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Pollution impact assessment in mangrove associated thermal bridge estuary, Thoothukudi, Tamil Nadu

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Abstract
The impact assessment of pollution in mangrove associated thermal bridge estuary, Thoothukudi, Tamil Nadu was carried out to find out the occurrence and abundance of various pollutants in different Months followed by the observation of ecological Impacts (No:10) and pollutants (No:18) were shortlisted along the study area. The polythene bags and water bottles forms the major pollutants in all sampling stations. The present study concludes the benefits of mangrove associated estuarine areas followed by adverse effects and suggestions to be incorporated by the people and the local fishers to regulate the system by conservatory measures to overcome the problems faced to maintain the ecological balance in a sustainable manner.

Keywords: Anthropogenic activities, pollutants, conservatory measures

1. Introduction
Basically mangroves are woody halophytic plants, which exist in the conditions of high salinity; extreme tides strong winds, high temperatures and muddy-anaerobic soils [3, 4]. Mangrove ecosystem is a very complex and fragile ecosystem on the Earth with rich biodiversity of flora and fauna [7]. Being unique nature, this ecosystem in subjected to many disturbances in terms of natural and anthropogenic activities (Kawalekar., 2015)[5]. Mangrove ecosystems can be used as indicators of coastal change or sea-level rise and as well called as Mangal (In Malayalam) and Alai athii kadal (In Tamil) [2, 6]. Mangrove ecosystem retains toxic metals and stops it from infiltrating into the marine ecosystems. Mangrove Soil and Water act as a pollution sink and as major place of carbon sinks [7, 10]. Mangroves dominate the coastal areas in tropical countries undergoing constant adjustments consequent to anthropogenic activities than the natural process that directly affects the diversity commercially important fin and shell fish species pertaining to fisheries aspects [2, 8]. This ecosystem is rich in organic production through the decay of the various plant litter and other nutrients from coastal and terrestrial land system, which provides the suitable environment for various aquatic organisms (Jayasurya *et al*, 2005) [3]. Litters including plastics bottles / polythene bags / other materials, is found in all the world's oceans and seas based on the increase in world population, tourism and other activities like fishing, poaching and hunting [1, 8 & 9]. Globally, mangroves are disappearing at an alarming rate of 1 to 2% per year, faster than the adjacent coral reefs or tropical rainforests because of the pollution caused by anthropogenic activities [6, 9].

1.1 Objectives of the study
- To study the impacts of pollution
- To collect the occurrence and abundance data of pollutants

2. Study area
Totally 5 sampling sites were fixed along with latitude and longitude position as follows sampling site 1 - 8°45'13.10"N; 78°09'45.14"E; sampling site 2 - 8°45'25.98"N; 78°09'46.83"E; sampling site 3 - 8°45'32.71"N; 78°09'50.96"E; sampling site 4 - 8°45'49.13"N; 78°09'57.16"E and sampling site 5 - 8°46'15.66"N; 78°09'56.82"E to assess the pollution impact in mangrove associated thermal bridge estuary, Thoothukudi, Tamil Nadu. The red spot in the map shows the indication of thermal power plant and yellow tags were plotted to identify various sampling sites / areas along the mangrove associated thermal bridge estuary. The sampling Site 01 facing towards freshwater flow due to Lake Korampallam to sampling site 05 towards the sea ward side (Plate – 1).

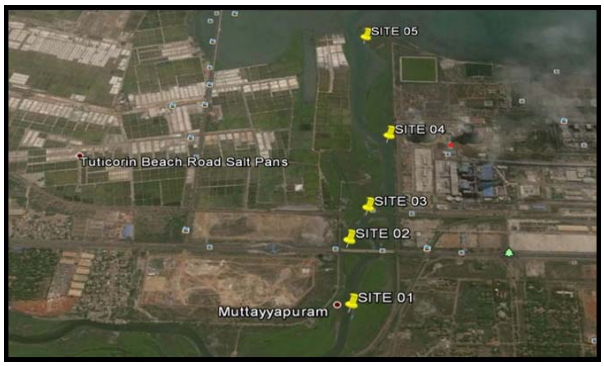

Plate 1: Map showing the various sampling sites along mangrove associated thermal bridge estuary, Thoothukudi, Tamil Nadu

