ANALYSIS OF DATA PROVIDED BY BURGAS MUNICIPALITY ABOUT THE OCCURANCE OF THE MAIN CATEGORIES OF MARINE LITTER ON BEACHES

The analysis of the data provided by the Municipality of on the occurrence of litter from the categories Artificial polymer materials, Rubber, Cloth/Textile, Paper/Cardboard, Processed/worked wood, Metal, Glass/ceramics, Unidentified was done using data from:

- institutional monitoring of beach marine litter (D10C1, indicator 1) in the period 2017-2019 including;

- 4-season monitoring of marine litter (2019-2020), conducted under contract 93-OP19-1/5/07.05.2019, Activity 2 "Monitoring of marine litter on selected part of the Black Sea coast"), concluded between the Municipality of Burgas and the "Nikola Vaptsarov" Naval Academy under the RedMarLitter project;

- remote monitoring of marine litter using an unmanned aerial vehicle (UAV) conducted under the same contract.

1. Beaches subject to monitoring

1.1 Beaches subject to Institutional monitoring of beach marine litter

Beaches subject to Institutional monitoring of beach marine litter are the following:

- beach "Durankulak North 1";
- beach "Krapetz";
- channel 2 - "Varna lake - Black Sea";
- beach "Shkorpilovtsi -north";
- beach "Byala - Karadere";
- beach "Obzor - childrens' camps";
- beach "Irakli";
- beach "Black sea saltpans" – Burgas;
- beach „Alepu";
- beach "River Veleka mouth".

Each of the monitoring areas is exposed to different pressures and experiences different impacts and loads of marine litter.

1.2   Beaches subject to 4-season monitoring of marine litter (2019-2020), conducted under contract 93-OP19-1/5/07.05.2019, Activity 2 "Monitoring of marine litter on selected part of the Black Sea coast"), concluded between Burgas Municipality and the "Nikola Vaptsarov" Naval Academy under the RedMarLitter project

4-season monitoring of marine litter (2019-2020) covers the following 3 beaches:

- beach "Black sea saltpans North" - Burgas;
- beach Vromos bay;
- beach „Alepu" between "Dyuni" resort and "Dyuni South".

1.3   Beaches subject to remote monitoring of marine litter using an unmanned aerial vehicle (UAV) conducted under the same contract

The remote monitoring of marine litter using an UAV covers the following 2 beaches:

- Krajmorie beach;
- cape Foros beach.

When conducting all three types of monitoring was used the internationally accepted classification of litter by main groups of materials and was applied criterion 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.

2.   Analysis of the data on marine litter deposited on the shore

2.1   Analysis of the data from the Institutional monitoring of beach marine litter. The analysis covers the data for the period 2017-2019 including

2.1.1   Analysis of the data for 2017

Figure 1 shows the share distribution of the main categories of solid waste (in percentages,%) for 2017 for all beaches in total.
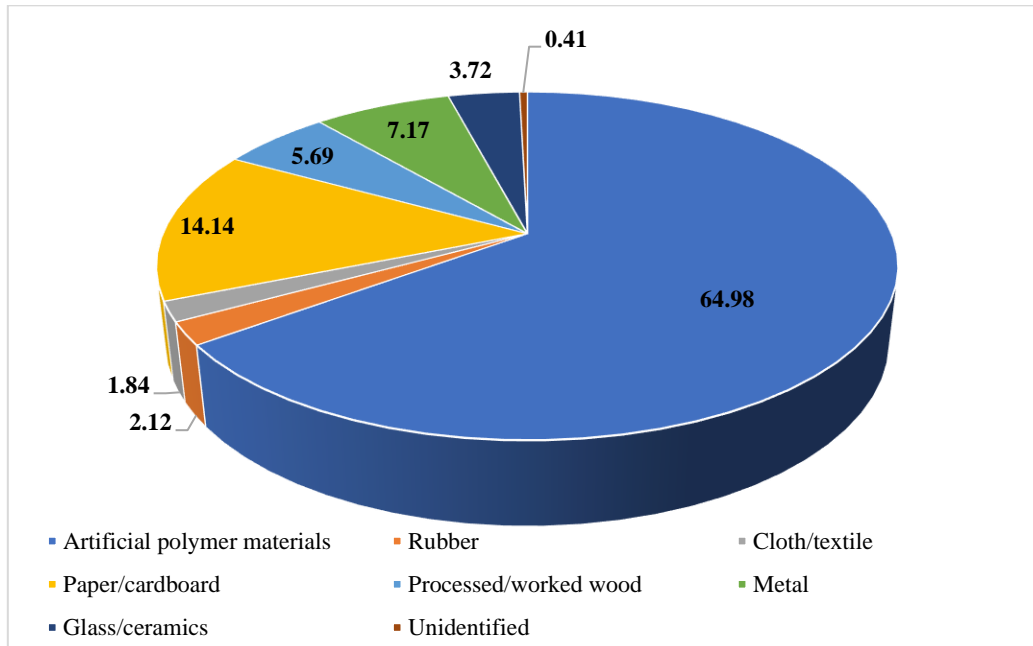
Figure 1. *Share distribution of the main categories of litter for 2017 on all beaches subject to the Institutional monitoring of beach marine litter*

As can be seen from **Figure 1**, the largest share of litter is in the category "Artificial polymer materials" - 64.98% of all marine litter, followed by category "Paper/cardboard" - 14.14%; category "Metal" - 7.17%; category "Processed/worked wood" - 5.69%; category "Glass/ceramics" - 3.72%; category "Rubber" - 2.12%; category "Cloth/textile" - 1.84% and category "Unidentified" - 0.41%.

