IMPACT OF ACCUMULATED BEACH LITTER ON *Chelonia mydas* L. 1758 (GREEN TURTLE) HATCHLINGS OF THE SAMANDAĞ COAST, HATAY, TURKEY

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SUMMARY

Samandağ coast, located in the northeastern corner of the Mediterranean, is specifically used by *Chelonia mydas* (green turtles) as nesting area. While predators, such as foxes, crabs and dogs, naturally exist in the area, human impact by means of solid waste accumulation on the shoreline helps such predators to prey on more than a quarter of emerged green turtle hatchlings (an estimated value) in the area, entrapping them during their short shoreline trips from their nests to the sea or beach litter.

In this study, litter accumulation, as well as its causes and types (recyclables, and medical, hazardous or hard-to-recycle ones) and amounts of these solid wastes at the Samandağ coast are assessed, and it was found that solid waste transport to the Mediterranean Sea from various sources accumulates the litter on the beach due to influence of wind. Moreover, the beach litter was found to be one of the most important causes that impact turtle hatchlings, when they try to safely arrive to the sea. It was found that River Asi, an international river passing through Lebanon, Syria and Turkey, mainly used for all types of solid waste disposal purposes (including medical and hazardous types) by its surrounding cities, is a notable solid waste source to the shoreline. Additionally, coastal communities had disposed all kinds of wastes on the coastal zone for a long time that resulted in several heaps of waste nearby and on the shoreline. Mid summer and early autumn were chosen as sampling periods, and remarkable increase in solid waste amount in the sampling area after the first autumn rainfall event could be observed. Surprisingly, medical and hazardous wastes on the beach were found to be notably elevated, representing more than 5% of the total beach litter. The study area is highly contaminated with solid wastes on the coast, when worldwide compared to similar beaches. It was found that solid waste accumulations on beaches negatively affect green turtle hatchlings trying to reach the sea, and percentage of hatchlings reaching the sea was found to be negatively correlated with beach litter amount (r^2 = - 0.84 on 8th July 2003; and r^2 = - 0.74 on 16th of September 2003).

KEYWORDS: Asi River, beach litter, coastal pollution, Samandağ beaches, solid wastes.

INTRODUCTION

The Mediterranean is known to be one of the most contaminated water-bodies in the world, because of densely populated coastal areas, unsustainable waste management practices, especially in the developing countries, and heavily performed agrarian and industrial activities in the surroundings [1, 2]. According to UNEP [1], the annual population growth rate in the southern Mediterranean countries is close to 3%, and this, alone, is a risk factor for both terrestrial and sea environments, especially the coastal zone, since most of the urban areas of the northern African, southern European, and western Middle East countries are concentrated on or around the sea strip. Moreover, the diversity of produced and consumed goods and the average consumption of goods per capita have an increasing trend. While various types and amounts of floating debris, mainly anthropogenic ones, were reported to be up-taken by some living sea resources (e.g. sea turtles, sea birds, dolphins, sea lions, etc.) [3, 5], and even cause the death of 13.2% green turtles [4], certain waste materials entangle and badly wound certain creatures, including sea-birds [6], pinniped [7], monk seals [8, 9] and others. Moreover, plastic debris was noted

not only to impair sea-water quality, but also to have probably caused plastic accumulation in plankton [10], thus impairing the quality of coral reef biota as well [11], and to be likely to cause the death of sea creatures, since they eat plastic items and feel their stomachs filled [12]. Furthermore, Golik and Gertner [13] showed in Israel that river mouths elevate beach debris, generally those of dry rivers, and particularly those located in arid and semi-arid regions, bring remarkable amounts of debris.

