Biodiversity and Restoration of Pulicat lake in India

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CHECK LIST OF FIN FISHES

- **Pulicat Lake rich in fish diversity, mostly marine species, some truly brackish water and a few freshwater species.**
- **In this lake a total of 59 species of fishes have been identified. It includes both Class: Elasmobranchii and Teleostomi.**

SCIENTIFIC NAME	COMMON NAME	VERNACULAR NAME
CLASS: TELEOSTII ORDER: PERCIFORMES		
Lates calcarifer	GIANT PERCH	KODUVA
Lutjanus argentimaculatus	RED SNAPPER	SHANKARA
Therapon puta	SMALL-SCALED BANDED GUNTER	KOVE KITCHAN
Therapon jarbua	CRESCENT PERCH	PALIN KITCHAN
Gerrus setifer	BLACK TIPPED SILVER BIDDY	UDUVAN
Lethrinus nebulosus	STARRY PIN-FACED BREAM	PULLI VELLAMEEN
Chrysophrys datnia	JAPANESE SILVER BREAM	KARUPPU MATTAVAN
Leiognathus ruconius	DEEP-BODIED PONY FISH	KAVEL
Sillage sihama	SILVER WHITING	KILANGANAN
Platycephalus puctatus	SPOTTED FLAT HEAD	GRIYAL
Anabas scandens	CLIMBING PERCH	KOVAIYAN
Etroplus suratensis	BANDED ETROPLUS	SETHAL KENDA
Etroplus maculates	SPOTTED ETROPLUS	KENDA
Epinephalus lanceolatus	GROUPER	KOMERI KELAVAN
Scomberoides tala	DEEP QUEEN FISH	TOL PARA

Scomberoides lysan	**LEATHER SKIN**	**KATTA**
Trahcinottus blochii	**BLOCH'S DART**	**KUTILI**
Pseudosciana diacanthus	**TWO-SPINED JEWFISH**	**KOPAYEN**
Parupeneus indicus	**INDIAN GOAT FISH**	**KAL MAKHARAI**
Monodactylus argentius	**SILVER BAT FISH**	**MOOLEN**
Ephippus orbis	**SPADE FISH**	**THIRALI**
Glossogobius giurus	**BAR-EYED GOBY**	**ULUVAI**
Platycephalus scaber	**ROUGH FLATFISH**	**_**
Gerrus filamentosus	**LONG-RAYED SILVER BIDDY**	**_**
Psettus argenteus	**SILVER BOAT FISH**	**MOOLEN**
Scatophagus argus	**SPOTTED BUTTERFLY**	**PULLI ILETHI**
Periophthalamus koelrewteri	**MUD-SKIPPER**	**KUDHURA KUTTI**
ORDER: MUGILIFORMES		
Mugil cephalus	**GREY MULLET**	**MADAVA**
Mugil cunnesius	**ROUND HEAD MULLET**	**_**
Sphyraena jello	**GIANT SEA-PIKE**	**CHEELA**

ORDER: CLUPEIFORMES		
Sardinella fimbriata	***FRINGE-SCALE SARDINE***	***SALAI***
Ilisha elongata	***SLENDER SHAD***	***PUVALI***
Nematolosa nasus	***LONG-RAYED BONY BREAM***	***KOI MEEN***
Anchoviella indica	***INDIAN ANCHOVY***	***NETHILI***
Kowala coval	***WHITE SARDINE***	***VELLAI SUDA***
ORDER: PLEURONECTIFORMES		
Pseudorhombus orsius	***LARGE-TOOTHED FLOUNDER***	_
Platophrys pantherinus	**LEOPARD FLOUNDER**	_
Brachirus orientalis	**ORIENTAL SOLE**	_
Cynoglossus puncticeps	_	_
Cynoglossus semifasciatus	_	_
ORDER: TETRADONTIFORMES		
Triacanthus brevirostris	**SHORT-NOSED TRIPOD FISH**	**MULLARU**
Tetradon nigropunctatus	**BLACK-SPOTTED BLOW FISH**	_
Tetradon leopardus	**BANDED LEOPARD BLOW FISH**	_
Arothron immaculatus	**IMMACULATE BLOW FISH**	_
Chelonodon patoca	**GANGETIC BLOW FISH**	_

Gastrophysus lunaris	**GREEN ROUGH-BACKED BLOW FISH**	_
Torguinger oblongus	**OBLONG BLOW FISH**	_
Cynoglossus brachycepahlus	**SHORT-HEADED TONGUE SOLE**	_
Synopterus commersoni	**COMMERSON'S SOLE**	_
Bothus polylepis	**MANY-SEALED FLOUNDER**	_
Arothron reticularis	**RETICULATED BLOW FISH**	_
Triacanthus biaculeatus	**HOLLOW SNOUTED TRIPOD FISH**	_
Lagocephalus inermis	**SMOOTH BLACK BLOW FISH**	_
Chelonodon fluviatilis	**ESTUARINE BLOW FISH**	_
Tetrodon lunaris	**GREEN ROUGH-BACKED BLOW FISH**	_
CLASS: ELASMOBRANCHII **ORDER: LAMNIFORMES**		
Carcharinus melanopterus	**BLACK SHARK**	**PERUNTHALAI SURA**
ORDER: RAJIFORMES		
Rhychobatus djeddensis	**WHITE-SPOTTED, RAY SHOVEL-NOSED**	**PAL ULUVAI**
Dasyatis sephen	**COW-TAIL RAY**	**ADA THIRUKKAI**
Dasyatis uarnak	**BANDED WHIP-TAILED STING RAY**	**MANAL THIRUKKAI**

Projection 1

Impact of the Sub-Fossil Molluscan Shell Mining at Pulicat Lake Ecosystem

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Introduction

- In International market there is a good demand for molluscan products. In India, the molluscan contribution is important for the fisheries, providing nutritious food and also foreign exchange earners to the country.

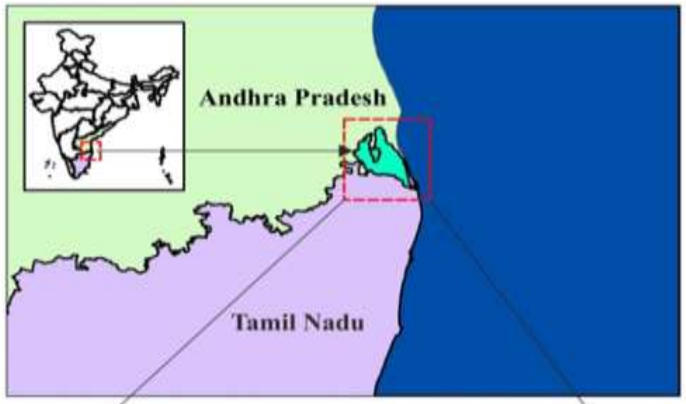
- Different species of bivalves and gastropods are utilized as food, shells for ornamental purposes and operculum for cosmetic and medicinal use.

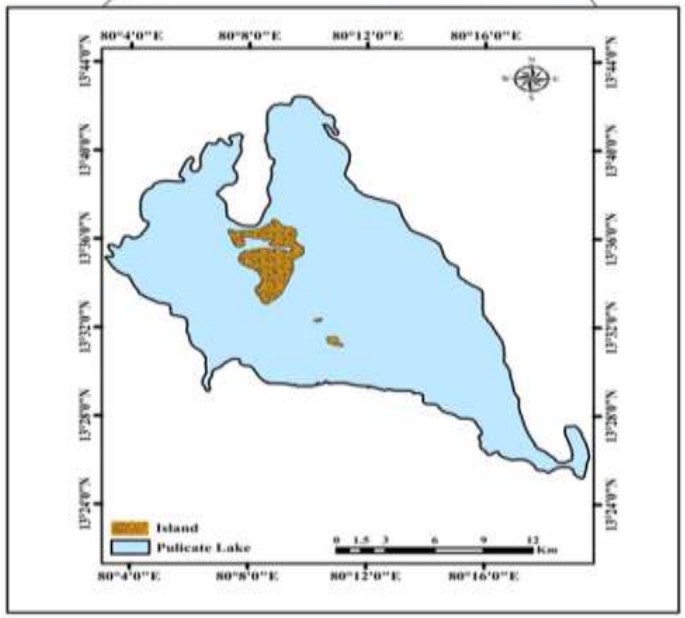
- Molluscan shell deposits are distributed in several places along the east and west coasts of India.

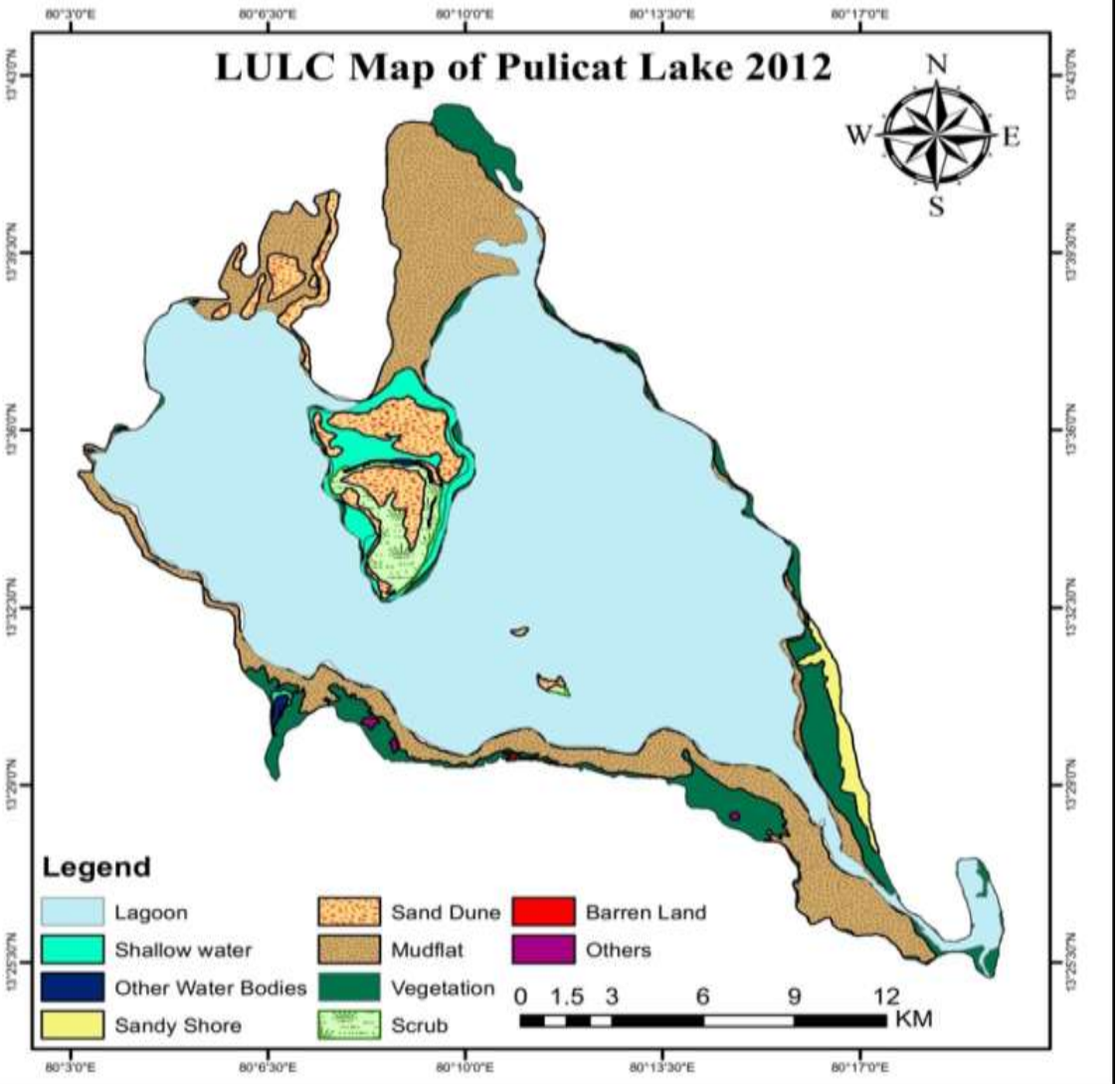
- Pulicat lake has rich sub-fossil lime shell deposits accumulated through centuries of accretion. There are extensive Pleistocene and Holocene deposits (Anjum Farooqui, 2000).

