Black sea marine litter pollution related to naval operations

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Abstract. The Black Sea, due to its weak exchange of waters and poor vertical circulation, has an increased sensibility to pollution. Even though this maritime basin is subject to numerous regulations at the national, regional, and international levels, the pollution issue is still actual and stringent. The present paper analyses the findings of three studies focused on marine litter issues and provide, in the concluding part, few directions which can improve the pollution prevention and containment effort. As the studies related to Black Sea litter pollution are scarce and fragmented, the authors took the opportunity and analyzed three different studies conducted in different periods and concluded that a significant part of marine debris is related to naval operations.

1 Introduction

The Black Sea is an almost landlocked basin connected to the Sea of Marmara and the Sea of Azov by the narrow Bosporus and Kerch Straits, respectively. The Black Sea is a deep basin (maximum depth of ~2200 m) with a large shelf, especially northwestern sub-basin. Its catchment area covers large parts of Europe and Asia, providing a total freshwater supply of 3 x 10^2 km^3 annually [1-3]. The important freshwater intake brought by a large number of rivers, including Danube, Dnieper, Southern Bug, Dniester, Don, and Kuban. These rivers are, also responsible for an essential introduction of pollutants including marine litter [4-6].

The region of the Black Sea is under high anthropogenic pressure from the pollution point of view, the catchment area and the coasts are well-populated with significant industrial activity, and the sea is the scene of intense shipping, tourism-related and military activities [1, 7, 8].

Accretion of marine debris in the ocean is a global issue. The condition mentioned above of the Black Sea, along with its poor vertical circulation, led to the conclusion that the marine debris is arrayed in layers corresponding with seawater disposition. Thus, the floating litter carried by surface currents, wind, waves, the densest fraction will sink to the seafloor, and a significant portion immersed amid surface and seabed. The synergic action of environmental factors will degrade the litter in time but not as fast as to avoid harmful effects on the economy, tourism, and marine flora and fauna [9, 10].

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Marine litter is referred to as persistent substantial matters of human origin, refined or processed, and discharged or abandoned in the marine environment or coastal area. The provenience of marine debris is associated with municipal improper waste disposal, industrial activity in the coastal area or on the rivers from the sea catchment area, fishing, tourism, military exercises, and many others [11-13].

The most common marine litter is plastic produced and used on a large scale at the global level is evident that a portion of it will end in seawater either from land or due to seaborne vectors [14].

Plastic marine debris found in the form of great stuff or macroplastic, with dimensions are easily seen and avoided by marine organisms; these larger pieces under the action of the marine environment will split into small parts (< 5 mm) called microplastic and the latest decomposed into smaller pieces (< 100 nm) – nano plastic. The latest categories can is quickly swallowed by marine animals and get further into the human food chain, though in-depth research regarding this matter is not complete [15-18].

Actual studies on Black Sea marine debris are very scarce and fragmented, but from the segments available can be easily observed that marine litter is mostly land originated, though a significant fraction owed to naval operations, merchant or military in nature. Shipping waste consists mainly, but not limited to, synthetic ropes, packaging items, pellets, food and cargo waste, fishing nets, cabin and recreational areas domestic waste. [10, 19, 20].

Due to its sensitivity to pollution matters, the Black Sea is accountable to several national, regional, and international conventions, regulations, and agreements. The most important at the regional level being the Bucharest Convention, which deals mainly with land-based pollution while, at the international level, MARPOL 73/78 regulates shipborne pollution. Following Annex V to MARPOL 73/78 Convention, Black Sea is ”Special Area,” thus any garbage disposal into Black Sea waters is strictly barred. At the same time, riparian states called to provide adequate port reception facilities. (PRF) [9].

2 Methods

The article analyzes the research activities conducted by some research institutions in the Romanian sector of the Black Sea. The activities conducted from 2012 through 2014 within the framework of three different projects.

2.1 Seabed litter survey facilitated by assessment of demersal fish stocks

The explorations were conducted in 2012 consisting of bottom trawling activity facilitated by demersal fish stocks assessment, such along with fishing seafloor litter samples were collected. The asset used was National Institute for Marine Research and Development “Grigore Antipa” research vessel ”STEUA DE MARE 1” with its bottom trawl as fishing gear.The depths of waters hauled were between 15 m and 90 m along with the entire Romanian coastal sector, from Vama Veche to Sulina. The study investigated areas with offshore platforms (AOI 3 - Area Of Interest 3), intense navigated shipping routes and ports basins – Constanta and Midia – AOI 1 and AOI 2 and a daggers area where bottom debris is likely to be retained, is also a challenge for the trawl (Figure 1). During the demersal surveys were conducted 69 hauls in two timeframes: 05 -10.05.2012 and 13 – 16.11.2012 [12].

