CHAPTER – 2

STUDY AREA – KUTTANAD WETLAND ECOSYSTEM

The present study was conducted in the Kuttanad wetland ecosystem, part of the Vembanad-Kol Ramsar site in South India and the largest in Kerala. The location of Kuttanad wetland in the south western coast of India is given as Figure 2.3 and the sampling locations are recorded in Figure 2.6.

2.1 Topography & Geographical Area.

Kuttanad is a highly complex, dynamic and unique rice growing agro-climatic tract of Kerala lying 0.5 to 2.5 m below MSL. It extends between North latitudes 9° 8’ and 9° 52’ and East longitudes 76° 19’ and 76° 44’, comprises the area of 54 revenue villages spread over Alappuzha, Kottayam and Pathanamthitta districts. The total geographic area of the region is 1100km². Kuttanad is bordered by Kaduthuruthy - Vaikom road in the north, Kaduthuruthy - Kottayam - Mavelikkara railway line in the east, Mavelikkara - Haripad - Thottapally road in the south and Thottapally - Alappuzha - Thaneermukkom road in the west.

Kuttanad acts as a receptacle to receive the flood waters of the fast flowing river systems Periyar, Muvattupuzha, Meenachil, Pampa and Achenkovil, all originating from the Kerala part of Western Ghat mountain ranges which receives two monsoonal rains, south west and north east. These rivers and their distributaries criss-cross Kuttanad wetlands and Vembanad lake before meeting Arabian Sea. The organic matter transported from the high ranges makes Kuttanad a unique ecosystem in the world due to its location near equator, equitable temperature regime, high rainfall and high solar radiation throughout the year similar to Philippines in the tropics.

Most of the areas in Kuttanad are water logged almost throughout the year and subjected to flood during the monsoon period. During the monsoon floods, the whole area becomes engulfed under a vast sheet of water as the above rivers branch into many water courses which are connected to one another. The flood waters move towards the Vembanad Lake to be drained to the Arabian Sea through Cochin Estuary. Vast areas of paddy fields get submerged for one or two weeks resulting in considerable loss. Communication and accessibility of the area become difficult as important roads in the locality get branched or submerged under water. The area includes mainly the wet rice fields and dry garden land like sandy areas, unreclaimed and reclaimed kayal land areas, and other water spread, rivers, canals, channels and waterways. The garden land is the land where human population of Kuttanad is inhabited which is up to 1.0 m
above MSL. The network of canals and rivers are extensively used for transportation, recreation and livelihood means.

2.2 Origin and Geology of Kuttanad

There are two major hypotheses on the origin of Kuttanad. According to the widely agreed hypothesis, millions of years ago these lands were forest and during a geological event, the Arabian Sea advanced up to the foot of Western Ghats in many places, submerging these areas. Years later there were upliftment and recession of sea, during which the trees of the entire forest that was under submergence got uprooted and buried ‘in situ’ under varying levels of silt to give rise to the low-lying marshy saline lands of Kuttanad. Soils of these areas have vast organic deposits, fossils of timber and shellfish in varying depths (MSSRF, 2007).

According to Geologists, Kuttanad represents a ‘Recent Sedimentary Formation’. It has been established that Arabian Sea once extended as far east as the eastern border of Kuttanad region. With the upliftment of the ‘Warkalay Laterite Formation’, the tract of the recent formation got elevated forming an extensive bay. The west flowing rivers Periyar, Muvattupuzha, Meenachil, Manimala, Pampa dn Achenkovil were discharged into the bay. The silt carried by these rivers was deposited at the mouth of the rivers and this gave rise to the present sea coast, converting the shallow bay in to an extensive back-water tract. The lagoon gradually silted up and gave rise to the shallow wet paddy lands, which now characterise the Kuttanad. Kuttanad is a deltaic formation of mainly four rivers Achankovil, Pampa, Manimala, and Meenachil and part of the contribution is from Muvattupuzha river at the northern part i.e., Vaikom. The deeper portions of the lagoon formed the present ‘Kayal’ (backwater).