- Molluscan shell deposits mainly occur in sub-fossilized deposits in thick layers beneath the soil surface and consists variety of bivalve and gastropod species.

Study Area





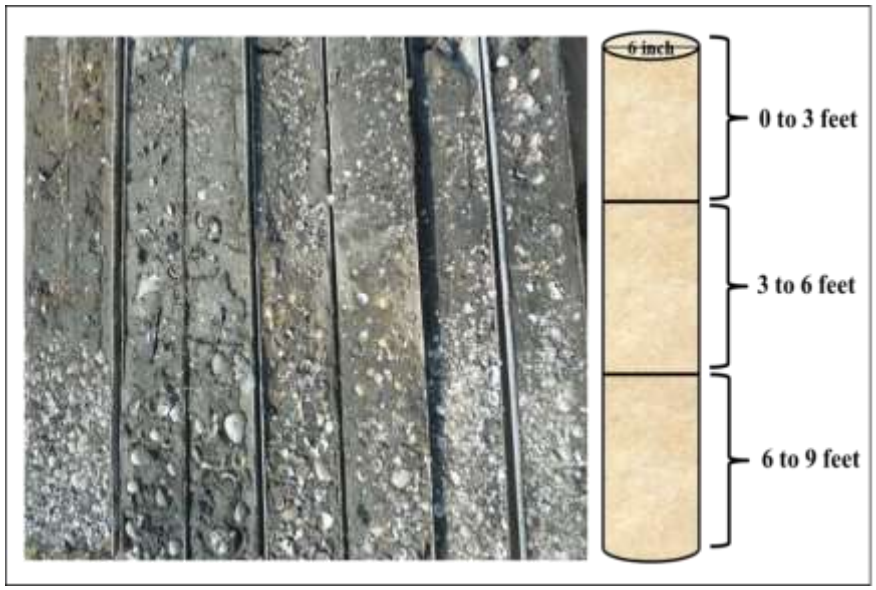


Wetland classes	Lake area	Forest	Plantation	Mud flat	Sandy beach	Other water body	Salt pan
Area in km^2	246.9	0.9	92.7	162.4	17.7	139	0.7

Materials and methods

- Twenty sampling stations were located in Pulicat coastal lake using GPS for a period of one year from January to December 2012

- The sediment sample was collected by using a PVC pipe as a ‘soil corer’, for the study of molluscan shell deposited in various depths up to 9 feet (3m)



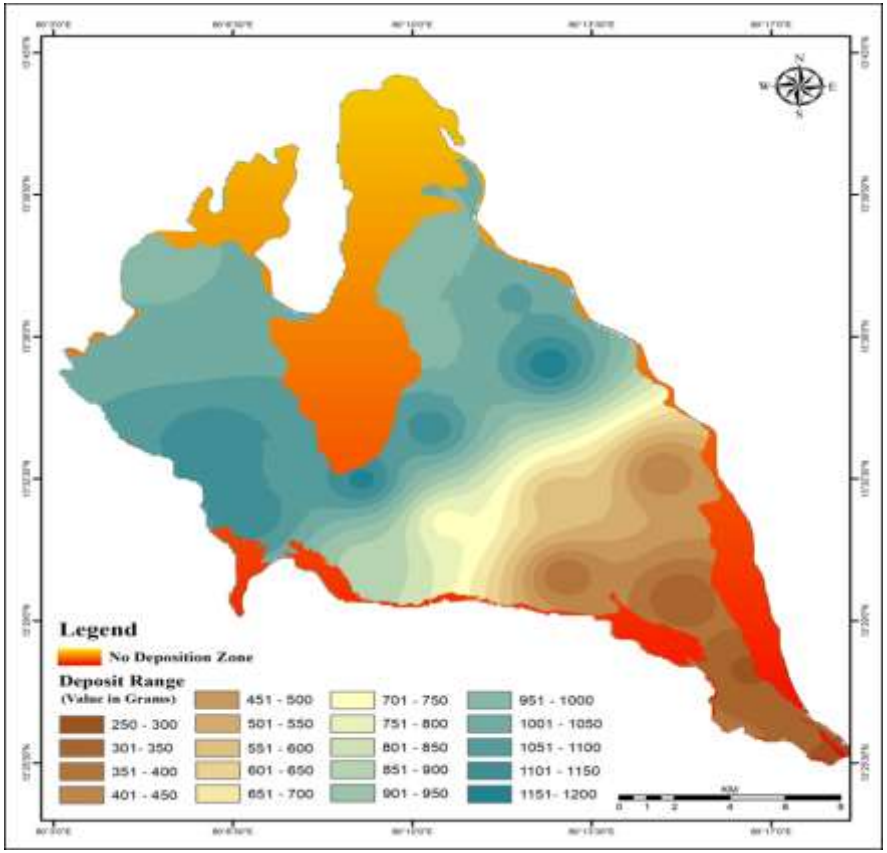
Formula:

Total Molluscan Density of Pulicat lake at a given depth (tonnes) =

$$\frac{\text{Area of Lake } (\text{km}^2)}{\text{Area of Mouth of Core Sampler } (\text{km}^2)} \text{ X Molluscan Deposit in Core Sampler (Tonnes);}$$

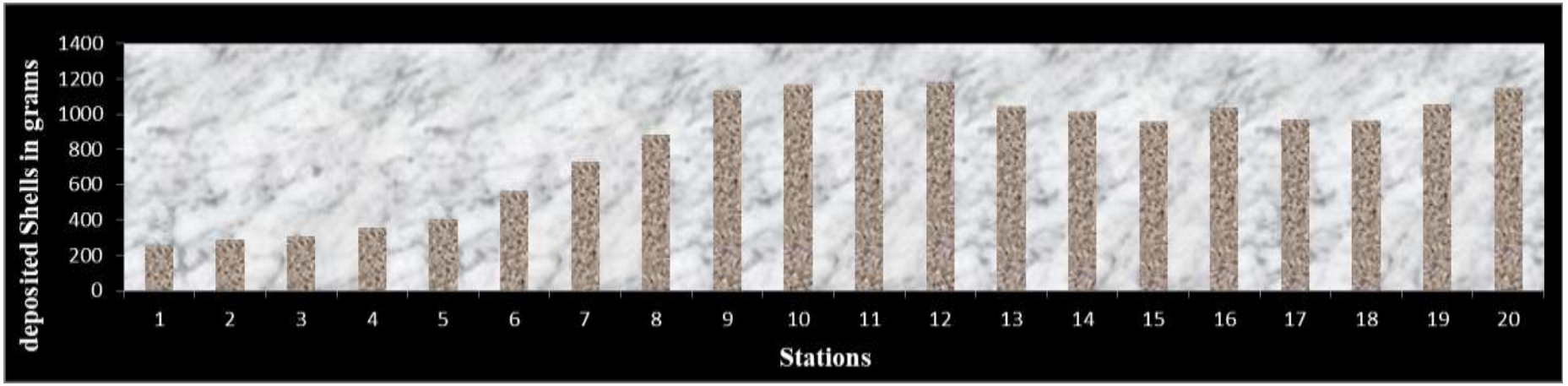
and, to generate a map depicting deposition using ARC MAP software 10.1.

Result



Sub-Fossil Deposit

- Sub-fossil deposits are present in 1.5m to 3m depth.
- Shell deposits are distributed over a distance of Northern and Central region.
- 26 species of molluscan sub-fossil shell deposits were categorized into14 bivalves and 12 gastropods.
- Total quantity of molluscan shells from 0 to 9 feet varied from 256g to 1185g with a mean deposit of 831g.
- Irukkam has a shell potential of about 1,000 ha and Venadu has 800 ha of shell deposits.



The checklist for bivalve sub-fossil deposited in all the stations of Pulicat coastal lake

SPECIES	STATIONS																		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
BIVALVE																				
Cucullaea labiate **(Lightfoot, 1786)**										*	*	*	*	*	*	*	*	*		
Crassostrea madrasensis **(Roding, 1798)**	*	*	*	*	*	*												*	*	*
Circe scripta **(Linnaeus, 1758)**	*								*	*	*	*	*	*	*	*	*	*	*	*
Gari fervensis **(Gmelin, 1791)**	*	*	*	*	*	*											*		*	*
Marcia opima **(Gmelin, 1791)**	*					*	*		*	*	*	*	*	*		*	*		*	*
Meretrix casta **(Gmelin, 1791)**	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Meretrix meretrix **(Linnaeus, 1758)**		*	*	*	*	*			*	*	*	*	*	*					*	*
Modiolus philippinarum **(Hanley, 1843)**			*	*	*									*	*		*	*	*	*
Perna viridis **(Linnaeus, 1758)**		*		*	*														*	*
Placuna placenta **(Linnaeus, 1758)**									*		*	*	*	*	*	*	*	*	*	
Saccostrea cucullata **(Born, 1778)**	*	*	*	*	*										*	*	*	*		*
Tegillarca granosa **(Linnaeus, 1758)**	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Trisidos tortuosa **(Linnaeus, 1758)**										*	*	*	*	*	*	*		*	*	*
Villorita cyprinoides **(Gray, 1825)**	*	*	*	*	*							*	*	*	*		*	*	*	*

The checklist for gastropod sub-fossil deposited in all the stations of Pulicat coastal lake

SPECIES	STATIONS																		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
GASTROPOD																				
***Cantharus tranquebaricus* (Gmelin, 1791)**												*	*	*	*	*	*	*		
***Conus sp* (Linnaeus, 1758)**										*	*	*	*	*	*	*			*	*
***Gyrineum natator* (Roding, 1798)**	*				*	*	*					*	*	*	*	*	*	*	*	*
***Indothais lacera* (Born,1778)**	*	*	*		*	*											*		*	*
***Natica sp* (Scopoli, 1777)**									*	*	*	*	*	*	*		*		*	*
***Nassarius stolatus* (Gmelin, 1791)**			*	*	*	*		*	*	*	*	*	*	*	*	*	*	*	*	*
***Pirenella cingulata* (Gmelin, 1791)**	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
***Rapana rapiformis* (Born,1778)**						*					*	*	*	*	*	*		*	*	*
***Terebralia palustris* (Linnaeus, 1767)**		*			*				*	*	*	*	*							
***Turbinella pyrum* (Linnaeus, 1767)**	*								*			*	*	*	*	*	*	*		
***Umbonium vestiarium* (Linnaeus, 1758)**	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
***Volegalea cochlidium* (Linnaeus, 1758)**													*	*	*	*	*	*	*	*

