NET4mPLASTIC PROJECT

WP4 – Act. 2 Lab's analysis on plastic and microplastic wastes on coastal and marine environments

D 4.2.2

Collection of plastic and microplastic items and identification of the plastic and origin by characterization of the different plastic polymers

August, 2022 – Final Version

Project Acronym	NET4mPLASTIC
Project ID Number	10046722
Project Title	New Technologies for macro and Microplastic Detection and Analysis in the Adriatic Basin
Priority Axis	3
Specific objective	3.3
Work Package Number	4
Work Package Title	Demonstration activities: testing and improvement of developed methodologies
Activity Number	4.2
Activity Title	Lab's analysis on plastic and microplastic wastes on coastal and marine environments
Partner in Charge	PP1 – University of Trieste (UNITS)
Partners involved	LP – University of Ferrara (UNIFE) PP6 – Teaching Institute for Public Health, Primorje-Gorski Kotar County (TIPH) PP7 – Public Institution RERA SD for Coordination and Development of Split Dalmatia County (RERA)
Status	Final
Distribution	Public

CONTRIBUTING PARTNERS	UNIFE, UNITS, TIPH, RERA-IOF

Data	Vers	Prep	Resp	Appr	Rev	Comment
30/11/2019	1.1	UNITS	UNITS	Chiara Schmid Luca Cozzarini	Report	Comment and approval
30/09/2021	Rev.0	UNITS	UNITS	Vanni Lughi Luca Cozzarini	Report	Comment and approval
06/10/2021	Rev.1	UNITS	UNITS	Vanni Lughi Luca Cozzarini	Report	Comment and approval
31/05/2022	1.1	RERA - IOF	UNTS	Gorana Baničević (RERA) Pero Tutman (IOF) Dubravka Bojanić Varezić (IOF)	Draft	Comment and approval
09/06/2022	Rev.0	UNITS	UNITS	Vanni Lughi Luca Cozzarini	Report	Comment and approval
18/08/2022	1.1	TIPH	UNITS	Itana Bokan Vucelić	Draft	Comment and approval
19/08/2022	1.1	UNIFE	UNITS	Carmela Vaccaro Corinne Corbau Joana Buoninsegni Maria Nicoli Elisabetta Olivo	Final	Comment and approval

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1 Introduction

This document contains the results of the activity 4.2: Laboratory analysis on plastic and microplastic wastes on coastal and marine environments.

The macro marine litter and microplastic samples were collected and analysed as described in NET4mPLASTIC project deliverable "D 4.1.1 - Sediments samplings, river and sea water samplings and biota sampling from the 4 macro-areas".

The data presented refer to the pilot sites selected by the NET4mPLASTIC project (for further information regarding the pilot site, please see the Deliverable 4.1.1):

1. ITALY - Po Delta area: Rosolina, Boccasette (Porto Tolle), Goro and Comacchio;
2. ITALY - Pescara-Teramo coastal area: Torre del Cerrano (Pineto), Montesilvano and Pescara-South beach;
3. CROATIA - Rijeka area: Meline Beach, Klimno, north-eastern coast of Krk Island, Island of Susak beach;
4. CROATIA - Split area.

As it will be show in the following paragraphs, it should be noted that not all types of data acquisition (and related methodologies described here) have been applied in all areas of interest, and the samplings were not carried out simultaneously in order to respect the specific environmental and climatic conditions of each macro-area under investigation.

The results presented (referring to the count of microplastics) contribute to the achievement of the target-output of the NET4mPLASTIC project << “3.3O3 Microplastic waste collected in marine areas”: identification of 10.000 plastic items collected in the beach sediment, sea surface and biota sampling >>.

2 UNIFE – Results

In the framework of the project NET4mPLASTIC, UNIFE-GEO team performed different kinds of sampling in the Italian pilot sites: Po Delta and Pescara area. Sampling methodologies are described in detail in the deliverable 4.1.1.

The raw data of the obtained results are all available on the web platform, developed within the NET4mPLASTIC project (www.net4mplastic.net). Moreover, the web platform is updated periodically, whenever new results related with the project will emerge.

Below are presented the results achieved regarding microplastics and marine litter, sorted by sampling and analyses methods.

It should be noticed that some SMP-samples analysed through the stereomicroscopic (test site Delta Po: Rosolina Mare and Volano Beach) have been processed by multiple operators, to testing the laboratory protocol trough a comparative approach. The results of laboratory tests have been included in the final counting of SMP only once, in order to not replicate the data. The above-mentioned results were not attached and uploaded in the online Project platform, as they are considered as "tests", used during the development phase of analysis protocols.

2.1 Beach Marine Litter (< 50 cm)

For the collection and sorting of marine litter with dimensions smaller than 50 cm, 13 monitoring campaign were carried out. 11 surveys were performed in Po Delta pilot site, of which 6 were done along the beaches of Delta northern sector (Rosolina Mare and Porto Tolle Municipalities – Rovigo, Italy), while 5 were carried out along the beaches of the southern sector of the Po Delta (Goro and Comacchio Municipalities – Ferrara, Italy). Finally, 2 surveys were done in Pescara area pilot site, of which one sampling north of Pescara River mouth (Pineto – Teramo, Italy) and the second one south of the river Pescara mouth (Pescara, Italy).