2.3 History

From the very early days, Kuttanad has been acknowledged, as the ‘rice-bowl of Kerala’. In ancient days, the term, ‘Kuttanad’ referred to a much larger area than what it denotes at present. At that time, region extended from Karunagappally to Alwaye was comprised the ‘Kuttanad’. In early Tamil literature like ‘Venpai’ and ‘Tholkappiyam’, Kuttanad is mentioned as one of the 12 ‘Nadus’ (principalities) where people spoke ‘Kodumthamil’. There are references to Kuttanad in the great Tamil work ‘Thiruvaymozhi’ written in 8th century A.D. By the renowned Vaishnavite Saint Nammalvar and in ‘Periyapuranom’ of the 11th century A.D.

Apart from these historical records, there are also certain legends connected with Kuttanad. It is said that the Khandava Vana mentioned in the Epic Mahabharatha was situated in Kuttanad and that burned forest still lie deep under the fields. Logs of burnt and charred wood are still seen in the Karinilams of Vaikom, Thuravoor, Thakazhy, Purakkad etc. According to some historians, it was originally known as ‘Chutta nadu’ meaning burnt land
which later became Kuttanad. Many people in Kuttanad often connect the term with ‘Karumadi kuttan’ a stone carved statue of Lord Budha situated at Karumadi, as the ‘land of Kuttan’ became Kuttanad. Early “Cheras” had their home in Kuttanad and they were called as “Kuttuvans” named after this place. Apart from this, there are also certain legends connected with Kuttanad. The legend that, after the forest was completely burnt down, mud set in gradually and gave rise to the fields existing at present. As such, it is said that this place was originally known as “Chutta nadu” (burnt land), which later on became “Kuttanadu”.

2.4 Climate

The climatic features of Kuttanad are typical of humid tropical features and it experiences fairly uniform temperature throughout the year ranging from 21°C to 36°C (Figure 2.1). The average annual rainfall recorded as 3000mm. 83% of the rainfall is from the two monsoons, south west and north east monsoons (Figure 2.2). Among them, the south west monsoon (June to August) has the highest percentage of rain than the north-east monsoon (October – November). The summer temperature is between 30-34°C from March to May and the lowest ranging between 22-24°C in December (Soman et al., 1988). The driest months are February and March followed by summer reaching to tropical severity during the months of April and May. The winds have seasonal direction of north west during monsoon and speeds attain 45-55km/hr. The humidity is on the higher side 70-80% due to maritime influence.

Figure 2.1: Atmospheric temperature (Max. and Min.) variation in Kuttanad from 2004 to 2008
Figure 2.2: Monthly rainfall (mm) pattern in Kuttanad (from 2004 to 2008)

Source: Rice Research Station, Mancompu and Regional Agricultural Research Station (RARS), Kumarakom.

2.5 Soil and its types

The soil in Kuttanad is a mixture of sand and clay in varying proportions. In some parts, presence of decayed organic matter including decayed parts of logs of wood has been reported (Ajaykumar et al., 2008). In most of the areas, the soil is highly acidic and contains toxic salts like acid sulphates (Mathew et al., 2004). The toxicity adversely affects plant life through capillary action when the fields are dry or when the water outside the fields rises high. The soil in Kuttanad is classified in to three major categories.

a. Kayal land - this type is seen in the kayal (lake) lands of Kuttanad, mainly in revenue villages Chennenkari, Kainakari, Pulimkunnu of Kuttanad Taluk and Thiruvanippur and southern regions of Kumarakom of Kottayam Taluk. The area lies 1 to 2m below MSL. Soils are seriously affected by salinity than the other types.

b. Karapadom - they are generally situated along waterways and rivers. They lie in the interior of the villages on the Eastern and Southern periphery of Kuttanad. They are periodically replenished by the silt deposit carried by the rivers during the flood.

