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Management Plan for the Eco-restoration of Pallikaranai Reserve Forest

Study team

PA Azeez, S Bhupathy, J Ranjini, R Dhanya, PP Nikhil Raj



Salim Ali Centre for Ornithology and Natural History

2007

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1. INTRODUCTION

1.1. BACKGROUND

Wetlands are among the most productive life supporting systems of the world with immense socio-economic, ecological and bio-aesthetic importance. From time immemorial, river valleys and wetlands have played a critical role in fostering culture and civilization. However, wetlands did not receive due consideration and appreciation. Consequently wetlands have diminished in size and quality at alarming rates throughout the developed and developing countries. Apparently, they are considered almost synonymous with wastelands, to be filled up, occupied and diverted for various human needs, disregarding the ecological services these ecosystems offer to humankind. Wetlands are lost / degraded due to anthropogenic activities such as agriculture, aquaculture and urbanization as infrastructure such as roads and bridges requires large space. Housing, business centers and other built up areas requires large extent of space, and therefore real estate activities around the urban centers, have grown to be a high-speed threat to the wetlands.

Compared to tropical rain forests and coral reefs, wetlands are remarkable in their biological productivity. With respect to species richness and species diversity, these ecosystems stand higher than most other ecosystems. Wetlands are diverse and unique in structure, characteristics and functions, probably much more than other ecosystems. Wetlands are dynamic and complex and are under the influence of an array of biotic and abiotic factors. Nevertheless, the single most important factor that determines the nature of a wetland is its hydrologic regime (Millennium Ecosystem Assessment, 2005). The hydrologic regime determines, modifies or changes the chemical and physical properties such as degree of substrate anoxia, pH, soil salinity and nutrient availability. Changes in the physico-chemical settings in turn have direct impact on biotic and abiotic systems of the wetland. Even for minor changes in the hydrologic regime of wetlands, biota may respond at times



markedly in terms of species composition, richness, trophic relations and ecosystem productivity.

Wetlands provide a variety of ecological goods and services. However, recognition of their importance and roles defied time until perhaps late sixties or early seventies of the last century. In recent years, innovative researches have shed light on the ecological and environmental intricacies of wetlands; their values are being recognized, and wetland protection is considered imperative in many parts of the world. The academia and managers have well acknowledged that wetlands perform a number of invaluable functions that offers several tangible and intangible services and commodities to humanity. To a lesser extent, but progressively more, the policy makers are also getting cognizant of the importance of wetlands for the sustenance of humankind.

Ecosystem services are functions that contribute to human welfare and help sustain the biosphere (Costanza *et al.* 1997). The value of a wetland is an estimate of the importance or worth of one or more of its functions to society. Ecosystem services offered by wetlands include floodwater storage and control, recharge of aquifers, treatment of waste water and pollution abatement, general water quality improvement, habitats for fish, wildlife and several other animals and plant species, and biological productivity. In addition, wetlands are of high aesthetic and heritage value and provide opportunities for recreation, research, and education. World over, wetlands are known to provide millions of days of commercial and recreational fishing and hunting, and invigorating pleasures of relishing nature's beauty. Wetlands also contribute to the stability of global levels of available nitrogen, atmospheric sulphur, carbon dioxide, and methane (Millennium Ecosystem Assessment, 2005). Although they are known methane emitters, they are also the most productive ecosystems helping in scavenging carbon dioxide. These beneficial services, considered valuable to societies worldwide, are the result of inherent and



unique natural characteristics of wetlands (Ecological Society of America, 2000). However, the processes by which environment produces resources, ecosystem goods and services, often are taken for granted.

Wetlands function like natural tubs or sponge, storing water and releasing it gradually. This process reduces flood heights, and facilitates ground water recharge, which contributes base flow to surface water systems during lean periods. The water storage capacity is noteworthy in reducing chances of flooding. Wetlands functioning as efficient filtration units have inspired environmental managers to construct similar artificial wetlands to treat wastewaters. Running water, while slowed down by a wetland, moving around the macrophytes, let the suspended sediment to settle (Millennium Ecosystem Assessment, 2005). The nutrients from various sources carried in the water are often absorbed by macrophytes and microbes.

The trade-off between environmental protection and development is most acute in dynamic and complex ecosystems such as wetlands (Arboretum leaflets, 2006). Wetlands worldwide face a range of anthropogenic threats. The chief indirect drivers of change are human population growth around wetlands coupled with growing economic and commercial activities. Major direct threats for inland wetlands are infrastructure development (dams, dykes, road, residential and commercial buildings), land reclamation and over-harvesting. Major indirect ones are aquaculture, agriculture, reduced water flow, depletion of ground and surface water supplies, introduction of invasive alien species, and organic and inorganic pollutants. Increased human use of freshwater has considerably reduced availability of water to maintain the ecological character/ balance of several inland wetlands.

In India, momentous losses of wetlands have resulted from conversion to industrial, agricultural and various other developments. These have caused hydrological perturbations and its various reverberations, pollution and several after effects.



Unsustainable levels of grazing and fishing activities have also resulted in degradation of wetlands. Only a few ecologically sensitive regions are protected by various acts such as forest conservation and wild life protection acts, while rest of such areas especially wetlands have continued easy targets to anthropogenic pressures and damages. A survey of 140 major sites across various agro-climatic zones of the country identified anthropogenic interferences as the main cause of wetland degradation (Anonymous 1993).

The state of Tamil Nadu is blessed with a number of water bodies and wetlands. Several of these are facing serious threats or are increasingly disappearing due to multifarious pressures. This is especially true for those wetlands located close to growing urban centers or bustling metropolises. Pallikaranai wetland located in the outskirts of Chennai is one such wetland that is very likely to disappear in near future, if active appropriate interventions are not made now.

Realizing environmental and ecological significance of the area, state of concern in the context of the expanding metropolis, and recognizing the need to protect, the Tamil Nadu state government (Gazette notification GO. Ms. No. 52, dated 09/04/2007), declared a part of the Pallikaranai marsh (317.00 ha) as reserve forest (under section 4 of Tamil Nadu Forest Act, 1882). Systematic and serious actions are underway to conserve and rejuvenate this wetland ecosystem in a systematic manner.

The present document reports a rapid investigation undertaken to develop an Environment Management Plan (EMP) Pallikaranai with the aim to protect and restoration of the same.

1.2. THE SCOPE, AIMS AND OBJECTIVES

A rapid investigation was undertaken with the scope to examine the present state of Pallikaranai wetland to develop an Ecological Management Plan (EMP) for the



portion declared as protected by the government of Tamil Nadu to conserve it. The primary aim of the present EMP is to restore the wetland to provide habitats for various species inhabiting or visiting the area and also to develop it as a demonstration / education site to inculcate the values and importance of ecological conservation in target groups such as students and public at large.

The major objectives were as follows:

- Document the baseline characteristics of the Pallikaranai marshes.
- Examine various threats.
- Brief about various action taken for conservation and,
- Develop an Ecological Management Plan for this wetland.

It is felt that it is proper to present a brief on the physical and biological characteristics of the wetland prior to presenting the EMP. Therefore, the presentation of this report is planned accordingly.



2. PALLIKARANAI MARSHES: CHARACTERISTICS

2.1. LOCATION

The Pallikaranai (12°59'N and 80°14'E) is one among the few remaining wetlands located near the Chennai metropolis (Figure 1 and Figure 2). It falls under Perungudi and Pallikaranai villages in the Kancheepuram district of Tamil Nadu, which is about 20km south from the Chennai metropolitan city. The wetland runs along the old Mahabalipuram road parallel to the Buckingham Canal throughout its length. The marsh is situated adjacent to Velachery also known as Vedashreni, a rapidly developing residential area in the south west Chennai. While Velachery is located towards northwest of this marsh, Taramani is towards north, Perungudi to northeast, Madipakkam to the west, Perumbakkam to the southwest and Sholinganallur towards the southeast. The wetland at Pallikaranai is an extensive low lying area, covered by mosaic of aquatic grass species, scrub, marsh, and water-filled depressions. The wetland adjoins the south Chennai aquifer that runs parallel to the old Mahabalipuram Road. The aquifer originating from the south of Thruvanmiyur extends upto the Kovalam Creek on the South (Patnaik, 2002). The general terrain of the area is plain with an average altitude of about 5 m above mean sea level. The substrate in the entire region is made up of the weathered Charnokite rock bed (Patnaik, 2002), covered with a layer of alluvial soil of varying thickness.

2.2. RAINFALL AND TEMPERATURE

The area receives major rainfall during northeast monsoon (September - November) and partially from southwest monsoon (June – August). Temperature varies seasonally, in summer ranging from 35° to 42° C and in winter the maximum ranging from 25° to 34° C (Patnaik, 2002).



2.3. EXTENT - CURRENT STATUS

Few years back the wetland area was vaster, with plenty of natural macrophytes, lesser weed infestation, and large number of birds; apparently once a natural haven for several fold of resident and migratory birds that are seen here currently. Currently due to legalized and illicit encroachments, fast developing real estate ventures, and various other developments the haven for birds is vanishing fast. As more and more information technology parks emerge along the old Mahabalipuram road, large workforce requires accommodation and other basic amenities. Hence, the area around Velachery is booming with real estate projects and pressures are exerted towards the Pallikaranai marshes. This part of the city considered by public as backward and not favoured few years back, has changed rapidly after the construction of the K T Link Road (under highway department) and opening of a string of stylish residential projects. The proximity to airport and development of several roads that cut down the commuting time to the heart of the city have made this area a reaping ground for real estate business.

Major concerns arising from these developments are water scarcity, congestion of roads with incredible traffic, huge quantity of solid wastes, effluents, emissions and, not the least damage to the marshland. It is feared that in the coming years unless some concrete plans are executed, the marshlands would all be converted into residential and commercial holdings. Thus, the metropolis will lose a wonderful locale of multifaceted ecological functions, such as recharge of ground water, clean air, flood buffer, habitat for several endangered or declining species, lung and kidney of the city, and a place comforting the eyes and ears of urban masses and precious revitalizing retreat from their demanding chores.

2.4. CATCHMENT

The Pallikaranai wetland has a catchment area of 235 km² that includes Velachery, Pallikaranai and Navalur. It drains through Okkium Maduvu (Figure 3) in



Thoraipakkam to the Buckingham Canal, which on the other hand discharges into the Kovalam estuary. A few decades back the marsh extended about 4000 – 5000ha (The Hindu, 2006; Care Earth, 2002; Joint Committee Report, 2003). The neglectful and ill conceived hasty construction activities of the past decades, associated with rapid urbanization has largely destroyed Pallikaranai marsh shrinking it to a small fraction of the original size.

2.5. WATER

The wetland gets plenty of water input during monsoon each year. Drainage channels from Velachery, Madipakkam and Kilkattalai are the main water inlets. Water from the Velachery Lake enters through channels located beneath the bridge near MRTS on the Velachery – Tambaram road. Water from Ullagram, Puzhuvivakkam, Krishna nagar, Balaji nagar enters through the culvert across Velachery - Tambaram road immediate to the south of the Velachery Bridge. The storm water flows from areas of Tirusulam, Old Pallavaram and Madipakkam enters the marsh through another canal located further south before the Kilkattalai - Thoraipakkam Road. Waters from Kilkattalai, Narayanapuram and vicinity flows into the marshes through a channel adjacent to the National Institute of Ocean Technology (NIOT).

