Understanding the Ecosystems of Puducherry & their Restoration Challenges

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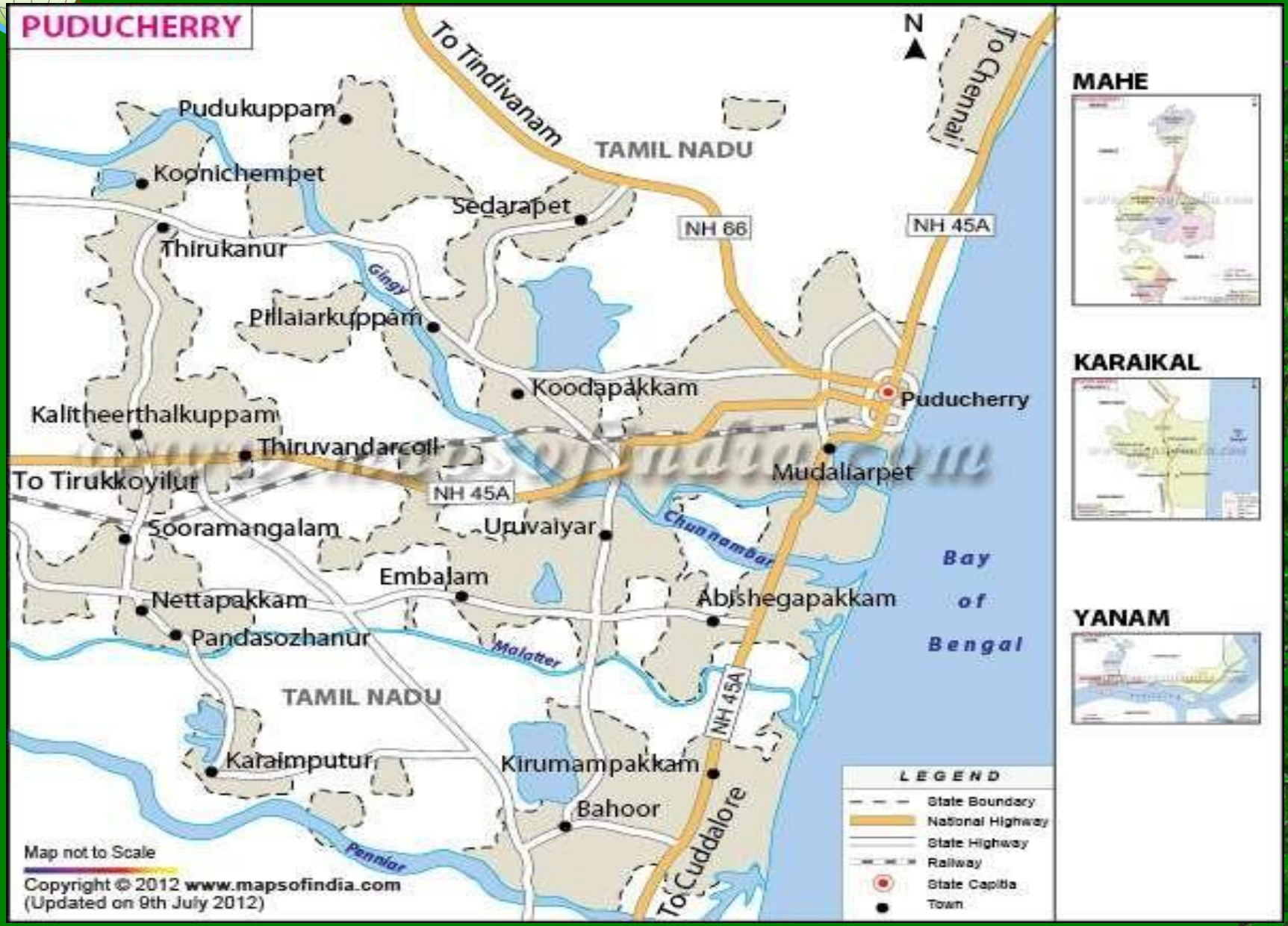
WED, 5th June 2021 Webinar

Presentation outline

- Introduction
- Definitions
- Classification of Puducherry Ecosystems
- **Terrestrial**- Rural (Agroecosystems & settlements) & urban/peri-urban (urban/peri-urban ecosystems & settlements)
- **Aquatic -** Freshwater (lentic & Lotic) , estuarine /Back waters, coastal
- Challenges and opportunities for Eco-restoration

Ecosystem-the complex community of living organisms, their physical environment, and all their interrelationships in a particular unit of space – local, regional, national, global

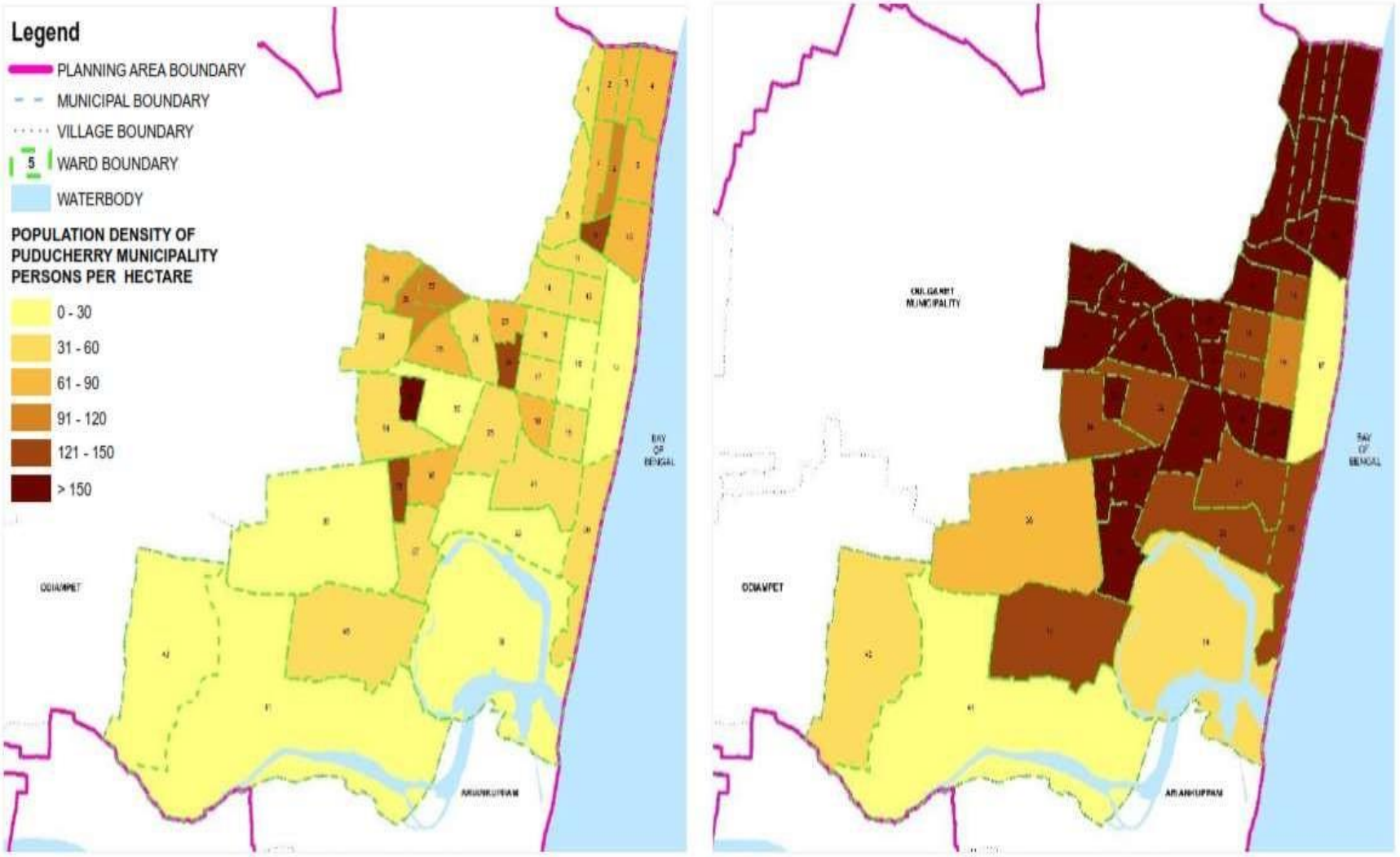
- Key characteristics of Ecosystems
- An Ecosystem is basically an energy processing and nutrient regenerating system.
- Almost all ecosystems have producers, consumers & Decomposers - connected by food webs & feed back loops
- Ecosystems have no fixed boundaries- overlaps & hidden linkages - transitional ecotones – River→ estuary /back water→ sea; Rural →Peri urban→Urban (E.G. land based pollution in sea water)
- Though Ecosystems have the capacities for resilience & regeneration, they have limited carrying and absorbing capacities- only dynamic balance- Habitat /Biological Diversity- Ecosystem services- livelihoods - SDGs