The occurrence of the main categories of litter on the beaches subject to the Institutional monitoring of beach marine litter (in percentages,%) for 2017 is presented in **Figure 2**. The data for the figure are presented in **Table 1 - Annex 1.1**.
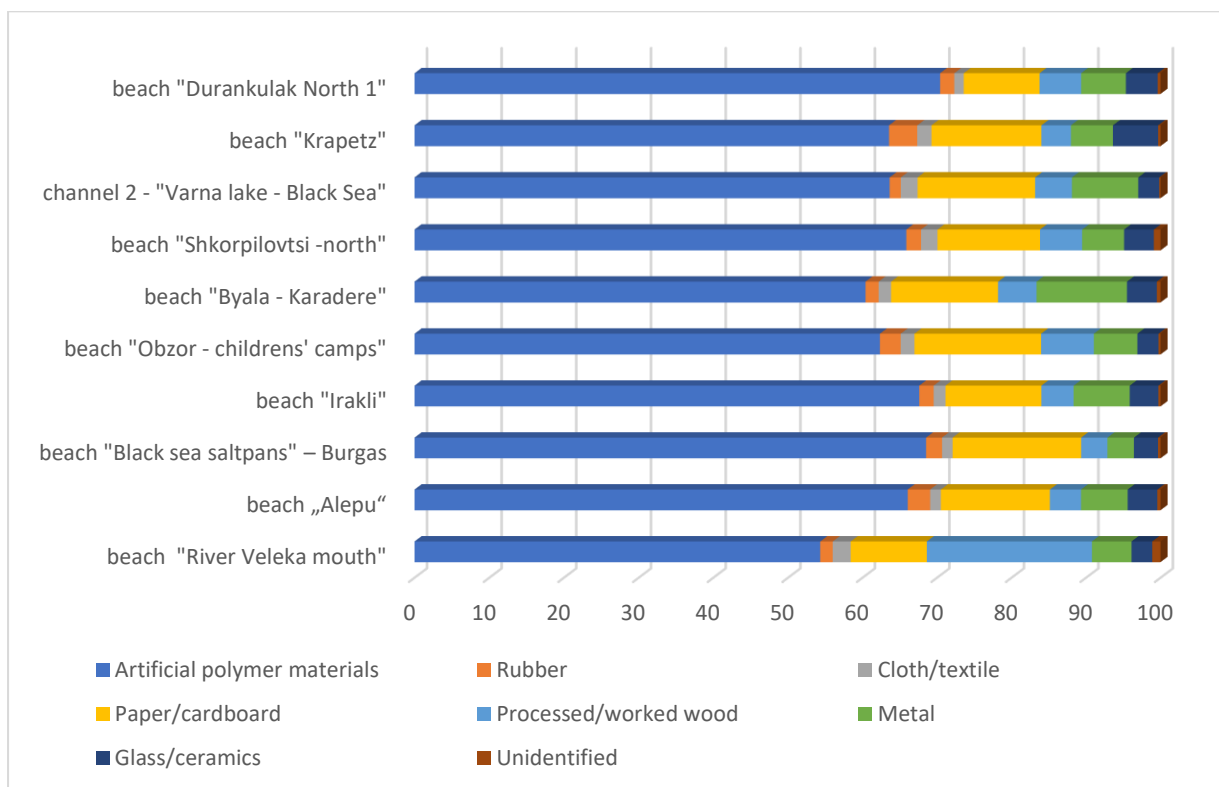
Figure 2. *Occurrence (in %) of the main categories of litter on the beaches subject to the Institutional monitoring of beach marine litter, 2017*

Figure 2 shows that on all beaches the share of litter from the category "Artificial polymer materials" has the highest percentage. This percentage is the highest on the beach "Durankulak - North 1" (70.42%) and the lowest - on the beach "River Veleka mouth" (54.33%). The largest percentage of the other categories of solid waste on the beaches is as follows:

- Rubber – beach "Krapetz" – 3.79%;
- Cloth/textile – beach "River Veleka mouth" – 2.41%;
- Paper/cardboard – beach "Black sea saltpans" – 17.25%;
- Processed/worked wood – beach "River Veleka mouth" – 22.16%;
- Metal – beach "Byala-Karadere" – 12.13%;
- Glass/ceramics – beach "Durankulak - North 1" – 4.26%;
- Unidentified – beach "River Veleka mouth" – 1.10%