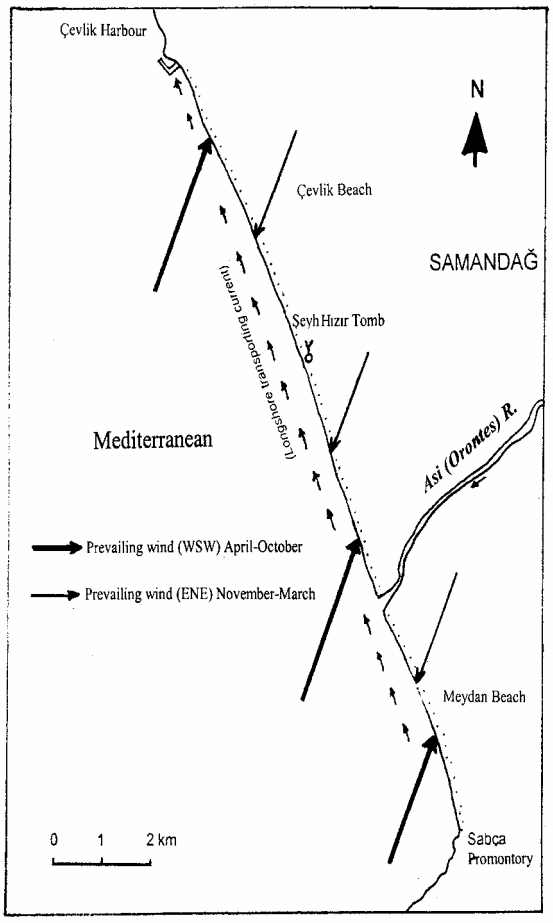


FIGURE 1 - The map of the study area .

Many works documented relationship between *C. mydas* and waste problem on the Samandağ beach [14-18]. Moreover, Baran and Kasparek [19], Kasparek *et al*. [20], and Yalçın [21] note that beach litter is a serious problem not only posing a risk to human health, but also a threat to the coastal habitat on Samandağ beaches (Fig. 1). The solid waste problem cannot be considered as a national issue, since Kasparek [22] also noted beach litters at Syrian coastline. Many studies have been focused on marine floating debris, sea floor debris, and their effects on the environment, whereas not much attention has been given to the effects of beach litter on turtles visiting the beaches to lay their eggs, and also on their hatchlings. Therefore, this study was designed to determine beach litter effects on *Chelonia mydas* hatchlings. During 2003 nesting season (late May through mid-September), the nests were successfully monitored and green turtle hatchlings counted in terms of the number of tracks of new individuals arriving the sea out of the total number of eggs found in the nests. In other words, this study was tailored in order to investigate human impact on endangered green turtle hatchlings in the case of solid waste accumulation on the beach, which is mainly generated by land-base human activities, followed by fishing and shipping activities, but also by estuarine systems affecting this environment, which is one of the most vulnerable ones in the world, and, finally, by the causes and consequences [23]. Beach litter amounts and densities were directly collected by a team of ten, on July 16 and September 8, 2003, when the hatchlings emerge from their nests. Temporal differences in terms of solid wastes collected from the shoreline were discussed, as similarly done by Thornton and Jackson [24]. It was found that the beach litter problem, along with light, impaired the success ratio of green turtle hatchlings trying to reach the sea. It was occasionally observed by the monitoring team that sea turtle hatchlings cannot pass beach litter, such as plastic bags, and then hunted by ghost crabs.

MATERIALS AND METHODS

The beach of Asi River Delta extends about 14 km on NNE direction between two rocky headlands: Çevlik on the north and Sabca on the south. The northern part of the beach is much larger (about 10 km) than the southern one, due to dominant long-shore transporting current towards north [25]. On this coast, about 6 km from the north and 4 km from the south of the River Asi, 10 m wide strips, and perpendicular to the permanently wet area, located between the sand hill and the sea from every thousand meters, were shared by ten litter-collecting people. The beach litter sampling method was developed according to Velander and Mocogni [26], whose study investigated the best litter sampling methodology out of ten different methods. Their study underlined that '5 m wide strip from vegetation line to water's edge' is not effective, if time is a concern, but since the method covers a large area and both old and new items accumulated on the beach [26], it is very effective in terms of total litter compiled. In the present study, instead of 5-m strips, 10 m-wide strips between sand dunes and permanently wet areas were designed, because the total study area is considerably large and the intervals between neighboring beach litter collectors are notably wide. The beach litter collection locations were carefully chosen using GPS Magellan® 315 model, and then marked by appropriate signs, properly on the day prior to sampling days. The minimum litter size was determined to be 1-2 cm in diameter, or larger than 2 cm [27]. Collected wastes were deposited into 3 different types of first-time used clean plastic bags: blue bags were used for medical and hazardous wastes, and other types of litter that might include hazardous waste stuff (such as grease-filled plastic strips to help illegally catching fish at night), whereas white bags were used for easily recyclable plastics, paper, and glass materials, and other types of recy-