2.1.1 Marine Litter (2,5 – 50 cm) from beach samples

Following the methodology which is extensively described within deliverable 4.1.1, 10.436 marine litter (ML) items with dimensions comprised between 2,5 – 50 cm were collected and sorted. The marine litter items were assigned to the following macro-categories of materials; artificial polymer; rubber; cloth/textile; paper/cardboard; processed/worked wood; metal; glass/ceramics; unidentified and/or chemicals. In particular, 9704 items (93%) were classified as plastic materials (artificial polymer), while 732 items (7%) were assigned, collectively, to the other macro-categories of materials cited above (Fig. 1)

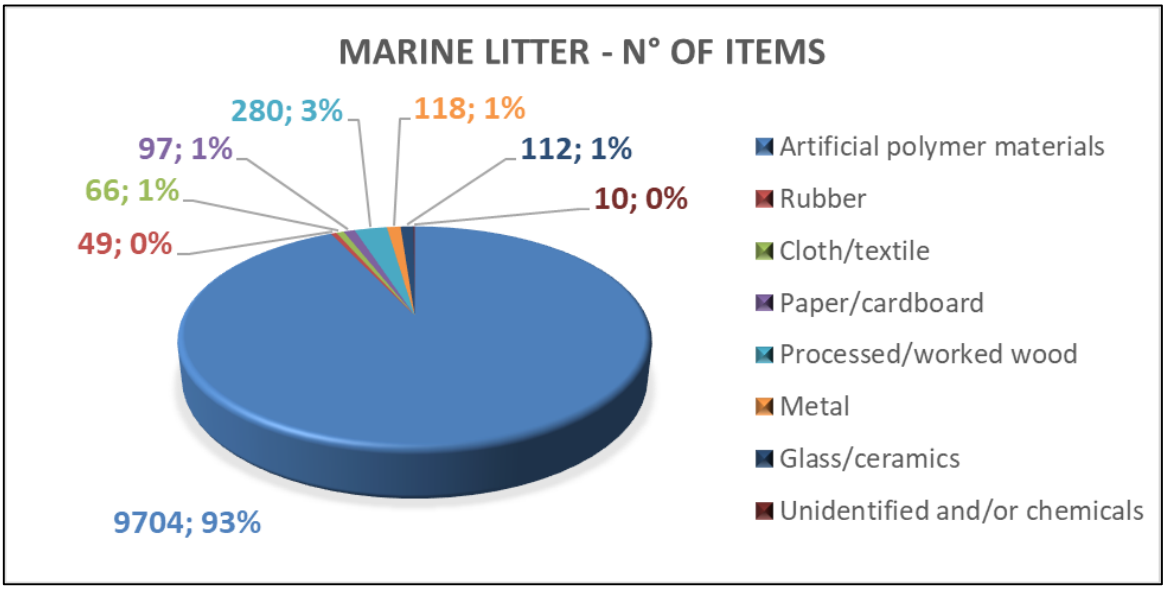

Figure 1 - Marine litter items from Italian pilot sites of NET4mPLASTIC Project. The values in the graphic represent the number of items for the two pilot sites (Po Delta and Pescara area) and the respective percentages over the total (rounded up).

More specifically, along the coasts of Po Delta area 9617 items in total were collected: 7086 in the northern sector of the Delta (Rosolina and Porto Tolle Municipalities – Rovigo, Italy) and 2531 in the southern sector (Goro Municipality and Volano beach – Ferrara, Italy) (Fig. 2).

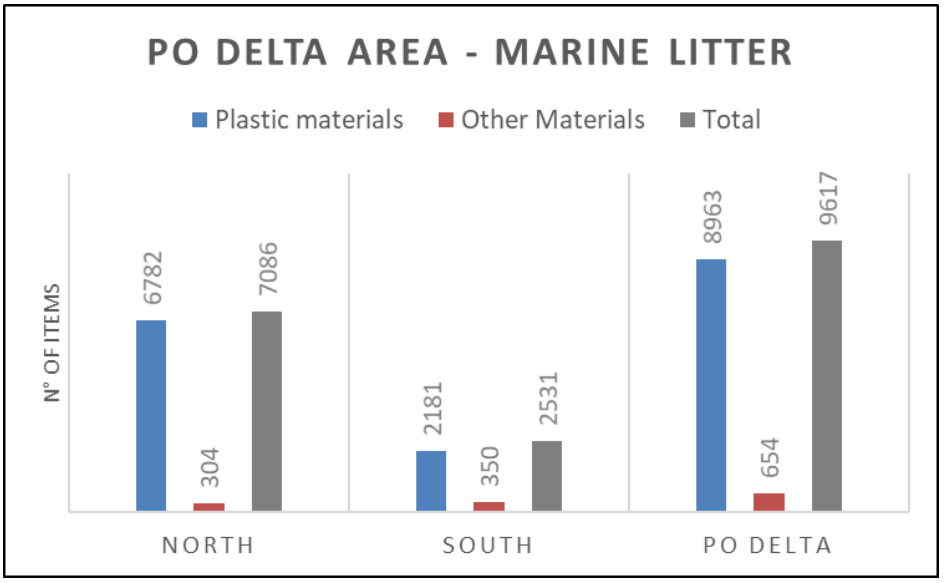

Figure 2 - Marine litter items from Po Delta area. X-axis of the graphic is divided to represent the reference sectors of the pilot site. Y-axis reports the total number of items for each category listed in the legend (plastic materials; other materials; total).

The plastic material recovered in the marine litter have been categorized in two subsets in relation to the main sources of release:

- **Improper waste disposal (IWD)**: referring to improper waste disposal and urban wastewater, whose release and transport into the marine environment is mainly driven by rivers. The most represented categories are, for example: "G79 - Plastic pieces 2.5-50 cm", "G21 - Plastic caps/lids drinks", "G5 - Plastic bag collective role; what remains from rip-off plastic bags", "G95 - Cotton bud sticks", etc.
- **Marine Waste by fishing and aquaculture activities (F-A)**: referring to maritime activities as fishing and aquaculture, whose release may be more or less accidental. The most represented categories are, for example: "G82 - Polystyrene pieces 2.5-50 cm" identified as products of fragmentation or degradation of fishing boxes, "G45 - Mussels nets", etc.