2.1.2   Analysis of the data for 2018

Figure 3 presents the share distribution of the main categories of litter (in percentages,%) for 2018 for all beaches subject to the Institutional monitoring of beach marine litter in total.
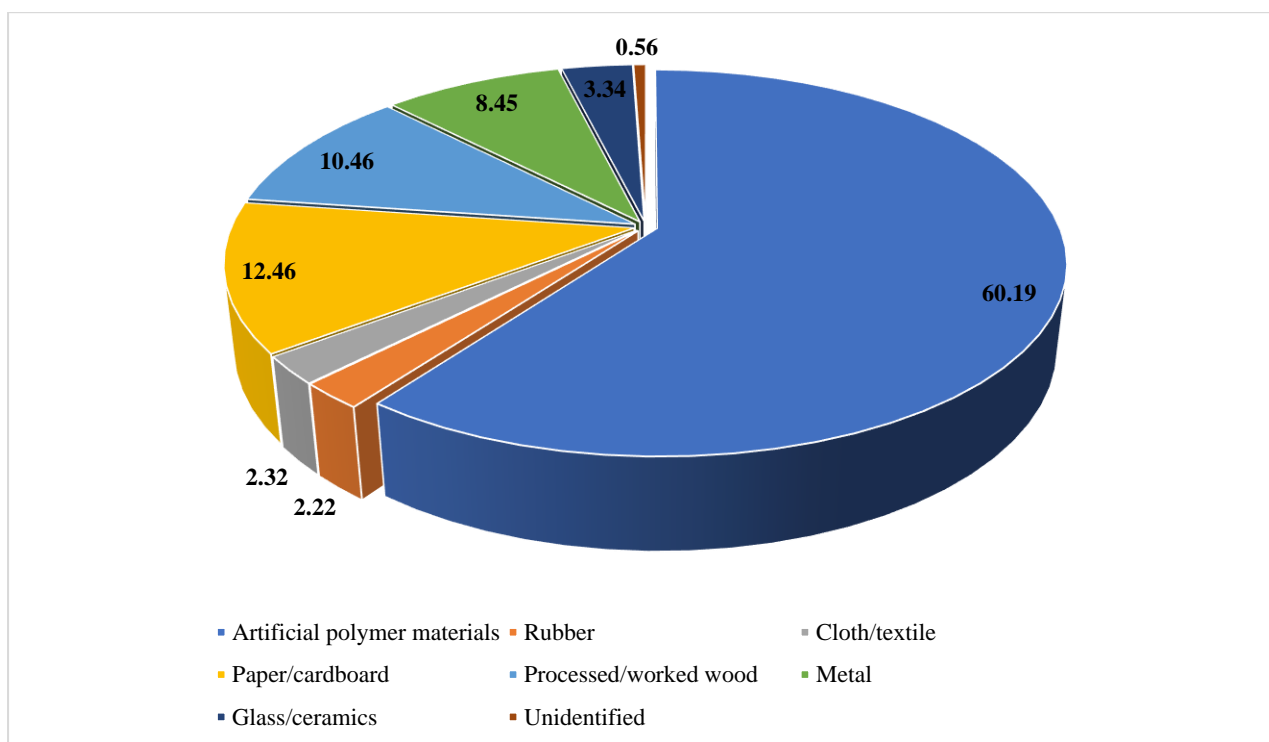

Figure 3. Share distribution of the main categories of litter on the beaches subject to the Institutional monitoring of beach marine litter, 2018

As can be seen from **Figure 3**, the largest share of litter is from the category "Artificial polymer materials" - 60.19% of all marine litter, followed by category "Paper/cardboard" - 12.46%; category " – Processed/worked wood " - 10.46%; category "Metal" - 8.45%; category "Glass/ceramics" - 3.34%; category "Cloth/textile" - 2.32%; category "Rubber" - 2.22%; and category "Unidentified" - 0.56%.

The occurrence of the main categories of litter on the beaches subject to the Institutional monitoring of beach marine litter (in percentages,%) for 2018 is presented in **Figure 4**. The data for the figure are presented in **Table 2 - Annex 1.1**.
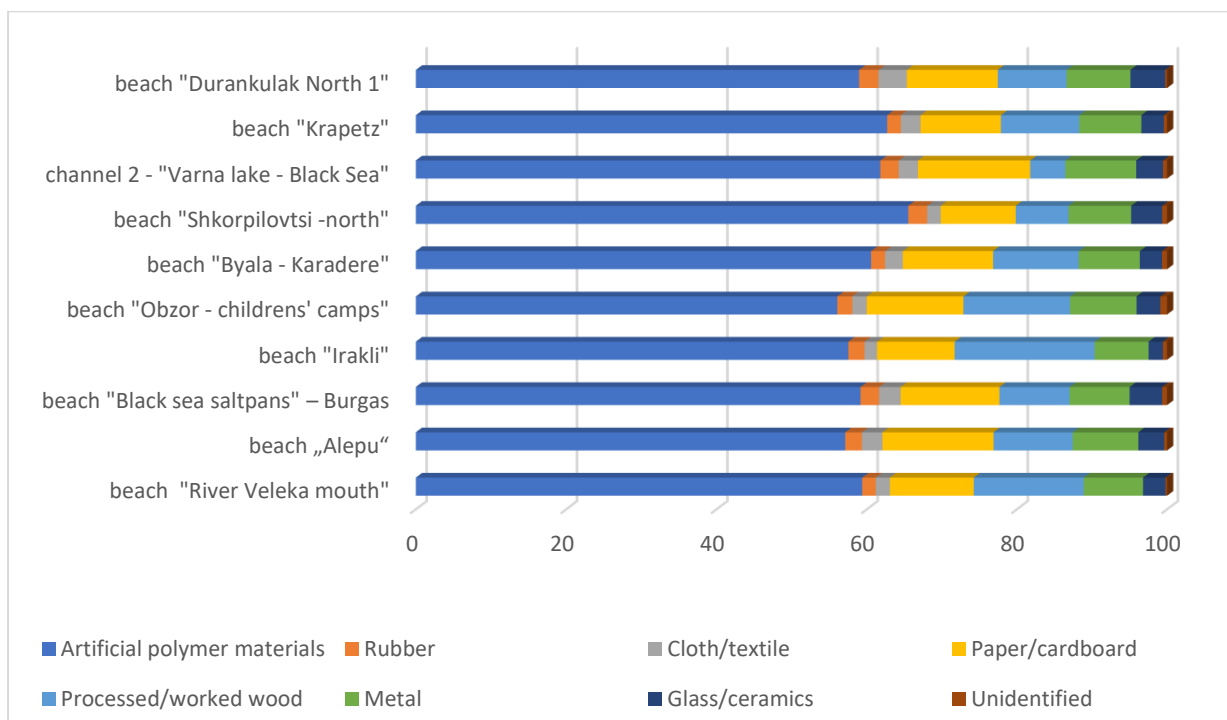
Figure 4. *Occurrence (in %) of the main categories of litter on the beaches subject to the Institutional monitoring of beach marine litter, 2018*

Figure 4 shows that on all beaches the share of litter from the category "Artificial polymer materials" has the highest percentage. This percentage is highest on the beach "Shkorpilovtsi-north" (65.53%) and lowest - on the beach "Obzor-children's camps" (56.06%). The largest percentage of the other categories of litter on the beaches is as follows:

- Rubber – beach "Durankulak - North 1" – 2.60%;
- Cloth/textile beach "Durankulak - North 1" – 3.77%;
- Paper/cardboard – beach channel 2 - "Varna lake-Black Sea" – 14.95%;
- Processed/worked wood – beach "Irakli" – 18.65%;
- Metal – beach channel 2 - "Varna lake-Black Sea" – 9.43%;
- Glass/ceramics – beach "Durankulak - North 1" – 4.63%;
- Unidentified – beach "Obzor-children's camps" – 0.90%

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2.1.3   Analysis of the data for 2019

Figure 5 presents the share distribution of the main categories of litter (in percentages,%) for 2019 for all beaches in total.
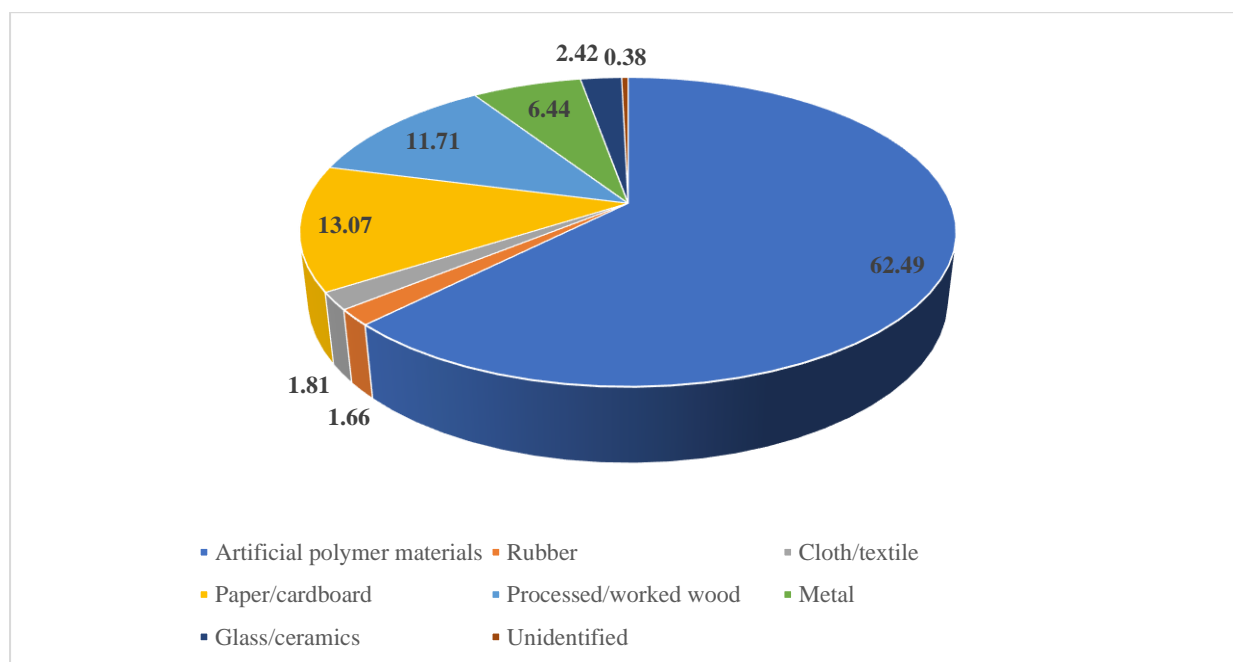

Figure 5. Share distribution of the main categories of litter on the beaches subject to the Institutional monitoring of beach marine litter, 2019

As can be seen from **Figure 5**, the largest share of litter is from the category "Artificial polymer materials" - 62.49% of all marine litter, followed by category "Paper/cardboard" – 13.07%; category " – Processed/worked wood " – 11.71%; category "Metal" – 6.44%; category "Glass/ceramics" – 2.42%; category "Cloth/textile" – 1.88%; category "Rubber" – 1.66%; and category "Unidentified" - 0.38%.

The occurrence of the main categories of litter on the beaches subject to the Institutional monitoring of beach marine litter (in percentages,%) for 2019 is presented in **Figure 6**. The data for the figure are presented in **Table 3 - Annex 1.1**.
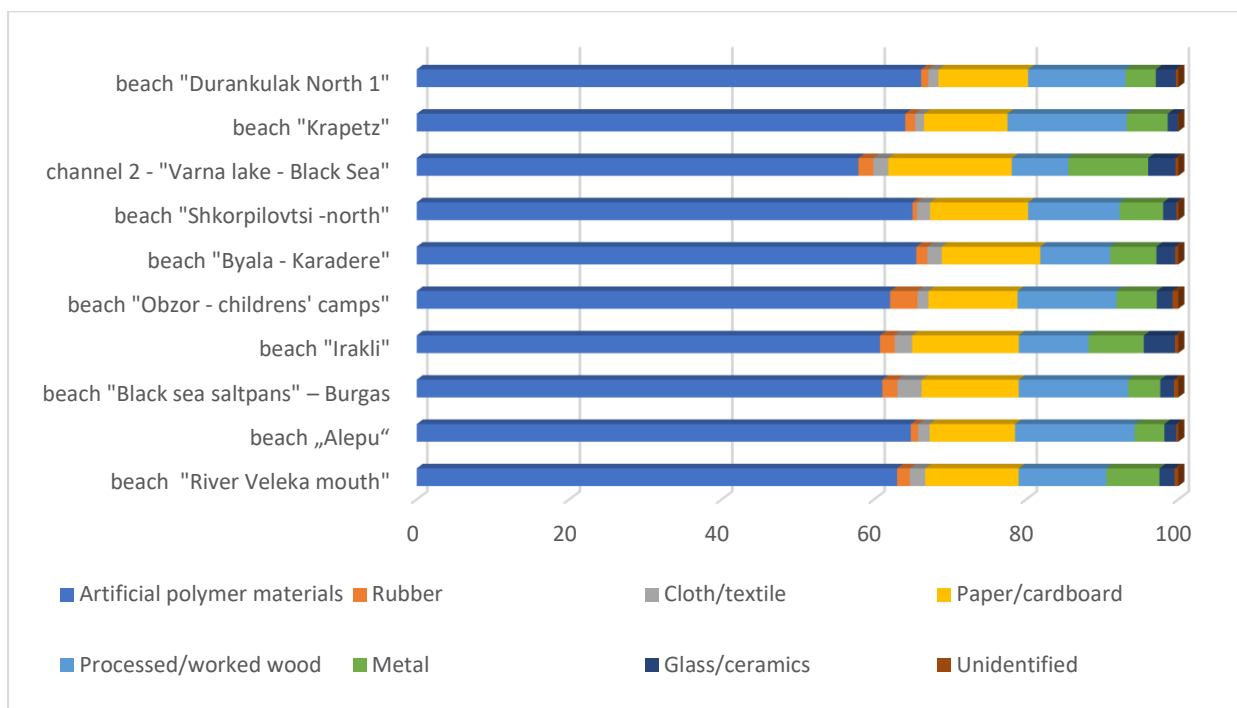
Figure 6. Occurrence (in %) of the main categories of litter on the beaches subject to the Institutional monitoring of beach marine litter, 2019