3. Materials and methods

The proposed study was organized and conducted during the year 2015. Occurrence of various pollutants in different Months from January to December 2015 along mangrove associated thermal bridge estuary, Thoothukudi, Tamil Nadu were observed by sight (i.e. Field visit) and collected information about cause of occurrence of pollutants and listed with the alphabetic code for predictions were as (a) Battery and rubber materials; (b) Cement bags; (c) Cigarettes & other pawn packets; (d) Cloth materials; (e) Fishing nets / hooks / lines; (f) Glass bottles; (g) liquor bottles; (h) Nylon wires; (i) Other plastic materials; (j) Paper materials; (k) Plastic water bottles; (l) Plastic water cover; (m) Polythene bags; (n) Slippers; (o) Steel / iron materials and electric ceramic insulators; (p)Thermocole; (q) Tyre tubes and (r) Pharmaceuticals and Personal Care Products. Abundance of pollutants was also listed and categorized into 3 different ranges that fall in High, Low and Traces. Based on the observations the ecological impacts were also studied and impacts were pooled together in table to access the severity of the impacts to each sampling area.

4. Results and discussion

The pollutants like Glass bottles, liquor bottles, Plastic water bottles and Plastic water cover falls in high abundant category. The pollutants like Cigarettes and other pawn packets, Fishing nets / hooks / lines, Nylon wires and paper materials falls in less abundant category.

The rest of the pollutants like Battery and rubber materials, Cement bags, Cloth materials, Other plastic materials, Polythene bags, Slippers Steel / iron materials and electric ceramic insulators, Thermocole, Tyre tubes, Pharmaceuticals and Personal Care Products falls in trace abundant category (Table -1).

The major pollutants like Cigarettes and other pawn packets, Glass bottles, liquor bottles, Plastic water bottles and Polythene bags were found in all five sampling areas. The minor pollutants like Paper materials and Plastic water covers were observed in four sampling areas. The other pollutants like Fishing nets / hooks / lines and Slippers were observed in 3 sampling areas. The unwanted materials like Cloth materials, Nylon wires, other plastic materials, Tyre tubes, Pharmaceuticals and Personal Care Products were found in 2 sampling areas. The other minor pollutants like Battery and rubber materials, Cement bags and Steel / iron materials and electric ceramic insulators were found in only one sampling area (Table- 2).

Impacts observed were death of aquatic organisms; effects on mangrove plants growth; negative impacts on health of the ecosystem; decline in aesthetic look; habitat destruction; aggregation of sessile organisms on plastics; entrapment of juvenile organisms; sedimentation disruption; blockage of pits (of burrowers) by plastic and salinity fluctuations. These impacts were tabulated in Table 3 with suitable symbols + Impacts observed; ++ Severity of Impacts Increased; +++ Severity of Impacts Doubled and - Impacts not observed based on the sight observation and field visit.

Impacts on Death of aquatic organisms were observed in 2nd and 3rd sampling area and the severity was doubled in sampling area 4. Impacts on effects on mangrove plant growth were recorded severely in 1st and 2nd sampling area. The negative impact on health of the ecosystem was found to be doubled in sampling area 5. Decline in aesthetic look, Habitat destruction, Aggregation of sessile organisms on plastics, Entrapment of juvenile organisms, Sedimentation disruption, Blockage of pits (of burrowers) by plastic and salinity rate was doubled in Sampling area 1, 4, 3,5, 2, 5 and 3 respectively (Table – 3).

The percentage contribution of plastics were pooled together according to season wise to arrive 77.78%, 100% and 50% of plastics in summer (March to May), monsoon (June to October) and winter (November to February) season respectively. The reasons for the abundance of plastic materials were listed in Table 4.

5. Benefits of mangrove associated estuarine areas

- Act as nursery grounds for commercially important shellfishes and fin fishes
- Act as breeding and spawning grounds
- Complex marine food chain and traps the nutrients
- Creation of critical habitat for fisheries and coastal bird populations
- Establishment of restrictive impounds that offer protection for maturing offspring
- Filtering and assimilating pollutants from upland run-off
- Stabilization of sediments and protection of shorelines from erosion
- Water and atmospheric quality improvements
- Contribute to the health of coral reefs
- Application in Green Funeral and living Memorial services