PUDUCHERRY
N
To Tindivanam
To Chennai
TAMIL NADU
Pudukuppam
Koonichempet
Sedarapet
NH 66
NH 45A
Thirukanur
Gingy
Pillaiarkuppam
Koodapakkam
Puducherry
Kalitheerthalkuppam
Thiruvandarcoil
Mudaliarpet
To Tirukkoyilur
NH 45A
Sooramangalam
Uruvaiyar
Chunnambar
Bay
of
Bengal
Embalam
Nettapakkam
Abishegapakkam
Pandasozhanur
Malattar
TAMIL NADU
NH 45A
Karaimputur
Kirumampakkam
Bahoor
Pennar
To Cuddalore
LEGEND
State Boundary
National Highway
State Highway
Railway
State Capital
Town
Map not to Scale
Copyright © 2012 www.mapsofindia.com
(Updated on 9th July 2012)
MAHE
KARAIKAL
YANAM

Puducherry region- Key details

- **Area** – 294 Sq Km; Average **elevation** -11 MASL
- **Human Settlements** - 5 towns and 2 municipalities,
- 5 communes & 81 revenue villages , 182 slums
- **Total Population (2011)-** 9,46,000
- Population density/Sq Km -3231 ;Decadal growth rate -29.2%

- **Climate** - tropical wet and dry climate
- Average **Rainfall** -1240 mm/yr around 63% is received during NE monsoon from June to Sept ember, while the remaining is scattered sporadically throughout the year
- Annual **evaporation** -1600 mm.
- **Temperature** - Summer- 36 °- 40°C, & Monsoon - 17 - 22 °C
- Relative humidity - 60% of 70%
- Prone to **cyclone/severe cyclones**, originate from the Bay of Bengal and move in a Westerly North Western direction- Flooding & drought if monsoon fails or meagre



Population Density 2001

Population Density 2011

Figure 2.3 Population Density Map of Puducherry Municipality, 2001 & 2011

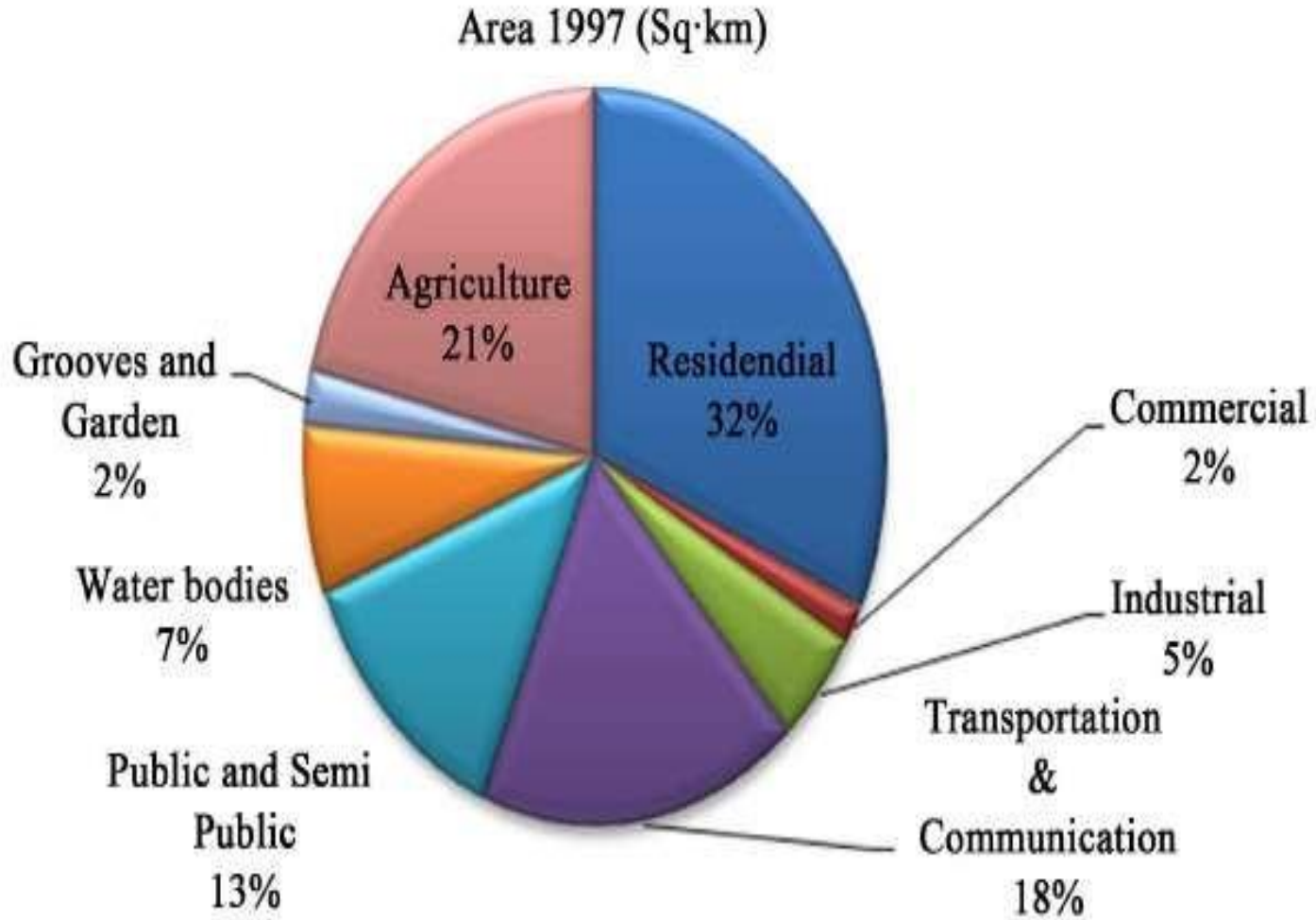
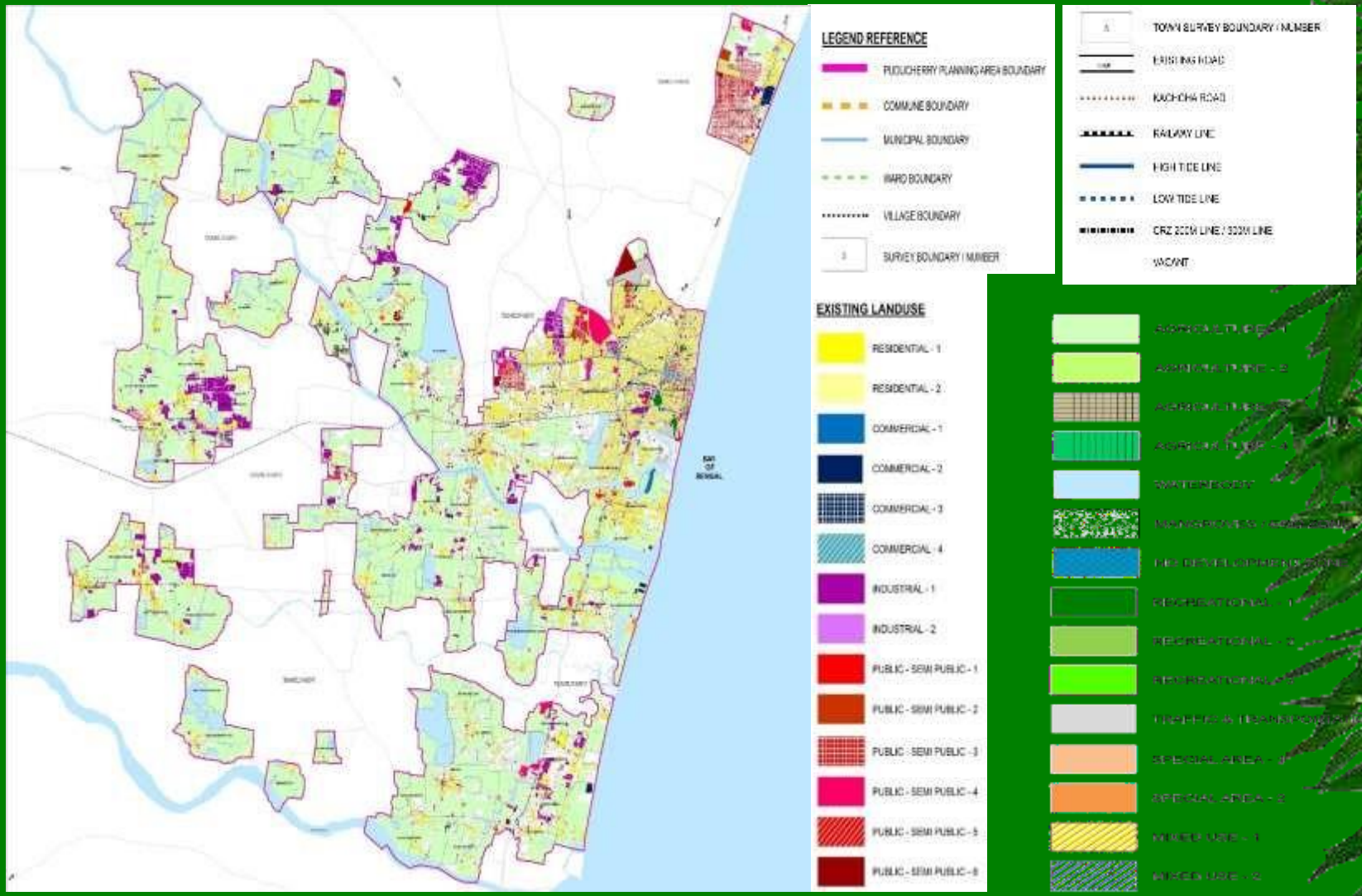


