018).

Satellite images for the Kuttanad region presented in **Figure 1**, extracted a few months before the floods and immediately after the floods, illustrate the extent of flooding as on the 22nd of August 2018.



February 6, 2018 August 22, 2018

Figure 1 *Satellite images of the Kuttanad region, February 2018 and August 2018*

Source: Earth Observatory, NASA, available at https://earthobservatory.nasa.gov/images/92669/before-and-after-the-kerala-floods.

Note: The Operational Land Imager (OLI) on the Landsat 8 satellite acquired the left image (bands 6-5-3) on February 6, 2018, a normal month before the flood. The Multispectral Instrument on the European Space Agency's Sentinel-2 satellite acquired the right image (bands 11-8-3) on August 22, 2018, after floodwater had inundated the area. The images are false-colour, which makes the floodwater appear dark blue. Vegetation is bright green.

Due to the heavy rainfall and the breaching of polder walls (bunds), more than 50,000 houses in Kuttanad were drowned or partly drowned. In an unprecedented rescue operation using India's Army and Navy units, more than 200,000 persons were evacuated and housed in relief

camps. Paddy crop cultivated in about 15,000 ha was destroyed. Almost the entire paddy area sown was lost due to the floods. The floods also uprooted more than 10,000 coconut palms, which were cultivated along the bunds of paddy crop as well as independently in garden lands. The Government of Kerala has received widespread praise for its leadership role in disaster management and relief provision during and after the floods. It now faces the uphill task of rebuilding the regions of the State affected by the floods. The government has embarked on a mission to "Rebuild Kerala". The reconstruction of infrastructure and livelihoods in Kuttanad is an integral part of rebuilding Kerala.

The Kerala State Planning Board (KSPB) has been closely studying Kuttanad for many years. Right from the days of the initial floods in June 2018, the KSPB undertook many study visits to the area, both to understand the losses as well as to help the government chart out a relief and rehabilitation plan. After the floods of August 2018, the Government of Kerala entrusted the KSPB with the task of preparing a plan for the reconstruction of Kuttanad.

This report proposes a blueprint for the future direction of public policy in the Kuttanad region. Drawing from the existing wealth of information on Kuttanad in the literature, as books, journal articles, study reports, policy documents, papers and journalistic writings, as well as on reports and studies after the August floods of 2018, we try to draw the contours of the approach that post-flood policy should adopt. In particular, we consider the Indo-Dutch study of 1989, the MSSRF report of 2007 and the Indo-Dutch assessment of 2019 as the starting points of a possible new approach (Indo-Dutch Mission, 1989; MSSRF, 2007; GoK, 2019b). The MSSRF report of 2007 already provides a master plan for Kuttanad, but we feel that it needs modifications in the light of the new challenges that the floods have posed.

While planning for Kuttanad, we also feel that a wide variety of voices of dfferent stakeholders should be heard. In this regard, first, the KSPB undertook detailed discussions with experts who have studied Kuttanad. Some notable names among them included M. S. Swaminathan, E. J. James, K. G. Padmakumar, Srikumar Chattopadhyay, N. Anil Kumar, Babu Ambat, N. C. Narayanan, Ajayakumar Varma, K. T. Thomson, Reena Mathew, K. Geetha, A. Suresh and M. Gopakumar. A meeting with invited experts was organized in the KSPB office in Thiruvananthapuram on 13th September 2018. Secondly, the KSPB undertook detailed discussions with staff of all the implementing departments that were, or were to be, concerned with the Kuttanad Package. A one-day workshop was convened in Alappuzha on 24th November 2018, in which staff from more than 10 line departments participated (**Figure 2**). E. J. James participated in this meeting as the external resource person. This was in addition to regular meetings, individually, with these departments.

Thirdly, the KSPB team conducted discussions with selected farmer's groups and selected farmers in Kuttanad to understand their specific problems and expectations. Fourthly, the KSPB team undertook visits to most of the major sites where the Kuttanad Package was implemented and directly analysed the progress and lessons learnt. Finally, the KSPB team conducted two rounds of discussions with the experts from Netherlands who studied Kuttanad floods. These experts were: Simon Warmerdam (Expert, Dutch Disaster Reduction Team); Job Dronkers (Coastal Zone expert); Paul van Meel (Expert, Dutch Disaster Reduction Team); and Pascal Weidema (Senior Advisor, GIS/Water Management). This report brings together much of what the team learnt during this process.

Figure 2 *From the one-day workshop in Alappuzha on 24th November 2018*

THE AGRO-ECOLOGY OF THE REGION

Kuttanad, or the "low lying lands", is a unique agro-ecological system spread over 10 taluks in three districts of Kerala i.e., Alappuzha, Kottayam and Pathanamthitta (see **Figure 3**). The region extends from 9°17' N to 9°40' N and 76°19' E to 76° 33' E. The geography of this area is marked by the deltaic formation that arose out of the confluence of the five major rivers viz., Achancovil, Manimala, Pampa, Meenachil and Muvattupuzha. It encompasses an area of 874 km^2. Out of this, an estimated area of 490 km^2 lies 1 to 2 m below MSL, which is predominantly used for rice cultivation. A substantial part of these lands were reclaimed by peasants from the Vembanad Lake. These lands are not contiguous as channels and waterways surround each strip of land. The garden lands comprise of about 304 km^2. These garden lands

look like islands of varying sizes and shapes. The natural blending of land and water coupled by the high fertility status of soil makes this land-water ecosystem ideal for agricultural purposes.

Nearly 57 per cent of Kuttanad is shared by Alappuzha district with 32 panchayats; about 30 per cent is shared by Kottayam district with 27 panchayats; and about 13 per cent is shared by Pathanamthitta district with 5 panchayats. Together, these form about 2.5 per cent of the State's geographical area. Nearly 95 per cent of the farm holdings in Kuttanad are small or marginal. Rice is the major crop in wetlands and coconut is the major crop in garden lands. Banana, tubers, vegetables and tree spices are grown as intercrops.

The whole of Kuttanad is divided into six agro-ecological zones based on the topography, proximity to saline water intrusion, flood etc. They are Lower Kuttanad, Upper Kuttanad, North Kuttanad, Kayal lands, Vaikom Kari and Purakkad Kari. The paddy fields in Kuttanad are wetlands, either natural low-lying land formations or man-made reclamations from the Vembanad Lake and are classified into three distinct zones viz., *Karappadam, Kayal* lands and *Kari* lands (see **Figures 4a** and **4b**).

Karappadam lands (about 33,000 ha) are areas of alluvial soils situated along waterways and constitute the lower reaches of the eastern and southern periphery. They are at a higher elevation than the *kayal* and *kari* soils. They are moderately acidic in reaction. *Kayal* lands (about 13,000 ha) constitute padashekharams reclaimed from the Vembanad Lake with elevations between 1.5 to 2.2 m below MSL. The soils here are neutral in reaction and contain vast deposits of fossils of lime shells beneath the topsoil. *Kari* lands (about 9,000 ha) have black peaty acidic soils and are located at or below MSL to the North (Vaikom), West (Thuravur) and South-West (Ambalapuzha, Thakazhi and Purakkad).

The Vembanad wetland ecosystem has a number of major associated values or functions, which could be termed as "ecosystem services" (James, 2000). First, the wetland serves as an important receptacle to monsoon flood flows, protecting the areas to its west from severe floods. Estimates are that monsoon flows into Vembanad range from 10,000 mm^3 to 18,000 mm^3. Secondly, the Vembanad wetland system is also home to rich flora and fauna. It consists of mangroves, and a large variety of fish, prawns, clams, reptiles and birds. The wetland system is one of the richest avifaunal habitats on India's west coast. Thirdly, the below sea-level agriculture practised in the system provides direct and indirect livelihood to about 1.5 to 2 lakh persons who reside within the system as well as in its vicinity. Fourthly, the region is also home to thousands of fisher-households, who obtain their livelihood from the rich variety of fish population in the waters. Fifthly, the waterways formed by the backwaters, estuaries, lagoons and canals form part of an integrated water transport network for the residents of the region. The Kollam-Kottappuram stretch of the west coast inland canal system of Kerala passes through the Vembanad wetland system. Sixthly, the Vembanad backwaters and its environs serve as a major base for international and domestic tourism in Kerala. During the monsoon season, many globally renowned boat races take place in the region. Hundreds of houseboats ply in the Vembanad Lake through the year, providing livelihoods to hundreds of educated youth in the region.

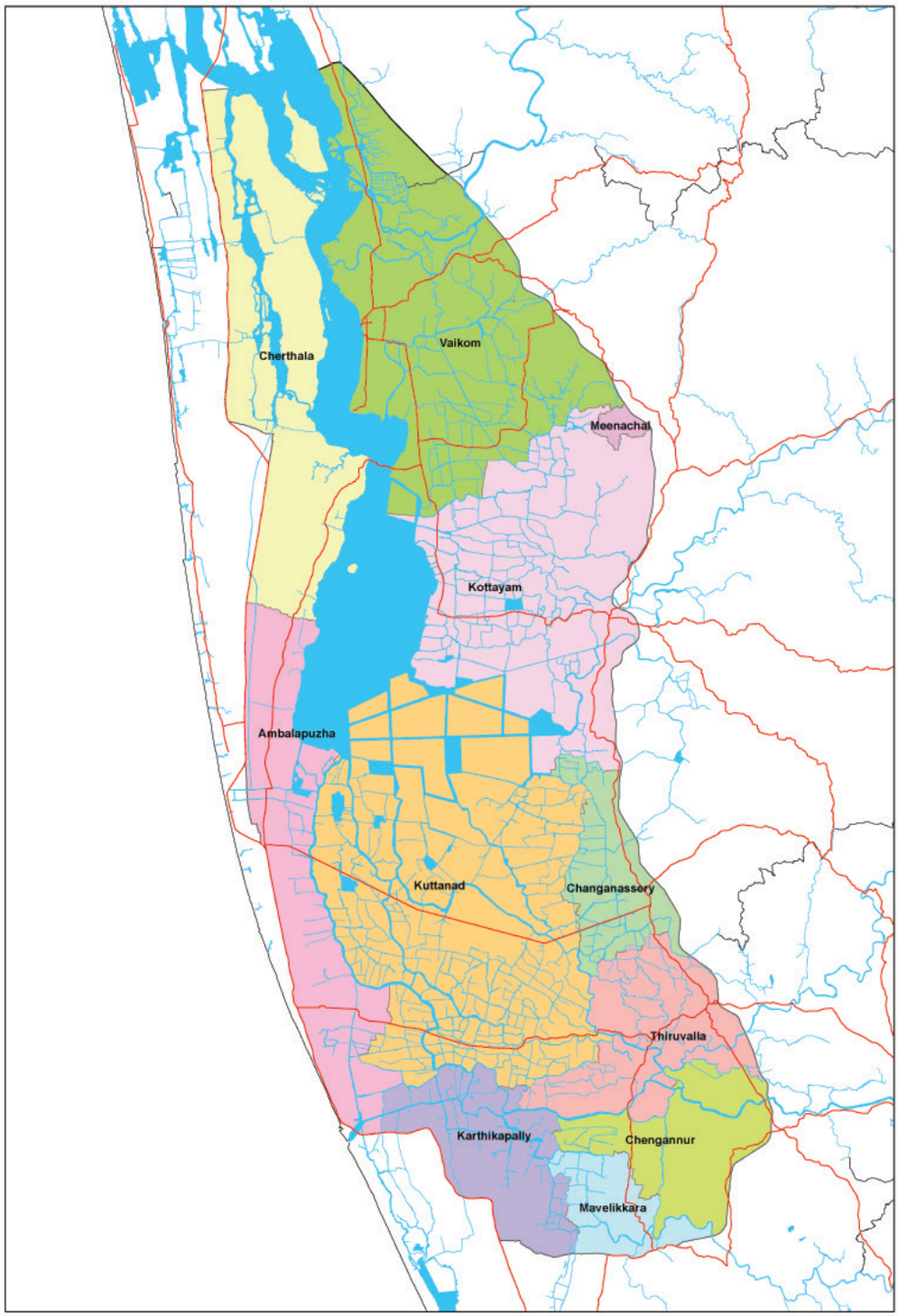


Figure 3 *Map of Kuttanad region depicting the portions of 10 taluks, Kerala.*
Source: Kerala State Land Use Board

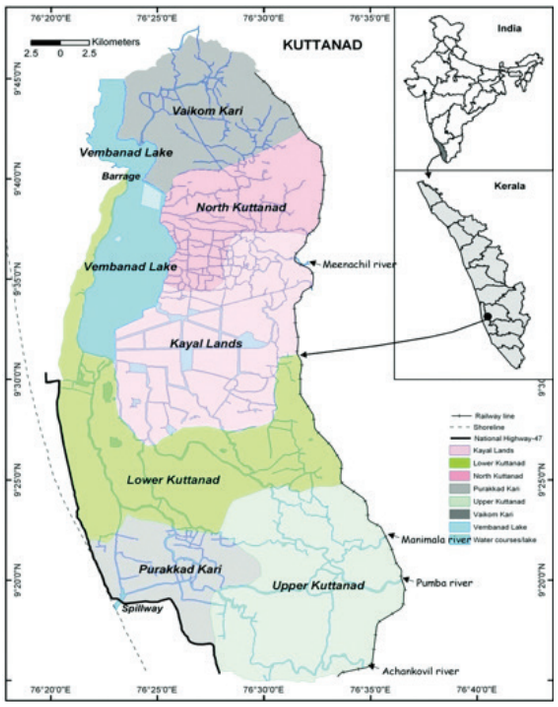


Figure 4a *The six agro-climatic zones in Kuttanad*

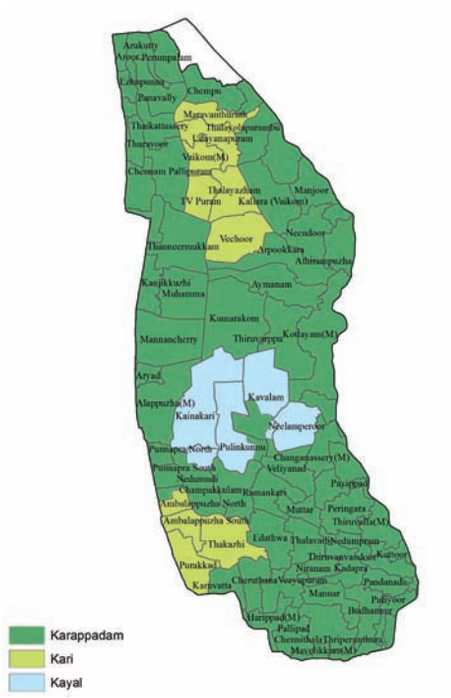


Figure 4b *Classification of soils in the Kuttanad region*

Source: Kerala Agricultural University; Kerala State Land Use Board

THE HISTORY OF "KUTTANAD DEVELOPMENT"

Prior to the 1960s, Kuttanad had only one annual crop of paddy called *puncha*. The *puncha* crop was cultivated during the non-monsoon months of the year beginning in October or November. From the 1930s onwards, given the high levels of underemployment in the region, the Government of Travancore came to identify two major constraints to the region's agricultural development: the problem of floods during the monsoon season and the problem of salt water intrusion during the post-monsoon months. Due to the problem of monsoon floods, a "second" crop of paddy during the monsoon months had become impossible. Due to the problem of salt-water intrusion, even the "first" *puncha* crop was facing constraints. If there was a way to better drain off the monsoon waters into the Arabian Sea, a second crop would become possible in the monsoon months; and if there was a way to prevent the infusion of salt water into Vembanad in the post-monsoon months, the existing *puncha* crop could be more securely cultivated.

In 1937, the government appointed two Italian engineers to investigate the potential of water resources in the State. These engineers suggested that a new flood way channel be cut open near Aryad, about 25 km north of Alappuzha, so that floodwaters could be drained out during the monsoon months. A few years after the study of the Italian engineers, an Executive Engineer with the Public Works Department (PWD) I. C. Chacko suggested in another report that a new spillway channel to the Arabian Sea be cut open at Thottappally, 20 km south of Alappuzha, to drain floodwater into the sea. However, neither of these reports were put into action till the early-1950s for various reasons.

In 1953-54, a detailed plan for the development of Kuttanad region was drawn up by the Travancore government. This plan had three major components:

(a) Construction of a spillway at Thottappally to drain floodwater from the Pamba, Achankovil and Manimala rivers into the sea;
(b) Construction of a salt water barrage at Thenneermukkam, about 40 km north of Alappuzha, to prevent intrusion of salt water into the Vembanad Lake from the Kochi side;
(c) A road-cum-canal connecting Alappuzha (west) and Changanacherry (east) to improve communication and transport within Kuttanad as well as drain floodwater from Upper Kuttanad into the Vembanad Lake.

As part of this plan, the construction of the Thottappally Spillway was completed in 1958. The first phase of the Thanneermukkam Bund was completed in 1965 and the second phase was completed in 1975. The third phase remained incomplete. Work on the AC Road was completed by the 1990s. Construction of the AC Canal, which was to run parallel to the AC Road, remains incomplete even today.

The Thottappally Spillway, the Thanneermukkam Bund and the AC Road have been the three major interventions undertaken as part of the various Kuttanad development projects by the governments of Travancore, and later Kerala (see **Figure 5**). The major objectives of these projects were (a) to stabilize the *puncha* crop by regulating the entry of salt water into Vembanad Lake; (b) to facilitate a "second crop" of paddy during the monsoon months by draining out the rainwater from the wetland plots into the Lake and then to the Sea; and (c) to improve transport and communication within the Kuttanad region.

Yet another plan of the government was to construct permanent bunds around all the *padasekharams*. If the second crop of paddy was to be raised in the monsoon periods, the bunds had to have the strength to withstand the floodwater flows. If the traditional method of preparing bunds with clay dug out of the canal beds and stabilized with bamboo and coconut trunks was to be followed, there was high risk of the bunds being breached by the strong waves and heavy currents during the monsoon. These bunds were indeed breached frequently and caused major crop losses if not reconstructed immediately. Thus, construction of permanent bunds, with a top width of 3 m, was considered a secure option. This too became part of the Kuttanad development projects from the 1950s onward.

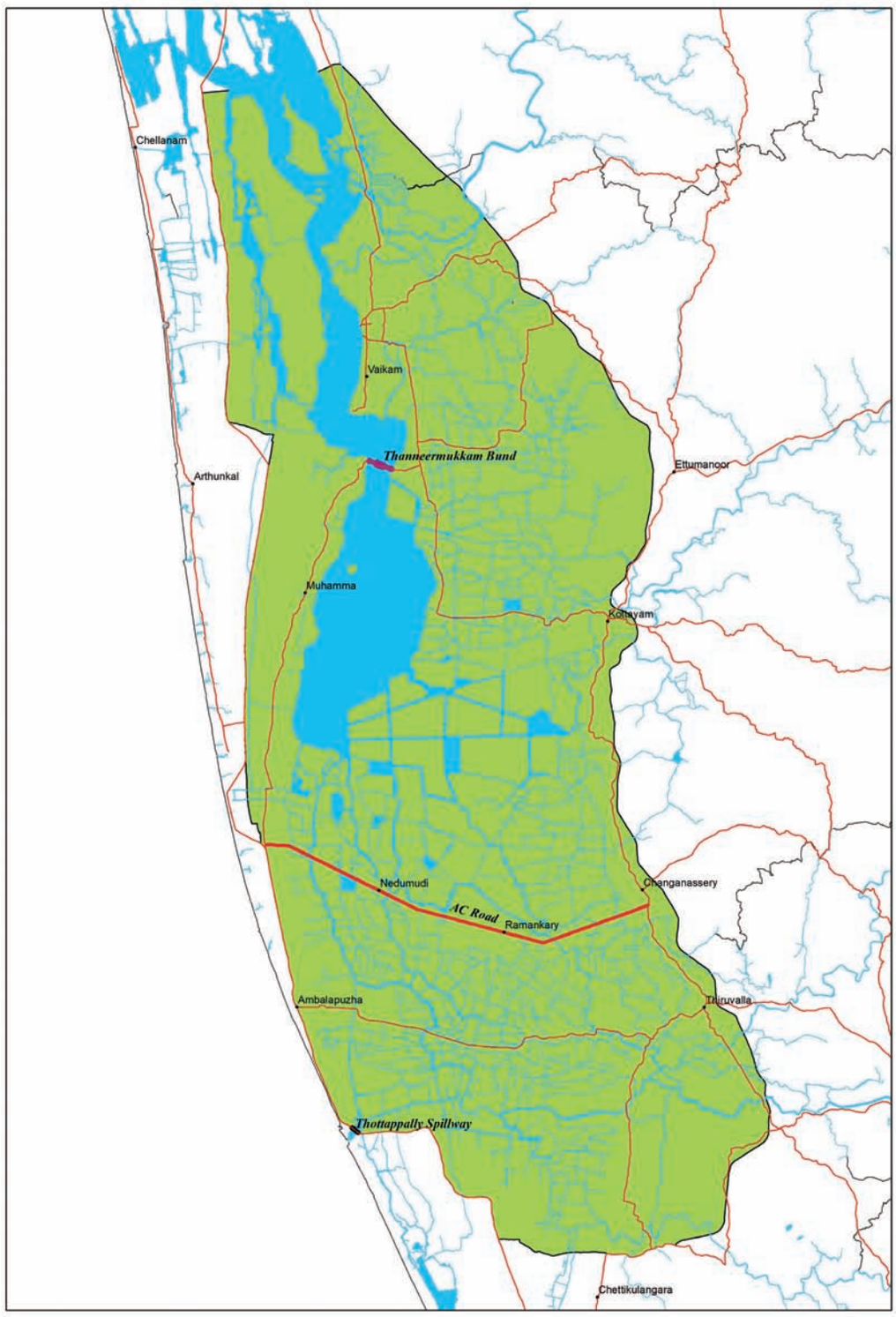


Figure 5 *Locations of the Thanneermukkam Bund, the AC Road and the Thottappally Spillway within Kuttanad*
Source: Kerala State Land Use Board

II

EARLY REPORTS AND CONCERNS

The slow progress of the many development projects initiated by the government and the absence of prompt corrective measures over time meant that Kuttanad development projects generated a number of debates and controversies. We shall discuss some of them below.

THOTTAPPALLY SPILLWAY

To begin with, it was argued that the Thottappally Spillway had not made any significant difference to the problem of floods in Kuttanad. As mentioned, the Spillway was designed to push out more water from Pamba, Achankovil and Manimala rivers into the Arabian Sea. As per the original design, the maximum discharge of water during the monsoon months of July and August through the rivers of Pamba, Achankovil and Manimala was estimated to be about 5349 m^3/second or about 189,000 ft^3/second. The Thottappally Spillway was designed to discharge about 1811 m^3/second or about 64,000 ft^3/second of water. However, the Spillway was found to be not discharging more than 566 m^3/second or 20,000 ft^3/second after it was commissioned.

There were two major reasons for the inability of the Spillway to discharge more water. First, as more water was discharged from the Spillway (see **Figure 6**), a sand bar was formed

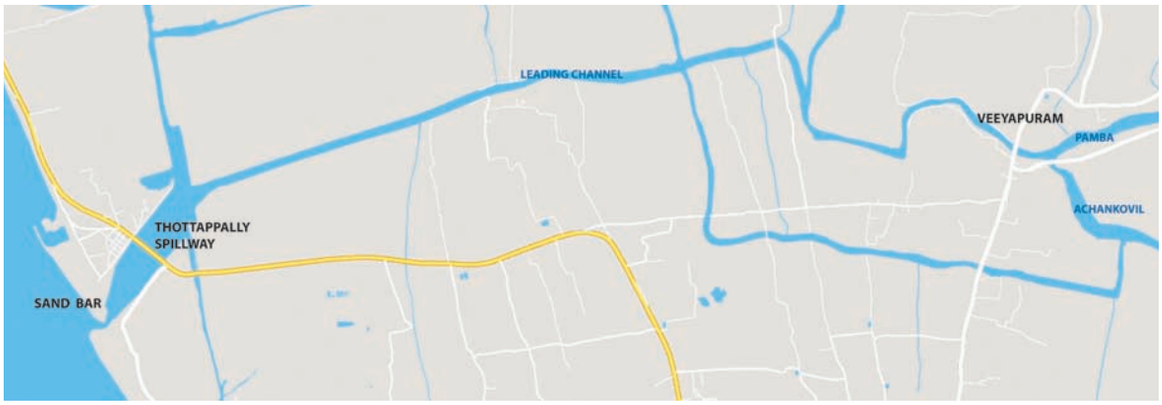


Figure 6 *The Thottappally Spillway, its leading channel (beginning from the confluence of Pamba and Achankovil rivers) and the sand bar at the sea mouth*
Source: Google Maps.

at the mouth. This sand bar reduced the amount of water that flowed into the sea through the Spillway. Every year, the government, to ensure that more water flows out into the sea, removed this sand bar either manually or using machines. This, however, did not help to increase water flows beyond a point.

Secondly, the total capacity of the Spillway was not being realized because the leading channel of the Spillway on the east (i.e., from Veeyapuram, the point where the Pamba and Achankovil rivers merge and begin flowing towards the Spillway; see **Figure 6**) did not have the width as in the original design. If the width of the leading channel as per the original design was 368 metres, the average width in reality was only about 80 to 100 metres. Further, due to the meanders in the path of the leading channel, the velocity of water flow reduced. As a result of these two factors, the amount of water that flowed out of the Spillway – even when all its shutters were open – was considerably less than its capacity.

Due to these reasons, doubts were raised as to whether the Thottappally Spillway was serving its original purpose of reducing the havoc of floods in Kuttanad.

Regardless of these criticisms, the contribution of the Thottappally Spillway to the reduction of floods in Kuttanad has been substantial. The Spillway has made a signal contribution to the raising of a second crop of paddy in Kuttanad over the years. The E. J. James committee had estimated that about 12,300 ha of land in Kuttanad was cultivated with a second crop in 2000-01, which was made possible by the Spillway (James, 2002). Assuming the employment of 33 men and 60 women per ha, the total number of labour days generated over the second crop season could be estimated at 11,43,900 days (405,900 male labour days and 738,000 female labour days). The value of output generated was about Rs 6500/tonne at a productivity of about 4.5 tonnes/ha. Our estimates show that about 15,000 ha of land in Kuttanad was cultivated with a second crop of paddy in 2018-19. The economic value of an additional crop of paddy, thus, has been substantial in Kuttanad's agriculture. Furthermore, our interviews with farmers suggested that, increasingly, farmers have been preferring the second crop of paddy over the *puncha* crop, as the yields were relatively high and the attack of pests and diseases were relatively less.

THANNEERMUKKAM BUND

The Thanneermukkam Bund was designed to prevent the entry of saline water from the Kochi side into the Vembanad Lake. The objective was to ensure that the *puncha* paddy crop in Kuttanad was cultivated without the threat of salinity intrusion during high tides. Critics have argued that the Thanneermukkam Bund failed to achieve its original objective for three major reasons.

First, it was argued that the Thanneermukkam Bund, being one large structure that considered Kuttanad as one homogenous entity, failed to account for the fact that different regions within Kuttanad had different levels of problems with regard to salinity intrusion. For instance, the areas of Vaikom, Thuravoor and Purakkad are outside the purview of the Thanneermukkam Bund and did not benefit from it. In other areas, like the northern part of Kuttanad close to the Thanneermukkam Bund, farmers used to put up temporary tidal bunds to prevent the entry of saline water even before the Bund was constructed. They were put up soon after cultivation began and were demolished soon after harvesting was completed. In parts of Upper

and Central Kuttanad, the problem of salinity was never too severe to necessitate a large structure like the Thanneermukkam Bund. It was, thus, argued that the Thanneermukkam Bund, even if beneficial, would benefit only about 8000 ha of Kayal lands and another 10,000 ha in North Kuttanad.

Secondly, it was argued that the Thanneermukkam Bund, by halting the entry of saline water into Vembanad Lake, would adversely affect the fish population of Kuttanad. Traditional fish species in the Vembanad Lake required an amount of salinity in the water to grow. In the absence of salinity for a long period between December and May, when the Thanneermukkam Bund was closed in the past, there was a fall in the population and diversity of fish species in the Lake. As a result, the livelihoods of the fisher folk in the region were adversely affected.

Thirdly, the absence of salinity in the Vembanad Lake was also argued to be the cause of the prolific growth of aquatic weeds – *Salvinia molesta* to begin with and later *Eichhornia crassipes* – in the region. The growth of these aquatic weeds was aided, of course, by eutrophication but also the absence of saline water. These weeds were causing multiple difficulties: they polluted water, prevented navigation, depleted dissolved oxygen, ensured that no sunlight entered water and harmed fish growth.

However, despite these drawbacks, it is beyond doubt that the construction of the Thanneermukkam Bund (TMB) led to a stabilization of *puncha* paddy cultivation in large parts of Kuttanad. A detailed report of the MSSRF noted that:

> "The land use change is reflected in paddy production. An analysis of data from 1960-61 to 1999-2000 for trends in paddy area and production shows that paddy area in Alappuzha has indeed increased from 1968-69 till 1975-76 upon which it started declining slowly initially till about 1985, and more steeply afterwards…By the year 2000, the area appeared to have reduced to one-third of the peak area in 1975-76. Production of paddy had peaked at about 1.4 lakhs tonnes/year during the decade 1971-72 to 1981-82, and the production decline started afterwards. This phase coincides with the spread of high-yielding paddy varieties which appear to have been the chief factor for the observed increase in paddy production. The increase was facilitated, no doubt, by the confidence that saline intrusion would be reduced by the TMB[1]. To this extent, it appears that the barrage did accomplish what it set out to do – agricultural intensification. It appears the major decline in paddy area and production started from 1983, almost 10 years after commissioning the TMB. This decline, in the case of Kuttanad, cannot be attributed solely to the TMB" (MSSRF, 2007, p. 71).

Yet another point is also worth noting. Over the last decade, the period of closure of the Thanneermukkam Bund has been substantially reduced. In the 1980s, the Bund was kept closed for about six months in a year, either between the early-January and mid-May or between the mid-December and early-May (see Table 5 in James, 2002). The E. J. James Committee was appointed in 2002 to examine the possibilities of reducing the period of closure of the Bund. This committee suggested a new operational plan for the opening and closure of the Bund, which was reiterated by the report of the M. S. Swaminathan Research Foundation (MSSRF) in 2007. The period of closure recommended was between mid-December and mid-March, or just three months. Over the last decade or so, the Thanneermukkam Bund has been kept closed only for a period of about three months. Thus, many of the old criticisms about the Bund need not hold true for the recent years.