clable matter, and, finally, black bags were used for collecting hard-to-recycle materials, including used foot wear, plastic pieces, plastic bags, and similar wastes. The above-listed solid wastes were collected on July 8 and September 16, 2003. All the members of the beach litter collection team were equipped with strong medical gloves for safety and health purposes, to prevent probable contaminations by remarkable amounts of medical and hazardous wastes encountered on the beaches.

Both sampling days were carefully chosen, since the nesting season of green turtles ranges from late May to late July, and hatchlings emerge between mid and late June and late September.

Interpretation on the waste amounts at the northern and southern sides of the river was made, in the light of coastal dynamics based on meteorological data, such as precipitation and wind directions. Having a Mediterranean type climate, the study area takes very limited amount of precipitation during this period, except early May and late August/early September. Therefore, it is a valid assumption that litters accumulation on the beach between May and September is only affected by wind from WSW/SW, oblique to the coast from seaward to land.

Collected solid waste samples were air-dried in their bags for 10 days, then weighed using an Oertling® balance (maximum weighing capacity = 5,000 g ± 1 g). Early summer and early autumn total solid waste amount values were compared by t-test and Cochran's t-test, since beach litter collection points were not changed. Moreover, based on the equation obtained using solid waste amounts, beach litter amounts on the total shoreline was computed and the obtained values were compared with the solid waste production from the private and state hospitals in the Turkish region of Asi River Basin.

Medical waste quantity collected from the shore was compared with the medical solid waste produced by both state and private health care facilities located within Asi Basin in the Province of Hatay, Turkey. Total medical solid waste production capacity of the medical facilities was calculated using approximate solid waste amount produced per bed of the state hospitals each day, giving 1.92 kg/ patient and day [28].

The total Asi catchment area is approx. 22,000 km^2, and about 18% of this area is within Hatay Province, Turkey. It is an international 380 km-long river flowing through Lebanon, Syria and Turkey, respectively. The length of the river in Turkey is 97 km (25% of total river length). The ephemeral tributaries located around the city of Antakya at river Asi are generally filled by solid wastes of local residents, who have no effective municipal solid waste management solutions, during dry summer months, and then, under spasmodic rains, these wastes are transferred into Asi river, and, finally, swept to the sea, if not accumulated around the way throughout the river bank or mouth.

The density of solid wastes (unit waste amounts) obtained was compared to different beach litter quantities throughout the world, reported by different researchers [29- 34].

The beaches were monitored daily by a volunteer group. Nests were counted, marked by sticks, and numbered, in order to easily recognize them in the future. Locations of all nests both in horizontal and in vertical distance (from the sea) were recorded in addition to the locations of turtles' tracks. The percentage of nesting success was computed using the following formula:

100 * [Nest number/ number of all tracks (nests plus tracks without nests)].

Nest density was calculated as number of nests on each km, and percentage of hatchling success was computed as follows:

100 * (hatchlings` number leaving their eggs)/ number of total eggs).

The percentage of hatchlings reaching the sea was calculated with the formula:

100 * (number of hatchling tracks on wet area/ number of hatchlings leaving their eggs.

It must be noted that, due to access problems at Meydan beach (south of Asi river mouth), the hatchlings reaching the sea could not been calculated there.

The correlation coefficients between the parameters explained above and beach litter amounts were calculated using Microsoft Excel® 7.0 spread-sheet program.

