IDENTIFICATION OF HOT SPOTS OF MARINE LITTER POLLUTION IN THE BULGARIAN BLACK SEA COASTAL AREA

(FINAL REPORT)

This report has been prepared under contract P-04-1 / 01/21/2020, signed between the VIA PONTICA Foundation and the "Nikola Vaptsarov" Naval Academy within position 1 **"Identification of hot spots of marine litter pollution in the target area"** under public procurement "Selection of contractor for identification of hot spots and modeling of marine litter distribution in the target area (Bulgarian Black Sea coast)"

Common borders. Common solutions

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Content

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1. GENERAL INFORMATION ON THE IMPLEMENTATION OF THE ACTIVITIES AND TASKS:

1.1. The requirements of the following guidelines and documents are complied in order to fulfill the contract activities:

- DIRECTIVE 2008/56/EC of the European parlament and of the council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive) - https://eur-lex.europa.eu/legalcontent/BG/TXT/?uri=CELEX%3A32008L0056
- REGULATION (EU) No. 1255/2011 of the European parlament and of the council of 30 November 2011 establishing a Programme to support the further development of an Integrated Maritime Policy - https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2011:321:0001:0010:EN:PDF
- COMMISSION DECISION (EU) 2017/848 of 17 May 2017 laying down criteria and methodological standards on good environmental status of marine waters and specifications and standardised methods for monitoring and assessment, and repealing Decision 2010/477/EU - https://mcc.jrc.ec.europa.eu/documents/ComDec/Com_dec_GES_2017_848_EU.pdf
- THE CONVENTION ON THE PROTECTION OF THE BLACK SEA AGAINST POLLUTION - https://www.bsbd.org/UserFiles/File/Convention_for_Protection_of_the_BS_Against_Pollution.pdf
- MARINE STRATEGY OF THE REPUBLIC OF BULGARIA 2016-2021г. - https://www.bsbd.org/bg/m_env_and_action.html?URI=
- ORDINANCE on environmental protection of marine waters, adopted by Decree No 273 of November 23, 2010 - https://www.bsbd.org/UserFiles/File/Naredba%20za%20morskite_vodi.pdf

1.2. Good practices have been adopted by:

- The contractor should study and follow the good monitoring practices applied within previous projects - MARLEN; ISMEIMP - https://www.bsbd.org/bg/ismeimp.html, Black SeaHotspots - http://bs-hotspotsproject.eu/index.htm etc..
- Protection of marine environment - good practices manual for reduction of solid waste at sea and coast, 2016 - http://mlwatch.bsnn.org/pdf/Rakovodstvo.pdf

1.3. The following data is used:

- The European Monitoring Program "Copernicus", where applicable - https://www.copernicus.eu/en;
- Data collected so far from the institutional monitoring of marine litter regarding descriptor D10C1, indicator 1

- Data collected till now from the institutional monitoring of marine litter regarding descriptor D10C1, indicator 2
- Data presented in the project "Innovative Techniques and Methods for Reducing Marine Litter in the Black Sea Coastal Areas" (BSB552 RedMarLitter), published in the project database, (https://map.redmarlitter.eu/bg/database);
- European Environmental Agency (EEA) and Marine LitterWatch (https://www.eea.europa.eu/themes/water/europes-seas-and-coasts/assessments/marine-litterwatch/data-and-results/marine-litterwatch-data-viewer)
- Data from other monitoring campaigns and analyses, including our own studies.

1.4. Target area: Bulgarian Black Sea coast, Bulgarian Black Sea aquatory.

2. GENERAL ANALYSIS OF MARINE LITTER ACCUMULATION ON THE TARGET AREA

2.1.   Subject of analysis*:* The subject of the present analysis is the accumulation of macro-marine litter (ML) on shore and on the sea surface (floating). There is a lot of accumulated empirical knowledge about ML, suggesting the accuracy and representativeness of the conclusions which will be made for the target area. The monitoring of ML in Bulgaria being conducted from 2015 shows that the highest quantities are registered on the shore compared with that found on the sea surface and sea floor. These results are in full compliance with some theoretical assumptions that 70% on all ML are found on shore, 15% on the sea floor and 15% are floating on the sea surface.

2.2.National monitoring of marine litter in Republic of Bulgaria

The national monitoring of ML is carried out following the requirements of the MSFD 2008/56/EC and the transposed in our legislation Ordinance on environmental protection of marine waters, 2010.

The criteria and methodological standards for achieving MSFD main objective set the requirements to assess ML characteristics, one of the qualitative descriptors to determine the status of marine environment (Descriptor - 10) in all compartments - coastline, seabed, water column and water surface.

The objective of ML monitoring campaign conducted in all marine environment compartments is to provided information on amounts, trends in quantities and accumulation, basic drivers (tourism, urbanization, ports, shipping, commercial and recreational fishing) and on the pressure of ML pollution in the marine environment. Another main target of the monitoring campaigns is to develop improved monitoring program for Descriptor 10, taking account of existing data and to facilitate its entry into force in 2017.

According to Descriptor 10 monitoring program, assessment of the status of marine environment must be carried out following several criteria and pressure indicators:

- **Criteria D10C1** - *Primary*: The composition, amount and spatial distribution of litter on the coastline, in the surface layer of the water column, and on the seabed, are at levels that do not cause harm to the coastal and marine environment.

- **Criteria D10C2** - *Primary*: The composition, amount and spatial distribution of micro-litter on the coastline, in the surface layer of the water column, and in seabed sediment, are at levels that do not cause harm to the coastal and marine environment.

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- **Criteria D10C3** - *Secondary*: The amount of litter and micro-litter ingested by marine animals is at a level that does not adversely affect the health of the species concerned.

- **Criteria D10**C4 - *Secondary*: The number of individuals of each species which are adversely affected due to litter, such as by entanglement, other types of injury or mortality, or health

2.3. Analysis of marine litter accumulation on the beaches of the target area for the period 2015 - 2018

The analyses of ML accumulation on the beaches of the target area has been prepared, based on data of the national monitoring of coastal ML for the period 2015 - 2018 (**D10C1, Indicator 1).**

The ML monitoring, analysis and assessment was following the recommendations of "Guidance on Monitoring of Marine Litter in European Seas and OSPAR Guideline for Monitoring Marine Litter on the Beach (https://ec.europa.eu/jrc/sites/default/files/lb-na-26113-en-n.pdf.; http://www.ospar.org/documents/dbase/decrecs/agreements/10-02e_beachlitter%20guideline_english%20only.pdf).

The monitored beaches were selected taking into consideration the basic drivers of ML accumulation on shore namely:

- *navigation and ports;*
- *urbanization;*
- *tourism and recreation in the coastal zones;*
- *commercial and recreational fishing;*
- *rivers inflow, including wastes discharges by rivers;*
- *transboundary transfer of waste between water basins, etc.*

The reference beaches were selected, following the recommended criteria in Guidance on Monitoring of Marine Litter in European Seas and OSPAR.

According to the requirements of the monitoring program regarding D10C1, Indicator 1 (beach litter > 2,5 cm), campaigns were being conducted every year, as the first survey was within the period 2015 - 2016. Eight unguarded beaches were monitored during the first campaign from the northern to the southern Bulgarian Black Sea coast, and ten beaches during the next years, after entry into force of the new national ML monitoring program in 2017. The monitored beaches and the number of campaigns conducted each year are presented in Table.1.

Table 1. Beaches, subject to the national monitoring of coastal marine litter, 2015 - 2018

№	Name of beach / coastline for monitoring of Beach macro-litter)	Geographical coordinates of 1000 m section (start)	Geographical coordinates of 1000 m section (end)	Conducted monitoring of Beach macro-litter			
				Number of campaigns			
				2015	2016	2017	2018
1.	Beach "Durankulak - north 1"	43 43 0.01N, 28 34 24.72E	43 42 23.24N, 28 34 40.15E	3	1	3	4
2.	Beach "Krapets"	43 39 4.00N, 28 34 10.00E	43 39 36.09N, 28 34 0.10E	3	1	3	4
3.	Channel 2 - "Varna lake - Black Sea"	43 11 8.95N, 27 53 23.20E	43 11 31.58N, 27 52 51.98E	3	1	3	4
4.	Beach "Shkorpilovtsi -north"	42 57 25.66N, 27 53 54.25E	42 57 57.56N, 27 53 46.47E	3	1	3	4
5.	Beach "Byala - Karadere"	42 55 12.06N, 27 53 48.06E	42 54 39.64N, 27 53 47.67E	0	0	3	4
6.	Beach "Obzor - childrens' camps"	42 48 1.38N, 27 53 25.64E	42 47 30.02N, 27 53 35.90E	3	1	3	4
7.	Beach "Irakli"	42 44 59.29N, 27 53 20.69E	42 44 27.29N, 27 53 28.57E	3	1	3	4
8.	Beach "Black sea saltpans" - Burgas	42 30 57.16N, 27 29 9.19E	42 31 28.62N, 27 29 19.77E	3	1	3	4
9.	Beach „Alepu"	42 22 7.00N, 27 42 33.00E	42 21 37.33N, 27 42 47.85E	3	1	3	4
10.	Beach "River Veleka mouth"	42 3 54.66N, 27 58 44. 57E	42 4 12.19N, 27 58 7.56E	0	0	3	4

The first ML campaign regarding criteria D10C1 Indicator 1 was conducted within the period August 2015 - March 2016. Eight country beaches were surveyed: "Durankulak" beach; "Krapets" beach; "Channel 2 - Varna" beach; "Shkorpilovtsi" beach, "Obzor" beach; "Irakli" beach; "Black Sea saltpans" beach - Burgas; "Alepu" beach. From 2017 monitoring was carried out on 10 beaches - two additional beaches were surveyed -"Byala - Karadere" beach and "River Veleka mouth" beach.

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D10C1 monitoring included 8 categories of ML:

- *Artificial polymer materials;*

- *Rubber;*

- *Cloth/Textile;*

- *Paper/Cardboard;*

- *Processed wood;*

- *Metal;*

- *Glass/ceramics and*

- *Unidentified*

According to the Master list of categories, each category consists of different number of subcategories - a total of 167. Largest is the number of subcategories in *Artificial polymer materials* category - 92, while in the rest of the categories the number is considerably lower - from 10 to 21 subcategories.

The total amount of items in each category, found on the shore of the target area during the institutional monitoring 2015 - 2018 is presented in Table 2.

In 2015, 3 monitoring campaigns were conducted (02.09.2015 - 03.12.2015) - one in summer, autumn and winter. The total number of items (> 2.5 cm) registered on all surveyed beaches was 15661 nos., with average count per beach - 1958 nos. The results exhibited greatest numerical predominance of category "Artificial polymer materials" - 13136 nos. (83,88% of the total ML), followed by category "Paper/cardboard" - 1235 nos. (7,89%); category " Glass/ceramics" - 398 nos. (2,54%); category "Metal" - 382 nos. (2,44%); category "Cloth/Textile" - 307 nos. (1,96%); category "Rubber" - 111 nos. (0,70%); category "Processed wood" - 74 nos. (0,47%) and category "Unidentified" - 18 nos. (0,11%).

The total amount of litter registered on the beaches was quite heterogeneous, depending on the location of the beach and the potential pressure.

Table 2. Marine litter on country beaches according to the national monitoring data, 2015-2018

№	Year / Indicator	2015			2016			2017			2018		
		Total count/ year		Aver. count/ beach	Total count/ year		Aver. count/ beach	Total count/ year		Average ML per beach	Total count/ year		Aver. count/ beach
		nos.	%	nos.	nos.	%	nos.	nos.	%	nos.	nos.	%	nos.
1.	*Total ML*	**15661**	100	1958	**4144**	100	518	**77196**	100	7720	**49789**	100	4979
2.	*Artificial polymer materials*	**13136**	83,88	1642	**3554**	85,76	444	**50114**	64,92	5011	**29970**	60,19	2997
3.	*Rubber*	**111**	0,71	14	**45**	1,09	6	**1633**	2,12	163	**1106**	2,22	111
4.	*Cloth/Textile*	**307**	1,96	38	**73**	1,76	9	**1417**	1,84	142	**1155**	2,32	116
5.	*Paper/*	**1235**	7,89	154	**178**	4,30	22	**10916**	14,14	1092	**6206**	12,46	621
6.	*Processed wood*	**74**	0,47	9	**62**	1,50	8	**4394**	5,69	439	**5207**	10,46	521
7.	*Metal*	**382**	2,44	48	**129**	3,11	16	**5533**	7,17	553	**4205**	8,45	421
8.	*Glass/ceramics*	**398**	2,54	50	**94**	2,27	12	**2870**	3,72	287	**1661**	3,34	166
9.	*Unidentified*	**18**	0,11	2	**9**	0,22	1	**318**	0,41	32	**279**	0,56	28
10.	*Number of monitored beaches*	**8**	100	-	**8**	100	-	**10**	100	-	**10**	100	-

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The ML total number recorded on each of the beaches during 2015 was as follows:

- "Krapets" beach - 2532 nos.;
- "Alepu" beach - 2168 nos.;
- "Channel 2 - Varna" - 2055 nos.;
- "Shkorpilovtsi north" beach - 1965 nos.;
- "Durankulak north 1" beach - 1940 nos.;
- "Black Sea saltpans" - Burgas beach- 1917 nos.;
- "Irakli" beach - 1822 nos.;
- "Obzor" beach -1275 nos.

The contribution of each of the category to the total ML on the beaches during 2015 in percentage is presented in Fig.1

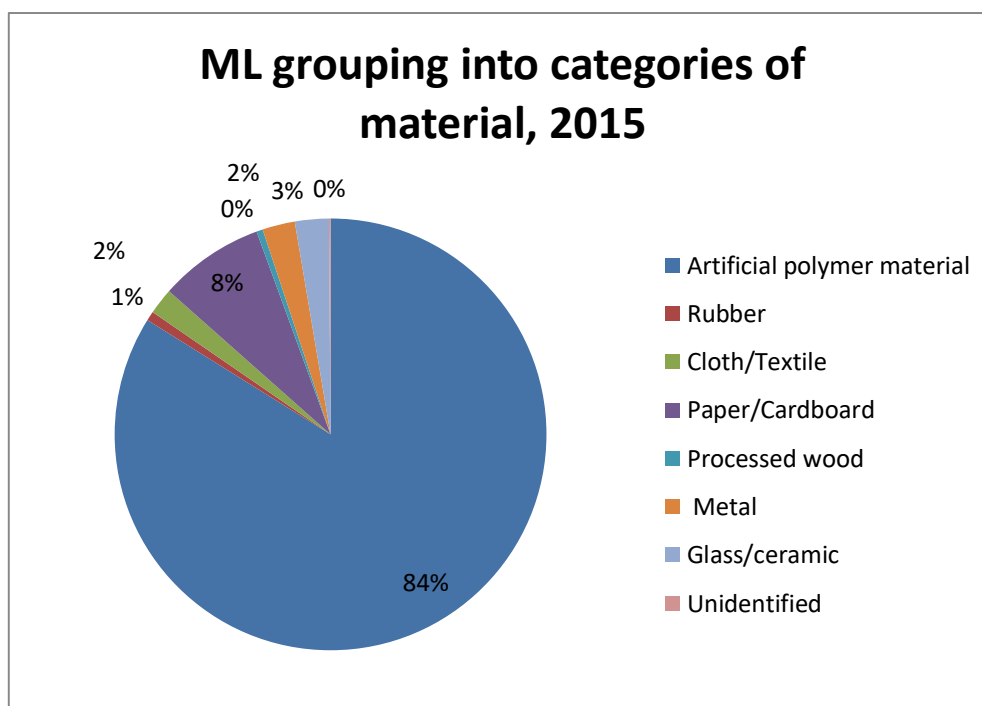**Fig. 1.** Aggregated results of the percentage (%) of each category to the total Ml, 2015
(8 monitored beaches)

Most dominant were the items from category "Artificial polymer materials", as their percentage of the total ML was different for the individual beaches:

- "Shkorpilovtsi north" beach - 90,59%;
- "Alepu" beach - 89,3%;
- Durankulak north 1" beach - 88,66%;

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- "Irakli" beach - 87,05%;

- "Krapets" beach - 86,33%;

- "Black Sea saltpans" beach - Burgas- 78,35%;

- "Obzor" beach - 73,33%;

- "Channel 2 - Varna" - 72,12%;

The highest was the contribution of "Artificial polymer materials" on "Shorpilovtsi north" beach as well as on the beaches situated on the northernmost and southernmost part of the coastline - "Alepu" beach and Durankulak north 1" beach. *Regarding " Durankulak north 1" beach possible reason for litter distribution could be transboundary transfer and for "Alepu" beach - shipment of litter by sea currents.*

"Channel 2 - Varna" is one of the beaches with very high ML accumulation which might be due to the *anthropogenic pressure from large populated area >100000 p.e (Varna town) as well as navigation, port activities, recreation and recreational fishing all year.*

In 2016, one monitoring campaign was conducted only during the spring. The total number of items (> 2.5 cm), registered from the southern to the northern beaches (8 beaches) was **4144** nos., with average count per beach - 1958 nos. (Table 2). The results showed highest quantities from category "Artificial polymer materials" - 3554 nos. (85,76% of the total ML), followed by category "Paper/cardboard" - 178 nos. (4,30%); category "Metal" - 129 nos. (3,11%); category "Glass/ceramics" - 94 nos. (2,27%); category "Cloth/Textile" - 73 nos. (1,76%); category "Processed wood" - 62 nos. (1,50%); category "Rubber" - 45 nos. (1,09%) and category "Unidentified" - 9 nos. (0,22%).