[1] TMB: Thanneermukkam Bund.

The James Committee was also clear in its view that the Thanneermukkam Bund held significant economic value. The *puncha* cultivation would become almost impossible if the Thanneermukkam Bund was kept open throughout the year. If *puncha* cultivation became impossible, the farmers would lose incomes and agricultural labourers would lose employment, both of which would have to be compensated for by the government. Salinity intrusion caused by the opening of the Bund would adversely affect the water sources of the five water supply schemes catering to the Kottayam town and its surrounding areas. The old practise of erecting *orumuttus*, the alternative often put forward, was no more practical due to the high costs involved and the risks that they entailed. In sum, the committee held that "the suggestion to leave the barrage open throughout the year is not a socially and economically viable solution to the problems [due to] the present operation of the barrage" (James, 2002, p. 36). In its place, the "more technically feasible and socially acceptable solution" was to minimise the period of closure of the Bund. The recommendations offered in this report are in line with the James' committee's view.

THE AC ROAD

The roughly 24 km road connecting Alappuzha and Changanacherry was envisaged to improve transport and communication facilities within Kuttanad. However, even by the 1980s, the construction of AC Road was not complete. Due to the lack of completion of three crucial bridges, boats continued to be the means of transport between the two towns. The construction of these bridges was completed only by the 1990s.

Apart from these delays, the AC Road was argued to have had two major fallouts. First, the AC Road was not supposed to be a road alone; it was supposed to be a road-cum-canal. A 40 m wide canal was to run parallel through the distance of the road. This canal was to drain out floodwater from Upper Kuttanad (the Changanacherry side) to the Vembanad Lake (near the Alappuzha side) and thus to the Arabian Sea. The road-cum-canal was also, thus, to alleviate the flood problem in Upper Kuttanad. The construction of this canal has remained incomplete even today. Secondly, the construction of AC Road resulted in a proliferation of smaller roads that approached it from either side. These roads, and many bridges too, were unplanned and unscientific with regard to their location and design. As a result, natural waterways across Kuttanad were blocked leading to an aggravation of flood problems (see **Figure** 7). Wetlands were cut into pieces and the natural circulation and mixing of water was stopped or disrupted.

OTHER MAJOR ISSUES

Pollution of the Vembanad Lake

Water in the Vembanad Lake was heavily polluted due to a number of reasons. The most important source of pollution was the sewage dumped into the lake from the nearby towns of Alappuzha, Kottayam and Vaikom. According to an early estimate, Alappuzha town alone directly contributed a sewage pollution load of 64,237 kg/day of BOD into the lake. Secondly, the Vembanad estuary was a receptacle for the effluents of many industrial units in the nearby regions. Thirdly, large amounts of fertilisers, insecticides and other chemicals used in agriculture in Kuttanad are flushed into the Vembanad Lake every season. Consequently, water in the lake is found to be highly acidic and loaded with ammonia (up to 2 mg/L), phosphates

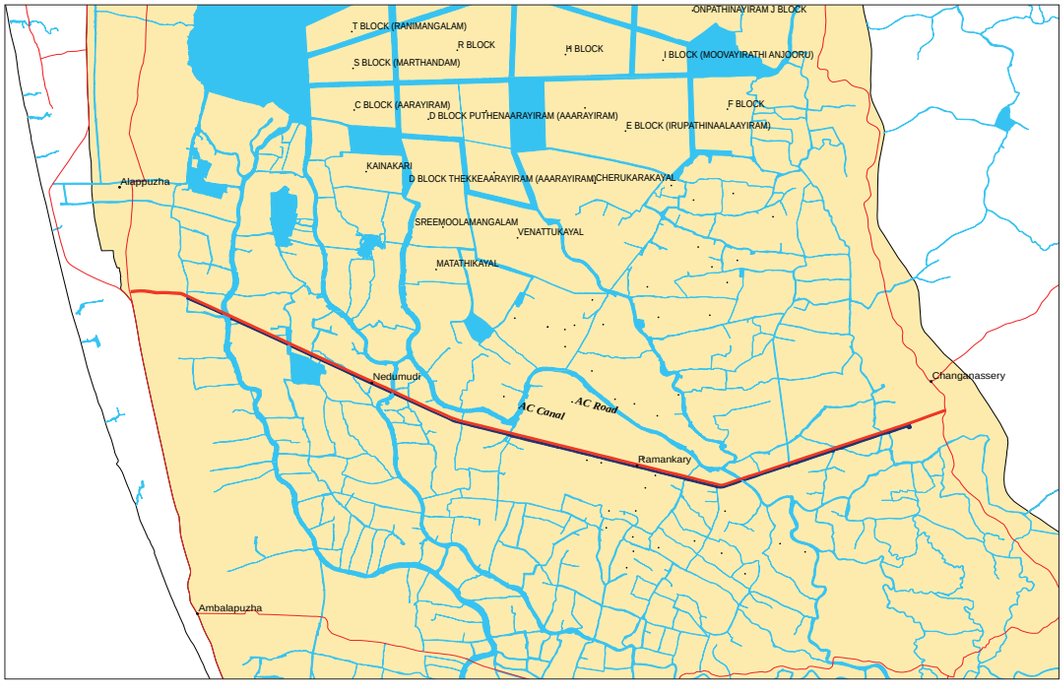


Figure 7 *The AC Road connecting Alappuzha and Changanacherry, cutting across multiple natural waterways*
Source: Kerala State Land Use Board

(up to 7 mg/L) and sulphates (up to 200 mg/L), which results in high levels of fish mortality. Yet another consequence was eutrophication that led to the prolific growth of water weeds in the lake waters. Water weeds also were a result of the decline of salinity in the lake waters compared to the past; it has been shown that water hyacinth can tolerate salinity levels of only up to 20 ppt. Fourthly, coconut husk-retting and related operations, even if small in scale, contributes to the organic pollution load of the lake water.

Health hazards

Health hazards among households living inside and near the Lake were adversely affected by more than one reason. To begin with, the heavy pollution of the water in the lake and the absence of a comprehensive water supply scheme have meant that households use polluted water for drinking and other purposes. Water-borne diseases are very common in the region, and the water weeds act as breeding grounds for the vectors of a number of pathogens.

SUMMING UP

In sum, the Thottappally Spillway, the Thanneermukkam Bund and the AC Road were argued to have been major disruptors to the natural water-based livelihoods and ecosystem of Kuttanad. The basis of the reviewed criticisms has been that planning in Kuttanad lacked an inter-disciplinary focus that brought technological, economic, social and environmental factors together.

However, it is equally important that a few under-emphasised bases of these criticisms are highlighted. A closer reading of these criticisms would also reveal a rather romanticised understanding of life and work around water in Kuttanad. Most critical accounts suffer

from an absence of robust evidence, particularly in terms of causal relationships between the interventions and the perceived environmental problems. To begin with, the original aim of Kuttanad development projects i.e., to reduce underemployment due to only one crop of paddy being cultivated, is not seriously taken up as a problem to be resolved. In many critical accounts, the efforts to introduce a second crop of paddy to reduce underemployment and raise incomes are often seen as the source of all "disruptions". The logical implication is that the Kuttanad ecosystem cannot ecologically afford a second crop. The impact of such a reverse shift on household incomes and employment in the region is not considered with the required seriousness in these critiques. Further, while more participation of "people" is demanded of policy in most of these critical accounts, it is unclear if the critical accounts themselves reflected the opinion of majority of people who live and work in the region.

THE INDO-DUTCH WATER BALANCE STUDY OF 1989

In 1981, the Government of Netherlands had sent an Agricultural Identification Mission to India. One of the projects identified by the Mission as worthy of intervention was the economic development and environmental improvement of Kuttanad, with particular reference to water management (Indo-Dutch Mission, 1989). In 1985, the project proposal on Kuttanad was approved; in May 1985 an Updating Mission visited India; and in November 1986, an agreement was signed for a study titled "Water Balance Study of Kuttanad Region". The objective of the study was to identify measures in water management and hydraulic engineering to eliminate or mitigate the water-related problems of Kuttanad. These problems were: flooding in the wet season, water shortage and salinity intrusion in the dry season, the conflict between agriculture and fisheries around the Vembanad Lake and a deteriorating aquatic environment.

After initial visits by Dutch experts in 1986, the study began in early 1987. The Plan Report was submitted after two years of intensive studies in April 1989. The study's major recommendations can be summarized into five broad schemes. These five schemes could be broadly classified into schemes for (a) Low Flow Augmentation; (b) Flood Protection; and (c) Fisheries Promotion. The different schemes and their brief details are given below.

Low Flow Augmentation schemes

Before the Thannermukkam Bund was constructed, Kuttanad faced the problem of excess salt water during the dry season. As a result, cultivation was not possible in many parts around the Lake. When the Thanneermukkam Bund was constructed, while the entry of saline water was halted, there emerged a new problem of shortage of fresh water for irrigation, particularly in the downstream (as most water was used upstream). The proposed low-flow augmentation schemes were designed to address this problem of inadequate fresh water flows into Kuttanad during the dry seasons. The recommendations were to ensure that more fresh water flowed into the Vembanad Lake after the monsoon months.

Regulation of operation of Sabarigiri Hydroelectric project. The Sabarigiri hydroelectric project is the second largest hydroelectric project in Kerala, which was commissioned in 1966. The water for this project is contributed by two reservoirs: Pamba and Kakki. The recommendation of the study was that power generation from the project could be increased during the summer season. Thus, water release from the reservoir would be in conformity with the requirements

of irrigation water downstream. If power generation in the non-summer months was reduced due to this shift, the power generation pattern at the Idukki hydroelectric project could be accordingly increased in those months. Thus, the recommendation was to ensure harmony between the operations of Idukki and Sabarigiri projects to ensure fresh water in the downstream areas in the dry season.

The Muvattupuzha Diversion scheme. The aim of the Muvattupuzha scheme was to get more fresh water into Kuttanad during the dry season. One way is to divert into Kuttanad the fresh water that flows into the sea from the Idukki Hydroelectric Project (through the Muvattupuzha River) on the northern side of the Thannermukkam Bund. This excess water from Muvattupuzha could be stopped using two small dams and an extra barrier near Vettikattumukku. This water could then be diverted into the Vembanad Lake, thus ensuring more freshwater in the Lake during the dry season (see **Figure 8** below).

Flood protection schemes

These schemes were designed to reduce the extent of flood-affected regions in Kuttanad.

The Pamba Diversion scheme. Here, the recommendation revolved around enlarging the flow of water out of the Thottappally Spillway. The first suggestion was to enlarge the leading channel of the Spillway so that the quantum of floodwater that flows out is increased. Secondly, it was suggested that more regulators – one in Manimala River and two in Pamba River – should be constructed across the two tributaries of Pamba. Thus, floodwater that would otherwise flood

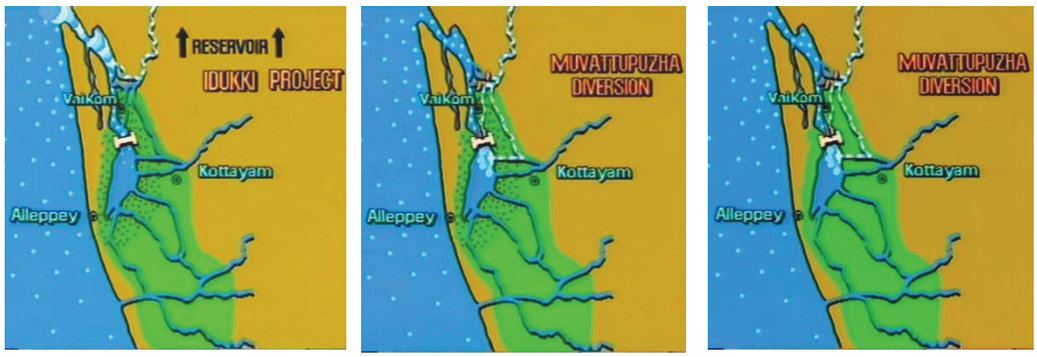


Figure 8 *Pictorial description of the proposal for Muvattupuzha Diversion Scheme, Indo-Dutch Mission, Kuttanad*

Note: Plate 1 shows the Thanneermukkam Bund and the then existing situation with dotted portions depicting salinity affected regions; Plate 2 shows the diversions effected through two small dams and the flow of fresh water into Vembanad Lake from the south side of the Thanneermukkam Bund; Plate 3 shows the potential reduction in salinity affected areas, as the salinity affected regions shrink.

the cultivated lands nearby would instead flow into the leading channel and drain out through the Spillway. The dykes would have to be raised and strengthened. Also, the Achankovil River would need straightening for about 4 km at the downstream end so as to allow faster flow of water. Where required, new bridges will have to be constructed so as to allow smoother transportation. As a result, it was proposed that the extent of flooding in the upper Kuttanad region could be reduced by about 33,400 ha (see **Figure 9**).

Figure 9 *Pictorial description of the proposal for Pamba Diversion Scheme, Indo-Dutch Mission, Kuttanad*

Note: Plate 1 shows the Thottappally Spillway and the then existing situation with the light blue shaded portion depicting the flooded portions; Plate 2 shows the draining of more floodwater through the Spillway with the two regulators in the tributaries of Pamba and the widening of the leading channel; Plate 3 shows the potential reduction in flooding, as the light blue portion shrinks.

The Meenachil and Vaikom diversion schemes. Here, the aim was to reduce flooding in the middle section of Kuttanad by about 12,000 ha. Water from the Meenachil River, instead of being allowed to flood the region, can be stopped through three regulators and one navigational lock in the river and directly dumped into the main Vembanad Lake through a diversion canal. This water would then drain into the sea through the Kochi side. This would require widening of the existing canals, constructing a new diversion canal and raising/ strengthening of dykes (see **Figure 10** below).

Figure 10 *Pictorial description of the proposal for Meenachil and Vaikom Diversion Schemes, Indo-Dutch Mission, Kuttanad*

Note: Plate 1 shows the then existing situation with the light blue shaded portion depicting the flooded portions; Plate 2 shows the draining of more floodwater into the Vembanad Lake with the regulators in the Meenachil River and the potential reduction in flooding, as the light blue portion shrinks.

Fisheries promotion schemes

Dividing Kuttanad with a dyke. The Muvattuppuzha diversion scheme, suggested earlier, would not have benefited fisher folk because saline water was being prevented from entering Vembanad Lake by infusing freshwater. For the project to benefit the fisher folk, the study suggested another solution. First, it was suggested that the Thanneermukkam Bund be kept

open throughout the year. Secondly, the fresh water that flows into the Vembanad Lake from Muvattupuzha could be isolated on the eastern side of Kuttanad by constructing a dyke (a fresh water barrier) parallel to the eastern shore of the Lake. This would mean that the regions east of the dyke can still have a *puncha* crop with fresh water diverted from Muvattupuzha. The regions west of the dyke can be slowly turned brackish over time. It was suggested that this measure could increase fish catch by 50 per cent on the western side of the dyke (see **Figure 11** below).

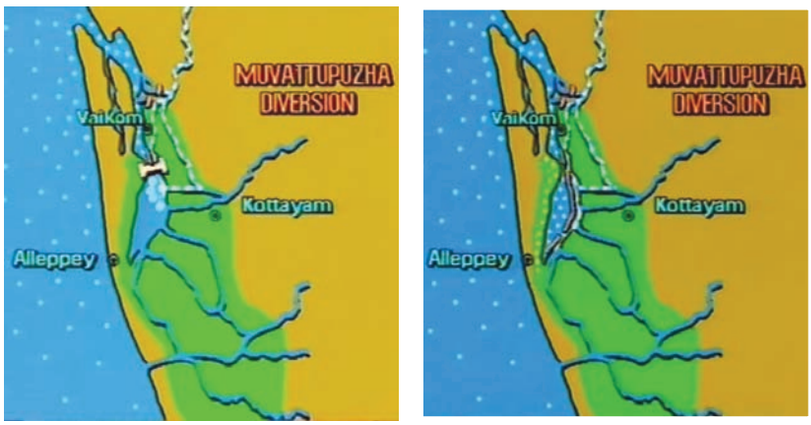


Figure 11 *Pictorial description of the proposal for the dyke scheme, Indo-Dutch Mission, Kuttanad*

Note: Plate 1 shows the Thanneermukkam Bund and the then existing situation with the Muvattupuzha Diversion Scheme; Plate 2 shows the dyke diving the Vembanad Lake into a western brackish region and an eastern fresh water region.

Actions taken

A few comments on the recommendations of the Indo-Dutch Mission are in order. First, some of the recommendations of the Mission have, over a period of time, become part of ongoing efforts to reduce flooding in Kuttanad. A good example is the Pamba Diversion Scheme, where efforts have been ongoing to expand the width of the leading channel of the Thottappally Spillway. Secondly, a few other recommendations, such as the synchronisation of the operations of the Idukki and Sabarigiri hydroelectric projects, have been discussed at various fora, but never implemented. Thirdly, the fisheries promotion schemes suggested, such as the construction of a dyke separating Kuttanad into two, have been widely thought of as overly expensive, inimical to the livelihoods of farmers and agricultural labourers and detrimental to the environment. The fact remains that a detailed analysis of the hydrology of Kuttanad, like the Indo-Dutch Mission, deserved immediate responses from the government. However, there was very little follow-up. The report of the study was sent to the Central Water Commission (CWC) by the State government with its comments. Neither the CWC nor the State government followed it up with policy interventions. Some recommendations in the report, such as the Pamba Diversion Scheme, were considered as part of some schemes related to the Spillway in the 2000s. We shall discuss them later.

Much time has passed since the Indo-Dutch study. A reopening of its recommendations today is constrained by the fact that many ecological changes have taken place in the region in the

intervening years. Two Dutch scholars in water management, writing after a visit to flood-hit Kuttanad in 2018, noted that:

> "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" (van Meel and Warmerdam, 2018, p. 16).

OTHER STUDIES AND REPORTS

Apart from the Indo-Dutch study, there have also been a few independent studies by individuals and organisations on various water-related issues in Kuttanad and Vembanad Lake.

Four reports were released by the Kerala Sastra Sahitya Parishad (KSSP), a non-governmental organization: in 1978, 1984, 1992 and 2017 (KSSP, 1978; KSSP, 1984; Ambat, 1992; People's Commission, 2017). These reports did not depend on scientific methodologies usually followed in hydrological studies but were prepared by scientists and engineers with knowledge of hydrology. These reports were premised on the fact that the early interventions by the government in Kuttanad were not based on any environmental impact assessments. The lack of such assessments meant that many unintended consequences of the interventions went unnoticed and were not attended to. The reports of 1978, 1984 and 1992 suggested that there have to be scientific studies on (a) the *Western Ghat region*, from where rivers that flow into Kuttanad originate; (b) the *river basins* of Pamba, Achankovil, Manimala and Meenachil to assess water use for different purposes; (c) the *hydrology of rivers* that drain Kuttanad; and (d) the *Vembanad* Lake and the *Kochi Harbour* to study issues of health, sanitation and siltation. These studies also recommended the construction of permanent bunds around polders, distribution of portable pump sets for drainage of water from fields, effective measures for water weed control, drinking water supply schemes and spread of awareness among farmers to reduce the use of fertilisers and pesticides.

In 1978, the Government of Kerala formed a committee to examine the water- and agriculture-related problems of Kuttanad (GoK, 1978). The report of the committee was titled "Report on Comprehensive Development of Kuttanad". Major suggestions of the report included: (a) tailrace water from the Idukki hydroelectric project in the Muvattupuzha River could be diverted to Kuttanad; (b) after hydrology studies, the zones suitable for a second crop should be identified in Kuttanad; (c) a Kuttanad Development Authority should be formed to oversee all activities related to water and agriculture in the region.

PERSISTENT TENSIONS

A perusal of all these reports and studies would reveal that some persistent tensions in the region emerge unresolved. We shall enlist some of them below, only as illustrations.

Let us begin with the question of *freshwater infusion* into Kuttanad, which the proposed low flow augmentation schemes attempt. If more freshwater was not allowed into Vembanad Lake

to reduce water shortage in the summer seasons, the consequences may be the deterioration of water quality in the Vembanad Lake, the fall of water levels in the Vembanad Lake to such an extent as to make navigation difficult and the drying up of channel bottoms that may prevent the flushing out of pollutants. If more fresh water was allowed into Vembanad Lake, navigation may become easier as water levels would rise close to mean sea level and there would be greater availability of fresh water for the residents of Kuttanad. On the other hand, with more fresh water in the Vembanad Lake, salinity would reduce and the marine fish population may be adversely affected. Concurrently, the availability of fresh water fishes may rise. If fresh water was diverted from Muvattupuzha into Kuttanad, some of the downstream branches of the Muvattupuzha Irrigation Project (MVIP) may experience salinity infusion, as the downstream water flow in the river may be weak to resist the inflow of seawater.

Let us now take the *flood control schemes*. Any reduction of flooded area within Kuttanad, which would be the result of these schemes, would also be reducing the area for fresh water fish production in Upper Kuttanad and Central Kuttanad. If flood control measures were successfully adopted in Pamba, there is the possibility that the quantum of freshwater that flows out through the Kochi side would fall. This would mean that there would be more inflow of seawater in and around Kochi harbor. This seawater would be bringing in silt that is brought up from the bottom of the sea during monsoon season. Thus, there is the risk of siltation in and around Kochi harbour, which would adversely affect its operation.

If we consider the proposed schemes for the creation of a *freshwater barrier splitting* Kuttanad into a brackish west and a freshwater east, major problems may arise with respect to habitation and drinking water availability, as well as the future of paddy cultivation in the areas west of the proposed barrier.

Another dimension of these tensions is the future of the second crop of paddy in Kuttanad. If zones were to be created for allowing a second crop of paddy, what would be the future of farmers who were taking a second crop outside these zones? What should be done to compensate their fall in incomes?

The MSSRF report in 2007 was an effort to address these persistent tensions.

III

A NEW MASTER PLAN: THE MSSRF REPORT OF 2007

In 2006, the M. S. Swaminathan Research Foundation (MSSRF) was invited by the Ministry of Agriculture to examine the economic and ecological problems of the Kuttanad Wetland Ecosystem. In particular, the MSSRF was asked to focus on the ecological security of the Kuttanad ecosystem and the sustainable livelihood of people living in the region. Though the government commissioned the report in the wake of an agrarian distress, it developed into a master plan for the eco-restoration of the Kuttanad region as a whole (see MSSRF, 2007).

The Swaminathan Commission (as the MSSRF report is often called) studied all the earlier reports on Kuttanad as well as had detailed interactions with farmers, government officials, academics, civil society groups, journalists and individuals with expertise on the region. Some of the authors of the earlier studies and reports were co-opted by the Commission as experts. The report noted that it received oral suggestions "from more than 1,300 persons and about 503 memoranda and proposals". An interim report was submitted on the 13th February 2007 and a final report was submitted on 22nd June 2007.

The MSSRF report was a very important landmark in the way public policy began to engage with the problems of Kuttanad. Its recommendations gave birth to a "Kuttanad Package" with funding coming in from the central government and the State government. They also guided and shaped much of the policy discourse on Kuttanad after 2007. We shall discuss the major recommendations of the report before we come to questions around its implementation.

The report's recommendations focused on seven major themes.

1) Declining water spread area of Vembanad Lake
2) Flood management
3) Salinity intrusion
4) Blocked waterways
5) Water pollution and aquatic weeds
6) Loss of animal and fish biodiversity
7) Health, sanitation and drinking water

We shall briefly describe each of these themes below.

DECLINING WATER SPREAD AREA OF VEMBANAD LAKE

The flood carrying capacity of the Vembanad Lake had shrunk by about 78 per cent over roughly the hundred years of the 20th century. As much of the monsoon water could be stored in the Lake itself earlier, a decline in the size of the Lake intensified the risk of flooding in Kuttanad. The major reasons for the decline in the water spread area were unchecked encroachments, reclamation of the Lake area and the rise of the Lakebed due to silting. Reclamation of the Lake area began in the 19th century and continued till the 1980s. It was responsible for a large part of the decline of Lake area (for an illustrative comparison of two Survey of India toposheets from 1912 and 1967, focusing on the *kayal* lands, see **Figure 12**). These reclamations were mainly for agricultural purposes, but also for industrial purposes, creation of the Wellington Island, building fishing harbours and the Thanneermukkam Bund as well as for tourism purposes of late. In addition, the depth of the Lake also declined.

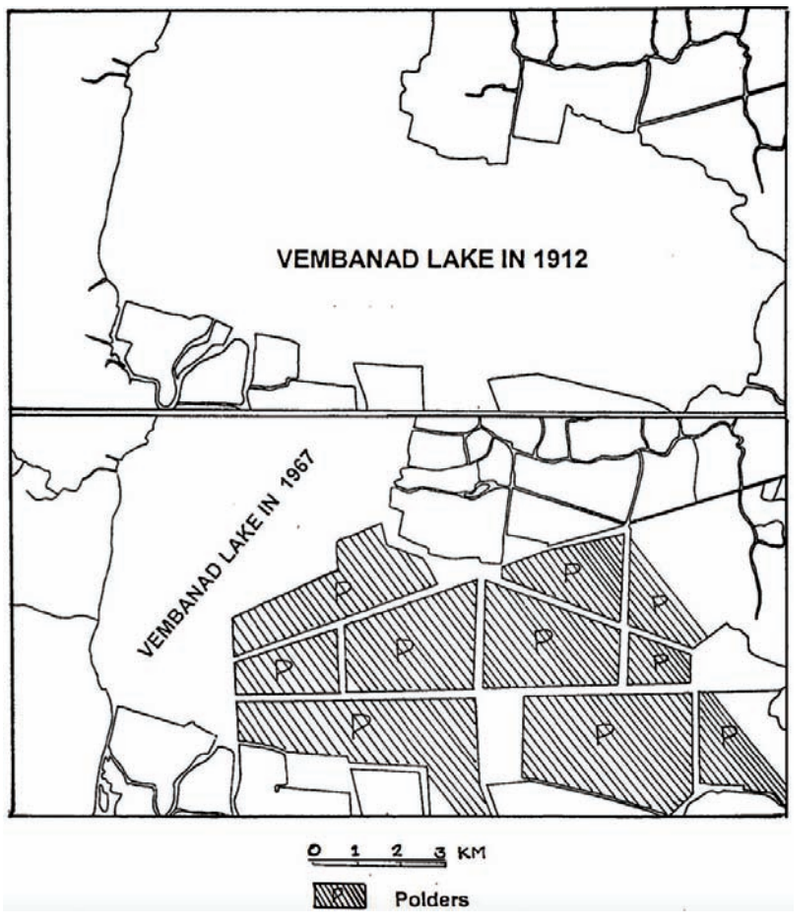


Figure 12 *A comparative illustration of the decline in water spread area of the Vembanad Lake, Kayal region, 1912 and 1967, Survey of India toposheets*
Source: Sabu (2000)

According to one estimate in Gopalan (1991), the average depth of the Lake fell from about 6.7 m in the 1940s to about 4.4 m in the early 1990s. This fall in depth was particularly acute in the areas south of the Thanneermukkam Bund.

The report recommended that the boundaries of the Lake and the canal networks should be demarcated using detailed satellite imagery and protected from encroachment and reclamation in the future. All illegal encroachments should be vacated and a 4 to 6 m wide strip of "ecotone", planted with mangroves or coconut trees, should be put in place between the main land and the Lake.

FLOOD MANAGEMENT

The key instrument introduced in Kuttanad to control floods was the Thottappally Spillway. The Spillway's flood management capacity, however, was only 30 per cent of its original designed capacity. This was partly due to structural reasons and partly due to maintenance reasons. The problems of inadequate width of the leading channel, poor quality of its side-bunds and the sand bar near the sea mouth were not addressed, though recognized, for years. The poor maintenance of shutters was another problem that needed urgent resolution.

The report recommended measures that included modernization of the Spillway shutters, deepening and side bund protection of the leading channel and improved management of spillway operation.

SALINITY INTRUSION

The intrusion of salinity into Kuttanad happened through various inlets, though the largest of them all was the Thanneermukkam Bund. The construction of the Thanneermukkam Bund was incomplete at the time of writing of the MSSRF report; only the Phase 1 from the Thanneermukkam side and Phase 2 from the Vechoor side were complete. The construction of Phase 3, connecting Phases 1 and 2, had not begun; a cofferdam made of sand was substituting for it over the years, which reduced the efficiency of the Bund (see **Figure 13**).

For a permanent resolution of the problem of salinity intrusion, the report recommended that the third stage of the Thanneermukkam Bund be completed, and the cofferdam be demolished. The Bund should be closed for a minimum period during every year; it was suggested that it closed on the 15th of December and opened on the 15th of March. The Bund's shutters were to be modernized or replaced and a timetable for the opening and closure was to be formalized.

Even when the Thanneermukkam Bund was completely closed, salinity infusion took place on a smaller scale through the Thrikkunnapuzha Lock, Andhakaran-*Azhi*, Kayamkulam Lake, Vaikkom *Kari*, Purakkad *Kari* and Aroor-Pattanakkad areas. Historically, farmers tried to halt salinity intrusion by constructing temporary barriers called *orumuttus*. However, *orumuttus* were vulnerable to damage and when they were breached, farmers incurred enormous cost and effort to rebuild them; crop losses were also frequent. The report suggested that *orumuttus* at 33 points of entry of saline water be replaced with the construction of permanent small and medium saltwater regulators, including a major one across Kariyar. This was to stabilize paddy cultivation in Kuttanad and the Purakkad-Thuravoor areas.