Regarding the two subsets, in the Delta Po area were identified 6546 items attributable to IWD and 2417 items attributable to F-A (Fig. 3)

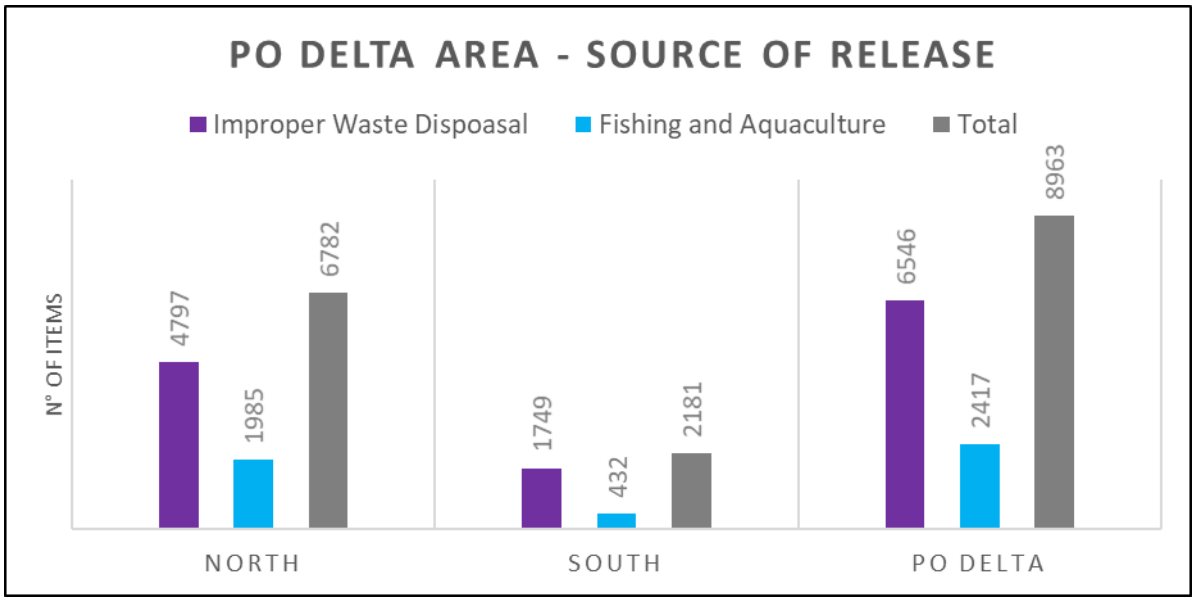

Figure 3 – Marine litter sources of release on Po Delta area. X-axis of the graphic is divided to represent the reference sectors of the pilot site. Y-axis reports the total number of items for each category listed in the legend (plastic materials; other materials; total).

Despite both the northern and the southern sectors of Po Delta are affected by the same main sources of release of ML (fishing, aquaculture and wastewater), it is emphasized that slight differences in the waste types and abundances have been found that concerning on the beaches of the northern sector where it was collected:

- IWD: 2,7 times more items than in the southern sector;
- F-A: 4,6 times more items than in the southern sector.

Concerning the pilot site of Pescara Area, 819 plastic waste items were collected on the whole. 361 of those come from the beaches of Torre del Cerrano (Pineto Municipality – Teramo, Italy) and 458 items come from the beach south of the mouth of Pescara River (Pescara Municipality, Italy) (Fig. 4).

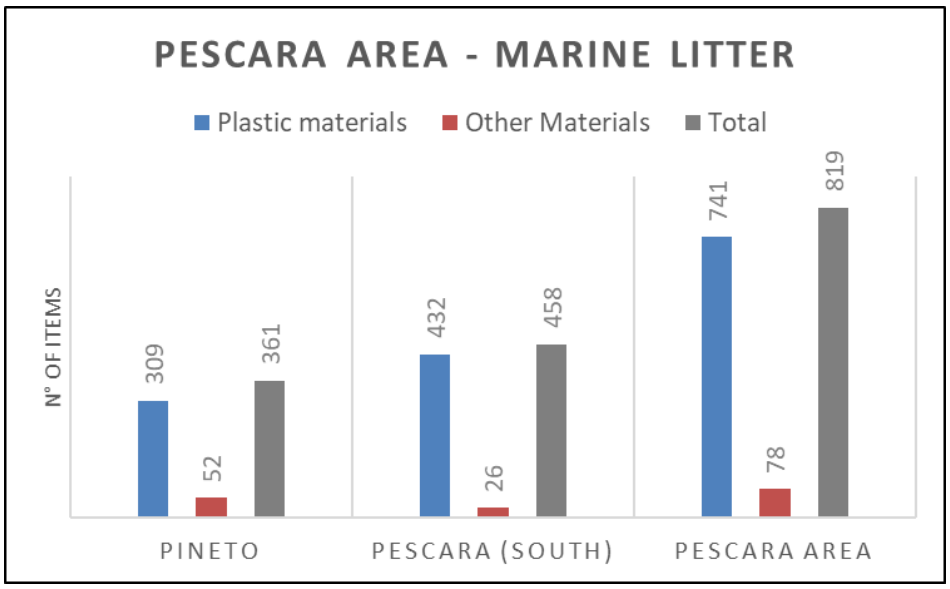

Figure 4 - Marine litter items from Pescara areas. X-axis of the graphic is divided to represent the reference sectors of the pilot site. Y-axis reports the total number of items for each category listed in the legend (plastic materials; other materials; total).

Moreover, in Pescara area 464 items were detected which are collectively attributable to IWD and 277 items which are attributable to F-A (Fig. 5).

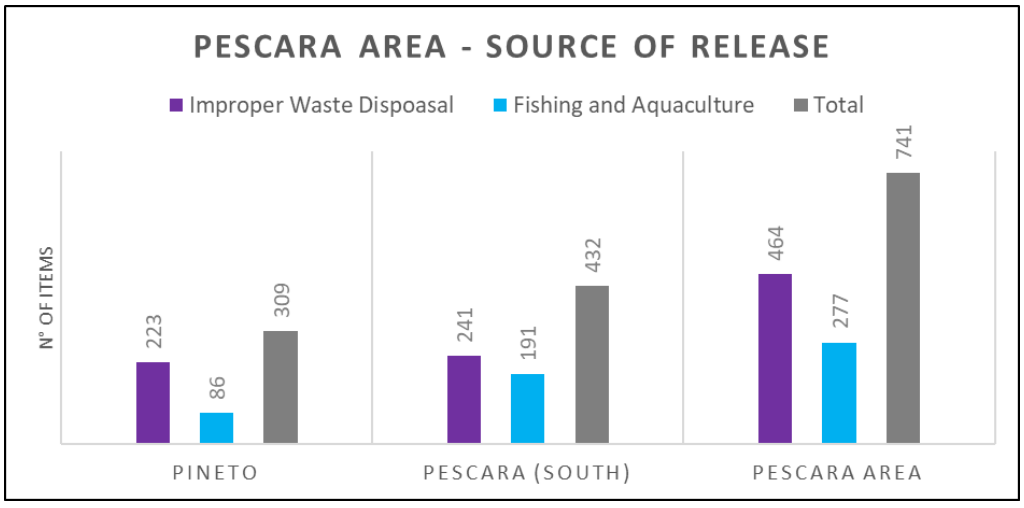

Figure 5 – Marine litter sources of release on Pescara areas. X-axis of the graphic is divided to represent the reference sectors of the pilot site. Y-axis reports the total number of items for each category listed in the legend (plastic materials; other materials; total).