Figure 6 shows that on all beaches the share of litter from the category "Artificial polymer materials" has the highest percentage. This percentage is highest on the beach "Shkorpilovtsi-north" (66.17%) and lowest - on the beach channel 2 - "Varna lake-Black Sea" (57.94%). The largest percentage of the other categories of litter on the beaches is as follows:

- Rubber – beach "Obzor-children's camps" – 3.60%;
- Cloth/textile – beach "Black sea saltpans" – 3.16%;
- Paper/cardboard – beach channel 2 - "Varna lake-Black Sea" – 16.23%;
- Processed/worked wood – beach "Alepu" – 15.73%;
- Metal – beach channel 2 - "Varna lake-Black Sea" – 10.49%;
- Glass/ceramics – beach "Irakli" – 4.08%;
- Unidentified – beach "Obzor-children's camps" – 0.77%

2.1.4   Summary results for the period 2017-2019

Figure 7 shows the share distribution of the main categories of litter on the beaches subject to the Institutional monitoring of beach marine litter for the period 2017-2019.
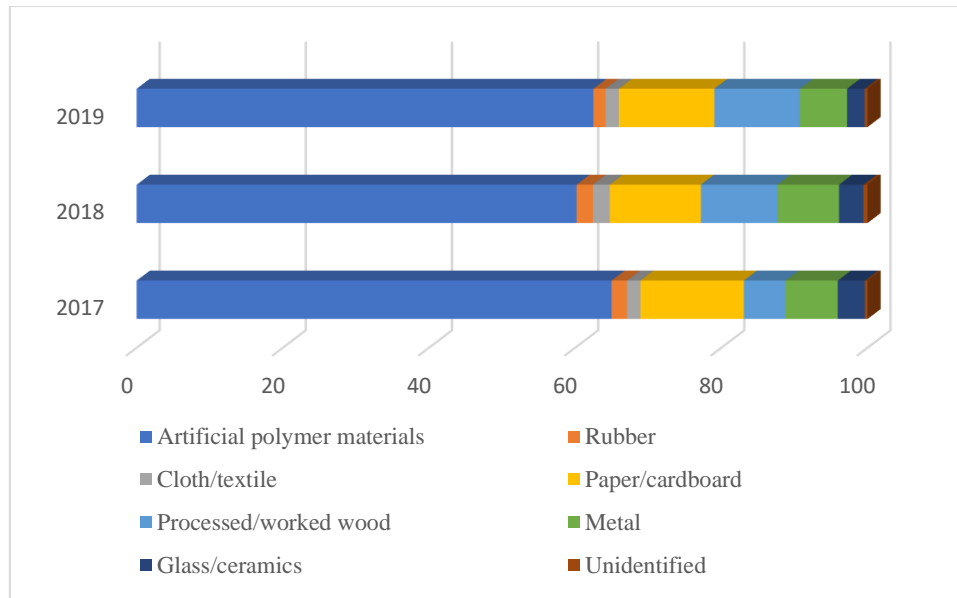

Figure 7. Share distribution (in%) of the main categories of litter on the beaches subject to the Institutional monitoring of beach marine litter, 2017-2019

From the analyzes made in the previous points and from **Figure 7** it can be concluded that with regard to the composition of litter deposited along the coast, for the period 2017-2019 there is a relatively similar trend. Throughout the period there is a significant predominance of the category "Artificial polymer materials" (60-65%). In second place in terms of share is the category "Paper/Cardboard" (12-15%), and in third place - "Metal" (7-8%) in 2017 and "Processed/worked wood" (10-12%) in 2018 and 2019.