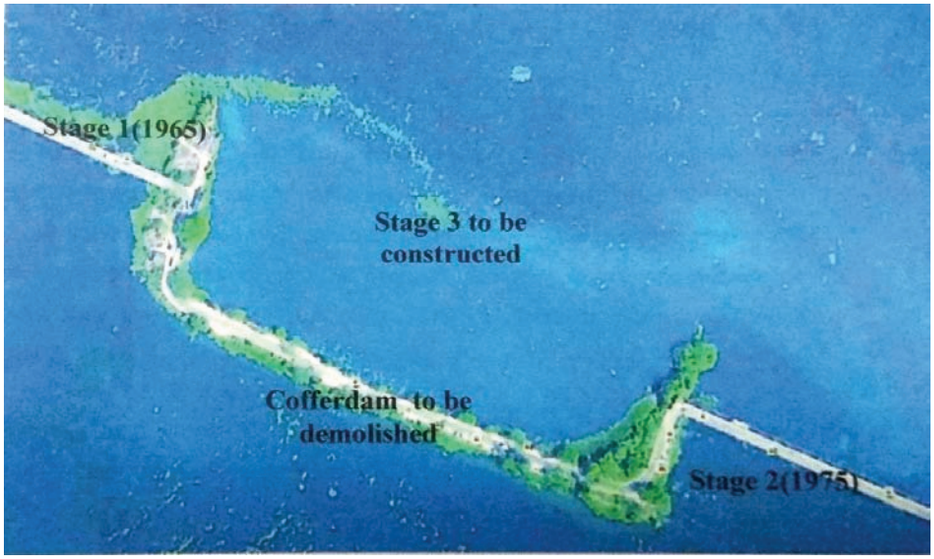


Figure 13 *Sketch of the Thanneermukkam Bund in 2007 showing the completed Phase 1 and Phase 2, the incomplete Phase 3 and the temporary coffer dam*

BLOCKED WATERWAYS

The report noted that most of the waterways in Kuttanad were blocked/choked by encroachments, unscientifically constructed roads, bridges and culverts, silting and aggressive spread of waterweeds. As a result, there was flooding, water logging, bund breaches, waste accumulation, breeding of predators, parasites and deadly pathogens, degradation of water quality and obstruction of navigation. Most roads and bridges built by the PWD violated environmental norms.

It was thus recommended that renovation be undertaken in canals (*thodu*) of about 700 km length and about 55 public ponds. Three major obstructions in the Lake area were to be removed. The first and second were between the C and D Blocks in Pulinkunnu and between the Rani and Chithira blocks in Kainakari. Here, the plan was to create a new canal – Kochar – to speed up the draining of floodwater into the Vembanad Lake. The third was the AC Canal that was to originally run parallel to the AC Road. These rectifications were expected to considerably reduce the problem of flooding in Kuttanad.

WATER POLLUTION AND AQUATIC WEEDS

Eutrophication, lack of saline water and waterlogging had led to prolific growth of aquatic weeds in the Vembanad Lake (see **Figure 14**). Water Hyacinth, in particular, had spread all over the streams, canals and rivulets. This resulted in water pollution, blocking of water navigation, depletion of dissolved oxygen, interference with entry of sunlight into water and thereby reduction in fish reproduction and growth.

The report suggested better management of the problem of aquatic weeds that included physical removal and reduction of eutrophication through less dependence on fertilisers,

Figure 14 *The menace of water weeds in Kuttanad*
Source: The Hindu

pesticides and weedicides in Kuttanad agriculture. The practice of one-paddy-one-fish was also likely to reduce weed growth, as it would help entry of saline water into Kuttanad for a greater number of months. The crop calendar of Kuttanad also had to be reformatted towards this end (see **Figure 15**).

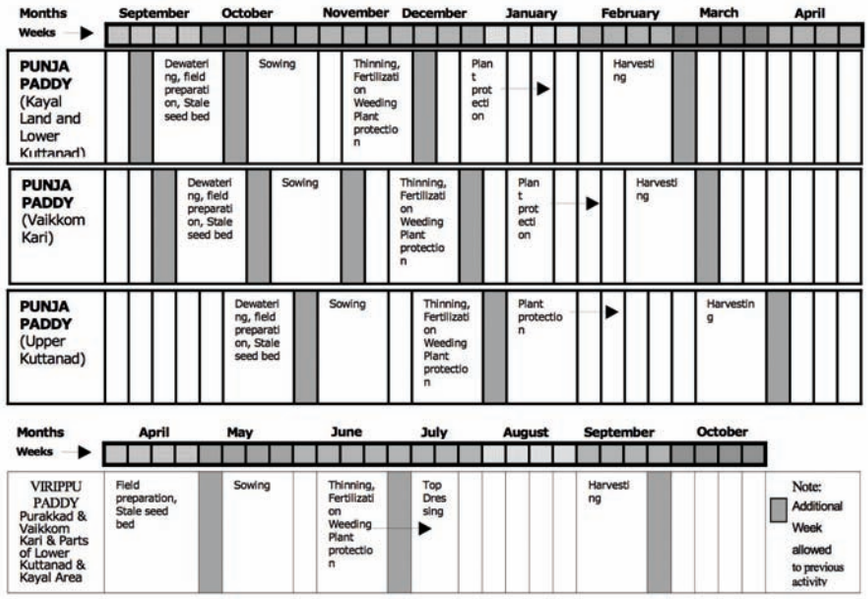


Figure 15 *The crop calendar suggested for Kuttanad in the MSSRF report*

Kuttanad has been a Ramsar site from 2002. However, changes in the Vembanad Lake area, changes in the quality of the Lake water and land use changes meant that the population and diversity of the fishes declined over the years. Mangroves were also destroyed on a large scale. It was estimated that about 23 species of fishes had been lost; migration of about 13 other

species had been prevented; there was a 33 per cent decline in the Lake's bird population; new predatory birds like *neerkozhi* had entered the waters; and the population of reptiles had risen significantly.

The report recommended a series of measures to augment the animal and fish biodiversity in Kuttanad. The Pathiramanal Islands – an area with pristine biodiversity – was to be restored and maintained. Mangrove restoration had to be initiated along the borders of the Vembanad and Kayamkulam Lakes. Special programmes to revive and promote the production and productivity of pearl spot (*karimeen*) and freshwater prawns using fish sanctuaries and specialized methods like cage farming had to be introduced.

HEALTH, SANITATION AND DRINKING WATER

The blocked waterways, growth of aquatic weeds and waterlogging led to major issues in public health. Water-borne vectors like mosquitoes bred freely. Rodent population increased considerably. Due to the lack of toilet facilities in households, most toilet waste was dumped into the Lake. This led to a rise in water pollution as well as contamination of water used for drinking and cooking. The coverage of piped water supply was very poor.

The report suggested that successful eco-restoration of Kuttanad wetlands themselves would go a long way in reducing the health and sanitation hazards. It suggested a programme for reviving ponds, canals and other natural water storage systems to augment clean drinking water availability, apart from increasing the supply of potable drinking water.

Apart from these seven broad themes, the MSSRF report also suggested measures to alleviate the agrarian distress that was acute in the region in the mid-2000s. Towards all these ends, the report suggested a series of schemes and programmes with a financial outlay of Rs 1839.75 crore. The Commission submitted this budget proposal to the central government, which approved it in principle. It was this proposal that arose from the MSSRF report that came to be called widely as the *Kuttanad Package*.

IV

THE KUTTANAD PACKAGE: IMPLEMENTATION AND PROGRESS

The Kuttanad Package is often mistaken for a single scheme of the central government. While the central government had approved the proposal of Rs 1839.75 crore as proposed in the MSSRF report, the actual allocation of money was spread across various existing schemes and different ministries/departments. Money was also allocated from the State plan schemes for various initiatives. As such, there is no composite account in the public domain on what were the different activities undertaken as part of the Kuttanad package and how much was spent on them. For the purpose of this report, the KSPB collated the information from its own databases, different departments and multiple other sources; the details are given in the sub-sections below.

A key issue in the implementation of the Kuttanad Package, as will be evident in the discussion below, was that it never had a unified focus. Different departments designed and implemented schemes with no engagement with each other. Even when the departments were organising works of a similar nature, such engagement was missing. As such, even when substantial achievements were realised, the design and implementation of the package was fragmented and disorganised. We believe that much of the public dissatisfaction and disenchantment with the Kuttanad Package has to do with this lack of coordination across departments.

DEPARTMENT OF WATER RESOURCES

Of the original aggregate proposal of Rs 1839.75 crore, an amount of Rs 1518 crore was earmarked for the Department of Water Resources. There were three sources of funding for the works undertaken by this department under Kuttanad Package: the Flood Management Programme (FMP) of the central government, a special grant-in-aid from the 13th Finance Commission and plan resources of the State government.

A major activity proposed by the department under the package was the strengthening of the outer bunds of *padasekharams*, including repair of breaches, construction of motor *thara*, pump house and *vachals*. These activities were proposed under three schemes in the FMP: KEL-1, KEL-2 and KEL-3. The coverage was as under.

KEL-1: covering 14 *padasekharams* in Group 1 of Kuttanad;
KEL-2: covering 4 *padasekharams* in the Kayal region, and 5 *padasekharams* in Group 9 of Kuttanad;
KEL-3: covering 231 *padasekharams* in Groups 2-5, 7, 8 and 10-19 of Kuttanad

Another scheme titled KEL-4 was concerned with the improvement of drainage in the rivers, drains and canals in Onattukara, Thuravoor and Pattanakkad areas of Kuttanad. Thus, KEL-1, KEL-2, KEL-3 and KEL-4 were schemes included in the FMP under the Kuttanad Package by the central government. In addition to the KEL schemes, three additional activities were proposed in the FMP by the State government under the Kuttanad Package. These were:

(a) Flood management work in 397 *padasekharams* in the Kuttanad Assembly constituency and 14 *padasekharams* in the Veeyapuram panchayat;
(b) Modernisation of the Thenneermukkom Barrage;
(c) Modernisation of the Thottappally Spillway and the improvement of channel efficiency.

These three works did not receive final approval from the central government under the Kuttanad Package. They have been under different stages of approval. However, even before the central government gave final approval and allocation, the State government decided to allocate money from the State plan for completing these works. As such, works under the above-mentioned (a), (b) and (c) works were financed directly from the State plan under the Kuttanad Package. No money was received from the centre for these works.

This apart, three more activities were financed under the Kuttanad Package for the Department of Water Resources. The finances for these activities came from a special grant-in-aid award of the 13th Finance Commission. These were:

(a) Construction of a permanent bridge-cum-regulator across Kariyar in Thalayazham panchayat;
(b) Renovation of a regulator in Pattanakkad;
(c) Construction of AC canal from Manakkalchira to Onnamkara.

A perusal of the physical progress of work shows a mixed record for the Department of Water Resources. We shall, below, consider each item separately.

(a) *KEL-1*: Works under KEL-1 included bund construction and related activities in 14 *padasekharams* in Nedumudi panchayat. Construction of bunds of total length 39.94 km was completed under KEL-1, which refers to protection for 574.83 ha of land. A total of 37 motor *tharas*, 8 *pothu madas* and 11 box/pipe culverts were also constructed. All works have been completed. According to the department, no breach of new bunds has been reported till date.

(b) *KEL-2*: Works under KEL-2 included bund construction and related activities in 4 *padasekharams* in the Kayal areas and cutting open a new canal – by name Kochar – in between C and D blocks and Rani and Chithira blocks. Construction of bunds of total length 65.45 km was completed, which refers to protection for 3265.91 ha of land. About 61 km

of the length of these bunds were protected using the pile and slab method (**see Figure 16**). A total of 94 motor *tharas* and 14 *pothu madas* were also constructed. All works have been completed.

Figure 16 *Outer bunds of kayal padasekharams completed using the pile and slab method, Kainakari North, Kuttanad.*

Note: These bunds are wide enough for small machines to ply. In the picture, paddy cultivation is progressing in wetlands 1 or 2 m below MSL even as water flows outside the bund at a higher level.

The completion of Kochar was a highlight of work under KEL-2 (**see Figure 17**). Prior to the opening up of Kochar, floodwater flow from Kuttanad into the Vembanad Lake was obstructed by two sets of *padasekharams* in Pulinkunnu panchayat: one between the C and D blocks and another between the Rani and Chithira blocks. In the case of C and D blocks, floodwater from the Pulinkunnu river (a branch of Pamba-Achankovil rivers) and the Kavalam river (a branch of Manimala river) reached the Tharasu *kayal* (the water body just below the C block in Figure 17) and then had to flow into the Vembanad Lake leftward through a very narrow canal south of the C block. The width of the rivers that brought floodwater into the Tharasu *kayal* was considerable, but the canal from Tharasu *kayal* to the Vembanad Lake was just 80 m wide. This was a major reason for the flooding upstream of the Tharasu *kayal*, leading also to frequent breaching of bunds in about 4000 ha of nearby *padasekharams*.

The MSSRF report recommended that a wide canal be cut open between C and D blocks and between Rani and Chithira blocks and the strengthening of canal bunds. In Figure 17, old channels that existed between these blocks is depicted in blue and the newly created channel areas are depicted in orange. One can see that while a very narrow channel existed between the Rani and Chithira blocks, almost no space existed between the C and D blocks. With the opening of Kochar (the orange areas), floodwater that reaches

Figure 17 *Drawing of the completed Kochar channel that drains Pamba-Achankovil-Manimala waters into the Vembanad Lake*
Source: Kerala State Land Use Board

Kuttanad from the Pamba River and its distributaries is now more quickly and efficiently drained into the Vembanad Lake. Many farmers the KSPB team spoke to in Pulinkunnu, Kainakari and Mankombu stated that the drainage of floodwater into the Lake has been quicker after the construction of Kochar. Further, from 2014, for the first time after 1992, paddy cultivation could be restarted in about 764 ha of *kayal* lands in Rani and Chithira blocks. In 2016-17, the total *puncha* paddy production in the Rani and Chithira *padasekharams* was 1402.49 MT.

Only one breach was reported in the pile and slab bunds in the Kayal areas: the west side bund of the D-block called *Puthanarayiram*. This bund, on the western side of Kochar, was originally protected with DR masonry. This work was completed in 2016. However, on 26-11-2016, a breach occurred during the *vrischika veliyettam* and the bund was damaged for a length of about 50 m. On a detailed examination, it was found that this breached portion was located over a deep pit called *kundarikuzhi*. This was the reason identified for the breach. This pit had a length about 80m and was used to catch fish during the dewatering of the *padasekharam*. To repair this portion of damaged bund, the Irrigation Design and Research Board (IDRB) prepared a design and work was arranged. This reconstruction work is in good progress; according to the department, 75 per cent of the work has been completed and all the work will be completed by January 2020.

(c) *KEL-3*: Work in KEL-3 included outer bund construction in 231 *padasekharams* in Alappuzha and Kottayam districts. Construction of bunds of total length 128.64 km was completed under KEL-3, which refers to protection for 2818 ha of land. A total of 61 motor *tharas*, 68 pothu *madas*, 14 box culverts and 22 pipe culverts were also constructed. About 99 per cent of the works have been completed.

The department estimates that as a result of KEL-3, an additional crop of paddy began to be sown in 325 ha over 8 *padasekharams* from 2014-15 onwards.[2] From 2017 onwards, paddy was newly cultivated in a gross area of 474.4 ha over 8 *padasekharams* that was previously fallow.[3] From 2018 onwards, paddy was newly cultivated in a gross area of 391.14 ha in 2 *padasekharams*.[4]

(d) *KEL-4*: Work in KEL-4 included the improvement of drainage in the rivers, drains and canals in Onattukara, Thuravoor and Pattanakkad areas. Most of these areas were to the south of the Achankovil River. Construction of bunds of total length 33.2 km was completed under KEL-4, which refers to protection for 5834 ha of land. A total of 1 motor *thara*, 9 pipe culverts, 17 foot bridges, 1 VCB and 27 ramp-with-*kadavu* were also constructed. All works under KEL-4 have not been completed. Tenders to renovate 12 watersheds were advertised but met with poor response from bidding contractors. As a result, only 9 out of 44 works were completed within these 12 watersheds.

Kareepuzha *thodu* is a natural channel that connects the Achankovil river and the Kayamkulam Lake. This *thodu* passes through Pallippadu, Eruva, Pathiyoor and the Kayamkulam Municipality. It drains the *ullitta puncha padasekharam* located at Pathiyoor and Kayamkulam. This *thodu* carries flood water from Achankovil river to the Kayamkulam Lake. The average width is about 40 m and the length is about 11 km. Earlier, this *thodu* was encroached at many portions and was filled with sediments, thus blocking the flow at various points. Under KEL-4, this *thodu* was renovated by deepening, widening and provision of side protection work at essential portions. A few natural water courses joining the main *thodu* were also renovated. Currently, this *thodu* is found useful in transferring flood water from Achankovil river directly to the Kayamkulam Lake.

(e) *Flood management in 397 plus 14 padasekharams*: Works under this title did not receive sanction from the centre under the Kuttanad Package but was financed directly from the State plan. Administrative sanction was given for works worth Rs 758.39 crore. This was later revised to Rs 1212.45 crore, but administrative sanction for the new estimate has not yet been provided. Of the 397 works tendered, only 83 works elicited response from bidding contractors. Of these 83 works, 49 works were completed; 3 works were terminated for various reasons.

Under this head, construction of bunds of total length 177.64 km was completed, which refers to protection for 3871.75 ha of land. A total of 166 motor *tharas*, 29 pothu *madas*, 24 box/pipe culverts and 587 *thoombus* were also constructed.

(f) *Modernisation of the Thenneermukkom Bund*: Work on the Phase 3 of the Thanneermukkam Bund was fully financed from the State plan. The department had

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[2] These 8 *padasekharams* were Mannar Michabhoomi, Mannar Puthankari, Mannar Thekkumpuram, Mannar Ollasseri, Erumanthuruthu Padinjareppuram, Erumanthuruthu Kizhakkumpuram, Ayamkudi Padinjareppuram and Mannar Kuruchikkari.

[3] These 8 *padasekharams* were Pallithodu Valiyathadam, Kochuvavakkadu Mukkaalveetham, Vettakkal A Block, Kochukadunaduvile Puthankadu, Perumthuruthukari, Pothimangalam, Punchapadam and Kakkathuruthu.

[4] These 2 *padasekharams* were Ezhumanthuruthu Kizhakkumpuram and Valachira.

Figure 18 *The Thanneermukkam Bund, after the completion of Phase 3 in the centre portion.*
Note: Figure 12 provides the status before the completion of Phase 3. The image also shows the cofferdam on the lower side, which is yet to be demolished.
Source: Google Maps.

prepared an estimate of Rs 255.36 crore for the completion of Phase 3 of the Bund as well as to renovate/replace the shutters and lock gates constructed under Phases 1 and 2. This proposal was submitted to the centre but is still under the consideration of the Inter-Ministerial Committee.

Work on Phase 3 of the Bund and renovation works on 62 old shutters from Phases 1 and 2 have been completed (**Figure 18**). The total length of the Phase 3 work was 428.5 m, with 28 vent ways. In addition, there is also a navigational lock of width 14 m.

A major unfinished part of work is that the old cofferdam, which was used both as a temporary barrage and as a road to transport vehicles between Phases 1 and 2, has not been demolished yet. There is a dispute between the contractor and the Thanneermukkam panchayat on who gets the right to auction the sand after the demolition of the cofferdam. As a result, even though Phase 3 is complete, the cofferdam remains and reduces the efficiency of operation of the Bund. This can be seen from Figure 17, which shows the completed Phase 3 as well as the cofferdam.

(g) *Modernisation of the Thottappally Spillway*: Work on the Spillway was also completely financed from the State plan. In 2013, administrative sanction worth Rs 13.49 crore was provided to modernize the shutters of the Spillway as well as to expand the leading channel. However, for a proposal to be submitted under the FMP of the centre, the minimum estimate required was Rs 40 crore. Hence, the department prepared a revised proposal for Rs 47 crore by including, additionally, work on 2 *padasekharams* in the Veeyapuram panchayat. This was given administrative sanction at the State-level in 2014. The centre has not yet accorded sanction. Work, however, began with funds from the State plan.

As part of the scheme, all the shutters of the Spillway were replaced with stainless steel shutters. However, work on the leading channel of the Spillway as well as the removal of sand bar at the *pozhi* mouth has not begun. Expanding the width of the leading channel requires land acquisition as well as vacation of encroachments. This is one reason for the work not having begun. Further, a scientific and permanent solution to the problem of sand bar has not been arrived at. The only work done is some dredging work in the 150 m portion upstream of the Spillway and the 300 m portion between the Spillway and the sea mouth.

(h) *Construction of bridge-cum-regulator across Kariyar*: This work was financed from the grants provided by the 13th FC. Work was completed in 2014.

The MSSRF report had recommended the construction of 33 permanent regulators, including the one across Kariyar. Of the remaining 32 structures, six structures (Penadi, Pulluveli, Anchuthengumthara, Kandackappally, 16th Mile and 19th Mile) are already permanent structures and in a sound condition. Their replacement was not found necessary though steel shutters have been provided wherever necessary. Pulikkezhu is a small *thodu* near Kayamkulam where a temporary bund is constructed annually by the concerned local self-government and the Department of Water Resources. Work on converting it into a permanent structure has begun in 2019. Vadayar is a branch of Muvattupuzha river in the Vaikom taluk. Salinity intrusion through Vadayar is dependent on power generation in the Idukki project. According to the department, a permanent bund across Vadayar is required only if power generation in Idukki falls below the annual average. The Minor Irrigation division in Kottayam has been regularly monitoring it. The remaining 24 bunds are proposed to be situated in very small *thodu*. Temporary bunds are sufficient at these locations, and these works are annually executed by the concerned local self-governments and the Department of Water Resources.

(i) *Renovation of regulator in Pattanakkad*: This work was financed from the grants provided by the 13th FC. The specific works included were on the regulator-cum-bridge in Pattanakkad panchayat, Penadi regulator in Ezhupunna panchayat, Pulluveli regulator in Kuthiathode panchayat and the construction of sluices in the Pullanchira Chathanthira *thodu*. Except for the Pulluveli regulator, all other works have been completed. The work on Pulluveli regulator has been halted due to a case that is being heard in the Kerala High Court.

(j) *Construction of AC canal from Manakkalchira to Onnamkara*: This work was financed from the grants provided by the 13th FC. Work on this Phase 1 of the AC Canal has only been partially completed (see **Figure 19**). While a major part of the work is complete, what remains in Phase 1 is the completion of retaining walls at two locations, which has been halted due to protests from local residents.

One of the key constraints faced by the department in the completion of outer bund works in *padasekharams*, as in (e) above, has been the lack of interest shown by bidders to the tenders floated. Out of the work on 397 *padasekharams* that were tendered (that too 3 to 4 times), in only 54 cases have contracts been effectively executed, agreement signed and task completed. Most of these *padasekharams* are located in remote regions. The major demand of the contractors has been to increase the rates of tenders to make it equal to the market rate, as

they have to bear the higher costs of conveyance of materials in boats and labour. There is a condition in the revised PWD Manual that tenders could be approved as per the market rates. However, the Finance Department has opposed this and issued an order that any increase in tender amounts by above 15 per cent of the DSR rates should be approved by Cabinet.

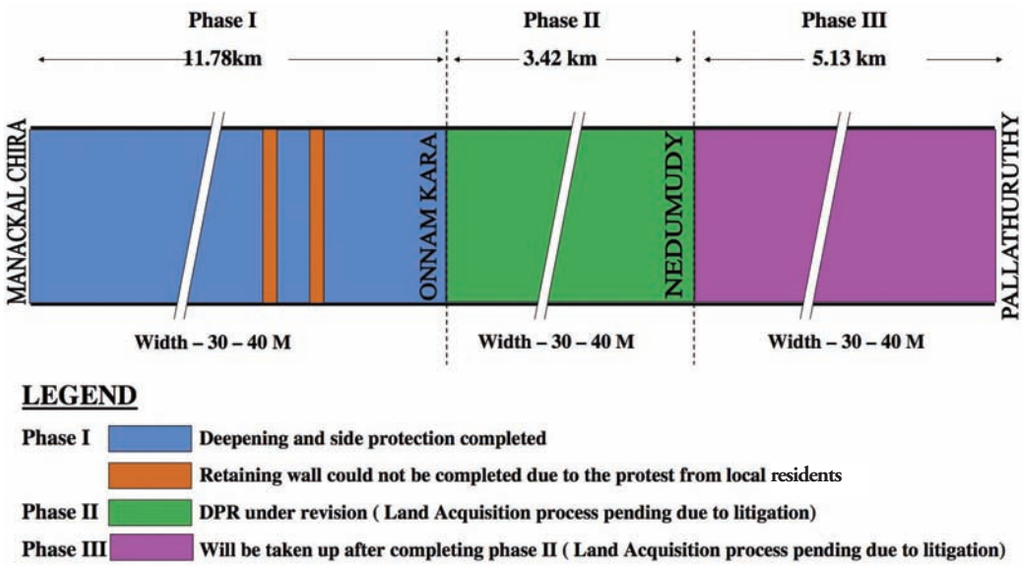

Figure 19 *The three different phases of work on the construction of AC Canal*
Note: Work on Phase 1 is largely complete. Work on Phases 2 and 3 are to be taken up.

A part of the problem here is also that the location and terrain of the work areas are not adequately factored in while preparing the tenders, particularly in the schedule of quantities, specifications, drawings and general conditions. This ambiguity has led to poor contract performance, litigations as well as opening up of space for contractors to make undue profit.

A solution to this problem has to be in the preparation of separate guidelines for the unique terrain of Kuttanad, with regard to time frame of implementation and conveyance of materials. The cost index used by the department is also grossly inadequate. Presently, the SAI Punnamada Cost Index is being used for Kuttanad area. This needs revision. We shall deal with this issue at a later stage in the report.

Expenditure details

The total expenditure on all these heads till March 2019 was Rs 693.28 crore (see **Table 2**). While the department had put up a proposal of Rs 2327.91 crore under all the ten items listed above, the central government had disbursed only Rs 177.03 crore (Rs 137.95 crore as central funds and Rs 39.08 crore as FC grants). The rest of Rs 516.25 crore was incurred from the plan resources of the State government.

Table 2 *Total allocations and actual expenditures under different heads of Kuttanad Package, Department of Water Resources, as on March 2019, in Rs crore*

Sl No	Scheme code	Estimated/ proposed amount	Central assistance received	Actual expenditure up to March 2019
1	KEL-1	24.70	11.20	19.92
2	KEL-2	118.91	65.86	126.03
3	KEL-3	379.05	49.64	87.29
4	KEL-4	248.39	11.25	58.64
5	397+14 *padasekharams* of Kuttanad Taluk	1212.45	-	157.93
6	Modernisation of Thanneermukkam Bund	255.34	-	196.12
7	Improving the efficiency of Thottappally Spillway	47.00	-	8.25
8	Works under 13th Finance Commission	42.07	39.08	39.08
Total		**2327.91**	**177.03**	**693.28**

Source: Kerala State Planning Board; Department of Water Resources.

DEPARTMENT OF AGRICULTURE DEVELOPMENT AND FARMERS' WELFARE

The participation of the Department of Agriculture (henceforth) in the Kuttanad Package was in the following areas. All these interventions were financed from the State plan, except specified otherwise.

(a) *Declaration of Kuttanad as a Special Agricultural Zone (SAZ)*: This move was proposed to help promote "eco-system friendly farming, generation of additional economic activity, promotion of investment, creation of employment opportunities and development of farming infrastructure to address in a holistic manner all links in the conservation, cultivation, consumption and commerce chain with regular support from the State and Central governments" (MSSRF, 2007, p. 21).

Kuttanad was declared an SAZ for paddy in 2017 by the Government of Kerala. However, the Department of Agriculture has not initiated any steps to operationalise this declaration. Even a project proposal for the zone has not yet been prepared.

(b) *Supply of petty, para and motor to dewater padasekharams*: According to department data, 328 motors and 328 petty-and-paras were distributed.

(c) *Enforce a crop calendar*: The MSSRF report had suggested the preparation and execution of a detailed crop calendar for different regions within Kuttanad. It was found that the longer period of opening of the Thanneermukkam Bund was due to the erratic schedules in sowing and harvesting followed by farmers. Late sowing was also found to be increasing pest and disease attacks and consequent application of pesticides. The crop calendar was to help ensure that *puncha* sowing was completed by the first quarter of November and harvested by the middle of March.

The recommendation of the MSSRF report was the following:

> "The recommended *puncha* crop calendar requires that sowing is first completed in *Kayal* Lands, Lower Kuttanad and North Kuttanad, then the *puncha* area in Vaikom Kari and lastly in Upper Kuttanad. Sowing in *Kayal* area, Lower Kuttanad and North Kuttanad has to be completed latest by the first week of November. *Puncha* sowing in Upper Kuttanad could extend up to third week of December. This would facilitate harvesting the crop in *Kayal* area, Lower Kuttanad and North Kuttanad by end of February and in Upper Kuttanad before first week of April" (MSSRF, 2007, p. 38).

The Department of Agriculture made no progress in the preparation and implementation of a crop calendar until the floods of August 2018.

(d) *Certified seed production in Kuttanad*: The MSSRF report had recommended that Upper Kuttanad should be developed as a region for production of certified seeds for the whole of Kuttanad. One or two state farms were to be entrusted with foundation seed production, the Regional Research Station (RRS) in Mankombu was to be entrusted with breeder seed production and selected *padasekharams* in Upper Kuttanad were to be developed for certified seed production. Necessary financial and infrastructural support was to be provided by the government.

The progress on this front has been poor. Under the Kuttanad Package, 2296 MT of seeds were distributed to farmers, work on one go-down and one seed processing unit of capacity 2000 MT in Pandalam were completed and the work on one go-down at RRS, Mankombu was completed. These, however, do not represent any institutional change in the seed production and distribution system, which was what the MSSRF report had suggested.

(e) *Expansion of soil testing facilities*: The MSSRF report had recommended that the Department of Agriculture, with the *Punchakrishi* Special Office (PSO), should undertake soil testing of sample plots every two years. They should also publish the soil nutrient and acidity status in each area with prescriptions for liming and manuring. Low-cost fertilizer options, including non-synthetic forms and soil ameliorants should be specifically prescribed and made available at the right time and in adequate quantity.

According to the department, about 60,000 soil samples were collected and analysed in Kuttanad and fertilizer prescriptions released. About 7500 soil health cards were also distributed to farmers in Kuttanad as a whole. Given the total number of farmers and the area involved, this coverage constitutes only a small proportion.

(f) *Establishment of rice mill* : The report had suggested the establishment of more rice mills in Kuttanad. No action was reported in this regard.

Expenditure details

The total expenditure on all these heads till March 2019 was Rs 90.19 crore. The total outlay was Rs 93.24 crore. The details are given in **Table 3** .