In this case, for what concern the IWD source of release, the number of collected items is fairly comparable between the site of Pineto and Pescara Sud. On the other hand, for what concern the F-A source of marine litter release, it is notable that in Pescara Sud were found 2,2 times more items than in Pineto test site. This fact highlights the positive influence onto the environment of Torre del Cerrano Marine Protected Area (MPA), where the fishing and aquaculture activities are not allowed.

2.1.2 "Meso" Litter (0 – 2,5 cm) from beach samples

In compliance with the methodology employed in the framework of NET4mPLASTIC project for the collection and sorting of marine litter smaller than 50 cm, items with dimensions between 0 and 2,5 cm should not be considered for marine litter analysis. However, during the sorting activities (which results are reported in the above paragraph), it became clear that the fraction of marine litter comprised between 0 and 2,5 cm was not negligible. Therefore, it has been decided to analyse this fraction separately, in order to not omit any collected data and to not affect the dataset of marine litter which considered items between 2,5 – 50 cm.

In the present document the authors refer to "Meso" litter as to the items with dimensions comprised between 0-2,5 cm, collected in accordance with the methodology for "Beach Marine Litter (< 50 cm)" (extensively described within the deliverable 4.1.1). Consequently, from the categories mentioned in the Master List of reference, the following categories were selected and adapted: "**G75** - Plastic/polystyrene pieces 0 – 2,5 cm", "**G78** - Plastic pieces 0 – 2,5 cm", "**G81** - Polystyrene pieces 0 – 2,5 cm", which could be successfully employed to classify the "meso" litter findings.

In the Delta Po area 401 Meso Litter items were collected on the whole (Fig. 6). The most abundant category in both sector of the Delta turned out to be the G78 (52% in the northern sector and 76% in the southern sector), followed by category G81 (34% in the northern sector and 19% in the southern sector) and by category G75 (15% in the northern sector and 6% in the southern sector).

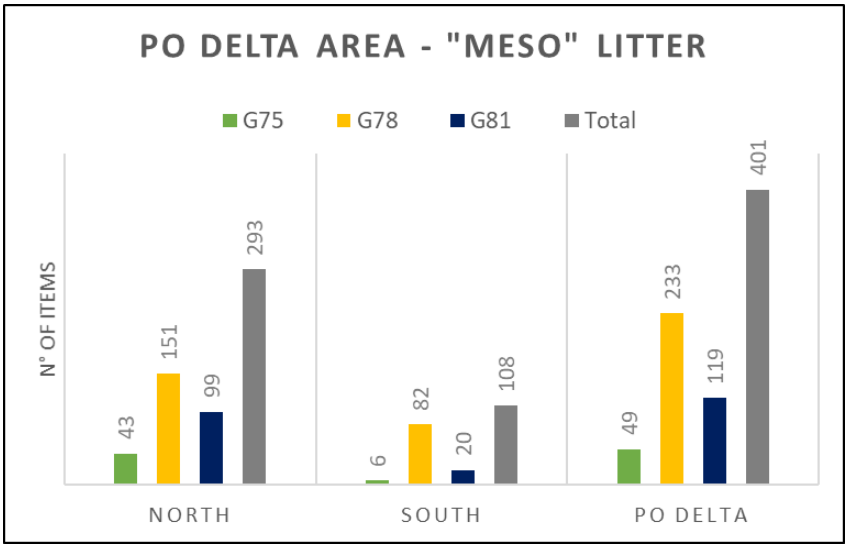

Figure 6 - Meso litter items from Po Delta area. X-axis of the graphic is divided to represent the reference sectors of the pilot site. Y-axis reports the total number of items for each category listed in the legend (G75, G78, G81, total).

In Pescara area pilot site were collected 101 Meso Litter items overall (Fig. 7). Also, in this case, the most abundant category for both sector of the area turned out to be G78 (81% on the beaches of Pineto and 68% on the beaches of Pescara - South), followed by category G81 (19% on the beaches of Pineto and 32% at Pescara – South beaches). Items attributable to category G75 were not detected in the two examined sites cited above.

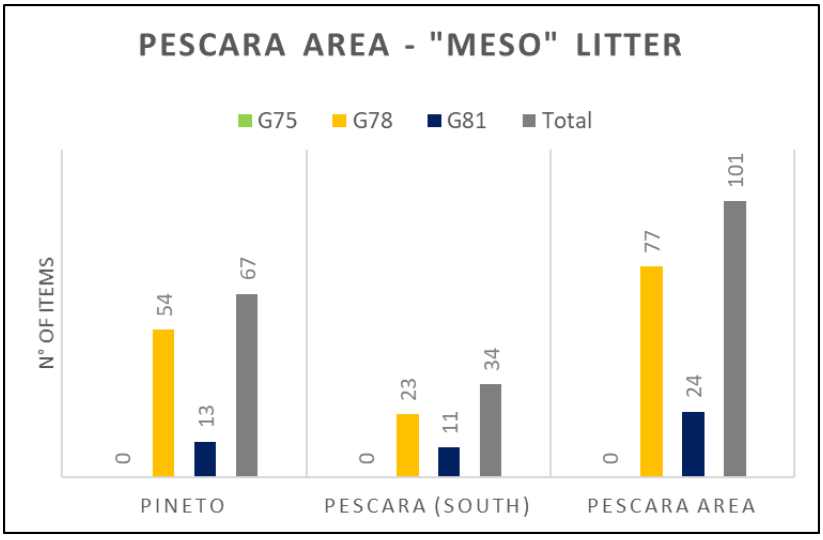

Figure 7 - Meso litter items from Pescara area. X-axis of the graphic is divided to represent the reference sectors of the pilot site. Y-axis reports the total number of items for each category listed in the legend (G75, G78, G81, total).