5.1 Adverse effects

- Surface and ground water pollution results in smothering effects on mangrove roots and suffocation of trees
- Sediment accumulation
- Harm or kills organisms present
- Breaks in the continuity of species among mangrove communities
- Causes physical damage to invertebrate species and mangroves
- Distresses migrating species such as shorebirds
- Bioaccumulation, bio-magnification and bio-transformation of micro plastics in to the food chain
- Dissolution of micro-plastic materials in to the ecosystem
- Swallowing of plastics by birds and other terrestrial as well as aquatic animals in thought of prey
- Traps the seeds of mangrove plants and makes them unfit for germination

5.2 Suggestions

- Plastic bags should be effectively replaced by reusable bags
- Plastic bottles could be reused and recycled eco-friendly

- Enforcement of laws should be strictly made possible with human force
- Recycling of wastes and other materials could reduce the abundance of single material
- Awareness should be created among the people living in and around areas associated with mangroves
- Educational campaigns should be organized to students to impart the importance of the ecosystems and their ecological role for sustainable development
- Leaflets or folders could be distributed (in regional language) to increase the effectiveness of conservation and to avoid use of plastics and unwanted materials in ecologically sensitive areas
- Posters that enhancing the awareness regarding the protection of sensitive areas could be kept in these areas to improve the knowledge among the rural communities

Table 1: Occurrence and abundance of various pollutants in different Months along mangrove associated thermal bridge estuary, Thoothukudi, Tamil Nadu

Sl. No	Name of the pollutants noticed	Occurrence												Abundance
		Jan.	Feb.	Mar.	Apr.	May	Jun.	July	Aug.	Sep.	Oct.	Nov.	Dec.	
1.	(a) Battery and rubber materials			▲		▲	▲	▲	▲	▲	▲			Traces
2.	(b) Cement bags						▲	▲	▲		▲			Traces
3.	(c) Cigarettes & other pawn packets	▲	▲	▲			▲	▲		▲	▲	▲		Low
4.	(d) Cloth materials			▲	▲	▲			▲					Traces
5.	(e) Fishing nets / hooks / lines	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲		▲	Low
6.	(f) Glass bottles	▲		▲	▲	▲	▲	▲	▲	▲	▲		▲	High
7.	(g) liquor bottles	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲		High
8.	(h) Nylon wires				▲	▲	▲	▲		▲	▲			Low
9.	(i) Other plastic materials						▲	▲	▲		▲			Traces
10.	(j) Paper materials	▲	▲	▲	▲					▲	▲			Low
11.	(k) Plastic water bottles	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	High
12.	(l) Plastic water cover	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	High
13.	(m) Polythene bags	▲	▲		▲			▲		▲	▲			Traces
14.	(n) Slippers			▲			▲	▲	▲					Traces
15.	(o) Steel / iron materials and electric ceramic insulators			▲	▲				▲	▲	▲			Traces
16.	(p) Thermocole		▲	▲	▲	▲		▲	▲	▲	▲	▲		Traces
17.	(q) Tyre tubes						▲				▲			Traces
18.	(r) Pharmaceuticals and Personal Care Products									▲	▲			Traces
	Total	8	8	12	11	9	12	13	12	13	16	5	4	

Table 2: List of Pollutants observed in different sampling area

S. No	List Of Pollutants Observed	Sa – 01	Sa – 02	Sa – 03	Sa – 04	Sa – 05
1.	(a) Battery and rubber materials			*		
2.	(b) Cement bags			*		
3.	(c) Cigarettes & other pawn packets	*	*	*	*	*
4.	(d) Cloth materials	*				*
5.	(e) Fishing nets / hooks / lines	*	*		*	
6.	(f) Glass bottles	*	*	*	*	*
7.	(g) liquor bottles	*	*	*	*	*
8.	(h) Nylon wires		*		*	
9.	(i) Other plastic materials		*			*
10.	(j) Paper materials	*	*		*	*
11.	(k) Plastic water bottles	*	*	*	*	*
12.	(l) Plastic water cover		*	*	*	*
13.	(m) Polythene bags	*	*	*	*	*
14.	(n) Slippers			*	*	*
15.	(o) Steel / iron materials and electric ceramic insulators	*				
16.	(p) Thermocole					*
17.	(q) Tyre tubes	*				*
18.	(r) Pharmaceuticals and Personal Care Products		*		*	