c. Kari - these are situated in the Ambalappuzha, Cherthala and Vaikom Taluks. The name Kari is derived from the intense black colour of the soil due to the presence of partially decayed organic matter (peat) and pyrites in high amount. The soil and water itself are highly acidic (pH 2 to 4.3) and saline.
2.6 Agro-ecological Zones

Based on the agro-ecological and climatic characteristics like the height from the mean sea level, influence of rivers, flood risk, risk of saline water intrusion, soil type and fertility and the cropping pattern, Kuttanad is divided in to six agro- ecological zones (Figure 2.3).

1. Upper Kuttanad
2. Purakkadu Kari
3. Lower Kuttanad
4. Kayal lands
5. North Kuttanad
6. Vaikom Kari

1) Upper Kuttanad: This zone lies in the south eastern side of Kuttanad which includes comparatively high lands. The elevation ranges from 0.5 to 6 m above MSL. The zone experiences low risk from saline intrusion and flood. Three major rivers include Achenkovil, Pampa and Manimala enter Kuttanad in this zone.

2) Purakkad Kari: It is situated at the western side of Upper Kuttanad zone, near to sea. The zone has high soil and water acidity owing to the presence of peaty soil (partially decomposed organic matter in high proportions). The risk of saline water intrusion is high compared to other zones, since it is near the sea coast.

3) Lower Kuttanad: It is situated north of Upper Kuttanad. The area lies 1 to 2 m below MSL in some parts. The risk from flood and saline water intrusion is the highest here. The flood season is slightly of more duration compared to other zones. The presence of a number of small islands with human habitation is a special feature of this zone.

4) Kayal lands: This zone lies north of Lower Kuttanad. It includes Kayal rice fields, which were reclaimed by earthen bunding of the shallow portions of south eastern part of then Vembanad lake. These fields lie 1 to 2m below MSL. The flood risk and saline water intrusion is high here.

5) North Kuttanad: This zone lies north of Kayal lands. It was formed by the natural reclamation of Vembanad Lake due to the silt carried by Meenachil River and its distributaries. The western portions lie 0.5m below MSL and the eastern portion lie 1m above MSL. Even though the flood risk is high, saline water intrusion is the major problem here since it is very near to the Cochin estuary.

6) Vaikom Kari: This zone lies at the northern most end of Kuttanad. It lies 0.5m below MSL in western portions and upto 6m above in eastern portions. The area lies at the northern side of Thannermukkom barrage, so the risk of saline water intrusion is the highest here in summer. The name ‘Kari’ is derived from the intense black colour of soil. High content of organic carbon
in this soil imparts this characteristic black colour to the soil. The presence of partially decayed or petrified logs of wood (peat) is high in this zone. Other characteristic features of Vaikom Kari soils are heavy texture, poor aeration, bad drainage and low content of available nutrients. The soil and water are highly acidic. There is accumulation of sulphur compound, which on microbial action, is converted to sulphuric acid. Due to acidity, toxic compound of iron, aluminum and manganese are released and they accumulate in toxic proportions in these soils. Because of its peat content, the soil become too hard on drying and when burned, it flames like coal. Odour of marsh gas and hydrogen sulphide persists in the soil. Yellow brown encrustations are very common. The area is fed by a major distributory of Muvattupuzha river called Kari Ar, entering at Thalayolaparambu, flowing through Ezhumamthuruthu and discharging into the Vembanad lake near Mootheadathukavu Temple at TV Puram, where a temporary earthen bund called ‘Kari Ar muttu’ is constructed to check the saline water if required. The size of the land holdings is large as in Kayal lands. The bunds around the fields are cultivated with coconut and banana.