RESULTS AND DISCUSSION

Solid waste types and amounts sampled on the shoreline at both collection days were tabulated in Table 1. Due to NNW configuration of the coastal line, the prevailing winds either from seaward or landward on the shoreline in the entire Samandağ coast play an important role in solid waste accumulation on the beaches. The long-term meteorological data show that the main direction of the prevailing wind is WSW/SW between April and October, and ENE/E between November and March. Therefore, for the July 8th sampling day, it is assumed that the land-borne waste accumulation on the shoreline is lower than that on 16th of September, because Asi with its tributaries continuously carried waste to the sea during late autumn 2002, and winter and early spring 2003. In April and May 2003, these litters were added to the beach with WSW winds (the strongest winds were prevalent from SSW in February and March 2003 with speeds of 23.0 m s^{-1} and 23.5 m s^{-1},

respectively). It must be noted that a high flow happened in Asi river from rain on 6th and 7th of September (4.5 and 2.2 kg/sqm area, respectively). This flow brought extra waste to the coast, which was added back to the beach by dominant WSW/W winds. Wastes carried by Asi were blown back to the shore by seaward winds.

TABLE 1 - Beach litter amounts collected from the Samandağ beaches on July 8 and on September 16, 2003 (the mouth of Asi considered as (0) m).

Distance from the river mouth, m	Length from sand hill to sea, m	Beach litter weight, g						Total waste weight, g	
		Medical & hazardous waste (Jul 8)	Medical & hazardous waste (Sep 16)	Recyclable waste (Jul 8)	Recyclable waste (Sep 16)	Hard-to-recycle waste (Jul 8)	Hard-to-recycle waste (Sep 16)	Total beach litter (Jul 8)	Total beach litter (Sep 16)
-6.000	64	15	40	800	100	2.000	1.600	2.815	1.750
-5.000	62	15	20	2.030	1.500	1.900	1.800	3.945	3.320
-4.000	76	100	400	900	2.300	2.800	15.900	3.800	18.600
-3.000	75	200	550	3.800	9.000	3.650	18.500	7.650	28.050
-2.000	61	215	200	4.260	2.900	11.200	10.100	15.675	13.200
-1.000	40	1.030	350	3.400	2.000	16.250	18.100	20.680	20.450
1.000	59	1.280	3.000	2.420	2.100	4.060	9.400	7.760	14.500
2.000	81	780	1.500	2.250	3.200	3.080	10.100	6.110	14.800
3.000	41	360	100	3.000	5.200	5.000	6.200	8.360	11.500
4.000	20	760	250	2.840	2.800	3.630	5.000	7.230	8.050
Sum	-	4.755	6.420	25.700	31.100	53.570	96.700	84.025	135.120
Mean	57.9	476	642	2.570	3.110	5.357	9.670	8.403	13.512
S.D.	19.03	453	933	1.138	2.444	4.660	6.229	5.613	7.917

The medical and hazardous beach litters are estimated from the compiled amounts of Şeyhhızır and Çevlik beaches on 8th of July 2003 to be approx. 414 kg, whereas that of September 16, 2003 was found to be 224 kg. However, the same or similar decline cannot be observed for the Meydan beach, since the medical and hazardous solid waste amounts on the southern side of the river were projected to be more than 389 kg on July 8, 2003 and 813 kg on September 16, 2003, which is more than twice in terms of total solid waste weight of the previous sampling effort. Total medical ad hazardous waste amounts between both sampling days increased from approx. 803 kg to more than 1,037 kg, being about 234 kg, or 29.14%, within 70 days. It should be underlined that some parts of this total waste might originate from international open-sea vessels, because of dominant WSW winds.

In general, approx. 2% of total medical wastes produced in health care facilities are medical syringes, pill bottles, serum products and bottles, and other similar types of items [21], listed under medical wastes that should be managed properly. In order to compare the medical waste matter that was surprisingly found in high quantities in the study area with that produced by health care institutions located in the Turkish part of the Asi basin, the total bed numbers and expected solid waste production amounts of the health care facilities were calculated to be 1.92 kg/patient and day. In Table 2, the bed numbers compiled and expected medical waste amounts from health care facilities per day were summarized. Despite the fact that Thornton and Jackson [16] reported that medical wastes composed only 0.1% of total litter collected from Clifford beach, New Jersey, USA, in our study the medical along with hazardous waste from the examined beaches weighed more than 5.2% of the total solid waste. This indicates that the Asi basin is a remarkably high medical/hazardous waste transport source to the river`s delta and beaches near its mouth.