The total number of ML recorded on each of the beaches during 2016 was as follows:

- "Irakli" beach - 1278 nos.;

- "Channel 2 - Varna" - 646 nos.;

- "Black Sea saltpans" beach - Burgas - 554 nos.;

- "Obzor" beach - 489 nos.;

- "Shkorpilovtsi north"beach - 335 nos.;

- "Alepu" beach - 329 nos;

- "Durankulak north 1" beach - 263 nos.;

- "Krapets" beach - 250 nos.

The contribution of each of the category to the total ML found on the beaches during 2016 in percentage is presented in Fig. 2.

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ML grouping into categories of material, 2016

- Artificial polymer material
- Rubber
- Cloth/Textile
- Paper/Cardboard
- Processed wood
- Metal
- Glass/ceramic
- Unidentified
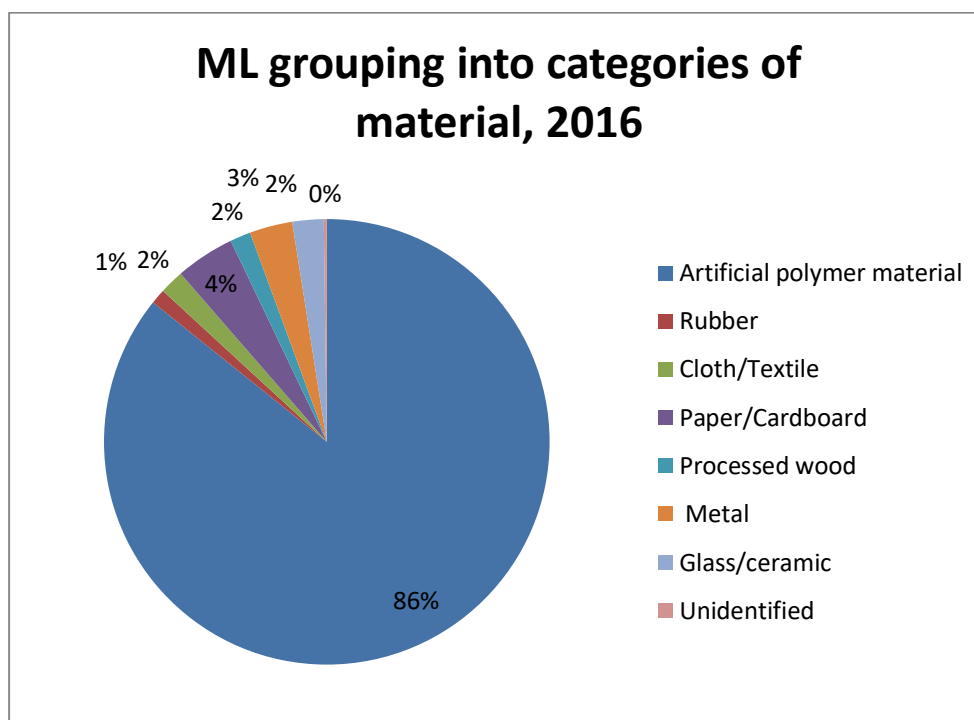
Fig. 2. *Aggregated results of the percentage (%) of each category to the total ML, 2016*   *(8 monitored beaches)*

The percentage of "Artificial polymer materials" to the total ML for the different beaches was as follows:

- "Irakli" beach - 92,01%;
- "Shkorpilovtsi north" beach - 91,04%;
- "Durankulak north 1" beach - 85,93%;
- "Krapets" beach - 85,60%;
- "Obzor" beach - 83,44%;
- "Black Sea saltpans" beach - Burgas - 83,21%;
- "Alepu" beach - 81,16%;
- "Channel 2 - Varna" - 76,78%.

The lowest was the percentage of "Artificial polymer materials" on the coastline of "Channel 2 - Varna" due to the high number of items of the category "Paper/cardboard" -9,75% and "Cloth/Textile" - 4,49%.

The ranking of beaches by ML pollution is quite different than that in 2015. The highest was the pollution observed on "Irakli" beach, which is famous with the wild camping sites. Camping in the area nearby the beach is observed all year round under favorable weather conditions, which is the main reason for the pollution of the beach due to waste transfer.

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Other beaches showing higher pollution during the survey were situated within two big cities - Varna and Burgas - "Channel 2 - Varna" and "Black Sea saltpans" beach. *These beaches are influenced by anthropogenic pressure all year round - shipping and port activities, fishing, sports, pollution from neighboring territories, etc.*

Beaches which were less contaminated are situated close to small settlements, where intense tourist flow and anthropogenic pressure are observed only during the period from mid-May to the end of September.

In 2017 and 2018, the monitoring was conducted on 10 beaches (Table 1) in compliance with the new monitoring program of MOEW. Beside the 8 beaches covered by the previous surveys, two additional beaches were monitored - "Byala - Karadere" and "River Veleka Mouth".

"Byala - Karadere" beach was selected as reference site due to its nature - friendly tourism. "River Veleka Mouth" beach was included in the monitoring in order to track the influence of the river as well as the transboundary transfer of litter from neighboring Turkey.

Within 2017, were conducted 4 monitoring campaigns including the end of the summer season and the whole autumn (30.08.2017 - 01.11. 2018), therefore seasonality requirements were not fulfilled. The total number of items (> 2.5 cm) registered on all beaches (10 beaches) was **77196** nos., with average count per beach - 7719,6 nos. (Table 2). The results showed highest numerical predominance of category "Artificial polymer materials" - 50160 nos. (64,98% of the total ML), followed by category "Paper/cardboard" - 10916 nos. (14,14%); category "Metal" - 5533 nos. (7,17%); category "Processed wood" - 4394 nos. (5,70%); category "Glass/ceramics" - 2870 nos. (3,72%); category "Rubber" - 1633 nos. (2,12%); category "Cloth/Textile" - 1417 nos. (1,84%) and category "Unidentified" - 318 nos. (0,41%).

The total number of ML recorded on each of the beaches during 2017 was as follows:

- "Channel 2 - Varna" - 17413 nos.;
- "Durankulak north 1" beach - 11782 nos.;
- "Shkorpilovtsi north" beach - 9889 nos.;
- "Obzor" beach - 8023 nos.;
- "Byala - Karadere" beach - 7216 nos.;
- "Irakli" beach - 6477 nos.;
- "Krapets" beach - 5624 nos.;
- "Alepu" beach - 5376 nos;
- "Black Sea saltpans" beach - Burgas - 2950 nos.;
- "River Veleka Mouth" beach - 2446 nos.;

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The total amount of ML recorded during 2017 was considerably higher than the previous period (2015- 2016), which can be explained by the lack of seasonality and the period of the monitoring - the busiest tourist season - summer - autumn. In addition, the lack of year-round campaigns in the previous 2016 (except in the spring) has a major impact on pollution.

"Byala - Karadere" beach selected as reference site showed considerable accumulation of ML which is an indicator of anthropogenic pressure on that area.

The highest was the quantity of items from category "Artificial polymer materials" on all beaches and the percentage of the total ML for the different beaches was as follows:

- "Durankulak north 1" beach - 70,42%;

- "Black Sea saltpans" beach - Burgas - 68,54%;

- "Irakli" beach - 67,62%;

- "Shkorpilovtsi north" beach - 66,35%;

- "Alepu" beach - 66,07%;

- "Channel 2 - Varna" - 63,65%;

- "Krapets" beach - 63,54%;

- "Obzor" beach - 62,35%;

- "Byala - Karadere" beach - 60,41%;

- "River Veleka Mouth" beach - 54,33%.

The contribution of each of the category to the total ML found on the beaches during 2017 in percentage is presented in Fig. 3.

In 2017, the contribution of polymer materials to other categories was significantly lower than in the previous years, while the contribution of Paper/cardboard was increased. The highest was the distribution of Paper/cardboard items on beach "Black Sea saltpans" beach - Burgas - 17,25%.

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ML grouping into categories of material, 2017

- Artificial polymer material
- Rubber
- Cloth/Textile
- Paper/Cardboard
- Processed wood
- Metal
- Glass/ceramic
- Unidentified
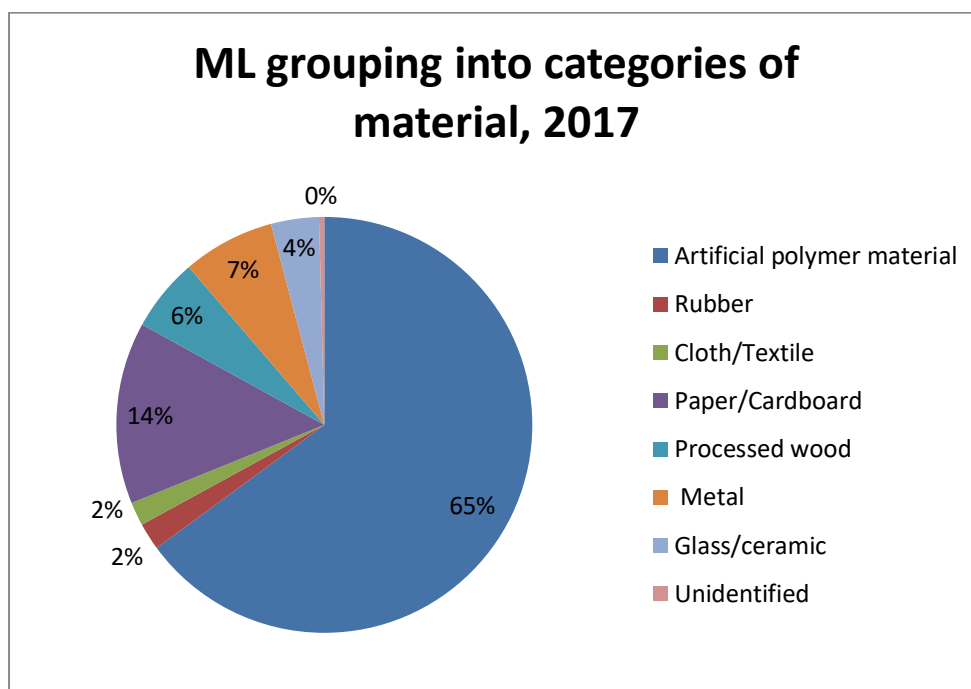
Fig. 3. *Aggregated results of the percentage (%) of each category to the total ML items, 2017 (10 monitored beaches)*

In 2018, 4 monitoring campaigns were conducted during summer and autumn (25.05.2018 - 01.10. 2018). The total number of items (> 2.5 cm), registered along all beaches (10 beaches) was **49789** nos., with average count per beach - 497819 nos. (Table 2).

The highest was the number of items from category "Artificial polymer materials" - 29970 nos. (60,19% of the total ML), followed by category "Paper/cardboard" - 6206 nos. (12,46%); category "Processed wood" - 5207 nos. (10,46%); category "Metal" - 4205 nos. (8,45%); category "Glass/ceramics" - 1661 nos. (3,34%); category "Cloth/Textile" - 1155 nos. (2,32%); category "Rubber" - 1106 nos. (2,32%); and category "Unidentified" - 279 nos. (0,56%).

The total ML registered was comparatively lower that the previous 2017 year, as one of the reasons might be the clean up effect of the surveys conducted in 2017.

The total number of ML recorded on each of the beaches during 2018 was as follows:

- "Channel 2 - Varna" - 6979 nos.;

- "Krapets" beach - 4079 nos.;

- "Irakli" beach - 3662 nos.;

- "Shkorpilovtsi north" beach - 3633 nos.;

- "Obzor" beach - 2862 nos.;

- "Black Sea saltpans" beach - Burgas - 2513 nos.;

- "River Veleka Mouth" beach - 2303 nos.;

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- "Byala - Karadere" beach - 2217 nos.;

- "Alepu" beach - 2085 nos.;

- "Durankulak north 1" beach - 1964 nos.

The contribution of each of the category to the total ML found on the beaches during 2018 in percentage is presented in Fig. 4.
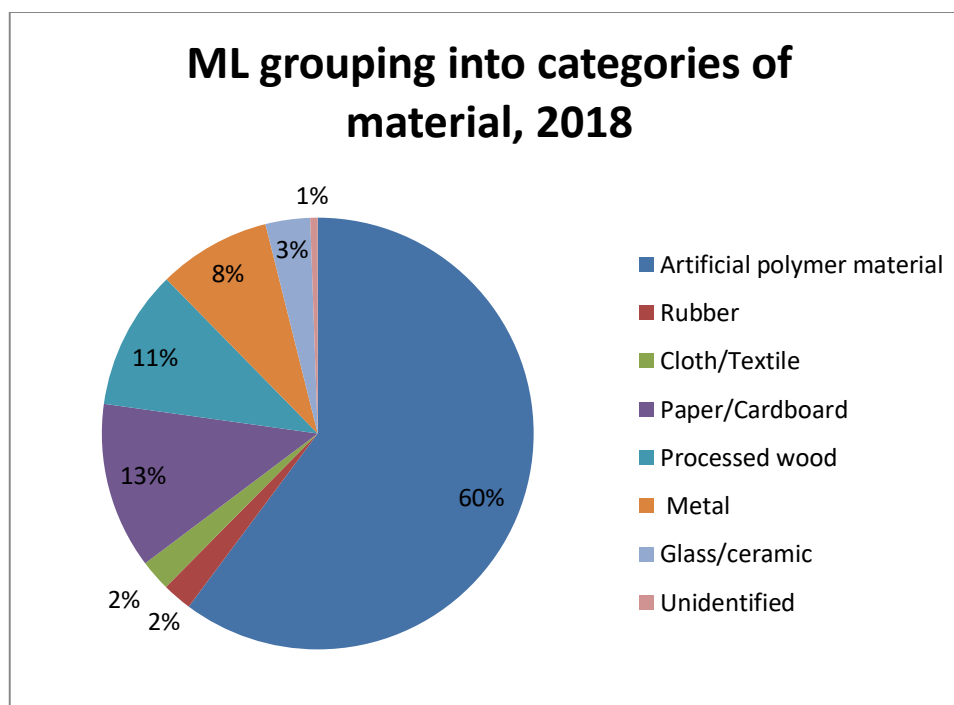
Fig. 4. *Aggregated results of the percentage (%) of each category to the total ML items, 2018 (10 monitored beaches)*

The highest was the number of items from category "Artificial polymer materials" on all beaches and the percentage of the total ML for the different beaches was as follows:

- "Shkorpilovtsi north" beach - 65,53%;

- "Krapets" beach - 62,71%;

- "Channel 2 - Varna" - 61,79%;

- "River Veleka Mouth" beach - 60,81%;

- "Byala - Karadere" beach - 60,56%;

- "Black Sea saltpans" beach - Burgas - 59,16%;

- "Durankulak north 1" beach - 58,96%;

- "Irakli" beach - 57,53%;

- "Alepu" beach - 57,12%;

- "Obzor" beach - 56,06%.

Second in abundance of items was the category "Paper/cardboard" for most of the beaches, highest on "Alepu" beach - 14, 79%. On three of the beaches second in abundance of items was the category "Processed wood": "Irakli" beach - 18,65%; "River Veleka Mouth" beach - 15% and "Obzor" beach - 14,20%.

2.4. Analysis of floating marine litter spatial distribution on the target area for the period 2015 - 2018

The analyses of floating ML spatial distribution in the target area was carried out, on the basis of the national monitoring data of floating ML for the period 2016 - 2018 (**D10C1, Indicator 2).**

In 2016, within the activities envisaged in MARLEN project, a pilot monitoring of floating ML > 2,5 cm was conducted, following the requirements of Guidance on Monitoring of Marine Litter in European Seas (https://ec.europa.eu/jrc/sites/default/files/lb-na-26113-en-n.pdf), which provides recommendations and information needed to commence the monitoring of the Descriptor 10 and to facilitate comparability of results with the other Black Sea and European countries.

The monitoring of floating ML >2,5 cm quantity, category of material, size and spatial distribution was performed within 01 - 20.07.2016, covering the coastal (0-30m) and shelf (30-200m) zones of the marine area between Cape Kaliakra and Sozopol. The survey was based on visual observations of the floating ML on 46 transects, equally distributed in the coastal and shelf zones (Fig. 5). The total observation sea surface was covering 2,34 km^2, with an observation track length of 325,2 km.

A total of 1252 items was observed on the sea surface of the monitored area - 558 nos. found in the coastal zone and 695 nos. in the shelf zone. In four transects (V001, V022, V023 and V024) - floating litter was not found.

The concentrations of floating litter on the sea surface varied between 0 and 8441 items/km², which accounts for an average concentration of 690 items/km². The average concentration of ML in the shelf was higher (796 items/km²) than that observed in the coastal zone (585 items/km²). Minimum (11 items/km²) and maximum (8441 items/km²) concentration of floating litter was recorded in the coastal zone of Cape Galata (transect V039) and the area between r. Kamchiya and Shkorpilovtsi (transect V012).