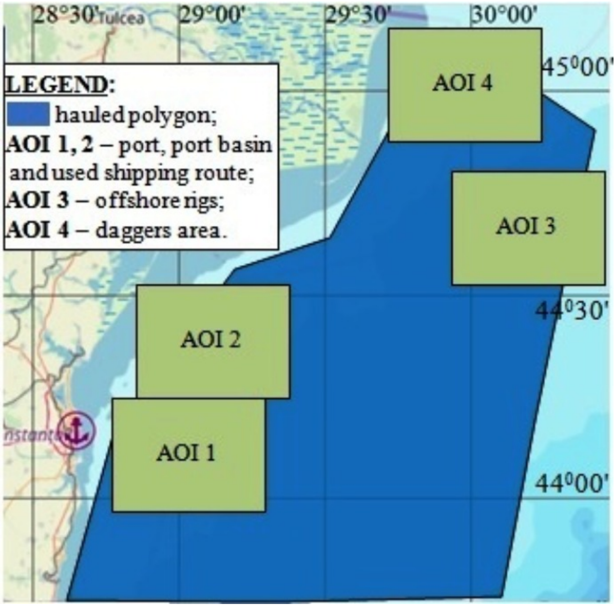

Fig. 1. Polygon hauled during demersal fish surveys – authors contribution based on [12, 21]

2.2 Black Sea marine litter survey – MISIS project

The assessment performed in the period of 22 – 31.08.2013 in the framework of MISIS Project Joint Black Sea along six polygonal surfaces, transverse of Romania, Bulgaria, and Turkey. MISIS was part of a broader program aimed to adjust the Black Sea area strategy in the marine environment protection with appropriate European policy in the field. European Council provided the funds for this project [22].

In order to have symmetry with the demersal survey (2.1) are analyzed just results related to the Romanian sector (see Figure 2 and Table 1). The researchers chose to survey one polygon in the coastal area and one in the shelf zone.

Marine debris grabbed using a beam trawl (2.5 m breadth), and the speed of trawling ship was 2.5 – 3 knots. The depths of hauls were for the coastal survey – 33 m while for shelf seabed 65 m. All trawled stuff was measured on board, categorized by type of the matter and dimension [8, 22].

Table 1. Coordinates of trawled polygons [8, 22].

Polygon	Depth [m]	Start		End		Trawled area [m^2]
		Lat	Lon	Lat	Lon	
B1	33	44^{0}10’08’’N	28^{0}48’58’’E	44^{0}10’07’’N	28^{0}48’21’’E	1250
B2	65	44^{0}10’06’’N	29^{0}40’24’’E	44^{0}10’06’’N	29^{0}42’55’’E	4600

2.3 Visual surveys of marine litter – CoCoBlas project

The observations were performed visually onboard R/V Mare Nigrum on the framework of CoCoBLAS 2014 (24 – 29.06.2014) part of broader EC Project CoCoNet. The survey area placed along the Romanian coast of the Black Sea amid the Danube delta and Constanta. The density of floating litter was estimated using the transect methodology. The same researcher conducted all observations during daylight at a low ship speed recording size, type, and position of all floating waste with dimensions above 2 cm.

Though, the authors in [4] split sighted debris in 2 main categories, for this paper considers just debris of anthropogenic origin (Anthropogenic Marine Debris - AMD) and the natural one omitted.

In the said study, were performed 30 transects, but the present paper retained just 10, the most relevant with the highest AMD values (table 2).

Table 2. Transects coordinates, surveyed area length, number of items sighted (n), and density of AMD [4].

Polygon	Length [km]	Start		End		AMD	
		Lat	Lon	Lat	Lon	n	D [items/km^2]
C1	7.75	44°12'55"N	29^{0}01'15"E	44°15'11"N	29^{0}06'10"E	2	23.46
C2	7.73	44°22'21"N	29^{0}22'17"E	44°24'37"N	29^{0}27'10"E	10	117.60
C3	7.39	44°29'59"N	29^{0}36'11"E	44°33'35"N	29^{0}38'35"E	3	36.93
C4	2.39	44°52'52"N	29^{0}50'01"E	44°52'54"N	29^{0}48'12"E	3	114.21
C5	2.01	44°52'58"N	29^{0}43'31"E	44°52'48"N	29^{0}42'00"E	3	135.98
C6	7.40	44°57'12"N	30^{0}19'00"E	44°58'49"N	30^{0}13'50"E	2	24.57
C7	4.50	45°04'56"N	30^{0}00'55"E	45°03'32"N	30^{0}03'44"E	4	80.75
C8	6.43	45°03'14"N	30^{0}03'32"E	44°05'18"N	29^{0}59'34"E	2	28.29
C9	4.50	45°05'00"N	30^{0}00'55"E	45°03'32"N	30^{0}03'44"E	4	80.75
C10	13.27	44°24'54"N	29^{0}33'48"E	44°21'28"N	29^{0}25'01"E	14	95.93

3 Results and discussions

Regarding first project presented, in 28 of 69 hauls performed was found marine litter in the trawl sack, summing 40% of total trawls conducted. Regarding the composition of debris, plastic was most frequent (containers, bags, buckets, canisters) most likely originated from ships or boats which to and fro along dedicated shipping routes. The plastic was followed by rubber, fishing gears most probably coming from illegal and unreported fishing activities which are common in assessed area [12].