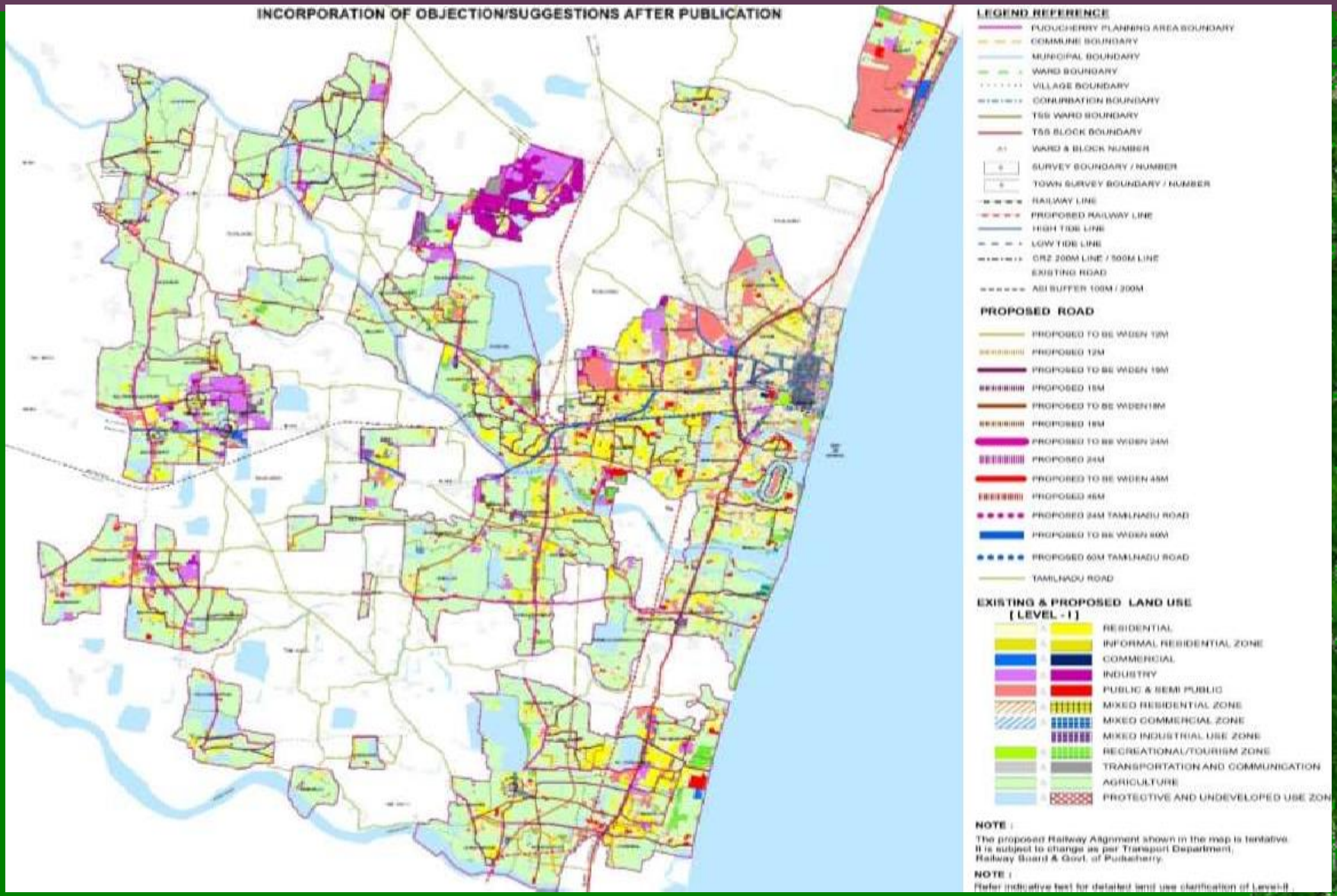
Figure 4. Percentage of Land use (1997).

Existing Land Use Map of Puducherry Planning Area – 2015

Published for adoption by PPA on 12.01.2017



Proposed Land Use Map 2036



Key Environmental Problems – causative factors

- Expanding population/tourism/EIs vs. infrastructural facilities
- Improper agricultural practices – GRA/BTA- excessive usage of water, fertilizer, pesticides, mono cropping- erosion of traditional varieties
- Conversion of large tract of agricultural land / wetlands – C sink?
- Unregulated sand / red earth mining
- Habitat degradation – GW? WL? Fisheries? Common property resources?
- Dumping of un-segregated solid wastes- MSW/BMW- burning? GHGs
- Air /noise /water pollution on the rise