Regarding the shelf zone, the minimum concentration was 1.5 times higher (28 items/km² - V020) than that observed in the coastal zone, while the maximum concentration was half lower (4857 items/km² - V018).
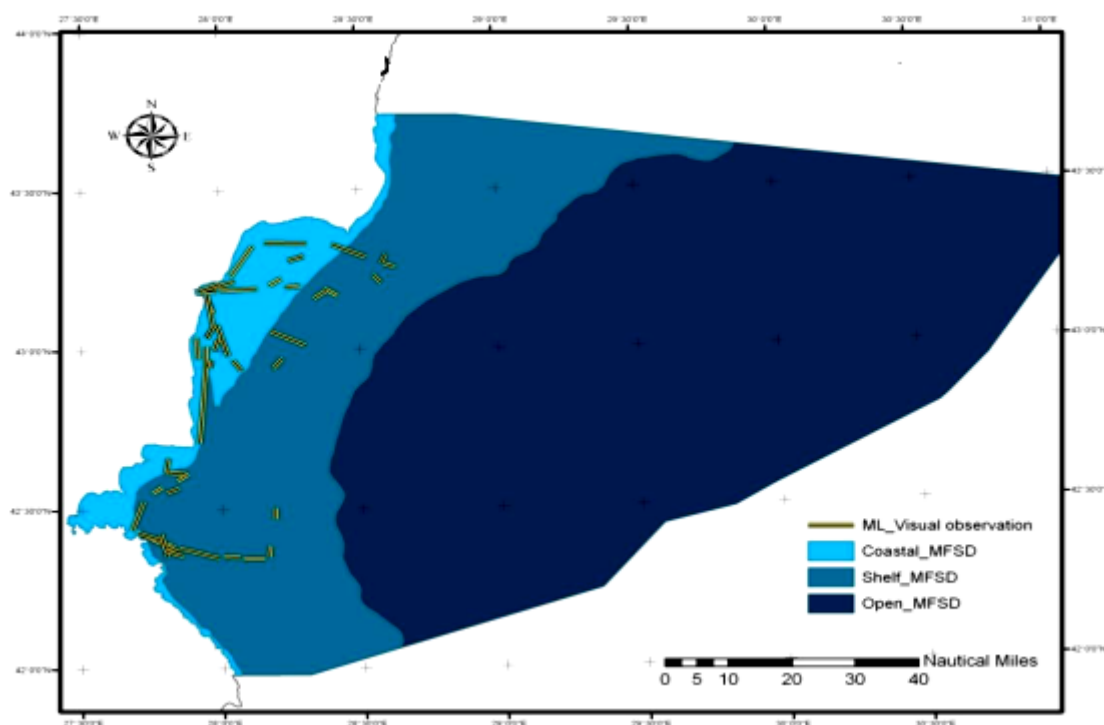
Fig.5. *Area of observation of floating marine litter >2,5 cm on the sea surface*

During the pilot monitoring, floating ML from all categories valid for D10C1, Indicator 2 was observed ("Artificial polymer materials"; "Rubber"; "Cloth/Textile"; "Paper/cardboard"; "Processed wood"; "Metal"). The most dominant was floating ML from category "Artificial polymer materials" and only 5% was the contribution of the other categories - Rubber, Paper, Metal, textile and Processed wood.

With reference to "Artificial polymer materials" category, the highest was the contribution of subcategory (G38) "Cover/packaging" - 57% and (G79) "Plastic pieces 2.5 cm > < 50cm" - 26%. Highest distribution of "Cover/packaging" items were registered in the area between r. Kamchiya and Shkorpilovtsi (transect V012) (5543 items/km^2) as well as in the shelf zone of Sozopol town (V018) (2998 item/ km^2).

In the shelf, the average concentration of floating ML from "Artificial polymer materials" category was 805 item/km^2, while in the coastal zone was considerably lower - 549 item/ km^2.

According to the size of floating litter - 88 % of all registered items were of size between 2.5 cm and 20 cm. Among them - 51% (636 items) were from „A" class (2,5 cm - 5 cm); 24% (301 items) from "B" class (5 cm - 10 cm); 13% (168 items) from „C" class (10 cm - 20 cm) and the rest 12% were higher than 20 cm. The floating items of size higher than 50 cm were only 26 items (2%), from which 24 items in the shelf zone.

Common borders. Common solutions

The Artificial polymer materials were found in all classes „A-F". More than 70% of their total number corresponded to the small size class „A" and „B" and only 2% were of size higher than 50 cm. Regarding the rest of the categories - Rubber, Paper, Metal, Textile and Processed wood, dominant were the items of sizes from „B" class - 59% and "C" class - 13% (5 - 20 cm).

In 2017, the monitoring of floating ML was performed by IO -BAS within two periods: 09.10.2017 – 16.10.2017 and 22.11.2017 – 30.11.2017 by scientific research vessel "Äkademik" on 117 transects.

A total of 582 *items was observed on the sea surface*. In 25 transects floating ML was not found (V002-X, V005-X, V008-X, V020-X, V025-X, V027-X, V032-X, V033-X, V051-X, V052-X, V053-X, V059-X, V017-XI, V025-XI, V027-XI, V030-XI, V032-XI, V033-XI, V035-XI, V039-XI, V047-XI, V048-XI, V049-XI, V051-XI and V056-XI).

Items from the following categories were found: "Artificial polymer materials", "Rubber", "Cloth/Textile", "Paper/cardboard", "Processed wood" and "Metal". 87% of all items were from "Artificial polymer material category, and the rest were distributed as follows: 9% from category "Paper/cardboard"; 2% - "Processed wood"; 1% - "Cloth/Textile" and 1% - "Metal".

According to the size of floating litter - 86 % of all registered items during the monitoring were of size between 2.5 cm and 50 cm. Among them - 45% were from „A" class (2,5 cm - 5 cm); 19% from "B" class (5 cm - 10 cm); 12% from „C" class (10 cm - 20 cm), 7% from "D" class" (20cm - 30 cm), 3% from „E" class (30 cm - 50 cm). Items of size higher than 50 cm were - 49 nos.

In 2018, the monitoring of floating litter was conducted under the program of Enterprise for management of environmental protection activities (WASHER). A total of 116 transects were covered - 36 in the shelf zone (observed in the period 21.07.2018-26.08.2018) and 80 in the coastal zone (40 transects monitored in the period 07.08.2018-10.9.2018 and 40 within 08.10.2018-31.10.2018)

A total of 413 *items were observed on the sea surface, as* in 35 transects floating ML was not observed.

Items from the following categories were found: "Artificial polymer materials", "Rubber", "Cloth/Textile", "Paper/cardboard", "Processed wood" and "Metal". 91% of all items were from "Artificial polymer materials" category, followed by "Paper/cardboard" - 7%.

The concentration of floating litter on the surface varied between 0 до 1750 items/km², which accounts for an average concentration of 160 items/km². The average concentration of ML in the shelf was higher (190 items/km²) than that observed in the coastal zone (148 items/km²). The maximum values of floating litter concentrations were recorded in the coastal zone within Sozopol - Alepu (transects V025-c1 and V026-c1). Minimum was the concentration of floating litter in the coastal zone of Shkorpilovtsi - Byala (transect V001-c and V002-c) and in the shelf zone of Durankulak - Kaliakra (transect V015).

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As spots with floating ML may be considered - the shelf zone in the area of Kaliakra, Durankulak and Burgas, as well as the coastal zone within Galata, Kamchiya, Sozopol and Alepu.

2.5. Main conclusion on the analyses of marine litter accumulation and distribution in the target area (2015-2018)

Regarding marine macro-litter accumulation on the coasts during 2015 - 2018, the following trends are observed:

- Marine macro-litter (over 2.5 cm in size) coastal accumulation in the target area is better studied than floating and sea floor litter distribution. Offshore ML (descriptor D10C1, indicator 1) represents the largest share of all ML found in the different compartments of the marine environment, indicating the pollution on the Bulgarian Black Sea coast and coastal waters.

- The total amount of coastal ML registered on the beaches was quite heterogeneous, depending on the location of the beach and the potential pressure.

- The highest was the coastal ML accumulation in 2017 - 77196 nos. with average count per beach - 7719,6 nos., followed by 2018 - 49789 nos. (average count per beach - 4978,9 nos.); 2015г - 15661 nos. (average count per beach - 1957 nos.) and 2016 -4144 nos. (average count per beach - 518 nos.).

- The first 3 categories with highest contribution to pollution were: first -category "Artificial polymer materials", second - "Paper/cardboard" and third - "Processed wood" and "Metal".

- The relative share of category "Artificial polymer materials" was significantly reduced within the whole monitoring period - from 86% in 2015 to 60% in 2018. In 2016 it was - 85,76%, 2015 - 83,88%, 2017 - 64,92% and 2018 г. - 60,19%. An exception was 2016 with higher Artificial polymeric materials contribution than 2015, but the reason is that only one campaign was conducted in spring.

- The share of the following categories was essential: "Paper/cardboard" (13-14% for the period 2017-2018); "Metal" (7-8% for the period 2017-2018) and „Processed wood" (6 - 11% for 2017 - 2018).

- The total amount of items from category "Processed wood" was increasing every year, ranging from 0.47% in 2015 to 10.46% in 2018.

- The following sources of pollution were identified as significant: *maritime transport and ports; urbanization; tourism and recreation, including wild camping; commercial and recreational fishing; river runoff and discharges; transboundary movement of waste between water basins.*

Regarding floating marine macro-litter on the sea surface during 2016 - 2018, the following trends are observed:

- Dominant were the floating marine litter from the category ""Artificial polymer materials", representing 95% in 2016, 87% in 2017 and 91% in 2018.

- Considerable differences in the average concentrations of floating litter in the shelf and coastal zone were not observed.

- Numerical predominance was recorded for small sized floating litter from class "A" (2,5 cm - 5 cm) and class „B" (5 cm - 10 cm). The maximum concentration of litter on the sea surface was registered in 2016 in the coastal zone of r. Kamchiya (8441 items/km²) and in the shelf zone of Sozopol (4857 items/km²) and Cape Kaliakra (3115 items/km²), characterized with intense marine traffic.

- As spots with floating ML in 2018 may be considered: the shelf zone in the area of Kaliakra, Durankulak and Burgas as well as the coastal zone within Galata, Kamchiya, Sozopol and Alepu.

- The presence of floating debris is highly variable and depends on the strength and direction of the prevailing winds and currents. In September 2018, after strong winds, waves and sea currents towards the Bulgarian coast, a large amount of plastic items was deposited on the beaches of the southern Black Sea coast (Alepu beach).

- The typical strong meltemi gusts and E-NE wind in combination with strong waves and surface currents with W - SW direction, caused "cleaning" of the coastal waters from drifting debris and depositing them on beach and rocky shores of the Bulgarian Black Sea coast.

- Pilot observations of floating marine litter on the sea surface provide information only about the current status, therefore it is advisable to be combined with observations on the water masses movement in the coastal zone and distribution modeling of various types of plastic items in the marine waters.

3. MARINE LITTER LOADING EVALUATION SCALE - PROPOSAL (allowing the particular area under consideration to be classified in one of the following at least four categories: low loaded, moderate loaded, heavily loaded, critical)

3.1. **The proposal considers**: the Black Sea and the target area's specific; the scheme and methodology of marine littler monitoring in Bulgaria adopted on national level and a set of good practices in survey implemented in the above-mentioned projects; the main findings of survey since 2015 regarding marine litter (ML) composition, abundance, distribution and accumulation typical within the target area; requirements set by the assignor in the technical specification.

Marine litter loading in the target area is the most studied with regards to marine litters bigger than 2,5cm, accumulated on the coastline, weather the floating marine litters and the accumulated on the seabed one are less studied. Marine litters accumulated on the coastline (descriptor D10C1, in accordance with Marine Strategy Framework Directive) present the largest percentage among the marine litters, characterizing the marine litter load of the Bulgarian Black Sea Coast and the Black Sea aquatory.

3.2. **The necessary data for marine litter loading assessment**, in the target areas, mainly concern the analysis of the accumulated marine litters according to the following main indicators:
- Marine litter type;
- Area of accumulation and territoriality of the region (accompanied by metadata);
- Quantity of the accumulated marine litter;
- Marine litter composition (by main categories of material);
- Classification of the predominant marine litter;
- Period of accumulation of the registered quantities;
- ML source/ Origin of marine litter loading;
- Main marine litter waterways of "movement".

3.3. **Marine littering/ loading evaluation scales**. Based on the purpose, the requirements for the evaluation scale's scope and the principles in the structuring of evaluation scales, as well as on similar assessment tools worldwide, the scale should be **five-rate** one. This will allow a clearly differentiation between the marine litter loading rates to be done, as well as it would facilitate the researched areas condition assessment. At the same time this will allow an adequate interval values of each rate to be used in accordance with the specification of the target area

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Main criteria. The main criterion against which the marine litter loading evaluation scale is structured   *is the density* of ML (parts/m²).

The findings of the national ML survey in Bulgaria since 2015 prove that the marine derbis on the shore has the highest contribution to the total accumulation of marine litter in comparison with the floating and accumulated on the seabed one. This is in a full compliance with the theoretical considerations according to which approximately 70% of the marine litters accumulate on the coastline, 15 % are in the water column and accumulate on the seabed and 15 % are floating one.

The already existing CCI (Clean Coast Index) is based on the density of the Artificial polymer materials found in determined beach transects on the exact territories and allow marine litter loading assessment of the beaches/ coastline. However, in Bulgaria, with the data generated by the institutional monitoring of beach marine litter, *this index cannot give a sufficiently clear idea of the total marine litter loading.*

This is due to the fact that with comparison to other sea basins and coasts, in which Artificial polymeric materials make up to 80-90% of the all accumulated marine litters, and in some cases even exceed 90%, in Bulgaria this percentage is significantly smaller.

Table 2 shows the quantities of marine macro-litters, grouping by main categories of material accounted during the institutional ML monitoring (2015-2018)

Figures 1 to 4 show the share of each of the main categories of material in the composition of the total accounted marine litters within national coastal ML monitoring for the period 2015 - 2018 including.

As it can be seen from the presented above tables and the graphs regarding ML accumulation in the target area, the relative share of "Artificial polymer materials" is significantly reduced (from 86% in 2015 up to 60% in 2018). Significant is the share of the main categories of material "Paper/Cardboard" (13-14% for the period 2017-2018), "Metal" (7-8% for the period 2017-2018) and "Processed/Worked wood" (6% in 2017 and 11% in 2018).

Based on the analyses presented above *we consider the necessity to incorporate the main four groups of materials with highest relative share of the total amount of marine liters*: "Artificial polymer materials", "Paper/Cardboard", "Processed/Worked wood" and "Metal" into the marine litter loading evaluation.

3.4.   Marine Litter Density Index.

Marine Litter Density Index (MLDI) **is proposed to be adopted** *using the following formula: (Toneva&Simeonova),*

$$MLDI = D_{av}\,K$$

Where:

D_{av} – *average density of marine litters from the main groups* "Artificial polymer materials", "Paper/Cardboard", "Processed/Worked wood" and "Metal" *for one monitoring campaign for the determined area of interest*, [parts/m²].

K – *coefficient,* with perceived value **20** (for statistically needs)

If we accept the following indications: $D_{APM_{av}}$ – *average density of marine litters from the main group* Artificial polymer materials *for the determined area;* $D_{P/C_{av}}$ – *average density of marine litters from the main group* Paper/Cardboard *for the determined area;* $D_{PW_{av}}$- *average density of marine litters from the main group* Processed/Worked wood *for the determined area;* $D_{M_{av}}$- *average density of marine litters from the main group* Metal *for the determined area,* **then:**

$$D_{av} = \left(D_{APM_{av}} + D_{P/C_{av}} + D_{PW_{av}} + D_{M_{av}}\right) \text{ [parts/m²]}$$

3.5. Calculation procedure.

We propose the following algorithm and calculation procedure:

- *Determine/ calculate the average amount of marine litter accounted from the 4 groups of material (*"Artificial polymer materials", "Paper/Cardboard", "Processed/Worked wood" and "Metal") *for one monitoring campaign* from the annual monitoring for the area of interest. It shall be calculated as simple average value, *[parts.]*

- *Determine/ calculate the total average amount of marine litter accounted from the 4 main groups [parts.] within the area of interest. (it shall be calculated as a sum of the already attributed average values of the marine litters by 4 groups of materials, [parts.]).*

- *Determine/ calculate the average density of marine litters from the main groups* "Artificial polymer materials", "Paper/Cardboard", "Processed/Worked wood" and "Metal" *for one monitoring campaign for the determined area of interest, [parts/m²] (total average amount marine litters referred to the determined area).*

- *Determination/ calculation of MLDI*

3.6. Scale structuring. Interval meanings.

The scale covers the range of D_{av} *(average sum density of marine litters from the 4 main groups* "Artificial polymer materials", "Paper/Cardboard", "Processed/Worked wood" and "Metal" for one monitoring campaign for the determined area) and ***MLDI*** (***Marine Litter Density Index***):

Table 3. Correlation between: ML density and Marine Litter Density Index
(*Toneva&Simeonova*)

D_{av} [parts/m^2]	*MLDI*	Evaluation
$D_{av} = 0 \div 0,1$	*MLDI* $= 0 \div 2$	**Unloaded area**/ very clean area
$D_{av} = 0,1 \div 0,25$	*MLDI* $= 2 \div 5$	**Low loaded area/** clean area
$D_{av} = 0,25 \div 0,5$	*MLDI* $= 5 \div 10$	**Moderate loaded area/** moderate littered area
$D_{av} = 0,5 \div 1$	*MLDI* $= 10 \div 20$	**Heavily loaded area/** very littered area
$D_{av} \geq 1$	*MLDI* $= 20 +$	**Critically load area/** extremely littered area

Table 4. ML littering/loading evaluation scale, based on *MLDI* (*Toneva&Simeonova*)

MLDI	*ML littering evaluation*				
Qualitative determination	*Very clean/ Unloaded*	*Clean/ Low loaded*	*Moderate/ Moderate loaded*	*Heavy/ Heavily loaded*	*Extreme/ Critically loaded*
Numeric index- value of **MLDI**	*0-2*	*2-5*	*5-10*	*10-20*	*Over 20*

We propose in addition to integrate colors with defined uniformed meanings to the scale as follows: blue - very clean/ unloaded; green –clean/ low loaded; yellow- moderate littered/ moderate loaded; orange- heavy littered/ heavily loaded; red- extremely littered/ critically loaded

Table 5. ML littering evaluation scale in colors, based on MLDI (*Toneva&Simeonova*)

MLDI	*ML littering evaluation*				
Qualitative determination	*Very clean/ Unloaded*	*Clean/ Low loaded*	*Moderate/ Moderate loaded*	*Heavy/ Heavily loaded*	*Extreme/ Critically loaded*
Numeric index- value of **MLDI**	*0-2*	*2-5*	*5-10*	*10-20*	*Over 20*

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4. IDENTIFICATION OF MARINE LITTER HOTSPOTS ON THE TARGET AREA

4.1. Aim of analysis: identification of marine litter hotspots on the target area (Bulgarian Black Sea coast), based of application of Marine Litter Density Index assessment scale against the results of the General analysis of marine litter accumulation on the target area.