However, all channels that collect water discharge into the unprotected area, which currently is practically isolated from the protected area by the K T Link road that bisects the Pallikaranai marsh. Okkium Maduvu, the channel that empties into the sea through the Buckingham canal lies in the protected part. This situation results in high flood water level during monsoon in the unprotected region of the marsh and adjacent areas, and also results in accumulation of nutrients and toxic wastes there. The deficient water flow to the protected part may speed up the ecological succession and may lead to drying up of the marsh.



The water in the marsh showed high Total Dissolved Solids (TDS). One of the prominent features of water quality of Pallikaranai wetlands is high coliform count. The high TDS level is probably because of effluents and presence of coliforms due to contamination from human excreta. Low level presence of heavy metals such as cadmium, chromium and mercury in the wetland water is also reported (Care Earth 2002).

2.6. ECOLOGICAL IMPORTANCE

- In recent years, several studies with more or less related objectives were conducted in Pallikaranai marshes. Among them, studies conducted by Care Earth (2002, 2003, and 2005) and the occasional documentations by individuals (For example Subramanian, 2000, unpublished) are notable. SACON in its latest report attempted summarizing the findings of previous works highlighting the need for conservation of the marshes (Azeez *et al.* 2007). The salient findings of various studies on the Pallikaranai wetland can be summarized as below.
- The reed-covered swamps and several associated smaller waterlogged areas located in the south Chennai help in storing storm water and aiding groundwater recharge. It is reported that more than 500 truck loads of drinking water, obviously an outcome of the recharge of ground water effectuated by the wetland, is collected daily by private operators from the vicinity. This harvest of water was banned by the Honorable High Court of Chennai in 2002. However, the practice is reportedly being still continued.
- Critical to existence of this wetland is exchange of fresh and saline water facilitated through various channels of the south Chennai and Okkium Maduvu in Thoraipakkam. Several small wetlands, many of which are under the threat of filling, are sustained by fluvial interactions with the Pallikaranai marshes.



- The profusely growing *Typha* and other aquatic macrophytes are reported to serve as bio-filter for pollutants / toxic waste discharged into the wetland (Joint committee report, 2003).
- The Pallikaranai marsh is a source of income to many locals. According to Subramanian (2000, unpublished) inhabitants of seven villages, namely Pallikaranai, Taramani, Velachery, Perungudi, Perumbakkam, Thorapakkam and Sholingannalur, partially depend on the wetland for subsistence (Subramanian, 2002, unpublished). Of these, some ethnic groups are highly reliant on the wetland; Meenavar are fully while *Adidraavidar* are partially dependent on the wetland. Their direct economic activities include gathering reed, fishing, grazing and agriculture.

2.6.1 Biodiversity

2.6.1.1 *Flora*

Pallikaranai marsh is identified as one of the major wetlands of India, and is prioritized for conservation (Joint committee report, 2003; Vijayan *et al.*, 2003). The wetland is rich with several plant species (61 species of flowering plants, Appendix 1). Of the 15 grass species recorded from the wetland at least two, namely *Cynodon barberi* and *Iseilemea enthephroides*, are endemic to Peninsular India (Care Earth, 2005). A wild variety of rice (*Oryza* sp.) is also reported from this area (Care Earth, 2002). Some exotic floating vegetation such as water hyacinth and water lettuce are also found, which are now extensive forming thick mats and highly spread.

2.6.1.2 *Fauna*

The wetland is rich in faunal species (Appendix 2). It is home for 10 species of mammals (Appendix 3), 112 species of birds (Appendix 4), 21 species of reptiles (Appendix 5), 9 species of amphibians (Appendix 6), 46 species of fish (Appendix 7), 7 species of butterflies (Appendix 8), 5 species of Crustaceans (Appendix 9) and 9 species of Mollusks (Appendix 10, Care Earth, 2002). The swamp also serves as



heronry, and wintering ground for migratory birds. Nearly 200 Spot-billed pelicans (categorized as ‘vulnerable’ by the BirdLife International, 2001) used this marshland during 2007 (The Hindu, 2007). The Shannon diversity index for birds (Care Earth, 2002) of the area was 3.27, which indicates the richness of the area. In a short field survey conducted by SACON during the first week of March, about 700 Little Grebes, 150 Black-winged stilts and 150 Asian-pied starlings were recorded. Recent finding of White-spotted garden skink from land area of this marsh is a new record for Tamil Nadu (Care Earth, 2002). Fishes such as dwarf gourami and chromides, which are widely bred and traded worldwide for aquaria, naturally occur in Pallikaranai wetland. Besides, the Windowpane oyster, Mud crab, Mullet, Half beak and Green chromide are some of the estuarine organisms present at the marsh (Care Earth, 2002).



3. THREATS AND RELATED KEY ISSUES

The Pallikaranai wetlands, as common for most wetlands that are situated neighboring growing cities, face serious threats from several sources. The wetland would most likely disappear soon if immediate and concerted efforts are not taken by government and non-government agencies and general public to save the fragile ecosystem. It is well-timed that the government of Tamil Nadu has declared 317.00 ha of the wetland as reserve forest. Intensive ecological management programme for comprehensive eco-restoration of the wetland is also envisaged. However, it may be noted that the declared part forms only a portion of the whole system of Pallikaranai marsh. It is apt that steps should be taken to bring the adjoining part of the wetland area under protection.

3.1. HUMAN POPULATION GROWTH

Being the third largest commercial and industrial centre of India, Chennai and its suburbs experience rapid industrial development, commercial activities, higher employment opportunities and consequent activities. The city extends to 174 km², while the Chennai metropolitan area that includes suburbs covers 1,177 km². In 1960, the population of Chennai was 15 lakhs, which since then tripled to 45-50 lakhs (www.nilacharal.com). In 2001 the population of Chennai city was 4.344 million, while estimated population for June 2007 was 5.375 million (Chennai metropolitan water supply and sewerage Board, 2007). The population density in the city including suburbs is 24,418 per km² while population density of the metropolitan area is 5,847 per km².

Similar to all metropolitan cities in the country, growth in population due to immigration is high in Chennai. During 2001 census, immigrants from different parts of Tamil Nadu, India and world was respectively 74.5%, 23.8% and 1.71% (www.ctn.org.in/cms/). Growing cities also support a growing slum population. In the case of Chennai, the slum population is 1079414 (The Hindu 28 august 2001).



A request for land in Pallikaranai wetland was made by the slum board probably for accommodating rehabilitated inhabitants of the slums. According to the population projection by the Chennai Transport Network (CTN), in the year 2026 Chennai Metropolitan Area will hold a population of 12.6 million. The population growth trend is higher in special panchayaths and municipal areas than interior of the city. Many places that earlier fell in suburban outskirts after having got integrated into the city are centers of high population growth facing consequential changes in environment, built up areas and land use. Velachery and Pallikaranai premises are among such locations that undergo such changes, facing severe pressures on land resources.

As per 2001 census (GR India), Pallikaranai town panchayath had population of 22,503. Of this, 52% are males and the rest females. Several IT, ITES and BPO's are aiming to open their new offices at Pallikaranai, owing to which the rate of growth of real estate business is almost 30%. The Rs. 38.5 crore road-over-bridge (ROB) project in Tambaram (The Hindu, 2006) and Rs. 13.2 crore grade separators at Pallikaranai will obviously boost real estate business in the panchayath. A Special Economic Zone (SEZ) is also going to be established along the Pallavaram - Thoraipakkam ring road. Private builders will find it lucrative to promote posh residences around the proposed SEZ in Pallikaranai.

3.2. REDUCTION IN WETLAND AREA

Until recent past, the Pallikaranai marsh was reportedly spread over 4000 to 5000 ha (The Hindu, 2006). Study conducted by Care Earth in 2002, supported by the Tamil Nadu Pollution Control Board (TNPCB) found that the area have been reduced to about 600 ha. Another study by the same agency conducted during 2005 reported further reduction (to 420 ha) of the wetland. About 30% reduction of the wetland area within a span of 3 years is very alarming.



Several requests made by various organizations to divert and allot lands from the wetland area for real estate, industrial and other purposes are reported in the Joint Committee Report (2003). Patnaik (2002) has also listed the agencies that had requested land for allotment (Appendix 11). Observations made during SACON's ecological surveys (during June 2007) indicate that more areas are likely to be surreptitiously lost, either functionally or structurally, in coming years or even within the scale of months.

Taking cue from earlier studies it appears that within five to six years, the marsh will vanish giving way to new constructions and built up areas. The settlements that carve their way into the wetlands are placed along major roads and around water bodies. Rehabilitation of socially marginalized groups such as slum dwellers of the city perhaps in initially low valued areas such as reclaimed wetlands added on to the fast decline in the extent of the wetland (Care Earth 2002, 2003, 2005, Subramanian, 2000 Unpublished; Patnaik, 2002). Lack of initiative and corrective actions by the concerned authorities to curtail the trend increased ecological / environmental damages by many folds.

3.3. ENCROACHMENTS

The wetland is gradually swallowed up by rapidly flourishing real estate business. Several organizations and housing developments have already occupied considerable portions of the wetland area. This low lying land near Chennai city offers a harvest for real estate business with the upcoming IT business, hospitals and proximity to airport. Other encroachments by small hutments and residential colonies are also common. The development activities are filling up the marsh at an alarming rate. Hence, boundary of the protected area has to be marked, and satellite wetlands and restorable parts are to be identified and protected at the earliest. Dredging undertaken by the Thangavelu Engineering College, located in the southern part of the protected area, has completely interfered with the movement of tidal waters into the marsh (Care Earth, 2005).



3.4. DUMPING SOLID WASTE

Modern society generates large quantity of solid wastes. The problem of disposal of large quantity of waste is serious especially in the context of a metropolis like Chennai. It is a common practice in the country to deem marshes or wetlands as 'wasteland', and use such areas to dump untreated raw sewage and solid wastes. Ignorant about the ecological values and negligent about the need for protecting common properties such as wetlands, it is easy for public to consider them as wasteland and use for easy garbage dump and sewage release. This practice serves two purposes in the public eye; filling up a seemingly useless low lying area and saving expenditure on solid waste management. Perhaps there are guarded schemes that promote filling up of wetland from the view of acquiring the refilled land for real estate development.

The practice of dumping solid wastes in wetlands also leads to fall in ecological / conservation value of the area, facilitating decision for diversion. The garbage dumping site, situated adjacent to the protected part of the Pallikaranai marsh has effectively choked over 250 acres of prime marshland (The Hindu, 2006). It has fragmented the marsh and obstructed the drainage and flood control potentials of the wetland.

Such unscientific and uninformed diversion, either advertently or otherwise, of ecosystems or lands rebuffs the several critical ecological services a wetland performs. The Pallikaranai wetland holds an estimated five million cubic meters of water at any given time (The Hindu, 2006), with high potential for ground water recharge, and offer valuable habitats for wide array of biodiversity such as birds, amphibians, mussels, worms and several other life forms. Less is known about several other ecological services that a wetland provides to an area or human kind. Destroying wetlands such as Pallikaranai that can absorb and hold huge quantities



of water foresee a potential hazard of flood and inundations in and around even with medium down pour of rain.

