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Status of Environment Related Issues in Puducherry

MANGROVES: PLANTING HOPE TO COMBAT CLIMATE CHANGE

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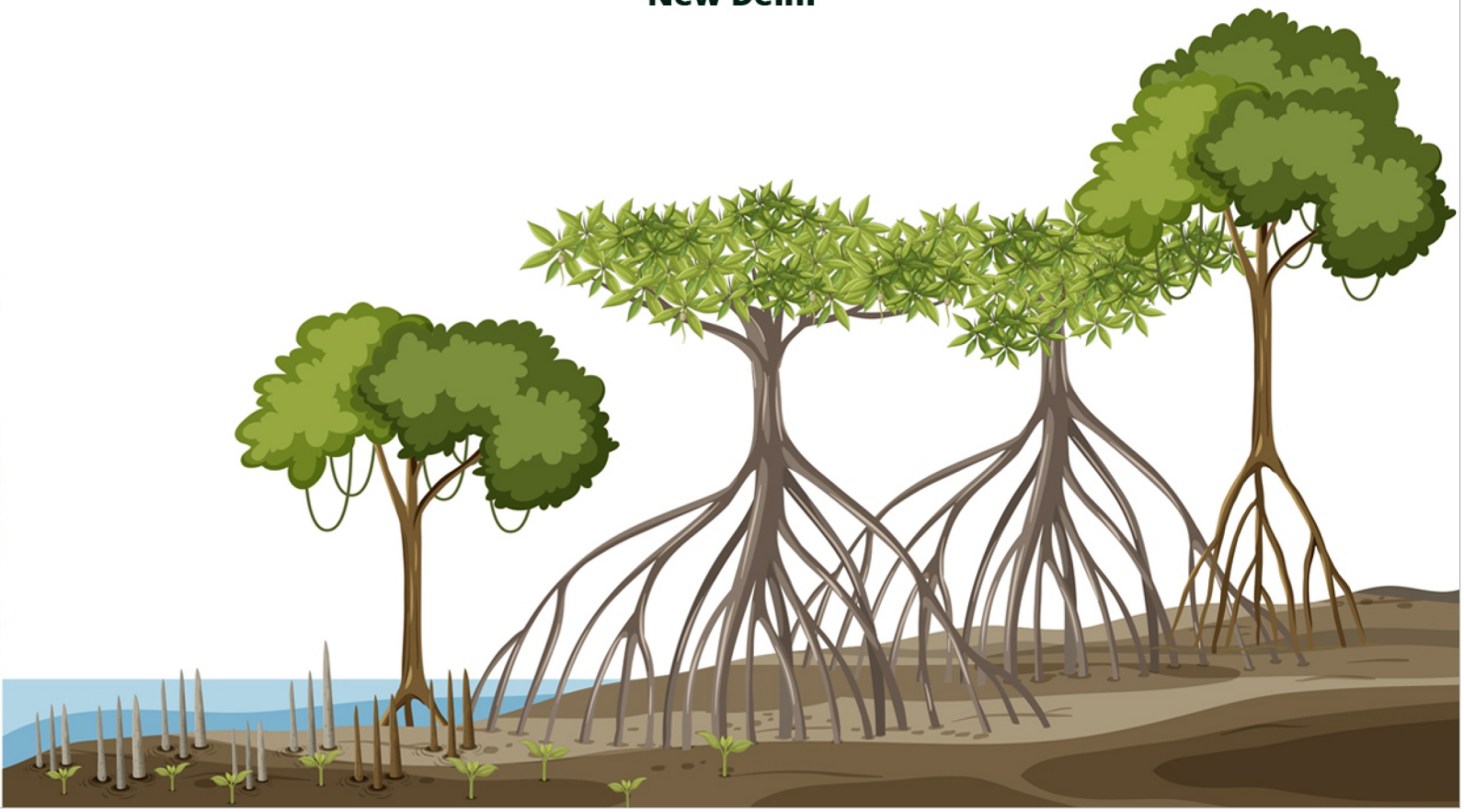

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About EIACP

- Environmental Information System (ENVIS) was renamed as EIACP (Environmental Information, Awareness, Capacity Building and Livelihood Programme).
- ENVIS came into existence as a plan programme in 1983.
- It is a project funded by the Ministry of Environment, Forests and Climate Change (MoEF&CC), to facilitate collection, analysis and dissemination of information on various facets of environment.
- The information is being disseminated through the quarterly newsletter and website.