4.2. Subject of analysis: обект на настоящия анализ се явява натоварването с морски макроотпадъци в целевата територия за периода 2015-2019г.включително.

The subject of the present analysis is the loading and accumulation of macro-marine litter (ML) on the target area in the period 2015-2019 including.

In order to identify the macro-marine litter hotspots on the target area a *General analysis of marine litter accumulation on the target area* is conducted and the results of the analysis are reported to the contracting authority (Via Pontica foundation) as a part of previous interim report. The subject of this analysis is the accumulation of macro-marine litter (ML) on shore (beach litter) and on the sea surface (floating) on target area for the period 2015-2018.

In order to obtain a more complete picture of the distribution and accumulation of marine litter and the areas of increased littering, *the analysis has been extended to 2019, inclusive.* It covers:

- Marine litter on the beaches and coastlines – subject to the national institutional monitoring (10 beaches) for the period 2015-2019;
- 3 beaches, monitored in the frames of the RedMarLitter project in 2019. The geographical coordinates
- 4 beaches beyond the scope of national monitoring, for which data are collected from the European Environment Agency, Marine LitterWatch (MLW)

4.3. Identification of marine litter hotspots on the target area - methods.

The *Marine Litter Density Index (MLDI) (Toneva&Simeonova) is applied.* It is calculated by the following *formula:*

$$MLDI = D_{av}\, K,$$

where:

D_{av} – *average density of marine litter from the main ML categories (materials)* <u>"Artificial polymer materials", "Paper/cardboard", "Processed wood" and "Metal"</u> *for one monitoring campaign for the determined area of interest, [parts/m²]*

K – *coefficient, with an accepted value of 20 (for statistics purposes)*

D_{av} *is calculated as follows:*

$$5. \quad D_{av} = \left(D_{APM_{av}} + D_{P/C_{av}} + D_{PW_{av}} + D_{M_{av}}\right) [parts/m^2]$$

where:

$D_{APM_{av}}$ – *average density of marine litter from the main ML category (material)* Artificial polymer materials *for the determined area*;

$D_{P/C_{av}}$ – *average density of marine litter from the main ML category (material)* Paper/cardboard *for the determined area*;

$D_{PW_{av}}$ - *average density of marine litter from the main ML category (material)* Processed wood *for the determined area*;

$D_{M_{av}}$ - *average density of marine litter from the main ML category (material)* Metal *for the determined area*;

The interdependence between *average density of marine litter from the main ML categories (materials)* <u>"Artificial polymer materials", "Paper/cardboard", "Processed wood" and "Metal"</u> *for a determined area of interest (D_{av}) and* Marine Litter Density Index *(MLDI)* is presented in table 3.

Five- step ML loading/ littering evaluation scale, based on ***MLDI,*** has been applied. (table 5)

This evaluation scale is designed to support hot spots identification. Nevertheless additional data should be consider in the process including Black Sea specific features, the main characteristics of targeted area; ML monitoring frequency and seasonal coverage of survey , respectately the accumulation of ML per defined period; seasonal dynamic of transfer, spatial coverage and accumulation of ML of each location; anthropogenic pressure, ect.

With reference to the target area, when marine litter density index (MLDI) of a certain territory is higher than 20 then this site is determined as a hot spot of ML pollution.

With reference to the target area, when MLDI of a certain territory is within the interval 10÷20, observed twice per year (on annual bases) in different seasons, then this site is determined as a hot spot of ML pollution.

With reference to the target area, when MLDI of a certain territory is within the interval 10÷20, observed only within one monitoring campaign (especially if this monitoring

is for the first time), then this site <u>cannot be</u> firmly considered as a hot spot of ML pollution. The reason is the uncertainty of ML accumulation period, and the ML accumulation rate. Subsequent monitoring and further analysis will be required for such areas.

4.4. Identification of marine litter hotspots on the target area – analytic part

Data and information from reliable sources have been analyzed. Geographical coordinates of beaches, subject to the national monitoring of coastal marine litter, 2015 – 2018, 1000 m sections are presented on table 6. The coordinates of 1000m sections of beaches, subject to monitoring of beach marine litter in the frames of RedMarLitter project, 2019 are presented on table 7.

Table 6. Geographical coordinates of beaches, subject to the national monitoring of coastal marine litter, 1000 m sections, 2015 – 2019

№	Name of beach / coastline (monitored beaches)	Geographical coordinates of 1000 m section (start)	Geographical coordinates of 1000 m section (end)	Coordinate system
1.	Beach "Durankulak - north 1"	43 43 0.01N, 28 34 24.72E	43 42 23.24N 28 34 40.15E	WGS84
2.	Beach "Krapets"	43 39 4.00N, 28 34 10.00E	43 39 36.09N 28 34 0.10E	WGS84
3.	Channel 2 - "Varna lake - Black Sea"	43 11 8.95N, 27 53 23.20E	43 11 31.58N 27 52 51.98E	WGS84
4.	Beach "Shkorpilovtsi -north"	42 57 25.66N, 27 53 54.25E	42 57 57.56N 27 53 46.47E	WGS84
5.	Beach "Byala - Karadere"	42 55 12.06N, 27 53 48.06E	43 54 39.64N 27 53 47.67E	WGS84
6.	Beach "Obzor - childrens' camps"	42 48 1.38N, 27 53 25.64E	42 47 30.02N 27 53 35.90E	WGS84
7.	Beach "Irakli"	42 44 59.29N, 27 53 20.69E	42 44 27.29N 27 53 28.57E	WGS84
8.	Beach "Black sea saltpans" - Burgas	42 30 57.16N, 27 29 9.19E	42 31 28.62N 27 29 19.77E	WGS84
9.	Beach „Alepu"	42 22 7.00N, 27 42 33.00E	42 21 37.33N 27 42 47.85E	WGS84
10.	Beach "River Veleka mouth"	42 3 54.66N, 27 58 44. 57E	42 4 12.19N 27 58 7.56E	WGS84

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Table 7. Geographical coordinates of beaches, subject to monitoring of coastal marine litter in the frames of RedMarLitter project, 1000 m sections, 2019

№	Name of beach / coastline (monitored beaches)	Geographical coordinates of 1000 m section (start)	Geographical coordinates of 1000 m section (end)	Coordinate system
1.	Beach north of "Black sea saltpans" - Burgas town	N 42°32'28.46" E 27°30'1.33"	N42°31'59.94" E 27°29'39.71"	WGS84
2.	Beach on Vromos bay	N 42°26'41.33" E 27°36'34.21"	N 42°26'41.19" E 27°37'19.17"	WGS84
3.	Beach „Alepu" between "Dyuni" resort and "Dyuni South"	N 42°21'28.46" E 27°42'55.62"	N 42°21'0.21" E 27°43'17.94"	WGS84

The different **observation frequency** by beaches and by years should be considered in marine litter hotspots identification process.

Table 8 shows the observed beaches and the number of monitoring campaigns carried out by year. Table 9 shows the beaches along the Bulgarian Black Sea coast, monitored in the frames of this project.

Table.8. Monitoring campaigns per year on beaches, subject to the national monitoring of coastal marine litter, 2015-2019г.

№	Name of beach / coastline (monitored beaches)	Monitoring of coastal marine litter				
		Number of monitoring campaigns per year				
		2015	2016	2017	2018	2019
1.	Beach "Durankulak - north 1"	3	1	3	4	4
2.	Beach "Krapets"	3	1	3	4	4
3.	Channel 2 - "Varna lake - Black Sea"	3	1	3	4	4
4.	Beach "Shkorpilovtsi -north"	3	1	3	4	4
5.	Beach "Byala - Karadere"	0	0	3	4	4
6.	Beach "Obzor - childrens' camps"	3	1	3	4	4
7.	Beach "Irakli"	3	1	3	4	4
8.	Beach "Black sea saltpans" - Burgas	3	1	3	4	4
9.	Beach „Alepu"	3	1	3	4	4
10.	Beach "River Veleka mouth"	0	0	3	4	4

The institutional ML monitoring regarding criteria D10C1 Indicator 1 (according MSFD) was conducted within the period August 2015 - March 2016. Eight country beaches were surveyed: "Durankulak" beach; "Krapets" beach; "Channel 2 - Varna" beach; "Shkorpilovtsi" beach, "Obzor"

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beach; "Irakli" beach; "Black Sea saltpans" beach - Burgas; "Alepu" beach. From 2017 monitoring was carried out on 10 beaches - two additional beaches were surveyed -"Byala - Karadere" beach and "River Veleka mouth" beach.

The marine litter monitoring within RedMarLitter project was conducted as a seasonal monitoring during "summer", "autumn" and "winter" seasons of year 2019. Survey was assigned by Burgas municipality and performed by "Nikola Vaptsarov" Naval Academy according OSPAR commission requirements and recommendations. The ML monitoring frequency is shown on table 9.

Table.9. Monitoring campaigns per year on beaches, monitored within RedMarLitter project, 2019

№	Name of beach / coastline (monitored beaches)	Monitoring of coastal marine litter				
		Number of monitoring campaigns per year				
		2015	2016	2017	2018	2019
1.	Beach "Black sea saltpans North" - Burgas	0	0	0	0	3
2.	Beach "Vromos Bay"	0	0	0	0	3
3.	Beach „Alepu" between "Dyuni" resort and "Dyuni South"	0	0	0	0	3

Table 10 shows other observed beaches within the target area and the number of monitoring campaigns carried out by year according EEA and Marine LitterWatch application.

Table.10. Monitoring campaigns per year on other beaches, *Marine LitterWatch*, 2015-2019

№	Name of beach / coastline (monitored beaches)	Monitoring of coastal marine litter				
		Number of monitoring campaigns per year				
		2015	2016	2017	2018	2019
1.	Beach Kamchia (north of river mouth)	1	0	0	2	0
2.	Beach "Kamchiyski pyasatsi"	1	0	0	2	0
3.	Beach Ropotamo	0	0	1	3	0
4.	Beach Gradina	1	0	0	0	0

The surveys are recorded in *Marine LitterWatch.*

The monitored beaches were selected taking into consideration the basic drivers of ML accumulation on shore namely:

- *navigation and ports;*
- *urbanization;*

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- *tourism and recreation in the coastal zones;*
- *commercial and recreational fishing;*
- *rivers inflow, including wastes discharges by rivers;*
- *transboundary transfer of waste between water basins, etc.*

All guidelines for selection of reference beaches are fulfilled. Table 11 shows the reference beaches subject to the national monitoring of coastal ML as well as the pressure- impact link. Table 12 and table 13 respectably show pressure- impact link for those beaches, monitored in 2019 in the frames of RedMarLitter project and other beaches within the target area (source MLW).

Table 11. Beaches, subject to the national monitoring of coastal marine litter, 2015 - 2019

№	Beach/coastline	Status	Pressure - Impact
1.	Beach "Durankulak North"	Unguarded	Transboundary transfer of waste
2.	Beach "Krapets"	Unguarded	Transboundary transfer of waste
3.	Channel 2 - "Varna lake - Black Sea"	Coastline	Pressure from large populated area, with >100000 p.e (Varna town)
4.	Beach "Shkorpilovtsi -north"	Unguarded	Pressure from less populated area, with < 2000 p.e (Shorpilovtsi village); seasonal recreational sites; recreational activities during summer; influence of the river "Fundukliyska" and transfer of waste from currents
5.	Beach "Byala - Karadere"	Nature-friendl tourism beach; Unguarded	Reference site; inflow of small rivers - the river "Cherna" and the river "Byala"; transfer of waste from currents
6.	Beach "Obzor - childrens' camps"	Unguarded	Pressure from large settlements > 10000 p.e. (town of Obzor); influence of the river "Dvoinitsa"; seasonal resort sites; agricultural lands and forests
7.	Beach "Irakli"	Nature-friendly tourism beach; Unguarded	Offshore reference place; mainly forests and arable land; transfer of waste from currents
8.	Beach "Black sea saltpans" - Burgas	Unguarded	Pressure from settlement with > 100000 p.e. (Burgas town) and Sarafovo neighborhood; in close proximity to "Black Sea Solnitsi" AD Salt plant; balneotherapy spot
9.	Beach „Alepu"	Unguarded	Pressure from large settlements > 10000 p.e. (town of Sozopol); seasonal resort sites ("Dyuni" resort and other smaller ones); close to "Alepu" swamp and transfer of waste from currents
10.	Beach "River Veleka mouth"	Unguarded	Pressure from small settlements < 2000 p.e. (village of Sinemorets); seasonal resort sites; influence of the "Veleka" river and transfer of waste from currents

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Table 12. Beaches, subject to monitoring of coastal marine litter under RedMarLitter, Project, 2019

№	Beach/coastline	Status	Pressure - Impact
1.	Beach "Black sea saltpans North" - Burgas	Coastline; unguarded sandy beach; accessible	Recreation, tourism, urbanization - pressure from large settlements > 100000 p.e., Burgas town); industrial extraction of sea salt
2.	Beach "Vromos Bay"	Unguarded sandy beach; accessible	Recreation; wild camping; urbanization - pressure from large settlements > 10000 p.e - Chernomorets town; Navy site "Atiya"; marine transport; transfer of waste from currents
3.	Beach „Alepu" between "Dyuni" resort and "Dyuni South"	Unguarded sandy beach; accessible; dunes' habitat	Tourism - seasonal resort sites; resort "Dyuni"; urbanization - pressure from large settlements > 10000 p.e. (town of Sozopol); transfer of waste from currents

Table 13. Other beaches within the target area, 2015-2018

№	Beach/coastline	Status	Pressure - Impact
1.	Beach "Kamchya" (next to River Kamchiya mouth)	Unguarded sandy beach; accessible	Recreation; tourism; seasonal resort sites; river "Kamchiya" inflow; transfer of waste from currents
2.	Beach "Kamchiyski pyasatsi"	Unguarded sandy beach; accessible, dunes' habitat	Recreation; wild camping; ; river "Kamchiya" inflow; transfer of waste from currents
3.	Beach Ropotamo	Unguarded sandy beach; accessible	Recreation; tourism; seasonal resort sites; river "Ropotamo" inflow; transfer of waste from currents
4.	Beach Garden camping	Nature-friendly tourism beach	Recreation; tourism; seasonal resort sites

As significant sources of pollution are identified: *maritime transport and harbors; urbanization; tourism and recreation, including wild camping; commercial and recreational fishing; river runoff and discharges; transboundary transfer of waste between water basins.*

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D10C1 monitoring included 8 main groups of materials (categories of ML):

- *Artificial polymer materials;*

- *Rubber;*

- *Cloth/Textile;*

- *Paper/Cardboard;*

- *Processed wood;*

- *Metal;*

- *Glass/ceramics and*

- *Unidentified*

According to the Master list of categories, each category consists of different number of subcategories - a total of 167. Largest is the number of subcategories in *Artificial polymer materials* category - 92, while in the rest of the categories the number is considerably lower - from 10 to 21 subcategories.

The main results of ML monitoring survey on beaches subject to the national ML monitoring in the period 2015-2019 are presented in ***Appendix 1***

The main results of ML monitoring survey carried out in 2019 on *beach Black Sea saltpans North, beach Vromos bay* and *beach Alepu between Duni resort and Duni South* are summarized in ***Appendix 2.*** Appendix 1 and Appendix 2 are integral part of this report.

The aggregated results of national coastal ML monitoring survey carried out 10 beaches in 2019 are presented in Table 14. Full and more detailed datasets are published in appendix 1. The contribution of each of the category to the total ML found on the beaches during 2019 in percentage is presented in Fig. 6.