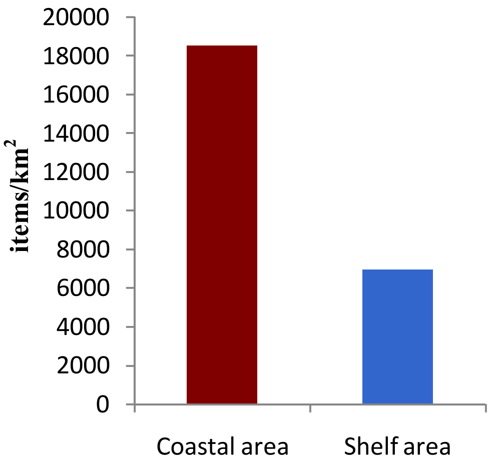

Fig. 2. Marine debris distribution in the Romanian sector [8, 22]

The second study revealed that the Romanian sector was most polluted compared with Bulgarian and Turkish ones. In the said area was registered the highest density of waste, approximately 20 000 items/km2 being more abundant near at depths below 40 m (almost a double amount) than in shelf area. The researchers who conducted the assessment concluded that mostly fishing and touristic activities were the most critical contributors to seafloor debris found. Between the main litter categories, plastic was again present in collected samples but also metal and natural products were the other debris significant constituents [8, 22].

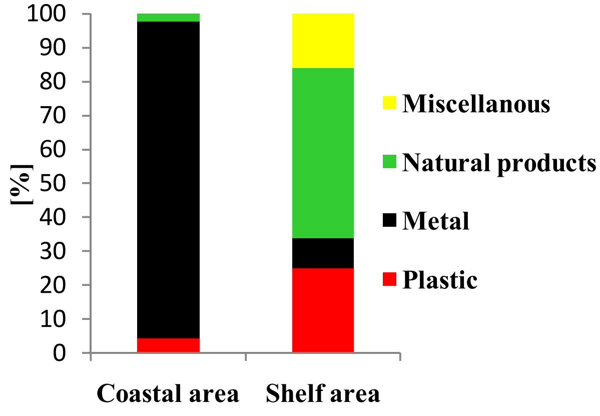

Fig. 3. Marine litter composition in the Romanian sector [8, 22]

Assessing the composition of marine debris can easily observe the abundance of metal and plastic linked with an intense shipping and fishing activity.

The last project also provides an accurate quantitative composition of debris sighted revealed that natural origin debris was more abundant (75,5%) than anthropogenic one (25,5%). The anthropogenic litter sighted consisted of plastic matters (89,1%), other man-made objects (9,1%) and styrofoam (1,8%). Composition of debris presented in the last report is in line with the previous ones regarding the likely origin of litter [4].

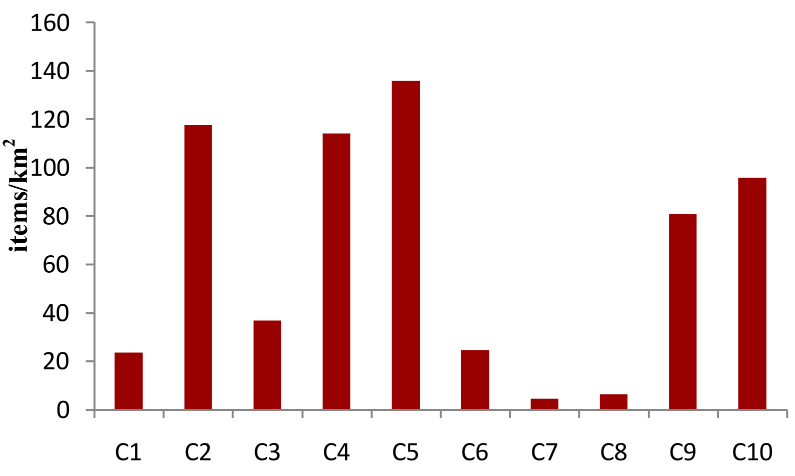

Fig. 4. Density of AMD in considered transects [4]

4 Concluding remarks

Considering significant quantities of marine debris found into Black Sea waters is evident that despite an adequate legal framework, the riparian states do not strictly adhere to provisions of international agreements signed.

More rigorous control of land discharges and onboard waste management is necessary to enforce.

Neighboring countries have to enforce surveillance from the air, surface, and subsurface – seabed employing unmanned means like Unmanned Aerial Vehicles, Unmanned Surface Vehicles, and Unmanned Underwater Vehicles, to reduce costs and eventual pollution by manned and more prominent platforms.

There is a need for multiple studies regarding pollutants type, circulation, and origins in all sensitive areas, and the effort of understanding the pollution mechanism must share at the regional level.

The most problematic remains the plastic debris, which is a threat to the environment, marine biota, and not at last for human consumptions of seafood.

As to diminish marine litter harmful effects, synergic actions shall be taken not only by naval authorities but also by local and regional responsible, and not at the end population have to be sensitized regarding pollution issues.

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