Current MSW/BMW handling management

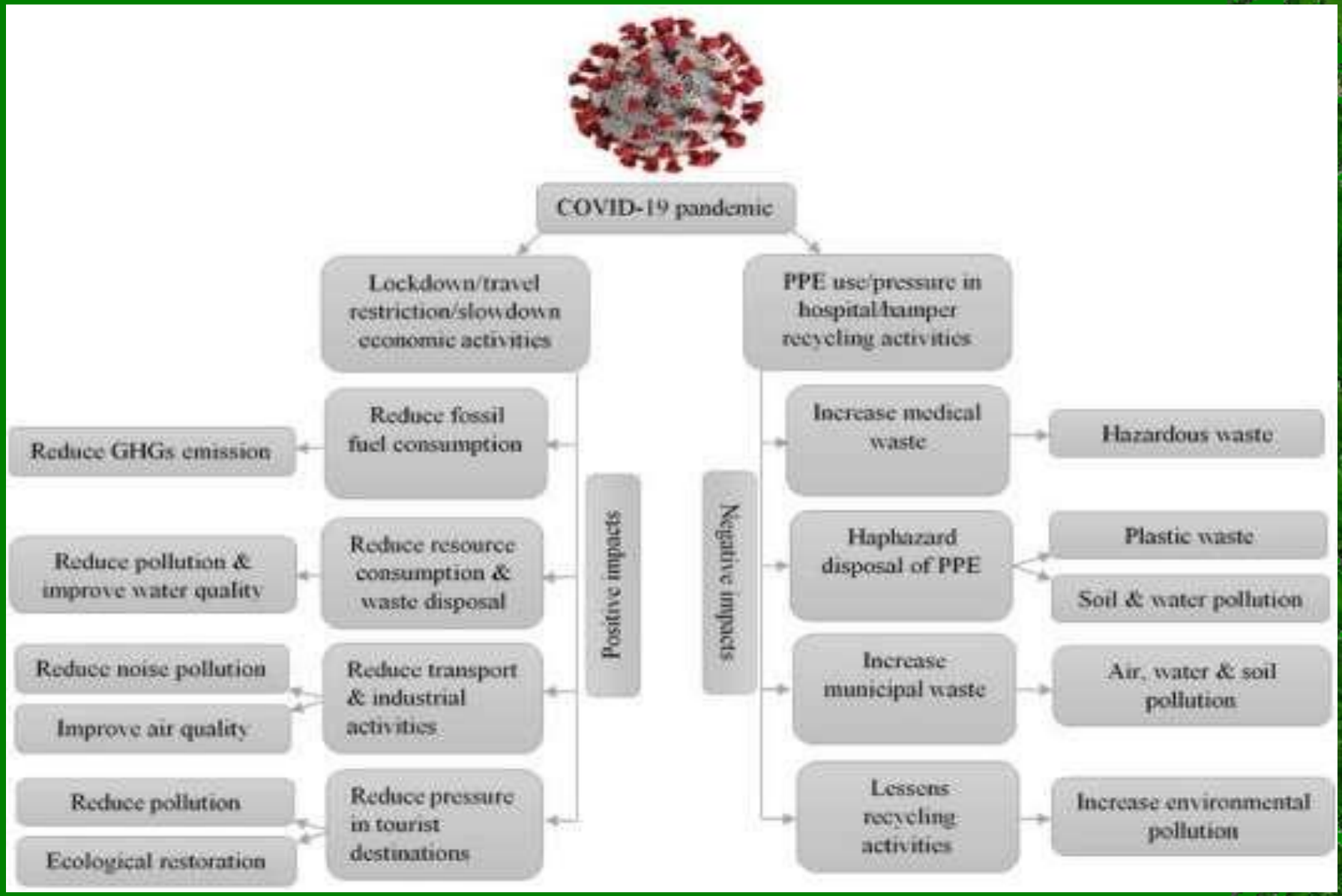
- No source level separation – NIMBY syndrome- mixed wastes (MSW & BMW- both infectious & non infectious) indiscriminately dumped
- 95% of the MSW generated in Puducherry have an economic value; 35-45% is biodegradable i.e. market, butchery, kitchen or garden waste; 35% is recyclable i.e. metal, paper and plastic.
- Piles of unattended garbage on the roadsides-choked sewers, streams and rivers; stink, flies, overflowing landfills - stray animals- dogs, pigs, cows in at storage & dump sites -diseases such as malaria, dengue, cholera, jaundice, gastroenteritis

- The region generates 50 million litres per day (MLD) waste- water with the entire amount discharged largely untreated into the sea
- Several water-intensive industries such as paper, alcoholic beverages, chemicals and pharmaceuticals, besides tourism & educational institutions- currently water intensive industries are not granted permission
- Remedies - aquifer mapping and assessment at local/regional levels to facilitate participatory sustainable water resources management; Water budgeting/ water foot prints ? Advanced rainwater harvesting (ARH) and Managed Aquifer Recharge (MAR) to recycle underutilized storm water and treated wastewater - a low-cost, low-energy water supply option

- Sewage wastewater contains biochemical oxygen demand (BOD) with 47 compounds including traces of oil and gas

- Civil Society Organizations (CSOs) - experienced in NRM and SD - play a critical role for training capacity building exercise - stake holders, in close co-ordination with Central Ground Water Board (CGWB), State Agencies (State Ground Water Board & PWD), and Research-Academia can play key roles – Citizen science networks?

Covid 19 pandemic & its Environmental implications (Rume& Islam, Heliyon, 6 (2020) e04965)



Coast line length -24 km -marine plain width -400 to 600 m - 15 coastal fishing villages

- Beaches are generally narrow -undergo severe erosion along the Northern segment ; in the Southern segment, beaches are comparatively broad and depositional.

- Barrier dunes are seen as continuous mounds between Ariyankuppam, Kirumambakkam, Manapattu and Narimedu areas. Dunes are also seen almost on the entire coast except at Manaveli, Pooranankuppam and Manapattu coastal blocks

- At least 7 km of the coast is undergoing erosion due to man-made interventions such as construction of Puducherry harbour, ,seawalls and groynes-7 break waters , 6.8 Km sea wall (rip rap)

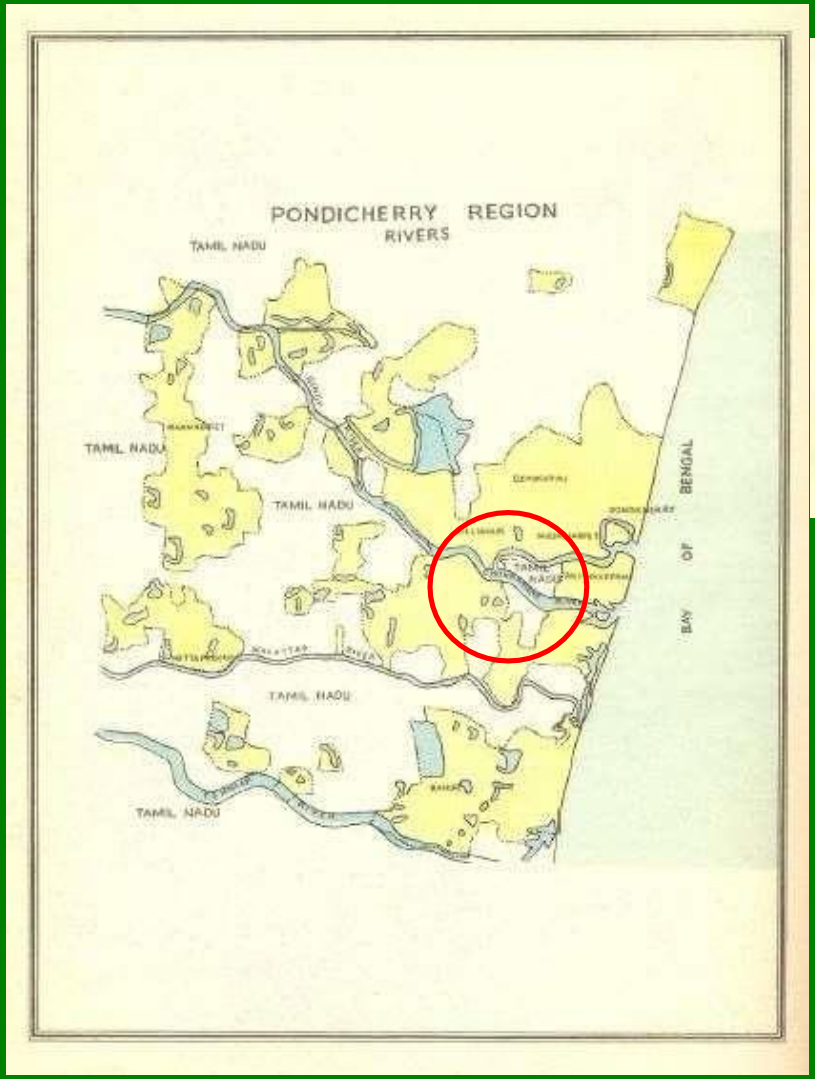
Rivers, lakes and wetlands of Puducherry

- **Rivers**: two river basins in Pondicherry – Gingee & Pennaiyar; Both are seasonal and run dry when rain ceases.
- **Lakes**: Bahour and Oussoudu

- **Bahour** the second largest lake –depends on its catchment for 75% of its water, the rest from diversion channels. seasonal (5-6 months) receives water during the monsoon **Oussoudu** is the largest lake -partly in Pondicherry and partly in Tamil Nadu-rich in flora and fauna- 200 flora -a major wintering ground for migratory birds-40 species (C. 20,000), one of the 93 significant wetlands in Asia

- Threats and pressures from anthropogenic activities- pollution , poaching , encroachment -Turbidity, COD, BOD , DO, Arsenic and Lead are higher than the stds

Vanished River of Puducherry (Ariyankuppam River)



II. RIVERS.

Pondicherry Region.

There are two important rivers one being the River Gingy which traverses the region diagonally from North-West to South-East and the other, Pennaiyar, which forms the Southern border of the region.