2.2   Analysis of the data from the 4-season monitoring of marine litter (2019-2020), conducted under contract 93-OP19-1/5/07.05.2019, Activity 2 "Monitoring of marine litter on selected part of the Black Sea coast"), concluded between Burgas Municipality and the "Nikola Vaptsarov" Naval Academy under the RedMarLitter project

Figure 8 shows the share distribution of the main categories of litter (in percentages,%) for all beaches subject to 4-season monitoring under the RedMarLitter project in total.
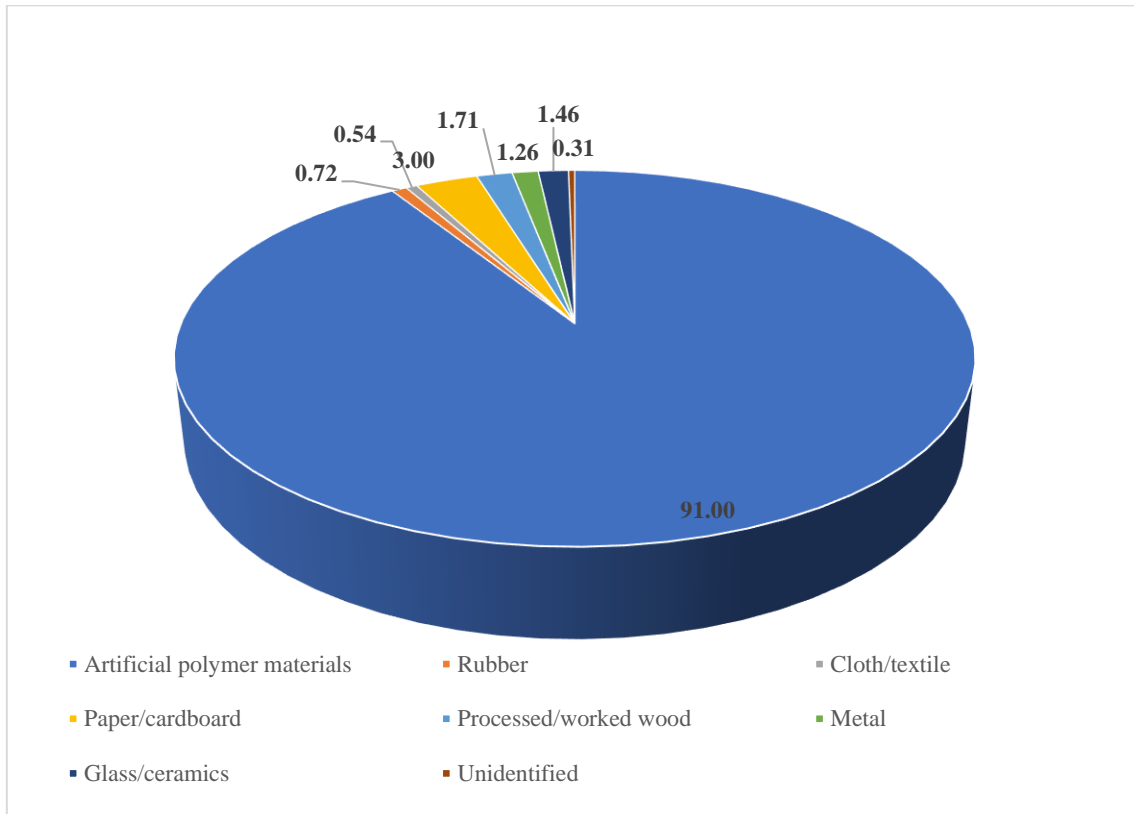
Figure 8. Share distribution of the main categories of litter (in %) for all beaches subject to 4-season monitoring under the RedMarLitter project, 2019/2020.

As can be seen from **Figure 8**, the share of waste in the category "Artificial polymer materials" is the largest - 91%. The share of the other categories is negligible (total 9%) and is distributed as follows: "Paper/cardboard" - 3%; "Processed/worked wood" - 1.71%; "Glass / ceramics" - 1.46%; "Metal" - 1.26%; "Rubber" - 0.72%; "Cloth/ textile" - 0.54% and "Unidentified" - 0.31%.

The occurrence of the main categories of solid waste on the beaches (in percentages,%) for 2019/2020 is presented in **Figure 9**. Data for the figure are presented in **Table 4 - Annex 1.1**
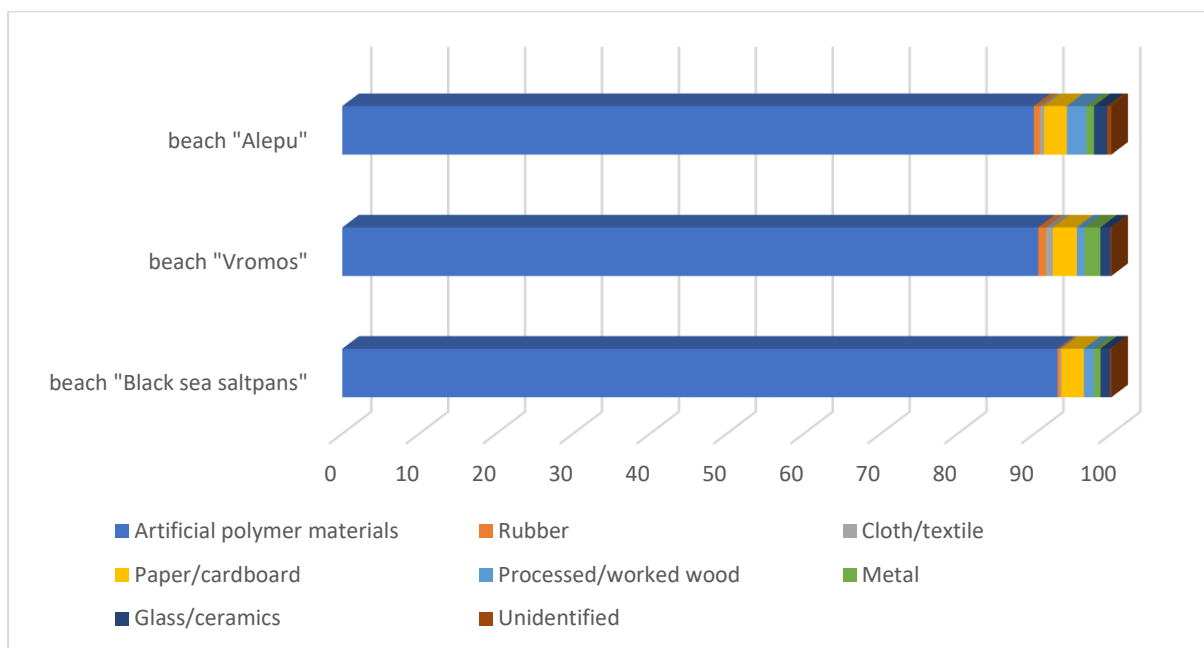
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Figure 9 *Occurrence (in %) of the main categories of litter on all beaches subject to*
4-season monitoring under the RedMarLitter project, 2019/2020.