2.2 LMP – Large Micro Plastic (1 – 5 mm) from beach sediment

For what concern LMP from beach sediments, 16 samples were analysed, of which 13 were collected along the beaches of Po Delta coast, and 3 along the Pescara area coast. Regarding the samples collected along Po Delta coast, 6 samples come from the Delta northern beaches (Rosolina Mare and Porto Tolle Municipalities – Rovigo, Italy) and 7 come from the Delta southern beaches (Goro and Volano beach, Ferrara, Italy). Regarding the samples collected along Pescara area coast, 2 samples come from the north of Pescara River mouth (Pineto – Teramo, Italy) and the third one south of the same river mouth (Pescara, Italy).

Overall, 333 items were identified, of which 247 from samples collected along Po Delta coasts, while 86 from samples collected in Pescara Area (Fig. 8). In particular, for what concern Po Delta pilot site, 221 items were identified in the northern sector (66,37% over the total) and 26 items in the southern sector (7,81%). In Pescara Area pilot site, 21 items were detected from samples collected along the coasts north of the mouth of Pescara River (6,31% over the total), while 65 items (19,52%) were detected in the samples collected south of the mouth of the same river.

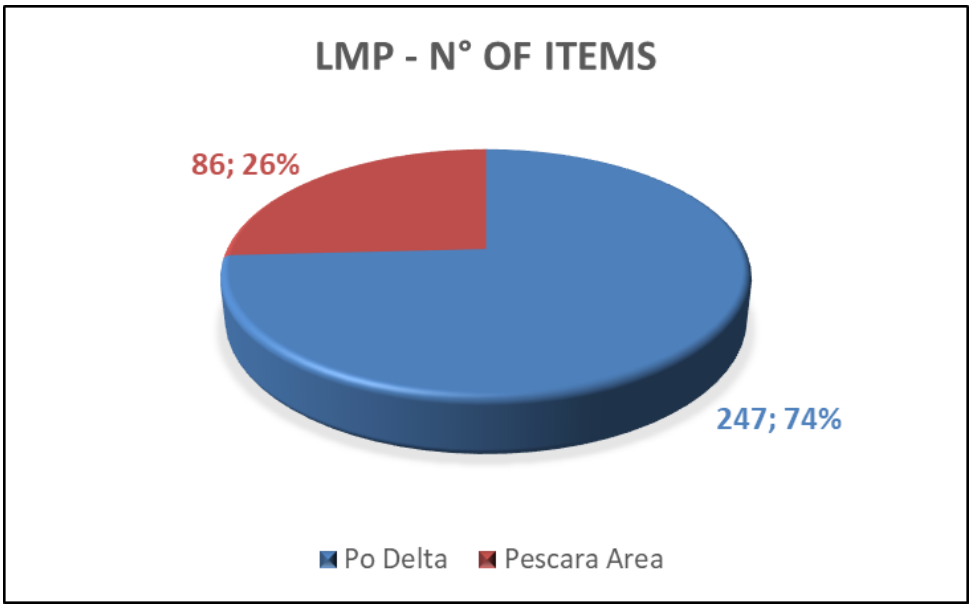

Figure 8 - LMP items from Italian pilot sites of NET4mPLASTIC Project. The values in the graphic represent the number of items for the two pilot sites (Po Delta and Pescara area) and the respective percentages over the total (rounded up).

Concerning the typology of LMP detected, the protocol employed allowed to identify 8 item categories (fragment, pellet, granule, filament, film, foam, other -nonplastic materials-, uncategorized plastic pieces). In particular, the most abundant typology resulted in fragments (76 %), followed by pellets (15%),

filaments and granule (for each 4%), and film (1 %). The remaining 3 categories of items (foam, other -nonplastic materials-, uncategorized plastic pieces) were not detected in the analysed samples (Fig. 9).

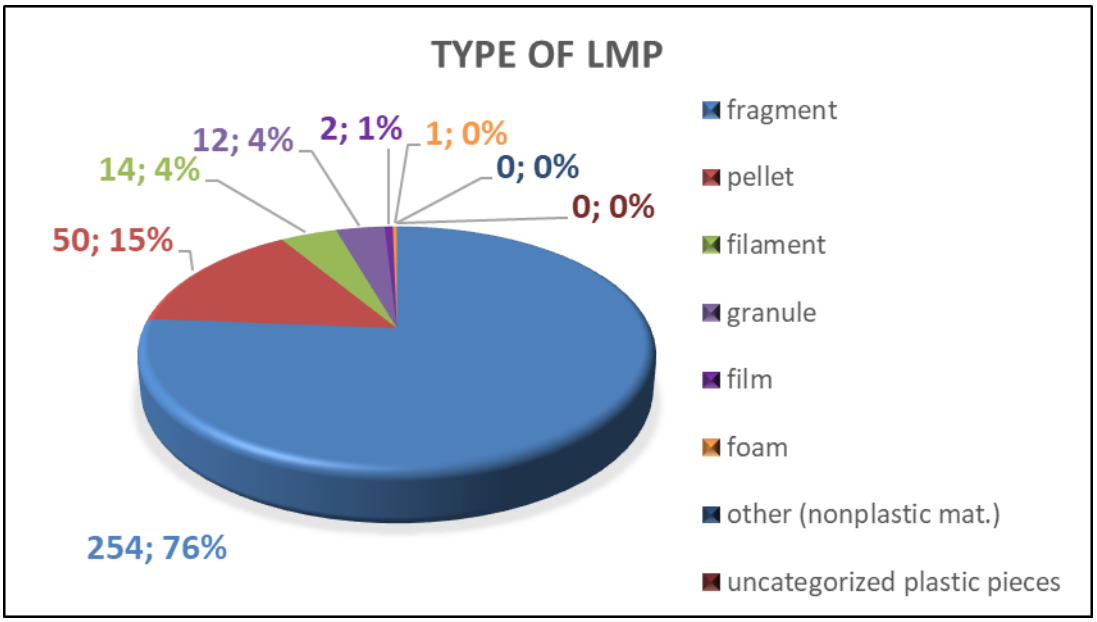

Figure 9 - Type of LMP identified from samples collected on Delta Po and Pescara areas. The values in the graphic represent the number of items for each established category and the respective percentages over the total (rounded up).