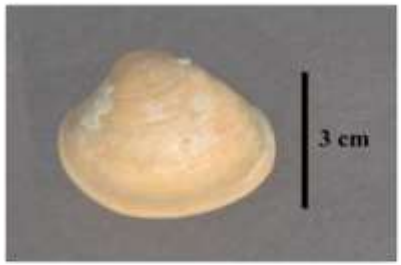
Sub-fossil deposit of Bivalve shells

Cucullaea labiata

Crassostrea madrasensis

Circe scripta

Gari fervensis



Marcia opima

Meretrix casta

Meretrix meretrix

Modiolus philippinarum

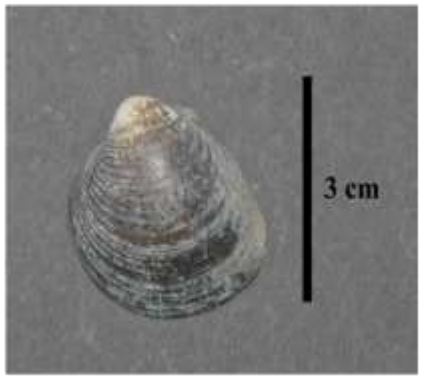
Perna viridis

Placuna placenta

Saccostrea cucullata

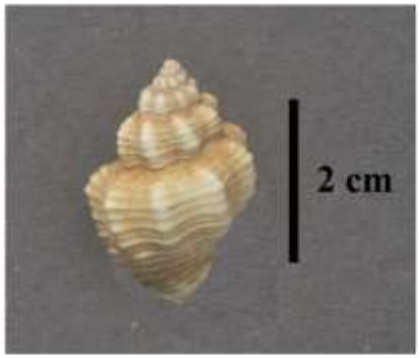
Tegillarca granosa

Trisidos tortuosa



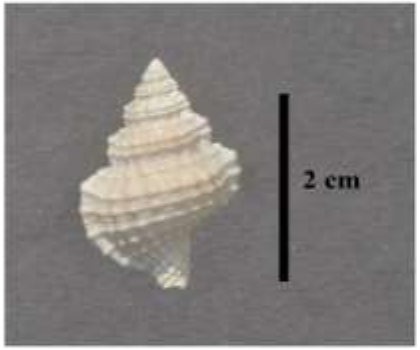
Villorita cyprinoides

Sub-fossil deposit of Gastropod shells

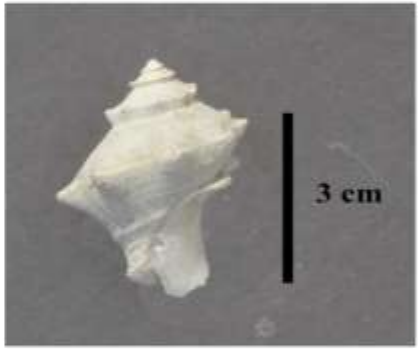


Cantharus tranquebaricus

Conus sp

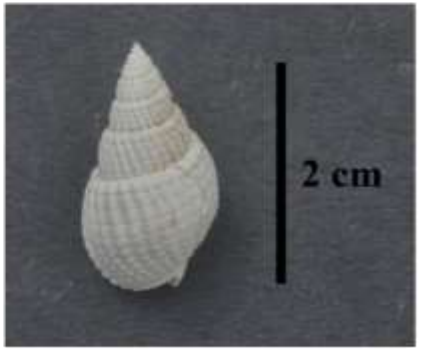


Gyrineum natator

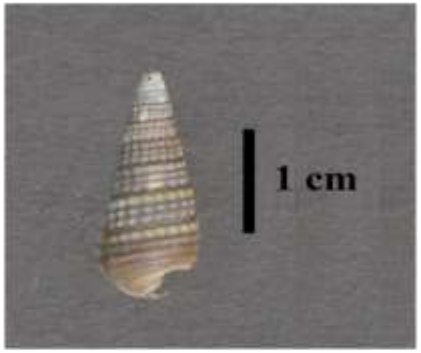


Indothais lacera

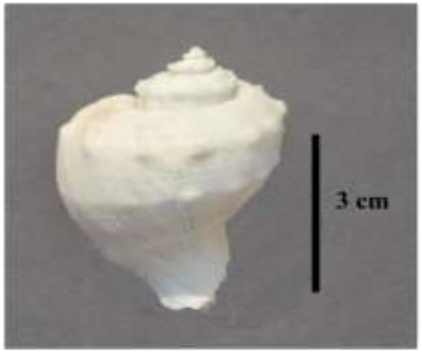
Natica sp



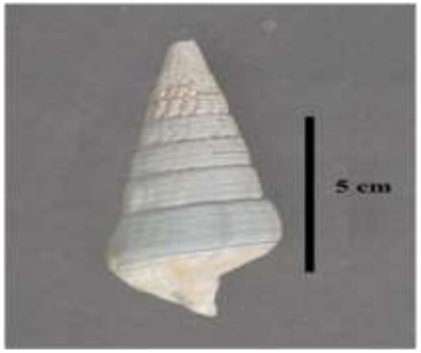
Nassarius stolatus



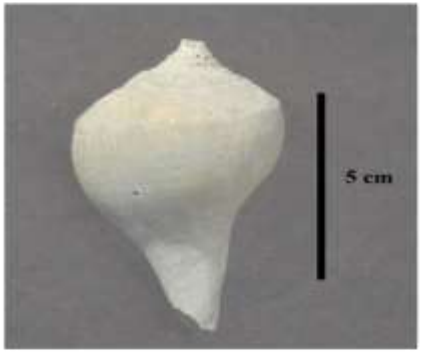
Pirenella cingulata



Rapana rapiformis

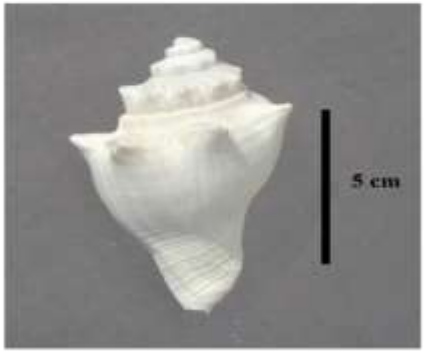


Terebralia palustris



Turbinella pyrum

Umbonium vestiarium

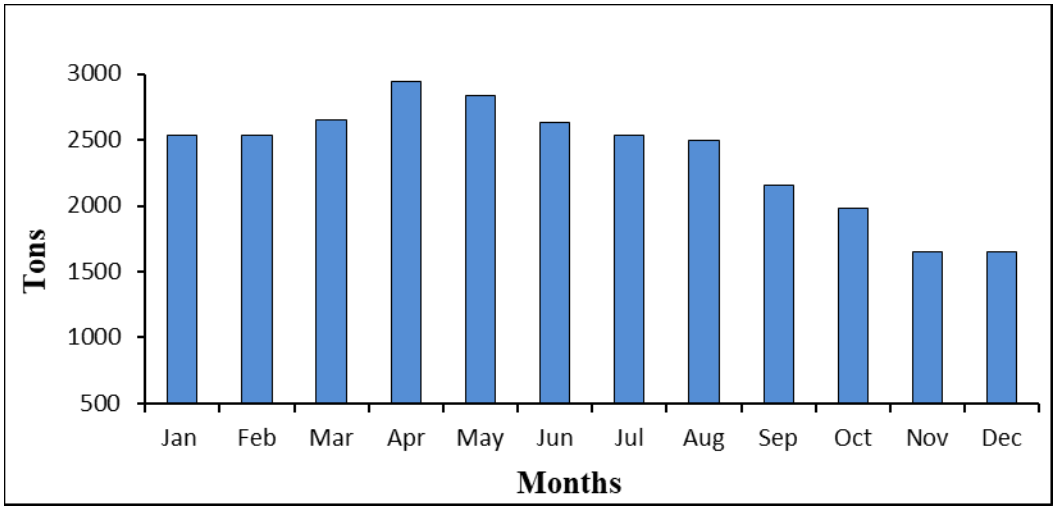


Volegalea cochlidium

Present scenario of molluscan mining and its utilization

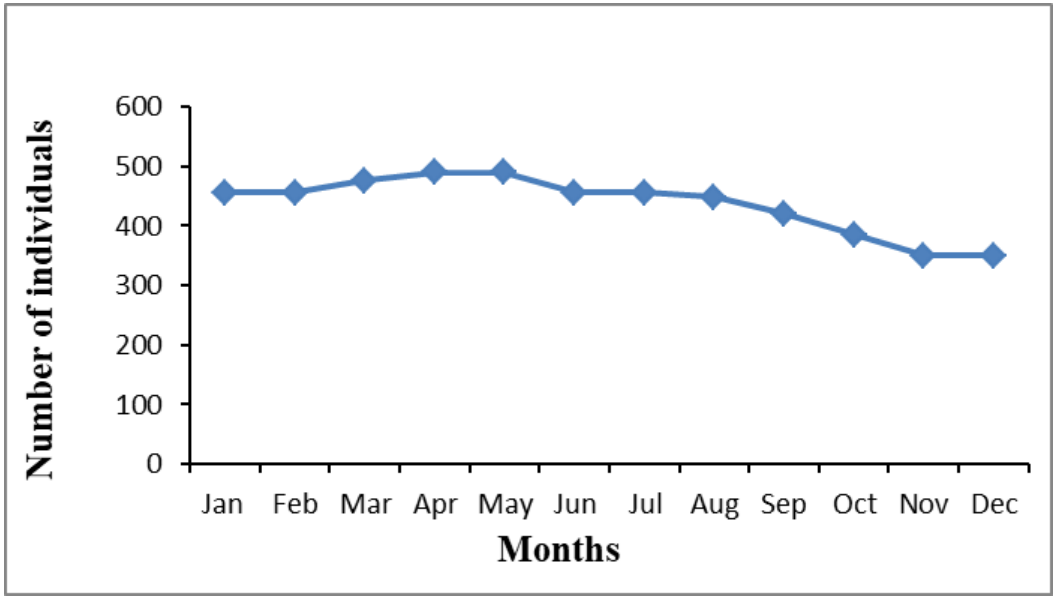
- The lime shell deposits plays a significant role to the economy of the coastal rural areas as it provides livelihood.
- Men, women and children participate in fishing molluscan, which provides employment and income in the coastal rural areas.
- Molluscan shells occurring in sub-fossil deposits are collected regularly in the Pulicat lake.
- Mining sub-fossil shells are used for industrial purposes which is a major activity in the Pulicat lake.
- Lime shells are used by factories for manufacturing calcium carbide and shells banked into lime are used for white washing, cement, sugar, and Poultry feed industries in Tamil Nadu. .