The findings of the extended General analysis of ML littering in the target area (to 2019) the following conclusions are confirmed once more:

- *Offshore marine macro-litter (descriptor D10C1, indicator 1) represents the largest share of all ML found in the different compartments of the marine environment, indicating the pollution on the Bulgarian Black Sea coast and coastal waters.*

- *The total amount of coastal ML registered on the beaches is quite heterogeneous, depending on the location of the beach and the potential pressure.*

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- *The highest was the coastal ML accumulation in 2017 - 77196 nos. with average count per beach - 7719,6 nos., while in 2019 the total amount is counted 40694 nos. (average count per beach - 406 nos.);*

- *The categories with highest contribution to pollution were: first -category "Artificial polymer materials", second - "Paper/cardboard" and third - "Processed wood" and "Metal".*

- *The share of the following categories was essential: "Paper/cardboard" (13-14% for the period 2017-2019); "Metal" (6-8% for the period 2017-2019) and „Processed wood" (6 - 11% for 2017 – 2018 and 12% in 2019).*

- *The total amount of items from category "Processed wood" is increasing every year, ranging from 0.47% in 2015 to 10.46% in 2018 and 13% in 2019.*

- *The typical strong meltemi gusts and E-NE wind in combination with strong waves and surface currents with W - SW direction, caused "cleaning" of the coastal waters from drifting debris and depositing them on beach and rocky shores of the Bulgarian Black Sea coast.*

- *As spots with high concentration of floating ML may be considered: the shelf zone in the area of Kaliakra, Durankulak and Burgas as well as the coastal zone within Galata, Kamchiya, Sozopol and Alepu and that contributes to the littering of coastal areas.*
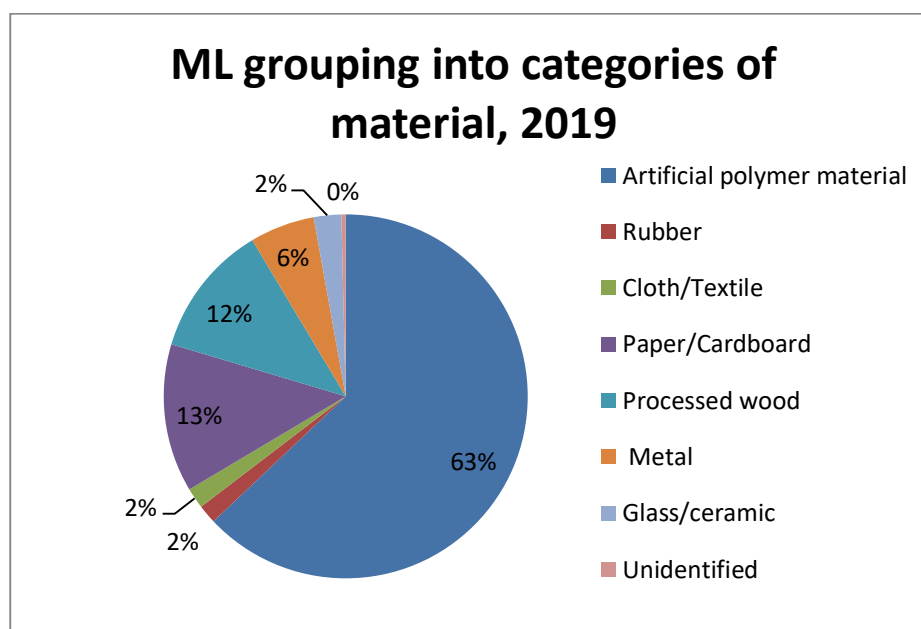

Fig.6. Aggregated results of the percentage (%) of each category to the total ML items, 2019 (10 monitored beaches)

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Table 14. Aggregated result according to the national ML monitoring data, 2019

№	Year	2019		
	Indicator	**Total count/ year**		**Aver.count/ per beach**
		nos.	**%**	**nos.**
1.	Total ML	40694	100	4069
2.	Artificial polymer materials	25616	62,95	2562
3.	Rubber	681	1,67	68
4.	Cloth/Textile	744	1,83	74
5.	Paper/	5359	13,17	536
6.	Processed wood	4802	11,80	480
7.	Metal	2342	5,76	234
8.	Glass/ceramics	992	2,44	99
9.	Unidentified	156	0,38	16
10.	Number of monitored beaches	10	100	-

In order to calculate Marine Litter Density Index (MLDI) correctly, beside the data presented above and in appendix 1 and appendix 2, the exact territory where ML monitoring was conducted is essential. Regarding the ten beaches, subject to national monitoring of D10C1 (according MSFD) the area of each 100-m section was calculated, based on official information, using remote methods, specialized licensed software and satellite images. The areas of others beach sections monitored/cleaned up within the target area are identified based on Marin LitterWatch datasets. Regarding beaches monitored in 2019 in the frames of RedMarLitter project the 100-m sections areas were measured directly on site. For these 3 beaches together with the measurement on site, remote methods for determination of the studied sections' area were applied. The deviation in the results obtained by both methods were in the range of acceptable GPS error. The results of this comparison gave us confidence to use both data (from direct measurements on site and from remote method and measurement) in current analysis, aiming identification of hot spots of littering in target area.

Identified areas in m^2 by beaches are as follows: beach "Durankulak North" - 8345,9 m^2; beach "Krapets"- 11550,20 m^2; Channel 2 - "Varna lake - Black Sea" - 1680,09 m^2; beach Shkorpilovtsi -north" - 10177,3 m^2; beach "Byala - Karadere"- 7459,70m^2; beach "Obzor - childrens' camps"- 5346,9m^2; beach "Irakli" - 9385,4m^2; beach "Black sea saltpans" - 5420,5m^2; beach Alepu"- 14051 m^2; beach "River Veleka mouth" - 5514,6m^2; beach "Kamchya" (next to River Kamchiya mouth) - 3846 m^2 ; beach Kamchiyski pyasatsi" - 3846 m^2; beach Ropotamo - 3130 m^2; beach Garden camping - 4292,4 m^2; beach Beach "Black sea saltpans North" - Burgas- 5340m^2; beach Vromos Bay" - 3024,075m^2; beach „Alepu" between "Dyuni" resort and "Dyuni South"- 11453,3 м².

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Calculation of MLDI.

Marine Litter density Index (MLDI) was calculated for each of the above described zones using the formula:

$$MLDI = D_{av}\,K,$$

Due to the significant differences in monitoring frequency, number of campaigns per year within the beaches where the survey was conducted the **MLDI was calculated by year by beach for the period 2015-2019**. All the results are presented in tables 15, 16 and 17.

The **MLDI results** varied from 0,45 to 64,44. The lowest value is registered for Alepu beach (subject of national ML monitoring) in 2016 and the highest MLDI value corresponds to Channel 2 - "Varna lake - Black Sea" in 2017. During the whole period of survey the Channel 2 - "Varna lake - Black Sea" shows the highest MLDI in comparison to other monitored sites**.** In 2016 this coastline site's MLDI was 7,01, but science 2017 the MLDI values raise up over 20 (64,44 in 2017, 40,73 in 2018г. and 23,96 in 2019).

The MLDI varies strongly not only by beaches, but and by years. 2016 is the year with lowest values of the index on almost every monitoring site. Probably it is due to the fact that in 2016 is conducted only one monitoring campaign in spring season. The highest MLDI for 9 of 10 beaches were calculated for 2017.

The 2017th peak most probably is related to the lack of survey in summer season of 2016 and respectively the extended period for ML accumulation along the coast, followed by increased number of monitoring campaigns to 3 seasonal campaigns in 2017. This is the year marked by significant an overall increase in the values of the index compared to the previous year. For example, MLDI for beach Durankulak North increase from 1,5 in 2015 and 0,62 in 2016 to 8,68 in 2017; for Shkorpilovtsi -north - from 1,25 in 2015 and 0,62 in 2016 to 5,92 in 2017.

With 3 seasonal surveys in 2017 and 4 monitoring campaigns in 2018 and 2019 the index values show overall decrease in 2018, excluding beach "River Veleka mouth" (MLDI 2,72 in 2017 and 3,27 in 2018).

Table 15. MLDI by beaches, subject to the national ML monitoring, 2015- 2019

№	Beach / coastline	MLDI by year				
		2015	2016	2017	2018	2019
1.	Beach "Durankulak North"	1,50	0,62	8,68	1,04	1,42
2.	Beach "Krapets"	1,38	0,40	2,85	1,63	1,74
3.	Channel 2 - "Varna lake - Black Sea"	7,47	7,01	64,44	40,73	23,96
4.	Beach "Shkorpilovtsi -north"	1,25	0,62	5,92	2,48	1,80
5.	Beach "Byala - Karadere"	na*	na	5,94	2,26	2,43
6.	Beach "Obzor - childrens' camps"	1,44	1,68	9,23	4,39	3,35
7.	Beach "Irakli"	1,24	2,63	4,25	3,18	1,42
8.	Beach "Black sea saltpans" - Burgas	2,20	1,97	3,37	3,51	2,51
9.	Beach „Alepu"	0,99	0,45	2,32	1,18	1,93
10.	Beach "River Veleka mouth"	na	na	2,72	3,27	1,82

na – not applicable

For 2015 6 from 8 beaches subject to the national coastal marine litter monitoring are classified as *unloaded* (with MLDI under 2 and marked in blue): beach Durankulak North, beach "Krapets", beach Shkorpilovtsi -north", beach "Obzor - childrens' camps", beach "Irakli" and beach "Alepu". One beach - beach "Black sea saltpans" is rated as *low loaded* with MLDI between 2 and 5 (marked in green) and one beach - Channel 2 - "Varna lake - Black Sea" is *moderate loaded* with corresponding MLDI value between 5 and 10 (marked in yellow according to the evaluation scale).

For 2016 6 beaches are *unloaded* (with MLDI under 2 and marked in blue): beach Durankulak North, beach "Krapets", beach Shkorpilovtsi -north", beach "Obzor - childrens' camps", beach "Black sea saltpans" and beach "Alepu". One beach - beach "Irakli" is classified as *low loaded* with MLDI between 2 and 5 (marked in green) and one beach - Channel 2 - "Varna lake - Black Sea" is *moderate loaded* with corresponding MLDI value between 5 and 10 (marked in yellow).

In 2017 a drastic change regarding beach littering was registered. None of the studies sites can be classified as *unloaded*. Half of the beaches – 5 were rated as *low loaded* with MLDI between 2 and 5 (marked in green): beach "Krapets", beach "Irakli", beach "Black sea saltpans", beach "Alepu" and beach "River Veleka mouth". The following 4 beaches: beach Durankulak North, beach Shkorpilovtsi -north", beach "Byala - Karadere" and beach "Obzor - childrens' camps" are classified as *moderate* loaded. Extremely/ *critical* load shows beach Channel 2 - "Varna lake - Black Sea".

For 2018 3 beaches are *unloaded*: "Durankulak North", beach "Krapets" and beach Alepu. As *critical* loading is recorded Channel 2 - "Varna lake - Black Sea". The majority of beaches – the rest 6 are categorized al *low* loaded

For 2019 an improvement is at hand and 6 sites are categorized as *unloaded***,** 3 as *low loaded* (beach "Byala - Karadere", beach "Obzor - childrens' camps" and "Black sea saltpans"). Channel 2 - "Varna lake - Black Sea" remains critically loaded.

The monitoring sites, where ML monitoring was conducted **within RedMarLitter project** in 2019 show different level of littering (table 11).

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Beach "Black Sea saltpans North" - Burgas**,** situated next to beach "Black sea saltpans" (subject of national monitoring) is rated as *moderate loading* with corresponding MLDI value of 8,19. The state of *beach Vromos bay* raises serious concern. The beach is initially categorized *heavily loaded* (**MLDI** 11,35), although in 2019 before the first monitoring campaign the site has been cleaned. Beach „Alepu" between "Dyuni" resort and "Dyuni South" is assessed as *low* loaded

Table 16. MLDI by beaches monitored within the RedMar Litter project, 2019

№	Beach / coastline	MLDI by year				
		2015	2016	2017	2018	2019
1.	Beach "Black sea saltpans North" - Burgas	na*	na	na	na	8,19
2.	Beach "Vromos Bay"	na	na	na	na	11,35
3.	Beach „Alepu" between "Dyuni" resort and "Dyuni South"	na	na	na	na	3,26

na – not available

Table 17. MLDI for other beaches within the target area according EEA (MLW) data, 2015-2018

№	Beach / coastline	MLDI by year				
		2015	2016	2017	2018	2019
1.	Beach "Kamchya" (next to River Kamchiya mouth)	5,14	na**	na	2,12	na
2.	Beach "Kamchiyski pyasatsi"	2,98	na	na	1,84	na
3.	Beach Ropotamo	na	na	1,02	2,29	na
4.	Beach Garden camping	0,74	na	na	na	na

**na – not available*

The result regarding other beaches within the target area, based on EEA (MLW) data for the period 2015-2018 are sporadic but do not rise particularly concerning. **For 2015** one beach is classified as *unloaded* (beach Garden camping), which may also be due to the informal stewardship of the beach; one is classified as low loaded site beach Kamchiyski pyasatsi and one is with *moderate loading* - beach "Kamchya" (next to River Kamchiya mouth). **For 2016** Ropotamo beach shows as *unloaded*, in **2017** – as *low* loaded. For 2018 beach "Kamchiyski pyasatsi" is rated as *unloaded* when "Kamchya" (next to River Kamchiya mouth) - as *low* loaded.

4.5.   Identified hot spots of the target area

The following considerations have been taken into account to determine an area as a hotspot:

• **With reference to the target area, when marine litter density index (MLDI) of a certain territory is higher than 20 then this site is determined as a hot spot of ML pollution.**

• **With reference to the target area, when MLDI of a certain territory is within the interval 10÷20, observed twice per year (on annual bases) in different seasons, then this site is determined as a hot spot of ML pollution.**

• **With reference to the target area, when MLDI of a certain territory is within the interval 10÷20, observed only within one monitoring campaign (especially if this monitoring is for the first time), then this site <u>cannot be</u> firmly considered as a hot spot of ML pollution.** The reason is   the uncertainty of ML accumulation period, and the ML accumulation rate. Subsequent monitoring and further analysis will be required for such areas.

On the basis of the general analysis regarding beach ML accumulation and distribution of floating ML on the sea surface in the target area; the Interim Report main findings and conclusions of the general analyses; this extended assessment including 2019 (presented above), as well as the scale offered for evaluation of ML loadings on the target area, the following conclusions have been drawn about ML hotspots:

<u>Hot spots of solid ML pollution in the target area are:</u>

1.   **Channel 2 - "Varna lake - Black Sea"** (MLDI - 64,44 in 2017; 40,73 in 2018 and 23,96 in 2019)

2.   **Beach "Vromos Bay"** (MLDI - 11,35 in 2019 conducted through all 3 seasonal campaigns and on the basis of previous non- institutional cleanup campaign in the same year)

Three of the beaches among all in the target area, showing <u>moderate loadings - MLDI > 8 are:</u>

1.   **Beach "Obzor - childrens' camps"** (MLDI - 9,23 in 2017, but the MLDI values in 2019 and 2019 are varying from 2 to 5)

2.   **Beach "Durankulak North"** ((MLDI - 8,68 in 2017, but the MLDI values in 2018 and 2019 are not higher than 2.)

3.   **Beach "Black sea saltpans - North" - Burgas** (MLDI - 8,19 in 2019, but the monitoring of this beach was conducted for the first time)

5. DEVELOPMENT OF A DIGITAL VIRTUAL NETWORK FOR REPORTING BY AN INNOVATIVE METHOD OF THE LOAD OF THE MARINE ENVIRONMENT WITH SOLID WASTE.

The proposal for the development of a digital virtual network is based on the transverse conformal cylindrical projection of Mercator (UTM) and the OSPAR commission's guide to monitoring marine litter on beaches.

The projection is more popular with the abbreviation UTM (Universal Transvers Mercator). Used to compile private nautical charts and navigation plans. In the UTM projection, the Earth is divided along the meridians into 60 six-degree zones (60 x 6° = 360°). Their numbering starts from the 180 ° meridian in the West with Arabic numerals from 1 to 60. Along the parallels the Earth is divided into 20 eight-degree bands, denoted by capital letters of the English alphabet from (C) to (X). An exception is the last 20th northern belt (X), which is 12 ° wide. The letters (A) and (B) are used for the Antarctic region and (Y) and (Z) for the Arctic region. To avoid errors, the letters (I) and (O) are excluded from the marking system (Fig.7). Coordinates are measured in meters.

The design is done in zones on the walls of a transverse cylinder. The earth is crossed by the cylinder in two lines (AB) and (DE), equidistant from the axial (middle) meridian (MR) of the projected area (Fig. 7).