The River Gingy has her source at the hills of Malayanur in the South Arcot District of Tamil Nadu and has a course of 34 kilo metres in this region. However, at a distance of 7 kilo metres off the Bay of Bengal she divides into two branches known as Ariankuppam River and Sunnambar. The Vikravandi River, Pambaiyar and Koduvaiyar are the affluents of the River Gingy. These affluents flow on the right side of the Gingy River. It will also be worthwhile to point out that Pambaiyar traverses for about 13 kilo metres in the Pondicherry Region before merging with the Gingy River while the Koduvaiyar flows for 12 kilo metres before joining the Sunnambar near Thirukanji.

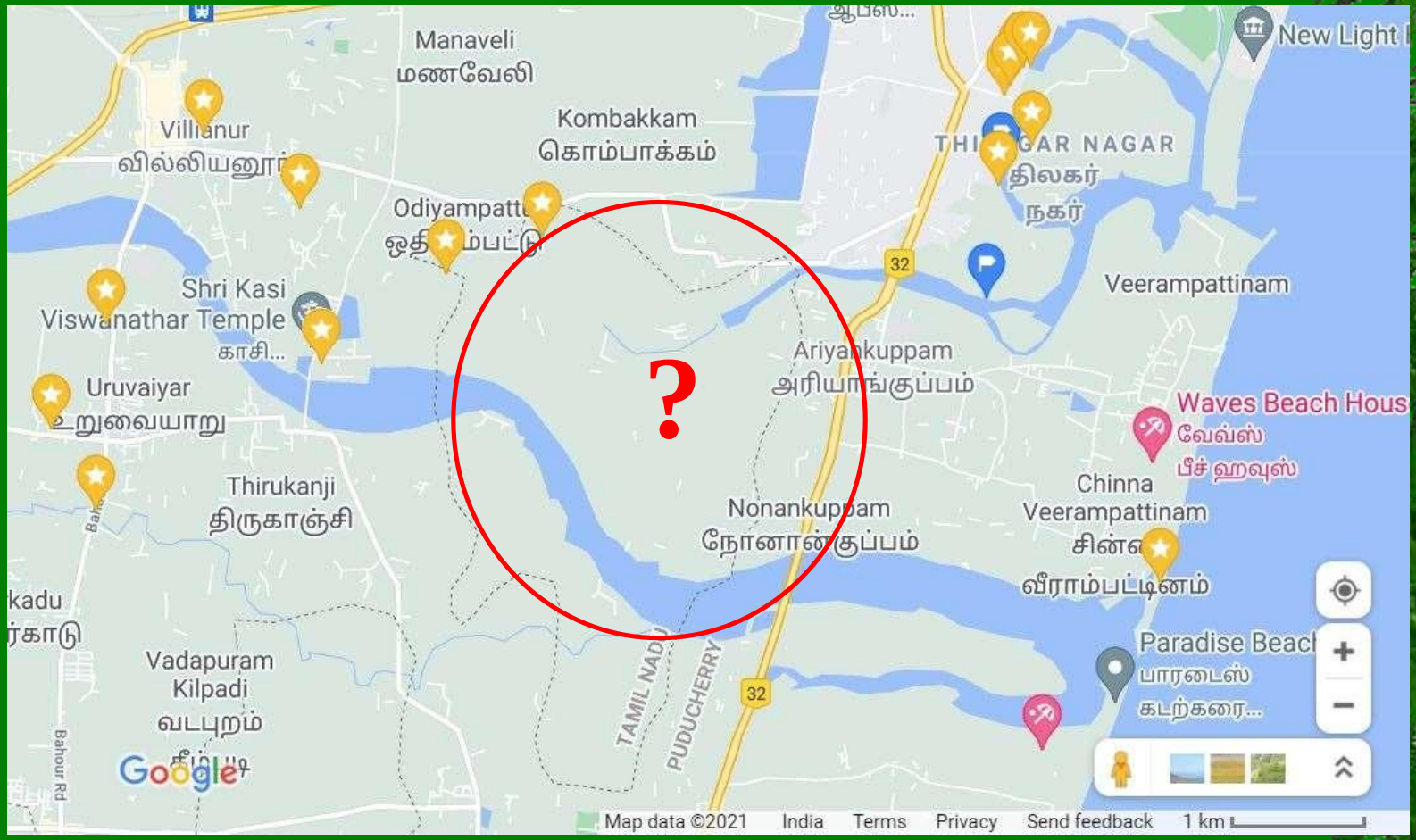
The branch river of the Pennaiyar is known as Malattar. The Malattar flows through the region touching the villages of Nettapakkam, Pandasozhanur, Nadunayagapuram, Sambadapet, Vadukuppam, Manakuppam, Kamblikaranikuppam, Karikalampakkam and Thammanayakkanpalayam, and discharges the water directly into the sea near Pannithittu and Aladimedu.

There are two dams, one across the River Gingy at Vidur and the other across the Pennaiyar at Somavoor. These two projects divert the flow of the river water into canals which feed the irrigation tanks.

Source: Statistical Atlas of the Union Territory of Puducherry – Bureau of Statistics and Evaluation, Government of Puducherry (1976)

Ariyankuppam River a distributary of Sankaraparani River near Thirukanchi - missing now due to encroachment, its origin was cut off- it has become a back water that receives both solid and liquid wastes from the adjacent human settlements - impeding free flow of water

Source - PWD Irrigation System Map (https://pwd.py.gov.in/document/Irrig_map.PDF accessed on 02-06-2021



Google Map - 2021

- **Water resources** - undervalued & overused without regard to current costs & future requirements – total reliance on GW - inter sectoral conflicts; Puducherry Region is not contiguous -areas surrounded by Tamil Nadu -transboundary conflicts
- Surface water bodies (84 Lakes and 600 ponds) will get filled with water during the NE monsoon (October to December) , if the RF is adequate- facilitate recharging of GW- the inlets, catchments and parts of waterbodies themselves are encroached upon- urgent need for removal of encroachments & restoration/rejuvenation of waterbodies (desilting & using the silt in farmlands) to ensure recharging is sustainable.
- In 15 villages-GW has become saline-water supplied through tankers
- Tanks – support BD & ESS -provide economic benefits
- Tanks-degraded over time due to the bore-well technology ,demanded by Hybrid based GRA- CB Tank rehabilitation -SLED

Current status of ground water

- Ground water status: Urbaniztion- declining trend over 10 years is of the order of 15 to 30 m in the West and about 7 m in the Eastern part of Puducherry ; declining water quality

- Over pumping- Reversal of gradient in certain areas like Kalapet, Muthialpet, Mudaliarpet, Kirumambakkam, and Panithittu

- Effects of Industrial Pollution – depletes surface and ground water: Contaminated with heavy metals, salts and fluoride

- Resulted in Closure of 2 borewells in Mettupalayam Industrial Estate

Wetlands

- Wetlands directly and indirectly support millions of people in providing services such as food, fiber and raw materials, storm and flood control, clean water supply, scenic beauty and educational and recreational benefits- Important Bird Areas

- Threatened by - encroachment by farmers, wildlife poaching, loss of the surrounding forests, increased siltation, dumping of solid/liquid wastes, increased commercial prawn farming→ habitat degradation & over exploitation → alteration of wetland characteristics, species composition and density→ Loss of BD/ESS

Ariyankuppam back waters (Vijayakumar etal 2012)

- Biologically rich but highly vulnerable ecosystem- receiving large quantities of largely untreated municipal and industrial wastes of the Ariyankuppam town of the Puducherry region. Owing to shallow nature of these areas, disposed mixed MSW - pollutants are highly persistent in the backwaters as flow is impeded due to the loss of connection with the Sankaraparani River

- During March, low DO and high BOD in the upstream water sample of Ariyankuppam Bridge,Kakkayanthoppu and 500m from tidal inlet stations.