In general, all items were measured by their 3D: length, width and height. The average length of all LMP is 5,20 mm (Std. dev. 4,51; Min. 1 mm; Max. 41 mm). The average width is 2,71 mm (Std. dev. 1,38; Min. 0 mm; Max. 10,50 µm). The average height is 1,10 mm (Std. dev. 0,81; Min. 0 mm; Max. 3,90 µm).

For what concern the colour of LMP, the protocol employed allowed to identify 12 “categories of colour”: white, clear-white-creme, red, orange, blue, black, grey, brown, green, pink, tan, yellow. The results achieved show that no items of colour “tan” were identified. Moreover, stereomicroscopic observations allowed to identify 1 additional category:

- **Colorless**: items with a faded aspect, which does not allow to clearly attribute them to one of the colour categories described above.

More specifically, as shown in Figure 10, the most abundant colour typology turned out to be the white one (42,64%), followed by:

- Blue - 12,91%
- Colorless - 11,11%
- Clear-white-creme - 6,91%
- Green - 6,91%
- Black - 5,11%
- Grey - 5,11%
- Yellow - 3,00%
- Red - 2,40%
- Pink - 2,10%
- Brown 1,20%
- Orange - 0,60%

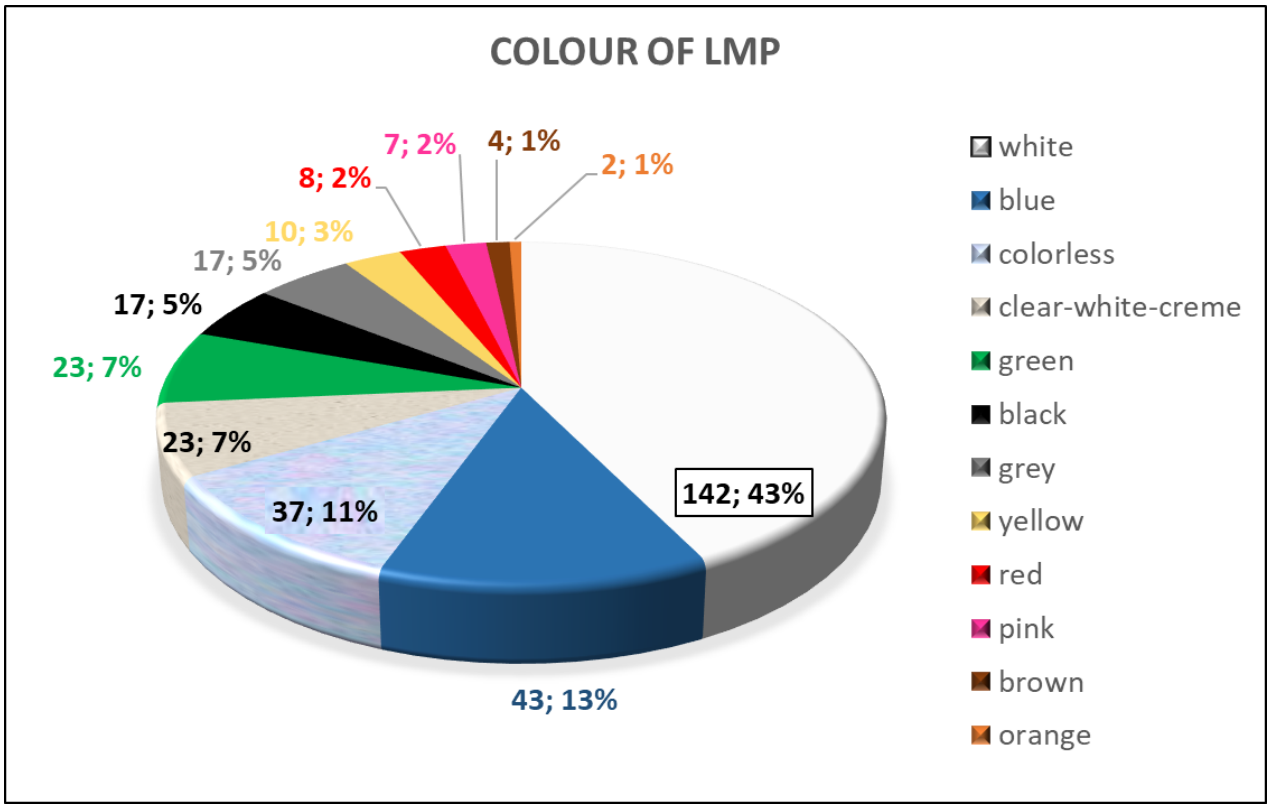

Figure 10 - Colour of LMP identified from samples collected on Delta Po and Pescara areas. The values in the graphic represent the number of items for each established category and the respective percentages over the total (rounded up).

In addition, the aspect of the LMP items was considered from the point of view of their transparency properties (Fig. 11). Results of the analyses suggest that the 89% of the determined items was opaque, while the 11% was transparent.