Figure 2.3 : Agro-ecological zones of Kuttanad
2.7 Landuse changes in Kuttanad

A comparison of the land use pattern of Kuttanad region in 1967, seven years before the erection of the Thannermukkom bund with those in 2003, 30 years later, using remote sensing with ground-truthing, showed considerable change. During this period, 20 % of paddy lands have become fallow lands, another 8.3 % became permanently water logged (Figure 2.4). Many of these neglected paddy lands have naturally been evolved into a dense scrubland; some of them have lost their depth as they get filled with gravel, silt, and plant debris. Weeds have also overgrown in adjacent water canals, promoting silting so that the land mass and the canal adjacent to each other look alike. The net built up land has increased by 185 %. It is not clear how much of built up land have been recovered from paddy and the water bodies (MSSRF, 2007) (Figure 2.5).

![Figure 2.4: Extent of change in area under each land use](image)

Adapted from MSSRF (2007); Source: Kerala Land Use Board, 2005

2.8 Agriculture and Environmental problems

Paddy cultivation is the major agricultural activity, followed by coconut and plantain cultivation in garden lands. Besides, Kuttanad is the natural habitat and home ground of many economically and ecologically important species of fishes, prawns, clams, frogs, birds and cattle. Other related economic activities include toddy tapping, shell mining, clay mining, live clam and fish capture.

Kuttanad is heavily polluted due to excess application of fertilizers, pesticides and other harmful chemicals in the plantations of upstream catchments of river systems. The pollutants get
concentrated and water is made in to a ‘cesspool’ during the summer months due to stagnation, low water level and less water flow. The situation got further deteriorated after the commissioning of Thanneermukkom salt water barrier in 1975, which prevented the tidal activity during summer months; otherwise the water can flow and get diluted with the tidal seawater. The unscientific construction of several roads, by obstructing the canals and water ways, also contributed to the situation. This situation paved way for a series of problems like proliferation of unwanted noxious exotic weeds, poisonous snakes, less fish and agricultural production and number of infectious diseases seriously affecting the health and livelihood of the inhabitants of the area. The problems can be listed as follows.

1. Nutrient accumulation and pesticide pollution due to excessive use of fertilizers and pesticides for growing high yielding varieties of rice.
2. Explosive growth of noxious aquatic weeds *Salvinia*, *Eichhornia*, *Pistia* and a large number of other invasive plants.
3. Drastic reduction of fish production and increased rate of fish diseases and fish killings.
4. Reduction in plankton, benthic fauna and native shell, fish and prawn yields.
5. Increased occurrence of water-borne diseases such as filariasis, schistomiasis, cholera, typhoid, jaundice, gastroenteritis and dysentery and recently the leptospirosis (Unni *et al.* 1997).
6. Reduction of wetland diversity due to the invasion of exotic weeds. A few dominant weeds are occupying most of the water surface.
7. Reduced flow rate in rivers due to interlocking of weeds and impoundment of large volume of water by the construction of dams in their catchments.
8. Blocking of canals and lakes due to accumulation of weeds impaired the inland water transport.
9. Pollution of Vembanad Lake, rivers, canals and even the dug wells of Kuttanad. Depletion of quality of water in the rivers, lakes, canals and wells of Kuttanad is much severe in summer.
10. Illegal sand mining from the rivers affecting the flow of water to the lake.
11. Increased tourism activity in the lake, particularly, water sports and boating lead to water pollution.
12. Accumulation of liquid and solid waste into the lake due to higher population density – in fact, highest amongst the Indian States – as well as from the human dwellings in the lake catchment.
13. Blocking of the free flow of Vembanad Lake by the Thannermmukkom Barrage for the prevention of salinity intrusion.
An Ecological study of the Macrophytic Vegetation of the Kuttanad Ecosystem

Chapter 2

Study area – Kuttanad wetland ecosystem

Figure 2.5: Landuse pattern in Kuttanad

Legend
- Road
- Panchayat boundary

LANDUSE
- Built-up land
- Mixed crop
- Paddy
- Paddy fallow
- Sandy area
- Water body
- Waterlogged
Kuttanad wetland system is undergoing transformation very fast due to unsustainable agriculture (major problems being lack of profit, lack of labourers, increasing cost of labour and their migration for other better jobs, reduction in yield, increased weed infestation and diseases etc.). As per reports, 35% of the area has been abandoned and these abandoned rice fields are causing major ecological changes into sudds and floating islands and swamps overgrown with *Eichhornia, Ischaemum* etc. Weed growth is creating serious problems of infectious diseases like recently spreading dengue fever, chikungunya etc.