- Concentrations of pollution level - dissolved inorganic compounds, and pathogens are significantly higher than the permissible limits

- Salinity concentration - more than the standard value

Mangroves

- According to earlier reports, the coastline from Marakkanam to Karaikal was once covered with thick mangrove vegetation. Their remnants as relics can be seen in the Marakkanam area, the Arasalar estuary in Karaikal and in Ariyankuppam river banks. The Ariyankuppam estuary is seasonally bar-built, it flows eastwards and empties into the Bay of Bengal at Veerampattinam carrying wastes from the adjacent agricultural lands and industries in addition to domestic municipal and industrial effluents- Hydrogen Sulphide smell indicates higher organic pollution load

- Channels are lined by a luxuriant vegetation of small saltmarsh plants, trees, shrubs and thickets, totalling about seven true mangrove species belonging to 3 families and 4 genera including *Avicennia, Rhizophora, Acanthus and Bruguiera*; and 16 mangrove associate plants belonging to12 families. A total of 76 animal species were recorded from four stations including molluscs (37) crustaceans (22), amphipods (7), polychaetes (6), barnacles (3) and oligochaetes(1). Five species of turtles -Olive Ridley turtle -nesting in the Puducherry coastal area

- Watch video -on mangrove by DST & E

Forests & Wildlife

Watch short video Urban Forest Trails

Forests in Puducherry region

- No natural forests- Littoral & Swamp Forests
- Forest cover (Sq Km)Moderate dense forests -10;
- open forest -15
- Lush green scenic treat is due to the soil quality /climate- back yards and Institutions –urbanization?
- Replanted mangroves – both pre and post tsunami - 168 Ha
- Sacred groves - remnants remain (108 in no- http://www.cpreecenvis.nic.in/Database/Puducherry_903.aspx)
- Tropical Dry Evergreen Forest (TDEF) - indigenous forest groves; Farm/community forestry

Fisheries

- Open sea ecosystem, surf beaten, most of the time rough, often exposed to cyclones
- Fishermen population -95,467
- Fresh water Ponds and Tanks
- Brackish water Prawn culture
- Traditional Vs modern crafts & gears – conflicts
- Glaring lack of basic CPUE data over time & space – ICTS?

Habitat modification, Ecosystem degradation, BD loss, Loss of Resilence & Assets

Impacts

- Reduction of Fishery Stocks
- Increased risk for endangered species
- Loss of ecosystems/ ecosystem services

Immediate causes

- Overexploitation
- Eutrophication
- Agricultural/ industrial/ urban pollution
- Construction/ development in the coastal zone
- Port/ Tourism activities
- Global climate change

Underlying causes

- Increased fishing Effort
- Increased technological capabilities
- Non selective Fishing Gear- Illegal, Unreported and Unregulated (IUU) catch
- Uncertainty of assessments
- Overcapitalizaton
- Deficient fisheries control policies

- Poor agricultural practices
- Poor planning
- Lack of capacity/ knowhow
- Lack of wastewater treatment/MSW management
- Weak enforcement

- Poor rural/urban planning
- Inadequate building codes
- Inadequate ICZM
- Lack of mitigation compensation mechanisms
- Weak enforcement of urban regulation

- Poor environmental planning/ coordination
- Lack of assessment of impacts ..
- All due to lack of funding & skilled manpower

Root causes

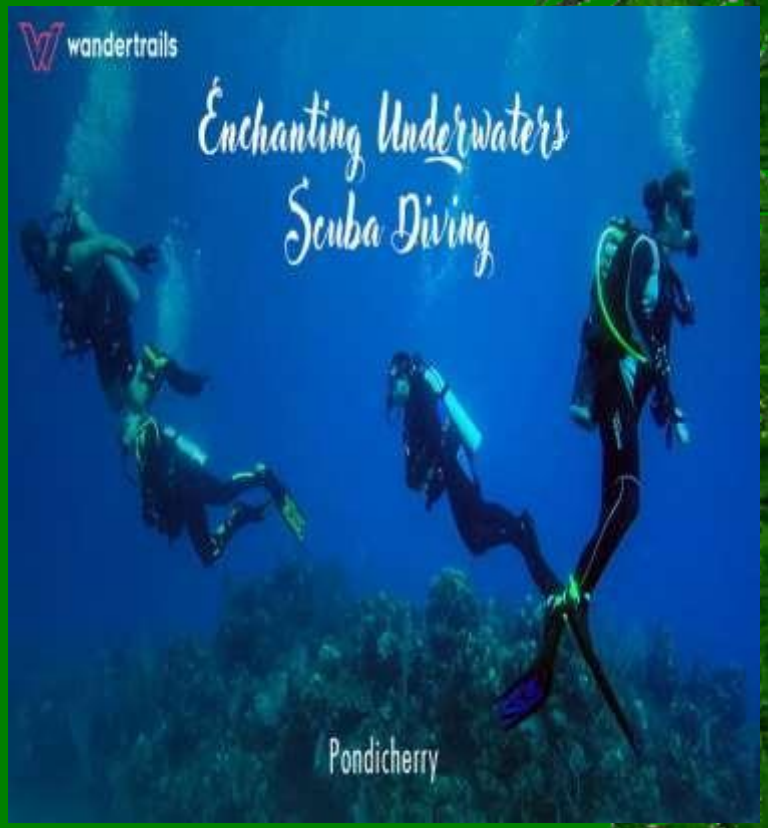
- Lack of participatory-ecosystem approach. Poorly implemented ICZM. Unplanned /uncoordinated growth – sectoral conflicts -profit maximisation as the single goal – greater pressure on CPRs- encroachment, overexploitation / pollution/BD loss

Coastal Fisheries- Tell tale symptoms of non sustainability

- Changing composition of catch, catching of small-sized and juvenile fish; decreasing size of fish; expanding fleet size; use of large quantities of gear; decreasing catch per unit effort; decreasing mesh size; high by-catch rates- more plastic than fish in the catch!

- Microplastics damage aquatic creatures, as well as turtles and birds- block digestive tracts, diminish the urge to eat, and alter feeding behavior, all of which reduce growth and reproductive output. Their stomachs stuffed with plastic, some species starve and die.

- Limited entries? trawl fleet retirement and redeployment, CB CoM of fisheries – CBET using ARs?



Agroecosystems

- Gradual loss of traditional seeds/livestock after GRA
- The arable land is shrinking due to increasing demands from other sectors (institutional, industrial, tourism ..) with land fragmentation further reducing the per capita land availability.
- 1997 - 2017 -conversion of 8.88 sq·km of agricultural land to built-up area.
- The irrigation water available for cultivation is depleting due to the over exploitation of the aquifer through bore wells. The quality of water is deteriorating due to the intrusion of sea water.
- Degradation of soil quality due to chemical intensive farming & salinisation
- Impacts of CC- floods & drought

GRA & its socio-ecological Impacts

- Hybrid monocultures- loss of traditional germ plasm- GMOs? Hybrid HYVs Vs local high yielding resilient “landraces” and their associated genetic diversity, has eroded the “genetic foundation” of its own success of GRA.

- Chemicalization -pollution- fertilizers & pesticides - Soil quality/ biota?

  Heavy reliance on fossil fuels- Environmental impacts- GHG Emission Over-exploitation /degradation of water/aquifers- Hydrology?- Salinization- Soil /human health – immunity?

- Socio-economic problems- loss of self-reliance- increasing debt burden, poverty spirals/traps, suicides?

What is Agroecology ?

- AE is envisaged as a blend of transdisciplinary knowledge systems, interdisciplinary agricultural practices & social movements.

- Food /nutritional security & sovereignty issues- local seeds /livestock-drought & salt resistant/tolerant self reliance & pro poor /pro environment approaches

- The combination of stable/sustainable /climate resilient and diverse production with relatively higher levels of productivity, internally generated and recycled inputs and nutrients, and articulation of both subsistence and surplus for market production- nutritional & health security

As urban areas expand, built area increase, cement covers the landscape→ trigger run off even for a few hours rain to create flash floods- aggravated by the haphazrad dumping of mixed solid wastes into the drain

Greenspaces including vegetation/soil allows for rainwater to penetrate to sub-surface aquifers. Standing surface accumulation is reduced, run-off is greatly slowed. Green buildings/infrastructure, earth based architecture

Absorption, Interception…

Green spaces …absorb particulate matter/noise- pure air

“Beautify”- aesthetics

Provide habitat for animals

Vertical farming/urban gardening

Clean water.

Reduce urban heat islands

Encourage outdoor activity
= healthier populous.