Quantity of molluscan shell mining in different months



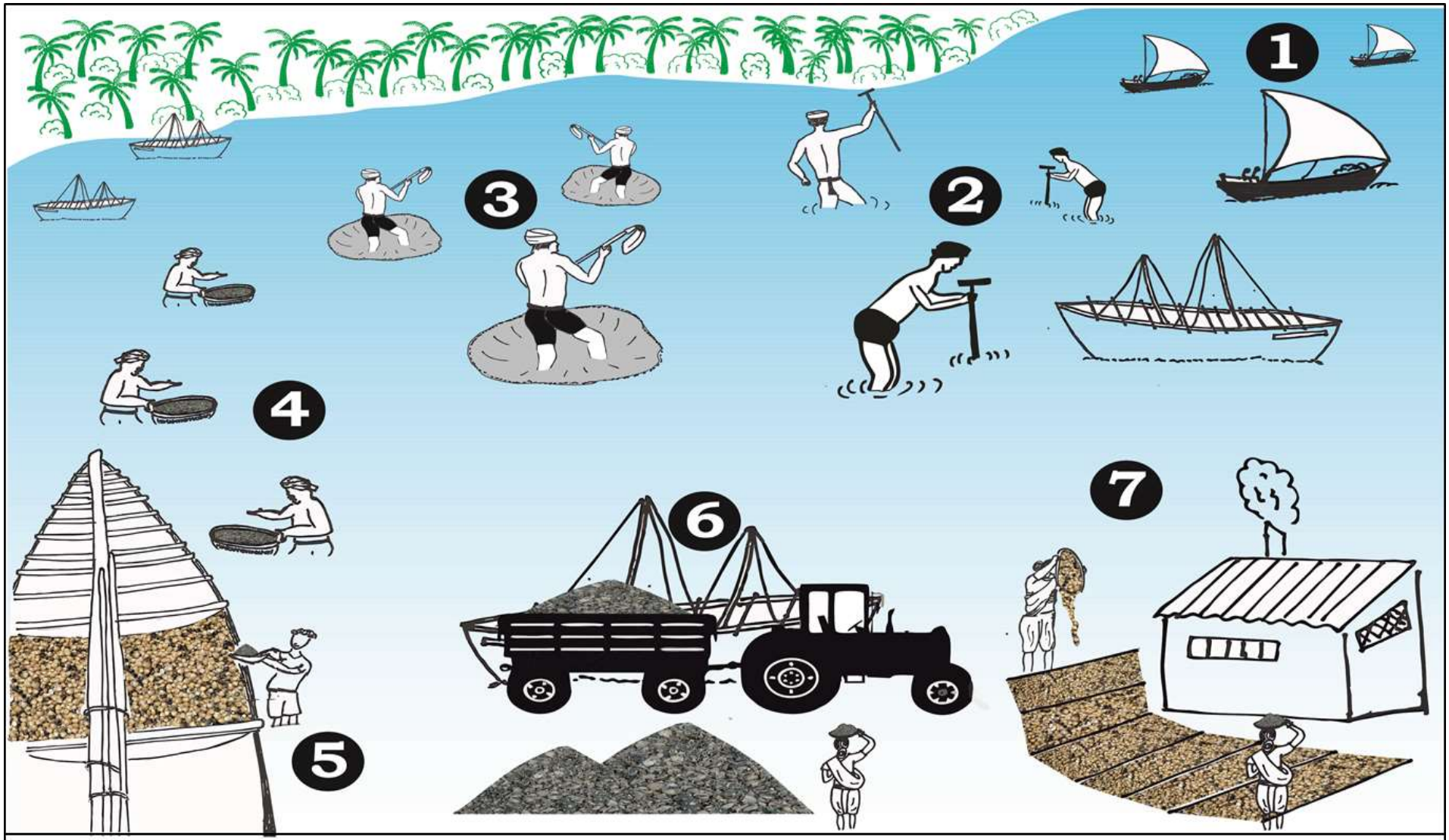
- Quantity of molluscan shell mining varied from 1650t to 2940t and the mean quantity of shells excavated was 2383t
- Annual yield of lime shells mining is around 30,000t.

Number of individuals engaged in shell mining



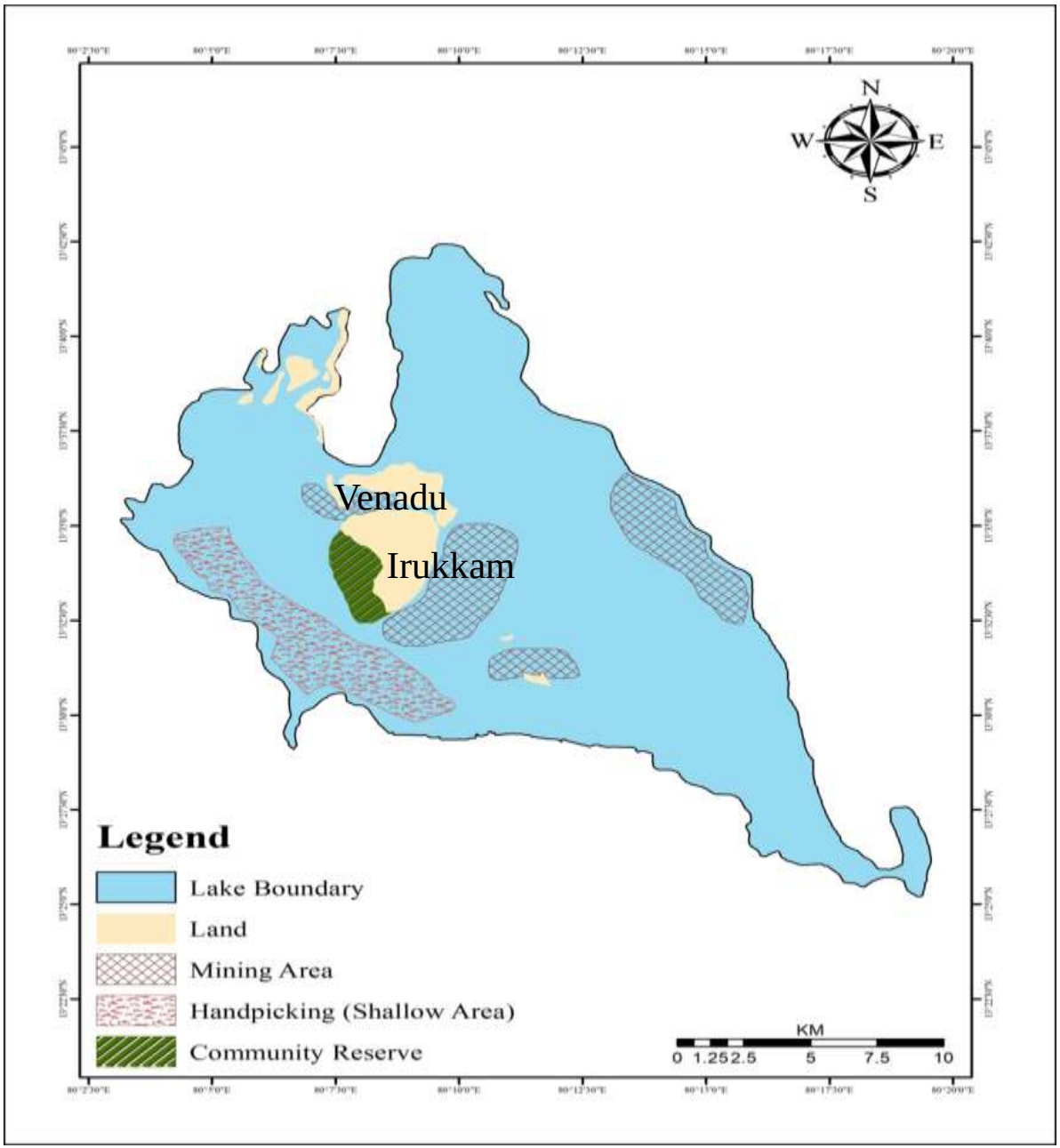
- The total number of collection days, and persons engaged in each month varied between 22 to 28 days.
- About 350 to 490 men and women were engaged in excavation.

Molluscan shell mining activities in Pulicat coastal lake



1. Boats sailed to different regions of the lake **2**. Finding shell deposits using iron rod **3**. Extraction of deposited shells by digging out pits **4**. Cleaning shells **5**. Transferring shells on to the boat **6**. Shells brought to the land and transported using tractors **7**. Sun drying and Processing of shells in small factories

Molluscan shell mining area in Pulicat coastal lake



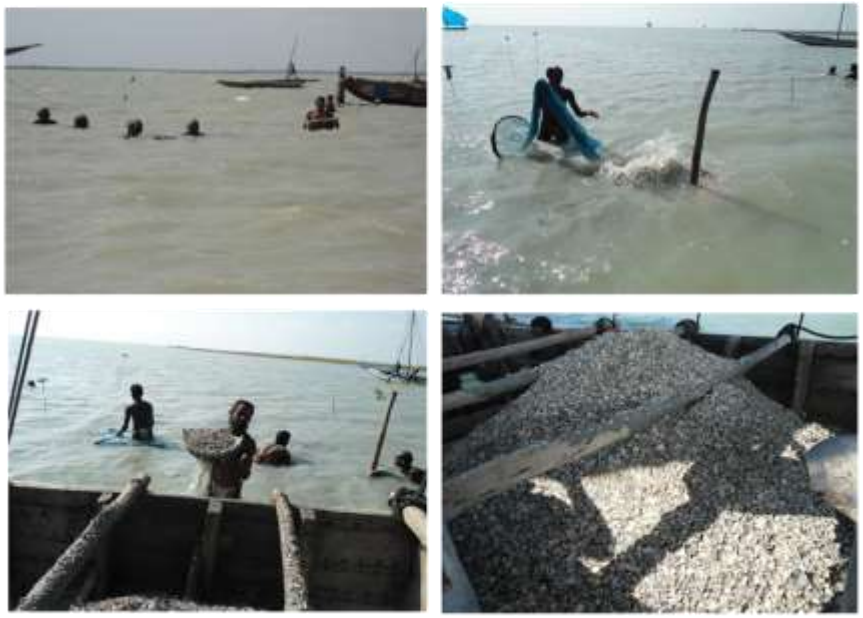
Molluscan live shell collections

Men and women involved in fetching the live shells

Collected shells are transferred to the boat

Sub-fossil deposited Molluscan shell mining

Traditional method of finding the shell deposited place with boat and equipment



Methods of extracting the shells and transferred to the boat

Shells transported to landing place




Heap of excavated shells are brought to the landing place




Excavated shells are transported to the factory

possessing method in near factory




Methods used to sun dry the shells




Different types of shell processing method

Impact on the ecosystem of molluscan shell mining area at Pulicat lake

- Over the history, in the planet most of the species that ever existed, evolved into new species or gradually went extinct.

- Species are going extinct at an dangerous rate, because of non-natural environmental changes caused by human activities like **habitat loss, degradation, over exploitation.**

- Pulicat lake is facing many serious problems and the molluscan sub-fossil shell mining is gradually becoming a major threat, the mining waste is being discharged in and around the lake.

Environmental impact

- Sub-fossil molluscan shell mining activities is creating a negative impact on water quality, sediment overall health and geographical changes

- These activities may result in decline of species abundance, diversity and change in the biology of the species.