Table 3 *Cumulative scheme-wise details of expenditure under Kuttanad Package, Department of Agriculture and Farmers' Welfare, Government of Kerala, as on March 2019, in Rs crore*

Name of the scheme	Project details	Total outlay	Total expenditure
Agriculture Mechanisation	Supply of *petty* and *para*, and motor	11.02	11.02
	Custom hiring of machinery: KAICO, purchase of machinery (combine harvester, tractors and power tiller) & custom hiring cum service centre including training	38.51	38.51
	Custom hiring through the State Agricultural Engineer	3.45	3.58
	Training and training infrastructure (by KAICO and the State Agricultural Engineer)	0.99	0.99
	Need-based machinery and executive infrastructure	0.49	0.49
Paddy: 1st paddy cultivation in Onattukara	-	4.10	4.10
Sesamum: Rice-sesamum rotation	-	0.20	0.20
Seed Village Programme	Seed production (distribution of paddy seeds at 50 per cent subsidy)	4.52	4.52
Establishment of Agri-clinics	Agri-clinics	0.65	0.65
Crash programme on replanting diseased and low yielding palms	Integrated management and enhancement of productivity	13.13	13.1
13th FC schemes	-	12.62	9.52
State Schemes			
Production bonus enhancement in Purakkad Kari (FSP)	-	0.20	0.20
Onattukara 1st crop paddy cultivation charges (FSP)	-	1.65	1.65
Project for promotion of sesamum cultivation in Onattukara region (FSP)	-	0.27	0.26
Support for soil test-based application	-	0.20	0.20
Pest forecasting and early warning services	-	0.20	0.16
Temporary seed godown	CAP Storage structures	1.04	1.04
Grand Total (Centre + State)		**93.24**	**90.19**

Source: Kerala State Planning Board and Department of Agriculture.
Note: Total amount sanctioned was Rs 93.56 crore.

STATE HORTICULTURE MISSION (SHM)

The SHM, which is part of the Department of Agriculture, initiated a set of measures under the Kuttanad Package. All these activities were financed from the State plan, except where stated otherwise.

(a) One of the main activities included expansion of area cultivated with Banana, Pineapple, Pepper, Nutmeg, Cocoa and minor horticultural crops like Guava (Lucknow variety), Jack (*Thenvarikka* variety), Sapota (oval shaped and sweet variety), Rambutan (N-18 variety) and Mangosteen. The total area newly brought under cultivation of each crop is given below.

Banana	: 1617.03 ha
Pineapple	: 61.72 ha
Pepper	: 110 ha
Nutmeg	: 313.13 ha
Cocoa	: 114 ha
Minor horticultural crops	: 319.97 ha

(b) Under floriculture, 40 units were initiated for cut flower cultivation and 62.2 ha were brought under loose flower cultivation, benefiting 1338 farmers.

(c) Expansion of area under fruit crops through homestead farming was attempted through the distribution of 2.75 lakh mango grafts, 1.82 lakh sapota grafts, 65,500 mangosteen grafts and 27,900 rambutan budded plants using finances from the award of the 13th FC.

(d) Under *Phalasree* programme, 14,985 mango grafts of the Banganappally variety were distributed to farmers of Alappuzha and Kottayam districts. Another 5920 mango grafts of the Alphonso variety were distributed to farmers of Pathanamthitta district, covering an area of 113 hectares.

(e) As part of a scheme titled "Value Addition in Cluster-Based Market-Linked Activities of Kuttanad", the following were established/initiated:

- Seed Processing Unit and Seed Testing Laboratory at DAF, Kozha, Kottayam;
- Sustainable Mushroom Production System at CARD KVK Pathanamthitta;
- Seed Infrastructure Unit at Sugar Cane Seed Farm, Pandalam, Pathanamthitta;
- Disease Forecasting Unit at RRS, Mankombu;
- Technology Dissemination through Demonstration;
- Exposure Visit of Progressive Farmers of Kuttanad Area; and
- Demonstration on high density planting of Nendran variety at the Sugar Cane Seed Farm, Pandalam.

Expenditure details

The total expenditure on all these heads till March 2019 was Rs 12.67 crore (see **Table 4**). Details of total outlay were not available.

Table 4 *Cumulative scheme-wise details of expenditure under Kuttanad Package, State Horticulture Mission, as on March 2019, in Rs crore*

Project Details	Total Outlay	Total Expenditure
(a) Area Expansion Programmes		
Banana	NA	3.79
Pineapple	NA	0.14
Minor Horticulture Crops	NA	0.54
Cut flower	NA	0.14
Loose flower	NA	0.07
Nutmeg	NA	0.6
Cocoa	NA	0.13
Pepper	NA	0.16
Vermi-compost Units	NA	0.28
Phalasree Programme	NA	0.2
Mission Management	NA	0.31
Bee-keeping	NA	0.12
Project-based activities	NA	2.84
Sub-total	NA	9.33
(b) 13th Finance Commission projects	NA	3.34
Total	**-**	**12.67**

Source: Kerala State Planning Board and Department of Agriculture.

KERALA AGRICULTURAL UNIVERSITY (KAU)

There were two key recommendations regarding the KAU in the MSSRF report.

(a) If a new crop calendar has to come into force, a pre-requisite was the availability of a rice seed variety with duration a week to 10 days less than the currently popular Uma variety. This will also help in ensuring a shorter closure period for the Thanneermukkam Bund. This research agenda was to be taken up by the RARS, Kumarakom over a period of 6 years.

The KAU has released a new short duration variety called *Prathyasa* for Kuttanad. Experiments were conducted in farmer's fields under zero/minimum and conventional tillage situations and in different agro-ecological zones of Kuttanad. Promising isolates of bacteria effective with regard to the varying soil conditions like pH, moisture, iron and aluminum toxicity and salinity were identified from the native soils of Kuttanad. New parasites were identified against pests of rice in Kuttanad and techniques for mass rearing and field release of suitable parasites are currently being developed.

The laboratory complex in the RARS, Kumarakom was strengthened. The existing laboratory, training hall and seed production unit were renovated. A mobile agro-clinic cum mobile lab was established.

The KAU also procured an Amphibian vessel/harvester with an engine of international norms of emission with different attachments. It has an attachment to remove and collect water weeds and harvesting of Pokkali rice. It can also be used for dredging excavation and roto-tilling. However, a full utilisation of such machinery procured has not been achieved. There has been a dearth of trained hands for operating the Amphibian. Temporary workers were employed who left the job frequently. There were also issues with respect to the remuneration of workers and difference of opinion as to who will bear the expenditures on wages and repair. According to the KAU, they have no objection to transfer their machinary, including the Amphibian, to the Department of Agriculture. They have also offered continued technical support for the use of these machines even after the transfer.

Four variants of rice-based farming systems viz., rice monoculture; rice-duck-buffalo-fish; rice-fish/prawn; and rice-colocasia were laid out in an area of 8 ha. An extensive survey on hydrobiology of the Vembanad wetland system comprising of open lake locations, riverine locations and paddy lands is being carried out. This will be the first such comprehensive study covering the Kuttanad ecosystem.

(b) Another recommendation was to intensify research on the eradication of water hyacinth in the Vemband Lake.

The KAU has fabricated a low-cost waterweed harvester. For size reduction and moisture removal of collected water hyacinth from the water bodies, two types of squeezers were developed. Tools for harvesting water hyacinth were developed. Methodologies for utilizing water hyacinth for making handicrafts and making fiberboards were also developed.

However, these research outcomes have not translated into the reduction of water hyacinth growth in the Lake.

There is an additional point to be made here with regard to research by the KAU. Sugar cane was always cultivated in the deltaic belt of rivers viz., Pampa, Manimala, Meenachil and Achankovil. Scientists consider it a suitable and eco-friendly crop for the flood prone areas of Upper Kuttanad. However, the area cultivated with sugar cane has been on a decline due to the closing down of three sugar factories: Travancore Sugars, Thiruvalla; Mannam Sugars, Pandalam; and Co-operative Sugar Factory, Menonpara. At present, most of the deltaic belt is left fallow.

An amount of Rs 39 lakhs was provided for Agricultural Research Station, Thiruvalla for a project titled "Marketing and Branding of Sugar Cane Jaggery (*Pathiyan*) of Upper Kuttanad Region" under the Kuttanad Package. The major achievements of this project were as follows. The processing of jaggery was standardised and the facilities for the existing model unit were enhanced by installing motorised jaggery transferring system. The jaggery produced from the belt, known as *Pathiyan Sarkkara*, which is of semi-solid consistency, is renowned for its quality, taste and flavour. The *Pathiyan Sarkkara* of the Central Travancore region has received GI registration, which has enhanced its commercial prospects. Pet jar packaging was found to be the most ideal method for storing small quantities for home use. Jaggery could be stored for 10 months with least changes in total sugar and sucrose contents and colour. However, high costs of production, lack of centralized processing units and shortage of labourers were important constraints in the spread of sugar cane cultivation.

Expenditure details

The total expenditure on all these heads till March 2019 was Rs 37.95 crore. The total outlay was Rs 41.86 crore. The details are given in **Table 5**.

Table 5 *Cumulative scheme-wise details of expenditure under Kuttanad Package, Kerala Agricultural University, as on March 2019, in Rs crore*

Project details	Total outlay	Total expenditure
Promoting location-specific research for encouraging profitability from rice farming and enhancing livelihood security of farmers	4.09	4.00
Strengthening of Regional Agriculture Research Station (ORARS), Kayamkulam	1.20	1.19
Promoting semi-solid Sugar cane jaggery in Upper Kuttanad region	0.39	0.39
Productivity enhancement by energy efficient biodiversity-based farming models in Kuttanad	3.39	3.37
Environmental surveillance centre for Wetland Farming system in Kuttanad	2.60	2.57
Establishment of Centre for Farm Machinery Research Development and Training	4.50	2.78
R&D for eradication and utilisation of water hyacinth	5.12	3.07
Strengthening research of the Kerala Agricultural University (funded by 13th FC)	20.57	20.58
Total	**41.86**	**37.95**

Source: Kerala State Planning Board and Department of Agriculture.

DEPARTMENT OF SOIL SURVEY AND SOIL CONSERVATION

Under the Kuttanad Package, the Department of Soil Survey and Soil Conservation implemented a scheme for "Mitigation of Agrarian Distress in Kuttanad and Upper Kuttanad regions through Eco-restoration". This scheme was financed by the 13th FC from 2011-12 onwards with a four year phasing. Administrative sanction was received for an amount of Rs 15.25 crore for the 1st phase and for an amount of Rs 25.20 crore for the 2nd phase. An amount of Rs 1.52 crore was additionally sanctioned for implementing the ongoing eco-restoration activities. Out of the administrative sanction of Rs. 41.97 crore, only an amount of Rs. 29.48 crore was released for implementation (see **Table 6**).

Table 6 *Cumulative scheme-wise details of expenditure under Kuttanad Package, Department of Soil Survey and Soil Conservation, Government of Kerala, as on March 2019, in Rs crore*

Name of the scheme	Total Outlay	Total expenditure
Mitigation of Agrarian Distress in Kuttanad and Upper Kuttanad region through Eco-restoration, 13th FC award	26.89	26.89
Mitigation of Agrarian Distress in Kuttanad and Upper Kuttanad region through Eco-restoration: 14th FC award	2.59	2.59
Total	**29.48**	**29.48**

Source: Kerala State Planning Board and Department of Soil Survey and Soil Conservation.

Utilizing the fund received, the Department implemented various activities in the districts of Alappuzha, Kottayam and Pathanamthitta. Renovation of 204 ponds was carried out in the districts that have an augmented ground water regime. 3258 wells were renovated by constructing parapet walls to help in ensuring hygienic water for domestic use and irrigation purposes. About 24,728 m of vettiver planting was undertaken. About 71,601 seedlings of medicinal plants and fruit trees were distributed to the beneficiaries in the project area as part of eco-restoration.

The Central Plantation Crops Research Institute, Kasargode undertook a post-project evaluation study on the Department's activities under the Kuttanad package. According to this study, majority of the ponds renovated were good perennial water sources. It recommended that in future initiatives, interventions on the renovation of open wells to ensure potable water have to be prioritised in Upper Kuttanad. It also recommended that emphasis should be given to strengthening of the banks of drains/embankments near the paddy fields to protect them from inundation.

Expenditure details

The total expenditure on all these heads till March 2019 was Rs 29.48 crore. The outlay provided was fully utilised by the department. The details are given in **Table 6**.

DEPARTMENT OF FISHERIES

The major recommendations of the MSSRF report and the actions/responses of the department were as follows. The projects of the Department of Fisheries under the Kuttanad Package were implemented either directly by the department or through the Agency for the Development of Aquaculture (ADAK) or the State Fisheries Resource Management Society (FIRMA) or MATSYAFED.

(a) *Promotion of paddy-fish farming*: The report had recommended that the practise of one paddy-one fish rotational culture should be promoted in Kuttanad to increase the incomes of farmers as well as to contribute to eco-restoration.

The ADAK implemented a scheme titled "Development of Inland Aquaculture and Fisheries". The stocking of 9,596,717 fish seeds and 2.75 lakh scamp seeds covering 2353 ha was completed, which benefited 1002 farmers in 58 *padasekharams*. The work has been completed. The budget estimate was Rs 2.4 crore, and the expenditure was Rs 81 lakh.

On the whole, according to the department, paddy-fish culture was introduced in an area of 11,625 ha under ADAK's schemes and other schemes using State plan resources and FC grants.

(b) *Setting up of fish sanctuaries*: The MSSRF report had recommended that fish sanctuaires should be set up in the Vembanad Lake to protect and expand fish population and diversity of fish species.

Three fish sanctuaries were established under the Kuttanad Package by the department. They were in Neelamperur, Kumarakom and Pathiramanal. There were, however,

difficulties faced in the establishment and maintanence of these sanctuaries. The sanctuaries set up were with an area of about 5 ha. It was difficult to get contiguous areas without other fishing activity and having an extent of 5 ha in the Vembanad Lake.

(c) *Promotion of cage farming and ranching*: The MATSYAFED implemented a scheme titled "Development of Inland Aquaculture and Fisheries". Under this scheme, 1000 cages were distributed to 10 self-help groups (SHG) and 204,000 pearl spot seeds were stocked. Of the 1000 cages distributed, cage culture of pearl spot was initiated in 900 cages by nine SHGs in Alappuzha district and in 100 cages by one SHG in Kottayam district. One training programme was also organized.

Schemes were also implemented for strengthening the hatcheries at Polachira and Edathara for the production of carp seeds. There were also schemes for training and capacity building in fingerlings production as well as for improving sanitation and hygiene in the processing units.

Some issues need to be flagged here. *First*, scarcity of good quality seeds of fishes and prawns at the appropriate time is one of the important constraints on the development of aquaculture in Kuttanad, as elsewhere in the State. *Secondly*, a sizeable proportion of water bodies in Kuttanad are under the ownership of the government/local bodies. In Kerala, at present, there is no policy for leasing of public water bodies for fish production/ aquaculture. In the absence of a leasing policy, public water bodies cannot be utilised for cage farming or pen farming on a large scale. In the absence of any agreement/lease deed, banks are also not willing to extend loans to fish farmers. *Thirdly*, inland aquaculture in Kuttanad, as in other parts of the State, is carp-centric. However, carps are generally not relished in the Kuttanad region and fetch a relatively low price. In this context, development of farming of indigenous fishes assumes significance. Though technology is readily available, hatcheries for the large-scale production of seeds of indigenous fishes do not exist in any part of the State.

(d) *Revival of productivity of pearl spot and giant prawn*: Across different schemes related to culture-based fisheries and open water ranching, 83.41 lakh giant fresh water prawn seeds (scampi) and 4.2 lakh pearl spot seeds were stocked in Kuttanad.

Using funds of the 13th FC, three specific activities were undertaken.

- *Establishment of a model hatchery, seed farm and a research and awareness centre at Ayiramthengu*: The infrastructure development works and the farm renovation works were entrusted with Kerala State Coastal Area Development Corporation. The construction work of raceway hatchery and rearing tanks and office block has been completed. The renovation of ponds is also complete. Construction of the awareness-cum-training centre is under progress. 13 training programmes were conducted for 992 farmers. Pearl spot seed production has started; 72,524 seeds were produced.
- *Establishment of sanctuaries, restoration, ranching and recruitment of giant prawn and pearl spot*: Two fish sanctuaries were established; one in Alappuzha district and the other in Kottayam district. About 75 lakh scampi seeds and 2.85 lakh *karimeen* seeds were stocked in different water bodies of the project area.

- *Cluster-based cage culture of pearl spot*: Under this scheme, 12 groups (or 240 cages) were installed and stocked with pearl spot and tilapia. About 21.1 tonnes of pearl spot and about 4 tonnes of tipalia were harvested.

(e) Relaying of clam seeds: A scheme was implemented to relay clam seeds from their natural beds to other areas with suitable salinity.

(f) *Construction of fish landing centres and prawn cleaning centres*: No action was taken.

(g) Institute SHGs of women from fisher-families: About 80 units of micro-enterprises for fisherwomen were set up.

(h) Eradication and utilisation of water hyacinth: The MSSRF report had recommended that ways of eradication of water hyacinth as well as promotion of its end uses should be promoted. With these objectives, three sets of schemes were implemented by the department.

- *Mechanical removal of water hyacinth*: Water hyacinth was periodically removed from Kanjiram *thodu* in Thiruvarppu panchayat, Puthenthodu in Kottayam Municipality, Kodoorattu in Kodimatha of Kottayam Municipality, Boat Jetty *thodu* in Changanasserry Municipality, AC Canal in Ramankari panchayat, AS Canal in Alappuzha Municipality, Akkanady *thodu*, Eeraya *thodu*, Purathezhi *thodu*, Pallikkara *thodu*, Kaithappuzha *kayal*, Pathinarilchira, Kacherikadavu *thodu*, Commercial Canal, Kainadi *thodu*, Kodooraru, Vilakkumaram *kayal* and Powerhouse *thodu* in Vembanad Lake.

- *Vermicompost units*: 174 vermicompost units (each costing Rs 15,000) based on water hyacinth were set up. Training was given to 748 beneficiaries for setting up of vermicompost units.

- *Biogas plant*: A biogas plant, which made use of water hyacinth for the production of electricity (with 5 tonnes capacity), was set up in Kotimatha vegetable market and handed over to Kottayam Municipality.

A few critical remarks with regard to these efforts may be in order.

- First, water hyacinth proliferates rapidly. Studies show that the weed has the capacity to double its biomass within 12 days. Hence, for a complete eradication of the weed, an integrated approach would be required that would encompass *manual, mechanical* and *biological* methods. There must also be attempts to reduce the accumulation of plant nutrients in the water bodies and for the periodic opening of the Thanneermukkam Bund, which would facilitate salt water incursion. Salinity is detrimental to the growth and proliferation of water hyacinth. In other words, mechanical methods alone are not sufficient to eradicate water hyacinth. In the Kuttanad package, though an integrated approach to eradicate the weed was envisaged, only mechanical methods were implemented. As a result, the results were poor.

- Secondly, the technology for the generation of electricity from water hyacinth is not cost-effective. It was found that for the production of electricity valued at around Rs 36,000, the cost involved was around Rs 110,000. In other words, biogas units with water hyacinth were not profitable given the current level of technology.
- Thirdly, vermicompost units using water hyacinth were also not economically attractive. To set up each unit, an amount of Rs 15,000 was required. On the other side, each unit generated a net income of around Rs 1000-1200 within a period of 45 days.
- Finally, water hyacinth accumulates heavy metals in large amounts. Since compost made of water hyacinth is likely to contain heavy metals in large quantities, people are generally reluctant to use the compost made out of water hyacinth for purposes like vegetable farming.

Expenditure details

The total expenditure on all these heads till March 2019 was Rs 32.70 crore. The total outlay was Rs 41.14 crore. The details are given in **Table 7**.

DEPARTMENT OF ENVIRONMENT/FOREST AND WILD LIFE

The activities of departments of environment and forestry were minimal under the Kuttanad Package. Under a project to augment mangrove forests in and around Pathiramanal Islands, about 1 lakh mangrove seedlings were planted in the Vembanad ecosystem and environmental awareness programmes were conducted. A quantity of about 209,196 m^3 of weeds was removed from different panchayats and municipality areas. The departments also installed 166 vermicompost units; 748 beneficiaries were trained in vermicompost technology.

Expenditure details

The total expenditure on all these heads till March 2019 was Rs 19.03 crore. The total outlay was Rs 21.68 crore. The details are given in **Table 8**.

DEPARTMENT OF ANIMAL HUSBANDRY AND DAIRY

The MSSRF report had made two major recommendations with regard to the animal husbandry sector in Kuttanad. First, it suggested that livestock be increasingly integrated into the farming systems to make them more diversified and sustainable. Secondly, it suggested that duck farming be widely promoted in the region. When the Kuttanad Package began, many recommendations were converted into schemes by the Departments of Animal Husbandry and Dairy. However, the recommended proposals submitted to Government of India were rejected since none of these conformed to the existing guidelines of schemes. The Government of Kerala then decided to include schemes costing below Rs 50 lakh under State plan schemes.

(a) *Integration of crop cultivation with livestock*: One of the report's recommendations was a one-time assistance for livestock-crop combination. This project was submitted to the Government of India, which instead sanctioned the following projects as replacements.

Table 7 *Cumulative scheme wise details of expenditure under Kuttanad Package, Department of Fisheries, Government of Kerala, as on March 2019, in Rs crore*

Name of the scheme indicating source of fund and components		Total outlay	Total expenditure
Restoration of Agro-eco systems of Kuttanad through Sustainable Aquaculture, funded by the 13th FC, implemented by ADAK	Fish/Prawn culture in rotation with paddy cultivation	17.84	17.84
	Pen Culture	0.54	0.54
	Conservation of indigenous fishes, consultation, Transfer of Technology		
	Establishment of Sanctuary at Pathiramanal in Muhamma panchayat	0.26	0.26
	Training in seed production	0.05	0.05
	Nursery Rearing (100 units)	0.10	0.10
	Consultancy charges	0.02	0.02
	Project managerial cost/ implementation charges	1.00	1.00
	Sub-total	**19.81**	**19.81**
Revival of Productivity of Pearl spot and Giant Freshwater Prawn on Life cycle Approach in Vembanad Ecosystem, funded by the 13th FC, implemented by Department of Fisheries	Establishment of a Model Fish hatchery, Seed farm, Research and Awareness centre for propagation & farming of State fish: *E. Suratensis* in Ayiramthengu fish farm	16.6	8.89
	Cluster-based Cage culture	1.43	1.43
Paddy fish integration for economic and ecological security and farmers training, central sector scheme	Development of inland aquaculture and fisheries	0.02	0.01
Programme for revival of productivity of pearl spot and giant prawn on a life cycle approach, State plan scheme		0.01	-
Ranching in Rani-Chithira and neighbouring kayal, funded by the 13th FC, implemented by ADAK	-	1.00	1.00
Cluster-based cage culture, implemented by Matsyafed	Development of inland aquaculture and fisheries	0.60	0.40
Ranching, involving large scale hatchery-reared production of post-larvae, State plan scheme	-	0.20	0.20
Fish hatcheries for raising adequate quality fingerlings, central sector scheme	Development of inland aquaculture and fisheries	0.60	0.15
Fresh water prawn and *karimeen*: Urgent conservation measures, State plan scheme	-	0.25	0.25
Group based enterprise on ornamental fish culture, State plan scheme	-	0.12	0.12
Cold storage facility for the fishing communities, State plan scheme, implemented by Matsyafed	-	0.30	0.23
Training and capacity building of fishermen, fingerlings production, improving sanitation and hygiene in processing units, State plan scheme	-	0.20	0.20
Total		**41.14**	**32.70**

Source: Kerala State Planning Board and Department of Fisheries.

Table 8 *Cumulative scheme wise details of expenditure under Kuttanad Package, Department of Forest and Wild Life/Environment, Government of Kerala, as on March 2019, in Rs crore*

Name of the scheme indicating source of fund	Total Outlay	Total Expenditure
Project to augment the Pathiramanal mangrove forests	0.30	0.27
Eradication and utilisation of water hyacinth	16.93	14.31
Biodiversity conservation in Vembanad Wetland Ecosystem	4.45	4.45
Total	**21.68**	**19.03**

Source: Kerala State Planning Board and Department of Forest/Environment.

- Induction of 2000 high yielding cows worth Rs 3 crore (1000 cows in Alappuzha, 500 cows in Kottayam and 500 cows in Pathanamthitta);
- Calf-feed subsidy scheme for 1000 calves worth Rs 73 lakh (500 calves in Alappuzha, 250 calves in Kottayam and 250 calves in Pathanamthitta);
- Artificial insemination for 80,000 cows worth Rs 1.28 crore;
- Estrous synchronization for 25,000 cows worth Rs 22 lakh; and
- Goat rearing assistance worth Rs 1.47 crore.

Under the scheme for the induction of high yielding cows, animals were purchased from outside the State and provided to farmers. One farmer was provided with 2 milch cows with assistance for construction of shed, purchase of utensils and fodder cultivation. All the animals were insured. Under the calf-feed subsidy scheme, calves of 4 to 6 months age were inducted and provided with calf-feed at subsidized rate with complete health coverage. These calves were scientifically managed so that they grow faster and mature at an early age. Thus, the farmers had a producing stock at earlier ages than before. Artificial insemination and estrous synchronization ensured that all cows were productive with optimum production. All the schemes, except the goat-rearing scheme, were completed.

(b) *Promotion of duck farming*: The MSSRF report gave much thrust to revive and strengthen duck rearing in Kuttanad. The only duck farm in Kerala was located at Niranam in Pathanamthitta district and any intervention to promote duck rearing required strengthening of this farm. The report recommended specific steps to make the farm fully functional utilizing its full capacity.

Incubators for Duck Farm, Niranam were purchased to ensure capacity enhancement under State plan scheme in 2008-09 (worth Rs 9 lakh) and under Rashtriya Krishi Vikas Yojana (RKVY) in 2009-10 (worth Rs 9 lakh). Duck insurance was implemented in 2009-10 and 2010-11 under State plan schemes worth Rs 3.65 lakh.

(c) *Schemes from FC grants*: For livestock promotion schemes in the Kuttanad Package, funds were also utilized from the FC grants. Two schemes were implemented in this regard.

- *Strengthening of Niranam Duck Farm* for revival of duck farming worth Rs 12.85 crore: In this scheme, sanction of which was given to KITCO Ltd., the following components were included, and the work completed.

- Restructuring of Duck Farm, Niranam;
- Duck hatchery and brooder unit at Manjady;
- Central Duck Training Institute at Manjady;
- Duck insurance;
- Duck rearing scheme;
- Mobile disease diagnostic lab; and
- An impact study by the College of Veterinary and Animal Sciences.

- *Comprehensive and Sustainable Animal Husbandry Practices for Kuttanad worth Rs 29.99 crore*: This scheme was a holistic project with special emphasis on the geographical constraints Kuttanad. The components included were:
  - Azolla cultivation;
  - Legume cultivation;
  - Control of amphistomiasis;
  - Use of bio-waste as manure;
  - Marketing of Kuttanadan brand of duck, eggs and meat;
  - Subsidized concentrate feeding;
  - Cattle rearing; and
  - Buffalo rearing.

  The project proposed to promote cattle rearing in Upper Kuttanad and buffalo rearing in Lower Kuttanad integrated with coconut and other agricultural/horticultural activities. Fodder, which was scarce in Kuttanad, was given importance and fodder production was promoted, especially legumes on bunds and azolla at farmer's premises. The scheme supported farmers with provision for concentrate feed at subsidized rate. A profitable marketing strategy was created to strengthen the marketing of Kuttanadan branded ducks, eggs and meat through SHGs. An efficient eco-friendly bio-waste usage system was also put in place to control environmental pollution.

The Kerala Veterinary and Animal Sciences University (KVASU) conducted an impact assessment of the scheme to induct cows as part of the Kuttanad Package in 2012 (KVASU, 2012). This rapid appraisal study had the objectives of assessing impacts in terms of survival percentage, milk production, employment generation and income generation as well as of assessing perceptions of beneficiaries regarding support services, such as calf-feed subsidy scheme, artificial insemination and fodder production. We are not discussing the conclusions of this study in great detail, but it may suffice to provide a snapshot of the conclusions through the lens of the SWOT analysis that was attempted (see **Table 9**).

Expenditure details

The total expenditure on all these heads till March 2019 was Rs 36.05 crore. The total outlay was Rs 37.05 crore. The details are given in **Table 10**.

DEPARTMENT OF TOURISM

The only activity of the Department of Tourism reported under the Kuttanad Package was the upgradation of the Tourist Facilitation Centre at Nedumudi.

Table 9 *Results of SWOT analysis of the scheme to induct cows, Kuttanad package, by KVASU, 2012*

Strengths	Weaknesses	Opportunities	Threats
The scheme served as a means for increasing overall milk production in Kuttanad.	Physiological adaptation problems of animals purchased from outside the State resulting in lower milk yields.	The creation of interest in dairying among youth and the community at large.	Exploitation of farmers by brokers outside the State. Brokers sometime intentionally misled farmers leading to financial losses.
Additional employment and income generated was significant.	Failure to obtain expected milk yield in some animals.	The scheme was instrumental in motivating new entrants to take up animal husbandry enterprises as a livelihood option.	Brokers and cattle traders in other States were well versed with subsidy norms and scheme details and fixed cattle prices accordingly.
Cattle and calf production in the region increased.	Reduction in milk production in some animals after 3-4 months of lactation.	The scheme offered an opportunity to make new advancements in dairying.	Problems in transporting animals through inter-State check posts.
Scheme was instrumental in helping farmers expand their farms and moving from small subsistence ventures to medium/large enterprises.	Difficulty in communicating with cattle merchants and brokers from outside the State due to language barriers.	The cost of purchasing animals form outside the State was less than the prevailing rates within the State.	Despite having ready cash to purchase animals, farmers were forced to take loans from banks and incur additional interest costs.
Subsidy provided under the scheme was a reasonable amount.	Practical difficulties for female veterinarians to accompany farmers to other State for purchase of animals.	The scheme provided an opportunity to introduce new germplasm into Kuttanad.	Banks not willing to sanction loans to farmers or charging higher interest rates on sanctioned loans.
-	Problems in managing waste.	The scheme helped in the production of more organic manure for use in agriculture.	Failure of beneficiaries to repay loans.
-	Fodder scarcity and lack of sufficient alternative fodder resources to feed animals.	-	More transparency to be ensured in selection of beneficiaries to include more with interest and aptitude in dairying.
-	High incidence of haemoprotozoan infections in animals procured from across the border.	-	Farmers were reluctant to purchase animals from other States.
-	Incidence of infertility problems.	-	Negative attitudes towards animal husbandry vocation due to failure of the scheme in some areas.
-	Lack of knowledge in hygienic farm practices among beneficiaries.	-	No proper follow-up after implementation of the scheme.