Figure 9 shows that on all beaches the share of litter the category "Artificial polymer materials" has the highest percentage. This percentage is the highest on the beach "Black Sea saltpans" (92.98%) and the lowest - the beach "Alepu" (89.92%). The largest percentage of the other categories of solid waste on the beaches is as follows:

-        Rubber – beach "Vromos" – 1.02%;
-        Cloth/textile – beach "Vromos" – 0.89%;
-        Paper/cardboard – beach "Vromos" – 3.12%;
-        Processed/worked wood – beach "Alepu" – 2.54%;
-        Metal – beach "Vromos" – 2.05%;
-        Glass/ceramics – beach "Alepu" – 1.70%;
-        Unidentified – beach "Alepu" – 0.56%

2.3   Analysis of the data from conducted remote monitoring of marine litter using an unmanned aerial vehicle (UAV) – 2019/2020 (summer 2019, autumn 2019 and spring 2020)

The occurrence of the main categories of litter on the beaches (in percentages,%) for 2019/2020 is presented in **Figure 10**. The data for the figure is presented in **Table 5 - Annex 1.1**
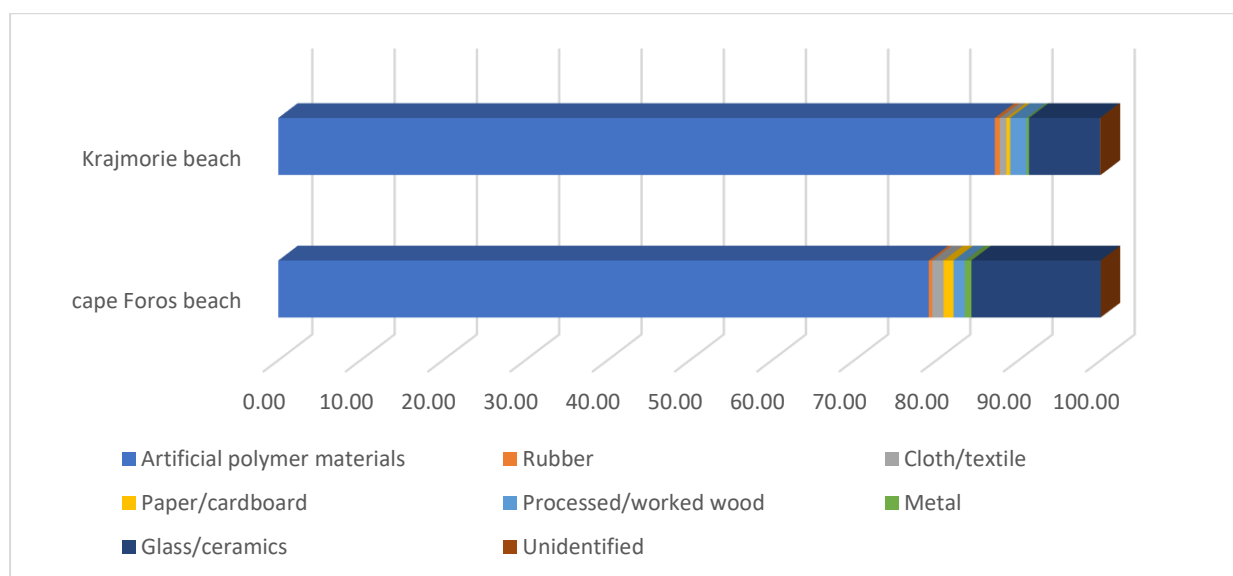

Figure 10. Occurrence (in %) of the main categories of litter on the beaches subject to remote monitoring of marine litter using UAV for 2019/2020

Figure 10 shows that on both beaches, the object of monitoring using UAV with the highest percentage is the participation of litter from the category "Artificial polymer materials". This percentage is higher on the beach "Krajmorie" (87.12%) and lower - on the "Cape Foros" beach (79.08%). The largest percentage of the other categories of litter on the beaches is as follows:

-    Rubber – "Cape Foros" beach – 0.60%;
-    Cloth/textile – "Cape Foros" beach – 1.38%;
-    Paper/cardboard – "Cape Foros" beach – 1.21%;
-    Processed/worked wood – beach "Krajmorie" – 1.99%;
-    Metal – "Cape Foros" beach – 0.79%;

- Glass/ceramics – "Cape Foros" beach – 15.73%;
- Unidentified – beach "Krajmorie" – 0.06%.

3. Conclusions

The following conclusions can be drawn from the performed analyzes:

1) The largest share (significantly exceeding that of the other categories) in the pollution of all beaches has the category "Artificial polymer materials". The share of litter in this category has a significant advantage over others. This is explained by the fact that most items used during recreation (sunbathing, recreational fishing) are made of plastic.

2) On all beaches (except those monitored using UAV) the second most common litter is from the category "Paper/cardboard". This is also a category closely related to recreation and tourism.

3) On the beaches, subject to monitoring using UAV, the second most common category is "Glass/ceramics". Litter of this type may be related to camping and construction activities.