- When the temperature increases (34.3°C), water level decreases due to evaporation and dissolved oxygen is reduced (2.36 mg/l).

- Increased frequency of higher intensity storm events will produce greater sediment and nutrient loads.

- The TSS in shell mining area was found to be 0.79 mg/l. The calcium level in the water was 1233.3 mg/l

Social impact

- In recent years, there is a increase in sub-fossil molluscan shell mining activities, were the annual yield is around 30,000 tons.

- Both mechanized and non-mechanized boats were involved in shell mining by the miners.

- The lake floor has been dented due to extensive digging into sediments to expose molluscan sub-fossil shells.

- The sub-fossil molluscan shell mining activities is creating a negative impact on physico-chemical characteristic which changes the overall health of the lake which is also serious concern.

Conservation and management strategies for sustainable molluscan ecosystem

- In the recent years, the coastal lake has been subjected to a variety of ecological crises by both natural and man-made. The sub-fossilized molluscan lime shell mining is a serious threat to the resources.

- Alteration of habitat in the lake, GNF (Global Nature Fund) nominated Pulicat as "**Threatened Lake of the year 2010**". Also, the WWF (World Wide Fund) for Nature declared it as a protected area.

- In this study, the major issues related to Pulicat lake biodiversity conservation and measures are address and highlighted.

Recommendations

- It is necessary to follow conservation strategy to manage the lake by **monitoring the environmental changes** of dredged area and **record the damages** caused during shell mining and also by setting up a **Hydrobiological research station** for maintenance of physico-chemical properties in the coastal lake. Provision of shallow-bottomed boats to enable sanctuary staff to **patrol** the lagoon.

- Regulation and **limiting the hand dredge and dredging, avoiding fishing during spawning of the aquatic animals, repopulating the dredged area** by re-laying of clam seeds, helps in maintain and also enhances the diversity of flora and fauna population in Pulicat.

- Due to freshwater inflow a large population of resident wetland birds and high number of migrant avian visitors face numerous threats by miners every year, hence **Pulicat definitely deserves to be declared as a RAMSAR site**

- **License to be issued for Lime shell fishing** as practiced by the State Department of Mining and Ecology (Tamilnadu Miner Minerals Concession Rules, 1967). Demarcation of the area for dredging of the sub-fossil resources after detailed Geological investigations.

- Pro-active methods to create fisher-folk unity and friendship to establish a set of principles to **declare traditional "Padu system" as sustainable and create awareness** in public through communication and educating fisher-folk about the need for conservation.

- **Edible Oyster** promotes a rich biodiversity in Pulicat lake, this ‘keystone’ species needs to be given the topmost priority for conservation.

- Coastal lake management is thus dynamic process that requires planning and implementation of management decisions, through development and implementation of a **National estuarine and coastal lake management protocol**.

- **Ecotourism** can be encouraged to spread awareness and also benefits the community. **Self-help Group (SHG’s)** can be promoted by providing alternative livelihood for members of the local community.

Projection 2

Impact of Climate Change on Coastal Lagoons with a Special note on Seagrass of Pulicat Lake

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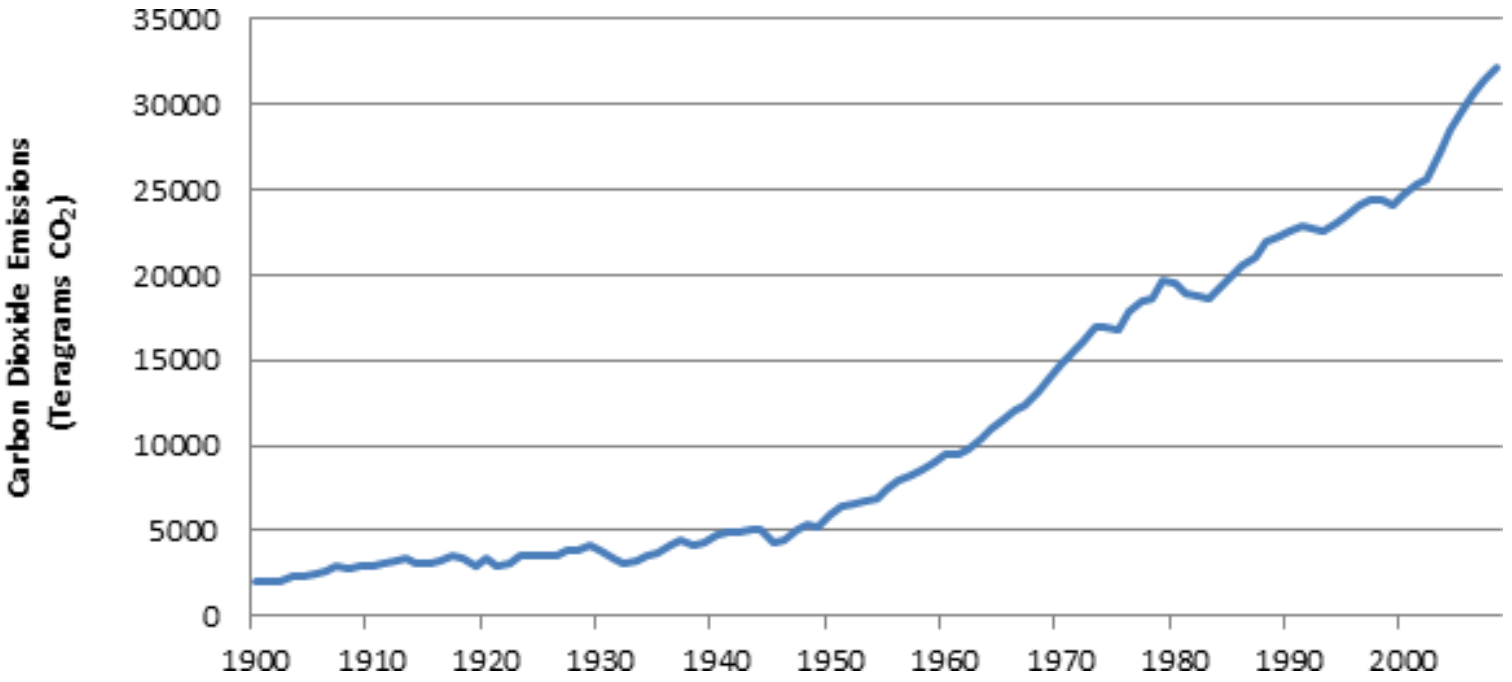
Department of Zoology
Madras Christian College

Climate change and Carbon dioxide



Source of data: Boden, T.A., G. Marland, and R.J. Andres (2010). Global, Regional, and National Fossil-Fuel CO_2 Emissions. Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, U.S. Department of Energy, Oak Ridge, Tenn., U.S.A. doi 10.3334/CDIAC/00001_V2010.

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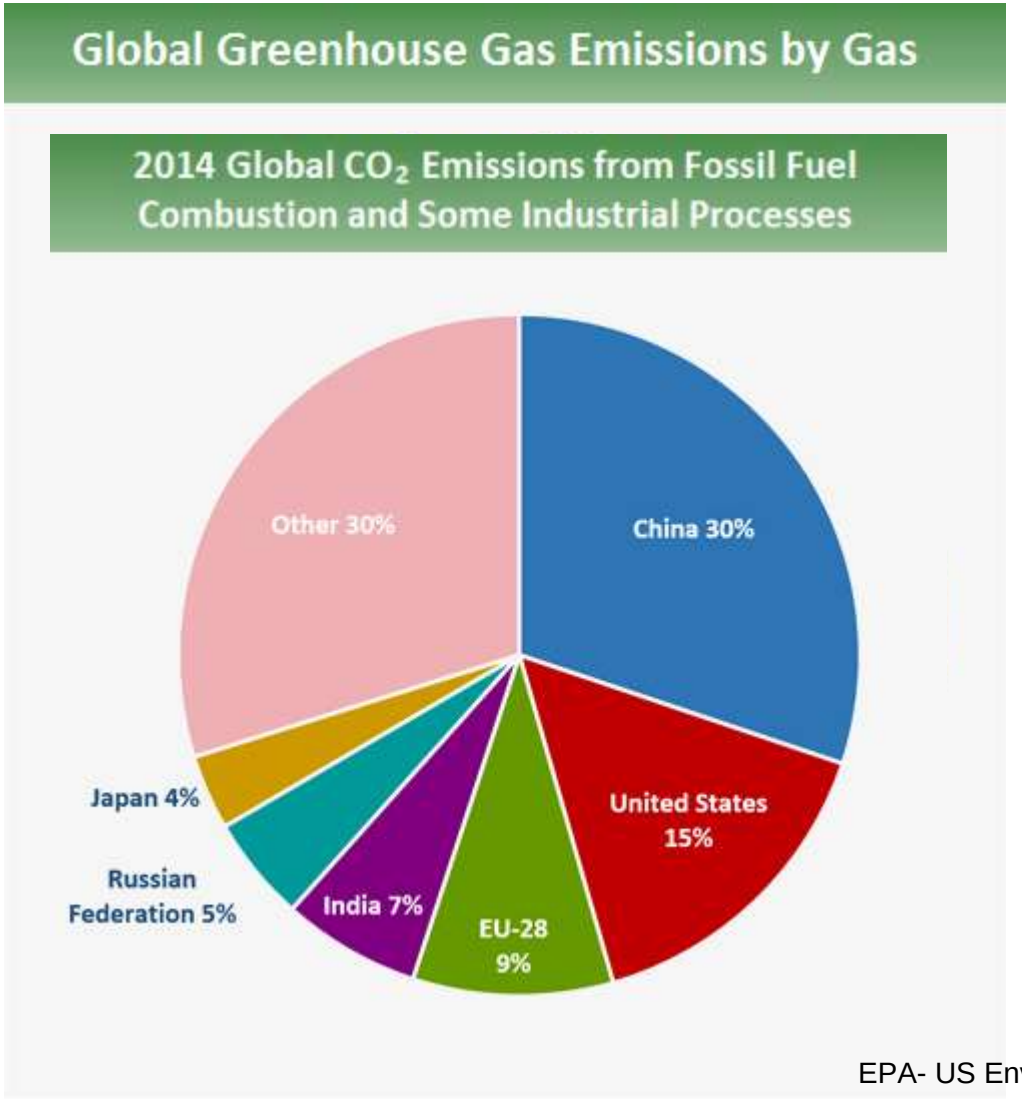
Analysis: Global CO2 emissions from fossil fuels hit record high in 2022

Global carbon dioxide emissions from fossil fuels and cement have increased by 1.0% in 2022, new estimates suggest, hitting a new record high of 36.6bn tonnes of CO2 (GtCO2).