Fig. 7 UTM projection

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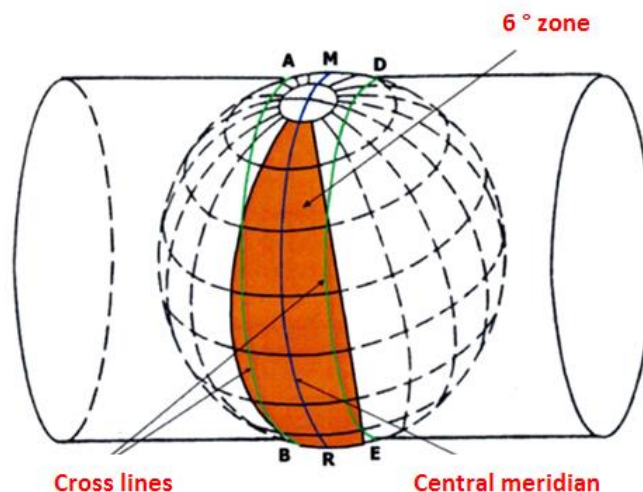
The scale along the axial meridian (MR) is equal to M = 0.9996, and along the two lines of the section (AB) and (DE) is M = 1. The deformations due to the change of the scale are within the geographical accuracy of the maps and cannot to be noticed by their users (Fig. 8).
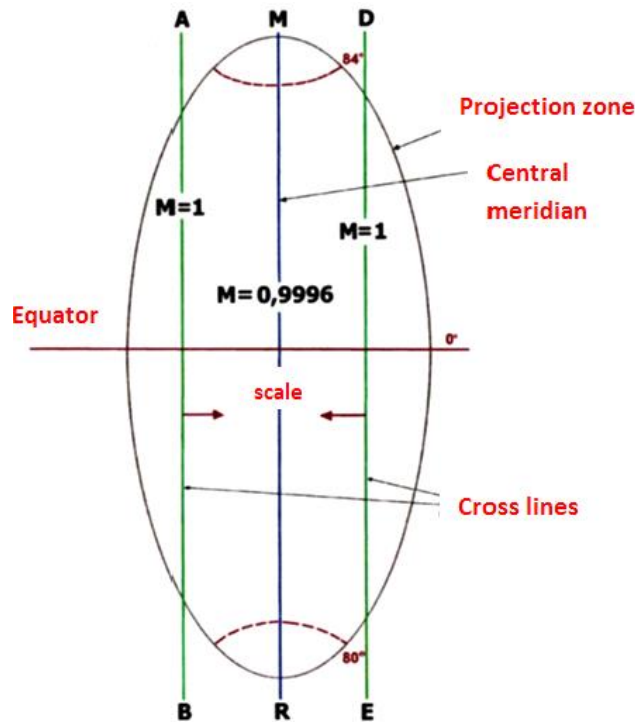
Fig. 8 Scale distribution in the projected area in UTM projection
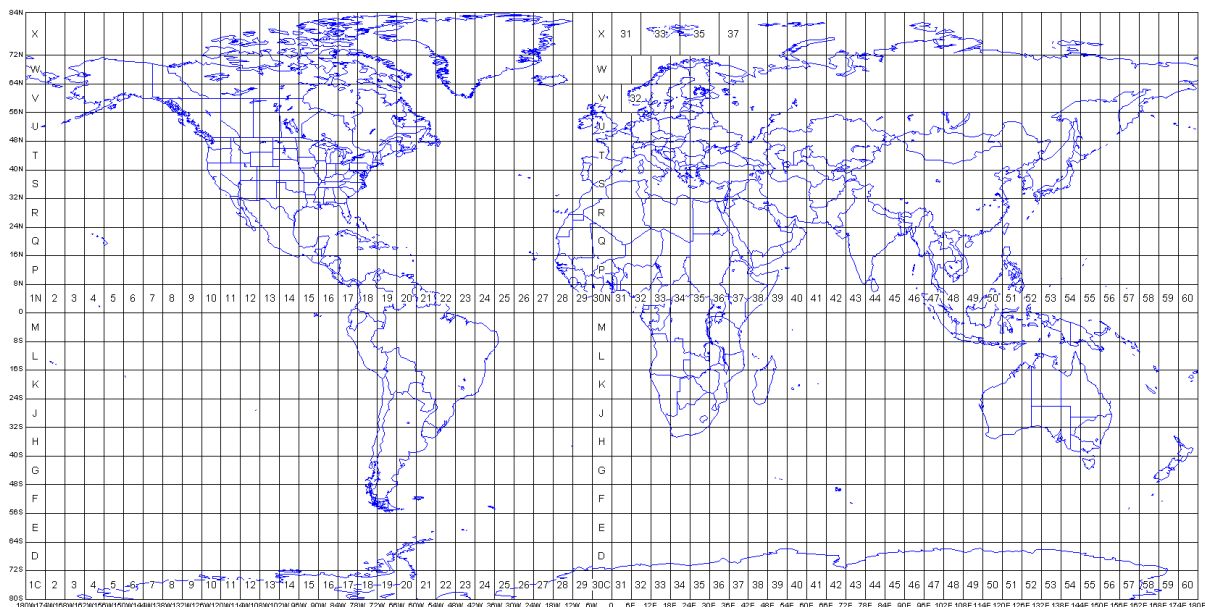
Fig. 9 UTM projection zone and zone marking system

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Figure 9 shows that the Republic of Bulgaria falls in UTM zones 34T and 35T, as the coastal zone is only in UTM zone 35T.

In addition, the fact is taken into account that in almost all geographic information systems, software applications and platforms for processing and visualization of georeferenced data there is an automatic transformation of coordinates from Lat / Lon [°] to UTM [m] and vice versa.

In this regard, it is proposed to develop and implement a virtual network with cell sizes close to 1 x 1 km, corresponding to the principles of monitoring of sea beaches, set out in the Guideline for Monitoring of Marine Waste on Beaches of the OSPAR Commission (Guideline for Monitoring Marine Litter on the Beaches in the OSPAR Maritime Area), where a survey of 100-meter sections of 1000-meter sections of sea beaches is applied (Fig. 10).

Fig. 10 Schematic diagram for monitoring of sea beaches according to the Guideline for monitoring marine litter on the beaches in the OSPAR maritime area

For the purposes of reporting the load of marine litter on the beaches of the Republic of Bulgaria, a virtual reference network is created within the UTM zone 35T with a starting point - a point with coordinates 40 ° N and 24 ° E and cell size 30 seconds, which is ½ marine mile or approximately 900 meters. (see Fig. 11)

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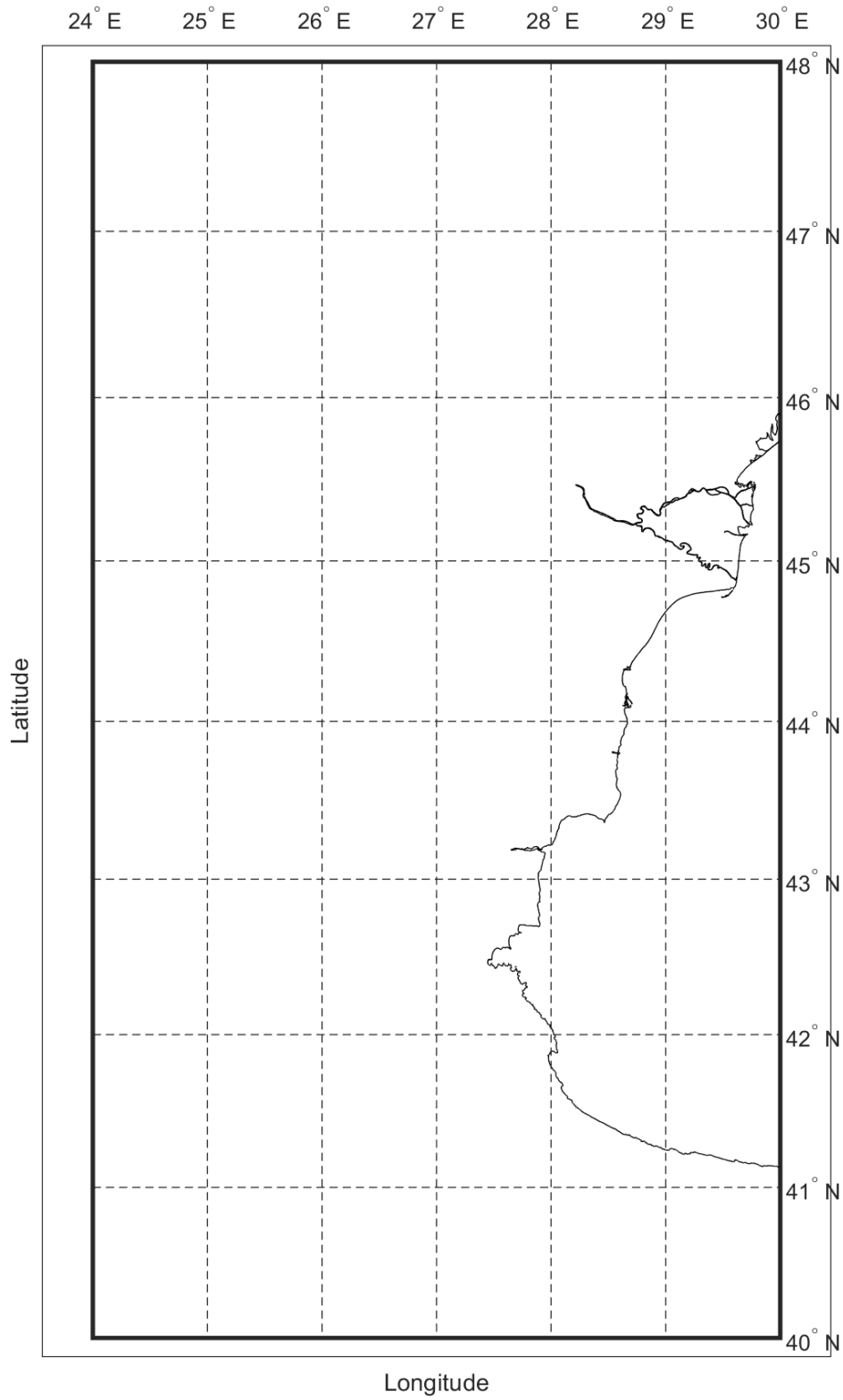
Fig. 11 UTM zone 35T

The virtual reference network created in this way also covers the beaches of the Republic of Romania - a partner in the RedMarLitter project.

The virtual reference network created in this way also covers the beaches of the Republic of Romania - a partner in the RedMarLitter project.

This approach allows the application of the virtual network on a global scale, not only in coastal areas, but also on the high seas and on land, such as accounting for the load of solid waste on the banks / pages of the Danube. The Black Sea additionally falls into UTM zones 36T and 37T, for which a virtual network for reporting the load of solid waste can also be developed.

Figure 12 shows a section of the virtual network of UTM zone 35T (depicted in yellow), mainly covering the coastal zone of the Republic of Bulgaria.
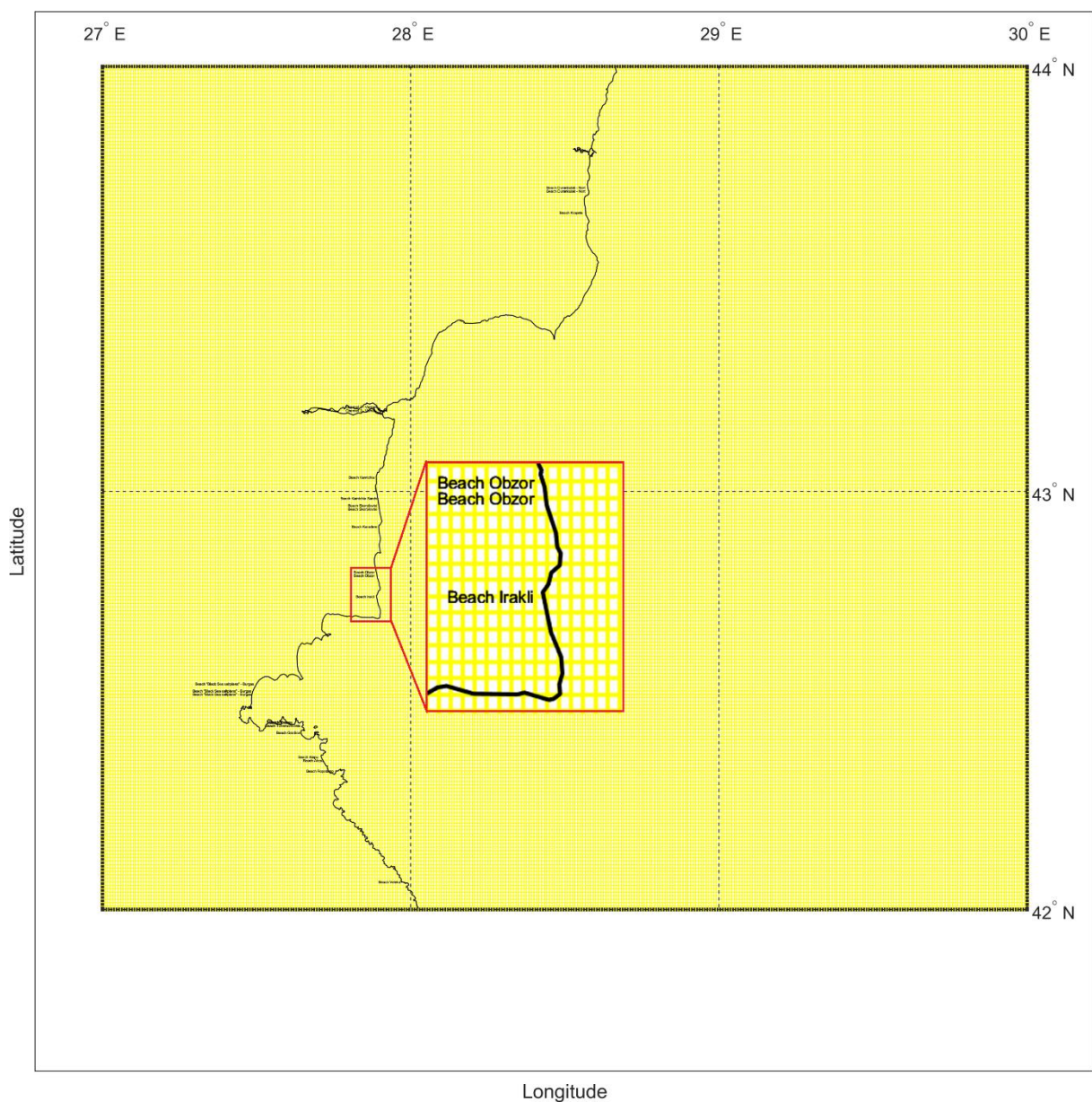
Fig. 12 Virtual network of the coastal zone of the Republic of Bulgaria

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Depending on the geographical coordinates and spatial orientation of the 1000 meter monitoring area according to the OSPAR Commission's Marine Waste Monitoring Guide, marine litter monitoring best practices and the above-mentioned guidance documents, it may turn out that that the section falls into two or more cells of the virtual network. In this case, the data from the conducted monitoring are displayed in the cell in which the coordinates of the 100-meter section, within which the monitoring of the marine waste was carried out, fall. (see Fig. 13)
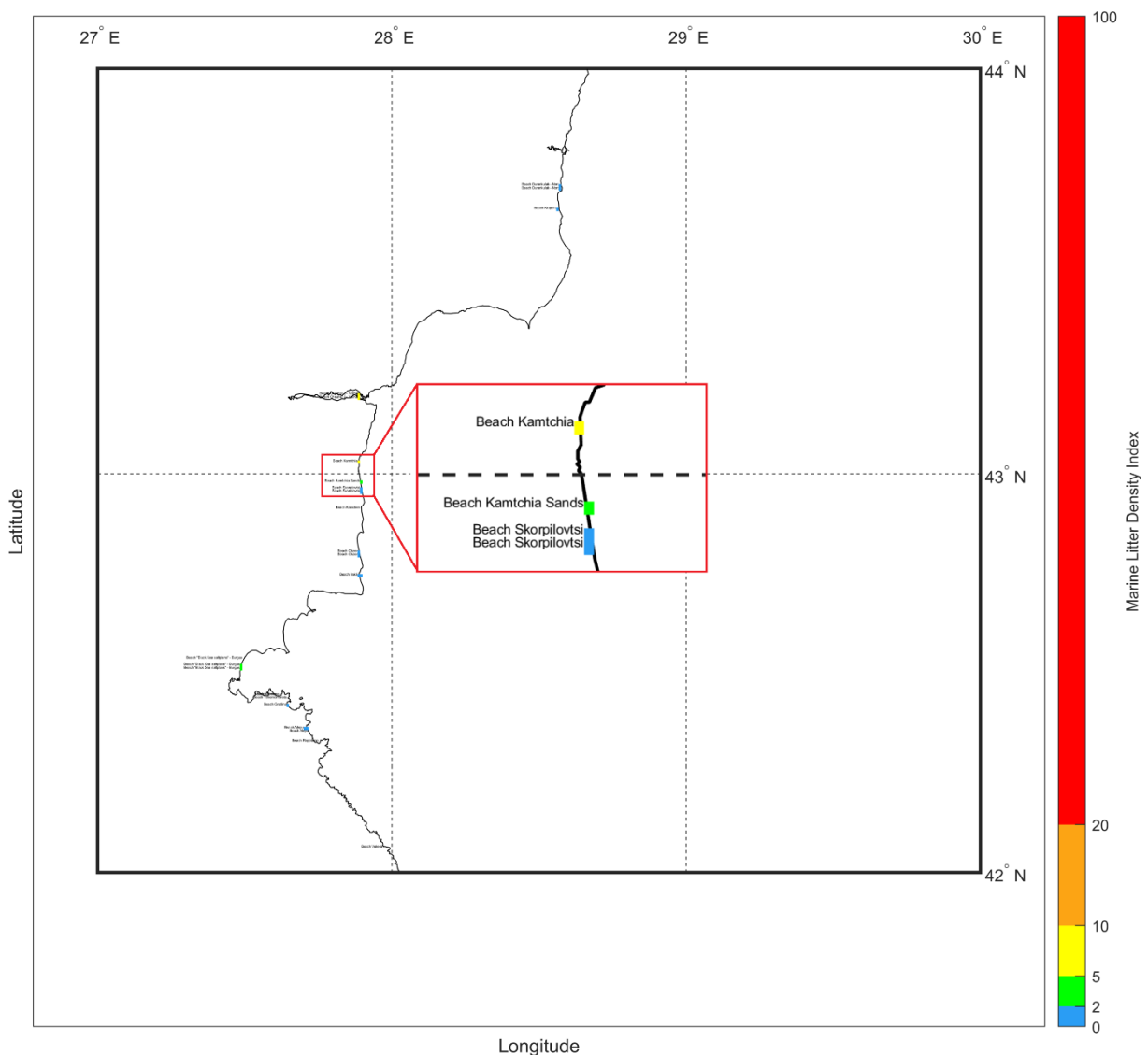
Fig. 13 Virtual network of the coastal zone of the Republic of Bulgaria with data from the monitoring of marine litter deposited along the coast and Marine Litter Density Index (MLDI)

