



Plastic pollution in the islands of Laccadive Archipelago and its possible impact on the atoll ecosystem

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Short communication

Abstract

All the islands of Laccadive Archipelago including the inhabited ones are known comparatively less impacted from anthropogenic means as they are far and free from polluting industries. However, it is estimated that beach debris in ten of the inhabited islands show mean quantity of 10.567 g/m² which includes PET and glass bottles, plastic carry bags, HDPE and nylon ropes, cement bags, net pieces, footwear and insulators like PUF, styrofoam and thermocol pieces when observed quarterly for one year period during October 2013 to September 2014. Minicoy Island accounted for maximum quantity (31.73 g/m²) and Kiltan Island accounted for minimum value (4.53 g/m²) of beach debris. Plastic thin carry bags and containers of household products account for 40% among the beach litter which is much higher than the national average of 14% reported for the entire coastline. The quantity of beach debris in the islands was proportional to the number of island population, except for Kavarathi Island which registered the maximum per capita share of 17.5 kg/head and the lowest (2.19 kg/head) by Kiltan Island. Thin carry bags and sheets smother over seagrass and seaweed beds and choke the macrophytes while damage the biota beneath. Upon photolysis over a period of time, these plastic bags can be fragmented and become microplastics. These tiny particles of plastics can enter into the food chain of fragile atoll ecosystem as well as can settle on the coral polyps which may lead to their mortality. The Island Administration can enforce strict legislation to discard plastics

after use in designated places only and to encourage reuse, reduce and recycle the plastic materials.

Keywords: Beach debris, microplastics, atoll ecosystem, plastic pollution, percapita share

Introduction

Beach debris including the non-biodegradable waste materials find their way to sea either through river runoff, or directly through anthropogenic interventions in different proportions. Plastic materials also end up in the marine environment when accidentally lost, carelessly handled (Wilber, 1987) or left behind by beachgoers (Pruter, 1987). The threat of plastics to the marine environment has been ignored for a long time, and its seriousness has been only recently recognised (Stefatos *et al.*, 1999). Around the globe nearly 300 million tonnes of plastic are produced annually; of which 8 million tonnes enter the oceans each year. 80% of marine plastics originate from land sources – impacting on all habitats and threatening wildlife, food safety, human health and contributing to climate change (Law, 2017). The United Nations Environmental Programme (UNEP) considers

plastic marine debris and its ability to transport harmful substances as one of the main emerging issues affecting the coastal environment.

Quantity and composition of beach debris from India are available from various parts such as Nicobar Islands (Dharani *et al.*, 2003; Sahu and Balakrishnan, 2019), Karnataka coast (Sridhar *et al.*, 2009), northern Gulf of Mannar (Ganesapandian *et al.*, 2011), select beaches of Kerala, Karnataka and Tamil Nadu (Kaladharan *et al.*, 2012), some urban beaches in Mumbai (Jayasiri *et al.*, 2013), Mangalore coast (Bindu *et al.*, 2014) and a comprehensive account from the entire peninsular and archipelagic coasts of India (Kaladharan *et al.*, 2017). All the islands of Laccadive Archipelago including the inhabited ones are known comparatively less impacted from anthropogenic means as they are free from polluting industries. However, intertidal areas of majority of lagoons of Lakshadweep Islands are contaminated with beach debris abandoned by the Island population and the tourists. Hence an attempt is made to quantify and categorize the beach debris from the beaches of 10 inhabited Islands.

Material and methods

The survey for beach debris was conducted in 10 inhabited

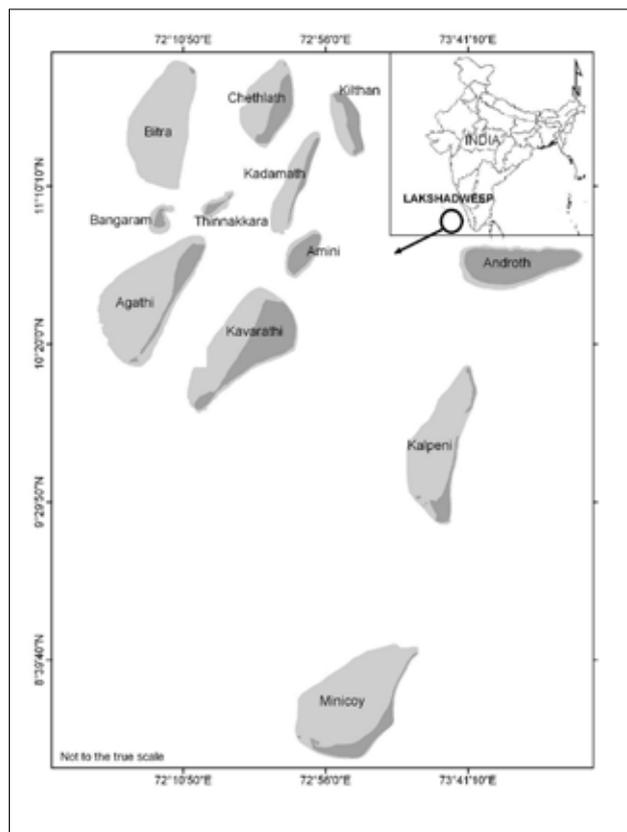


Fig. 1. Map of Lakshadweep Islands showing the 10 inhabited Islands

Atolls (Fig.1) whose details such as name, area, geographic locations etc. are given in Table 1.