Heavy traffic at a stand

CO2- major green house gas (US EPA)



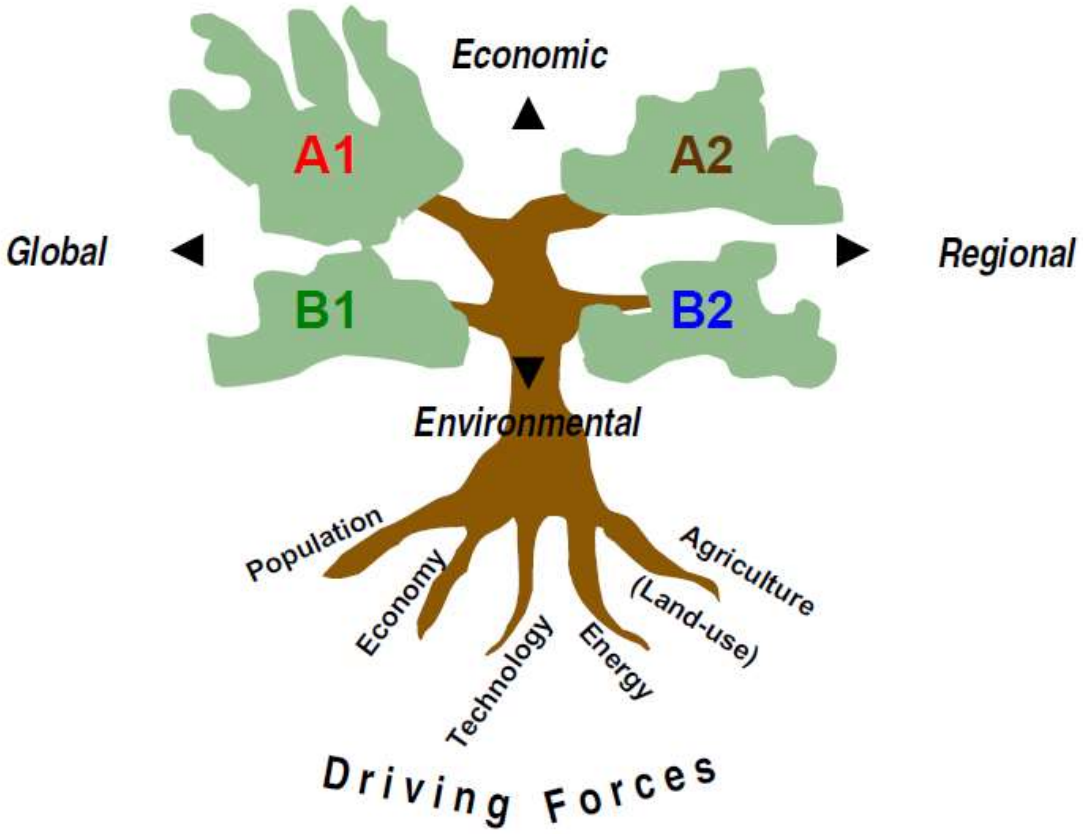
EPA- US Environment Protection Agency

Global Climate Change Models (GCMs) and Scenarios

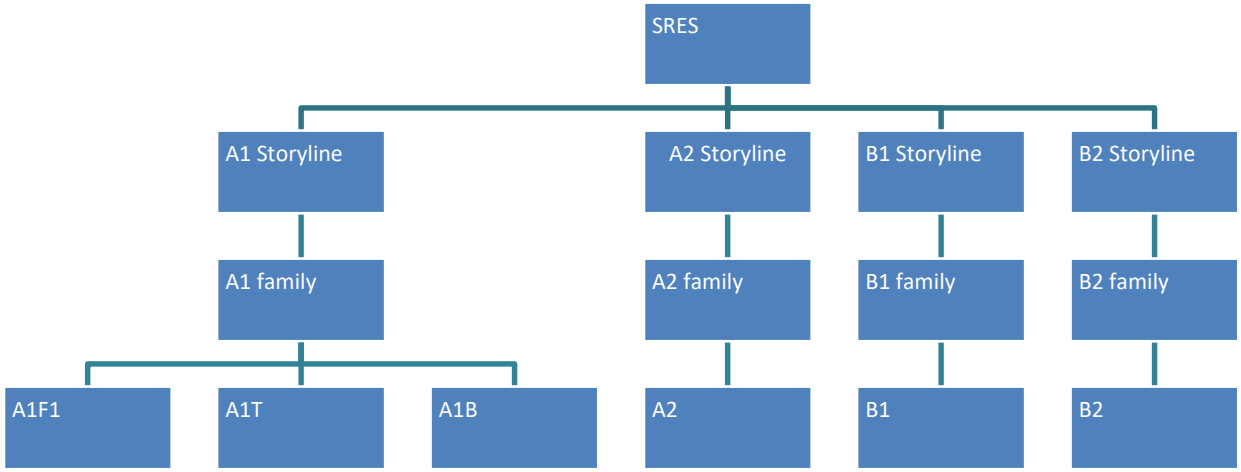
- The IPCC published a set of scenarios in 2000 for use in climate change studies known as SRES=Special Report on Emission Studies (Carter, 2007) .

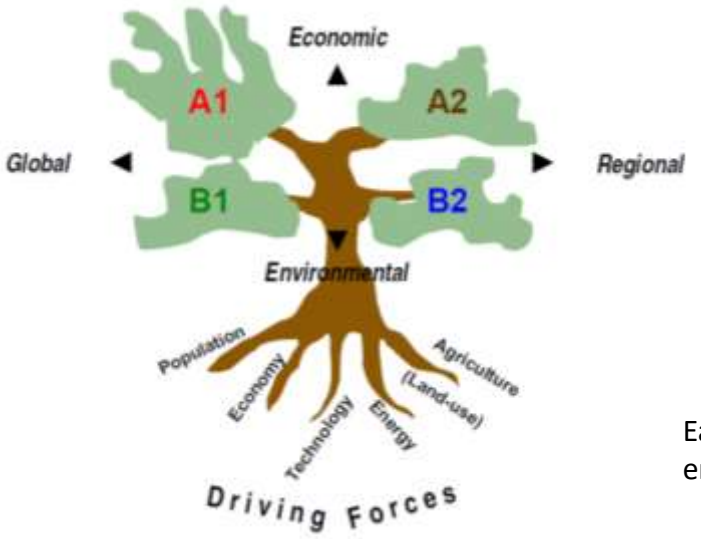
- SRES is constructed to explore future development in global environment with special reference to production of green house gases and aerosol precursor emissions (Carter, 2007).

- The SRES team defined four narrative storylines, **A1, A2, B1 and B2.** Each story line represents different demographic, social, economic, technological and environmental developments that diverge in increasingly irreversible ways (Carter, 2007).



The four story lines combine two sets of divergent tendencies:
one set varying between
strong economic values and **strong environmental values**
andthe other set between
increasing globalization and **increasing regionalization** (Carter, 2007).

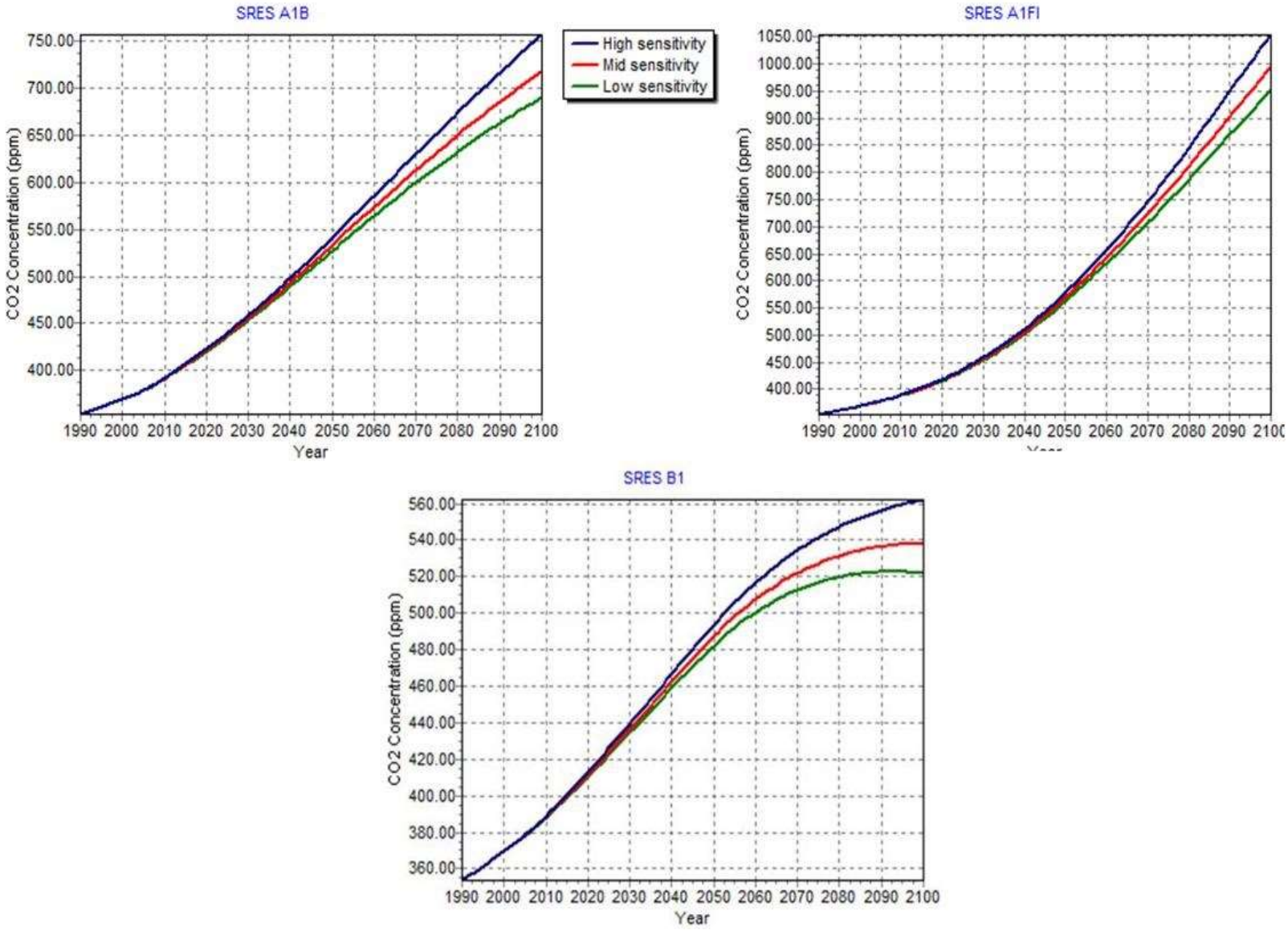




IPCC'S SRES storylines and emission scenarios

Each story line represents different demographic, social, economic, technological and environmental developments that diverge in increasingly irreversible ways.