About Puducherry - EIACP PC HUB

Puducherry Envis Hub Centre was started on 22nd September, 2005. Our ENVIS centre located at the Puducherry Pollution Control Committee (PPCC), Puducherry, focuses on special reference to "Status of Environment Related Issues". Activities of our centre include collection, analysis, storage, retrieval and dissemination of information in the subject area allotted. The information is being disseminated through the quarterly newsletter and various environmental awareness program in schools and colleges for imparting Environmental comprehension among students.

Aims and Objectives

- To nurture green, sustainable and inclusive workforce in order to enhance both living and environment standards while fostering gainful and self-employment of youth.
- To conduct skilling courses not only in traditional areas but also in new emerging areas like electric vehicles, hazardous waste/ Bio-medical waste etc. considering their future scope, requirements and prospects.

  To be involved in the Mission LiFE (Lifestyle for Environment) being conceptualized by the Ministry.
- To facilitate technical and environmentally conscious industrial participation focused on sustainable development.
- To develop national and international collaboration for knowledge exchange and skilling and facilitating attainment of the SDGs.
- To aid sustainable livelihoods of tribal population especially in NER based on traditional knowledge and crafts.
- To facilitate informed decisions and policy making by catering to demand for research, innovation and data on emerging issues related to environment.
- To facilitate transition to environmentally conscious futuristic citizens including awareness among public/communities on environment related issues.

MANGROVES: PLANTING HOPE TO COMBAT CLIMATE CHANGE

INTRODUCTION

Mangroves are a unique type of vegetation found in intertidal areas where freshwater and saltwater combine. These salt-tolerant plants are commercially and environmentally significant, protecting coastal areas from tsunami storm surges and soil erosions. Their complex root systems dissipate sea wave energy, arresting coastal erosion and seawater pollution. Sediment deposition is a visible feature that arrests coastal erosion and seawater pollution. Mangroves reproduce through viviparity, where seeds germinate within the tree before falling to the ground. Some species leak excess salt through their leaves, while others prevent salt absorption at their roots. Mangroves can serve as natural carbon capture and sequestration agents for humans. Mangroves are salt-tolerant forest ecosystems found in tropical and subtropical intertidal zones along the coast. They rely on terrestrial and tidal waters for nutrients and slit deposits from highland erosion as substrates for support. The tides nourish the forest, while mineral-rich river silt enriches the marsh. Mangroves provide a wide range of ecological and economic products and services while supporting other coastal and marine ecosystems. They are one of the most prolific ecosystems and a naturally renewable resource.

However, the world's mangroves face threats from all sides. India contributes 3% of the world's mangroves, and the largest Sundarbans is a Transboundary Forest that spans around one million hectares in Bangladesh and India. The smallest man made mangroves in Puducherry contribute 0.4%, while Karaikal contributes 0.1% to India's total. Mangroves in Puducherry and Karaikal are classified into two types based on their natural habitats: real mangroves and mangrove associates.

True mangroves are plants that grow only in intertidal zones, although mangrove allies can be found in both littoral and terrestrial environments. Puducherry mangrove is located at latitude 11° 46'03" to 11° 53'40" North and longitude 79° 49'45" to 79°48'00" East. It is surrounded by three villages: Ariyankuppam, Murungapakkam, and Veerampattinam, as well as two islets: Thengaithittu and Ashramthittu. Mangroves grow as bordering vegetation along the shores of the Ariyankuppam estuary, which opens into the Bay of Bengal on the Coromandel coast. The canal is a tributary of the Gingee River. The tidal amplitude ranges from 20 to 70 cm and varies with the lunar period, peaking during the northeast monsoon. The climate is characterised by 65-75% relative humidity and temperatures ranging from 28°C to 30°C. The annual rainfall is 1200 millimetres.