### 2.9 Different systems of Kuttanad wetland ecosystem

Kuttanad wetland comprises different types of ecological subsystems, which vary very much and differ from each other locally at a particular station. These subsystems are:

**a. Cultivated Rice Fields (CF):** comprise major part of the wetland and undergo fast changes between the cultivation period in the post-monsoon and the fallow period in the flooded monsoon during which the fields are inundated. Macrophytes dominate the flooded monsoon from June to September. The weeds are removed in October-November for raising the rice crop.

**b. Abandoned Rice Fields (ABF):** comprise rice fields which have been abandoned over different periods ranging between 5, 10 and more than 15 years. These abandoned rice fields, according to their period of abundance, have different types of communities. Those fields abandoned for over 15 years is characterized by the development of permanent floating sudd even with terrestrial plants *Melastoma, Schizigium* and *Lycopodium* along with *Ischaemum*.

**c. Canals:** are the arteries of Kuttanad wetland crisscrossing the whole delta area. They connect the river systems and the lake and are major routes of transportation through country boats. Canals of Kuttanad vary from 10 – 15m wide bringing river water in to the fields, 5 – 10m wide around rice fields and smaller ones, less than 5m wide, now transformed and blocked for the construction of roads.

**d. River courses:** (i) Smaller river systems - such as Kodurar and Kariyar (part of Muvattupuzha river) are mostly stagnant and fully grown by the macrophytes over longer periods. (ii) Larger river systems - Achenkovil, Pamba, Manimala and Meenachil and their major distributaries have permanent water flow deeper and wider. These rivers are interconnected by wide canals.
2.10 Sampling locations

A total of 40 sampling stations were selected from the different systems of Kuttanad and among which, 9 are river sites, 20 canal sites, 8 cultivated fields and 3 abandoned fields. Water samples were taken monthly wise from January, 2006 to December, 2007. Sediment and plant samples were taken season wise and analyzed as per standard procedures. Detailed methodology is described separately in each chapter.

All the 4 subsystems were included in our 7 permanent stations for detailed investigations located at 1) Thakazhy, 2) Kavalam, 3) Alappuzha – Changanassery Canal 4) Pallom, 5) Kumarakom, 6) Neendoor and 7) Vaikom. Seasonal observations were conducted from selected sites in Upper Kuttanad, Purakkad Kari and Kayal Lands. Floristic surveys from another 14 different sites were also made (Figure 2.6).