Projected increase in Global Carbon dioxide Concentration SimCLIM settings: SRES A1B, A1F1 and B1 Scenarios



Seagrass

- **Seagrasses are a functional group of about sixty species worldwide of underwater marine flowering plants that can form extensive meadows in shallow coastal waters.**

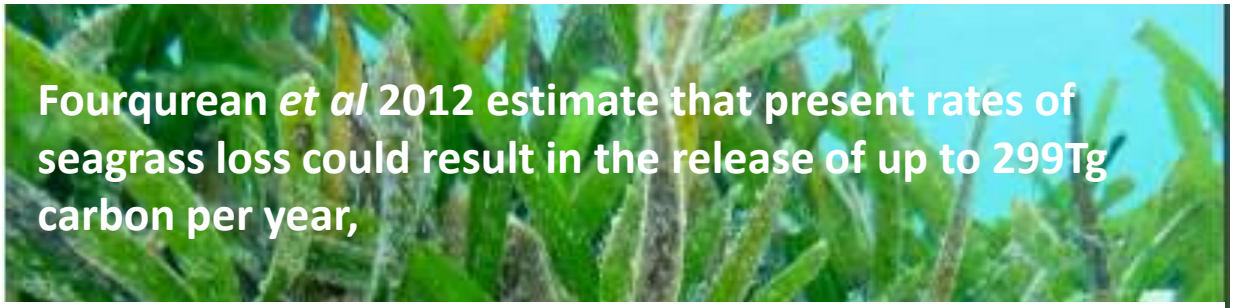
- **They are considered as ecosystem engineers because of the role they play in regulating the abiotic environment by relieving hydrodynamic stresses by attenuating waves and currents and improve light conditions by removing suspending sediments.**

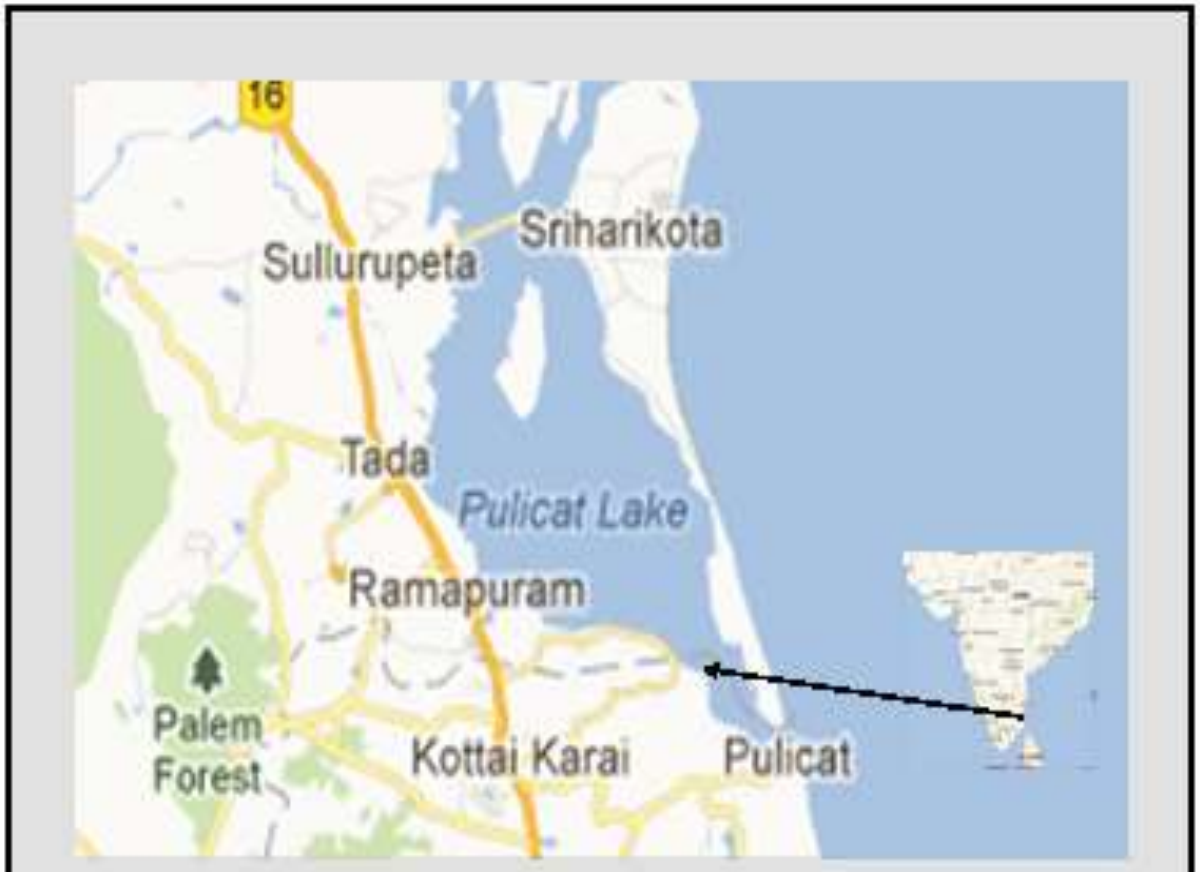
- **They are also considered as Keystone components because of their role in providing habitat and food to a number of organisms and thereby sustain the biodiversity.**

Blue Carbon

- Vegetative coastal habitats like mangroves, salt marshes and seagrass meadows have large carbon sink capacity.
- Blue carbon sinks are strongly autotrophic. They fix the atmospheric carbon dioxide photosynthetically as organic matter in excess of the carbon dioxide respired by the biota.
- Some of the excess carbon is buried in the sediments where it can remain stored for a long time.
- The carbon burial capacity of a marine vegetated habitat is about 180 times greater than the average burial rate in the open ocean.
- Blue carbon sinks, which cover less than 0.2% of the seafloor, contribute about 50% of the total burial of organic carbon in ocean sediments and therefore rank amongst the most intense carbon sinks in the biosphere

The contribution of seagrass of Pulicat lagoon to the organic carbon of the sediment.





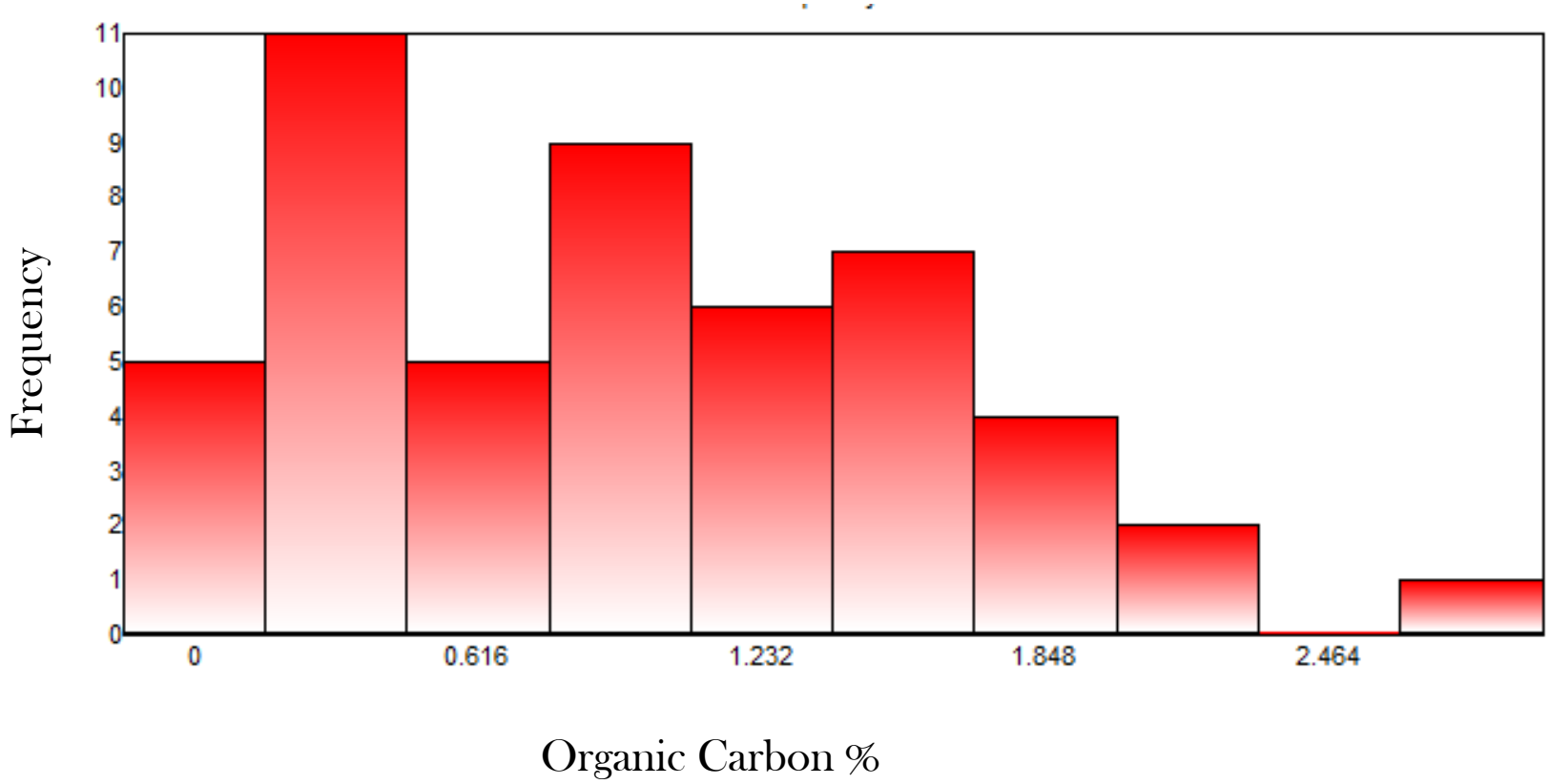
Seagrass of Pulicat

- Seagrasses are extensively distributed along the margins of the lagoon and also in the region surrounding the islands.

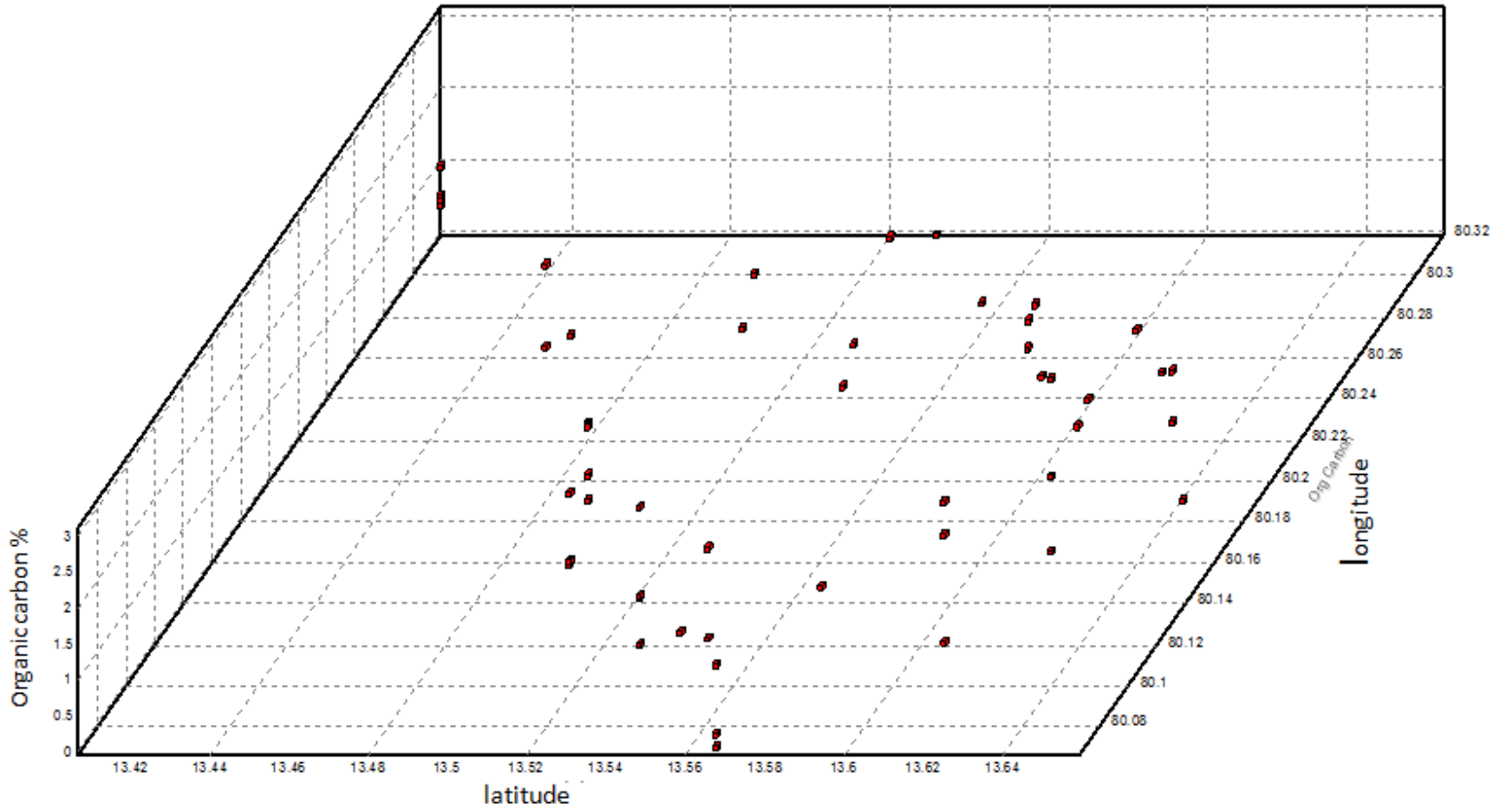
- Seagrass of Pulicat is under stress from various natural and anthropogenic activities.

