Litter Pollution on the Coastline of Obhur, Kingdom of Saudi Arabia

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ABSTRACT

Anthropogenic debris has become a source of considerable interest and concern due to their biological effects both in and out of the water. Coastal debris is one of the realistic visual negative impacts of human activities on marine habitat and environment. In order to assess the nature, extent and source of litter, point survey was conducted along the Obhur coastline of Jeddah, Saudi Arabia. Most of the litter appeared to be from local land-based sources, although there were some regional influences as well. More than 75% of the litter was plastic origin and the rest were from wood, metal, glass, and paper materials. The type of litter components (empty cans of food, beverages, cosmetics, hand bags, cloths, rubber mattresses and toys) indicate that these were left by beach goers. Remnants of fishing crafts and gear were comparatively less. The survey result was compared with the coastal litter reported in other regions of the world. Abundance of litter $m^{-1}$was indicated at 1.72-12.54 items for Obhur beach study area. Litter quantity on the coast is inversely proportional to its geographical distance to a population and directly proportional to visitor frequency. Public education and awareness on waste disposal was found essential to protect the coastal environment.

Introduction

On a hemi-centennial review of yesteryears, marine litter has received increasing attention. As a consequence of the world-wide nature of the litter problem, many international and regional conventions, regional agreements, sea programs and action plans have been adopted: MARPOL, 1973, 1978, London Dumping Convention (LDC), 1973; Helsinki Convention, 1974; Oslo Convention, 1972; Kuwait Regional Convention, 1978; Regional Convention for the Conservation of the Red Sea and the Gulf of Aden Environment (Jeddah Convention), 1982. Studies from many parts of the world have quantified beach litter, and in coastal and oceanic waters (Al-Shuely, 1998, Carpenter *et al.,* 1972; Coleman and Wehle, 1984; Cundell, 1973; Dixon and Cooke, 1977; Furness, 1985; Golik and Gertner, 1992, Horsman, 1982; Jones 1995, Khordagui and Abu-Hilal, 1994; Madzena and Lasiak, 1997; McCoy, 1988; Merrell, 1980; Morris, 1980; Scott, 1975; Shiber, 1979; Shiber and Barrales-Rienda, 1991; Silva-Iniguez, and Fisher, 2003; Wade *et al.,* 1991; Whiting, 1998; Wilber, 1987; Willoughby, 1986, 1997).

There are negative ecological effects of litter such that leading to starvation and death from ingesting of plastics resulting in blockages and ulceration or damage to the delicate internal tissues of the stomach and intestines (Gramentz, 1988; Gregory, 1991; Laist, 1987; Wehle and Coleman, 1983), and concentration of synthetic chemicals up the food chain (Gregory, 1978; Wehleand Coleman, 1983). Marine litter also poses a health and safety hazard to coastal residents and tourists. Human injuries also result from beach litter; particularly foot lacerations when bathers or beach goers have trodden on ring pull taps from drink containers or broken glass bottles (Dixon and Dixon, 1981). There is also a continuing cost to coastal communities for clean-up

of beaches. However, the most obvious impact of marine litter is the aesthetic degradation of coastal amenities, particularly leisure and recreational beaches. There is little information on accumulation rates, distribution, sources and problems of marine debris on beaches of Jeddah. Accordingly, a brief monitoring program was carried out to investigate the magnitude of this environmental problem in the most urbanized and industrialized parts of the eastern Red sea. The investigation is the first attempt to quantify the problem of beach litter along the shores of Obhur, Jeddah.

Materials and Methods

Jeddah is the largest city in Makkah Province which is a major urban center located on the coast of Red Sea, Saudi Arabia. The population of the city currently stands at 3.2 million and is an important commercial hub. The study was conducted during the month of July 2010. Point survey by transect method was carried out for a distance of 1 km along the Obhur coastline to assess the litter pollution. The coastline (Figure 1) was marked into the following 7 locations (Table 1) by Global Positional System (GPS) and the litter in each location was assessed by transect method for a week comprising seven days (11-18 July 2010).