Source: KVASU (2012).

Table 10 *Cumulative scheme wise details of expenditure under Kuttanad Package, Department of Animal Husbandry and Dairy, Government of Kerala, as on March 2019, in Rs crore*

Name of the scheme	Total outlay	Total expenditure
(a) Central government schemes		
Induction of Cows (2000 cows/1000 beneficiaries), implemented by KLDB	3.00	3.00
Female Calf-Rearing (1000 calves), implemented by KLDB	0.73	0.73
Artificial Insemination, implemented by KLDB	1.28	1.28
Estrous Synchronization, implemented by KLDB	0.22	0.22
Goat Rearing, implemented by KLDB	1.47	1.47
(b) State government schemes		
Incubators for Duck Farm, Niranam	0.09	0.09
Rashtriya Krishi Vikas Yojana	0.09	0.09
Duck Insurance	0.036	0.036
(c) Schemes financed by the 13th Finance Commission		
Strengthening of Niranam Duck Farm for Revival of Duck Rearing in Kuttanad	8.85	7.85
Comprehensive and Sustainable Animal Husbandry Practices for Kuttanad	21.28	21.28
Total	**37.05**	**36.05**

Source: Kerala State Planning Board and Department of Animal Husbandry and Dairy.

SUCHITWA MISSION

The Suchitwa Mission proposed to implement a scheme to ensure sanitation coverage by the construction of eco-toilets in Kuttanad. However, this scheme was not implemented and the amount allocated was refunded for unknown reasons.

KERALA WATER AUTHORITY

The MSSRF report of 2007 had the following observation on the state of drinking water availability in Kuttanad.

> "…drinking water is in serious shortage throughout Kuttanad. Kuttanad is now in a typical state of 'water, water everywhere, but not a drop to drink'. But many who cannot afford costly potable water, or receive panchayat-arranged water supply, often drink what is available. The Upper Kuttanad, due to fallowing and conversion of paddy fields, is facing water shortage during summer. During summer, the low-lying areas of Kuttanad face additional problem [of] drinking water due to salinity. While there are a few drinking water projects, the acuteness of potable water shortage in Kuttanad is still keenly felt. Piped water facility reaches only 25 per cent population, and that too, at the rate of 40 ltrs/day/person" (MSSRF, 2007, p. 88).

The key challenge of provision of clean drinking water is within 12 panchayats in the Kuttanad taluk. All these panchayats were severely affected by the recent floods. This region has about 60,000 households spread over 180 wards. While there are multiple suggestions

towards the provision of clean drinking water to these households, including digging more numbers of wells and ponds, we believe that the sustainable solution would be the provision of clean piped drinking water to these households. Currently, there are schemes to provide clean piped drinking water in this region. However, the quantity supplied is grossly inadequate and most pipelines are dilapidated. We shall provide a short background to the past interventions in this sphere below, and then move into possible solutions.

Past efforts

No potable surface water source is available within Kuttanad. During the early 1970s, a few tube wells were drilled in selected areas of Kuttanad and water distribution was arranged for a limited area. However, these shallow tube wells soon became unusable due to contamination with iron and chloride. Then, in 1977, a comprehensive water supply scheme to cover 18 villages in Kuttanad was planned and partially commissioned under the 'minimum needs program' (Fifth Five Year Plan; 1974-78). For this purpose, a surface source was selected at Kattodu in Thiruvalla in the Manimala river. All these initiatives fell under a larger scheme called the Kuttanad Water Supply Scheme (KWSS).

Meanwhile, as part of the Accelerated Rural Water Supply Programme (ARWSP) initiated in 1972-73 by the Government of India, a scheme to provide water supply to Nedumudi and Kainakari panchayats was taken up. The water source identified for these schemes was tube wells. Alongside, the works for schemes for Pulinkunnu, Kavalam and Neelamperoor panchayats were taken up under the Accelerated Rural Water Supply Programme (ARP). Treated water of the Manimala river was the source for these panchayats. A water supply scheme to Veeyapuram was also sanctioned under the ARP as an extension of the KWSS.

As part of these interventions, some basic infrastructure towards the provision of piped water was laid out in Kuttanad by the Kerala Water Authority (KWA). Water transmission mains were laid from the Thiruvalla water treatment plant to Thalavady, Edathua, Muttar, Veliyanadu and Ramankari panchayats. About 60 per cent of the transmission mains were laid in Champakkulam, Pulinkunnu, Kavalam and Neelamperoor panchayats. The works on GL tanks at Edathua and Pallikoottumma were completed. Five RCC overhead reservoirs were constructed in Kuttanad, at Veliyanadu, Nedumudi, Kainakari, Edathua and Neelamperoor. Distribution lines were laid partially in Thalavady (80 per cent), Edathua (75 per cent), Thakazhy (60 per cent), Muttar (80 per cent), Veliyanadu (30 per cent) and Ramankari (50 per cent) panchayats. These lines were also partially commissioned by connecting them to the transmission main laid from Thiruvalla.

Yet, water supply could not be satisfactorily ensured to households in these regions for a variety of reasons. As the water levels in the Manimala river declined during the summer months, the required water supply from the Kattodu treatment plant could not be assured. Also, the construction of transmission mains, overhead reservoirs, booster stations and distribution lines remained incomplete in many areas. As the proposed storage reservoirs were not fully constructed, the overall quantum of water supply remained inadequate. A portion of the treated water was also diverted to the suburban panchayats around Thiruvalla and Changanacherry municipalities. Further, new extensions of pipelines became necessary for full coverage when new roads and bunds were constructed. The coverage was also uneven across Kuttanad, as about 50 per cent of the distribution lines were laid in Champakulam, Kainakari, Pulinkunnu, Kavalam and Neelamperoor panchayats.

Thus, a new scheme to augment water availability from the project was initiated in 1995 under the 'Technology Mission Programme' with 75 per cent central assistance and 25 per cent State assistance. The proposal included augmentation of the capacity of the Kattodu treatment plant by laying a pipeline from the canal networks of the Pamba Irrigation Project, construction of overhead tanks and laying of distribution networks. The augmentation part of this scheme, in particular, was not successful as the canals of the Pamba project were also dry during the summer months following the setting up of a low head power generating station at Maniyar. As a result, the Kattodu plant continued to be dependent on water from Manimala.

The Neerattupuram project

As a result, in 2002, the KWA established another 14 MLD water treatment plant (WTP) with an alternate water source at Neerattupuram in the Thalavady panchayat. It was intended to supply safe drinking water to 13 panchayats: Thalavady, Edathua, Thakazhi, Muttar, Nedumudi, Ramankari, Champakkulam, Neelamperoor, Kavalam, Pulinkunnu, Kainakari, Veliyanadu and Veeyapuram. An amount of Rs 6.14 crore was sanctioned for this purpose. However, this phase of the Nerattupuram project was also a failure. To begin with, the amount allocated to the project was inadequate, due to which only the intake well, the treatment plant and the raw water pumping system could be completed. As there were no transmission systems and reservoirs, water could not reach the targeted panchayats like Kainakari, Pulinkunnu, Thakazhi, and Neelamperoor. According to the department's own data, average water supply could be maintained only for 8 hours a day in the Thalavady and Muttar villages, and 4 hours in the rest of the villages. In most places, water supply could be ensured only for 2 or 3 days in a week. A report from Kuttanad in *The Hindu*, dated 13 July 2003 illustrated the crisis of water most vividly:

> "…when it comes to drinking water, they need to wait for the call that heralds water supply twice a week, often at night. The water call sometimes comes over the telephone, too! The officials at Kuttanad Water Supply Scheme (KWSS) located 40 kilometres away in Thiruvalla will telephone the *panchayat* president when water comes in the pipe. He will then pass on the message to the houses where telephones are available. Men, women and children jump into their *changaadams* (tiny rowboats). Across the canal, they rush to the public water tap. When the tap runs dry, they pick up their pots, sometimes half full, and return home to resume their interrupted slumber. 'We get piped water only twice a week, that too for an hour often at night,' says Omana, one of the inhabitants. 'Though surrounded by water, we live like sparrow-hawks; always looking out for drinking water'" ("Thirst Below Sea Level", *The Hindu*, 13 July 2003).

In Thalavady, Muttar and Nedumudi villages, the water supply level maintained was only 10-15 litre per capita per day (lpcd) on an average. The distribution lines laid were designed for a supply level of 40 lpcd. Most of the old lines are leaking and damaged. These lines were laid during 1970s and 1980s and majority of them were unserviceable. For instance, many of these lines were laid along the old foot paths and bunds. These foot paths and bunds had been developed afterwards into roads with the surface raised by 1-2 metres. As such, the pipelines became buried 2.5 to 3 m below the ground level. The maintenance of these lines was practically impossible due to the very high water table in the area. Thus, even the limited water supply reaching the service area was being lost due to broken pipes and leakages.

At this point, the department prepared another project to complete the balance work under the Neerattupuram project. The proposal was presented to the 13th Finance Commission for

the receipt of a grant. An amount of Rs 70 crore was sanctioned, under which the components included 45 mm of transmission main, 47 km of distribution lines in 6 panchayats and an overhead service reservoir (OHSR) at Thakazhi. Administrative sanction was obtained in October 2013. The project was structured as four packages. The progress achieved under each package as on May 2019 are given in **Table 11**.

Table 11 *Progress of improvements in the water supply system in Kuttanad taluk, Grant from the 13th Finance Commission, as on May 2019*

Package	Objective	Physical progress	Cumulative expenditure, as on May 2019
Package 1	Transmission System 1; for laying part of transmission system 1 to service reservoirs at Veeyapuram, Edathua, Thalavady, Muttar and Neelamperoor; HDPE = 27.2 km	Completed	Rs 51.72 crore out of the total allocation of Rs 70 crore
Package 2	Transmission System 2; for laying part of transmission system 2 to service reservoirs at Ramankari, Champakkulam, Pulinkunnu, Kavalam, Nedumudi and Kainakari; HDPE = 17.8 km	Completed	
Package 3	Portion of distribution lines to Thakazhi, Edathua, Thalavadi, Muttar, Veliyanadu and Neelamperoor panchayats and the construction of an OHSR at Thakazhi; HDPE = 150 mm to 350 mm; DI pipe	35 km completed out of 47 km. On the railway crossing of Thakazhi, online request already submitted. But the railway authorities have not allowed the pipe line to cross near Smrithi Mandapam. But an alternate route has been traced at another railway cross. Joint inspection already conducted with railway authorities. The OHSR at Thakazhi completed.	
Package 4	Distribution lines in Transmission System 2 area; Construction of OHSR	Not taken up	

Source: Kerala Water Authority.

DETAILS OF TOTAL EXPENDITURE UNDER THE KUTTANAD PACKAGE

The total expenditure, department-wise, incurred under the Kuttanad Package is given in **Table 12**. As per our tentative estimate, a total expenditure of Rs 1013.35 crore has been incurred on the Kuttanad Package as on 31st March 2019. This is as against the proposal of Rs 1839.75 crore recommended by the MSSRF report of 2007. A minor addition in the total amount spent will result when the final bills on some completed works come in during the financial year of 2019-20.

Table 12 *Department-wise expenditures incurred on the Kuttanad Package between 2008 and 2019, as on 31st March 2019, in Rs crore*

Departments	Government of India		Government of Kerala		13th Finance Commission grants		Total expenditure	
	Release	Expenditure	Release	Expenditure	Release	Expenditure	Release	Expenditure
Water Resources	137.95	137.54	516.25	516.25	39.08	39.08	693.28	692.87
Agriculture Development and Farmers' Welfare	77.06	77.18	3.55	3.50	12.62	9.51	93.23	90.19
State Horticulture Mission	9.32	9.32			3.35	3.35	12.67	12.67
Kerala Agricultural University	21.29	17.37			20.58	20.58	41.87	37.95
Soil Survey and Soil Conservation					29.48	29.48	29.48	29.48
Fisheries	0.54	0.54	1.00	1.00	34.93	31.13	36.47	32.67
Animal Husbandry and Dairy	6.70	6.70	0.22	0.22	30.13	29.13	37.05	36.05
Kerala Livestock Development Board (KLDB)	5.23	5.23					5.23	5.23
Forest and Wild Life	17.23	14.58			4.45	4.45	21.68	19.03
Tourism			0.50	0.12			0.50	0.12
Kerala Water Authority					38.20	38.20	38.20	38.2
Others					20.61	18.89	20.61	18.89
Total	**275.32**	**268.46**	**521.52**	**521.09**	**233.43**	**223.8**	**1030.27**	**1013.35**

Source: Kerala State Planning Board and different departments.
Note: Others include expenditures incurred by local self-governments, NCESS, OPIL Kottayam. All amounts are tentative and subject to revision.

V

TOWARDS A NEW KUTTANAD PACKAGE

As the Hon'ble Chief Minister of Kerala Pinarayi Vijayan has repeatedly emphasized, the rebuilding of Kerala after the August 2018 floods cannot simply be a routine reconstruction process. It has to be a "New Kerala" (*navakeralam*) that has to be built from the ruins of the floods. As he stated in an interview:

> "A disaster has fallen upon the state [and] it needs to get its head above the water. This is what everybody wants. But we are not seeing it in that way, we are thinking a bit different. We see it as an opportunity to create a 'Navakeralam'.[5]

As was stated in the Hon'ble Governor's address to the State Legislative Assembly on the 25th January 2019,

> "It is clear that we would require 4 to 5 years to rebuild Kerala. My Government is of the resolve that it is not enough that the State merely undertake a rehabilitation and restoration plan in the aftermath of this natural disaster. This calamity should be taken up as a challenge and as an opportunity to rebuild the State to ensure *better standards of living* to all sections of society. *Higher standards of infrastructure* should be adopted in repair and reconstruction. *New major projects* should be envisioned for the State. *Ecological safeguards and standards* should be adhered to while building structures that will be constructed to equip new and restored assets to better withstand the onslaught of such calamities in the future" (GoK, 2019, p. 6, emphasis added).

As the address clearly put on table, the rebuilding of Kerala involves improving the standard of living of people, designing new major projects with higher standards of infrastructure and ensuring ecological safeguards and standards. The KSPB was entrusted by the government with the task of preparing a new package for the eco-restoration and reconstruction of the Kuttanad region. As the Hon'ble Governor stated:

> "The State Planning Board is also preparing a special package for Kuttanad Wetland Ecosystem to revitalize the overall development of the region through development of various components and envisaging the integration of all the departments" (GoK, 2019, p. 42).

[5] Available at: https://www.livemint.com/Politics/509fVdQUbGu6Hq0t4ys5QP/We-see-the-floods-as-an-opportunity-to-create-a-new-Kerala.html.

Soon after the August floods, as the State moved from the relief to the recovery stage, the Government of Kerala commissioned a post-disaster needs assessment (PDNA) to be jointly developed by three international development partners: the European Union, the World Bank and the United Nations system. On the ground, it was undertaken by a large number of officials from the line departments of the Government of Kerala and experts from the United Nations and the European Union. This report suggested different options for a recovery policy as well as institutional arrangements for recovery over a time frame of five years (GoK, 2018). In the preface to the report, the Chief Secretary Tom Jose noted that the vision for recovery in *Navakeralam* is based on four pillars:

(a) "Integrated Water Resources Management (IWRM) based on the principles of 'room for river' and 'living with water';
(b) Eco-sensitive and risk-informed land use and settlements to build a green and resilient Kerala;
(c) Inclusive and people-centred approach (leave no one behind);
(d) Promotion of knowledge, innovation, technology through partnerships to build back faster, safer and sustainably."

The PDNA report noted that:

> "The government should also prepare a master plan for the Kuttanad area, start an awareness programme on living with water in flood prone areas, and set up a Kerala Water Partnership to organise dialogues and promote communication for behaviour change" (GoK, 2018, p. 22).

The PDNA report also noted some of the problems related to the Vembanad Lake system and Kuttanad as a whole that were already flagged by the the Indo-Dutch Mission of 1989 and the MSSRF report of 2007.

> "…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… (p.33)
>
> …The drainage channel system of Kuttanad is poorly maintained and silted, thus reducing drainage discharge capacities towards the Thottappally Spillway…(p. 67)
>
> …To improve 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…(p. 72)
>
> …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…(p. 72)
>
> … Kuttanad should be demarcated as a special zone for land-use planning…(p. 103)
>
> … Just as the extensive Vembanad lake system continues into the Kuttanad Wetlands, so

> should these wetlands be seen as an intrinsic part of the overall Vembanad – Kuttanad basin (including the five river basins feeding into the area). The proposed authority should rather be named Vembanad/Kuttanad Development Authority within the overall institutional setting envisaged for the development planning of the Kuttanad Wetlands… (p. 77).

This report by the KSPB is an effort towards building a master plan for Kuttanad wetland system's eco-restoration and rejuvenation.

As per the PDNA report's recommendation that a new study should be organized on water balance in Kuttanad, the Government of Kerala invited an expert team from Netherlands to develop a perspective on sustainable Kerala, in which IWRM was to be one of the pillars. The draft report of this team has special reference to Kuttanad (GoK, 2019b). This report by the KSPB takes into consideration some of the preliminary findings of this study, jointly done by the Department of Water Resources and the Dutch team. We shall provide the references at the appropriate points in this report.

The basic analytical approach in this report is set to ensure that any policy framework for Kuttanad is geared towards:

(a) Increasing agricultural growth and farmer's incomes;
(b) Building ecological resilience in the Vembanad Lake system;
(c) Enabling people to live safely and securely; and
(d) Resolving conflicting concerns of different socioeconomic sections.

In other words, *productivity, profitability, ecology, security* and *cooperation* have to be cornerstones of any future policy on Kuttanad. We believe that these are not mutually exclusive objectives. These objectives can be attained by making use of modern technologies, scientific planning for water management, building up appropriate flood proofing systems and deepening democracy in the decision-making process.

VI

THE APPROACH IN WATER MANAGEMENT

To begin with, Kuttanad is a water-centric ecosystem. It has a complex system of five rivers opening up into a web of larger and smaller canals with many permanent and temporary links. Its land is a conjugation of bowl-shaped islands with a deep central part and a shallow periphery. Settlements have mostly developed along water courses occupying natural levees and to take the advantage of movement along waterways (Chattopadhyay, 2019). Even if we manage floodwater efficiently, the complexities of Kuttanad would not disappear. Given the uniqueness of Kuttanad in being a confluence of marine, estuarine and fluvial systems, conflicting concerns of crop cultivation on the one hand and fisheries on the other would still need resolution. In other words, the way land is put to use and livelihoods are structured is integrally linked to the way water is managed.

Further, any effort to *completely eliminate* flood threats in a region like Kuttanad might actually fail, if not be counterproductive. It is here that we need to conceptualise IWRM as a central feature in the management of Kuttanad's development question.[6]

It is within the overall management strategy of water that we would need to place the practise of multiple occupations in the region, such as agriculture, fisheries, animal husbandry and tourism. The same applies for sectors like industry, health, sanitation and drinking water. The making of Kuttanad's future development strategy, thus, will be an inter-disciplinary task involving agricultural science, veterinary science, fisheries, hydrology, engineering and ocean sciences. It is not just in the making of policy strategies that inter-disciplinarity would come into play. While strategies are translated into projects, the different departments that implement them would also need to work in tandem. In many cases, the possibility of one project jointly implemented by more than one department would need to be explored. As was evident from the experience of the previous Kuttanad Package, lack of coordination across departments leads to absolute chaos in how schemes are designed and implemented. This has to be avoided in the future.

[6] Globally, parallel to the IWRM framework, concepts like "room for the river", "living with water" and "building with nature" have been developed. "Room for the river" refers to efforts to provide the river with more room to be able to manage higher water levels. "Living with water" refers to efforts to create natural and fortified solutions to facilitate more resilient forms of inhabitation in the places most at risk from severe floods or storms. "Building with nature" is a concept where nature is considered an integral part of a design, and is used to cope with climate change risks, such as floods, waves and sea level rise. However, it is important to note that each of these concepts, to be used in a particular context, cannot be mechanically transplanted and applied on to other historical and geographical contexts.

The thinking on better managing water in Kuttanad has to begin from a scientifically designed river basin policy. The KSPB has, over the past 3 years, been advocating the location of all projects of the Department of Water Resources based on specific river basin policies. The floods of August 2018 have demonstrated the urgency of moving towards such a policy framework from the existing haphazard and *adhoc* system of planning and implementing "schemes" under different departments. The post-flood study in Kuttanad by the team of Dutch scholars also underlines this shift as instrumental to the better management of river waters in the State (GoK, 2019b). We shall outline the contours of such a policy below.

We begin this discussion with the need to appreciate a hierarchy of water systems in Kuttanad as into *primary, secondary* and *tertiary* systems. This is in tune with a water management policy based on a holistic understanding of river basins.

PRIMARY SYSTEM

The primary system would consist of the lower reaches of five rivers – Pamba, Achankovil, Manimala, Meenachil and Muvattupuzha. This system could be envisaged as to begin from about 40 m above MSL till they fall in to the Vembanad Lake through their main riverbeds and canals. This system would also consist of the Thottapally Spillway, the AC Canal and the Vembanad Lake up to Kochi.

SECONDARY SYSTEM

The secondary system links the primary and tertiary systems. It would consist of the heavily entangled system of larger canals in Kuttanad. Water flows and use in the secondary system need to be managed based on a watershed plan (for a brief note on two successful watershed projects implemented in Kerala, see **Boxes 1** and **2**).

TERTIARY SYSTEM

The tertiary system would refer to the small and very small canals immediately adjacent to the *padasekharams*. Here, each *padasekharam*, or a set of small *padasekharams*, are is envisaged as a single group consisting of an outer bund and a series of small canals that take water into the individual paddy fields. The outer bund would serve the function of flood protection and have inlets for entry of water into the compartment or *padasekharam*. They would have a height above the normal/maximum flood level. In **Figure 20**, we have provided an illustration of how a *padasekharam* or a group of *padasekharams* may look like inside a compartment. Water from the main river in the secondary system is let into the main canal inside the compartment through a sluice gate in the outer bund, from where water flows to the fields through the distributing canals and the field canals. Thus, the outer bunds can serve two potential functions. *One*, it will help the existing second crop of paddy by protecting it from floods, by allowing inward flow of monsoon water to fill the smaller canals with fresh water and by storing this water even after the monsoons. *Two*, it will help protect the *puncha* crop from the entry of saline water even if the Thanneermukkam Bund is kept open after December. Concurrently, it would become possible to address the issues related to declining marine fish population and growth of aquatic weeds like water hyacinth.

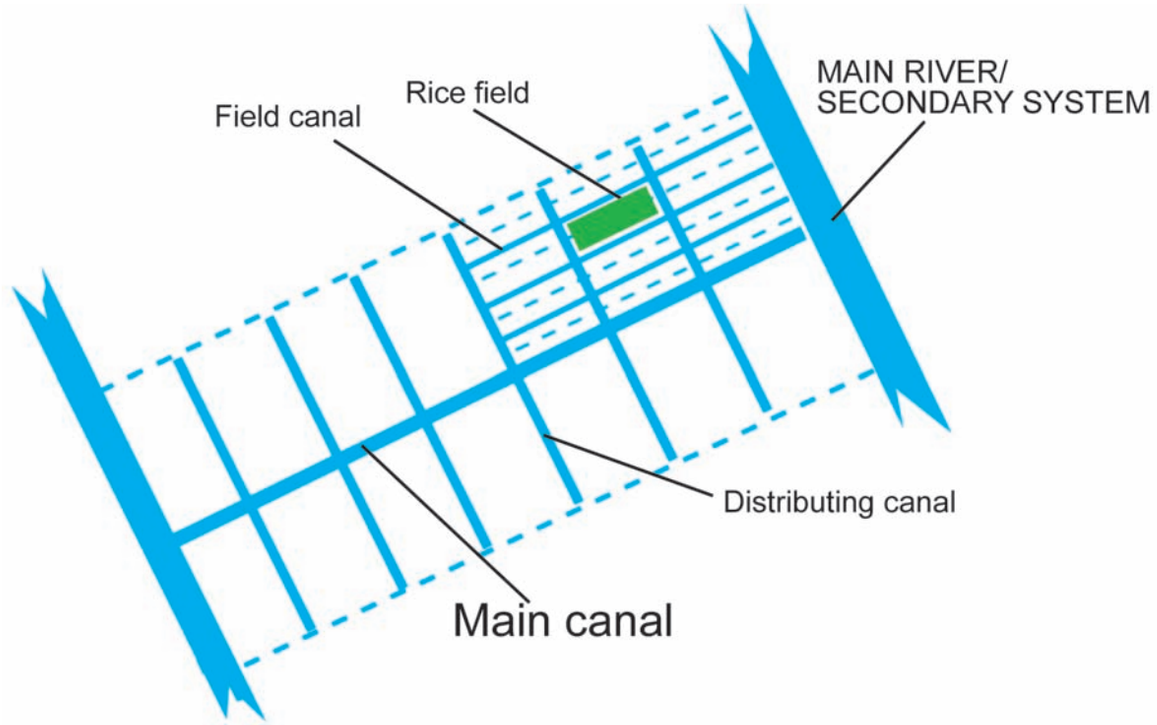

Figure 20 *A representation of the water distribution network inside a compartment/padasekharam/group of padasekharams*
Source: Adapted from Tran and Weger (2017).

The smaller canals within the outer bunds would serve the function of internal water distribution, drainage and storage of water. Arrangements to pump out water, when required, can be built into this level of hierarchy. Thus, we need to arrive at a logical clustering of *padasekharams* at the tertiary level, which could be called *compartmentalisation*.

COMPARTMENTALISATION

Technically, the term compartmentalisation implies "dividing large dike-ring areas into smaller ones by dividing embankments, which are equally high as the primary defense" (Klijn, Asselman and der Most, 2010, p. 4). The objective is to reduce the surface area that will be vulnerable to flooding in case of a single flood event. The assumption here is that reducing the surface area flooded will reduce flood damage and the number of people affected by a flood. In **Figure 21**, we have provided representative diagram depicting compartmentalisation. In the figure, we have provided two scenarios: one, a dyke breach before compartmentalisation and two, a dyke breach after compartmentalisation. In the first scenario, the entire area inside the dyke is flooded. In the second scenario, only one part of the area inside the dyke is flooded and the remaining parts are protected from floods by a bund of required height and strength.

Compartmentalistion is an exercise to be undertaken scientifically, democratically and ensuring that there are no adverse ecological implications. First, the new compartments have to be large enough in size for efficient water storage and distribution. The MSSRF report in 2007 had recommended that the existing size of *padasekharams* should be brought down from about 600 acres at present to about 250 acres; this was to allow faster dewatering, to improve water

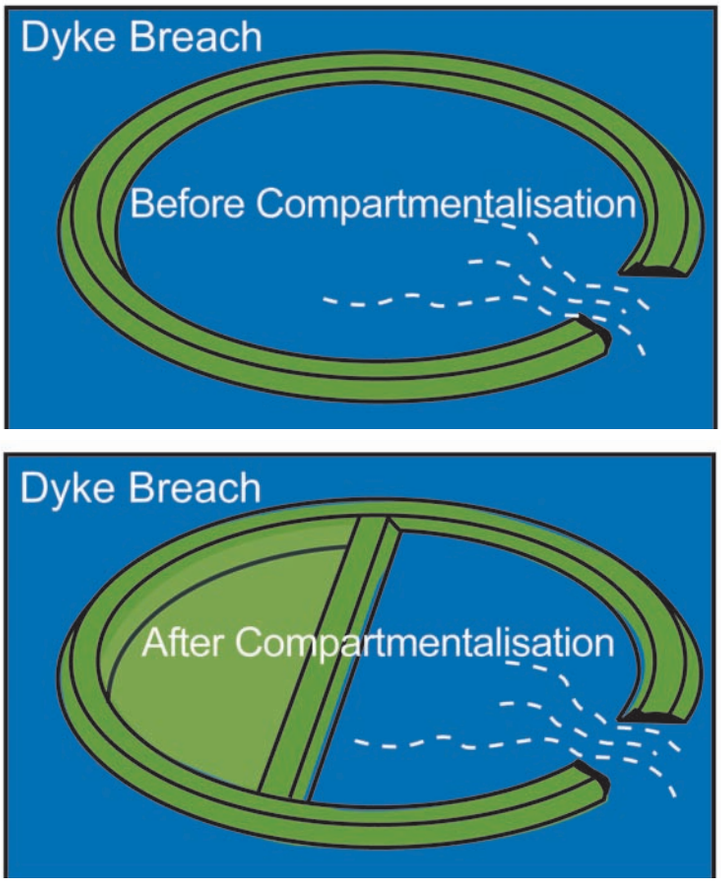

Figure 21 *An illustration of compartmentalisation*
Source: Adapted from Kolen, Leenders and Hemert (2007).

management efficiency and to reduce the cost of operation of holdings deep inside these *padasekharams*. However, our suggestion to keep the size of compartments large enough in this report is different in scope. Secondly, the size and shape of each compartment would have to be decided with the consent of, and after detailed discussions with, the concerned *padasekhara samithies*. Thirdly, it would be best to align the bunds of the compartments with the existing river bunds and main roads. Such a solution may not be perfect, but will save enormous amount of time, effort and resources.

If compartmentalisation becomes possible, all bunds everywhere will not require to be raised, or be constructed with the same material (for example, the question of pile and slab *versus* retaining wall). Only the outer bunds of the compartment would require to be higher (i.e., above the normal/maximum flood level) and stronger (i.e., with pile & slab). The inner bunds may be of lesser height and may function as retaining walls. As a result, the total cost of bunding can also be brought down.