Table 3: Impacts Observed

S. No	Impacts observed	SA – 01	SA – 02	SA – 03	SA – 04	SA – 05
1.	Death of aquatic organisms	-	+	+	+++	-
2.	Effects on mangrove plants growth	+++	+++	+	+	+
3.	Negative impacts on health of the ecosystem	++	+	+	+	+++
4.	Decline in aesthetic look	+++	+	+	+	+
5.	Habitat destruction	+	+	++	+++	+
6.	Aggregation of sessile organisms on plastics	-	-	+++	-	-
7.	Entrapment of juvenile organisms	-	-	-	-	+++
8.	Sedimentation disruption	-	+++	-	-	-
9.	Blockage of pits (of burrowers) by plastic	-	-	+	++	+++
10.	Salinity	-	-	+++	++	-

+ Impacts observed
++ Severity of Impacts Increased
+++ Severity of Impacts Doubled
- Impacts not observed

Table 4: Percentage Contribution of Plastics based on temporal variation

S. No	Seasons	Plastic Materials Observed	Percentage Contribution of Plastics	Reason For Abundance of Plastic Materials
1.	SUMMER SEASON (March to May)	a; c; d; e; f; g; h; j; k; l; m; n; o and p	77.78%	Festivals, Pilgrimage activities and tourism
2.	MONSOON SEASON (June to October)	a; b; c; d; e; f; g; h; i; j; k; l; m; n; o; p; q and r.	100%	Run offs from residential areas and domestic sewages
3.	WINTER SEASON (November to February)	c; e; f; g; j; k; l; m and p	50%	Religious activities