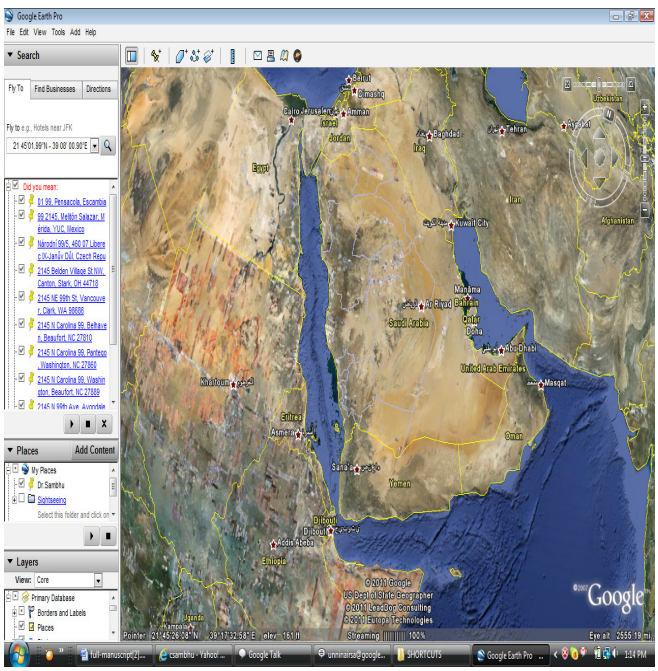

Figure 1: Site selected for litter study at Obhur coastline, Jeddah, KSA

Table 1: Global positional system (GPS) co-ordinates of the stations studied (Zones 1-7).

Position	Latitude	Longitude
Zone 1	21°45' 01.99" N	39° 08' 00.90" E
Zone 2	21° 45' 01.69" N	39° 07' 58.53" E
Zone 3	21°44' 57.03" N	39° 07' 57.8" E
Zone 4	21°44' 57.19" N	39° 07' 57.26" E
Zone 5	21°44' 55.08" N	39° 07' 56.62" E
Zone 6	21°44' 53.23" N	39° 07' 56.15" E
Zone 7	21°44' 51.34" N	39° 07' 55.91" E

Transects ($25m^2$) were perpendicular to the coastline and was marked running from the edge of low water at the time of data collection, to the back of the beach. The back of the beach was determined as the foot of the dunes, the vegetated areas or the coastal road walls running parallel to the beach along the coastline, where litter removed from the shore by wind action accumulates. During survey, all pieces of debris found in the strip transect equal to or larger than 2 cm were counted, categorized and recorded. The method for classifying sources of litter items were taken from previous studies elsewhere in the world (Debrot *et al.,* 1999; Garrity and Levings, 1993; Golik and Gertner, 1992; Khordagui and Abu-Hilal, 1994; Shiber and Barrales-Rienda, 1991; Vauk and Schrey, 1987; Wade *et al.,* 1991).

Results

Details of litter collected from various transects (21°45'01.99"N-39° 07'55.91"E) are presented in numbers in Table 2. Litter from marine-based sources includes wood pieces, ropes, fishing net, floats, buoys, oil cans and polystyrene (Styrofoam) blocks. Litter from land-based sources includes glass, plastic bags, plastic containers, bottles, cans, caps and covers, aerosol containers, cardboard, rubber and footwear.

Table 2: Litter collected from various transects

Litter	Transects						
	1	2	3	4	5	6	7
Plastics							
Polythene bags	3	8	0	0	1	1	4
Plastic caps	6	22	6	2	7	5	9
Plastic Bottle	1	1	1	0	0	1	6
Ear Buds	0	1	0	0	0	2	3
Soft drink caps	2	0	1	0	0	0	0
Plastic Materials	3	1	50	10	7	25	2
Snacks covers	0	5	0	0	0	4	0
Plastic coffee cups	0	2	0	0	0	2	1
Plastic spoon	0	0	10	3	2	4	3
Plastic straw	0	0	0	0	0	0	7
Sub Total	**15**	**40**	**68**	**15**	**17**	**44**	**35**
Metals							
Metal cap	7	0	0	0	3	1	9
Metal strips	0	0	20	25	8	0	60
Sub Total	7	0	20	25	11	1	69
Biologicals							
Mutton Bones	12	0	2	0	4	0	4
Orange peels	2	1	0	0	0	5	1
Cigar butt (with tobacco)	50	100	200	45	30	40	300
Tea Bags	0	1	3	0	3	0	2
Sub Total	**64**	**102**	**205**	**45**	**37**	**45**	**307**
Cellulose paper types							
Face Tissues	3	0	0	1	3	6	0
Cigar cover	1	0	0	0	0	0	0
Sub Total	4	0	0	1	3	6	0
Cloth materials							
Floor Carpets	1	1	0	0	0	0	0
Garments	0	0	0	0	0	0	1
Sub Total	1	1	0	0	0	0	1
Wood types							
Wood	2	1	0	0	1	4	1
Plywood	2	0	0	0	0	0	0
Sub Total	**4**	**1**	**0**	**0**	**1**	**4**	**1**
Miscellaneous							
Synthetic sponge	3	0	0	0	0	1	1
Charcoal	0	1	0	0	19	25	200
Rubbers and Tubes	0	0	0	0	1	0	10
Glass pieces	2	0	0	0	0	0	3
Sub Total	**5**	**1**	**0**	**0**	**20**	**26**	**214**
Grand Total	**100**	**145**	**293**	**86**	**89**	**126**	**627**