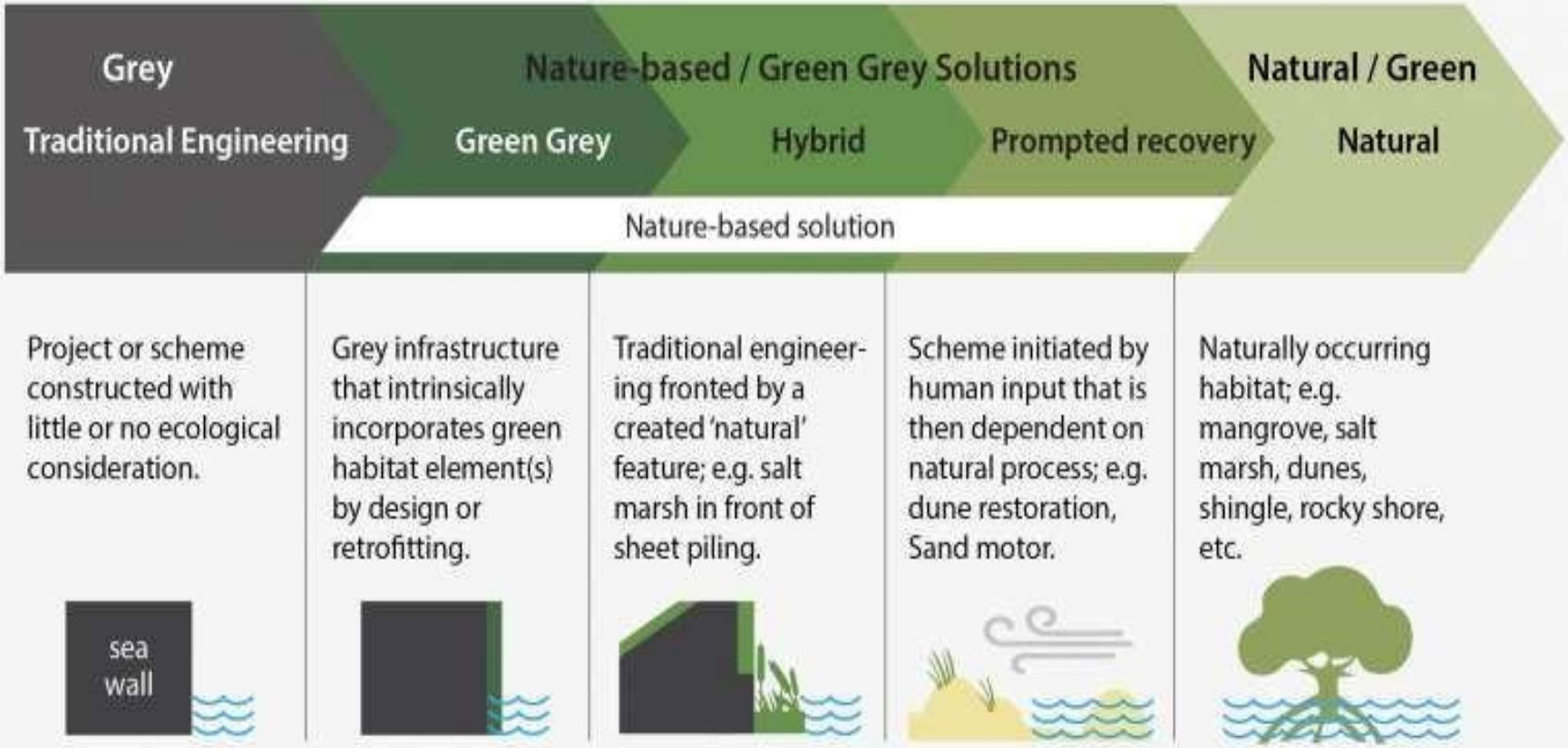
Give kids a place to play Buffer

IUCN Resolution 069 – Defining Nature-based Solutions

Nature-based Solutions Definition:

"**Actions** to **protect, manage and restore natural or modified ecosystems**, which **address societal challenges**, **effectively and adaptively**, providing **human well-being** and **biodiversity benefits**".

**Societal challenges: climate change, natural disasters, social and economic development, human health, food/nutritional security, energy/water security, ecosystem degradation and biodiversity loss.*


Grey
Traditional Engineering
Nature-based / Green Grey Solutions
Green Grey
Hybrid
Prompted recovery
Natural / Green
Natural
Nature-based solution
Project or scheme constructed with little or no ecological consideration.
Grey infrastructure that intrinsically incorporates green habitat element(s) by design or retrofitting.
Traditional engineering fronted by a created 'natural' feature; e.g. salt marsh in front of sheet piling.
Scheme initiated by human input that is then dependent on natural process; e.g. dune restoration, Sand motor.
Naturally occurring habitat; e.g. mangrove, salt marsh, dunes, shingle, rocky shore, etc.
sea wall

Demonstration of Shore Protection Measures

- The Pondicherry coast experiences severe erosion. Environmentally friendly shoreline stabilization measures were demonstrated.
  - Beach nourishment and construction of an artificial reef were implemented. Gain of beach width to an extent of 60 m was observed.
  - The efforts made by ESSO-NIOT was appreciated by Punduchery Government.

Ecosystem restoration - Management of the structure and function of vulnerable ecosystems to achieve a desired future condition that will sustain ecological services and meet human socio-economic needs.

- *SER, BC, Canada*

Ecosystem Restoration is about:

Creating green, abundant, life giving systems

- Work with nature, not against it
- Biogeochemical Cycling
- The flow of energy
- Maintenance of biological diversity& Ecosystem services
- UN Decade on Ecosystem Restoration -2021 – 2030
- Several ER projects have failed as they had a narrow focus- Species or habitat – Eco system approach?
- By 2030, we must nearly halve GHG emissions to prevent devastating climate change.

Eight Principles Underpinning Ecological Restoration

1 ENGAGES **STAKEHOLDERS**

2 DRAWS ON **MANY TYPES OF KNOWLEDGE**

8 IS PART OF A **CONTINUUM** OF **RESTORATIVE ACTIVITIES**

7 **GAINS CUMULATIVE VALUE** WHEN APPLIED AT LARGE SCALES

3 IS INFORMED BY **NATIVE REFERENCE ECOSYSTEMS,** WHILE CONSIDERING ENVIRONMENTAL CHANGE

4 SUPPORTS **ECOSYSTEM RECOVERY PROCESSES**

5 IS ASSESSED AGAINST **CLEAR GOALS AND OBJECTIVES** USING MEASURABLE INDICATORS

6 SEEKS THE **HIGHEST LEVEL OF RECOVERY** POSSIBLE

SER SOCIETY FOR ECOLOGICAL RESTORATION

THE RESTORATIVE CONTINUUM

Improving biodiversity, ecological integrity, and ecosystem services

REDUCING	IMPROVING	REPAIRING	INITIATING	PARTIALLY	FULLY
SOCIETAL IMPACTS	ECOSYSTEM MANAGEMENT	ECOSYSTEM FUNCTION	NATIVE RECOVERY	RECOVERING NATIVE ECOSYSTEMS	RECOVERING NATIVE ECOSYSTEMS

REDUCED IMPACTS

REMEDIATION

REHABILITATION

ECOLOGICAL RESTORATION

SER SOCIETY FOR ECOLOGICAL RESTORATION

Sand dune restoration in Puducherry region

Selection and planting of native, saline tolerant, economic and ecologically valuable species in dune habitat without disturbing the existing coastal vegetation such *as Spinifex littoreus, Ipomoea pes-caprae, Launaea sarmentosa and Cyperus arenarius*; taking care not to disrupt the turtle nesting grounds, i.e., planting at optimum distance and approporate species from the high tide line.