Table 2.1: Sampling Sites/ Observation Stations

<table>
<thead>
<tr>
<th>Systems</th>
<th>Site code</th>
<th>Agro-ecological zones</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>River systems</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>KV1</td>
<td>Lower Kuttanad</td>
<td>Manimala River course. Continuous flow of water. <em>Eichhornia crassipes</em> mats are making navigation problems during the premonsoon season. <em>Nymphoides hydrophylla</em> is growing along the sides of the river.</td>
<td></td>
</tr>
<tr>
<td>TH3</td>
<td></td>
<td>Pampa River course. Communities of <em>Aponogeton appendiculatus, N. heterophylla, N. nouchali, E. crassipes</em> and <em>Cabombo caroliniana</em> are growing along the sides. Motor boat service and human disturbances were noticed in this site.</td>
<td></td>
</tr>
<tr>
<td>P3</td>
<td>Kayal lands</td>
<td>Kodur river course – North, <em>E. crassipes</em> and <em>N. hydrophylla</em> are commonly seen at the site.</td>
<td></td>
</tr>
<tr>
<td>P4</td>
<td></td>
<td>Kodur river course - Canal junction – (South). <em>E. crassipes</em> and <em>N. hydrophylla</em> are commonly seen along the margins of the river. During premonsoon season thick floating mats of <em>Eichhornia</em> is completely covers the river surface.</td>
<td></td>
</tr>
<tr>
<td>ACC4</td>
<td>Lower Kuttanad</td>
<td>Manimala river course. Good flow and mixing of water observed through out the period due to the joining of Manimala river course. <em>N. hydrophylla</em> is the dominant plant</td>
<td></td>
</tr>
<tr>
<td>KR1</td>
<td>North Kuttanad</td>
<td>River course (Meenachil river). Interspersed growth of <em>N. hydrophylla</em> was noticed in this system. <em>E. crassipes</em> mats were also noticed during the premonsoon season.</td>
<td></td>
</tr>
<tr>
<td>VPM</td>
<td>Upper Kuttanad</td>
<td>Pampa river course. <em>C. caroliniana</em> is growing along the margins of the river.</td>
<td></td>
</tr>
<tr>
<td>THOT</td>
<td>Purakkad kari</td>
<td>Achankovil river course. Submerged communities of <em>C. caroliniana</em> and <em>L. heterophylla</em> were noted. <em>N. hydrophylla, E. crassipes</em> and <em>N. pubescence</em> are the other major communities growing along the margins of the river system</td>
<td></td>
</tr>
<tr>
<td>Systems</td>
<td>Site code</td>
<td>Agro-ecological zones</td>
<td>Description</td>
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<tr>
<td>KODI</td>
<td></td>
<td>Kayal lands</td>
<td>River Kodurar system which receives the municipal drainage and other wastes from Kottayam municipality. Washing of vehicles and motor boat operation causes spreading of oil and grease in this site.</td>
</tr>
<tr>
<td>TH1</td>
<td></td>
<td></td>
<td>Canal system, which receives the paddy field waste and sewage from nearby households. <em>N. hydrophylla</em> and <em>N. indica</em> are growing throughout the season.</td>