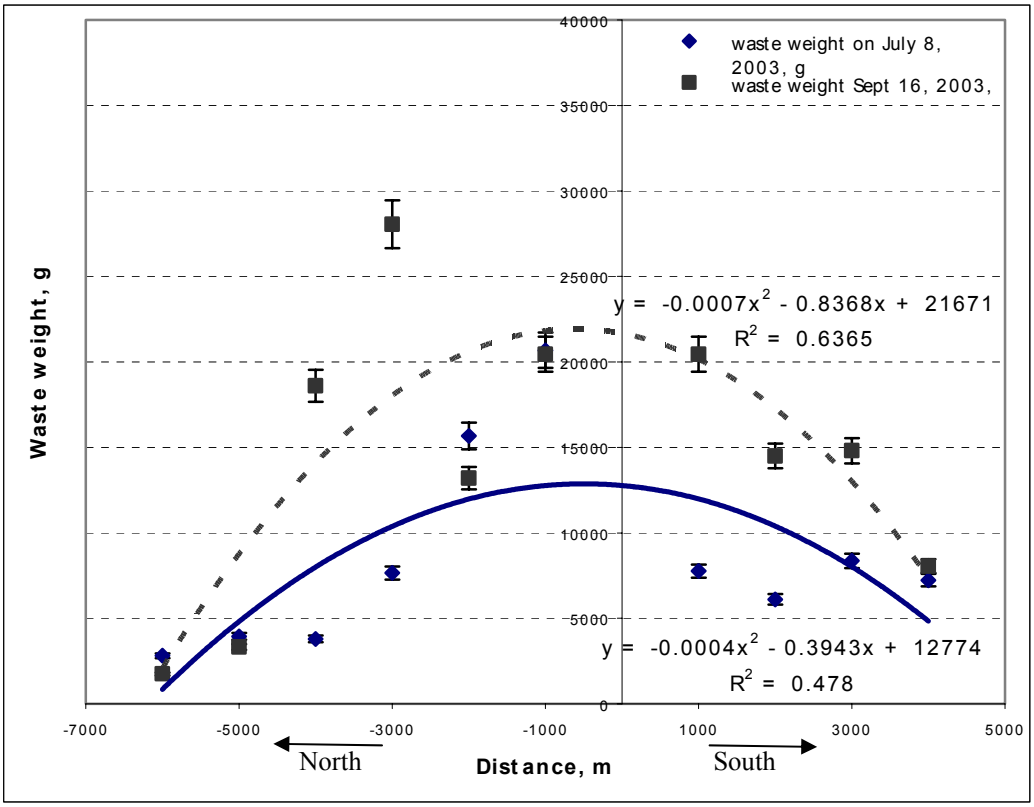
TABLE 2 - Major health care facilities situated around the Asi River Basin, Hatay, Turkey.

Name of the medical facility	Bed number	Estimated daily medical waste weight, kg day^{-1}
Samandağ State Hospital (H)	50	96
Private Eastern Med. H.	60	115
Private Hatay H.	35	67
Antakya State H.	250	480
Antakya Maternity Home	105	202
Social Insurance H.	100	192
Reyhanlı State H.	75	144
Total	675	1.296

In the light of total medical waste production capacity (Table 2) from the Asi basin health care institutions, it is expected that total medical waste widespread on the Samandağ beaches from the hospitals is 25.9 kg per day. Therefore, in 70 days (period between sampling events), a total of 1,814 kg medical waste was expected from the medical facilities being in full capacity. However, the increase of total medical and hazardous wastes on Samandağ beaches was actually found to be 335 kg in this 70-days period. In other words, about 18.5% of medical wastes produced from medical care facilities in the Asi basin were accumulated on the shoreline examined. However, based on DPT [28], the occupation proportion of total capacity of hospitals in Turkey is 65%. When this is taken into account, total medical waste produced by the hospitals in the Turkish part of Asi basin was computed to be 1,209 kg, or 27.71% of the total medical waste compiled from the beaches of Samandağ. It should be noted that some wastes are burnt, though not safely, or

buried in the environs of the Asi, but the rest is assumed to be either trapped on the way in the river or swept on-shore from the sea. The amount transported to the sea either sinks or floats, ending on that beaches, where flow and wind conditions are suitable. This critical increase between July 8th and September 16th is even dangerously high, since the effects of such wastes considered to be hazardous to environmental health are not exactly known. On the contrary, during winter months, wind direction is from land to the sea. This is another marine litter accumulation factor on and into the sea, but also a sweeping factor for the land, or, particularly, for the shores.