The noted human disruptions include harbour development operations and ongoing dredging for convenient fishing and unloading vessel transportation. Many developing nations are deeply concerned about the effects of mangrove loss on the environment and the economy. Estuaries and near-shore fisheries, together with a variety of wildlife and avifauna, are all supported by their primary output. As a result, the ongoing deterioration and depletion of this essential resource will negatively impact villages by reducing both terrestrial and aquatic production as well as wildlife habitats. More importantly, though, it will negatively affect the environmental stability of coastal forests, which protect inland crops.

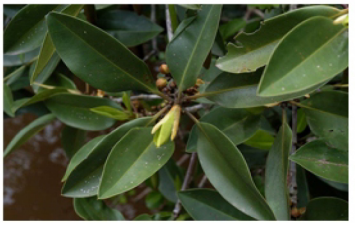
Mangrove forests offer practical advantages to human societies in addition to their ecological significance. Historically, mangroves have provided coastal populations with commodities like fuelwood, lumber, and nontimber forest products. Since these places serve as breeding grounds and homes for fish species that are vital to the fishing industry, many people depend on the fisheries associated with mangrove ecosystems for a living. Several hazards affect mangrove forests, such as habitat degradation from urbanisation, the growth of aquaculture, and climate change. The sustainability of these significant ecosystems depends on conservation efforts. By acknowledging and preserving the ecological, financial, and protective advantages that mangrove forests offer to coastal ecosystems and the populations they support, we can achieve sustainable coexistence.

MANGROVES OF PUDUCHERRY

Three families of true mangrove flower species (Class: Dicotyledonae) have been recognized. *Avicennia marina,* first identified by Blasco in 1975, is a true mangrove that grows rapidly and disperses throughout the flooded area. It forms a dense stand along the tiny creek and near to the bridge on Thengaithittu's western and northern sides. Another notable A. marina cover can be found on the eastern section of Ashram Islet along the creek, as well as the western portion of Murungapakkam. From the western end of Murungapakkam to the eastern end of Ashram islet, *Bruguiera cylindrica* grows thick. However, *B. gymnorrhiza* can only be found in patches in the creek at the Ashram islet. *Acanthus ebracteatus* and *Acanthus illicifolius* parts can be found throughout Murungapakkam, Ariankuppam, and Thengaithittu. *Rhizophora mucronata* can be found in four patches on the southern side of Thengaithittu, while *R. apiculata* and *R. mucronata* are found in four patches at the river's mouth.

Mangrove partners: Clerodendrum inerme is found in every site of the sixteen mangrove-associated floral species from 12 families that have been described. Every flooded region has *Thespesia populnea, Aleuropus logopoides, Pongamia pinnata, and Calophyllum inophyllum. A.logopoides* is the only monocotyledon in the Graminales class; the rest are in the Dicotyledoneae class. The southern end of Ashram islet and the eastern end of Thengaithittu are primarily covered by *Sesuvium portulacastrum, Suaeda maritima,* and *Suaeda monoica.*

ORDER	FAMILY	SPECIES / COMMON NAME	PICTURE
Labiales	Avicenniaceae	*Avicennia marina* White / Grey mangrove	
Myrtales	Rhizophoraceae	*Bruguiera cylindrica* Small-leafed orange mangrove	
Myrtales	Rhizophoraceae	*Bruguiera gymnorrhiza* Large leafed orange mangrove	

ORDER	FAMILY	SPECIES / COMMON NAME	PICTURE
Myrtales	Rhizophoraceae	*Rhizophora apiculate* Tall stilted red mangrove	
Myrtales	Rhizophoraceae	*Rhizophora mucronate* Loop-root/Long fruited stilted red mangrove	
Personales	Acanthaceae	*Acanthus ebracteatus* Sea Holly	
Personales	Acanthaceae	*Acanthus illicifolius* Holly mangrove	

DETERMINING FACTORS OF MANGROVES

Larger tidal amplitude, gently sloping coastal topography, freshwater flow quantity and duration, species diversity, biomass, and productivity all influence the health of the mangrove wetlands concerning hydrology and soil conditions, as well as the mangrove wetlands' wealth in terms of area, productivity, and species diversity. Mangrove trees can endure the intensity of storms, cyclones, and tsunami, but they can only be found growing along the coast where wave energy is minimal or when sand barriers shield the mangrove wetlands from strong waves. For the mangrove plant seedlings to settle, develop, and grow, they need this protection.