Suggested species - *Aegle marmelos, Alangium salviifolium, Albizia lebbeck, Bauhinia racemose, Butea monosperma, Calophyllum inophyllum, Cassia fistula, Clerodendrum inerme, Cordia dichotoma, Ficus racemose, Hibiscus rosa-sinensis, Madhuca longifolia, Morinda citrifolia, Polyalthia suberosa, Pongamia pinnata, Syzygium cumini, Terminalia arjuna, Terminalia bellirica, Terminalia catappa, Thespesia populnea, Vitex leucoxylon, Wrightia tinctorea, Jatropha curcas*

Paradigm shifts to mainstream ER based on NbS

Photo credit: Flickr/WRI

- T & CB to implement **ER planning & scientific monitoring** ; **strict implementation**
- **Cross-sectoral coordination at ES level**
- Applied Behavioral change through **knowledge sharing/ dissemination –CSNWs through trans-disciplinary approaches- ER camps**
- Encourage **supportive policy -EPI**
- **Funds- public, private & international**
- Social and governance innovation -engage all stakeholders –**PLA & CBCOM- TBNRM**

Useful references and resources

Websites: https://www.iucn.org/commissions/commission-ecosystem-management/our-work/nature-based-solutions; https://www.iucn.org/theme/nature-based-solutions; https://www.gfdrr.org/en/nbs; https://wwf.panda.org/discover/our_focus/climate_and_energy_practice/what_we_do/nature_based_solutions_for_climate/?

https://www.wsp.com/en-US/insights/2020-un-guide-ecosystem-restoration-into-mainstream

Cohen-Shacham E, Walters G, Janzen C, Maginnis S. (eds.). 2016. **Nature-based Solutions to address global societal challenges**. Gland, Switzerland: IUCN. https://portals.iucn.org/library/node/46191

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IUCN. 2020. ***Guidance for using the IUCN Global Standard for Nature-based Solutions****.* A user-friendly framework for the verification, design and scaling up of Nature-based Solutions. First edition. Gland, Switzerland: IUCN. Available online (En/Fr/Sp): https://portals.iucn.org/library/node/49071

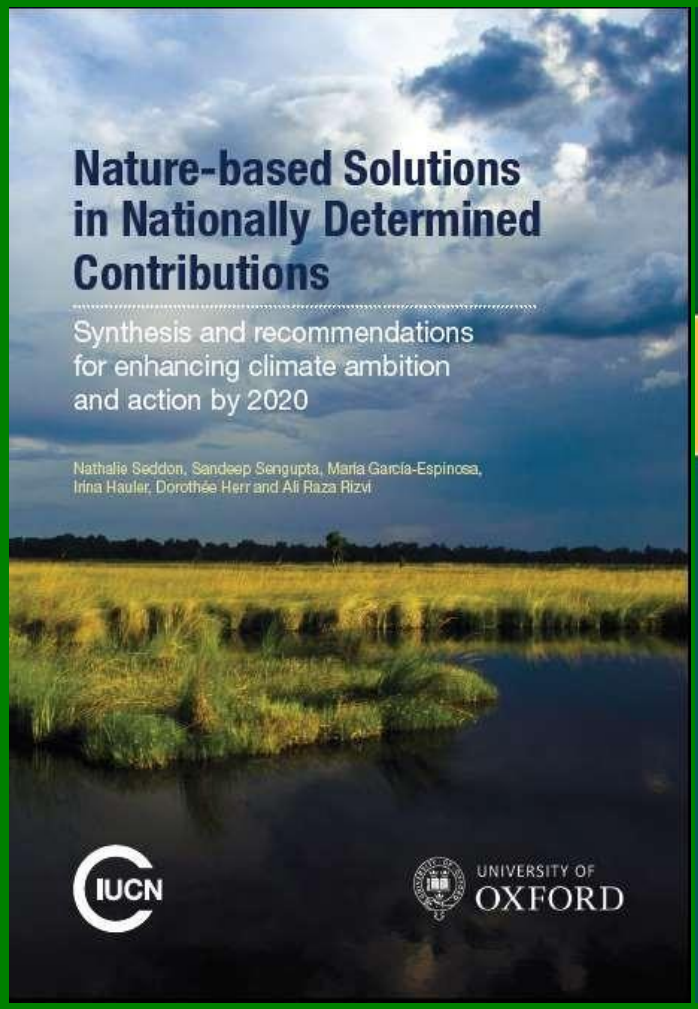
Selected videos

UN Decade on Ecosystem Restoration: 10 years to heal the planet- https://www.youtube.com/watch?v=lcpJ1EbH91c&feature=emb_rel_end

Interactive restoration experience - http://www.onebigrobot.com/IUCN/decade-landscape/,

Together We can Restore the Earth short video - http://www.onebigrobot.com/IUCN/benefits-of-ecosystem-restoration

ER documentary (45 minutes)
https://www.youtube.com/watch?v=YBLZmwlPa8A
https://vimeo.com/262719163


Nature-based Solutions in Nationally Determined Contributions
Synthesis and recommendations for enhancing climate ambition and action by 2020
Nathalie Seddon, Sandeep Sengupta, María García-Espinosa, Irina Hauler, Dorothée Herr and Ali Raza Rizvi
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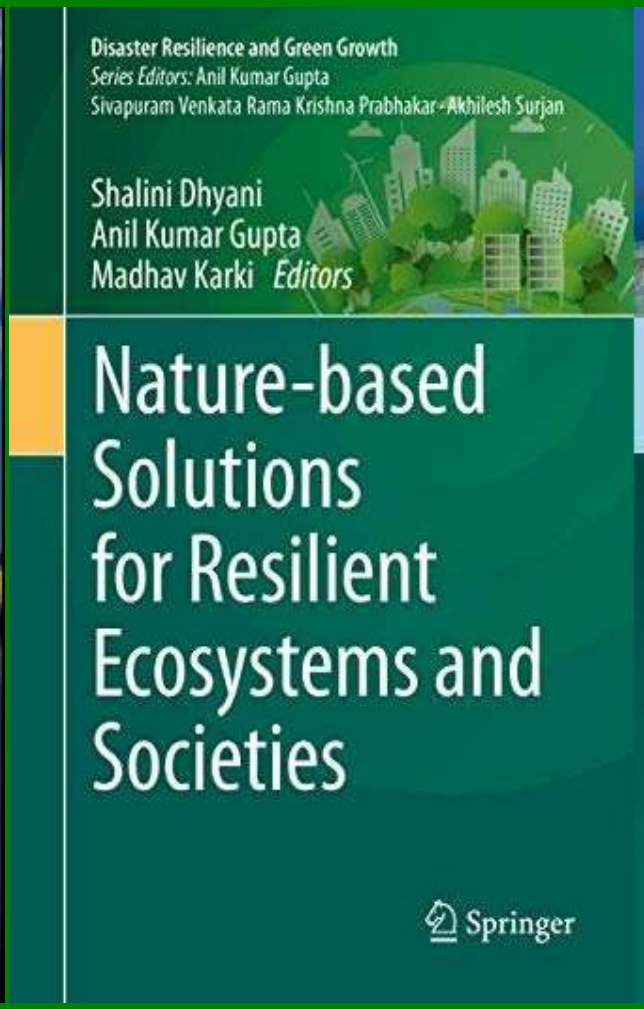
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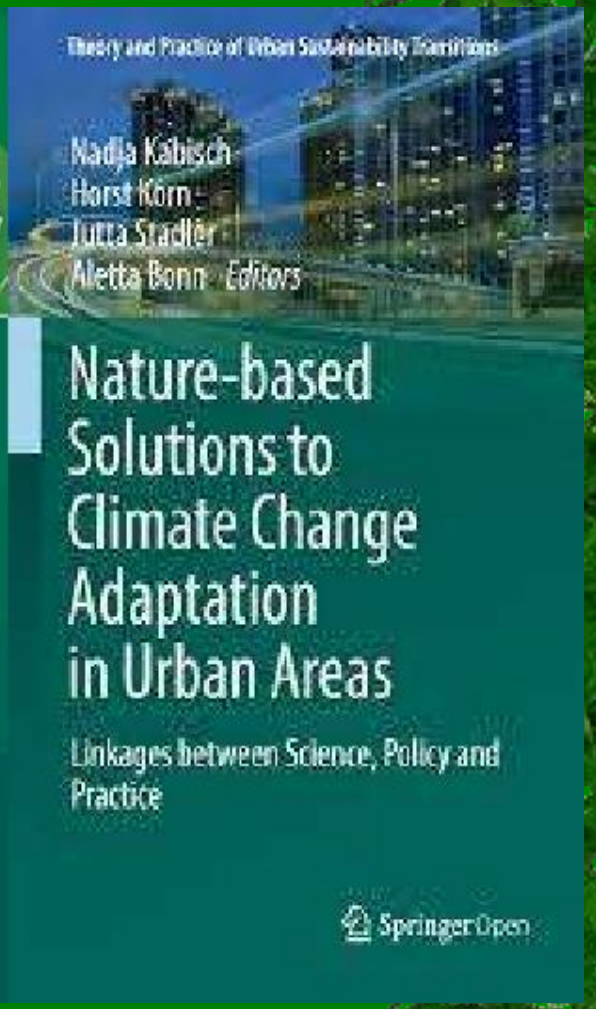
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