</tr>
<tr>
<td>P5</td>
<td></td>
<td>Kayal lands</td>
<td>Canal systems which receive the domestic waste and agricultural run off from the nearby paddy fields. <em>E. crassipes</em> is the dominant community especially during the premonsoon season.</td>
</tr>
<tr>
<td>P6</td>
<td></td>
<td></td>
<td>Canal system which receives the water from nearby crumb rubber and pickle factory. Stagnant and black colour with foul smell. The sewage from the household over the bund also goes to this canal system. Floating mats of <em>Alternanthera philoxeroides</em>, <em>Hymanachne acutugluma</em>, <em>I. travancorense</em>, <em>E. crassipes</em>, <em>Pistia stratiotes</em> etc. are commonly growing in this site.</td>
</tr>
<tr>
<td>ACC1</td>
<td></td>
<td>Lower Kuttanad</td>
<td>Starting point of the canal with thick floating vegetation mat of <em>E. crassipes</em> was noted throughout the year. The sewage channel from Changanassery municipality joins at this site. Water is black colour with dense suspended matter with foul smell.</td>
</tr>
<tr>
<td>ACC2</td>
<td></td>
<td></td>
<td>2 km away from ACC 1, slow flowing water with foul smell. The luxuriant growth of <em>E. crassipes</em>, which is overtopped with <em>I. travancorense</em>.</td>
</tr>
<tr>
<td>ACC3</td>
<td></td>
<td></td>
<td>2 km away from ACC 2 site and a canal joins at this site. Flowing water and the dominant community of <em>N. hydrophylla</em> is growing along the sides.</td>
</tr>
<tr>
<td>ACC5</td>
<td></td>
<td></td>
<td>A major side canal carrying discharge from the nearby rice fields and joins the AC-Canal. <em>C. caroliniana</em> is the dominant plant.</td>
</tr>
<tr>
<td>ACC6</td>
<td></td>
<td></td>
<td>Tail end of the canal. Flowing mats of Eichhornia is the major vegetation. Human activities like bathing and washing are profound here.</td>
</tr>
<tr>
<td>N1</td>
<td></td>
<td>North Kuttanad</td>
<td>Canal system, which receives the paddy field discharge. <em>N. nouchali</em>, <em>N. pubescence</em>, <em>L. heterophylla</em> and <em>E. crassipes</em> are the common macrophytes.</td>
</tr>
<tr>
<td>VA1</td>
<td></td>
<td>Vaikom kari</td>
<td>Canal system flowing in the middle of Vaikom kari region, which receives the runoff from the fields and plantain. <em>N. pubescence</em> and <em>N. nouchali</em> is the dominant community.</td>
</tr>
<tr>
<td>VA2</td>
<td></td>
<td></td>
<td>Small Canal in connection with VA1 site.</td>
</tr>
<tr>
<td>KR3</td>
<td></td>
<td>North Kuttanad</td>
<td>Canal system fully covered with <em>E. crassipes</em> during the premonsoon season and other periods, it was with <em>N. pubescence</em>.</td>
</tr>
<tr>
<td>ACHIN</td>
<td></td>
<td>Vaikom kari</td>
<td>Canal system connected to the Vembanad lake directly. The canal receives the runoff from the kari paddy fields and is almost stagnant during the pre-monsoon season.</td>
</tr>
</tbody>
</table>
### Chapter 2