Additionally, for the purposes of reporting the data of the project partner from the Republic of Georgia, a digital virtual network has been developed for reporting by an innovative method of loading the marine environment with solid waste for UTM zone 37T with starting point - point with coordinates 40°N and 36°E and cell dimensions 30 seconds.
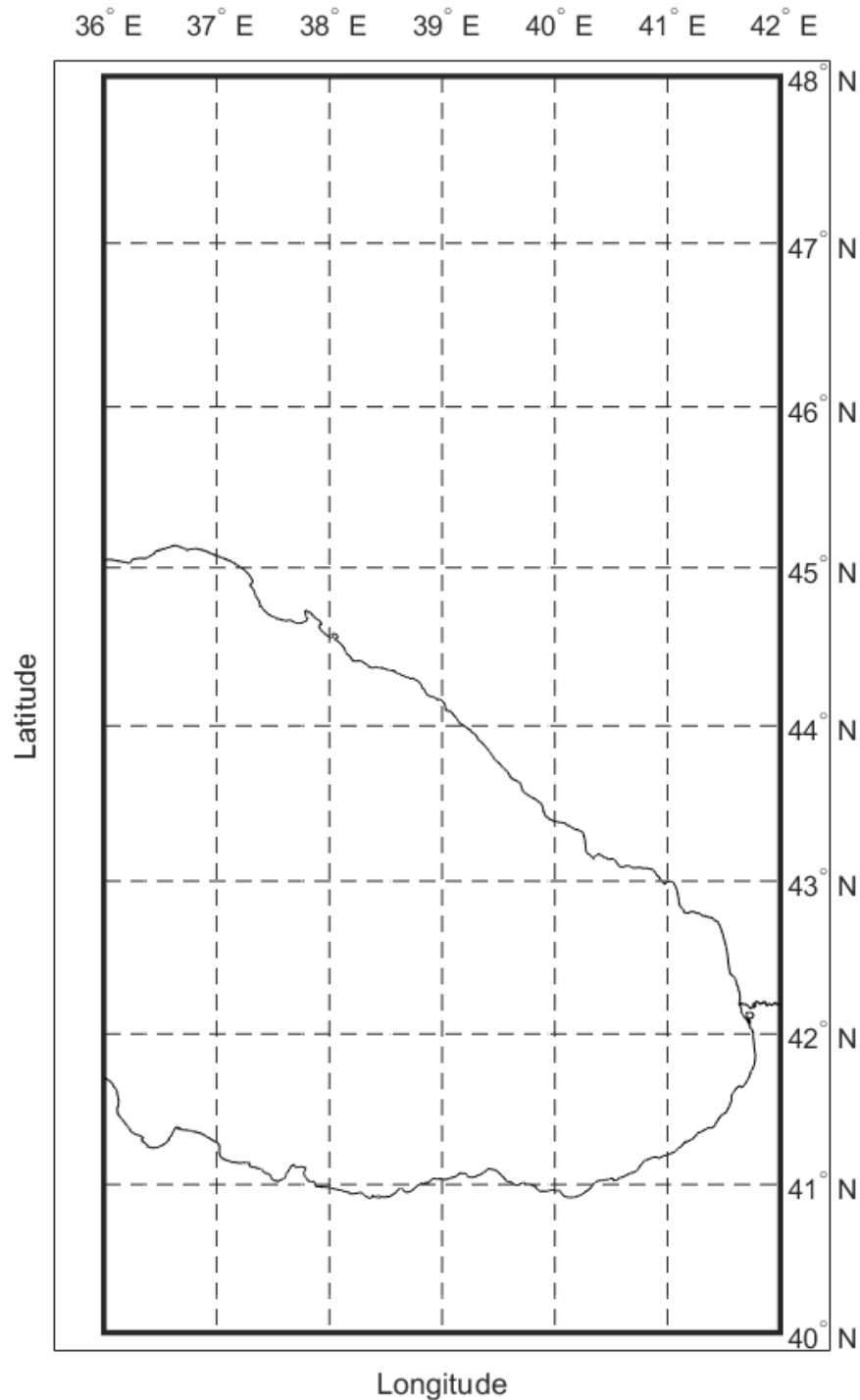
Fig. 14 UTM zone 37T

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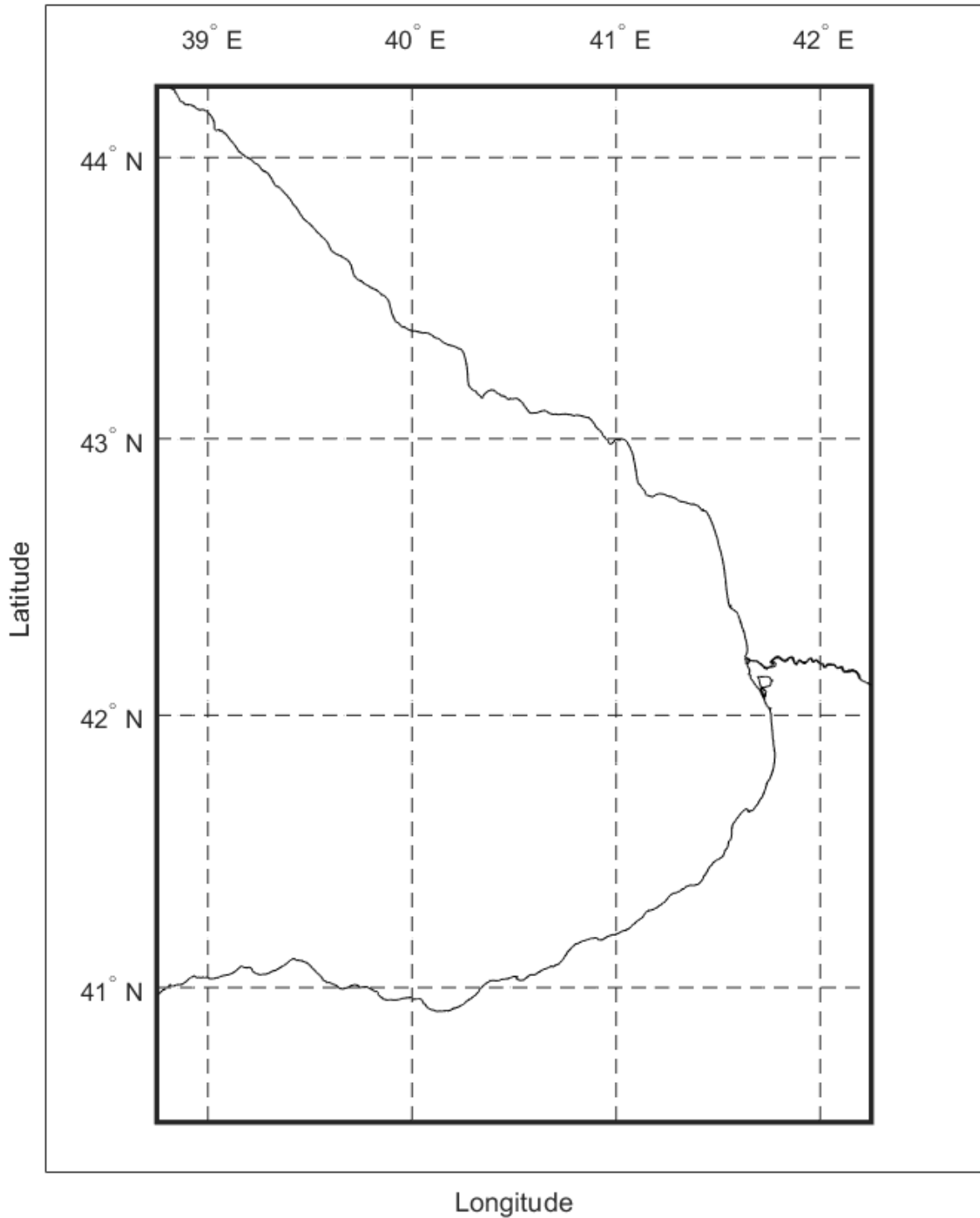
Fig. 15 Virtual network of the coastal zone of the Republic of Georgia

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Advantages of the proposed virtual network for reporting the load of sea beaches with solid waste according to the OSPAR Commission's Guideline for Monitoring Marine Litter on the Beaches in the OSPAR Maritime Area:

• Applicability on a global, regional and local scale;

• Applicability both for Moscow beaches and in the open sea and on land;

• Ability to integrate with other types of data (sea and air currents, digital terrain model, bathymetric data, etc.);

• Ability to quickly resize when needed.

This virtual network is also used for the implementation of position 2 of the public procurement with subject "Selection of contractor for identification of hot spots and modeling of the distribution of solid marine litter distribution in the target area (Bulgarian Black Sea coast)".

6. PRESENTATION OF THE IDENTIFIED HOTSPOTS WITH GEOREFERENCED MAP MATERIAL

Identified marine litter hotspots on the target area are presented on georeferenced maps. The maps are shown below (see fig. 16, 17 and 18). Figure 16 shows the information for year 2017, figure 17 – for 2018 and figure 18 – for 2019. Additionally, surface currents are visulised on figures as follows: 2017 – August, 2018 – September, 2019 – September.

Fig. 16. Presentation of Marine litter hotspots on the target area – georeferenced map with MLDI and sea currents, August 2017

Nikola Vaptsarov Naval Academy - Scientific Department
West Black Sea Currents (cm/s) on H = 2.50 m for 2018-09
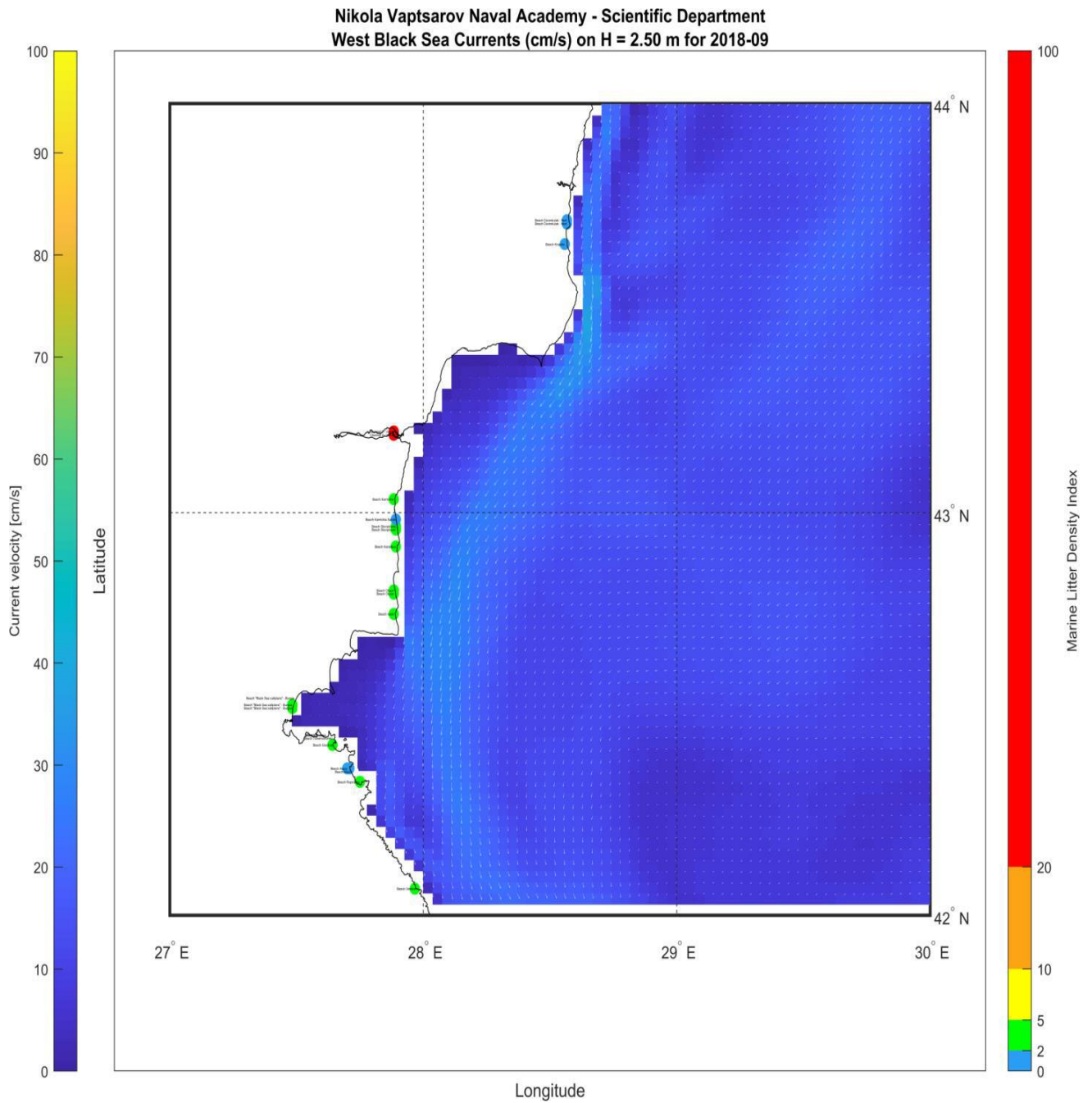
Fig. 17. Presentation of Marine litter hotspots on the target area – georeferenced map with MLDI and sea currents, September 2018
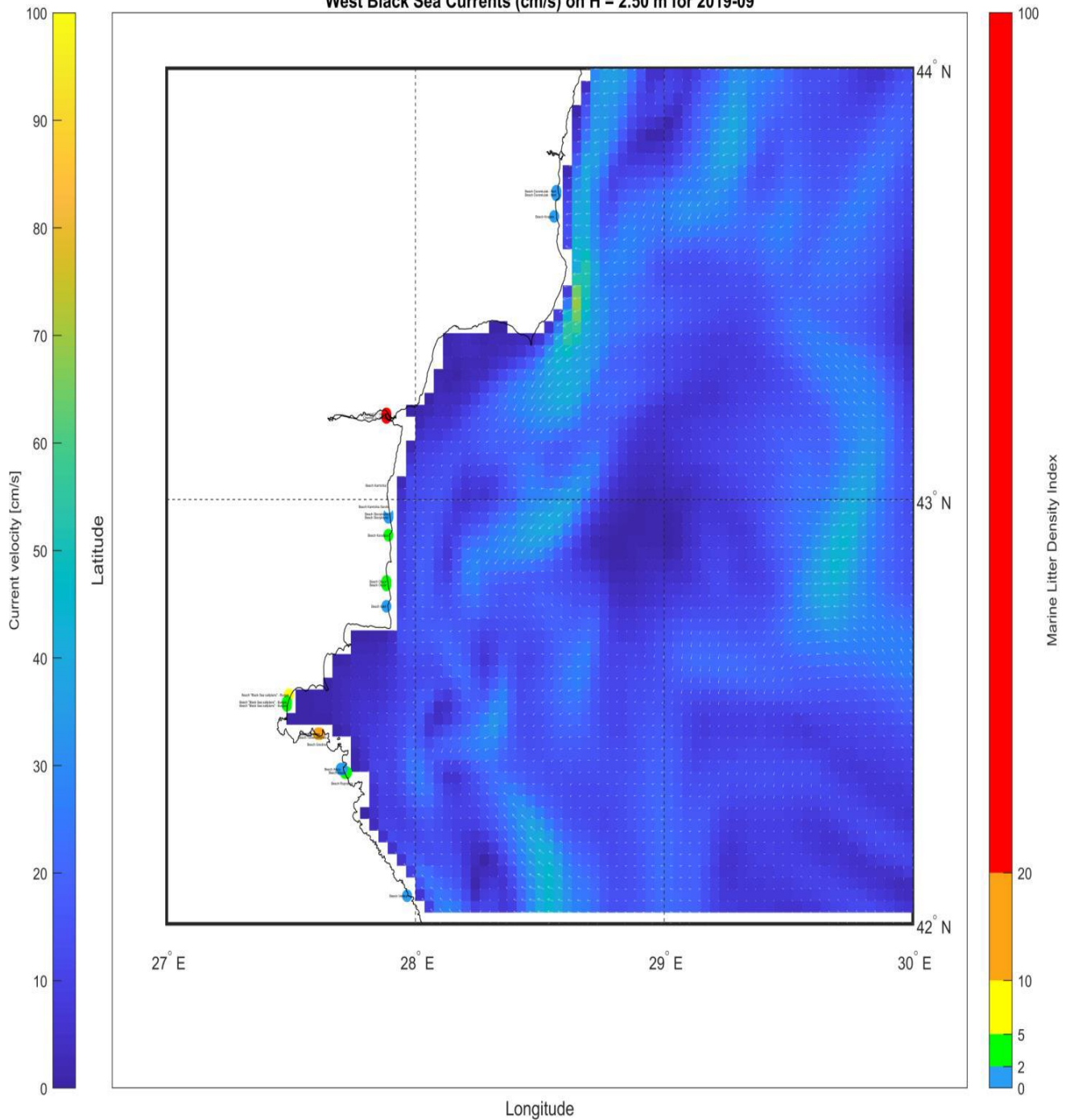
Fig. 18. Presentation of Marine litter hotspots on the target area – georeferenced map with MLDI and sea currents, September 2019

7. VALIDATION

All data used to perform the tasks are obtained from institutions - reliable sources of information. The requirements of the guiding documents and the good practices indicated in item 1 of this report have been complied with. The data from the environmental monitoring of marine litter conducted within the RedMarLitter project have been validated.