Apart from filling up of the area, dumping municipal waste can have serious effect on water bodies by releasing noxious chemicals during decomposition. The heavy organic contents in municipal wastes degrade slowly and release acidic and toxic leachates for many years, a persistent problem for several coming years. In developed countries, sanitary landfills (where municipal wastes are dumped) have special liners to prevent leachates from reaching groundwater.

Every single day, the Chennai city generates 3,500 tonnes of garbage. In March 2000, C.E.S. *Onyx*, a Chennai-based company (a subsidiary of *Veolia*, formerly *Vivendi*), obtained a seven year service contract from the Chennai Municipal Corporation to collect, transport and dispose off household and commercial wastes from three key areas of the city (Sawhney, 2006). It is reported that this company dumped at least 1000 tons of garbage everyday in and around the Pallikaranai wetland (Jayaraman, 2002). In 2002, however, *Onyx* was served with a notice by the TNPCB for dumping wastes indiscriminately in this wetland without designating any area either as landfill site or with liner underneath, which may directly pollute the freshwater resources. The TNPCB took exception to the fact that *Onyx* had failed to demarcate the area allotted for dumping, and that primitive mode of dumping have threatened the wetlands (Sawhney, 2006). *Onyx*, however, maintained that the dumping area in the wetland was used as per the contract with the Municipal Corporation. Although it is stated that the Municipal Corporation (and *Onyx*) is allowed to use 30 ha to dump garbage, the *Onyx* uses about 180 ha for the purpose. About 40 MLD (Million Liters per day) of domestic sewage is also released in to the wetland everyday (Dams, Rivers and People, 2004).



3.5. SOIL EROSION AND SILTATION

The booming real estate business lead to massive land modification and uprooting of native vegetation that causes large scale soil erosion. A considerable portion of the marsh is becoming drier due to settled soil and silt and this is one of the main threats to its existence. Rapid urbanization involves land clearing, leveling and construction activities in the catchment area. Thus, the disturbed and loosened surface soil is easily washed off in rain and is carried away in the run off. The silt and sediments reaching the wetland make the water turbid and settles in low lying areas subsequently reducing the depth and extent of marsh that chokes macrophytes, reduce productivity, water and sediment quality and subsequently the habitat quality. High siltation is a significant step in the life of a vanishing wetland.

3.6. INCREASE IN POLLUTANT LEVELS

As noted above, open dumping of waste in a wetland can be a significant source of surface water contamination within short period and subsequently groundwater pollution due to leaching. Once contaminated, it is virtually impossible to clean groundwater. As mentioned above, where *Onyx* dumps garbage, there is neither appropriately prepared landfill site, nor impermeable linings, but only the low-lying land (Corp Watch India, 2002). This aggravates the situation making the condition most hazardous to life, including humans.

Incessant burning of garbage is a sight round the clock nearby the marshes. Including three carcinogens, 27 chemicals were reported in the air samples analyzed for 69 volatile organic chemicals and 20 sulphur compounds (CEM, 2006) in the area. Carcinogens such as 1,3-Butadiene, Benzene and Chloromethane were present at levels of 34782, 2360 and 209 times higher respectively than the levels considered safe by the US Environmental Protection Agency (US EPA). At least 15 (56%) out of 27 chemicals recorded exceeded US EPA's regulatory levels. It was reported that sources of these pollutants are open burning of garbage containing



plastics and other such items. Other common pollutants like respirable suspended particulates, SO_x, and NO_x are emitted in intolerable levels in almost all places where solid wastes smolder round the day.

Studies in all residential areas skirting the marsh revealed that water at all depths is unfit for human consumption. It was also reported that water in and around the garbage dump had low levels of heavy metals such as Mercury, Cadmium and Lead (Care Earth, 2002; Patnaik, 2002; CEM, 2006).

3.7. ROADS

The Pallikaranai marsh is divided into two distinct portions by the K T Link road, which is becoming a dense traffic corridor. The road practically cuts off the continuity of the wetland system. Some of the likely consequences of the road across the wetland are listed below.

- Hinder water movement between two portions of the marsh
- Larger rate of settling of sediment in the upstream portion
- Accumulation of nutrients in the upstream segment
- Reduced input of nutrients in the downstream portion
- Restriction on movement of aquatic species across the two parts
- Reduction in the flush-out rate of both portions
- Accumulation of pollutants
- Higher chance of illicit waste dumping along the road side
- Increased chance of unlawful release of effluents engaging tankers
- Colonization of the wetland by weedy species such as water hyacinth and other floating species
- Increased growth of rooted species leading to fall in water spread area
- Increase in insect vector species and their abundance
- Reduction in the movement of water birds, reptiles and amphibians across the segments of the wetlands



- Higher mortality (road kills) of smaller species such as reptiles and amphibians during their diurnal / seasonal movements
- Noise and air pollution due to heavy traffic affects the bird fauna
- Accumulation of pathogenic organisms

The construction of several culverts can considerably reduce negative environmental implications of the road cutting across the wetland

3.7.1 Loss of biodiversity

Reduction in the wetland area and in the water and soil quality due to garbage dumping and increased level of pollutants will lead to visible loss of biodiversity, especially the aquatic flora and fauna. Avifauna that includes both resident and migratory birds will be visibly affected particularly by human, vehicular and machinery disturbances. A study conducted in 2000 reported 836 Black-winged stilts and 834 Cattle egrets (Subramanian, 2000, unpublished), whereas the study by Care Earth during 2002 reported only 202 and 500 of these species respectively. It is possible that the change in species number could be either due to habitat loss or due to reduction in its quality or even annual / cyclic fluctuations in the populations of these species. However, this needs to be investigated. It is reported that many bird species reportedly common earlier are declining fast in the area.

3.7.2 Human wastes

As mentioned earlier water in the wetlands is aplenty with faecal *Escherichia coli*. This is due to unhygienic use of catchment and exposed flood plain of the marsh for defecation, probably by the deprived class of people and also solid wastes dumped. The presence of large levels of *E. coli* indicates the likelihood of other pathogenic species entering the water body. Control of this contamination is important from the public health point of view and could be achieved through a proper catchment area protection plan and providing appropriate amenities for the residents and peripheral communities.



4. CONSERVATION MEASURES TAKEN

As discussed earlier the Pallikaranai wetland is rich in biodiversity, and also serves several other important ecological services. The wetlands also face serious anthropogenic pressure that threatens its very existence. If the Pallikaranai area is left unattended, this precious ecosystem may disappear within few years; therefore, urgent steps are to be taken to conserve this ecologically important area. Recognizing the ecological and environmental significance of the area, several concerned individuals and organizations raised their voice demanding conservation. Recently, the government of Tamil Nadu declared downstream portion of the wetland as a protected area; a very momentous step in the conservation of Pallikaranai wetlands.

4.1.1 Actions by government agencies

4.1.1.1 Department of environment / Government of Tamil Nadu

A number of actions were taken or under progress by the Government of Tamil Nadu to protect, study, conserve and manage the Pallikaranai marshes.

- The Chief Minister of Tamil Nadu suggested that the marsh could be developed into an ‘eco-park’ with facilities including interpretation centre (Care Earth, 2003).
- The Environment Minister of Tamil Nadu evinced keen interest to clean the Pallikaranai wetland, smothered by garbage and sewage from Chennai (Anonymous, 2004).
- The Pallikaranai swamp is one among the potential sites selected for flood protection works and the same was noted in the budget document 2006-2007 by the state government (Public Works Department Policy Note 2006 – 2007).



- Action is underway to prepare Detailed Project Report (DPR) to be submitted to the Government of India for allocation of funds for comprehensive eco-restoration of selected lakes in and around the Chennai city including the Pallikaranai marsh (Environment and Forests Department, Policy Note 2006-2007, Demand No.15).
- The Kancheepuram district administration has already issued orders canceling allocation of lands in the marsh area. Hence, the Chennai Corporation had to restrict dumping of garbage to 200 acres of land. In order to control the dumping it is proposed to demarcate the 200 acre area for dumping wastes (The Hindu September 1, 2006).
- Based on several studies and reports prompting the need of conserving the Pallikaranai marshes, a part of the marsh land (317.00 ha) is declared as a reserve forest by the government of Tamil Nadu. Further actions to protect and ecologically restore the area are in progress.

4.1.1.2 Pollution control board

The Government of Tamil Nadu, through the Tamil Nadu Pollution Control Board (TNPCB) has constituted a Local Area Environment Committee under the Environment Protection Act, 1986 to suggest means by which the problem could be solved. The TNPCB has also commissioned studies on the wetlands. Of these, the notable ones are that conducted by the Care Earth and TNPCB in 2002, 2003 and 2005. Such studies have generated valuable information, highlighting the need for conservation of the area and offered valuable suggestions (Appendix 12).

The TNPCB has banned dumping of waste and discharging sewage or industrial effluents into the Pallikaranai marshes. In an official release on June 9, 2006, the TNPCB, while underscoring the need to protect the Pallikaranai marsh for its rare species, groundwater recharge potential and ecological importance, warned that any violation of its directions would be penalized without prior notice under Section 15 (1) of the Environment (Protection) Act, 1986. The TNPCB directive also states



that untreated sewage be discharged only into the Sewage Treatment Plant (STP) operated by the Metro water at Perungudi (The Hindu, 2006). The TNPCB has also issued directions to the Commissioner, Corporation of Chennai to stop dumping of garbage at the Pallikaranai dump yard.

4.1.1.3 Expert committee of MoEF

An expert team from the Union Ministry of Environment and Forests (MoEF, the Government of India) visited the Pallikaranai marshes during October 2003 and inspected damage to the ecosystem. The team included renowned ecologists, officials and experienced researchers. The committee has submitted its recommendations for conserving this marsh (Appendix 15). It was suggested that immediate action should be taken to bring Pallikaranai marshes under the National Wetland Conservation Programme.

4.1.2 Non governmental organizations and other agencies

- A multi-disciplinary pilot study of the flood potential of the Pallikaranai marshes was undertaken by Freiberg University of Germany in January 2007. The major objective of the study was to examine flood risk in the waterways of Chennai and, in and around the Pallikaranai.
- Care Earth, a Chennai based organization, have made significant contribution towards conservation studies of this marsh.
- The Community Environment and Management, an NGO has studied the pollution affecting physical quality parameters of the marsh. Several educational institutions have also conducted short term studies on this wetland. Studies by Patnaik (2002) and Subramanian (2000) are significant and valuable. Observations of several amateur nature watchers have also contributed to the knowledge base immensely.



4.1.2.1 Public participation and awareness campaigns

Conservation of the areas under serious threat would attain better success with public participation. Several research organizations, individuals, non-governmental organizations, volunteer institutions such as Care Earth (Chennai), Centre for Environmental Education (Ahmedabad, Tamil Nadu centre), Anna University (Chennai), Worldwide Fund for Nature (India), CPR Foundation (Chennai), Save Pallikaranai Marshland Forum (Chennai), and Community Environmental Monitoring are involved in research, nature awareness and conservation campaigns in the region.