Common borders. Common Solutions

ANNEX 1.1

Table 1. *Occurrence of the main categories of litter on the beaches subject to the Institutional monitoring of beach marine litter (in percentages,%) for 2017*

Litter category / Beach monitoring area	Artificial polymer materials	Rubber	Cloth/textile	Paper/ cardboard	Processed/ worked wood	Metal	Glass/ ceramics	Unidentified
1	2	3	4	5	6	7	8	9
beach "Durankulak North 1"	70.42	1.90	1.26	10.19	5.58	6.01	4.26	0.38
beach "Krapetz"	63.57	3.79	1.90	14.76	3.97	5.64	6.06	0.32
channel 2 - "Varna lake - Black Sea"	63.65	1.49	2.25	15.78	4.95	8.89	2.81	0.18
beach "Shkorpilovtsi - north"	65.89	1.97	2.20	13.76	5.65	5.63	3.99	0.89
beach "Byala - Karadere"	60.41	1.76	1.68	14.36	5.17	12.13	4.00	0.50
beach "Obzor - childrens' camps"	62.35	2.78	1.86	16.99	7.08	5.85	2.83	0.27
beach "Irakli"	67.62	1.93	1.59	12.86	4.34	7.53	3.84	0.28
beach "Black sea saltpans" – Burgas	68.54	2.14	1.42	17.25	3.53	3.56	3.22	0.34

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Litter category / Beach monitoring area	Artificial polymer materials	Rubber	Cloth/textile	Paper/ cardboard	Processed/ worked wood	Metal	Glass/ ceramics	Unidentified
1	2	3	4	5	6	7	8	9
beach „Alepu"	66.07	3.01	1.43	14.64	4.19	6.25	3.98	0.43
beach "River Veleka mouth"	54.33	1.68	2.41	10.22	22.16	5.31	2.78	1.10

Table 2. *Occurrence of the main categories of litter on the beaches subject to the Institutional monitoring of beach marine litter (in percentages,%) for 2018*

Litter category / Beach monitoring area	Artificial polymer materials	Rubber	Cloth/textile	Paper/ cardboard	Processed/ worked wood	Metal	Glass/ ceramics	Unidentified
1	2	3	4	5	6	7	8	9
beach "Durankulak North 1"	58.96	2.60	3.77	12.12	9.16	8.50	4.63	0.25
beach "Krapetz"	62.71	1.81	2.62	10.71	10.44	8.26	2.99	0.44
channel 2 - "Varna lake - Black Sea"	61.79	2.45	2.56	14.95	4.70	9.43	3.57	0.55
beach "Shkorpilovtsi -north"	65.53	2.51	1.80	9.99	7.03	8.35	4.11	0.67
beach "Byala - Karadere"	60.56	1.88	2.35	12.02	11.42	8.14	2.95	0.68

beach "Obzor - childrens' camps"	56.06	2.00	1.92	12.89	14.20	8.85	3.17	0.90
beach "Irakli"	57.53	2.17	1.67	10.34	18.65	7.18	1.90	0.57
beach "Black sea saltpans" – Burgas	59.16	2.47	2.87	13.16	9.35	8.00	4.33	0.66
beach „Alepu"	57.12	2.22	2.74	14.79	10.55	8.74	3.45	0.38
beach "River Veleka mouth"	59.39	1.81	1.88	11.17	14.65	7.92	2.99	0.21

Table 3. Occurrence of the main categories of litter on the beaches subject to the Institutional monitoring of beach marine litter (in percentages,%) for 2019

Litter category / Beach monitoring area	Artificial polymer materials	Rubber	Cloth/textile	Paper/ cardboard	Processed/ worked wood	Metal	Glass/ ceramics	Unidentified
1	2	3	4	5	6	7	8	9
beach "Durankulak North 1"	66.17	0.96	1.32	11.81	12.80	3.99	2.63	0.32
beach "Krapetz"	64.09	1.32	1.15	10.98	15.67	5.41	1.34	0.05
channel 2 - "Varna lake - Black Sea"	57.94	1.96	1.97	16.23	7.43	10.49	3.60	0.37
beach "Shkorpilovtsi -north"	65.04	0.60	1.73	12.89	12.06	5.70	1.73	0.26

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beach "Byala - Karadere"	65.55	1.45	1.92	12.92	9.19	6.09	2.46	0.41
beach "Obzor - childrens' camps"	62.11	3.60	1.44	11.71	13.02	5.29	2.05	0.77
beach "Irakli"	60.78	1.96	2.26	14.04	9.16	7.28	4.08	0.45
beach "Black sea saltpans" – Burgas	61.09	2.00	3.16	12.77	14.40	4.21	1.80	0.58
beach „Alepu"	64.83	0.95	1.52	11.23	15.73	3.90	1.57	0.26
beach "River Veleka mouth"	63.02	1.68	2.01	12.30	11.55	6.97	1.96	0.51

Table 4. *Occurrence of the main categories of litter on the beaches subject to the 4-season monitoring under the project RedMarLitter (in percentages,%) for 2019/2020*

Litter category / Beach monitoring area	Artificial polymer materials	Rubber	Cloth/textile	Paper/ cardboard	Processed/ worked wood	Metal	Glass/ ceramics	Unidentified
1	2	3	4	5	6	7	8	9
beach "Black sea saltpans"	92.98	0.32	0.21	2.93	1.31	0.83	1.28	0.14
beach "Vromos"	90.48	1.02	0.89	3.12	1.02	2.05	1.30	0.13
beach "Alepu"	89.91	0.80	0.53	2.97	2.54	0.98	1.70	0.56

Table 5. *Occurrence of the main categories of litter on the beaches subject to remote monitoring of marine litter using an UAV (in percentages,%) for 2019/2020*

Litter category / Beach monitoring area	Artificial polymer materials	Rubber	Cloth/textile	Paper/ cardboard	Processed/ worked wood	Metal	Glass/ ceramics	Unidentified
1	2	3	4	5	6	7	8	9
cape Foros beach	79.08	0.42	1.38	1.21	1.38	0.79	15.73	0
Krajmorie beach	87.12	0.60	0.79	0.48	1.99	0.30	8.66	0.06

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