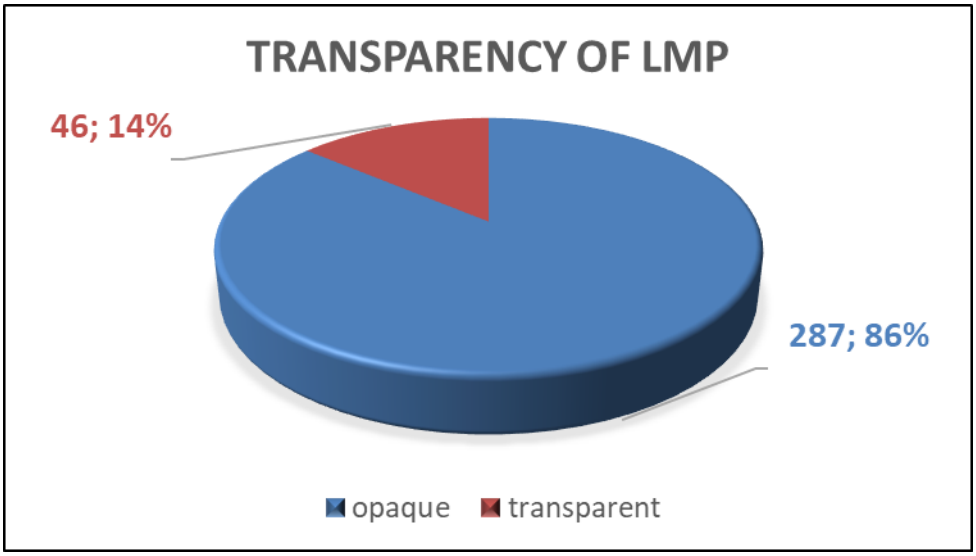

Figure 11 - Transparency of LMP collected on Delta Po and Pescara areas. The values in the graphic represent the number of items for each established category and the respective percentages over the total (rounded up).

2.3 SMP – Small Micro Plastic (20 µm – 1 mm) from beach sediment

For what concern the SMP separated from beach sediments samples collected in Po Delta pilot site, 7131 items were identified in 18 samples analysed.

Of the 7131 SMP isolated, 2766 items pertain to the beaches of the northern sector (Rosolina Mare and Porto Tolle Municipalities – Rovigo, Italy), while 4365 items pertain to the beaches sampled in the southern sector of Po Delta (Goro and Comacchio Municipalities – Ferrara, Italy) (Fig. 12).

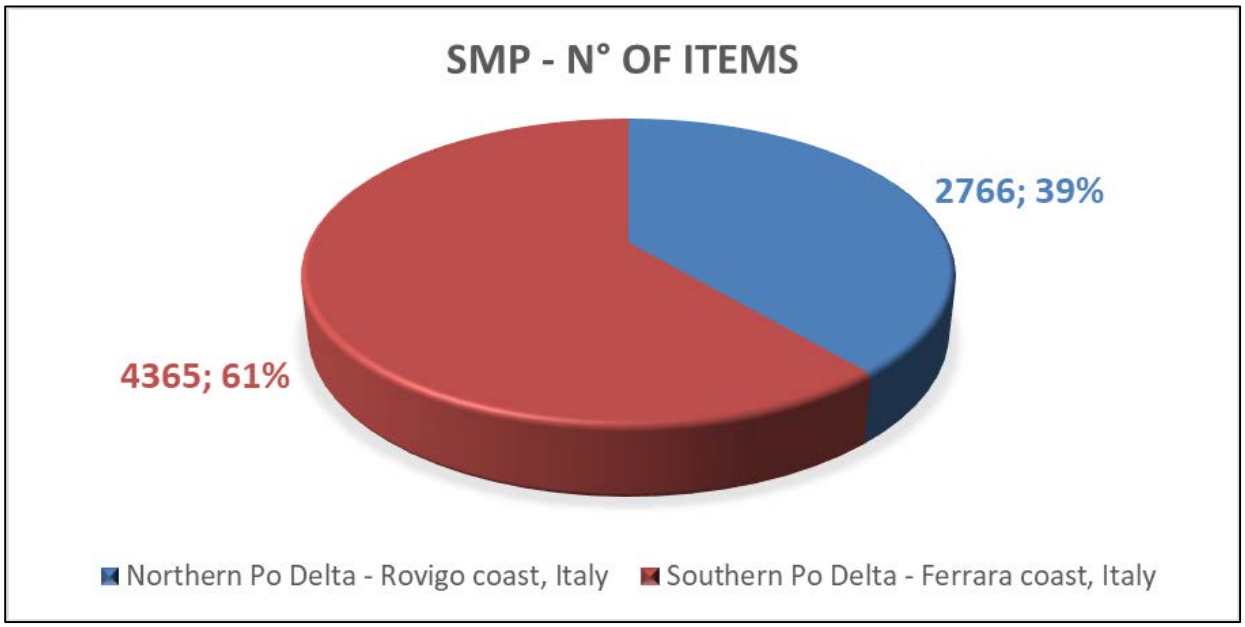

Figure 12 - SMP items from Po Delta area, Italian pilot site of NET4mPLASTIC Project. The values in the graphic represent the number of items for the two categories (Northern Po Delta and Southern Po Delta) and the respective percentages over the total (rounded up).

Concerning the typology of SMP detected, the protocol employed allowed to identify 8 item categories (fragment, pellet, granule, filament, film, foam, other -nonplastic materials-, uncategorized plastic pieces). In particular, the most abundant typology resulted in filaments (87,81%), followed by fragment (10,05%), pellet (1,74%), granule (0,34%) and film (0,06%). The remaining 3 categories of items (foam, other -nonplastic materials-, uncategorized plastic pieces) were not detected in the analysed samples (Fig. 13).