Quite a lot of Chennai populace are also interested and involved in conservation of the Pallikaranai marsh. Several individuals have undertaken studies of the marsh on their own concern and involved in studies and awareness campaigns. The residents affiliated to about ten welfare organizations, formed a human chain, under the banner of Save Pallikaranai Marshland Forum (SPMF), holding placards to draw attention of the concerned. More than 3000 volunteers participated in a bicycle rally during September 2003, in Chennai, organized to demand protection of the Pallikaranai wetlands.



5. ENVIRONMENT MANAGEMENT PLAN

In view of the threats to its sustenance, the Pallikaranai wetland needs active conservation measures to be implemented. This may include activities such as protection, prevention of encroachment, control of polluting activities, and ecosystem restoration. As noted earlier only one part of the wetland is declared as protected by the Government of Tamilnadu. The area is bounded by the KT Link road (North), the Old Mahabalipuram Road (East), the Velachery road (West) and the road behind the Thankavelu Engineering College (South). The protected part (the reserve forest) is located opposite to the unprotected part of the marsh, where the waste dumping yard is situated, on its south.

The proposed EMP deals with the protected part of the Pallikaranai marsh.

5.1. PROTECTION

The place should be protected from any further disturbance during the years to come. This may require fencing, preferably making a compound wall, all around the 317.00 ha that is declared as reserve forest. It may be noted that but for the compound wall, the world famous Keoladeo National Park, Bharatpur would not have remained intact till date with respect to its extent and rich biodiversity. A patrolling path around the boundary is also inevitable. From a long term perspective, it will be appropriate to mark the boundary of the close by satellite wetlands and the remaining part of the wetland for protection.

The Tamil Nadu Forest Department has deployed their field staff to the area. However, there is a need for infrastructural facilities and additional staff. They may also co-ordinate monitoring, identification of the problems, and execute necessary mitigatory and management actions. The staff may include officials and guards. Construction of office rooms and check posts with transportation and communication facilities such as jeeps, motorbikes, bicycles, and pedal boats /



coracles, telephone and wireless facilities is inevitable for protection and management of the wetland.

To stop using other part of the wetland as a solid waste dump yard and disposal site for sewage immediate measures have to be implemented on a war footing basis, aimed to check any such illegal activities. Any practice of waste dumping should be strictly prevented and handled firmly both in the protected and the unprotected parts. Such locations should be cleaned, preferably at the expense of the polluter, and guarded strictly. Building check posts is an appropriate measure to curtail illegal waste dumping. It may be noted that no such areas where large scale dumping is done is currently under the protected area.

Awareness campaigns are also very essential highlighting the need for protection / conservation of the wetland, and identifying various target groups including those at upstream as well as downstream locations. Open burning of the garbage should be banned and checked as a routine. Burning garbage is done by certain elements of the society to facilitate collection of metal objects or is done inadvertently by public or by the personnel responsible for handling wastes. Incineration units could be established on an urgent basis, at a site identified located away from the marsh.

Other than Okkium Maduvu, there are no channels from the protected part of the wetland. Channels are essential to maintain the health of the wetland, prevent drying up and retain the hydrological balance. Such connections in the water body are also essential to ensure species movements. Culverts, bridges, sluice gates are essential along the highways and roads passing nearby or through the wetland, and also the trails and pathways in the wetland. Culverts and sluices connect the protected area with remaining part of the wetland and other water bodies. Channels that connect the neighboring satellite wetlands can also be made or restored. This requires detailed mapping of the original channel routes. GIS and satellite imageries will be useful in this context. The restored channels have to be



maintained properly to avoid any blockage and cause undue flooding of catchments during monsoon. Unauthorized activities such as dredging and filling need to be prevented. The dredging undertaken by the Thangavelu Engineering College, located in the southern part of the protected area, completely interfere the movement of tidal waters into the marsh (Care Earth, 2005).

5.2. ECOSYSTEM RESTORATION

The first activity towards the restoration is to solve the issue of encroachments. Encroachment can be prevented by taking adequate measures including demarcation of the outer boundary of the wetland, controlling unauthorized human entry and unauthorized fishing inside the wetland area. Cleaning up the channels connecting the wetland with its tributaries and distributaries also can be done to remove the impediments in water flow. Connection of both parts of the wetland by opening more channels / passages underneath the KT link road needs to be made.

Removal of overgrown aquatic weeds, especially *Eichhornia crassipes*, from the wetland helps sustaining the vegetation structure, water quality including salinity, habitat quality and diversity etc., of the system. Plants species such as *Typha* should be retained in patches, as they are integral part of the natural ecosystem. The municipal and domestic sewage entering the marsh promotes growth of weeds such as *Eichhornia*. One of the immediate steps should be controlling the release of such effluents.

Wetland already filled and converted to terrestrial land should be afforested by appropriate local species of plants. Green belts / tree planting are suggested along the trails / path made along the boundary. The species should be selected based on their dust and sound absorbing capacity and water tolerance. Bird attracting species need to be given preference for plantation. It is also proper to plant butterfly attracting species of plants especially herbs. Appropriate mangrove associates also may be included for planting in suitable locations. Tree species will serve as



roosting and nesting sites for birds, including migratory species. Pollution due to dust and sound can be minimized to an extent. Sanitation / public conveniences / health facilities and maintenance can be provided for the local folks making sure that human waste do not enter the system untreated. SHG's can be encouraged to take care of such system and also to associate in other waste management activities. Similarly, public places should be provided with sufficient waste bins and public should be made aware of that.

Institutions and other organizations that are located in the marsh can be encouraged to grow plant species specified by the Pallikaranai marsh protection authorities and could be encouraged to maintain a marsh land within their campus (as in the case of National Institute of Ocean Technology - NIOT), so as to promote bird diversity and to offer roosting and nesting sites for birds. They shall also be advised not to empty their sewage drains and wastes into the marsh.

Identification of satellite wetlands and their protection provide abode to resident and migratory species. The conservation of satellite wetlands also add on to ecological quality of the protected area. It will also reduce the stress of flood and further improve ground water recharge and quality.

A wetland with a gradient of depth or heterogeneous depth profile will increase habitat diversity and there by attract more species. Excavation of certain areas in the wetland is likely to be necessary to maintain depths suitable for various species groups, and also to maintain a proper hydro-period in the marsh.

5.2.1 Transfer of Land

Encroached areas by private individuals or organizations and those under the custody of the Chennai Municipal Corporation may be transferred to the Department of Forests, the Government of Tamil Nadu or any appropriate body for management. Declaring entire area of the wetland (about 700 ha) as a closed area /



ecologically sensitive area / sanctuary considering it as a single unit will help executing future conservation programmes more effectively. A proposal may be submitted for inclusion of this wetland under the National Wetland Conservation Program and also consider taking action to declare this wetland as Ramsar site.

5.3. ACTION PLAN

5.3.1 Threat identification and minimization

5.3.1.1 Land

- A survey has to be done to mark the extent of the wetlands available at present. GPS readings may be taken during the surveys. Identification of encroachments will also be an outcome of the surveys.
- Boundary wall has to be constructed in order to permanently mark the wetland, prevent further encroachment, and help conservation activities. Further to the construction of boundary consistent maintenance need to be ensured to achieve its purpose. The boundary wall needs to be designed so as not to disturb the natural flow of water. Culverts/channels can be made wherever necessary on the wall itself; the existing ones can be renewed and new ones can be made.
- Identification of encroachment is necessary to take immediate action to reclaim the lost lands and prevent or curb further intrusions. Several organization and other settlements has already encroached / occupied the wetlands. In addition, several agencies and industries insidiously and illegally are in the process of filling certain parts of the wetland by dumping solid waste or debris; any such actions have to be curtailed. The eastern part of the marsh is infringed by the local inhabitants as hutments and low income houses. Moreover, most of the area is already under the pressure of real estate business. This has to be checked and further actions have to be taken.



5.3.1.2 *Depth profile of the wetland*

- Bathymetric measurements will be helpful in preparing a depth profile of the wetland. Such data will be handy to plan any ecological development programs in the water spread area. If such a survey can be carried out with an interval of four to five years that will provide valuable information on the siltation and availability of the water spread area.

5.3.2 Protection

5.3.2.1 *Wastes*

- Ban on dumping and open burning of wastes in the dump yard located in the other half of the wetland is an immediate step required for conservation of the wetland. Incineration and secured / sanitary land fills are suggested to be executed in an ecologically benign manner. Composting can be a good method for waste reduction and recycling, but doubtful for large quantities of wastes.
- Setting up waste treatment plants, incinerators and waste segregation units may be done by the municipal establishments. Possibilities of generating funds from user agencies may be explored.
- Waste dumps, especially those located on the upstream, should be provided at the bottom with water proof lining. This World curtail contamination of soil and ground water

5.3.2.2 *Eco-restoration*

- In the protected part, except the Okkiam Maduvu, no other channels exist. Channels are necessary to maintain ecosystem health, prevent drying up and regain the hydrological balance of the wetland. The channels, which existed in the past, need to be identified and restored.
- More culverts, bridges, sluice gates are essential in the existing roads passing through, and also the trails and pathways in the wetland. This



connects the protected area with remaining part of the wetland and other water bodies. Without such pathways of interaction, the ecological degradation of the wetland will be fast and speedup the wetland being dried up.

- Identification of satellite wetlands that provide abode to resident and migratory species and their conservation add on to ecological quality of the protected area.
- Restoration and identification of satellite wetlands is necessary to ensure the hydrological balance of the system. It will also reduce the stress of flood and facilitate ground water recharge and quality. Wetlands holds huge amount of water and is the main source for recharging the ground water.
- Re-establishing links among the separated portions of the wetland ensures flood control of the region as well as protects the wetland from loosing the characteristics. Such connections in the water body are also essential to ensure species movements. During the survey boundaries may be marked, the channels of water flow may be identified and demarcated.
- To establish the channels and connect the neighboring satellite wetlands, the routes in the past has to be traced out. GIS, satellite imageries and field surveys will be useful in this exercise. Channels have to be maintained properly to avoid any blockage and cause undue flooding of the catchments during monsoon.
- Excavation of certain areas in the wetland is necessary to maintain a gradient of depth suitable for various species of organisms, especially the most visible group the birds, and also to maintain a proper hydro-regime in the marsh. To identify such locations a survey of the depth profile is inevitable.
- The dredged overburden in the southern part of the marsh has to be removed to resume tidal flow. The Thankavelu Engineering College could be charged for this.



- Removal of the overgrown aquatic weeds, especially *Eichhornia crassipes*, from the wetland helps sustain the natural vegetation structure, water quality including salinity, micro-habitat heterogeneity etc., of the system. Plants such as *Typha* should be maintained, as they are integral parts of the natural ecosystem.
- The municipal and domestic sewage entering the marsh promotes growth of weeds such as *Eichhornia* and unwanted algal blooms. One of the immediate steps should be controlling the release of such effluents.
- Green belts / tree planting are suggested along the trails / path made along the boundary. The species should be selected based on their dust and sound absorbing capacity and water tolerance. Bird attracting plants need to be considered for plantation. Butterfly attracting species can also be planted. It is also proper to explore the possibility of planting some mangrove associate plants.
- At specific locations, preferably butterfly attracting plant species may be established, to increase their diversity and abundance and also to attract visitors.
- Sanitation / public health facilities and maintenance can be provided for the local residents / socially lesser privileged people so that human waste shall not enter the wetland system untreated. SHG's may be involved to maintain such a system and also help in other waste management activities. Similarly, at public places sufficient waste bins should be provided.
- Institutions and other organizations that are located nearby the marsh growing appropriate plant species and maintaining a marsh land within their campus will enrich roosting and nesting birds. They also shall not empty their sewage drains and wastes into the marsh.