From the 10 inhabited Atolls, sampling sites along the intertidal zone were selected systematically at every one km intervals on a line transect around the island using a rope quadrat of 10 x 10 m. All debris larger than 2.5 cm in diameter/ length that occurred within the quadrats laid between the low tide mark and the highest tide mark on the shore around the island were collected, cleaned of adhering sand and moisture and classified into six categories (Kaladharan *et al.*, 2017) as shown below within one year period from October 2013 to September 2014.

Debris thus segregated were counted and weighed by group (drained weight) using a portable balance in the survey sites itself. Debris counted and weighed on the beach were removed after the survey every time. The mean values (g/m²) of beach debris for each Atoll were calculated using Excel software. From the mean values of each Atoll total quantity of beach litter (kg) was calculated by multiplying the mean value with the total land area of respective Atolls (ICMAM, 2010). Similarly per capita share of beach debris was also calculated by dividing the total quantity for the Atoll with the respective population (Marine Census, 2010) without taking into account the number of tourists and visitors to the Atolls.

Table 1. The names and details of the Atolls in the UT of Lakshadweep where beach debris study carried out.

Sl.No	Name of Atoll	Geographic Location	Land area (sq.Km)	Lagoon area (sq. Km)
1	Agathi	Lat.10°52' N Long.72°11' E	2.71	8.8
2	Amini	Lat.11°07' N Long.72°44' E	2.59	3.6
3	Androth	Lat.10°49' N Long.73°4' E	4.8	-
4	Bitra	Lat.11°36' N Long.72°10' E	0.1	2.29
5	Chetlat	Lat.11°42' N Long.72°43' E	1.04	1.4
6	Kadmat	Lat.11°13' N Long.73°39' E	3.13	13.3
7	Kalpeni	Lat.10°05' N Long.72°11' E	2.28	5.2
8	Kavarathi	Lat.10°33' N Long.72°38' E	3.63	6.75
9	Kiltan	Lat.11°29' N Long.73° 01' E	1.63	2.02
10	Minicoy	Lat.8°17' N Long.73°04' E	4.37	21.8

Results and discussion

The Laccadives or the Lakshadweep Islands are the northernmost of the Lakshadweep-Maldives-Chagos group of islands, which are on the top of a vast undersea mountain range, the Chagos-Laccadive Ridge (Ashalatha *et al.*, 1991) as an archipelago is formed of 36 islands comprising 12 atolls, 3 reefs, 5 submerged banks and 10 inhabited islands with an area of 32 sq km. It is estimated that beach debris in the ten inhabited islands studied show mean value of 10.567 g/m² which includes PET (polyethylene terephthalate) and glass bottles, plastic carry bags, HDPE (high density polyethylene) and nylon ropes, net pieces, long lines, cigarette lighters, footwear and insulators like PUF (polyurethane foam), styrofoam and thermocol pieces. Distribution of beach litter recorded maximum in Minicoy Island and minimum in Kiltan Island (Fig 2). In both these islands the fishing related litter (A-group) were negligible or nil (Table 2). Plastic thin carry bags and wrappers of household products (B-group) formed the major composition in all the Islands and registered maximum per unit area in Minicoy Island which accounted for 50% among the beach debris, while the Androth Island that generated lower quantity of beach litter registered 89% of house hold plastic items (Table 2). Lakshadweep Islands, the smallest Union Territory of India registered 40% of house hold plastics over the total debris which is much higher than

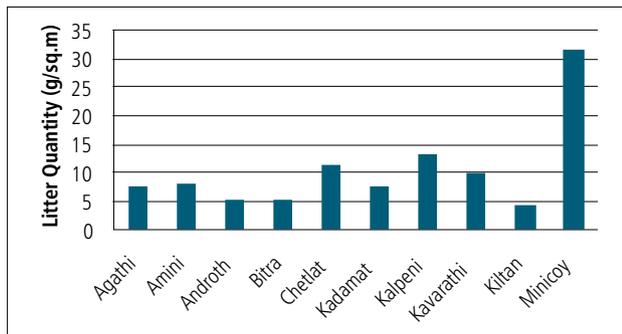


Fig. 2. Quantity of litter (g/m²) in the beaches of ten inhabited Lakshadweep Islands

the national average of 14% of beach litter reported for the entire coastline by Kaladharan *et al.* (2017).