Mangroves cannot grow along the coast because most mangrove plants require low salinity conditions for growth and reproduction. Therefore, lush mangrove forests are only found in estuarine regions where a significant amount of freshwater is discharged for a longer period each year. This is the case in the Puducherry and Karaikal regions where a narrow sandy beach situated between the sea and the mangroves prevents the forest from being directly exposed to high-energy waves. The slope of the coastline and the tidal amplitude—which is the difference between high and low tide—determine the area of the mangrove wetlands. The tidal amplitude is nothing more than the momentary rise and fall of seawater caused by the moon's and sun's gravitational pull.

Mangroves thrive in transition zones between terrestrial and marine settings, where salt levels vary due to tide movements. Their ability to endure and adapt to different salinity levels is an important feature in their dispersion. Mangroves require nutrient-rich sediments for growth. Sediments in mangrove ecosystems serve as sinks for nutrients transported by rivers and tides. Anthropogenic activities, such as deforestation and agriculture, can affect nutrient levels and mangrove health. Various environmental conditions influence mangrove development and dispersal, resulting in diverse ecosystems. Understanding the determining elements is critical for successful mangrove management and conservation. Salinity, waterlogged conditions, tidal movements, soil, temperature, light, freshwater supply, wave motions, and storm events highlight the delicate balance of mangrove ecosystems.

HABITAT IN MANGROVE WETLANDS

Mangrove wetlands are biodiversity hotspots that sustain a wide variety of species. They act as important nurseries for many marine creatures, providing refuge and food for juvenile fish and crustaceans. Birds, animals, and reptiles also live in these places. Mangrove wetlands frequently contain vast mudflats and sediments. These sites contribute to nitrogen cycling and serve as habitats for burrowing organisms like crabs and molluscs. Mangroves' dense foliage and extensive root systems serve as natural barriers, protecting the coastline from erosion, storm surges, and tsunami.

The specific characteristics of the mangrove habitat vary depending on the species present, the surrounding conditions, and geographical location. The plant community in the mangrove environment is classified into two types namely, true mangrove species and associate mangrove species. True mangrove species are found only in the mangrove wetlands whereas associated species are found both in the mangrove environment and in the nearby areas. Globally a total number of About 69 species in 27 genera, belonging to 20 families are considered as true, mangrove species. All these species can grow in saline water but only a few of them can tolerate high salinity. For example, *Avicennia marina* can tolerate soil salinity as high as 90 grams per litre but many of the mangrove plants grow luxuriantly only in places where salinity is between 10 to 20 grams per litre.

UNIQUE FEATURES OF MANGROVES

Mangrove plants tolerate the salinity of the soil and water in the following ways:

- **Salt excretion:** Some mangrove plants take saline water as such through their roots. But in the tissues, only water molecules and essential salts are retained. Excess salts are excreted through salt glands that are present in the leaves.
- **Salt exclusion:** In some of the mangrove plants the roots possess an ultra-filtration mechanism called reverse osmosis by which water and salts in the seawater are separated in the root zone itself and only water is taken inside, and the salts are rejected (reverse osmosis mechanism is widely used for producing drinking water from seawater!).
- **Salt accumulation:** In this type of mangrove, plants possess neither salt glands nor an ultra-filtration system, but these species can accumulate a large number of salts in their leaves.

Mangrove regeneration is a potential countermeasure to global warming, as it significantly lowers carbon emissions. Mangrove trees are crucial in the global carbon cycle, absorbing and storing carbon, which helps slow down climate change. Policymakers should consider using mangroves in the carbon market, trading, and REDD (Reducing Emissions from Deforestation and Forest Degradation). Mangroves in India must be preserved for their ecological functions, with active community involvement needed to mitigate climate change effects. Mangrove sediments support microbial communities crucial to nutrient breakdown and cycling, maintaining the ecology around mangroves.