5.3.3 Research and monitoring

- Research and monitoring is an essential part of a comprehensive eco-restoration programme. It helps to document the status, identify the threats, and suggest mitigatory measures. A structured eco-monitoring programme will be appropriate for the purpose
- Monitoring biodiversity (floral and faunal components) and basic physio-chemical parameters should be conducted seasonally over years preferably by independent research organizations. The biotic and abiotic characteristics can indicate success of the restoration project, and suggest future improvements.
- Monitoring of pollutants (air, water, soil) and other threats may be done periodically by independent research organizations. A survey may be conducted to locate point and non-point sources of pollution.
- Assessing and monitoring the status of upstream and downstream areas, and suggesting corrective measures also may be entrusted to outside agencies in collaboration with the concerned government agencies.
- Monitoring the success of conservation measures implemented by an independent agency is required, so that necessary alterations may be suggested for implementation, if required.
- Data management and geographical information system (GIS) of the wetland and the surrounding areas are important components of the management scheme, and should be developed and updated consistently.
- A research and monitoring committee may be set up, which advises upon the research and monitoring activities. A local committee entrusted with monitoring the implementation of conservation measures and interventions may also be constituted. This committee may seek advice from the panel of experts / consultants from various sectors, constituting the research and monitoring committee.



- Research aids should be provided such as computers, internet, wireless and phone facilities, field equipments, additional man power, transportation (jeep, bicycles, and coracles) and field station. An appropriate laboratory equipped with equipments for routine works, meteorology station and a library may be established. It is also possible that laboratory works will be outsourced to any appropriate organizations.

5.3.4 Outreach / nature education

- An interpretation centre is one of the important components for outreach / nature education. The centre can emphasize the importance and conservation issues of wetland and the ecosystem services derived from such ecosystems. Audiovisual centre and museum are also important components of the centre.
- Such a centre needs to be designed, with facilities such as gallery, diorama, museum, halls, and projection and field equipments. This can be open for children, students and public. The centre can also organize and conduct camps, workshops and seminars targeting different segments of the society. This centre will also provide information to tourists.
- Signage / display boards, field guides, nature trails, boats and coracles shall be made to facilitate field visits.
- The staff designated for outreach should include a nature education officer / fellows and assistants.
- Facilities such as computers, projectors, vehicles, phone and internet may be made available for the centre.



6. BUDGET PROVISIONS

The budget requirements for the Environment Management Plan for the protected portion of the wetland are given below. The budget estimate is made for the first five year period. Justification for each of the major heads follows the table.

6.1. ABSTRACT ESTIMATE

The abstract estimate given below summarizes total estimate for the duration of five years (Table 1) for environment management and eco-restoration of the Pallikaranai protected area (reserve forest). The total project amount is Rs 1232 lakhs for the first five year period. The annual break-ups are also given in the table. The major portion of the projected budget is envisaged to meet the expenditure towards project.

Table 1: Summary of the budget estimate (in lakhs) for the EMP of the Pallikaranai marsh (Reserve Forest)

	Heads	Year					Total
		1	2	3	4	5	
A	Threat identification and minimization	90	90	5	10	3	198
B	Protection	100	95	42	35	41	313
C	Eco-restoration	100	124	39	24	24	311
D	Research and monitoring	20	35	15	15	15	100
E	Outreach / nature education	87	97	32	18	17	251
F	Contingency / miscellaneous	20	22	7	5	5	59
	Gross Total	417	463	140	107	105	1232



6.2. DETAILED ESTIMATE

The detailed estimate given below (Table 2) provides detailed break-ups of the estimate under different heads mentioned above in the Table 1.

Table 2: Details of the aspects covered under each head of the budget for the EMP (in lakhs).							
	Heads	Year					Total
		1	2	3	4	5	
A	Threat identification and minimization						
	Survey and identification of encroachment, boundary wall construction, maintenance, reclamation and identification of satellite wetlands	90	90	5	10	3	198
B	Protection						
1	Office, check post, guards, watch towers, hanging bridge and patrolling path	65	70	12	5	5	157
2	Staff	20	20	25	25	30	120
3	Vehicle, communication gadgets and fuel	15	5	5	5	6	36
C	Eco-restoration						
1	Cleaning the channels and drainage system	25	20	15	10	10	80
2	Culverts, bridges, sluice gates and maintenance	40	60	3	3	3	109
3	Green belts / tree planting / butterfly garden	5	7	3	2	2	19



4	Removal of aquatic weeds	5	5	5	3	3	21
5	Excavation to make gradients in certain areas	3	5	3			11
6	Sanitation / public health facilities and maintenance	15	15	5	1	1	37
7	Alternative livelihoods, self help groups	7	12	5	5	5	34
D	Research and monitoring						
1	Pollution source identification and monitoring, monitoring biological diversity and catchment, data management, GIS	20	35	15	15	15	100
E	Outreach / nature education						
1	Plan, design, construction and maintenance of interpretation centre	25	35	3	3	3	69
2	Gallery, diorama, museum, hall, library, laboratory, equipments and maintenance	35	30	20	5	5	95
3	Signage, nature trail and lightings	12	15	3	3	3	36
4	Boat, coracle and maintenance	12	12	2	2	2	30
5	Staff for Outreach	3	5	4	5	4	21
	Total of the heads	397	441	133	102	100	1173
F	Contingency / miscellaneous	20	22	7	5	5	59
	Gross Total	417	463	140	107	105	1232



6.3. JUSTIFICATIONS FOR THE BUDGET PROVISIONS

6.3.1 Threat identification and minimization

6.3.1.1 *The survey*

A detailed survey is inevitable to execute an environment management programme. An intensive survey is also essential to fine tune the EMP. Survey of the protected part of the wetland and the nearby satellite wetlands is envisaged here. The expenditure projected, under the survey is to meet the wages for the surveyors, hiring charges for vehicles / boats /coracles and gadgets for surveys and purchase of equipments such as binoculars, telescope, Global Positioning System, Digital camera etc, and consumables such as stationeries.

6.3.1.2 *Boundary wall construction*

The proposed expenditure is to meet the following expenses

- Construction of the boundary wall,
- Consultancy charges payable to the engineers or consultants,
- Transportation charges for men and materials, and
- Wages for the employees

The boundary wall could be approximately of 1.5 m high and about 15 km long. Since the area is water logged special foundation is needed for the walls. To estimate the cost of the wall Rs 1200/- as running meter cost is assumed. The wall is scheduled to be completed within two years. The boundary wall should have provision for flow of water, but should also prevent unauthorized entries.

6.3.2 Protection

Protection is the first step necessary for restoration of the wetland. Considering the layout of the protected area, one major check post close by the office buildings and four choukies / guard rooms (one standard size) are proposed at the locations marked in the Figure 4. Appropriate patrolling pathways are also envisaged in the



EMP. The expenditure proposed under this head meet the expenses for constructions of the office, check posts and patrolling path.

The following are included in projecting the expenses towards construction and maintenance of structures envisaged for the protection.

- Office (1) – staff rooms: Assuming a building of 500 m² the cost of buildings alone will be around Rs 20 lakhs
- Check posts (5), parking sheds (4) and watch tower (1). This is likely to cost around Rs 10 lakhs. The watch tower can be located on the top of interpretation centre to save money and access to target groups.
- Trek path, hanging bridge and artificial nest boxes for birds: The trek paths are conceived along the boundary of the protected area aesthetically placed within an appropriate green belt of indigenous tree species. Two hanging bridge (about 500 m long), placed on buoys, across the water spread area, probably camouflaged with live vines and climbers will be very fitting for recreational as well as academic bird watching.
- Salaries and wages for the officer in charge, remuneration for the site engineer (1), salary for the security officer (1), salary for the security staffs (12), salary for gardeners (2), salary for drivers (4). This is likely to cost about Rs 15 lakhs.
- Purchase of vehicles - bicycles (8), motor bikes (4), jeeps (1), mechanical boats (5) and coracles (5)
- Computers with internet connection (2), communication gadgets such as telephones (6) and wireless (9) for which a provision of Rs 3 lakhs is proposed.
- Expenditures for fuel, hiring vehicles and other general maintenance



6.3.2.1 Eco-restoration

- The expenditures envisaged under this head include those towards
- Restoring / de-silting / cleaning the channels that are connected to the wetland and construction of culverts / sluices.
- Identifying and restoring channels linking the wetland with the adjacent wetlands
- Wages, material charges, transportation charges, hiring charges for earth moving machinery like JCBs, dredgers, tippers etc
- Expenditure towards developing Green belt, mounts with trees suitable for colonial nesters.
- Collection and transportation of planting materials, planting the saplings and their maintenance
- Raising nurseries, seed treatment charges etc.
- Conservation of the existing greenery / trees
- Weed removal from the wetland and flood plains
- Consultation charge for experts, materials, wages, and transportation charge, hiring machinery supports

6.3.2.2 Sanitation / Public health facilities and maintenance

The amount accounted under this heads is envisaged to be spend on

- Construction and maintenance of the sanitation / public health facilities
- Charges for regular public health campaigns and public awareness programs
- Promoting alternative livelihoods programmes for the peripheral community, promoting self help groups
- Salary and wages for the keepers and counselors: The keepers are expected to be responsible for up keeping of the setups, while the counselors are expected to help in promoting the concept of self help groups and alternate livelihoods options among the local underprivileged population.



6.3.2.3 Research and Monitoring

The expenditures envisaged here are to meet

- Charges towards construction and maintenance of field station, meteorological station, laboratory, computers, image processors, software and library with internet facilities
- Salary and wages for consultants, research / laboratory / field assistants and drivers
- Equipment purchase, insurance and annual maintenance charges of the equipments, and maintenance charges for other infrastructure
- Expenditures for items such as chemicals and consumables for analyzing physical, chemical, and biological parameters / samples
- Expenditures towards outsourcing scientific studies and expertise
- Acquiring imageries and other remote sensed data sources

6.3.2.4 Budget for outreach / nature education

The expenditures envisaged here include those to be spent on

- Construction and maintenance of the interpretation centre: With gross assumption of 1000 m² the building is likely to cost around Rs 35 lakhs. This can be done within first two years.
- Gallery, diorama, museum, hall in the interpretation centre is also envisaged to be done within first two years
- Signage and other information materials
- Nature trail – construction and maintenance
- Charges for purchasing and maintaining boats, coracles
- Salary for the staffs - Nature education officer / coordinator, office assistant
- Contingency / miscellaneous expenditures
- Expenditures towards conducting seminars, nature camps and workshops

7. ACKNOWLEDGEMENTS

The Government of Tamil Nadu is showing keen interest in conserving the natural resources and heritages of the state. In this regard, recently a notable initiative has been taken towards protecting the Pallikaranai wetland by elevating a portion as reserve forest. A long term conservation and management plan is being prepared by the government to protect and conserve this area for posterity. SACON is honoured to associate with this important initiative.

We express our gratitude to Mr. R Rajagopal, IAS (Secretary Environment and Forest, Government of Tamil Nadu) for providing this opportunity to prepare a management plan to conserve the wetland.