Based on calculations in the light of Fig. 2, which shows beach litter amount in grams as a function of distance from the river mouth, the total amount on the shoreline surface of the northern coastal region of the Asi river was found to increase from 9,960,000 g (9.96 tons) to almost 11,500,000 g (11.55 tons), just after the moderate flood occurring in the 6/7th days of September, 2003. The increase in beach litter on the southern part of the river (Meydan beach) was computed to be approx. 4,333,000 g (4.33 tons) and 5,000,000 g (5 tons) on July 8 and September 16, 2003, respectively. The increases were computed to be approx. 16% and 15%, respectively. Moreover, it should be noted that the last segments (between -6,000 and -4,000 m) of Çevlik beach were continuously cleaned up during the summer months of 2003 (thanks to a World Bank supported project). It is easily seen that solid wastes collected from these locations did not increase, if not reduced, due to this cleaning effort. However, due to the lack of cleaning-up activities on the closer north side (Şeyhhızır beach) and south side of the river mouth (Meydan beach), it is obvious that the litter will continuously accumulate. Naturally this threatens the beach health, when considering not only the natural environment but also the local people and other visitors, who swim in and use the area for recreation. Based on the paired t-test, no temporal differences between first and second sampling event ($t = 2.083 < t_{0.01,\ 9} = 2.821$) could be observed. Moreover, the χ-squared distribution t test applied to both sampling days resulted in $\chi_{computed} = 1.5517 < \chi_{0.01}$, showing a non-significant difference between the first and second beach litter sampling event with regard to total beach litter com-



Distance, km	-6	-5	-4	-3	- 2	-1	1	2	3	4	**Mean**
Jul 8, g m^{-2}	4.40	6.36	5.00	10.2	25.7	51.7	13.2	7.54	20.4	36.2	**18**
Sep. 16, g m^{-2}	2.73	5.35	24.5	37.4	21.6	51.1	34.7	17.9	36.1	40.3	**27**

FIGURE 2 - Total waste amount illustrated and unit waste amount tabulated as a function of distance from the Asi River mouth.

piled. When only the shoreline portion between -4,000 and 4,000 m is taken into account, in other words, distances of -6,000 and -5,000 m are ignored, the temporal difference was also found to be statistically indifferent ($t = 2.323$ (since $t_{0.01, 7} = 2.988$)). On the other hand, as shown and tabulated in Fig. 2, the mean unit beach litter amount in the study area was increased from 18 to 27 g m^{-2}, and this increase is exactly 50% in 70 days (8th of July - 16th of September, 2003).

Chi-squared statistical calculations revealed that the total beach litter between the sampling events was $\chi = 8762.456$ (df = 18, $p \leq 0.001$), the medical and hazardous matter was $\chi = 1808.505$ (df = 9, $p \leq 0.001$), the recyclable matter and that of the difficult-to-recycle one on the beach between the two sampling days were $\chi = 4{,}274.338$ (df = 9, $p \leq 0.001$) and $\chi = 14{,}342.586$ (df = 9, $p \leq 0.001$). These results indicate that both the total beach litter amount and those classified as medical and hazardous, recyclable and hard-to-recycle materials differ statistically between the sampling dates, which means that beach litter amounts between the samplings increased significantly.