The information is calibrated and validated for standardized quality, thus ensuring the compatibility and coherence of the data and creating conditions for the deployment of a virtual network, for registrating the load of marine litter through computer modeling of the areas for which information is collected and there is an indication for significant pollution due to anthropogenic load.

8. PUBLICATION OF THE IDENTIFIED HOTSPOTS IN THE OPEN DATABASE OF THE PROJECT

Georeferenced maps reflecting the identified ML hotspots are presented in electronic form so that they can be published on the project website.

The data for the identified ML hotspots (geographical coordinates and description) are prepared in a form allowing integration in the open project database (https://map.redmarlitter.eu/bg/database/) in the specified format (using downloaded from the website format examle) via the interface for manual entry of waste data in the project database at the Internet address (https://map.redmarlitter.eu/bg/profil-tablo/rchno-dobaviane/otpadtsi) or by import using a *.xlsx file.

The file for importation (.xlsx) is attached to appendix 4.

This report has been prepared by "N. Vaptsarov" Naval Academy under public procurement with subject "Selection of contractor for identification of hot spots and modeling of marine litter distribution in the target area (Bulgarian Black Sea coast)", position 1 "Identification of hot spots of marine litter pollution in the target area" with assignor VIA PONTICA Foundation.

9. APPENDIXES

9.1. Appendix 1 "Identification of hot spots of marine litter pollution in the target area" - ML by main categories of material by beaches subject to national ML monitoring, 2015-2019

Identification of hot spots of marine litter pollution in the target area

Table 1. ML by main categories of material by beaches subject to national ML monitoring, 2015-2019

I.	Beach Durankulak North 1										
№	Year	2015		2016		2017		2018		2019	
	Indicator	Total count/ year	Aver. Count/ campaign	Total count/ year	Aver. Count/ campaign	Total count/ year	Aver. Count/ campaign	Total count/ year	Aver. Count/ campaign	Total count/ year	Aver. Count/ campaign
		nos.	nos.	nos.	nos.	nos.	nos.	nos.	nos.	nos.	nos.
1	Total ML	1940	647	263	263	11782	3927	1964	491	2507	627
2	Artificial polymer materials	1720	573	226	226	8297	2766	1158	290	1659	415
3	Rubber	14	5	3	3	224	75	51	13	24	6
4	Cloth/Textile	27	9	0	0	149	50	74	19	33	8
5	Paper/ cardboard	105	35	10	10	1200	400	238	60	296	74
6	Processed wood	20	7	4	4	657	219	180	45	321	80
7	Metal	37	12	18	18	708	236	167	42	100	25
8	Glass/ceramics	17	6	0	0	502	167	91	23	66	17
9	Unidentified	0	0	2	2	45	15	5	1	8	2
10	Number of monitoring campaigns	3	1	1	1	3	1	4	1	4	1

Common borders. Common solutions

II.		Beach Krapets									
№	Year	**2015**		**2016**		**2017**		**2018**		**2019**	
	Indicator	Total count/ year	Aver. Count/ campaign	Total count/ year	Aver. Count/ campaign	Total count/ year	Aver. Count/ campaign	Total count/ year	Aver. Count/ campaign	Total count/ year	Aver. Count/ campaign
		nos.	nos.	nos.	nos.	nos.	nos.	nos.	nos.	nos.	nos.
1	Total ML	**2532**	844	250	250	5624	1875	4079	1020	4180	**1045**
2	Artificial polymer materials	2186	729	214	214	3575	1192	2558	640	2678	**670**
3	Rubber	21	7	2	2	213	71	74	19	55	**14**
4	Cloth/Textile	43	14	2	2	107	36	107	27	48	**12**
5	Paper/ cardboard	135	45	6	6	830	277	437	109	459	**115**
6	Processed wood	13	4	3	3	223	74	426	107	655	**164**
7	Metal	57	19	9	9	317	106	337	84	226	**57**
8	Glass/ceramics	75	25	13	13	341	114	122	31	56	**14**
9	Unidentified	2	1	1	1	18	6	18	5	2	**1**
10	Number of monitoring campaigns	3	1	1	1	3	1	4	1	4	1

Common borders. Common solutions

III.	Chanel 2 "Varna lake- Black Sea" (new chenal)									
№	Year	2015		2016		2017		2018		2019	
	Indicator	Total count/ year	Aver. Count/ campaign	Total count/ year	Aver. Count/ campaign	Total count/ year	Aver. Count/ campaign	Total count/ year	Aver. Count/ campaign	Total count/ year	Aver. Count/ campaign
		nos.	nos.	nos.	nos.	nos.	nos.	nos.	nos.	nos.	nos.
1	Total ML	**2055**	685	646	646	17413	5804	11295	3765	8767	**2192**
2	Artificial polymer materials	1482	494	496	496	11083	3694	6979	2326	5253	**1313**
3	Rubber	0	0	8	8	260	87	277	92	178	**45**
4	Cloth/Textile	117	39	29	29	392	131	289	96	179	**45**
5	Paper/ cardboard	338	113	63	63	2747	916	1689	563	1472	**368**
6	Processed wood	1	0	11	11	862	287	531	177	674	**169**
7	Metal	61	20	19	19	1548	516	1065	355	651	**163**
8	Glass/ceramics	54	18	20	20	490	163	403	134	326	**82**
9	Unidentified	2	1	0	0	31	10	62	21	34	**9**
10	Number of monitoring campaigns	3	1	1	1	3	1	3	1	4	1

Common borders. Common solutions

IV.		Beach Schkorpilovtsi- North									
№	Year	2015		2016		2017		2018		2019	
	Indicator	Total count/ year	Aver. Count/ campaign	Total count/ year	Aver. Count/ campaign	Total count/ year	Aver. Count/ campaign	Total count/ year	Aver. Count/ campaign	Total count/ year	Aver. Count/ campaign
		nos.	nos.	nos.	nos.	nos.	nos.	nos.	nos.	nos.	nos.
1	Total ML	1965	655	335	335	9889	3296	5544	1386	3824	956
2	Artificial polymer materials	1780	593	305	305	6561	2187	3633	908	2487	622
3	Rubber	11	4	2	2	195	65	139	35	23	6
4	Cloth/Textile	11	4	5	5	218	73	100	25	66	17
5	Paper/ cardboard	87	29	1	1	1361	454	554	139	493	123
6	Processed wood	3	1	3	3	559	186	390	98	461	115
7	Metal	37	12	5	5	557	186	463	116	218	55
8	Glass/ceramics	35	12	14	14	395	132	228	57	66	17
9	Unidentified	1	0	0	0	88	29	37	9	10	3
10	Number of monitoring campaigns	3	1	1	1	3	1	4	1	4	1

Common borders. Common solutions

V.	Beach Byala- Karadere									
№	Year	**2015**		**2016**		**2017**		**2018**		**2019**	
	Indicator	Total count/ year	Aver. Count/ campaign	Total count/ year	Aver. Count/ campaign	Total count/ year	Aver. Count/ campaign	Total count/ year	Aver. Count/ campaign	Total count/ year	Aver. Count/ campaign
		nos.	nos.	nos.	nos.	nos.	nos.	nos.	nos.	nos.	nos.
1	Total ML	Na*	na	na	na	7216	2405	3661	915	3861	**965**
2	Artificial polymer materials	na	na	na	na	4359	1453	2217	554	2531	**633**
3	Rubber	na	na	na	na	127	42	69	17	56	**14**
4	Cloth/Textile	na	na	na	na	121	40	86	22	74	**19**
5	Paper/ cardboard	na	na	na	na	1036	345	440	110	499	**125**
6	Processed wood	na	na	na	na	373	124	418	105	355	**89**
7	Metal	na	na	na	na	875	292	298	75	235	**59**
8	Glass/ceramics	na	na	na	na	289	96	108	27	95	**24**
9	Unidentified	na	na	na	na	36	12	25	6	16	**4**
10	Number of monitoring campaigns	na	na	na	na	3	1	4	1	4	1

Common borders. Common solutions

VI.		Beach Obzor – Children's camps									
№	Year	2015		2016		2017		2018		2019	
	Indicator	Total count/ year	Aver. Count/ campaign	Total count/ year	Aver. Count/ campaign	Total count/ year	Aver. Count/ campaign	Total count/ year	Aver. Count/ campaign	Total count/ year	Aver. Count/ campaign
		nos.	nos.	nos.	nos.	nos.	nos.	nos.	nos.	nos.	nos.
1	Total ML	**1275**	425	489	489	8023	2674	5105	1276	3893	**973**
2	Artificial polymer materials	935	312	408	408	5002	1667	2862	716	2418	**605**
3	Rubber	29	10	8	8	223	74	102	26	140	**35**
4	Cloth/Textile	24	8	11	11	149	50	98	25	56	**14**
5	Paper/ cardboard	160	53	17	17	1363	454	658	165	456	**114**
6	Processed wood	11	4	7	7	568	189	725	181	507	**127**
7	Metal	47	16	16	16	469	156	452	113	206	**52**
8	Glass/ceramics	56	19	18	18	227	76	162	41	80	**20**
9	Unidentified	3	1	4	4	22	7	46	12	30	**8**
10	Number of monitoring campaigns	3	1	1	1	3	1	4	1	4	1

Common borders. Common solutions

VII.		Beach Irakli										
№	Year	2015		2016		2017		2018		2019	
	Indicator	Total count/ year	Aver. Count/ campaign	Total count/ year	Aver. Count/ campaign	Total count/ year	Aver. Count/ campaign	Total count/ year	Aver. Count/ campaign	Total count/ year	Aver. Count/ campaign
		nos.	nos.	nos.	nos.	nos.	nos.	nos.	nos.	nos.	nos.
1	Total ML	1822	607	1278	1278	6477	2159	6365	1591	2914	729
2	Artificial polymer materials	1586	529	1177	1177	4380	1460	3662	916	1771	443
3	Rubber	6	2	12	12	125	42	138	35	57	14
4	Cloth/Textile	31	10	14	14	103	34	106	27	66	17
5	Paper/ cardboard	111	37	25	25	833	278	658	165	409	102
6	Processed wood	0	0	20	20	281	94	1187	297	267	67
7	Metal	49	16	12	12	488	163	457	114	212	53
8	Glass/ceramics	35	12	18	18	249	83	121	30	119	30
9	Unidentified	4	1	0	0	18	6	36	9	13	3
10	Number of monitoring campaigns	3	1	1	1	3	1	4	1	4	1

Common borders. Common solutions

VIII.	Beach Black Sea saltpans - Burgas										
№	Year	2015		2016		2017		2018		2019	
	Indicator	Total count/ year	Aver. Count/ campaign	Total count/ year	Aver. Count/ campaign	Total count/ year	Aver. Count/ campaign	Total count/ year	Aver. Count/ campaign	Total count/ year	Aver. Count/ campaign
		nos.	nos.	nos.	nos.	nos.	nos.	nos.	nos.	nos.	nos.
1	Total ML	1917	639	554	554	2950	983	4248	1062	2945	736
2	Artificial polymer materials	1502	501	461	461	2022	674	2513	628	1799	450
3	Rubber	15	5	5	5	63	21	105	26	59	15
4	Cloth/Textile	36	12	6	6	42	14	122	31	93	23
5	Paper/ cardboard	217	72	46	46	509	170	559	140	376	94
6	Processed wood	17	6	8	8	104	35	397	99	424	106
7	Metal	49	16	20	20	105	35	340	85	124	31
8	Glass/ceramics	76	25	6	6	95	32	184	46	53	13
9	Unidentified	5	2	2	2	10	3	28	7	17	4
10	Number of monitoring campaigns	3	1	1	1	3	1	4	1	4	1

Common borders. Common solutions

IX.	Beach Alepu										
№	Year	2015		2016		2017		2018		2019	
	Indicator	Total count/ year	Aver. Count/ campaign	Total count/ year	Aver. Count/ campaign	Total count/ year	Aver. Count/ campaign	Total count/ year	Aver. Count/ campaign	Total count/ year	Aver. Count/ campaign
		nos.	nos.	nos.	nos.	nos.	nos.	nos.	nos.	nos.	nos.
1	Total ML	2168	723	329	329	5376	1792	3650	913	5664	1416
2	Artificial polymer materials	1936	645	267	267	3552	1184	2085	521	3672	918
3	Rubber	15	5	5	5	162	54	81	20	54	14
4	Cloth/Textile	31	10	5	5	77	26	100	25	86	22
5	Paper/ cardboard	82	27	10	10	787	262	540	135	636	159
6	Processed wood	9	3	7	7	225	75	385	96	891	223
7	Metal	52	17	30	30	336	112	319	80	221	55
8	Glass/ceramics	43	14	5	5	214	71	126	32	89	22
9	Unidentified	0	0	0	0	23	8	14	4	15	4
10	Number of monitoring campaigns	3	1	1	1	3	1	4	1	4	1

Common borders. Common solutions

X.	Beach River Veleka Mouth									
№	Year	2015		2016		2017		2018		2019	
	Indicator	Total count/ year	Aver. Count/ campaign	Total count/ year	Aver. Count/ campaign	Total count/ year	Aver. Count/ campaign	Total count/ year	Aver. Count/ campaign	Total count/ year	Aver. Count/ campaign
		nos.	nos.	nos.	nos.	nos.	nos.	nos.	nos.	nos.	nos.
1	Total ML	na*	na	na	na	2446	815	3787	947	2139	535
2	Artificial polymer materials	na	na	na	na	1329	443	2303	576	1348	337
3	Rubber	na	na	na	na	41	14	70	18	35	9
4	Cloth/Textile	na	na	na	na	59	20	73	18	43	11
5	Paper/ cardboard	na	na	na	na	250	83	433	108	263	66
6	Processed wood	na	na	na	na	542	181	568	142	247	62
7	Metal	na	na	na	na	130	43	307	77	149	37
8	Glass/ceramics	na	na	na	na	68	23	116	29	42	11
9	Unidentified	na	na	na	na	27	9	8	2	11	3
10	Number of monitoring campaigns	na	na	na	na	3	1	4	1	4	1

*na – not applicable

Common borders. Common solutions

CROSS BORDER COOPERATION

9.2. Appendix 2 "Identification of hot spots of marine litter pollution in the target area" – ML by main categories of material bt beaches, subject to RedMarLitter ML monitoring, 2019

Table. 2. ML by main categories of material by beaches subject to RedMarLitter projectl ML monitoring, 2019

I.	Beach "Black sea saltpans North" - Burgas		
№	Year	**2019**	
	Indicator	Total count/ year	Average count/ campaign
		nos.	nos.
1	Total ML	6719	2240
2	Artificial polymer materials	6161	2054
3	Rubber	31	10
4	Cloth/Textile	19	6
5	Paper/ cardboard	275	92
6	Processed wood	71	24
7	Metal	52	17
8	Glass/ceramics	87	29
9	Unidentified	23	8
10	Number of monitoring campaigns	3	1
II.	Beach "Vromos Bay"		
№	Year	**2019**	
	Indicator	Total count/ year	Average count/ campaign
		nos.	nos.
1	Total ML	5319	1773
2	Artificial polymer materials	4806	1602
3	Rubber	55	18
4	Cloth/Textile	46	15
5	Paper/ cardboard	187	62
6	Processed wood	40	13
7	Metal	115	38
8	Glass/ceramics	62	21
9	Unidentified	8	3
10	Number of monitoring campaigns	3	1

Common borders. Common solutions

III.	Beach „Alepu" between "Dyuni" resort and "Dyuni South"		
№	Year	**2019**	
	Indicator	Total count/ year	Average count/ campaign
		nos.	nos.
1	Total ML	5829	1943
2	Artificial polymer materials	5230	1743
3	Rubber	37	12
4	Cloth/Textile	31	10
5	Paper/ cardboard	208	69
6	Processed wood	102	34
7	Metal	67	22
8	Glass/ceramics	119	40
9	Unidentified	35	12
10	Number of monitoring campaigns	3	1

Common borders. Common solutions

9.3. **Appendix 3: Presentation of the identified hotspots with georeferenced map material on digital format (on CD)**

9.4. **Appendix 4: ML hotspots – *.xlsx file for importation to the open database of the project (on CD)**

Common borders. Common solutions