BOX 1

'JALASAMRUDHI'

A MODEL INITIATIVE ON WATER CONSERVATION IN THE KATTAKKADA LEGISLATIVE ASSEMBLY CONSTITUENCY

To address and mitigate water scarcity problems in the Kattakada LAC in Thirivananthapuram district, an Integrated Water Conservation and Management Project viz., "*Vattatha Uravakkay JalaSamrudhi*" was conceived by I. B. Satheesh, the MLA of the Kattakkada LAC, with the support of various government departments and local bodies. The major reasons for the initiation of the programme were the following:

(1) *Falling water table*: Kattakkada LAC falls under the semi-critical category and experiences drastic reduction in the water table levels during summer months;
(2) *Drying of wells and poor water quality*: Wells, the major source of drinking water in the LAC, dry up rapidly during the summer months. Out of 43,043 wells, 19,681 wells dry up totally in summer. Further, the quality of water available is also poor;
(3) *Reduction in the area of wetlands/paddy lands*; and
(4) *Deterioration of surface water resources*

A comprehensive database on existing water resources in the LAC was prepared by the Kerala State Land Use Board using primary data and satellite images. The database was then brought into the GIS platform. Community participation was ensured at various phases of project planning by organising a series of seminars, discussions and trainings. The objective was to identify the major problems leading to water scarcity and to identify short-term and long-term measures to conserve and rejuvenate water resources and structures. This project was launched on 22nd March 2017. Since then, it has been successfully implemented through the convergence of activities of LSGIs, line departments, autonomous bodies and other agencies.

The major activities under this programme include planting of seedlings, digging of rain water pits, protection of ponds and streams using coir geotextiles, rejuvenation of and streams, artificial recharging of wells in schools and public buildings, digging of new farm ponds, inland fisheries in renovated ponds, setting up of water quality testing labs and increased area cultivated with paddy. Under the campaign "Veettiloru Mazhakkuzhi", rainwater pits were dug in the households. Jala clubs were formed to ensure student's participation and a volunteer force – Jalamithrams – were trained by the Suchitwa Mission and Youth Welfare Board. In order to create awareness on water conservation, several programmes such as Neerthada Samrakshana Yathra, Kalajatha and street plays were carried out.

As a result of the various projects implemented under the scheme, ground water level has improved considerably. The water level in the wells where artificial recharging was done has increased and many wells have turned perennial. In areas where new farm ponds were constructed, the water level in the nearby wells have also improved considerably.

JalaSamrudhi project of the Kattakada LAC is a replicable model for water conservation projects through active people's participation, effective planning and coordination of the activities across all concerned departments and organizations.

BOX 2

'SAMRUDHI'

A PARTICIPATORY & SUSTAINABLE WATERSHED DEVELOPMENT MODEL IN THALIPARAMBA LEGISLATIVE ASSEMBLY CONSTITUENCY

The Thaliparamba Legislative Assembly Constituency (LAC) is located in the Kannur district of Kerala. The LAC comprises of 2 municipalities and 7 panchayats. The area belongs to the midland and the highland ranges with moderate to gentle slopes, except at a few places with steep slopes. The LAC is drained by 4 rivers viz., Kuppam, Valapattanam, Ramapuram and Perumba. The majority of area in the LAC comes under the Kuppam river basin. Out of the 712 micro-watersheds in Kannur district, 106 micro watersheds come under the Thaliparamba LAC, either fully or partially. Under the leadership of James Mathew, the MLA of the Thaliparamba LAC, and with the wholehearted co-operation of the nine local bodies, the preparation of a Watershed Master Plan for each and every micro-watershed in the LAC has been completed. The plan has been named *Samrudhi*.

Samrudhi was initially to promote rural micro-enterprises. But when the programme advanced, it was found that uninterrupted availability of water is an essential pre-requisite for these enterprises to succeed. Parts of the LAC experience severe water shortage during the summer months. The sustainable solution identified was watershed-based local planning through the conservation of natural resources.

As part of the programme to promote micro-enterprises, five Farmer Producer Organisations (FPOs) were set up with assistance from NABARD. These FPOs function as livelihood-promoting organisations, ensuring forward and backward linkages from input supply to marketing and value addition. Joint Liability Groups (JLGs) and Self-Help Groups (SHGs) were formed under each FPO to function as activity groups. For all non-farm service activities at the panchayat level, the Kudumbasree Community Development Society acts as a federation. Panchayats are the agencies that plan and implement projects. Panchayat identifies beneficiaries, facilitates unit installation processes, monitors implementation and co-ordinates with other agencies. In every panchayat/municipality, nano-clusters were formed with members from 8-10 families as the basic unit. About 8-10 such nano-clusters form the micro-cluster and about 8-10 micro-Clusters form the macro-clusters. In addition to these, micro-watershed committees were also formed for micro-watershed planning.

Apart from the secondary data and information gathered through cluster meetings, ground-truthing through field transects was an important technique adopted during the planning process. People from all walks of life took part in this endeavour. The plan prepared at the micro-watershed level was presented before the cluster meetings, watershed communities and meetings of the concerned local bodies.

"ROOM FOR THE RIVER" AND "ROOM FOR VEMBANAD"

In the context of the hierarchy of water systems discussed above, we need to allow maximum room for the natural flow of the rivers and the Vembanad waters in Kuttanad. In other words, we need to restore the natural flow of water in the primary and secondary systems. These are the two levels at which we attempt to organise the discussion in this section: the river and the lake.

To begin with, world over, and particularly in flood-prone regions like Netherlands, the idea of "Room for the River" is being followed to reduce the acuteness of flood damages and ensure safety and security of people. The objective of the intervention is to identify stretches where the river can be given more room to flow so that higher water levels can be effectively managed during a flood. It restores the river's natural flood plains where it is the least harmful so that areas that are thickly inhabited or are economically important are protected in the event of a flood. There are a number of measures and techniques adopted to provide the river more room to flow. These are identified based on the specific conditions obtained in each situation. A summary of measures and techniques adopted as part of the "Room for the River" programme in the Netherlands is given in **Figure 22**.

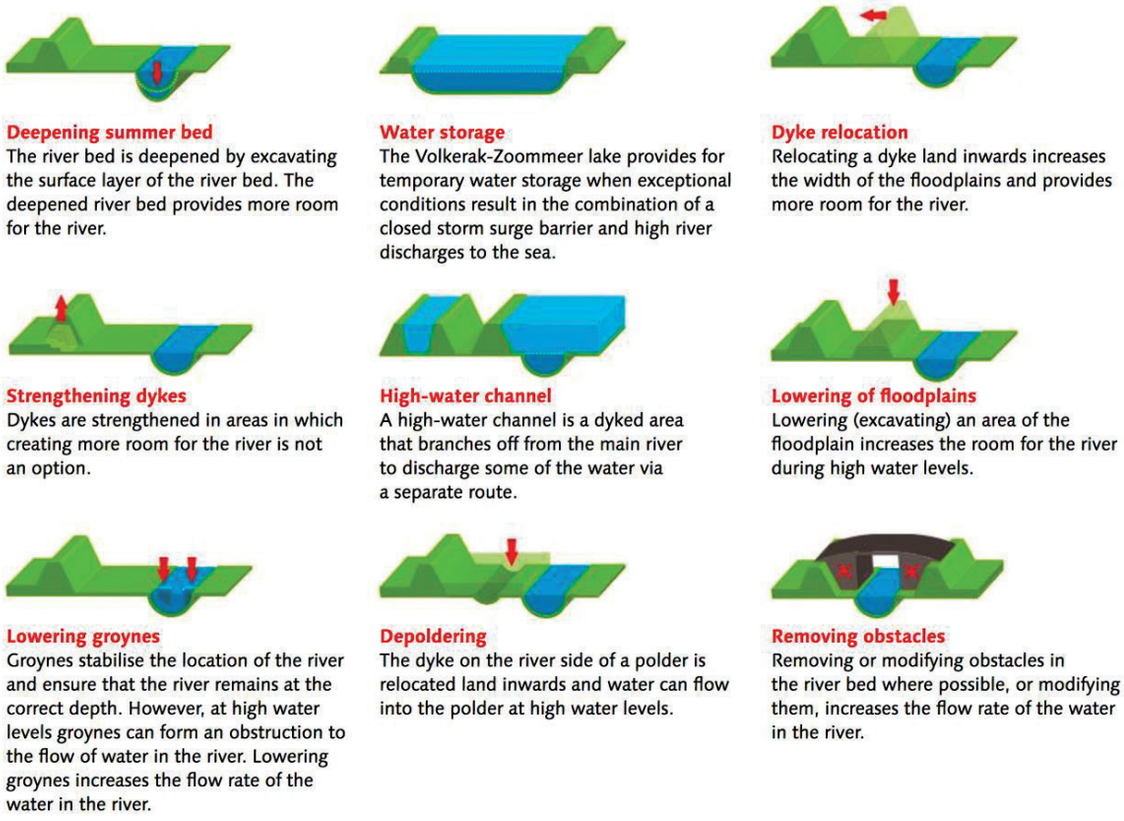

Figure 22 *An illustrative set of measures and techniques used in the 'Room for the River' plan in Netherlands*
Source: "Dutch Water Programme: Room for the River", at <www.roomfortheriver.com>.

First, implementing a similar "Room for the River" programme in Kuttanad may not be as simple as it might seem from Figure 22. The areas in and around Kuttanad through which the five rivers pass and finally debouch into the Vembanad Lake and the sea are densely populated. Any large-scale land acquisition programme may be expensive, time-consuming and administratively cumbersome. Hence, this report recommends what could be termed as a more modest "Room for Pamba" programme. A slightly different version of this scheme was earlier recommended by the Indo-Dutch Mission in 1989 as the "Pamba Diversion Scheme" (see Chapter 2). The objective of the "Room for Pamba" programme that we are recommending is to ensure that more water from the Pamba river is drained into the Arabian Sea instead of letting it flow northward into Kuttanad. Thus, flooding in parts of Upper and Lower Kuttanad can be reduced. For this purpose, three regulators may be installed at three different points in the streams that take Pamba water into Kuttanad. These regulators would ensure that flood water is directed away from Kuttanad and towards the leading channel of the Thottappally Spillway. After discussions with the Department of Water Resources, these three regulators are suggested to be installed at Kuthiyathode, Cheruthana and Kunnumma (see **Figure 23**). However, a final decision on the location of these regulators may be taken only after a detailed physiographic and hydrological study.

Figure 23 *Possible locations for the three flood regulators in the Pamba river*

Needless to say, a "Room for Pamba" programme should also envisage improving the leading channel of the Thottappally Spillway as well as instituting a permanent solution to the problem of sand bar formation at the sea mouth to the west of the Spillway. These solutions are dealt with in the sub-sections that follow. A summary of the solutions that we envisage under the "Room for Pamba" initiative are provided in **Box 3**.

Secondly, the shrinkage of surface area and depth of the Vembanad Lake is a major reason for the acuteness of Kuttanad floods. To reduce flood damages in the future would require that we preserve the existing surface area of the Vembanad Lake, even if it might not be possible to increase it (see **Figure 24**). We recommend that an action plan be formulated to protect the Vembanad Lake; we call it "Room for Vembanad" in this report. The MSSRF report had suggested a plan to demarcate the boundaries of the Lake using detailed satellite imagery and

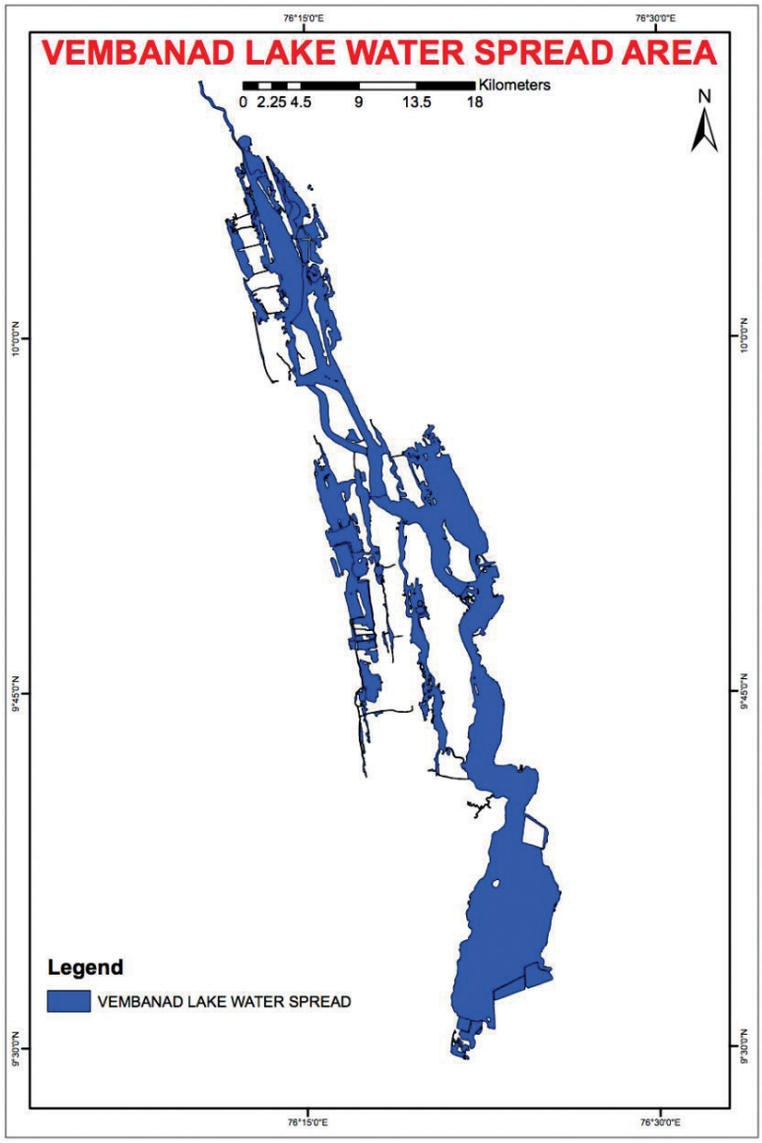

Figure 24 *The existing water spread area of the Vembanad Lake*
Source: Kerala State Remote Sensing and Environment Centre

protect it from encroachment and reclamation in the future. No action has been taken on this recommendation yet. We suggest an initial study to be conducted based on temporal satellite images and drone-based images along the periphery of the Vembanad wetland system. These images should be integrated with cadastral data in order to identify the boundaries of the wetland system. These boundaries should be marked and strictly protected from any future encroachment. Wherever possible, the suggestion in the MSSRF report to erect "ecotones" along these boundaries should be implemented.

Through these two plans – a "Room for Pamba" plan and a "Room for Vembanad" plan – we could protect parts of Kuttanad where floods result in large extents of human and economic losses. As mentioned earlier, a careful assessment needs to be made by a specialist

team of hydrologists and agricultural scientists to create these plans. The formulation of these plans would need to ensure that minimum losses are incurred by farmers, fisherfolk and other households living near the boundaries of the rivers and the lake even as a larger area is identified for the floodwaters to occupy. Local governments of the concerned regions should be involved during the formulation stage itself.

BOX 3

ROOM FOR PAMBA: SUMMARY COMPONENTS

- Construction of 3 flood regulators at Kuthiyathode, Cheruthana and Kunnumma
- Straightening the 3 km stretch (Koppara *valavu*) at Veeyapuram
- Increasing the width of the leading channel of the Thottappally spillway, where feasible
- Increasing the depth of the leading channel of the Thottappally spillway, where feasible
- Removal and disposal of sediments from the river at the bathing ghat near Sabarimala
- Construction of a groyne to prevent sand bar formation at Thottappally
- Completion of the construction of AC Canal
- Delineation and protection of existing water spread area in the Vembanad Lake

UNBLOCKING WATERWAYS AND BUND PROTECTION WORKS

Ensuring free and natural flow of waters within Kuttanad also requires the construction of strong outer bunds to *padasekharams*, construction of side protection walls as well as de-clogging and desilting of drainage channels/canals.

In the case of earthen bunds that are traditionally erected (*orumuttu*), floodwater pressure and tides result in frequent breaches; these frequent breaches have resulted not just in the escalation of risks and costs in cultivation but also in the requirement of a large labour force. Such a situation is not sustainable. Farmers of Kuttanad deserve permanent outer bunds, which can withstand the force of water currents.

The plan for the construction of outer bunds in *padasekharams* has to be aligned with the plan for compartmentalisation. The height of the bunds and the materials used for bunding would depend on the location of the structure after compartmentalisation, maximum floodwater level and flow pressure. However, what is clear is that given the water flows obtaining in Kuttanad, *padasekharams* need *strong* and *permanent* outer bunds with necessary height and width. Wider and stronger bunds allow also for transporting equipment, threshing space and the small-scale cultivation of vegetables. Outer bunds also require side protection walls for protection from floodwater currents and tidal flows. The plan for bunding and side protection should be a part of the larger plan for compartmentalisation of *padasekharams*.

Where possible, bio-protection of bunds could be implemented. The MSSRF report had underlined the necessity of R. R. Masonry and granite pitching in areas of bunds where strength was critically important. But it had also noted that wherever feasible, bunds could be made of stiff clay with appropriate slope in conjunction with bio-protection on the waterside.

Different species of grasses may be used (including fodder grasses and other appropriate grass/ shrubs) for bio-protection, which may be firmed up using geo-textiles as a binding material. Vettiver is one plant species that is well-known for its soil-binding properties. Hence, departments should plant locally adaptable Vettiver and other grass species for strengthening of bunds in the *padasekharams*. The use of geo-textiles would also give a boost to the local coir industry. Yet another possibility is the planting of coconut on one side of the bunds facing the waterways with fodder crops cultivated in the inter-spaces. This measure would also help promote cattle rearing among the local farming households.

While attempting to construct permanent bunds for *padasekharams*, the departments might encounter the same problem as witnessed during the implementation of Kuttanad Package after 2008. As many *padasekharams* are situated at remote locations, contractors refused to put up bids on tenders. Their demand has been that the condition in the revised PWD Manual that tenders could be approved only as per the market rates needs to be waived for bund construction in Kuttanad. Furthermore, the Finance Department has issued an order to the effect that any increase in tender amounts by above 15 percent of the DSR rates should be approved by Cabinet. As the difficult terrains of the work areas are not adequately factored in while the department prepares the tenders, particularly in the schedule of quantities, specifications, drawings and general conditions, there is lack of bidding on many tenders, poor contract performance and unnecessary litigations.

A solution to this problem lies in the preparation of separate guidelines for the unique terrain of Kuttanad, with regard to the time frame of implementation and conveyance of materials. The cost index used by the department is also grossly inadequate. Presently, the SAI Punnamada Cost Index is being used for the Kuttanad region. This needs revision. Discussions have to be initiated with the Finance Department to explore if the clause necessitating cabinet approval in cases where tender amounts are raised by above 15 per cent of the DSR rates could be relaxed for Kuttanad, given its unique location and terrain.

Even before the floods of August 2018, most canals within Kuttanad were rendered shallow, if not blocked, by many years of siltation and clogging. The MSSRF report of 2007 recommended the cleaning of 700 km of channels in Kuttanad. Work has been completed in only about 280 km of channels. After the floods, this may require a relook and most of the drainage channels in the region may have to be cleaned again. The Department of Water Resources estimates that 420 km of drainage channels in Kuttanad need urgent cleaning. Cleaning has to be followed by the construction of firm and high enough bunds on either sides. Much of the clay required for this construction of bunds may be obtained from the deepening work on the channels.

Finally, unscientific construction of bridges and approach roads are major constraints or obstruction to the free flow of water and navigation. During the floods of 2018, these unscientific bridges across the Lake and canals had adversely affected the rescue operations. Smooth navigation was not possible as the bridges were not given proper elevation to allow even small boats to pass under. Such bridges need to be identified and reconstructed scientifically without affecting either the water flow or navigation.

IMPROVING THE EFFICIENCY OF THE THOTTAPPALLY SPILLWAY

The question of the poor efficiency of the Thottappally Spillway in pushing out adequate quantities of floodwater into the sea has been discussed in an earlier section. Data show that though the Spillway is designed to carry floodwater to the tune of 1800 m^3/s, the present utilised capacity may only be 600-700 m^3/s. The two reasons for such poor performance were identified as (a) the insufficient width of the leading channel upstream, which reduces the amount of water flowing into the Spillway; and (b) the formation of a sand bar downstream near the sea, which obstructs the flow of floodwater through the sea mouth.

We recommend a resolution of both these concerns on an urgent basis.

In the upstream of the Spillway, the width of the leading channel is only about 80 m from Veeyapuram to Thottappally while the desired width in the original design was 368 m. This stretch is of a length of 10.5 km. The improvement in the capacity of this leading channel is essential to increase the efficiency of the Spillway. There are four major interventions that are possible in this regard.

(a) The *width* of the leading channel has to be increased with the construction of higher flood bunds. However, any increase in the width of the leading channel is constrained by challenges of land acquisition and the attendant costs, as most of the area needed for the channel is currently habitated or cultivated. As a result, it may be advisable to undertake a technical examination to arrive at a desired width of the leading channel that would require lesser land acquisition even while we are able to increase the quantum of water flow in the channel. This desired width may lie between the 368 m as in the original design and the 80 m as of present.

(b) While we assess the above, what could be attempted in the short-run is an increase in the *depth* of the leading channel. The depth of the channel may be increased up to 4 to 6 m so that the quantum of water flows can be increased without increasing the width.

(c) Much of the path of the Pamba river leading to the Spillway is prone to the problem of poor sediment transport, which leads to siltation of canals and bottlenecks in the river. Especially in the bathing ghat of Pamba below the Sabarimala temple, there is extreme sediment deposition. The removal and disposal of these sediments is necessary so that the natural flow of the river is restored. A part of these sediments can be made use of for ongoing construction activities in Sabarimala and Pamba.

(d) There are multiple points in the path of Pamba river where the curves are so sharp as to significantly reduce the velocity of water flow. Steps could be taken to straighten the paths at selected places so that the velocity of water flow in the river can be increased. This would help in a faster flow of water through the Pamba into the sea through the Spillway. As part of "Room for Pamba" initiative, we suggest that the approximately 3 km stretch of the leading channel at Veeyapuram (called the "Koppara *valavu*") be straightened.

The second problem faced is the formation of a sand bar across the Pamba at the *pozhi* mouth.

This sandbar is an obstacle to water flow when the discharge of Pamba increases at the start of the monsoon; this increases the risk of flooding. At present, the sandbar is partly dredged away at the start of the monsoon (see **Figure 25** for an aerial photograph of the sea mouth with and without the sand bar). There has to be a permanent solution to this problem. As is well-known, sand bars are formed in sea mouths due to wave breaks at shallow points and the resulting sand deposits. Experts have suggested that the construction of a groyne should be explored to ensure that sand bars are not formed. In our view, this recommendation deserves serious engagement.

Figure 25 *Aerial photographs of the sea mouth at the Thottappally Spillway, with the sand bar and after the manual removal of the sand bar during the floods of 2019.*
Source: By special arrangement with the Department of Water Resources.

COMPLETION OF AC CANAL

The completion of the AC Canal is essential for the efficient drainage of floodwater from Upper Kuttanad regions. As of now, only the Phase 1 of AC Canal is complete between Manakkalchira and Onnamkara. Phase 2, from Onnamkara to Nedumudy, and Phase 3, from Nedumudy to Pallathuruthy, need to be completed at the earliest. A potential constraint here is the encroachment into the area set apart by the revenue department for the AC Canal. A considerable extent of this space is occupied by households, shops and other establishments along the AC Road. These encroachments need to be vacated and work on the AC Canal completed at the original width of 40 m.

THANNEERMUKKAM BUND AND SALINITY INTRUSION

Much of the modernization work on the Thanneermukkam Bund is complete. However, there is one outstanding issue that remains unresolved. Even though the period of closure of the Bund has been reduced significantly from about 6 months a year in the past to about 3 months a year at present, there still exists a demand to further reduce the period of closure of the Bund for at least two reasons. First, reduced salinity in the Lake has reduced the marine fish population and fish diversity. As a result, the livelihoods of the fisher households are adversely affected. Secondly, reduced salinity in water has led to the proliferation of aquatic weeds like water hyacinth in the Lake.

Of course, with the completion of Phase 3 of the Thanneermukkam Bund, the closure period of the Bund has to be strictly limited to the 3 months between 15 December and 15 March. However, we further need to explore the possibilities of the Bund being kept open for short periods between 15 December and 15 March – "snap openings" – during the low tide so that the entry of saline water could be limited to levels that do not adversely affect *puncha* paddy cultivation. The prospects of such snap openings of the Bund have to be explored. A suggestion that may be seriously considered is the automation of the opening and closing of the shutters of the Bund based on the levels of salinity in the lake waters. The acceptable limit for salinity in paddy cultivation is 2.1 milli mho. The shutters of the Bund could be kept open as long as the salinity levels are less than 2.1 milli mho and could close as soon as the salinity levels reach this limit. This would help ensure more presence of saline water in the lake waters without harming the prospects of paddy cultivation. To begin with, a study could be commissioned to better understand the implications of this proposal.

VII

TOWARDS A RESILIENT AGRICULTURE

The floods of 2018 dealt a severe blow to paddy cultivation in Kuttanad. Around 14,000 ha of land was under the cultivation of the second (monsoon) crop of paddy in Kuttanad in 2018-19. In the first flood of June 2018, about 2500 ha of paddy crop was destroyed. In the second flood of July 2018, about 7400 ha of paddy crop was destroyed. In the third and severe flood of August 2018, all the 14,000 ha of paddy crop was destroyed. Paddy crop in only 3605 ha was insured, and this meant a huge economic loss for the farmers cultivating the rest of the area.

Rebuilding paddy cultivation in Kuttanad requires not just relief to help farmers cultivate the next crop, but a major overhaul of the way in which paddy cultivation is practiced in the region. We need to equip Kuttanad agriculture with measures and techniques that would help farmers mitigate the impact of flood shocks. After a series of consultations with farmers, experts and officials, we recommend the following.

KUTTANAD AS A SPECIAL AGRICULTURAL ZONE

The government has already declared Kuttanad as a Special Agricultural Zone (SAZ). By declaring a region as an SAZ, the objective is not to ensure more flow of funds to the region. While more funds may be required, the key to the organization of agriculture in a SAZ is to converge a number of aspects of agriculture and policy in order to increase productivity in agriculture, raise incomes of farmers and ensure ecological sustainability. The seven key spheres that the KSPB sees as central in the convergence efforts within each SAZ are: seeds, water, soil, extension, mechanisation, marketing and value-addition. We need a distinctive approach to the evaluation of yield potential and the selection of varieties. Support services with regard to agricultural information, soil and plant health, input costs and output prices, post-harvest market linkages, storage, distribution, and value addition need to be planned within the zone.

Even though Kuttanad was declared as a SAZ by the government in 2017, the Department of Agriculture has been slow in executing the declaration. We understand that the department has outsourced the preparation of the proposal for converting Kuttanad into a SAZ to an external agency. This agency has not prepared the proposal as yet. As a result, the transformation of Kuttanad into a SAZ has remained stalled. We urge the department to speed up the process with no further delays.

PREPARATION OF A CROP CALENDAR FOR PADDY

The preparation of a crop calendar for paddy in Kuttanad is a long-pending issue. To begin with, the preparation and enforcement of a crop calendar is absolutely essential for the timely opening and closing of the Thanneermukkam Bund. In the absence of a calendar, erratic sowing and harvesting is followed and demands arise for longer periods of closure of the Bund. This has adverse impacts on the region's ecology and ecosystem. Also, late sowing is reported to increase the intensity of pest and disease attacks.

The area cultivated with a second crop of paddy in Kuttanad has been rising. There are reports that farmers are increasingly preferring the second crop than the *puncha* crop due to low risks related to pests and diseases as well as yield losses resulting from acidity and salinity. Hence, any crop calendar has to cover the monsoon crop and the *puncha* crop. It is advisable that farmers raising two crops should adopt one medium duration crop and one short duration crop. Further, the *puncha* cropping season needs to be completed by February. Data on electrical conductivity monitoring in Kavanar shows that if there are less summer rains in January–February, the electrical conductivity goes up from February 2nd week; as a result, grain filling and quality of rice crop will be affected if harvesting is delayed. For optimum results, thus, *puncha* crop should be harvested in February itself.

According to the Kerala Agricultural University (KAU), best results demand that the crop calendar be arranged in the broad format given below.

- **October to March**: Sowing for the *puncha* crop has to be completed first in Kayal lands, Lower Kuttanad and North Kuttanad; this should be followed by Vaikom Kari areas and finally in Upper Kuttanad areas. For ensuring timely sowing, dewatering should start one month prior to sowing.
- **May to September**: The second crop of paddy is raised in Purakkad Kari, parts of Lower Kuttanad, parts of Kayal lands and in parts of Vaikom Kari. Here, the use of short duration varieties (100-105 days maturity) is recommended for areas where sowing is delayed up to two weeks.

A broad suggestion on a new crop calendar that could be followed in Kuttanad is given in **Table 13** .

Most of Kuttanad farmers currently sow a variety of paddy called Uma. Uma is not a short duration variety but is popular among farmers due to its high yield (6 to 6.5 tonnes/ha) and excellent grain quality. Scientists in the KAU have been working on a number of short-duration alternatives to Uma, which could be harvested about 15 days earlier. Some of the alternatives are Prathyasa, Manuratna, Shreyas, Pournami and Makom. Prathyasa (or MO. 21) was released in 2010. It has excellent milling and cooking qualities as well as a higher content of zinc but is poorer than Uma on two counts: first, its yield is less at only 5.5 to 6 tonnes/ha and secondly, it is 5 cm taller than Uma that makes it susceptible to lodging. However, the lodging tendency can be overcome by reducing the dose of nitrogenous fertilizers, which would render the culm stronger and more erect. The other two improved varieties, Shreyas and Pournami, with an average yield of 6 to 6.5 tonnes/ha, have the potential to replace Uma. Like Uma, these varieties exhibit tolerance to brown plant hopper and gall midge. Both the varieties are tolerant to glume discoloration and false smut, which are rampant in Uma.