The numbers of successful arrivals of new green turtle hatchlings were counted from the representative nests, and, expressed as percentages, were compared with the solid waste amounts on the corresponding distance. Table 3 summarizes the number of nests used in this comparison, and the mean success ratio calculated by dividing the total number of successful arrivals and total number of eggshells obtained from the nest. In Figure 3, the relationship between unit solid waste quantity (g m^{-2}) and success rate of new green turtles reaching the sea upon completion of their incubation period is shown. In this stage, the success rates of new green turtles were calculated by dividing the number of tracks reaching the end of the permanently wet area line and the total number of eggshells counted in the representative nest. It is worthnoty to say that the northern river side, namely Şeyhhızır and Çevlik beaches, have a higher mean success rate (49.59%) compared to that (36.48%) of Meydan beach on the southern side of the river-mouth. The correlations between the unit total solid waste density (g m^{-1}) and biotic factors, such as successful arrivals of newly emerged green turtles, are given in Table 4. Remarkably negative correlations between waste amount and the number of hatchlings reaching the sea were computed (for 8th July sampling $r^2 = -0.81$, and for 16th September $r^2 = -0.74$), despite the fact that the correlations were not found statistically significant ($t = 2.56 < t_{0.01, 4} = 3.75$ for 8th of July, and $t = 1.55 < t_{0.01, 4} = 3.75$ for 16th of September). Therefore, beach litter cannot be announced to be the most-influencing factor that reduces hatchling success, but when beach litter amount increases, hatchlings safely reaching the sea decreases. Furthermore, it is noteworthy suspected that beach litter helps predator species to kill turtle hatchlings, and cause changes in their direction through artificial lights originating from inner terrestrial locations.

TABLE 3
The success ratios of new green turtle individuals.

Location. m	No of nests recorded in 2003	Mean success ratio. %
-6.000	1	0
-5.000	0	0
-4.000	1	48.10
-3.000	16	84.98
-2.000	43	80.68
-1.000	32	83.77
1.000	21	76.48
2.000	10	26.92
3.000	2	86.67
4.000	0	0
All locations	126	48.76

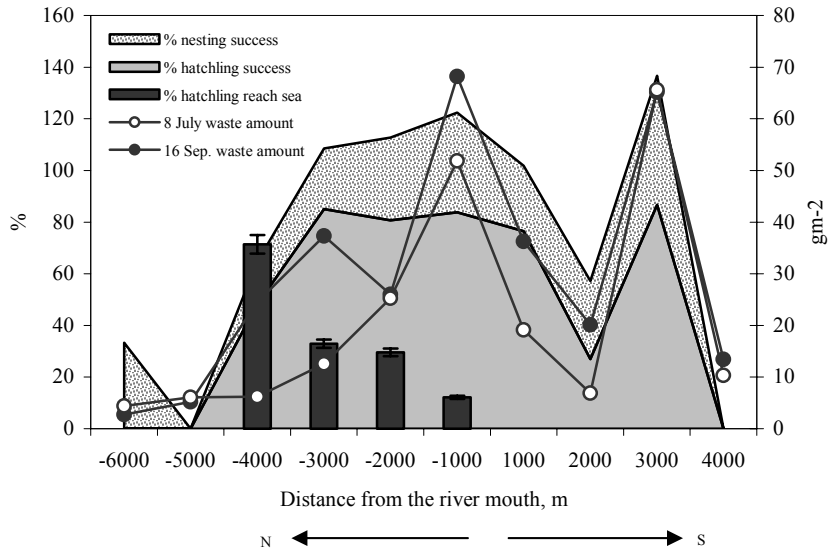


FIGURE 3 - Unit solid waste amounts and green turtle success ratios on the Samandağ beaches.

TABLE 4 - The correlation values of waste amount collected from the beach and nests and hatchling success of Samandağ *C. mydas* turtles (The bold ones represents significant correlations).

Parameter	Nesting success, %	Nest density	Hatchling success, %	Hatchlings reached to the sea, %	Beach litter on 8th Jul, g m^{-2}	Beach litter on 16th Sept, g m^{-2}
Nesting success, %	1.000					
Nest density	0.379	1.000				
Hatchling success, %	**0.639**	**0.655**	1.000			
Hatchlings reached to the sea, %	**-0.925**	**-0.798**	**-0.930**	1.000		
Beach litter on 8th Jul, g m^{-2}	**0.698**	0.321	**0.668**	**-0.837**	1.000	
Beach litter on 16th Sept, g m^{-2}	**0.670**	0.405	**0.838**	**-0.739**	**0.900**	1.000

TABLE 5 - Comparison of beach litter amounts throughout the globe.