Dr. K S Neelakandan, IFS (Director, Environment, Government of Tamil Nadu) was instrumental in making this work successful. Reference materials and co-ordination provided by him was highly useful. Discussion with Dr V N Singh, IFS (Chief Conservator of forests, Tamil Nadu) was extremely helpful in planning this work and organizing the report.

We thank Mr. Subramanian J (Chennai) and Dr T Sundaramurthy (CPR Centre for Environmental Education, Chennai) for providing literatures on the subject and help. Various organizations such as National Institute of Ocean Technology (NIOT), Centre for Wind Energy Technology (C-WET), Tamil Nadu Pollution Control Board (TNPCB), Centre for Environmental Education (CEE) and Chennai Snake Park Trust (CSPT) were helpful while preparing this document.

We have greatly benefited from the discussion with colleagues and friends at SACON especially Dr P Pramod, Dr P Balasubramanian, Dr Ravi Sankaran, Ms Rachna Chandra and Mr Anjan Kumar Prusty. Mr Vaidyanathan and Mr Manoharan of SACON helped us in getting some important literatures with respect to Pallikaranai wetlands.

The information provided in this report is collected extensively from several published and unpublished reports, articles and books, which are listed under the reference section. We profusely thank the authors of those reports and those who shared valuable information; we apologise for omissions, if any.



8. REFERENCES

- Azeez P A, Bhupathy S, Ranjini J, Dhanya R. 2007. Pallikaranai wetlands – a proposal for conservation. Sálim Ali Centre for Ornithology and Natural History, Coimbatore.
- Arboretum leaflets. 2006. www.botany.wisc.edu/zedler/images/Leaflet_10.pdf
- Care Earth. 2002. Conservation of urban wetlands – Pallikaranai Marsh. Tamil Nadu Pollution Control Board
- Care Earth. 2003. Major research management concerns of the Pallikaranai Marsh, Chennai.
- Care Earth. 2005. Current status of Pallikaranai marsh and recommendations for protection and restoration. Tamil Nadu Pollution Control Board
- Chennai metropolitan water supply and sewerage board, 2007 www.ctn.org.in/cms/
- Community Environmental Monitoring (CEM) 2006. Smoke Screen: Ambient air quality in India. www.slpcotcudalore.com
- Costanza R., d'Arge R, deGroot R, Farber S, Grasso M, Hannon B, Limburg K, Naeem S, O'Neill R V, Paruelo J, Raskin R G, Sutton P and Belt M. 1997. The value of the world's ecosystem services and natural capital. *Nature* 387:253-260.
- Corp Watch India. 2002. Trashing Water is Good Business For Water Companies. Report by Jayaraman, N. <http://www.corpwatchindia.org/issues/PID>
- Dams, Rivers & People. 2004. Update on related Issues. 2 (2, 3, 4).
- Ecological Society of America, 2000. Ecosystem Services. <http://www.esa.org>
- Environment and Forests Department. 2006. Eco-restoration plan for selected lakes in and around Chennai city. Policy Note 2006-2007. Demand no. 15.
- Jayaraman, N. 2002. Trashing water is good business for water companies (Article). India Resource Centre
- Joint Committee Report. 2003. Threats to Pallikaranai wetland and need for its immediate remedial measures. Joint Committee, Ministry of Environment and Forest, Government of India, New Delhi



- Millennium Ecosystem Assessment. 2005. Ecosystems and human well-being: Wetlands and water. Synthesis. World Resources Institute, Washington DC.
- Patnaik, D.C. 2002. Pallikaranai marsh in Chennai. Environment, GIS & Remote Sensing.htm
- Public works department policy note 2006 - 2007
- Sawhney A. 2006. An evaluation of domestic and trade policies in building environmental services capacity in Asia: Balancing diverse interests and priorities. Management Development Institute, Gurgaon, India (ICTSD Draft) In: Delivering Sustainable Development in Negotiations on Environmental Goods and Services An ICTSD Informal Roundtable - Geneva, Switzerland 12-13 October 2006. ICTSD Programme on Trade and Environment
- Subramanian J. 2000. A preliminary study of Pallikaranai marshes. Unpublished report.
- The Hindu, 22nd October 2003. Expert visit to Pallikaranai Swamp (News).
- The Hindu. 2006. The marshland gone waste (report by J Vencatesan). www.thehindu.com/thehindu/pp/2006/07/01/stories/006070100040100.htm
- The Hindu 2001. The Chennai tops in slum population. August 28.
- Vijayan V S, Prasad S N, Vijayan L and Muralidharan S. 2004. Inland wetlands of India - conservation priorities. Sálim Ali Centre for Ornithology and Natural History, Coimbatore.
- www.nilacharal.com

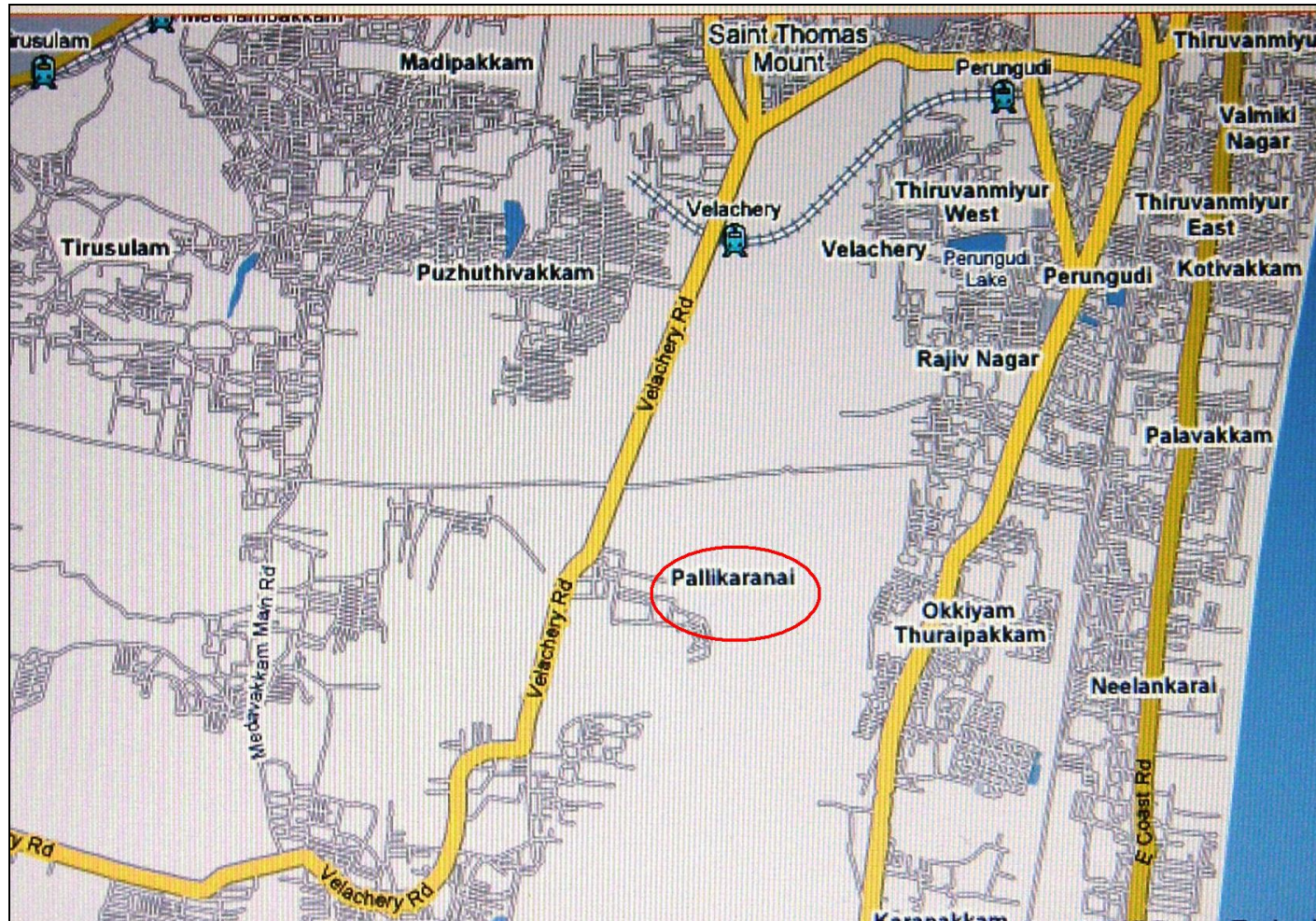


Figure 1: Map of south Chennai showing the location of Pallikaranai wetland



Figure 2: The Pallikaranai marsh - Sewage Treatment Plant (STP), National Institute of Ocean Technology (NIOT), Mass Road Transport System (MRTS)
Source: Google Earth 2007



Figure 3: Details of Okkium Maduvu, the only channel that drains water from the wetland

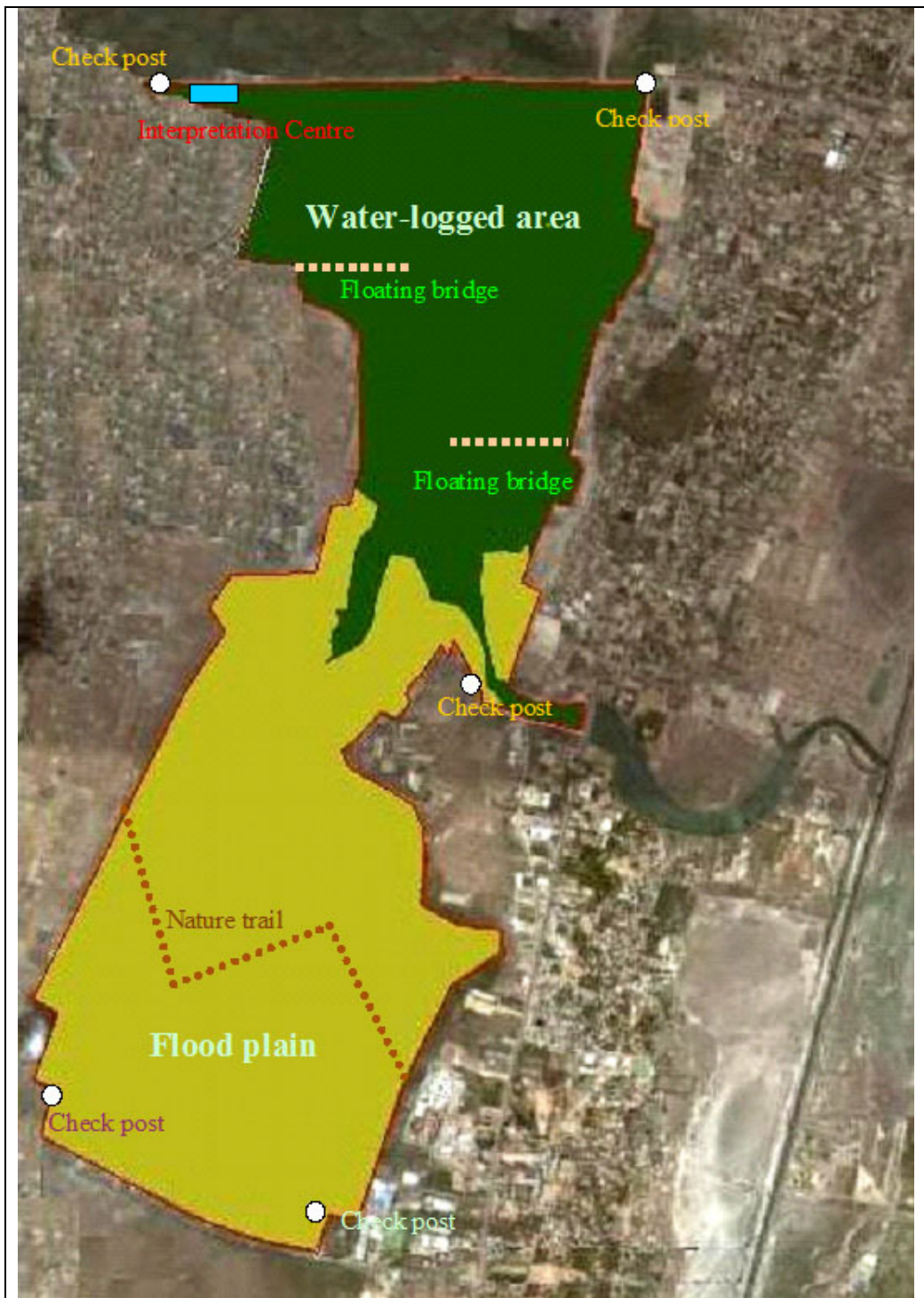


Figure 4: Details of the protected area showing proposed locations for management interventions