#### Study area – Kuttanad wetland ecosystem

<table>
<thead>
<tr>
<th>Systems</th>
<th>Site code</th>
<th>Agro-ecological zones</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Canal systems</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>THRP</strong></td>
<td></td>
<td>Upper Kuttanad</td>
<td>Canal system, which receives the discharge from the nearby paddy fields. Washing and bathing are quiet common at this site.</td>
</tr>
<tr>
<td><strong>KARU</strong></td>
<td></td>
<td>Purakkad kari</td>
<td>Canal system, part of Kollam –Kottapuram National waterway. <em>Aponogeton appendiculatus</em>, <em>N. hydrophylla</em> are the major communities.</td>
</tr>
<tr>
<td><strong>S1</strong></td>
<td></td>
<td>Kayal lands</td>
<td>Canal system. <em>N. hydrophylla</em>, <em>E. crassipes</em>, <em>N. nouchali</em> and <em>N. pubescence</em> are the common macrophytes found in this site. These canals are receiving the pumping out water from the paddy fields, which are lying below the water level.</td>
</tr>
<tr>
<td><strong>S2</strong></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td><strong>S3</strong></td>
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<tr>
<td><strong>S4</strong></td>
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<td></td>
<td></td>
</tr>
<tr>
<td><strong>KV3</strong></td>
<td></td>
<td>Lower Kuttanad</td>
<td>Cultivated rice field. Aquatic macrophytes like <em>N. pubescence</em>, <em>Nymphaea nouchali</em>, <em>Limnophila heterophylla</em> are growing during the off season period.</td>
</tr>
<tr>
<td><strong>TH2</strong></td>
<td></td>
<td></td>
<td>Cultivated rice field channel. Acidic in nature and all the drains from the field joints in the channels. Luxuriant growth of <em>Hygrorhiza aristata</em> was noted during the monsoon season and off season period with <em>E. crassipes</em>, <em>Leersia hexandra</em>, <em>Sacciolepis interrupta</em> and <em>Nymphaea pubescence</em>.</td>
</tr>
<tr>
<td><strong>P2</strong></td>
<td></td>
<td>Kayal lands</td>
<td>Cultivated rice field interconnected with small channels. <em>Salvinia molesta</em>, <em>Eichhornia crassipes</em>, <em>Jussea repens</em> etc. are the common macrophytes in this site.</td>
</tr>
<tr>
<td><strong>KR4</strong></td>
<td></td>
<td>North Kuttanad</td>
<td>Cultivated rice field. Seasonal growth of <em>N. pubescence</em> and <em>N. nouchali</em> is noted.</td>
</tr>
<tr>
<td><strong>PILA</strong></td>
<td></td>
<td>Upper Kuttanad</td>
<td>Cultivated rice field. Aquatic plants like <em>E. crassipes</em>, <em>C. caroliniana</em>, <em>N. pubescence</em> etc are commonly growing</td>
</tr>
<tr>
<td><strong>PURA</strong></td>
<td></td>
<td>Purakkad kari</td>
<td>Cultivated rice field. <em>N. pubescence</em> is the dominant community. <em>Nelumbo nucifera</em> growing as interspersed community in this field.</td>
</tr>
<tr>
<td><strong>S2CF</strong></td>
<td></td>
<td>Kayal lands</td>
<td>Cultivated rice field. <em>N. pubescence</em>, <em>N. rubra</em> and <em>N. nouchali</em> are the common macrophytes. <em>Limnophilla heterophylla</em> is also noted.</td>
</tr>
<tr>
<td><strong>S4CF</strong></td>
<td></td>
<td></td>
<td>Cultivated rice field. <em>N. nouchali</em>, <em>L. heterophylla</em> and <em>N. pubescence</em> is the common macrophytes.</td>
</tr>
<tr>
<td><strong>Abandoned field systems</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>P1</strong></td>
<td></td>
<td>Kayal lands</td>
<td>Abandoned rice field. Dense floating mats of <em>Ischaemum travancorense</em> were noted. Water is turbid with foul smell.</td>
</tr>
<tr>
<td><strong>N2</strong></td>
<td></td>
<td>North Kuttanad</td>
<td>Abandoned rice field system mostly covered with <em>Eleocharis dulcis</em>. <em>N. nouchali</em> and <em>Salvinia molesta</em> are growing interspersely in this field</td>
</tr>
<tr>
<td><strong>KR2</strong></td>
<td></td>
<td></td>
<td>Abandoned rice field fully covered with <em>I. travancorense</em>, <em>N. pubescence</em> and <em>E. crassipes</em> going interspersaly. <em>Cyperus platystylis</em> and <em>Kyllinga squamulata</em> is growing over the decaying <em>S. molesta</em> mats.</td>
</tr>
</tbody>
</table>
Apart from the permanent sampling locations, 14 seasonal observation sites were also made. The distribution and percentage cover of macrophytes were recorded from these sites. Following are the seasonal observation sites;

a. Karunattuvala near Kurichy in Kottayam district
b. Muttathukadavu
c. Neelamperoor
d. Eara
e. Chakkachampacka near Kavalam
f. Kainadi near Kavalam
g. Changanasserry bypass
h. Vellakinar near Edathua
i. Puthukary and Mithrakary
j. Thanneermukkom
k. Ullala
l. Moothedathukavu
m. Kaippuzha near Mannanam
n. Poovathikari near Kallara
Chapter 2

Study area – Kuttanad wetland ecosystem

Figure 2.6
SAMPLING / OBSERVATION STATIONS
KUTTANAD WETLAND AREA

Legend
- Sampling / Observation stations
- Major places
- Coast line
- Roads
- NH 47
- Railway line
- Paddy fields / Garden land
- Major water courses
PLATE : 1

General views on different systems of Kuttanad

- Off season Cultivated Field
- Canal system – AC Canal
- Abandoned Field with Floating islands
- Cultivated Field
- Thickness of Floating Island – View from Kannady
- Typical canal system of Kari land
- River system – view from Kainakary