Study area	Study period	Mean beach litter amount, g m^{-1}	Reference
Chatnam County, GA, USA	1989-1990	45	Gilligan *et al*, [29]
Curaçao, Caribbean	12/1992– 10/1993	3832	Debrot *et al* [30]
Transkei Coast, South Africa	04/1994– 04/1995	101	Matzena and Lasiak [31]
Orange County, CA, USA	08-09/1998	16	Moore *et al.* [32]
Volunteer Beach, Falkland Islands	11/2001-04/ 2002	19	Otley and Ingham [33]
Japanese beaches (Sea of Japan)	09–11/2002	14	Kusui and Noda [34]
Russian beaches (Sea of Japan)	09–11/2002	8	Kusui and Noda [34]
Samandağ beaches, Hatay, Turkey	07-09/2003	1251	The present study

Based on Table 3 and Fig. 3, the overall success rate of new green turtles on the southern part of river Asi was found to be less with regard to that in the northern side. The problematic areas are not merely disturbed in terms of solid waste amounts accumulated on the shoreline, but also have the illumination from summer resorts of Samandağ in -6,000 m, a remarkably high density of ghost crabs (especially in -2,000 and -1,000 m), and illumination from Meydan Village at around 2,000 m. It is difficult to assess the importance of the impairment of these three problems, namely, illumination (light-pollution), ghost crab density, and solid wastes, on the shoreline. However, the mentioned order (1. crab populations and beach litter, 2. illumination from the settlements) is a good estimate in terms of their impact on new green turtle members that try to reach the sea. Furthermore, these problems, in addition to beach litter, are associated closely (ghost crab populations are dense, especially between -2,000 and 3,000 m, where also beach litter densities are large). Especially in this area, the litters were huge obstacles for the rushing hatchlings, and when they hang on the litter they were easily hunted by ghost crabs living there.

In Table 5, findings on beach litter amounts in selected shorelines throughout the world [27-31] were compared with that of the Samandağ coast. By far, Caribbean and Samandağ beaches (namely Çevlik, Şeyhhızır and Meydan) exceed other beaches tabulated in Table 5, in terms of beach litter quantities measured. Although organics, both naturally occurring, such as sea grass, and land-borne ones, such as vegetable and other plant wastes were not sampled in this study, the amount of solid waste compiled from the Samandağ coastline is dramatically higher than those of other beaches located in the Sea of Japan, Falkland Islands, California, and South Africa (with the exception of the studied Caribbean one).

CONCLUSIONS AND RECOMMENDATIONS

The solid waste collected from the shore region was found to be remarkably elevated after a moderately high flow (due to notable precipitation) event in the Asi river. This indicates that urban and rural runoff caused an elevation in medical and hazardous, and recyclable and hard-to-recyclable solid waste matter on Samandağ coast shoreline, Hatay, Turkey. Although the impact of hazardous materials was not investigated in the present study, medical, hazardous and other types of potentially dangerous wastes have negative effects on the sea-based and land-based creatures, inhabitants of this region. Almost a two-fold increase in total solid waste amount was found on the investigated beaches after this moderate, but notable, stream flow increase in Asi river, illustrating that the river is the main solid waste transporting source from inland locations.

It is essential and also critical to clean-up the shoreline, just between May and September. Probably the best option to avoid beach litter problems is to construct an effective solid waste management program eliminating all types of waste sources. As Metin *et al.* [35] noted, recycling could be implemented in Turkey. If the shoreline that is used by green and loggerhead turtles is cleaned-up, and people are trained about the importance of healthy and clean beaches, the success rate of both turtle species loggerhead ones not examined in this study), will definitely increase. Solid waste accumulated on shoreline will cease to be a handicap, and ghost crabs will not easily prey on the new turtles.

Therefore, it is extremely crucial that the surrounding municipalities build responsible and effective solid waste management programs for solid wastes from houses, businesses, and other pollution sources on the Samandağ coast. If solid wastes brought to the shoreline via the Asi could

be controlled and minimized, the ghost crab population density on the shoreline is expected to decline naturally.

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