9. APPENDICES

Appendix 1: Plant species reported from Pallikaranai marsh	
SI No	Scientific name
1	<i>Abutilon indicum</i>
2	<i>Acalypha indica</i>
3	<i>Achyranthes aspera</i>
4	<i>Alternanthera sessilis</i>
5	<i>Amaranthus spinosus</i>
6	<i>Amaranthus viridis</i>
7	<i>Astracanthus longifolius</i>
8	<i>Bacopa</i> sp.
9	<i>Boerhavia diffusa</i>
10	<i>Brachiaria</i> sp.
11	<i>Calotropis gigantea</i>
12	<i>Cardiospermum halicacabum</i>
13	<i>Cassia occidentals</i>
14	<i>Cleome viscosa</i>
15	<i>Coccinia grantis</i>
16	<i>Crotalaria pallida</i>
17	<i>Croton vonplandianus</i>
18	<i>Cynodon dactylon</i>
19	<i>Cyprus rotundus</i>
20	<i>Cyprus</i> sp.
21	<i>Datura metel</i>
22	<i>Dolichos</i> sp.
23	<i>Echinochloa</i> sp.
24	<i>Eclipta prostrata</i>
25	<i>Eichhornia crassipes</i>
26	<i>Evolvus alsinoides</i>
27	<i>Gomphrena celestioides</i>
28	<i>Heliotropium indicum</i>
29	<i>Heliotropium curassavicum</i>
30	<i>Hydrilla verticillata</i>
31	<i>Hygrophylla auriculata</i>
32	<i>Ipomea carnea</i>
33	<i>Jatropha gossypifilia</i>
34	<i>Lantana camara</i>
35	<i>Lemna</i> sp.
36	<i>Leucas aspera</i>

37	<i>Mukia leiosperma</i>
38	<i>Nymphaea pubescens</i>
39	<i>Ottelia alismoides</i>
40	<i>Parthenium hysterophorus</i>
41	<i>Parssiflora foetida</i>
42	<i>Phyla nodiflora</i>
43	<i>Phyllanthus amarus</i>
44	<i>Phyllanthus reticulotes</i>
45	<i>Physalis minima</i>
46	<i>Pistia stratiotes</i>
47	<i>Prosopis juliflora</i>
48	<i>Ricinus communis</i>
49	<i>Ruellia tuberosa</i>
50	<i>Sesuvium portulacastrum</i>
51	<i>Sida</i> sp.
52	<i>Sphaeranthus indicus</i>
53	<i>Stachytarpheta</i> sp.
54	<i>Trianthema portulacastrum</i>
55	<i>Tridax procumbens</i>
56	<i>Turnera ulmifolia</i>
57	<i>Tylophora indica</i>
58	<i>Typha angustata</i>
59	<i>Utricularia stellaris</i>
60	<i>Wattakaka volubilis</i>
61	<i>Xanthium indicum</i>
	Source: Care Earth, 2002

Appendix 2: Animal species found in Pallikaranai	
Animal/plant groups	Number of species
Mammals	10
Birds	106
Reptiles	21
Amphibians	9
Fishes	46
Butterflies	7
Crustaceans	5
Molluscans	9
Source: Care Earth, 2002	

Appendix 3: Mammals found in Pallikaranai marsh		
SI No	Common name	Scientific name
1	Spotted deer	<i>Axis axis</i>
2	Bonnet macaque	<i>Macaca radiata</i>
3	Indian pipistrelle	<i>Pipistrellus coromandra</i>
4	Leaf-nosed bat	<i>Hipposideros sp.</i>
5	Three-striped palm squirrel	<i>Funambulus palmarum</i>
6	Bandicoot	<i>Badicota bengalensis</i>
7	House rat	<i>Rattus rattus</i>
8	Mice	<i>Mus sp.</i>
9	Jackal	<i>Cannis aureus</i>
10	Mongoose	<i>Herpestes edwardsii</i>
Source: Care Earth, 2002		

Appendix 4: Bird species recorded in Pallikaranai marsh		
SI No	Common name	Scientific name
1	Little grebe	<i>Tachybaptus ruficollis</i>
2	Little cormorant	<i>Phalacrocorax niger</i>
3	Large cormorant	<i>Phalacrocorax carbo</i>
4	Spot-billed duck	<i>Anas poecilorhyncha</i>
5	Grey heron	<i>Ardea cineria</i>
6	Purple heron	<i>Ardea purpurea</i>
7	Cattle egret	<i>Bubulcus ibis</i>
8	Large egret	<i>Casmerodius albus</i>
9	Small egret	<i>Mesophoyx intermedia</i>
10	Little egret	<i>Egretta garzetta</i>
11	Pond heron	<i>Ardeola grayii</i>
12	Night heron	<i>Ncticorax ncticorax</i>
13	Black bittern	<i>Ixobrychus flavicollis</i>
14	Cinnamon bittern	<i>Ixobrychus cinnamomeus</i>
15	Yellow bittern	<i>Ixobrychus chinensis</i>
16	Spot-billed pelican	<i>Pelecanus philippensis</i>
17	Open-billed stork	<i>Anastomus oscitans</i>
18	Wooly-necked stork	<i>Ciconia episcopus</i>
19	Glossy ibis	<i>Plegadis falcinellus</i>
20	Black-headed ibis	<i>Threskiornis melanocephalus</i>
21	Pariah kite	<i>Milvus migrans</i>
22	Black-winged kite	<i>Elanus caeruleus</i>
23	Brahminy Kite	<i>Haliastur Indus</i>
24	Pale harrier	<i>Circus macrourus</i>
25	Pied harrier	<i>Circus melanoleucos</i>
26	Marsh harrier	<i>Circus aeruginosus</i>
27	Shikra	<i>Accipiter badius</i>
28	Kestral	<i>Falco tannunculus</i>
29	Indian moorhen	<i>Gallinula chloropus</i>
30	Purple moorhen	<i>Porphyrio porphyrio</i>
31	Coot	<i>Fulica atra</i>
32	Stone curlew	<i>Burhinus oedicephalus</i>
33	Great thick-knee	<i>Burhinus recurvirostris</i>
34	Red-necked phalarope	<i>Phalaropus lobatus</i>
35	Pheasant-tailed Jacana	<i>Hydrophasianus chirurgus</i>
36	Red-wattled lapwing	<i>Vanellus indicus</i>
37	Yellow-wattled lapwing	<i>Vanellus malabaricus</i>
38	Black-winged stilt	<i>Himantopus himantopus</i>

SI No	Common name	Scientific name
39	Spotted sandpiper	<i>Tringa glareola</i>
40	Marsh sandpiper	<i>Tringa stagnatilis</i>
41	Stint	<i>Calidris sp.</i>
42	Oriental pranticole	<i>Glareola maldivarum</i>
43	Snipe	<i>Gallinago sp.</i>
44	Black-tailed godwit	<i>Limosa limosa</i>
45	Whiskered tern	<i>Chlidonias hybridus</i>
46	White-winged black tern	<i>Chlidonias leucopterus</i>
47	Gull-billed tern	<i>Gelochelidon nilotica</i>
48	Blue-rock pigeon	<i>Colomba livia</i>
49	Spotted dove	<i>Sterptopilia chinensis</i>
50	Rose-ringed parakeet	<i>Psittacula krameri</i>
51	Asian koel	<i>Eudynamys scolopacea</i>
52	Hawk cuckoo	<i>Cuculus varius</i>
53	Pied-crested cuckoo	<i>Oxylophus jacobinus</i>
54	Spotted owl	<i>Athene brama</i>
55	Barn owl	<i>Tyto alba</i>
56	Small-blue kingfisher	<i>Alcedo atthis</i>
57	White-breasted kingfisher	<i>Halcyon smyrnensis</i>
58	Pied kingfisher	<i>Ceryle rudis</i>
59	Indian roller	<i>Coracias bengalensis</i>
60	Blue-tailed bee-eater	<i>Merops philippinus</i>
61	Small-green bee-eater	<i>Merops orientalis</i>
62	Hoopoe	<i>Upupa epops</i>
63	House swift	<i>Apus affinis</i>
64	Palm swift	<i>Cypsiurus batasiensis</i>
65	Golden-backed woodpecker	<i>Dinopium bengalensis</i>
66	Barn swallow	<i>Hirundo rustica</i>
67	Wire-tailed swallow	<i>Hirundo smithii</i>
68	Ashy-crowned finch lark	<i>Erimopterix grisea</i>
69	Syke's-crested lark	<i>Galerida deva</i>
70	Oriental skylark	<i>Alauda gulgula</i>
71	Eurasian skylark	<i>Alauda arvensis</i>
72	Singing lark	<i>Mirafra cantillans</i>
73	Black-crowned finchlark	<i>Erimopterix nigriceps</i>
74	Common myna	<i>Acridotheres tristis</i>
75	Brahminy starling	<i>Sturnus pagodarum</i>
76	Asian-pied starling	<i>Sturnus contra</i>
77	House crow	<i>Corvus splendens</i>
78	Jungle crow	<i>Corvus macrorhynchus</i>
79	Indian treepie	<i>Dendrocitta vagabunda</i>