Mangrove habitats are hotspots for biodiversity, supporting a variety of marine and terrestrial species. However, India's east coast is more susceptible to sea level rise due to its smooth slope, unlike its west coast. The 2004 tsunami caused a rise in coastal soil salinity, altering the species mix of flowers and impacting benthic animals in mangrove sediments, especially on the east coast.

CARBON SEQUESTRATION

Mangrove forests can store and store carbon three to four times more than land-based forests, potentially sequestering around 24 million metric tons of carbon annually. They require fine-grained growth material, robust shorelines, salty water, and a wide tidal range to thrive. Mangroves contribute to 14% of ocean carbon sequestration and 1% of global forest carbon sequestration. However, their carbon reserves are disrupted, leading to significant gas emissions. Mangroves have varying production rates and carbon production-respiration balances, making large reductions in greenhouse gas emissions unachievable without passive and active CO_2 capture and storage. They can benefit from investing more fixed carbon in producing highly expensive root systems that turnover quickly to maximize water gain. Carbon is deposited in mangroves through direct carbon inputs into the soil pool and increased mass sediment formation, but much of it is lost in the short and medium term through clear-cutting, human usage, decomposition, and export to adjacent ecosystems.

If mangroves' high per-hectare carbon reserves are disrupted, considerable GHG emissions could result. The mangrove forest floor is distinctive, with cracks, fissures, vast roots, tunnels, tubes, and drainage channels. Its dynamic nature promotes non-steady-state early diagenesis of organic matter in the soil. On average, carbon respiration over the surface soil-air/water interface equals just 25% of the total carbon mineralized within the entire soil horizon. Subsurface respiration is the second-largest respiratory flux after canopy respiration.

Statistical models were constructed to predict mangrove soil organic carbon where it had not before been observed. A suite of climatic variables typically used in species distribution modelling and earlier global mangrove modelling efforts were generated using historical climate datasets for all global mangrove locations using a global mangrove presence/absence mask, as stated. Previous worldwide soil carbon mangrove modelling research included non-climatic factors such as tidal range, river discharge, and geomorphological context. However, only climatic predictors were utilized in this study, recognizing the need to better understand how the magnitude of anticipated climate change will affect future mangrove carbon reserves.

CHALLENGES IN MANGROVE

Mangroves are frequently destroyed for a variety of reasons, including agriculture, urbanization, aquaculture, and infrastructural construction. Such operations fragment and deplete mangrove habitats, compromising ecosystem function and biodiversity. The conversion of mangroves to shrimp farms and other commercial purposes is a major concern. Mangroves face a serious threat from rising sea levels caused by climate change. Climate change also causes extreme weather events like cyclones and hurricanes, which can cause significant damage to mangrove forests. Pollution from agricultural runoff, industrial discharges, and poor waste management contaminates mangrove ecosystems. Heavy metals, plastics, and other contaminants harm the flora and wildlife of these habitats. Mangroves are frequently managed in isolation, without regard for their connectivity with neighbouring ecosystems such as coral reefs and seagrass beds. Effective conservation requires integrated management approaches that take into account the entire coastal ecosystem.

Except for Sundarban, Indian mangroves lack density and health. Threats to species diversity in Indian mangroves include deforestation for urbanization, aquaculture and agriculture expansion, reduced freshwater flow, marine and coastal pollution, siltation, sedimentation, and high salinity levels. Deforestation and overexploitation of mangrove resources have led to the creation of open marshy land covering approximately 100,000 ha.

Mangrove habitats worldwide are under threat from human activity and climate change. Mangroves are the only marginal ecosystem that distributes resources with neighbouring habitats. Adverse effects on mangroves could have major ramifications for nearby fragile and essential ecosystems like coral reefs and seagrass meadows. Mangrove damage disrupts the sediment budget and contributes to coastal erosion. Mangroves provide several ecological and economic benefits that cannot be quantified. Mangrove conservation should be a top focus in national conservation efforts. Understanding the status and species composition of mangrove forests is essential for managing and conserving these resources. Collecting detailed species information for mangroves is crucial.