Table 13 *Crop calendars proposed for Kuttanad, paddy cultivation*

Sl.No	Name of Crop	Name of ADAs	Area (ha)	Calender of Operations												Next Year			Remarks
				April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
ALAPPUZHA DISTRICT																			
A	**Padasekharams where two crops are taken annually (additional crop and puncha main crop)**																		
A1	Additional crop	Alappuzha Ambalappuzha Champakulam Ramankary	8970	Land preparation	Land preparation	Sowing and basal application of fertilizers	1st topdressing	2nd topdressing		Harvesting and processing									Medium duration Uma variety
A2	Puncha after additional crop	Alappuzha Ambalappuzha Champakulam Ramankary	8970								Land preparation	Sowing by December 15	Fertilizer application	Harvesting and processing	Harvesting to be completed by March 15				Short duration variety
B	**Padasekharams where one crop is taken annually (puncha main crop)**																		
B1	Kayal lands with strong outer bunds	Champakulam Ramankary	3000						Dewatering, Land preparation	Sowing	Sowing to be complete by November 1;	Fertilizer application, intercultural operations	Top dressing	Harvesting	Harvesting complete by March 1st week				Medium duration Uma variety
B2	Kayal lands with weak outer bunds	Champakulam Ramankary	1840							Dewatering, Land preparation	Sowing by November 15	Fertilizer application		Harvesting by March 15					Medium duration Uma variety
B3	Lower Kuttanad (Single crop)	Alappuzha Ambalappuzha Champakulam Ramankary	9075						Dewatering, Land preparation	Sowing	Sowing, Fertilizer application	Fertilizer application		Harvesting	Harvesting by March 15				Medium duration Uma variety
B4	Upper Kuttanad	Mavelikkara Haripad Chengannur	5115								Dewatering, Land preparation	Sowing and basal application of fertilizers	1st top dressing	2nd top dressing		Harvesting			SD/MD variety prefered
KOTTAYAM DISTRICT																			
A	Virippu	Kaduthuruthy Ettumanoor Vaikom	6433			Land preparation/sowing	Sowing	Sowing and fertiliser application	Fertilizer application	Harvesting	Harvesting								Medium duration varieties
A1	Mundakan	Vaikom Pampady Uzhavoor	614						Land preparation	Sowing	Sowing and fertiliser application	Harvesting							Medium duration varieties
A2	Puncha	Kaduthuruthy Ettumanoor Kottayam Madappally	10641							Land preparation	Sowing	Sowing and fertiliser application	Intercultural operations		Harvesting	Harvesting			Medium duration varieties
PATHANAMTHITTA DISTRICT																			
A	**Padasekharams where only puncha is taken annually**																		
A1	Puncha	Thiruvalla	1879								Land preparation	Lime application Sowing	Fertilizer application	Fertilizer application	Harvesting	Harvesting and processing			Uma and Jyothy varieties
A2	Puncha	Mallappally (Kaviyoor puncha)	100								Land preparation	Lime application Sowing	Fertilizer application	Fertilizer application	Harvesting	Harvesting and processing			Uma and Jyothy varieties

Source: Prepared by the Principal Agricultural Offices of the districts.

Manuratna is of 105 days duration but its yield is lower than that of Uma. As a result, farmers have been hesitant to move out of Uma. We suggest that the KAU should hasten research on the development of a suitable short-duration alternative to Uma, which is also acceptable to the farmers.

TIMELY SUPPLY OF QUALITY SEEDS

Timely availability of quality paddy seeds is to be ensured before each sowing season in Kuttanad. About 37,000 ha is being cultivated with paddy every year (*Puncha*: 26,000 ha and second crop: 11,000 ha) with a total seed requirement of 3700 MT/year. Estimates of the KAU put the requirement of seeds at a higher level of 4000 to 5000 MT/year. At present, the seeds are made available from the Kerala State Seed Development Authority (KSSDA). However, there is frequent shortage of seeds and availability is delayed.

To meet the requirement of paddy seeds in Kuttanad, the Registered Seed Growers Programme (RSGP) needs reform. Every year, one-third of the requirement should be produced in Kuttanad itself through farmer participatory seed production programmes in selected *padasekharams* of Upper Kuttanad and Onattukara during the *puncha* season. For assuring timely supply of seeds, Upper Kuttanad may be identified as the ideal tract for production of certified seeds of popular varieties. Breeder seed production for Kuttanad can be entrusted with RRS Moncompu, for which additional area has to be set apart. Onattukara Regional Agricultural Research Station (ORARS) at Kayamkulam may be entrusted with breeder seed production for Onattukara. The Rice Research Station (RRS) at Vyttila may meet the seed requirement for Pokkali areas. In these regions, foundation seeds can be produced at the Regional Agricultural Research Station (RARS) Kumarakom and State Seed Farms.

Currently, due to lack of infrastructural facilities like drying and processing yards and transportation facilities, farmers are reluctant to participate in the RSGP. This can be rectified by adopting the following steps.

- Selection of smaller *padasekharams* that are adjacent to main roads;
- Ensuring proper drainage facilities; and
- Supply of foundation seeds required for multiplication to farmers free of cost.

The Agricultural Officers (AO) of Krishi Bhavans should ensure that the registered growers adopt all scientific cultivation practices in the selected areas. Care should be taken to keep proper isolation distance. Timely rouging of off type seeds should be ensured in selected plots. We should also ensure that facilities for seed processing, grading and storage of seeds as well as a seed testing laboratory to monitor seed quality are available. Since two crops of paddy are to be raised within a year, proper drying is not done at the time of harvest. Hence, a seed drying machine needs to be installed at least at the block level. A seed store for storing the seeds of paddy, sesamum and pulses is another requirement.

Conserving germplasm of major crops of the region – rice, sesamum and pulses – in the KAU stations is absolutely essential. An infrastructure with medium storage facility is required for storing the seeds of varieties/races that constitute valuable genetic wealth in these crops. Onattukara has had the reputation of being the major producer of the medicinal rice variety *njavara*. Market-linked revival of cultivation of *njavara* needs to be explored.

DEWATERING IN PADASEKHARAMS

First, dewatering systems in Kuttanad *padasekharams* are not modern and need urgent replacement with modern equipment. Secondly, in the context of the floods, engine platforms/ *tharas* or pump houses that host the pumping motors need to be reconstructed and protected from future floods.

In Kuttanad, the excess floodwater is pumped out to the drainage lines or canals using the old petty and para mechanism or motor pumps. The pumping (dewatering) station is popularly known as the engine/motor *thara*. It is basically a platform for installing the dewatering devices. Engine sheds are provided to cover the platforms and machinery. Engine platforms facilitate the purpose of dewatering of polders by using either the old *petty* and *para* mechanism or motor pumps. Most of these *tharas* were destroyed during the floods of 2018. They need replacement and reconstruction.

All the *petty* and *para* systems and old motor pump sets of Kuttanad be replaced with low-head, high-discharge vertical axial flow propeller pump sets run by electric motors. The Department of Agriculture should undertake this task within a short time frame, preferably before the *puncha* crop of 2019. The horse power of the motors supplied to the *padasekharams* could vary with the area of the polders to be dewatered. So, the engine platforms should be built with enough structural strength compatible to the respective motor. The design of engine platforms should be based on the experience gained during the recent floods and modern innovations should be considered before finalising the designs.

SOIL HEALTH MANAGEMENT

Since Kuttanad soils are acidic, application of ameliorants is inevitable. Ameliorants and fertilizers are to be applied on the basis of detailed soil analysis, which will help reduce the costs of cultivation and restore soil health. Regulation of soil acidity using dolomite or burnt lime should be a regular practice, especially in Kari soils.

KAU, along with Department of Agriculture, has to undertake soil analysis of individual *padasekharams* and create a databank. The data should be made available to each *padasekhara samithi* and subsidies should be based on these recommendations. Soil test-based fertiliser application for nutrients, except nitrogen, should be enforced. The dose of the nitrogen fertiliser can be fixed based on the Leaf Colour Chart. Under conditions of limited root growth, foliar application of deficient nutrients should be recommended.

SMALL FARM MECHANIZATION

The case for mechanisation of paddy cultivation in Kuttanad is very important given the increasing cost of upkeep of animals and the growing scarcity of human labour. Further, the use of mechanical power has a direct bearing on the productivity of crops apart from reducing the drudgery of labour and facilitating the timeliness of agricultural operations. Currently, mechanical power is largely adopted in the larger land holdings and is beyond the reach of small and marginal holdings. This is because small and marginal farmers, by virtue of their economic status, are unable to purchase farm machinery on their own or through institutional credit. Therefore, to bring farm machinery within the reach of small and marginal holdings, collective ownership or Custom Hiring Centres (CHC) needs to be promoted.

CHCs are basically a unit comprising of a set of farm machinery, implements and equipment meant for hiring by farmers. Though certain implements and equipment are crop specific, the traction units like tractors, power tillers and self-propelled machinery like combined harvesters are used across more than one crop. An ideal model envisaged for CHC could comprise of farm machinery commonly used for tillage operations for all crops, multi-crop equipment and a minimum number of crop-specific machinery. A problem in this sector is the lack of service centres for the repair of machinery due to which many machines available with the farmers and other agencies are kept idle. Hence, a service centre at the block level with trained technicians is essential for the efficient utilization and maintenance of agricultural machinery. Periodical training is also to be given to the technicians on the operational aspects of these machines.

Improvements and refinements in farm machinery, like drum seeder, cono-weeder and bund former are inevitable in the agrarian conditions of Kuttanad. The Farm Machinery and Research and Training Centre, established at RRS, Moncompu during the first phase of Kuttanad Package, should serve as the nodal centre to meet the current and future farm mechanization needs of Kuttanad. This centre should train youth on machinery operation and maintenance as well as provision of specialized service facility to farm machinery in this region.

PROMOTION OF IPM AND WEED MANAGEMENT

Timely availability of farm inputs and biocontrol agents is very important in the context of Kuttanad agriculture. For management of pests and diseases, Integrated Pest Management (IPM) measures have to be popularized. Farmers should have easy access to biofertilizers, bio-inputs, biocontrol agents and bio-inoculants. Application of pesticides and fertilisers have to be need-based, for which the production of quality bio-inputs have to be strengthened at the different KAU stations and departmental farms. Pest surveillance and pest and disease forewarning systems should also be institutionalised and strengthened.

The KAU should intensify research on an appropriate biological control measure to address the menace of water weeds like Water Hyacinth in Kuttanad.

INTEGRATED FARMING IN PADDY FIELDS WITH MULTI-COMMODITY ENTERPRISES

In smaller *padasekharams* (less than 50 ha) and in paddy fields adjoining garden lands, integrated farming with rice–fish/duck–cattle combination should be promoted. Estimates of the KAU suggest that such integrations could fetch a net income of up to Rs 1.5 lakhs/ha/year. Duck farming must be promoted in paddy fields after the crop harvest. The provision of training to farmers, agricultural labourers and extension personnel should be undertaken by the KAU. In Pokkali areas also, rotational cropping of rice and fish can be followed.

REVIVAL OF COCONUT FARMING

In the garden lands of Kuttanad, coconut is the major crop. Coconut is severely affected by the root (wilt) disease and red palm weevil. Productivity improvement in non-diseased palms requires a major exercise in replanting. This replanting exercise may be integrated with intercropping with tubers, vegetables, fodder and livestock farming activities. In coconut-

based cropping systems too, seed materials of vegetables, pulses, tuber crops, spices, medicinal plants and fodder crops are required. In coconut, panchayat or block level community nurseries can be developed.

Studies at RARS Kumarakom have indicated that integrated farming of crop and livestock in Kuttanad could generate a net profit of Rs 85,818 whereas monoculture of coconut has a profit of only Rs 15,225.

In each panchayat, a data bank of coconut climbers, by setting up a *climber sena* using unemployed youth, should be maintained and have to be given training for using climbing devices. In Onattukara and Upper Kuttanad also, coconut revival programme has to be integrated with other income generating activities like livestock rearing, homestead fisheries and intercropping with vegetables and tuber crops.

INTEGRATED FARMING IN HOMESTEADS AND COCONUT-BASED ENTERPRISES

Particularly in homesteads, there is a need to integrate the coconut revival programme with other income and employment-generating activities. Coconut is the pivotal crop in the intercropping systems of garden lands. However, banana, tuber crops, vegetables, spices and fodder grass are grown as intercrops without any regard for scientific planting. Scientific models for homestead cultivation have been developed for different cropping systems by the KAU. These need to be popularised among farmers.

Historically, the traditional homesteads of Onattukkara region and Upper Kuttanad have had a livestock unit that served as the source of organic manure, and homestead agriculture relied solely on organic inputs. Enhancement of on-farm income generation from garden lands with integration of one or more location-specific components, such as livestock (cow, buffalo, goat, fowls, ducks, rabbit and pigs), organic recycling and intercropping of coconut with vegetables, pulses, tuber crops, ornamental plants including flowering plants, medicinal plants, fodder crops and farmstead fish culture are recommended.

The riverine alluvium soils in Kuttanad are suitable for the cultivation of vegetables. Enhancing area under vegetables during the summer season, such as yard long bean, snake gourd, bitter gourd and brinjal is another strategy to be adopted for maximizing farm revenues. During the rainy season, emphasis may be given to protected cultivation (example, the use of rain shelters) in raising vegetables. For vegetable seed production, the possibilities of a participatory approach with farmers should be explored.

VALUE ADDITION IN COCONUT AND SESAME

The products of coconut and other components from integrated farming offers location-specific and market-linked opportunities for value addition. It would be more viable that such production and value addition is taken up on a cluster basis with farm women groups like *Kudumbasree, Ayalkkoottam* and *Harithasangam*. Departments should impart trainings to these groups and technical support should be extended for establishing such units. Intensification of research along these lines should be envisaged by KAU.

For increasing area under sesame, which is the principal crop in Onattukara region, establishment of small oil extraction units and promotion of value added products are necessary.

ENVIRONMENT SURVEILLANCE

Environment surveillance has to be strengthened in Kuttanad. Regular and correct weather advisories can be given by the KAU, for which, infrastructure facilities with modern equipment are to be instituted. Regular monitoring of the Kuttanad ecosystem has to be ensured for hydrological and hydrobiological aspects, monitoring of pesticide residues and presence of heavy metals. The sources of these pollutants have to be identified and measures are to be taken to control them.

PROMOTING MANGROVE RESTORATION

The MSSRF report had recommended the promotion of mangroves along the banks of Vembanad Lake and Kayamkulam *kayal* and the stretches available on the banks of the designated national waterways to strengthen the fisheries resource base and add to the scenic beauty of the backwaters. This was to minimize the flood damage to the adjoining land areas. We suggest that this recommendation be revived and implemented. The Department of Agriculture or Environment should plant location specific mangrove species in the most vulnerable areas along the banks of the two lakes. This will also help in regulating and addressing salinity problems faced in the region.

ESTABLISHMENT OF A KNOWLEDGE HUB AND AGRO-CLINICS

Establishment of a knowledge hub and agro-clinics under the direct supervision of experts in each discipline is another priority area to be identified and implemented for the Kuttanad region.

ESTABLISHMENT OF KNOWLEDGE HUB IN ORGANIC FARMING

Establishment of a training-cum-production centre is essential to conduct systematic research on various components of organic farming viz., preparation and use of various organic manures including biofertilizers, biological pest and disease management, sustainable crop production and environmental safety. In Onattukara and Upper Kuttanad, there is a need for the creation of farmer facilitation centres and a organic farming knowledge hub, particularly in the cultivation of vegetables, sesame and *njavara*. It is proposed that a knowledge hub be set up for organic farming at the ORARS Kayamkulam for producing organic inputs using locally available materials and to impart training to farmers on large-scale production of these inputs along with the production and sale of organic produce and value added products. This will facilitate awareness creation among farmers and generation of employment opportunities for unemployed youth.

Currently, the ORARS is producing and distributing organic inputs based on the requirements of farmers. These are distributed both directly to farmers and through ecoshops operating under the Department of Agriculture. For effective distribution of these inputs, a sales outlet is required.

Various forms of farmer-friendly input formulations viz., granules, sachets, sticks, blocks and tablets have to be developed and distributed to facilitate their easy field application and also to cater to the needs of landless and urban population, who raise crops in grow bags and pots. Development of fortified organic fertilizer pellets using various organic sources, biofertilizers and permitted minerals for soil application will ensure efficient nutrient management in organic production systems.

WASTE MANAGEMENT THROUGH ORGANIC RECYCLING

Waste management through organic recycling is well-accepted as an efficient disposal alternative. By utilizing the advantages of organic recycling waste management system, organic farming of different crops can be practised with sufficient organic inputs produced *in situ*. More awareness should be created about resource recycling and organic crop production. Trainings and demonstrations on organic input production at the block level and development of a model organic farm in the ORARS may be useful in better awareness generation.

SUGAR CANE IN UPPER KUTTANAD

Area cultivated with sugar cane can be increased in Upper Kuttanad through the following strategies. To begin with, seed materials can be produced with farmer's participation at the ARS Thiruvalla. Costs of cultivation have to be brought down through mechanisation of various operations. This will also address the issues related to labour shortage. Superior quality *Pathiyan Sarkkara* has to be branded and marketed efficiently, including the promotion of its export prospects. A production bonus to sugar cane cultivators is an idea worth exploring. A centralised processing unit for jaggery production has to be set up in the Sugar cane belt of Upper Kuttanad.

An integrated farming system (IFS) approach should be followed in the cultivation of sugar cane. Farm revenue can be increased by integration with livestock, intercropping, organic recycling and pisciculture. Sugar cane can be intercropped with banana, vegetables or short duration tapioca. Banana suckers can be raised in poly bags and 3-4 months old crop can be harvested before the rain starts. IFS can be more efficiently adopted through the land configuration concept, with fish, duck and He buffalo. Duck provides eggs and meat, while He Buffalo provides meat and dung. The dung can be used as manure and fuel.

Sugar cane can also be cultivated in ridges and the interspaces can be utilized for raising fish, duck and fodder. In fish rearing, the water can be conserved through the use of silpaulin. Water in the furrows can be used for irrigation. For rearing He Buffaloes, para grass, which grows well in a high moisture regime, can be raised in the interspaces. In addition to green tops, water shoots and defoliated leaves obtained through the detrashing of Sugar cane can be provided as feed to the buffaloes.

PROMOTION OF PADDY FARMING IN POKKALI REGIONS

Pokkali rice cultivation exists in Thuravoor and Pattanakkad panchayats of Alappuzha district and extends to the Ernakulam district, which is continuous to the Kuttanad wetland ecosystem. It is the only naturally existing organic integrated farming system in Kerala with one rice and one prawn or fish, thus successfully balancing saline and non-saline phases.

The Pokkali tracts, which earlier registered an area of 26,400 ha in Ernakulam, Thrissur and Alappuzha districts, is today confined to just about 2500 ha. Another traditional system of the region is the *Kootumundakan* system. These systems have to be sustained and strengthened for conserving the ecological balance of the Kuttanad region.

The major issues in paddy cultivation in the Pokkali region are as follows. As only one crop is raised in an year, seeds are not stored. Hence, shortage of seeds is experienced at all times. High labour costs and non-availability of a suitable harvesting machine for Pokkali rice are identified by studies as the major reasons for the non-adoption of high yielding, short-statured rice varieties by Pokkali farmers. Timely procurement of paddy from the field and timely payment of cash for the produce do not take place. There is a general trend of adopting monoculture of prawn/fish among the Pokkali farmers, by abandoning rice cultivation, citing economic reasons. Finally, water weeds like *Salvinia, Pistia* and *Eichornia* create considerable menace in Pokkali rice fields.

We propose the following major interventions to promote Pokkali farming in Kuttanad.

Development of climate resilient varieties

The RRS Vyttila has so far released 11 high yielding improved varieties for the Pokkali farmers. Eight varieties exhibiting tolerance to salinity, acidity and submergence are in the pipeline. The variety Jyotsna, wherein the Saltol gene has been introgressed in the high yielding variety Jyothi, was released in 2018. Demonstrations of these saline-tolerant and submergence-tolerant varieties developed and released from RRS Vyttila should be undertaken on a large scale.

Similarly, the introgression of Saltol and Sub–one genes, conferring resistance to salinity and submergence respectively into high yielding varieties like Uma and Jaya, are progressing. More research should be undertaken into the introgression of biotic stress-tolerant genes (i.e., tolerant to BLB, sheath blight and blast) into high yielding varieties like Jyothi. We understand that introgression of genes conferring resistance to blast and BLB has already commenced. Pyramiding of abiotic and biotic stress tolerant genes together in high yielding varieties, through biotechnological interventions, is also being undertaken. These research projects need to be intensified and hastened.

Seed requirements

Presently, the RRS Vyttila produces around 3-4 tonnes of paddy seeds every year. Strengthening of seed production of improved varieties at the station (breeder/foundation seed) and ensuring farmer's participation in seed production in Pokkali fields are needed. A seed store with A/C and dehumidifier, facilitating storage of paddy seed for 6 months, is proposed.

Implementing IFS models

Demonstration units of various IFS models like Rice-Fish, Rice-Fish-Duck, Rice-Fish-Poultry and Livestock–Rice-Fish–Poultry/Duck have been set up at RRS Vyttila. Awareness and trainings on these various IFS models have to be imparted to the farming community.

Monitoring of soil health and water quality for enhanced rice and fish production

Soil health cards have to be generated for all farmers based on soil test values, which should be distributed to *padasekhara samithies* along with the recommendations for nutrient management two months prior to every cropping season (May to October-November). Testing of water quality parameters like pH and electrical conductivity in water prior to fish farming is already being done at the Vyttila station of KAU, which have to be strengthened.

Mechanization in Pokkali rice fields

Development of farmer-friendly harvesting machines for the deep water situation that exist in Pokkali lands needs to be a major thrust area in agricultural research.

Development of bio fertilizers and bio inputs for timely availability

Nearly 53-55 tonnes of biocontrol agents and microbial inoculants are produced and distributed from the Vyttila centre every year. These quantities will have to be further scaled up.

Rectifying nutrient deficiencies in Pokkali rice

Studies on nutrient disorders in crop plants have to be continued and suitable advisories should be issued to the farming community for rectifying the deficiencies on time.

VIII
ISSUES IN ANIMAL HUSBANDRY

There have been a few important lessons from the implementation of the first phase of Kuttanad Package in the animal husbandry and dairy sectors. To begin with, goat rearing was not found to be a feasible enterprise to promote in Kuttanad. Secondly, promotion of fodder cultivation was found to be a difficult goal to achieve, primarily due to the absence of adequate extents of land. Thirdly, it was realized that the design and construction of cattle sheds should better suit the unique geography of Kuttanad. Fourthly, it was found that the cultivation of Azolla and legumes could be promoted on a larger scale. Finally, biowaste treatment should receive prime consideration in all the implemented programmes.

Future interventions in animal husbandry in Kuttanad have to imbibe these lessons and also suit the strategy to the specific requirements of the sector after the floods of 2018. The two major projects in animal husbandry that need focus in the next stage are (a) the integration of livestock with agriculture within the homesteads systems of farming; and (b) promotion of duck farming.

CROP-LIVESTOCK INTEGRATION

In the efforts to integrate livestock into the homestead systems of farming, the following components have to be included:

(a) *Heifer rearing*: Heifer distribution projects may be adopted on a wider scale to enhance farmer's income and increase the cattle population. Inducted heifers will get time to acclimatize with the climatic conditions and reduce chance of diseases while attaining milch status.

(b) *Elevated common shelter facility* to provide shelter to animals during floods or any other natural calamity with 100 per cent subsidy from the government;

(c) *Feed assistance to cattle*: High production cost of milk is due to high feed cost and lack of unconventional feeds. Many a times, the farmer cannot afford the high feed cost. Hence, feed assistance to dry and milch animals may be given based on production.

(d) *Fodder block making units*: Paddy straw is wasted in wetland paddy fields owing to the high cost of loading and unloading. Hence, a unit to compress the straw to make fodder blocks may be considered.

(e) *Veterinary ambulance unit*: Geographical restrictions of Kuttanad make it difficult for the farmers to take their animals to the veterinary institutions. To overcome this, veterinary ambulatory units should be installed to provide fast and quality service to farmers.

(f) *Strengthening of the single window at Veterinary Poly Clinic (VPC), Mankombu*: A single window system was allotted to VPC, Mankombu in the first phase of Kuttanad Package. It mainly coordinates the activities like vaccination, disease control, duckling supply and training to duck farmers. This facility should be strengthened for providing timely and quality service to farmers.

(g) *Preservation of Kuttanadan Buffalo* in association with the KVASU, Pookkode;

(h) *One incinerator should be installed* in every panchayat or block to dispose the carcases of dead animals; and

(i) *Hay bailing units* should be set up to cut residual hay in paddy fields after the *puncha* harvest, so that the hay can be collected for feeding cattle or stored.

For all Kuttanad farmers, the government should either replace the cattle assets lost during the floods or give 100 per cent assistance for purchase of cattle assets lost during the floods. All the cattle assets of milk farmers who supply milk to the milk co-operatives have to be insured with 100 per cent subsidy. For those farmers supplying milk through milk co-operatives, the government should also give 50 per cent subsidy for the provision of cattle feed. The milk societies of Kuttanad need assistance to rebuild infrastructure after the floods. It is suggested that the government assists milk societies to build an additional floor in their office buildings. Thus, societies can move cattle feed and other stocks to the first floor during the floods. These floors can also be rented out to shops or other establishments during other seasons, which might help the societies earn an additional revenue too.

PROMOTION OF DUCK FARMING

Some amount of planning has to go into how to intensify duck farming in Kuttanad. The Kuttanad ducks are the indigenous desi ducks of Kerala, which include the *Chara, Chemballi, Pulli* and *Black* varieties. Among these four varieties, Chara and Chemballi are the two familiar varieties. They are hardy water fowls, acclimatized to the geographical area and resistant to many diseases. Even though Kuttanad ducks are dual purpose in nature (i.e., reared for egg and meat), they are reared in Kuttanad mainly for egg production. This is because even though consumers prefer Kuttanad duck meat for its tasty and nutritious meat, farmers do not prefer to rear them exclusively for meat purpose due to their low body weight, meat:bone ratio and feed efficiency. Presently, exotic meat type duck breeds like *Vigova Super-M* and *White Pekin* are reared for meat purposes, but their major drawbacks are low egg production, high costs of day-old ducklings and less consumer preference for white feathered birds.

One major issue faced by duck farmers is the high level of mortality due to the outbreak of Duck Pasteurellosis, Duck Plaque and New Duck diseases. Around 90 per cent of the ducks are reared without any systematic or scientific feeding practises or disease control measures. Ducks largely rely on spilled grains, grass hoppers, slugs, snails, small crabs, insects, mosquitoes and other larvae and small fishes from the harvested paddy fields, ponds, water ways and rivers. The geographical peculiarities of Kuttanad invite a large number of migratory birds, which in turn leads to infections like Bird Flu or Avian Influenza among the local duck population.

Lack of knowledge about vaccination against these diseases and scarcity of vaccination experts are some of the other factors leading to high levels of duck mortality. Kuttanad urgently needs a large project that would vaccinate most of the ducks within a strict time frame. It also needs proper disease surveillance programmes and vaccination of nomadic ducks to prevent mass deaths. A cadre of field workers has to be created for this purpose. We suggest that a major project be allotted to the KVASU, Pookkode towards this purpose for exclusive operation in the Kuttanad region. This project site should have infrastructural facilities to provide and distribute 5 lakh day-old ducklings per year. In addition, the project should create facilities for providing services like disease diagnosis, feed analysis, training to duck farmers, custom hatching facilities for duck farmers (aiming at about 15,000 eggs/week) and field veterinary services. It is estimated that for producing 5 lakh ducklings, 4000 parent stocks have to be reared, which needs around 12000 ft^2 shed area. Additionally, area will be required for a hatchery, an experimental shed, a disease diagnosis and feed analysis laboratory, a waste treatment plant and a training centre. The KSPB has already provided an initial allocation to the KVASU for the year 2019-20 to begin work on this project. We recommend that Kerala Government should provide 10 acres of land to the KVASU in Kuttanad to establish the project site.

Insuring the duck population is absolutely essential to minimize financial losses to the duck farmers in the aftermath of disease outbreaks. Generally, insurance companies are not willing to take up duck and poultry insurance. Government intervention should be ensured in this regard so that insurance cover is ensured for both ducks and poultry.

IX
PROSPECTS FOR FISHERIES

Given the centrality of Kuttanad as a water-based ecosystem, the fisheries sector should get as much priority as agriculture in the new rejuvenation plan. A key aspect of conflict we noted earlier in this report was between crop cultivation that needs more of fresh water and fisheries that needs more of saline water. We believe that with the appreciation of Kuttanad as a water-based ecosystem, we can find constructive ways in which these two occupations can be harmoniously integrated into the livelihoods of Kuttanad households.

INTEGRATED FARMING

Integration of fisheries with agriculture and/or animal husbandry is one of the best ways of improving productivity, reducing cost of production and increasing profitability of farming households in Kuttanad. A number of combinations are identified by scientists in the agricultural and fisheries sectors, which can be popularised in a region like Kuttanad.

(a) *Rice–freshwater fish culture*: In freshwater areas, rice may be integrated with fresh water fishes like carps. We suggest that the departments of agriculture and fisheries work together in identifying an area of 15,000 ha for this purpose in the initial phase.

(b) *Pokkali–Shrimp farming*: Pokkali fields may be made use of for this combination, which is one of the most eco-friendly methods of farming shrimp. Areas to the north of Thanneermukkam Bund, where sufficient salinity for rearing shrimp is available for at least four months in a year, may be utilised for the scientific farming of black tiger prawn, Indian white prawn and white legged shrimp. In the first phase, we suggest that an area of 500 ha may be identified and utilised for shrimp farming with varying degrees of intensity in the Kuttanad region.

(c) *Rice–Fish–Duck farming*: Integration of fish with rice and duck brings down the costs of production and increases the profitability of farming considerably. Rice and fish may be integrated with the *vigova* breed of ducks. In the first phase, we suggest that 100 such units may be set up in Kuttanad.

(d) *Integration of Fish with Vegetables/Banana and Pig and/or Poultry*: Another option for improving the profitability of farming and increase farm incomes is the integration of fish with vegetables/banana and pig and/or poultry. In the first phase, we suggest that 100 such units may be set up in Kuttanad.

FISH SANCTUARIES

One of the key instruments to protect the Vembanad Lake as a Ramsar site is to establish a minimum number of fish sanctuaries. Fish sanctuaries act as places for breeding, hiding and feeding to a large number of species of fishes. Three fish sanctuaries were set up in the first phase of Kuttanad Package: at Neelamperur, Kumarakom and Pathiramanal. We recommend that at least 10 fish sanctuaries should be set up in the Vembanad Lake over the next three years. Each sanctuary should be of size of at least 5 ha.