Plastic litter comprising mostly beverage and cosmetic bottles from South-east Asian countries has been reported accumulating along the shores of Great Nicobar by currents via the Malacca Strait, posing a threat to its rich and unique ecosystem (Darani *et al.*, 2003; Sahu and Balakrishnan, 2019). Darani *et al.* (2003) had already quantified the share of plastic litter being swept in to the shores of Great Nicobar Island from Malaysia (40.5%), Indonesia (23.9%), Thailand (16.3%) and Singapore (7.4%). Similar to the Great Nicobar Island in the Andaman Nicobar archipelago, Minicoy Island, which is the southern most island and so proximate to Maldives Ridge has the highest deposition



Fig. 3. View of barnacles settled on a beach litter



Fig. 4. View of drifted piece of litter found in the shores of Minicoy Island

Table 2. Composition of beach litter (A – F g/m²) and the relative percentage of house hold plastics (B) over the total quantity of litter

Name of Islands	A	B	C	D	E	F	% of B over total
Agathi	0.45	2.85	2.15	0.60	0.00	1.59	38.8
Amini	0.05	2.67	2.48	1.35	1.09	0.57	24.9
Androth	0.00	4.03	0.23	0.50	0.08	0.67	89.0
Bitra	0.54	2.09	1.47	1.06	0.00	0.13	39.5
Chetlat	1.78	4.35	3.75	0.84	0.06	0.54	37.7
Kadamat	2.48	2.08	1.05	0.49	0.00	1.84	21.0
Kalpeni	7.69	3.49	1.80	0.00	0.00	0.37	26.0
Kavarathi	0.51	5.28	3.02	0.14	0.15	1.01	48.6
Kiltan	1.59	1.01	1.61	0.23	0.00	0.09	22.0
Minicoy	0.00	15.85	10.84	0.00	0.00	5.04	50.0
Mean	1.51±2.2	4.37± 4	2.84±2.8	0.52±.4	0.14±0.3	1.19±1.4	39.75±19.2

of beach litter (Fig. 2) Many floating debris collected from Minicoy and Kiltan Islands have deposition of barnacles and other oceanic foulants (Figs. 3 and 4) indicating that these debris particles have drifted a long distances floating before settling to the shore. Barnacles such as *Lepas* spp. are considered as foundation species on plastic debris (Gil and Pfaller, 2016).

The quantity of beach debris in the islands was directly proportional to the number of island population, except for Kavarathi Island (Table 3) which might be due to the higher number of non-resident population including the Government employees and hence the highest per capita share of 17.53 kg/head. Visitors and tourists do play major role in littering the beaches as evident from the per capita share of litter from the Islands of socio- cultural and tourism importance (Table 3).

Marine debris scattered on beaches can impair the aesthetic value of beaches and can create an eyesore for tourists and beachgoers. Marine debris is a source of serious damage to

Table 3. Per capita share of beach litter in the inhabited Islands

Name of Islands	Fisher population	Qty (g/m ²)	Land area (sq.km)	Total debris(kg)	Per capita (kg/head)
Agathi	3284	7.674	2.71	20796.54	6.33
Amini	3628	8.213	2.59	21271.67	5.86
Androth	4637	5.51	4.8	26448.00	5.70
Bitra	154	5.29	0.1	529.00	3.44
Chetlat	1287	11.32	1.04	11772.80	9.15
Kadamat	2949	7.94	3.13	24852.20	8.43
Kalpeni	4982	13.35	2.28	30438.00	6.11
Kavarathi	2093	10.11	3.63	36699.30	17.53
Kiltan	3371	4.533	1.63	7388.79	2.19
Minicoy	8426	31.73	4.37	138660.10	16.46
Total	34811	-	26.29	277700.80	-
Mean	-	10.56 ± 7.53	-	-	8.12 ± 4.84

marine lives, ecosystems, fisheries, and navigational safety. Upon photolysis over a period of time, plastic bags and carry bags can be fragmented and become microplastics. These tiny particles of plastics can enter into the food chain of fragile atoll ecosystem as well as can settle on the coral polyps resulting in their mortality. Marine turtles use a variety of habitats including seagrass meadows, their migratory behaviour and complex life histories expose them to a wide range of anthropogenic stressors, including marine plastic pollution. Beach litter may also entangle nesting females or emerging hatchlings of turtles. Transfer of chemicals to marine biota through the marine debris

especially plastics has also been recorded recently (Derraik, 2002; Hong *et al.*, 2013; Rochman *et al.*, 2013) which might cause deleterious effects on the sensitive and fragile ecosystem.

Although plastic is omnipresent and widespread pollutant, it is an important and inevitable item for the inhabitants of Lakshadweep Islands to protect their belongings, valuables and food materials from the vagaries of sea and rain water. So a total ban for plastics may not be feasible in the Lakshadweep. However, the Island Administration can enforce strict legislation to discard plastics after use in designated places only and to encourage reuse, reduce and recycle the plastic materials.

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