- Eutrophication and occurrence of algal blooms, increased sedimentation and silt accumulation, alteration in water clarity and quality and changes in sediment quality have a direct impact on the seagrass distribution and health in Pulicat

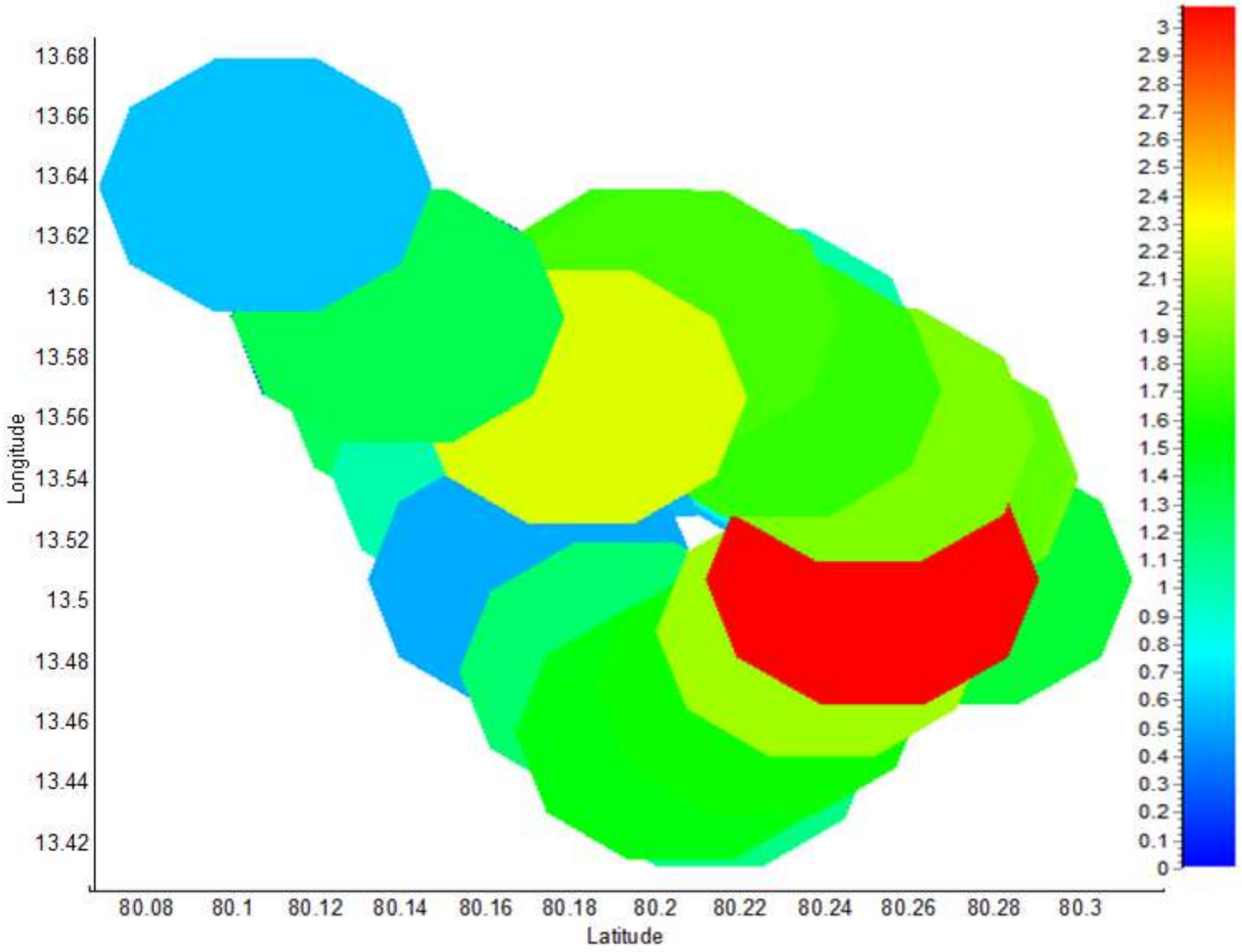
Organic carbon (sediment) in Pulicat



Scatter plot- Organic Carbon distribution in Pulicat

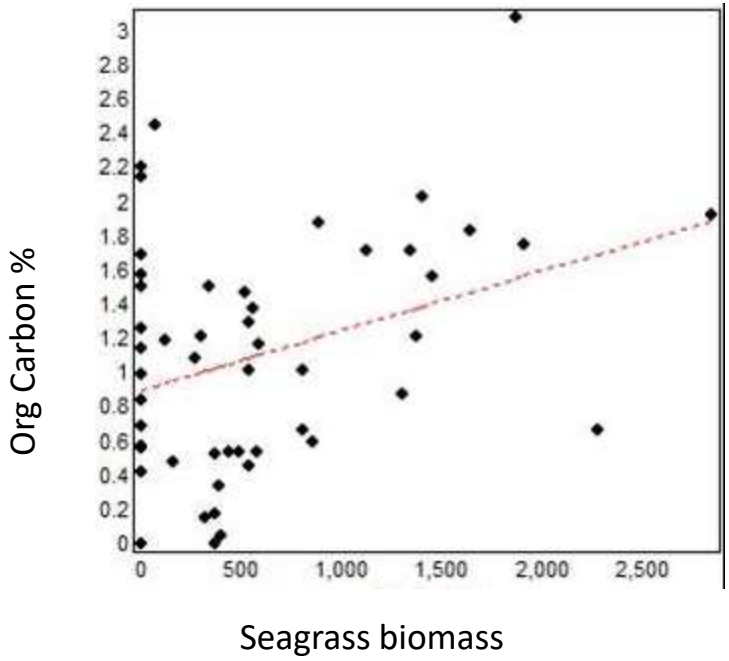


Organic Carbon (Sediment) distribution in Pulicat

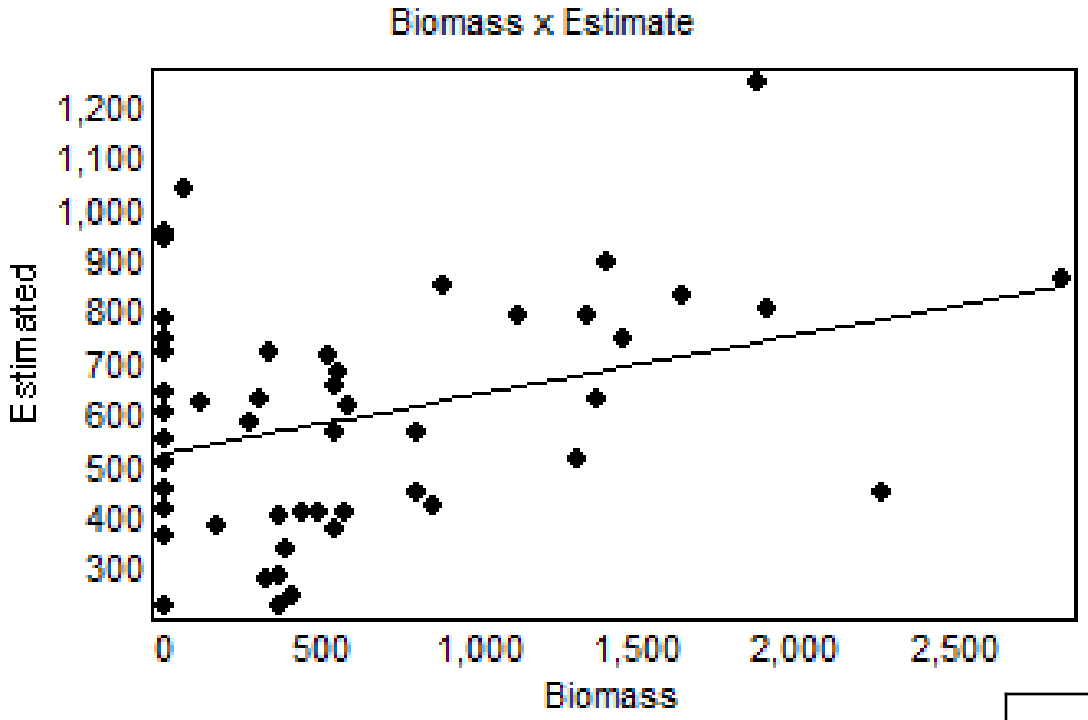


Results- Correlation Analysis

- Positive correlation is observed between the biomass of seagrass and the organic carbon content of the sediment.



Results-Linear Regression model



$Y=0.34\ (x) +\varepsilon$

r	0.34
R^2	0.116
F	6.285
P	0.016
ε	<0.001

Loss of seagrass area (Fourquerean, 2012)

Ecosystem	Area (10^6 ha)	Loss (% $year^{-1}$)	Value (US$ ha^{-1} $year^{-1}$)
Seagrass	18	2–5	19 004
Salt marsh	140	1–2	9 990
Mangrove	15	1–3	9 990
Coral	62	4–9	6 075
Tropical forest	1 900	0.5	2 007

Conclusion

- Decline in the extent of seagrass distribution has been documented globally.

- Loss of seagrass habitats means that not only lesser amount of carbon dioxide is taken from the atmosphere but also that the fixed carbon in the sediment of seagrass meadows will be released leading to more carbon dioxide in the atmosphere.

- The present study indicates that biomass of seagrass contributes to the carbon sink in Pulicat.

Projection 1. STOP SHELL MINING / CREATE ALTERNATE LIVELIHOOD

Projection 2. STOP SEAGRASS DECLINE/ PROPAGATE SEAGRASS


Thank You!