In terms of numbers of items m^{-1}, biological dominated the samples recording 2.3 items m^{-1}. The next most abundant groups were miscellaneous types, comprising principally of charcoal scoring 0.76 items m^{-1}. In terms of weight, the debris were dominated by charcoal followed by organic bone pieces. Debris resulting directly from beach use were the most abundant numerically. The plastic bottles and containers vary in size, shape, color and usage, but the majority was 1.5-litre water bottle. Only a small fraction of the plastic containers were associated with industrial or household activities such as detergents, cleansers and oils. Wood, which is the second most abundant group, includes wood pieces, lumber, boxes and plywood. Wood pieces in the range of 10 cm or more constitute the major component of the wood group. Metal components included rods, pipes, tins and food. soft drink and aerosol cans. Rubber items were mainly truck and small car tires and constitute a small fraction of the total litter. Litter that can be attributed with any certainty to fishing, shipping and boating activities in the study area includes pieces of plastic or nylon nets, threads, lines and ropes. The biodegradability levels of materials washed ashore on the beach are tabulated in Table 3.

Table 3: Materials pushed ashore on the beach

#	Types	Nature of Degradation
1	Buoys	Non biodegradable
2	Balls	Non biodegradable
3	Nets	Non biodegradable
4	Line Strings	Non biodegradable
5	Non biodegradable	Non biodegradable
6	Soft drink covers	Non biodegradable
7	Non biodegradable	Non biodegradable
8	Shade caps	Non biodegradable
9	Non biodegradable	Non biodegradable
10	Plastic Pepsi bottles	Non biodegradable
11	Rubbers & Tubes	Non biodegradable
12	Plastic ropes	Non biodegradable
13	Styrofoam floats	Non biodegradable
14	Plastic Footwear	Non biodegradable
15	Garments	Non biodegradable

Visitor diversity, their different types and numbers with all the days of the week has been found to be variable (Table 4).

Table 4. Number of visitors frequenting the locations (1-7)

Entertainers	Sat	Sun	Mon	Tue	Wed	Thu	Fri
Idlers	46	19	11	14	96	340	860
Sun buskers	35	10	7	4	27	192	755
Beach swimmers	42	12	6	5	35	390	850
Game attendees	9	3	-21	0	33	348	696
Beach Surfers	11	3	1	2	1	46	98
Boat / Jet ski Riders	69	31	18	21	73	132	556
Night watchers	80	11	0	0	284	490	980
Barbecue favourites	13	4	0	0	23	61	119
Youth Oglers	21	33	27	38	154	475	918
Onlookers/ Starers	59	62	64	57	320	621	1024
Family unions	72	0	0	1	22	86	356

A clear weekly trend was observed with gradual increase of counts on the weekends and its preceding eve day. After a relatively high level of litter during solid weekends (Thursday and Friday), Saturday, the first day of the week had a subsequent effect of the week end swell of solid waste refuse (Table 5).

Table 5. Weight of refuse (g) estimated from beach garbage

Refuse	Sat	Sun	Mon	Tue	Wed	Thu	Fri
Plastics	339	19	6	6	10	143	92
Metals	917	75	80	90	213	655	1400
Organics	1698	100	80	117	390	700	3700
Glass	120	35	111	56	540	1100	4200
Cellulosic	45	17	68	48	288	545	1100
Cloth	165	10	0	0	0	860	1788
Wood	259	0	0	0	0	900	1350
Charcoal	1300	0	0	0	0	1800	5900
Miscellaneous	1300	0	0	0	0	1800	5900
Total	**6143**	**256**	**345**	**317**	**1441**	**8503**	**25430**

Discussion

This study provides important information about the composition, variability and sources of litter on Obhur coastline, Jeddah. The largest determinant of litter is the extent and nature of local human activities as well as certain coastal features. The principle categories of human activities include coastal industrial development, shipping, tourism, solid waste disposal and fishing. These activities are more likely to give rise to litter than other activities such as mariculture, oil import and export, and waste water disposal. Beach litter appears to be mainly due to in situ deposition and dispersion and/or transportation by wind induced waves and surface currents of litter dumped into the coastal waters of the riparian countries. It is well known that material floating at the surface is brought up to beaches primarily by wind and secondarily by currents (Neuman, 1966) and on the incoming tides (Caulton andMocogni, 1987). Examination of litter components shows that most of the litter on the Obhur coastline of Jeddah results from two sources; recreational and shore fishing activities. The problem of litter on these zones studied appears to be mainly due to the un-controlled dumping of large quantities of plastic materials and in part the result of dropping other items such as soft drinks cans, match boxes, plastic straws, sanitary napkins, disposable diapers and garment pieces such as shoes, boots, sandals shirts and small blankets. In addition a lot of cigarette butts and filters, cigarette boxes and spent disposable lighters were observed on this beach area studied.