PRODUCTION OF FISH SEEDS

Kerala has a huge gap between the production of, and demand for, carp seeds. While fish seed production is around 2.80 crore, the present demand is around 13 crore. In fact, scarcity of fish seed is one of the most important hurdles for inland aquaculture development in Kerala. In this context, there is an urgent need for setting up more number of seed production centres, and Kuttanad offers an excellent site to realise this task. It can also considerably add to the incomes of farmers.

However, given that carps are generally not relished in the Kuttanad, development of farming of indigenous fishes also assumes great significance. Though the technology is readily available, hatcheries for the large-scale production of seeds of indigenous fishes do not exist in any part of the State. In the case of indigenous fishes like pearl spot (in whose case the fecundity is relatively lower), smaller hatchery units are preferred to large centralised ones.

FISH FARMING

Fresh water fish farming may be practised in all the ponds available in the region without affecting their present use pattern. The renovation of ponds implemented by the Department of Soil Survey and Soil Conservation during the first phase of Kuttanad Package had gathered wide appreciation. Considering this, we suggest that the department renovate all the existing ponds in Kuttanad through people's participation to prepare them for fishing, to improve the ground water potential, to increase their irrigation potential and to avoid water stagnation and consequent water borne diseases. In the first phase, an area of 50 ha may be utilised for pond fish farming in Kuttanad.

Farming of fish in cages is another productive way of utilising the water bodies. Since water is continuously being replenished with fresh oxygenated water in cages, high stocking density and consequently high production is possible. We suggest that 500 cage farming units may be set up in the initial stage.

Ornamental fish farming has excellent scope in Kuttanad. It requires low investment and is ideal for areas where availability of land is limited. In the first phase, 500 small-scale ornamental fish production units may be set up.

It is important that the capacity of local fishing community is strengthened by the provision of common and social infrastructure for the promotion cage/pen fishery, fish integration in paddy fields, fish culture in water bodies like ponds and the development of models for homestead fisheries. The RARS in Kumarakom and the Department of Fisheries should provide the technology transfer, and the training and supply of fingerlings of appropriate species of fishes and prawn.

ERADICATION OF WATER HYACINTH

As discussed in detail earlier, Kuttanad waterbodies are acutely infested with water hyacinth and other water weeds. One of the reasons for the depletion of fish stock in Vembanad Lake and connected water bodies is the proliferation of water weeds. Hence, there is an urgent need to clear these water bodies of weeds.

Mechanical methods alone are not sufficient to eradicate water hyacinth (see **Figure 26** for an illustration of mechanical removal). In the first Kuttanad package, though an integrated approach to eradicate the weed was envisaged, only mechanical methods were implemented.

Figure 26 *Mechanical removal of water weeds in progress, Kuttanad, 2019*
Source: Department of Water Resources.

As a result, the results were poor. This mistake should not be repeated in the second stage. We need an integrated approach encompassing *manual, mechanical* and *biological* methods of eradication. The work on eradication of weeds may be entrusted to the concerned local bodies and the services of local fishermen may be utilised for the purpose. Steps may also be taken to avoid excessive building up of plant nutrients in these water bodies (that leads to eutrophication) and the periodic opening of the Thanneermukkam Bund to facilitate salinity incursion into the Lake. Salinity is detrimental to the growth and proliferation of water hyacinth.

CLEARING OF FISH MIGRATION CHANNELS

Many fishes and crustaceans in the Vembanad Lake and associated water bodies undertake periodic migration for feeding and/for breeding. However, due to the accumulation of silt in the Lake/River/canal basin and due to the construction of the Thanneermukkam Bund, these migratory pathways have been blocked, leading to the depletion/extinction of fish stocks. In the context, there is an urgent need to clear all the migratory pathways for fishes in the region.

LIVELIHOODS OF FISHERFOLK

The economic status of the fishing community in and around the Vembanad Lake is inferior compared to the crop farming community. The MSSRF report of 2007 had pointed out that most fisher households did not have any assets, 70 per cent of the fisher households were below the poverty line and most fisher households were indebted. The report had suggested that free ration should be provided to all the fishing households during the period of closure of the Thanneermukkam Bund. This suggestion has remained unimplemented. We recommend that this be implemented immediately.

Women form about 47 per cent of the fishing work force. Women work mostly in the processing of fish, such as prawns peeling and clam meat extraction, where the working and sanitary conditions are extremely poor. There should be conscious promotion of self-help groups (SHG) of women belonging to fishing households in the region. There should be an effort, linked to SHGs, to impart vocational training and build capacities in these women. We also recommend that credit facilities should be extended to women's groups at zero percent interest rate to help enhance their livelihoods.

A large proportion of the fishing families live in small and untidy huts without proper ventilation. They own less than 5 cents of land and their houses are predominantly *kutcha* houses. We suggest that fishing households of Kuttanad should receive priority treatment in the housing schemes of the State government.

X

NEED FOR RESPONSIBLE TOURISM

RESPONSIBLE TOURISM

Responsible Tourism (RT) Mission was formed by the Kerala Government in June 2017. From then on, the Mission has been actively involved in various responsible tourism initiatives in Kuttanad, especially in Alappuzha, Vaikom, Kumarakom and Aymanam.

Vaikom has been developed as new tourism destination by the RT Mission through its flagship project 'PEPPER' (Peoples' Participation through Participatory Planning and Empowerment through Responsible Tourism) while Kumarakom has continued with its RT activities. In both cases, trainings for the local community, with special focus on women, have been organised to directly or indirectly equip them with skills, goods and services in the tourism industry. Till now, 723 local community members have been trained under various sectors linked to tourism. Various small, medium and micro enterprises have been identified, registered under the RT Mission and networked with the larger tourism industry. At present, 3236 registered RT Mission units function in the Kottayam district, most of which are from Kuttanad; 1008 units of these 3236 units function in Alappuzha district. These units provide perishable and non-perishable goods to hotels/resorts in the area, undertake cultural performances for guests in hotels/resorts and even directly provide skilled, semi-skilled and un-skilled services to tourists.

Various experiential tour packages are operated by the RT Mission in Kuttanad, linked to the real experiences of Kerala villages, festivals, cuisines and culture. These tours are led by local community members, thus generating additional income to the community members without any additional investment.

RT Mission also initiated a project to protect the Vembanad Lake in 2018 titled 'Clean Vembanad Initiative'. Cleaning programmes were organised in the lake and 55 loads of waste were removed from the Lake. Scientific waste management trainings were organised for house boat owners and staff. Cloth bags were distributed to make the area plastic-free. RT Mission also developed a waste management system for house boats through its registered units, and this system was taken over by the District Tourism Promotion Council (DTPC) recently.

RT Mission has also launched its project 'New RT Destination' at Muhamma and Alappuzha to convert the tourism destinations into Responsible Tourism practising destinations. As part of the project, one of the registered RT Mission units is managing waste management activities at Muhamma and Athirampuzha block panchayats.

These activities of the RT Mission have to be scaled up over the next few years. The Mission should initiate waste management programmes in more numbers of tourism destinations at selected destinations in Alappuzha and Kumarakom. As part of the initiative for scientific waste management, there should be more numbers of training programmes, cleaning campaigns, awareness workshops and brochures for tourists.

A GOVERNING BODY TO MONITOR HOUSEBOATS

A key contributor to the pollution of water bodies in Kuttanad is tourism and, in particular, house boats. As per the inspection report of the Accountant General (ERSA) of Kerala, there are 746 registered house boats under the Alleppey Port Registry. Apart from these 746 registered house boats, there are also approximately another 750 unregistered house boats in Alappuzha. Thus, more than 1500 house boats operate in the Vembanad Lake.

Neither the DTPC nor the Department of Tourism have any control in house boat registration, sanction and monitoring. Department of Tourism has just one right: to issue classification to the house boats. It is the Department of Ports that has the control over the registration, sanction and monitoring of these house boats. For these purposes, the Department of Ports uses the provisions of the Kerala Inland Vessels Act, which mainly deals with vessels that are sea going. Further, the shortage of staff and lack of space for anchoring confiscated/unauthorized house boats discourage the Department of Ports from conducting periodic inspections of unregistered house boats. With regard to pollution caused by house boats, the Pollution Control Board is the authorized department to conduct inspections. We can thus see that there are multiple departments that are in charge of multiple functions related to the regulation of the house boat industry. This has to end.

We suggest that a separate governing body be constituted for regulating and monitoring the house boat industry. The body's jurisdiction should cover provision of licenses, conducting inspections and controlling pollution caused by house boats. This should be under the District Collector and should consist of the representatives of the Departments of Ports, Department of Home, DTPC and the Pollution Control Board as well as the District Panchayat President.

PRESERVATION OF PATHIRAMANAL ISLANDS

The Pathiramanal Island in the Vembanad Lake is a pristine area with diverse biodiversity in Kuttanad. This island should be protected and promoted as a natural habitat for endemic flora and fauna and a destination for migratory birds. Restricted nature tourism under the control of Forest Department could be allowed here. However, no constructional and commercial activities or ecological modification of the island should be allowed. Mangroves may be planted all around as a belt and this may help promote fish conservation and proliferation.

XI

SANITATION, TOILETS AND DRINKING WATER

DRINKING WATER: THE NEW PROPOSAL

A thorough renewal of the existing water distribution system is essential to provide treated water to all households in the Kuttanad taluk. The Finance Minister of Kerala has already declared the intent for such a project in his Budget Speech for 2017-18. The idea is to introduce the "Kuttanad Drinking Water Project: 2nd Phase". The earlier efforts to provide clean drinking water to Kuttanad households failed primarily due to inadequate allocation of funds, due to which construction and installation works were left incomplete. Whatever works were undertaken became useless after a few years. What Kuttanad needs today is new project that does not repeat the mistakes of the past.

To begin with, the WTP needs to be of adequate capacity to factor in the needs of Kuttanad for the next 2 or 3 decades. For the 13 panchayats, the projected population for 2050 is 193,504 (assuming a 0.61 per cent decennial growth rate). The projected demand for water for 2050 @ 100 lpcd is 32.2 MLD. If we add the demand from the floating tourist population and other needs, such as industrial and institutional needs, the overall demand for water in 2050 is 44 MLD. Thus, any WTP installed should be of a capacity of 44 MLD. The existing Neerattupuram WTP has a capacity of 14 MLD. New capacity of 30 MLD has to be added at Neerattupuram itself. Thus, the major requirements of the proposed project would be:

(a) Construction of intake structure;
(b) Construction of 30 MLD WTP;
(c) Raw water pumping main;
(d) Clear water transmission system;
(e) 13 OHSRs, one at each of the 13 panchayats;
(f) Distribution system for 13 panchayats (about 895 km);
(g) Supply and erection of raw water and clear water pump sets; and
(h) Replacement of existing lines from Neerettupuram to Kidangara.

The total cost of the project is projected by the department at Rs 291 crore. An ideal source of finance for a project of this nature of capital investment would be the Kerala Infrastructure Investment Fund Board (KIIFB).

Most of the wells in Kuttanad are without parapet walls, which affects the quality of water available in these water sources. Hence renovation of the existing wells by construction of well curbs should be undertaken to ensure hygienic water for domestic use. Well recharging using rainwater received on the roof top should also be promoted.

TOILETS

Most households in Kuttanad have no access to toilets and discharge their household wastes directly into the Vembanad Lake. The disposal of human excreta is through on-site sanitation facilities, such as latrines with single/twin pit or septic tank. Such disposal or containment in the shallow groundwater horizon directly contaminates wells and other drinking water sources. During the monsoons, there are overflows from the tanks and closets, and in places with waterlogging the situation is extremely filthy. The protective cement rings used for constructing leach pits and concrete protections provided for septic tanks are frequently damaged due to the peculiar subsurface soil conditions in the region. There are also no facilities for periodically emptying septage and faecal sludge from septic tanks or leach pits and their treatment. As a result, the pollution load to the water body is significantly high with the BOD of septage ranging from 440-75000 mg/L. The solid waste generated in the area is around 1500 tpd, which is equivalent to about 4000 m^3/day by volume with a potential to generate leachates to the tune of 800 m^3/day or about 4 tpd of chemical oxygen demand. Due to the poor condition of sanitation, there is increasing concern related to public health in Kuttanad.

Therefore, appropriate technology solutions are necessary to improve the state of sanitation in the region. The following alternatives could be considered for improving sanitation.

1. *Modified Prefabricated Septic Tank*: Here, adequately sized and watertight, multi-chambered receptacles are used. They receive black and/or grey water and separate the liquid from the solid waste, which is stored and partially digested. The effluent, although clarified to a large extent, contains appreciable amounts of organic solids and pathogens. It is taken to another water-tight tank through a one-sided valve. This tank is fitted with a vertical reactor-cum-filter with an appropriate valve system. The effluent flows out after treatment and filtering. The gases produced are allowed to escape through vent pipes of adequate height. The sludge that gets accumulated in the septic tanks are periodically emptied and transferred to a centralized septage treatment plant.

2. *Specially Designed Septic Tank*: This is a combination of pit latrine and septic tank. It consists of a water closet with water-seal trap and two-cement concrete hume pipes of different diameter and length with interconnections. The length and diameter of the pipes depend on the number of users. This system facilitates the decomposition of liquefied human excreta and discharges effluent of reduced pollution load, turbidity and foul smell. Such a system could be attempted in areas adjacent to waterlogged domains.

3. *Anaerobic Baffled Reactor (ABR)*: The ABR is an improved septic tank. After a primary settling chamber, it uses a series of baffles to force all kinds of wastewater, as it passes from the inlet to the outlet, to flow under and over the baffles. The ABRs are robust and capable of treating a wide range of wastewater. However, the remaining sludge and effluents would need to be emptied and treated periodically. The ABR technology is

suitable for individual households or group of households or at a community level and is suitable for areas with high water table and waterlogging.

4. *Anaerobic Filter (AF)*: The AF is an improved design over the ABR, which facilitates better degradation of organic matter. It is commonly known as the BORDA Model of DEWATS (Decentralised Wastewater Treatment Solutions). The Hydraulic Retention Time (HRT) in the system is designed for 12 to 36 hours only and therefore the system needs only lesser space than the ABR or the septic tank systems. The system is suitable for all types of soil. The chances of groundwater pollution are marginal.

5. *Toilet-linked Biogas Plants*: This technology facilitates the complete reuse of nutrients in human wastes through anaerobic digestion in a bio-digester producing bio-energy and manure. It could be used in waterlogged areas without any odour. One of the limitations of this system is the excessive hydraulic loading i.e., liquid loading of 3 litres for solid loading of 300 g in one instance (1:30) against a conventional solid-liquid loading ratio of 1:1. However, this drawback could be overcome by adding animal dung or household biodegradable waste, such as food waste, along with the faecal matter.

6. *Biodigester Tank*: This tank was developed by the Defence Research and Development Organization (DRDO) for the disposal of human waste using anaerobic microbial inoculum in high altitude locations, where the temperature is as low as -40^{o}C. It is replicable in plains by developing a suitable anaerobic microbial consortium for the ambient temperature range of that locality. The biotank is fabricated using mild steel or FRP and is usable in waterlogged areas. This technology has many advantages over the conventional septic tank system and are generally free of maintenance.

7. *Up-Flow Anaerobic Filter*: This technology is used for the secondary treatment of septic tank effluents in areas where dense soil conditions, high water table and limited availability of land preclude soil absorption or the leaching system for effluent disposal. It is a submerged filter with stone media. The septic tank effluent is introduced from the bottom, making possible higher loading rates and efficient digestion. The up-flow anaerobic filter can be either a separate unit or constructed as an extended part of septic tanks.

The above options are not listed based on any order of priority. Each option should be selected based on spot specific terrain characteristics. For example, Modified Prefabricated Septic Tanks or Specially Designed Septic Tanks require periodical emptying of septage and provision of soak pit or up-flow anaerobic filter for the effluent from the septic tank. These may be attempted in areas where such facilities can be easily arranged. In institutions like Primary Health Centres (PHC) or schools in high water table areas with limited land availability, one may choose the ABR or the AF. In areas with possibilities for seasonal inundation, one may adopt the Biodigester Tank, as practiced in some areas in the Munroe Islands (*Munroe Thuruthu*) in Kollam district. In areas without seasonal water logging, and where the water table is relatively low, one may go for Toilet-linked Biogas Plants.

It is important that while adopting the above options in waterlogged areas, the toilet seat as well as the RCC cover of the chambers should be suitably raised to avoid the entry of floodwater. It is also necessary to empty the septage periodically and send it for treatment to a

Septage Treatment Plant (STP) located at a rather remote location. The STP is an unavoidable requirement for an On-site Sanitation System (OSS), which is yet to be a systematic practice in Kerala. The STP could be established in a government or private-owned agricultural farm, wherein the treated water could be effectively used for irrigation and the sludge could be composted into manure. There are two government-owned large agricultural farms, one located within 40 km and the other within 70 km from the Kuttanad region. In order to improve the operational efficiency of the STP, it is desirable to operate the desludging and collection, transportation and treatment system on an end-to-end basis as well as in a fully mechanised manner. The option of a mobile STP could also be considered if there is provision for composting of the sludge generated.

BOX 4

DE-POLLUTING VEMBANAD LAKE

Vembanad Lake has many sources of pollution. It is well-known that it is polluted by the overuse of fertilisers and pesticides in Kuttanad's agriculture, oil spills from houseboats and toilet wastes, household wastes and industrial wastes from within Kuttanad. This report contains many recommendations to address these concerns. However, another major source of pollution is often underemphasised. Tonnes of household and industrial waste reach the Lake from nearby cities and towns of Kuttanad, such as Alappuzha, Kochi and Vaikom. While exact estimates are not available, these cities and towns are important contributors to pollution in the Lake. Of them, Alappuzha needs special attention. The town has a network of canals that open up entirely into the Vembanad Lake and poses one of the main sources of lake pollution.

Alappuzha town – wedged between the Arabian Sea and Vembanad Lake – was built on the banks of two canals, Vadai canal and Commercial canal. These two canals are interconnected by nine sub-canals and about 104 small canals. In other words, a thick network of canals mark the geography of Alappuzha town. Kuttanad lies on the eastern side of the town. After Alappuzha lost its significance as a port town with the advent of nearby Kochi, the canals fell into disuse and were not regularly maintained. Gradually, these canals turned into sewers due to the dumping of solid and liquid waste by households and commercial institutions. Almost all of this waste reaches Vembanad Lake. With the decline of the water-holding capacity of the Lake over time, this pollution has attained serious proportions.

Nirmala Bhavanam Nirmala Nagaram programme

From 2012, a major effort was undertaken in Alappuzha to address the question of solid waste management. This effort was led by Alappuzha's Member of Legislative Assembly – Dr. T. M. Thomas Isaac. This intervention won recognition from the United Nations Environment Programme (UNEP) along with three other cities in Asia and Europe.

In 2012, Alappuzha town area resembled a vast waste dump with no proper waste management systems in place. Garbage had piled up on roadsides, and canals and drains were clogged with waste from hotels, markets and meat shops. Since November 2012,

the Alappuzha Municipality has been implementing a decentralized programme of solid waste management by name Nirmala Bhavanam Nirmala Nagaram (Clean Homes, Clean City). As part of the programme, on-site waste management systems (biogas plants and pipe compost) were provided to households and community-based aerobic composting units were established at different locations. About 786 families set up biogas plants and 525 households set up pipe-compost units. The focus of the initiative was segregation and treatment of wet waste at the source itself. Two and a half years down the line, Alappuzha underwent a dramatic transformation. The most surprising makeover was that of the biggest and dirtiest garbage dumping yard near Vazhicherry in the heart of the city. It was transformed into a WATSAN (water and sanitation) park with six composting tanks that could convert two tonnes of wet waste into compost in 90 days. The WATSAN Park was also envisaged as a permanent exhibition-cum-learning centre for an environment friendly waste management system and water conservation techniques. Alappuzha's experiment with decentralized waste management has inspired other urban local bodies (ULBs) in the State to undertake similar initiatives.

Regarding liquid waste management, Alappuzha lacks underground sewerage network and treatment facilities and relies on septic tanks or soak pit type onsite sanitation systems (OSS). The partially and untreated wastewater either leads to subsurface soil or drains into the canals. Flat topography and high water table make it further difficult to establish a conventional sewerage network system. In fact, this is also the case with the whole of the Kuttanad region.

The CANALPY project

The CANALPY project was jointly initiated in 2017 by IIT-Bombay and the Kerala Institute of Local Administration (KILA). It intends to clean and reclaim the canals of Alappuzha with suitable technological and social interventions. As a starting point of the project, a number of studies were undertaken. According to these studies, the major contributor of waste water to the main canals were the sub-canals. Hence, to ensure sustainability and cleanliness of the main canal, all sub-canals had to be cleaned first. Since one of the urgent needs was to contain the contamination, a proposal was prepared to replace all the unscientific septic tanks in the 660 households on the banks of the canals. There was also no system of faecal sludge management (FSM) in the town. So even the presence of septic tanks might not assure an answer to pollution since the sludge was most likely to be dumped into the water bodies.

In sum, it was found that one of the major requirements for Alappuzha town is a programme for septic plant replacement among households and adequate capacity for treatment of faecal sludge.

Between 2017 and 2019, the CANALPY project has developed working systems of decentralised waste water and solid waste management (integrated sanitation). There are also well-defined protocols of participatory implementation and institutionalisation of the processes. The next step is to expand this programme into the panchayats and towns around Vembanad Lake as well as city centres like Kochi and industrial areas like Eloor.

XII

OTHER NEEDS AND INTERVENTIONS

INDUSTRY: ESTABLISHMENT OF AN INTEGRATED RICE PARK

An Integrated Rice Park of international standards should be established in Alappuzha. A supply chain/value chain should also be established and linked up, including across the export of rice and rice products. The Integrated Rice Park should provide high-tech integrated solutions for paddy processing, packaging and marketing, including processing the grains into primary, secondary and tertiary products. This will include primary processing facilities i.e., grading, sorting, branding and packaging facilities; secondary processing facilities for rice powder, its branding and packaging for national and international markets; and tertiary processing facilities for exuded rice of two types viz., (i) Ready To Eat products (like chips and other crispy snacks) and (ii) Ready to Cook products (like noodles and pastas).

The Rice Park should also have (a) processing facilities for high value rice/specialty rice like *njavara*; (b) incubation facilities for small entrepreneurs and start-ups in small quantity milling, processing and packaging; (c) a business centre for trade and business negotiations; and (d) elevated paddy and rice godowns. There should also be arrangements for ancillary infrastructure support, such as dedicated banking facilities through major banks, single window systems for faster clearance, weigh bridges, effluent treatment plants, quality testing labs, uninterrupted power and water supply, all weather roads, a truck terminus, world class price information dissemination system and sale outlets.

POWER: NEED FOR A KSEB SUB-STATION IN KUTTANAD

Farmers of Kuttanad desire uninterrupted power supply. Pumping out water from the paddy fields is the most important task in the agriculture of Kuttanad. There are motor *tharas*, where oil engines/electric motors are installed, and their power ranges from 5 to 50 HP. The work of pumping out is undertaken through contracts given in auction by the *Puncha* Special Officer or as per private contracts executed by the cultivators. Part of the expenditure on electricity connection is subsidized by the government. Usually, the pumping out of water is continued without interruption for 20 to 30 days till the fields are completely drained of all excess water.

Interruption of power supply during the time of de-watering is a major problem faced in all the *padasekharams* in Kuttanad. In the event of a power failure, farmers are left at the mercy of Kerala State Electricity Board (KSEB) officials, who are stationed kilometres away at Pallom in Kottayam district. It takes 2 to 3 days for the KSEB to address some complaints, by which time the drained water would have returned to the *padasekharams*. This is the reason why farmers in Kuttanad desire a new KSEB sub-station inside Kuttanad.

The KSEB is already in possession of 1.5 acres of reclaimed land in the H-Block of Kuttanad (south side of H-Block, locally known as Chekkathara), which was donated by Joseph Murikkan for installing a sub-station decades ago. If the sub-station at Chekkathara in H-Block becomes a reality, the menace of the power interruption will be largely avoided, which will thereby help in ensuring efficient de-watering of paddy fields of Kuttanad. We recommend this measure at the earliest.

XIII

FINANCIAL IMPLICATIONS: A TENTATIVE OUTLINE

Sl No	Sector	Intervention	Tentative Cost (in Rs. crore)
1	Industry	Establishment of an Integrated Rice Park in Alappuzha	15.00
		Sub Total	*15.00*
2	Power	KSEB sub-station in Kuttanad	7.50
			33.00
		Sub Total	*40.50*
3	Drinking Water	Renewal of existing water distribution system for providing clean and safe water	290.00
		Enhancement of the capacity of Water Treatment Plant (WTP)	
		Renovation of existing wells for domestic use (local bodies)	1.00
		Sub Total	*291.00*
4	Sanitation	Adoption of appropriate technological solutions for improving the state of sanitation including the establishment of Septage Treatment Plant (STP)	3.00
		Sub Total	*3.00*
5	Tourism	Scale up the activities of RT Mission with special focus on scientific waste management activities	3.00
		Constitution of a Governing Body to monitor the operation of houseboats	
		Preservation of Pathiramanal Islands	8.00
		Sub total	*11.00*
6	Fisheries	Adoption of Integrated Farming – Integration of Fisheries with Agriculture/Animal Husbandry	30.00
		Setting up of Seed Production Centres	25.00
		Encouragement of pond fish farming including ornamental fish farming (including backyard farming)	10.00
		Improvement of the livelihoods of fisherfolk by extending credit facilities to women SHGs, provision of free ration, better housing facilities etc.	20.00
		Eradication of Water Hyacinth: Adoption of Integrated approach - manual, mechanical and biological methods - for eradication	30.00
		Fish sanctuaries along with participative model of conservation in Vembanad Eco system	100.00
		Clearing of fish migratory pathways	15.00
		Sub Total	*230.00*
7	Animal Husbandry	Integration of livestock with agriculture within homestead farming systems	2.00
		100 percent assistance for the purchase of cattle for the flood affected households	5.00
		Promotion of duck farming	7.00
		Insurance cover for both duck and poultry	2.00
		Sub Total	*16.00*

8	Agriculture	Transformation of Kuttanad into a Special Agricultural Zone thereby converging the services on agriculture, soil and plant health, pricing, market linkages, storage, value addition etc	10.00
		Reformation of Registered Seed Growers Programme (RSGP) to ensure timely supply of seeds	10.00
		Development of facilities for seed processing, grading and storage of seeds	3.00
		Setting up a seed testing laboratory to monitor seed quality	0.50
		Methods to conserve germplasm of major crops in the region	0.70
		Market linked revival of cultivation of *njavara*	0.25
		Preparation of a crop calendar for paddy	0.10
		Replacement of petty and para systems and old motor pump sets with low head, high discharge vertical axial flow propeller pump sets run by electric motors for dewatering of *padasekharams*	200.00
		Soil Health Management - Creation of a data bank on soil analysis and application of nutrients based on soil tests	1.00
		Promotion of Custom Hiring Centres to improve mechanisation of paddy cultivation	1.00
		Promotion of Integrated farming in paddy fields – Rice – fish/duck-cattle combination	16.00
		Integration of coconut revival programme with income generating activities like livestock rearing, homestead fisheries, and intercropping with vegetables and tuber crops	3.00
		Adoption of Integrated Farming System approach for Sugarcane cultivation in Upper Kuttanad	0.25
		Strengthening the environmental surveillance in Kuttanad with the help of KAU	1.00
		Establish a training cum research centre for the researches on organic farming	0.20
		Strengthening of Pokkali rice cultivation and Koottumundakan system	5.00
		Sub Total	*252.00*
9	Water Resources	An initial study based on satellite images and drone images along the periphery of Vembanad wetland system	12.00
		Concept of "Room for River"in Kuttanad to ensure the natural flow of water (Phase 1)	60.00
		Compartmentalisation of *padasekharams* in Kuttanad area (Total bund length – 350 km)	700.00
		Cleaning of drainage channels and bund protection works	420.00
		Improvement of the efficiency of Thottappally spillway to its designed capacity	175.16
		a. Electrification of shutters	0.15
		b. Maintenance of spillway structure embedded parts and shutter grooves	4.48
		c. Development of leading channel from Veeyapuram to Thottappally and constructing flood regulators –	120.00
		d. Development of 2 channels of Thottappally (bypass channels)	40.00
		e. Hydrodynamic study of spillway and leading channel	0.30
		f. Study for providing groyne at Thottappally	0.23
		g. Construction of groyne at Thottappally	10.00
		Completion of AC canal (Phase 2 & 3) to its original width of 40 m (including rehabilitation, land acquisition, canal development and cross structures)	220.00
		Conduct of study to explore the possibility of snap openings of Thaneermukkam Bund to control salinity and automation of 30 shutters in the Thanneermukkam Bund	2.00
		Sub Total	*1589.16*
		GRAND TOTAL	**2447.66**

GLOSSARY

Karappadam	-	paddy cultivation in elevated or at sea-level land
Kayal	-	paddy cultivation in land reclaimed from the Vembanad Lake, below mean sea-level.
Kari	-	paddy cultivation in black peaty acidic soils located below or at mean sea-level
Puncha	-	The annual crop of Kuttanad, after monsoons
Padasekharams	-	blocks of multiple paddy fields
Padasekhara Samithies	-	an apex body monitoring the activities of *padasekharams*
Pozhi	-	sand bar formed at the sea mouth
Azhi	-	estuary
Orumuttu	-	salt water barrier
Motor *thara*	-	a raised platform for placing motor
Vachals	-	a small sluice
Pothu madas	-	clay bunds
Thodu	-	rivulet
Petty& Para	-	petty mens a box and para is a cylindrical vessel. This was used for de-watering from *padasekharams*
Climber *Sena*	-	a team of coconut climbers
Ayalkkootam	-	Neighbourhood groups
Harithasangam	-	A green collective
Pathiyan Sarkkara	-	a special variety of jaggery
Koottumundakan	-	a system of rice cultivation wherein the *virippu* and *mundakam* varieties of rice are sown in a particular proportion.

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A SPECIAL PACKAGE FOR POST-FLOOD KUTTANAD

Kerala State Planning Board
2019