SI No	Common name	Scientific name
80	Red-vented bulbul	<i>Pycnonotus cafer</i>
81	Red-whiskered bulbul	<i>Pycnonotus jocosus</i>
82	Yellow-billed babbler	<i>Turdoides affinis</i>
83	Tailor bird	<i>Orhtotomus sutorius</i>
84	Ashy prinia	<i>Prinia socialis</i>
85	Plain prinia	<i>Prinia inornata</i>
86	Blyth's reed warbler	<i>Acrocephalus dumetorum</i>
87	Great reed warbler	<i>Acrocephalus stentoreus</i>
88	Streaked fantail warbler	<i>Cisticola juncidis</i>
89	Pied bush chat	<i>Saxicola caprata</i>
90	Magpie robin	<i>Copsychus saularis</i>
91	Orange-headed thrush	<i>Zoothera citrine</i>
92	Yellow wagtail	<i>Motacilla flava</i>
93	Large-pied wagtail	<i>Motacilla maderaspatensis</i>
94	Paddy-field pipit	<i>Anthus novaeseelandiae</i>
95	Richard's pipit	<i>Anthus richardi</i>
96	House sparrow	<i>Passer domesticus</i>
97	Streaked weaver bird	<i>Ploceus manyar</i>
98	Black-headed munia	<i>Lonchura malacca</i>
99	Black drongo	<i>Dicrurus adsimilis</i>
100	Ashy swallow-shrike	<i>Artamus fuscus</i>
101	Grey shrike	<i>Lanius excubitor</i>
102	Golden oriole	<i>Oriolus oriolus</i>
103	Loten's sunbird	<i>Nectarinia lotenia</i>
104	Grey francolin	<i>Francolinus pondicerianus</i>
105	White-breasted waterhen	<i>Amaurornis phoenicurus</i>
106	Water cock	<i>Gallicrex cinerea</i>
107	Painted snipe	<i>Rostratula benghalensis</i>
108	Little ringed plover	<i>Chadrius dubius</i>
109	Grey plover	<i>Pluvialis squatarola</i>
110	Indian river tern	<i>Sterna aurantia</i>
111	Indian roller	<i>Coracias benghalensis</i>
112	Zitting cisticola	<i>Cisticola juncidis</i>

Source: Subramanian, 2000; Care Earth, 2002; SACON, 2007

Appendix 5: Reptiles recorded from Pallikaranai marsh		
SI No	Common name	Scientific name
1	Garden lizard	<i>Calotes versicolor</i>
2	Fan-throated lizard	<i>Sitana ponticeriana</i>
3	Common skink	<i>Mabuya carinata</i>
4	Garden skink	<i>Lygosoma punctata</i>
5	White-spotted garden skink	<i>Yigosoma albopunctata</i>
6	Indian monitor lizard	<i>Varanus bhengalensis</i>
7	Spotted gecko	<i>Hemidactylus brooki</i>
8	Termite-hill gecko	<i>Hemidactylus triedrus</i>
9	House gecko	<i>Hemidactylus frenatus</i>
10	Bark gecko	<i>Hemidactylus leschenaultia</i>
11	Blind snake	<i>Rhamphotyphlops braminus</i>
12	Striped keel back	<i>Amphiesma stolata</i>
13	Olive keel back	<i>Atretium schistosum</i>
14	Checkered keel back	<i>Xeenochrophis piscator</i>
15	Rat snake	<i>Ptyas mucosus</i>
16	Green vine snake	<i>Ahaetulla nasutus</i>
17	Cobra	<i>Naja naja</i>
18	Krait	<i>Bungarus caeruleus</i>
19	Russell's viper	<i>Vipera russelli</i>
20	Pond turtle	<i>Melanichelys trijuga</i>
21	Falpsnell	<i>Lissemys punctata</i>
Source: Care Earth, 2002		

Appendix 6: Amphibians recorded from Pallikaranai		
SI No	Common name	Scientific name
1	Indian pond frog	<i>Euphlyctis hexadactylus</i>
2	Skipper	<i>Euphlyctis cynophlyctis</i>
3	Burrowing frog	<i>Tomopterna rolandae</i>
4	Jerdon's bull frog	<i>Hoplobatrachus crassus</i>
5	Paddy Field frog	<i>Limnonectes limnocharis</i>
6	Painted frog	<i>Kaloula taprobanica</i>
7	Marbled frog	<i>Ramanella variegata</i>
8	Indian Toad	<i>Bufo melanostictus</i>
9	Common tree frog	<i>Polypedates maculatus</i>
Source: Care Earth, 2002		

Appendix 7: Fishes recorded from Pallikaranai marsh		
SI No	Common name	Scientific name
1	Long-fin eel	<i>Anguilla benghalensis</i>
2	Short-fin eel	<i>Anguilla bicolor</i>
3	Anchovy	<i>Stolephorus sp.</i>
4	Baril	<i>Barilius bendelisis</i>
5	Glass barb	<i>Esomus danricus</i>
6	Carplet	<i>Amblyphryngodon microlepis</i>
7	Black-line rasbora	<i>Rasbora daniconius</i>
8	Razor belly	<i>Salmostoma clupeoides</i>
9	Silver razor belly	<i>Salmostoma acinaces</i>
10	One-spot barb	<i>Puntius filamentosus</i>
11	Scarlet-banded barb	<i>Puntius amphibious</i>
12	Spot-fin barb	<i>Puntius sophore</i>
13	Ticto barb	<i>Puntius ticto</i>
14	Peninsular olive barb	<i>Barbodes sarana</i>
15	Swamp barb	<i>Puntius chola</i>
16	Long-snouted barb	<i>Puntius dorsalis</i>
17	Fringe-lipped peninsular carp	<i>Labeo fimbriatus</i>
18	Loach	<i>Lepidocephalus thermalis</i>
19	Gangetic mystus	<i>Mystus cavasius</i>
20	Long-whiskered catfish	<i>Mystus gulio</i>
21	Striped dwarf catfish	<i>Mystus gulio</i>
22	River catfish	<i>Aorichthys aor</i>
23	Giant river catfish	<i>Aorichthys seenghala</i>
24	Stinging catfish	<i>Heteropneustes fossilis</i>
25	Indian potassi	<i>Pseudeutropius atherinoides</i>
26	Magur	<i>Clarias batrachusq</i>
27	Panchax	<i>Aplochelius parvus</i>
28	Half beak	<i>Hyporhamphus limbatus</i>
29	Rice fish	<i>Oryzias melastigma</i>
30	Mosquito fish	<i>Gambusia affinis</i>
31	Spotted snake head	<i>Channa punctatus</i>
32	Striped snake head	<i>Channa striatus</i>
33	Asiatic snake head	<i>Channa orientalis</i>

34	Giant snake head	<i>Channa marulius</i>
35	Orange chromide	<i>Etroplus maculatus</i>
36	Green chromide	<i>Etroplus suratensis</i>
37	Tilapia	<i>Oreochromis mossambicus</i>
38	Glass fish	<i>Ambassis commersonii</i>
39	Tank goby	<i>Glossogobius giurus</i>
40	Climbing perch	<i>Anabas testudineus</i>
41	Dwarf gourami	<i>Colisa lalia</i>
42	Spike tailed paradise fish	<i>Macropodus cupanus</i>
43	One stripe spiny eel	<i>Macrognathus aral</i>
44	Striped spiny eel	<i>Macrognathus pancalus</i>
45	Mullet	<i>Liza parsia</i>
46	Tire tracked spiny eel	<i>Mastacembelus armatus</i>
Source: Care Earth, 2002		

Appendix 8: Butterflies of Pallikaranai		
SI No	Common name	Scientific name
1	Lime butterfly	<i>Papilio demoleus</i>
2	Mottled emigrant	<i>Catopsilia pyranthe</i>
3	Common crow	<i>Euploea core</i>
4	Plain tiger	<i>Danaus chrysippus</i>
5	Glassy tiger	<i>Parantica aglaea</i>
6	Peacock pansy	<i>Junonia almanac</i>
7	Tawny coster	<i>Acraea violae</i>
Source: Care Earth, 2002		

Appendix 9: Crustaceans of Pallikaranai		
SI No	Common name	Scientific name
1	Prawn	<i>Paliemon sp.</i>
2	Fresh water prawn	<i>Macrobrachium rosenburgii</i>
3	Pond crab	<i>Paratelphusa sp.</i>
4	Mud crab	<i>Scylla cerrata</i>
5	Fresh water shrimp	
Source: Care Earth, 2002		

Appendix 10: Mollusks of Pallikaranai		
SI No	Common name	Scientific name
1	Windowpane oyster	<i>Placenta placenta</i>
2	Arc shell	<i>Arca spp.</i>
3	Oyster	<i>Crassostrea spp.</i>
4	Apple snail	<i>Pyla virens</i>
5	Fresh water mussel	<i>Lamellidens marginalis</i>
6	Fresh water snail	<i>Plidomus sp.</i>
7	Fresh water snail	<i>Thiara sp.</i>
8	Fresh water snail	<i>Lymnaea sp.</i>
9	Ram's horn snail	<i>Indoplanorbis exustus</i>
Source: Care Earth, 2002		

Appendix 11: Some agencies requesting land for non-wetland use / diversion in Pallikaranai	
SI No	Organizations
1	Ambedkar Law University
2	Alandur Municipality
3	National Institute of Ocean Technology (NIOT)
4	Engineering Colleges
5	Commercial Establishments
6	The Film Workers association
7	Private Firms
8	The CMWSSB
9	Mass Rapid Transit System (MRTS)
10	Tamil Nadu Slum Clearance Board
Source: Patnaik, 2002	

Appendix 12: Research concerns listed by Care Earth	
1	Monitor the distribution of the contaminants in the soil, water and biota of the marsh
2	Identify zones that are more contaminated than the others
3	Assess the possible impacts that this contaminants might have on humans and live stock directly and through the pollution of ground water in the long term, since the marsh is surrounded by human habitation including schools
4	Suggest means to reclaim the marsh by a process of biotic purification of the water
Management concerns	
5	Reclaiming the dumped area by actually removing the inorganic wastes
6	Planting trees to reclaim the dumps (an area close to 500 ha) and create roosts for storks, herons and ibises that visit the marsh
7	Habitat improvement by creating opportunities for the water to freely flow from segment to segment, especially across the link road that bisects the marsh
8	Slowly eliminate the water hyacinth that has choked the marsh in certain segments and introduce lotus and water lilies
9	Wherever necessary, fencing of the marsh to improve the habitat. Areas that need to be thus fenced should be carefully identified
Source: Care Earth 2003	

Appendix 13: Recommendations of the expert team	
1	Considering the present status of the wetland and the threats caused to the ecology due to indiscriminate dumping of garbage and untreated sewage, CPCB should issue directions to the concerned State Government authorities for immediate stoppage of dumping of these wastes.
2	The area are presently under custody of Corporation must be Immediately withdrawn from them
3	Corporation should find alternate sites for either composting of garbage or landfill as well as for discharge of untreated sewage
4	The entire area of 743 ha including the remaining water body must be declared as a sanctuary. Converted land mass should be afforested
5	MoEF requested State Government on 26th March 2003 to submit a proposal for inclusion of this wetland under the National Wetland Conservation Programme. A reminder was set on 19th August 2003. No action taken by State Government so far
6	The State Government should expedite submission of the proposal and also consider taking action to declare this wetland as a Ramsar site, so that it can be protected
7	The sewage treatment plants under NRCP project must be constructed on a war footing and completed as early as possible
Source: Joint committee report, 2003	



Plate 1: A view of the Pallikaranai wetland (protected part)



Plate 2: Low-lying area of the Pallikaranai marsh that gets flooded seasonally



Plate 3: Pallikaranai marsh supports both migratory and resident birds



Plate 4: Encroachment – a major reason for deterioration of the marsh



Plate 5: Incessant burning of waste, a major source of air pollution



Plate 6: Unscientific mode of garbage dump affects soil and water quality