The results obtained from world-wide studies (Table 6) indicate that factors which affect the litter distribution on beaches include location and proximity of the beach to the litter source, type of beach, beach usage, beach physiography, slope, orientation and extent of exposure (Dixon and Dixon, 1981; Wade *et al.,* 1991; Thornton and Jackson, 1998; Whiting, 1998).

Table 6: Mean estimate of abundances of litter/m of shore reported from various beaches

Region (Country)	Counts per m of Beach front	Reference
Helgoland (Germany)	1.3 items	Vauk and Schrey (1987)
Inaccessible Island (South Africa)	0.014–0.421 items	Ryan and Watkins (1988)
Central Transkei (South Africa)	20–72 items	Madzena and Lasiak (1997)
Curacao	8–88 items	Debrot *et al.* (1999)
New Jersey (USA)	1.456 items	Ribic (1998)
Fog Bay (Northern Australia)	0.052–0.149 items	Whiting (1998)
Baja California (Mexico)	7.43–10.97 items	Silva-Iniguez & Fisher (2003)
St. Lucia, (Dominica)	4.5–11 items	Corbin and Singh (1993)
Jamaica	19 items	Wade *et al*. (1991)
Tasmania	0.3 items	Jones (1995)
Mormion Marine Park (Western Australia)	2.7–3.6 items	Jones (1995)
Israel	5.8–9.2 items	Golik and Gertner (1992)
Indonesia		Willoughby *et al.* (1997)
Inshore Islands	15.24 items	
Offshore Islands	2.38 items	
Mediterranean Shores	14–96 items	Gabrielides *et al.* (1991)
Sable Island (Nova Scotia Canada)	0.179–0.287 items	Lucas (1992)
North Coast (Oman)	0.43–6.01 items	Claereboudt (2004)
Obhur Beach, Jeddah (Saudi Arabia)	1.72-12.54 items	Present study

Environmental factors affecting the distribution include the direction of wind, surface waves and currents (Dixon and Cooke, 1977; Vauk and Schrey, 1987; Golik and Gertner, 1992; Garrity and Levings, 1993; Debrot et al., 1999). Analysing the number of items of marine debris in the study area found thatmost of the mega litter on the beach was of local origin. Khordagui and Abu-Hilal (1994) surveyed beaches along 800 km of the Arabian Gulf and Gulf of Oman shorelines. Of the estimated 13*:*5 x 10^6 stranded items, plastics were the most common. They related most of the litterwhichthey found on the beaches of the United Arab Emirates to marine-based sources, particularly, to fishing activities.

The present study confirmed organic bones has the maximum biomass and charcoal ranking second in weight and numbers (Figure 2).

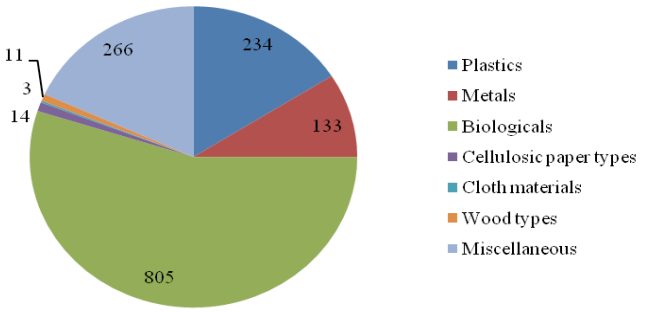

Figure 2: Relative abundance of beach litter in the study area (Obhur Beach, Jeddah , KSA)

Comparing the characteristics of the litter in study area with those of other beaches in the world (see, table 5), Jeddah beaches have a serious trend of solid waste contamination that needs urgent redressal.

Conclusion

Based on the above and other findings, it is believed that in order to enhance the appreciation of the litter problem in the study area, efforts have to include the following 6 actions.

1. Initiate local and regional marine litter monitoring programs and cleanup campaigns with school children energetic participation.
2. Increase existing co-operation among scientists, decision makers and general public on local, national, regional and international scales.
3. Promote sound solid waste management practices all along the eastern Red sea coast cities.
4. Promote pilot projects that demonstrate integrated approaches for reducing marine litter in the study area and in the whole region.
5. Promote the active participation of relevant (PERSGA, MEPA) agencies in the activities needed to combat the problem.
6. Develop a strategy for conducting a marine litter outreach campaign and establish a region-wide public education programs.

Since most of the litter appears to be of local origin, provision and regular removal of adequate numbers of wind resistant litter bins adjacent to prime recreational areas combined with an awareness campaign could probably help reduce the quantity of litter discarded by beach users (Claereboudt, 2004).

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