MANGROVES FOR FUTURE

India is a pioneer in bioprospecting the mangroves, which are a rich source of salt-resistant genes, novel chemicals and high value products such as (i) black tea beverages, (ii) mosquito repellents, (iii) lignins for controlling oral and cervical cancers, (iv) polysaccharides from preventing the Human Immunodeficiency Virus (HIV) that causes AIDS, (v) anti-diabetic extract, (vi) hair growth stimulant, and (vii) rapid synthesis of nanoparticles. Further studies in this aspect will lead to the development of patents, processes, and valuable products including medicines. Mangroves operate as natural buffers, shielding coastal areas from storm surges and erosion. Protecting and restoring mangrove forests helps coastal communities withstand the effects of climate change. Mangrove biodiversity conservation efforts help to improve the overall health of coastal ecosystems. Use drone technology with high-resolution cameras and AI algorithms to monitor mangrove health and detect unlawful activities like encroachment or logging. This strategy can aid in efficient and timely surveillance across large areas. Launch a community-driven project in which individuals, businesses, and institutions can "adopt" a patch of mangroves. Balancing local community demands with mangrove ecosystem conservation is critical for guaranteeing fisheries' long-term viability. Recognising mangroves' significance as carbon sinks and incorporating them into climate change mitigation plans is critical for addressing the larger issue of greenhouse gas emissions.

Sustainable management approaches and community-based conservation activities can assist achieve a balance between human demands and environmental preservation. Mangroves' future conservation depends on raising public awareness and understanding of their importance. Educational programmes, community engagement, and ecotourism can help to instil a sense of responsibility and stewardship among local communities and the general public. Balancing the needs of economic development, habitat protection, and community well-being necessitates coordinated actions on the local, national, and international levels. Investing in research to investigate novel mangrove applications, such as phytoremediation to clean polluted water or the development of new medications derived from mangrove plant extract. This could lead to new ways to use mangroves' unique qualities to promote sustainable development.

CONCLUSION

The Mangroves are the salt-tolerant forest ecosystems of tropical and subtropical intertidal regions of the world. This paper has picturized the nourishment of the forest, and mineral-rich river-borne sediments enrich the swamp and proved the mangroves derive from both marine and terrestrial influences. Evidence to prove that the mangroves as one of the most productive ecosystems and a natural, renewable resource are sorted and proved with needful references. There is also a rising threat of climate change especially sea level rise in low-lying coastal areas of the country. The genuine flora species of Puducherry Mangroves are tabulated with their core details as certain the core significance of the same. Statistical models were constructed to predict mangrove soil organic carbon where it had not before been observed. A suite of climatic variables typically used in species distribution modelling and earlier global mangrove modelling efforts were generated using historical climate datasets for all global mangrove locations using a global mangrove presence/absence mask, as stated. Further, this paper throws light on the future mandates for the mangroves in India for the required restoration to match the ecosystem, with strong involvement of community participation to mitigate the impacts of climate change.

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Puducherry ENVIS Hub Environment Events (Jan – March, 2024)

Puducherry EIACP Hub organized mass awareness campaign and also conducted various competition i.e., Quiz, Elocution, Drawing etc. on Mission LiFE at Schools, Colleges & Industries in the U.T. of Puducherry.

SL. NO.	REGION	NO. OF INSTITUTIONAL VISITS	NO. OF PARTICIPANTS
1	Puducherry	10	1258
2	Karaikal	8	836
3	Mahe	8	724
4	Yanam	8	1233

Workshop

Puducherry EIACP PC Hub in collaboration with Centre for Pollution Control and Environmental Engineering, Pondicherry University and Citizen Science Task Force - Purpose conducted a One Day workshop on "Perspective of Circular Economy through Implementation of Solid Waste Management Rules" on 11.01.2024 at Centre for Pollution Control and Environmental Engineering, Pondicherry University. 130 students and staff were participated.

World Wetlands Day Celebration

Puducherry EIACP PC Hub in coordination Puducherry NSS Cell and Universal Eco Foundation jointly organized the following activities on the occasion of World Wetlands Day on 30.01.2024 at Kazhuveli lake. Awareness Lecture, Wetland Walk, Birds Identification & Field Survey Training, Pledge on Wetlands Conservation, Elocution Competition on the topic “Wetlands and Human Wellbeing” and Infographics released.150 students from Puducherry NSS Cell and various college students participated.

EIACP PC HUB PUDUCHERRY

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