Study area 1

Fig 1: Presence of Paper

Fig 2: Presence of Polythene bags

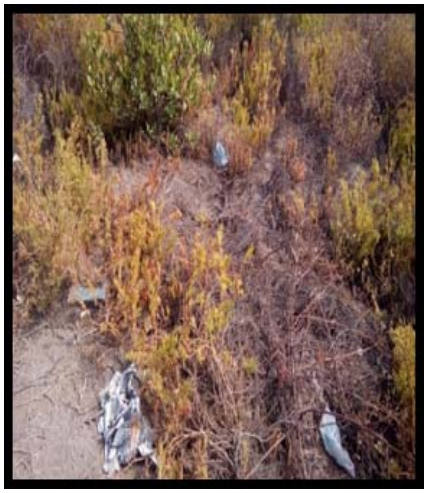

Fig 3: Presence of Plastic materials

Fig 4: Presence of Hook & steel materials

Fig 5: Presence of Brush

Fig 6: Presence of cigarettes

Study area 2

Fig 7: Presence of fishing net

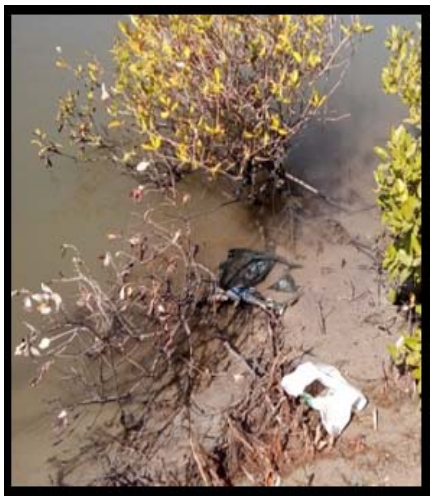

Fig 8: Presence of plastic papers

Fig 9: Presence of papers and other plastic materials

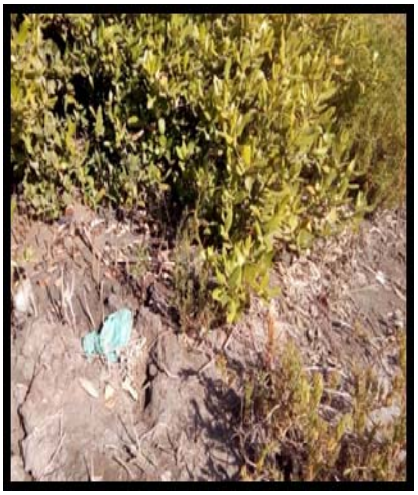

Fig 10: Presence of polythene bags

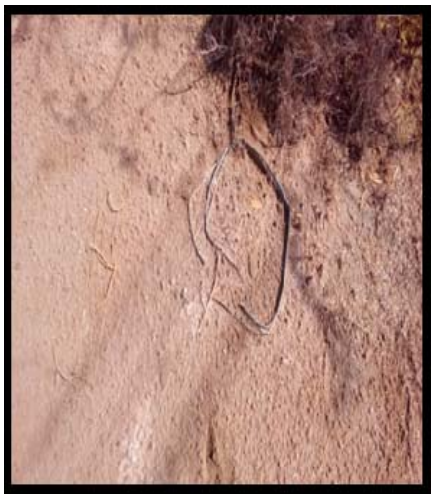

Fig 11: Presence of nylon rope

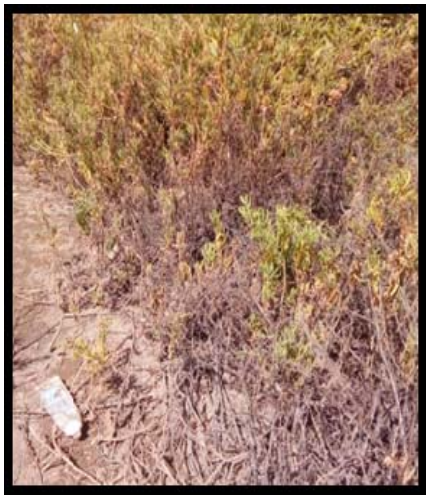

Fig 12: Presence of paste tubes

Study area 3

Fig 13: Presence of polythene bags

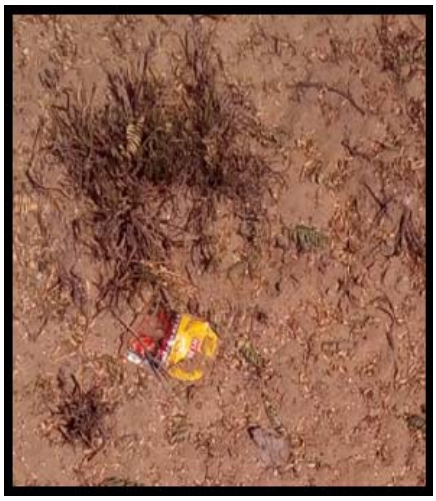

Fig 14: Presence of pawn packet

Fig 15: Presence of battery materials

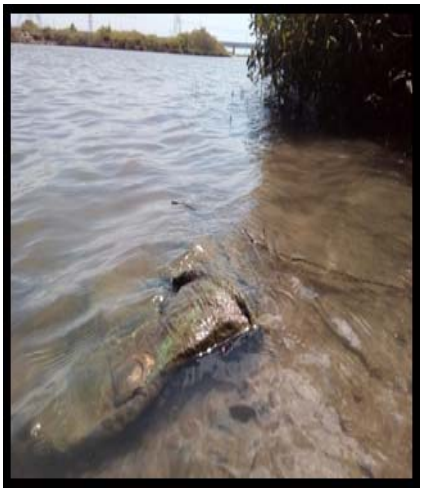

Fig 16: Presence of cement bag

Fig 17: Presence of barnacles on sack

Fig 18: Presence of Slipper and unwanted plastics

Study area 4

Fig 19: Presence of fishing net

Fig 20: Presence of polythene bags

Fig 21: Presence of slipper & plastic materials

Fig 22: Presence of nylon rope

Fig 23: Presence of liquor bottles & Paper materials

Fig 24: Mass death of jelly fishes

Study area 5

Fig 25: Presence of plastic materials

Fig 26: Presence of papers, Cloth and other materials

Fig 27: Presence of Thermocole

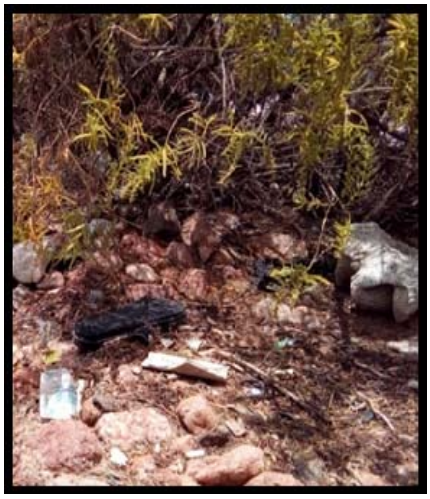

Fig 28: Presence of slipper and polythene bags

Fig 29: Presence of polythene bags

Fig 30: Presence of Polythene bags affects the growth of plants

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