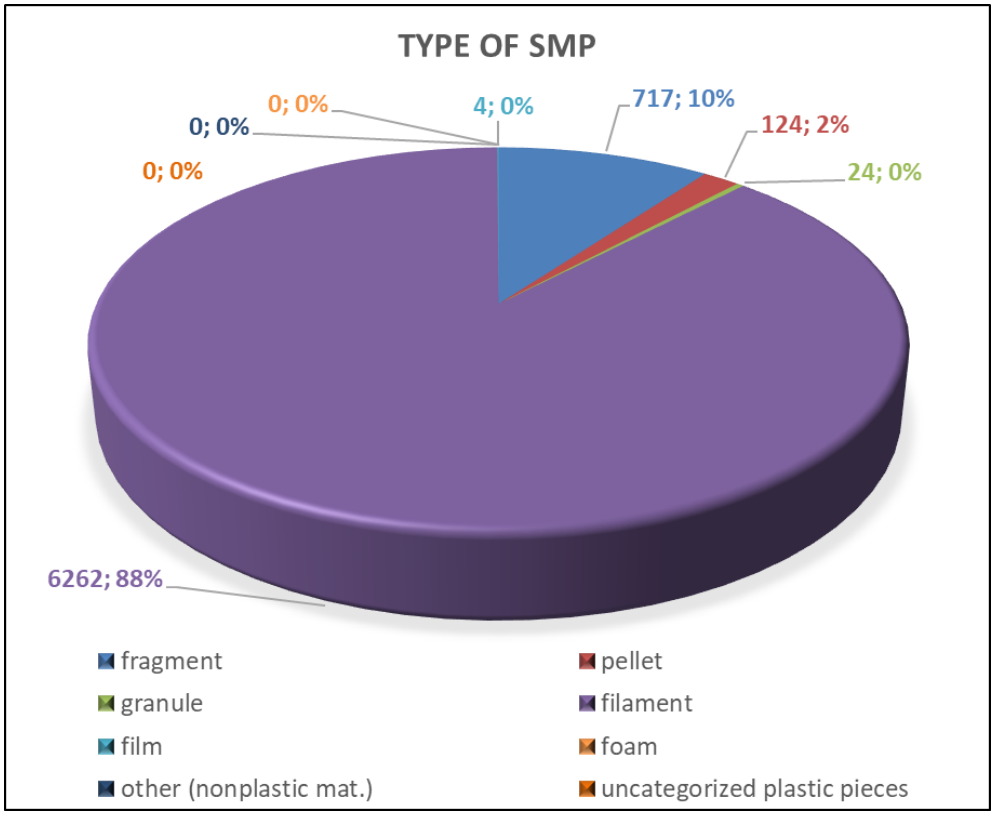

Figure 13 - Type of SMP identified in Delta Po samples. The values in the graphic represent the number of items for each established category and the respective percentages over the total (rounded up).

In general, all items were measured by their main diagonal. Filaments were measured by their total length, leaving out the width. For granule and pellets was considered the measure of the diameter. For fragments both length and width were measured.

The average length of all SMP is 405,53 µm (Std. dev. 420,98; Min. 21,83 µm; Max. 10009,55 µm). The average width, referred in particular to fragments, is 147,29 µm (Std. dev. 124,69; Min. 16,45 µm; Max. 794,23 µm).

For what concern the colour of SMP, the protocol employed allowed to identify 12 "categories of colour": white, clear-white-creme, red, orange, blue, black, grey, brown, green, pink, tan, yellow. The results achieved show that all the mentioned categories have been detected in the samples. Moreover, stereomicroscopic observations allowed to identify 2 additional categories:

- **Multicolor**: "composite" items which present more than one colour, none of which is predominant;
- **Colorless**: items with a faded aspect, which does not allow to clearly attribute them to one of the colour categories described above.

More specifically, as shown in Figure 14, the most abundant colour typology turned out to be the blue one (68,28%), followed by:

- Black - 7,26%
- Red - 4,73%
- White - 4,61%
- Colorless - 4,47%
- Yellow - 3,77%
- Pink - 1,57%
- Brown - 1,57%
- Clear-white-creme - 1,29%
- Green - 1,19%
- Orange - 0,62%
- Grey - 0,53%
- Tan - 0,06%
- Multicolour - 0,04%

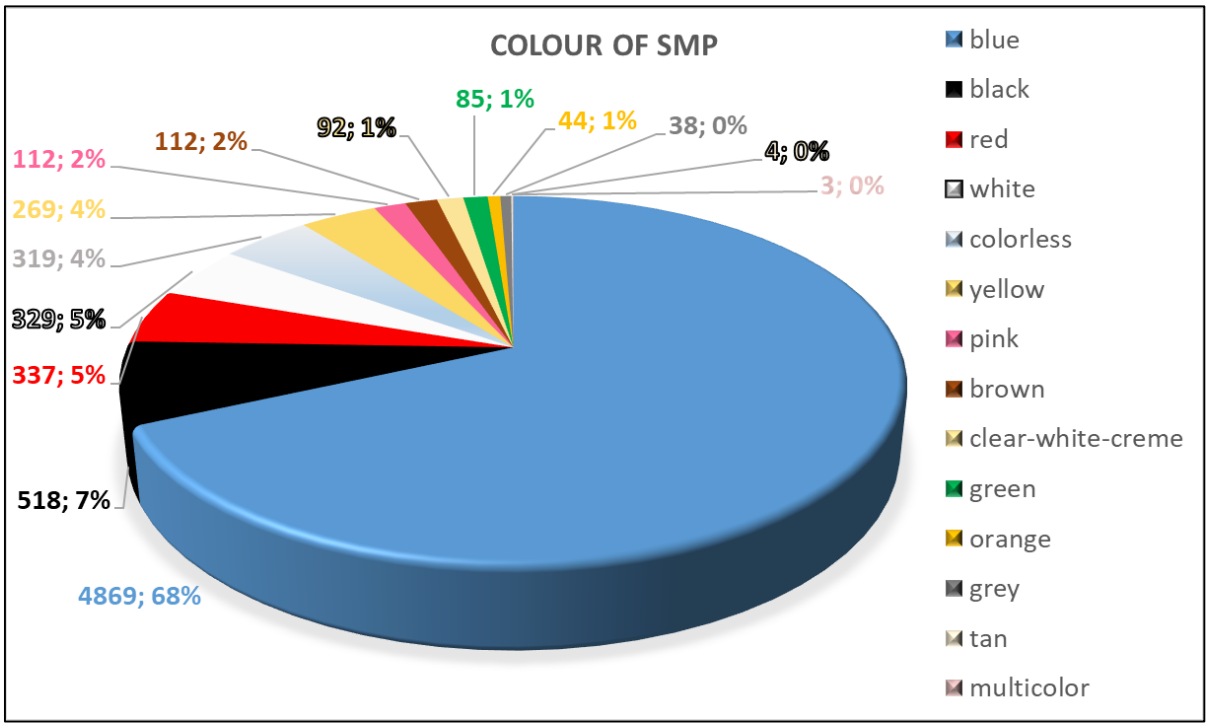

Figure 14 - Colour of SMP identified in Delta Po samples. The values in the graphic represent the number of items for each established category and the respective percentages over the total (rounded up).

In addition, the aspect of the examined items was considered from the point of view of their transparency properties (Fig. 15). Results of the analyses suggest that the 89% of the determined SMP items was opaque, while the 11% was transparent.

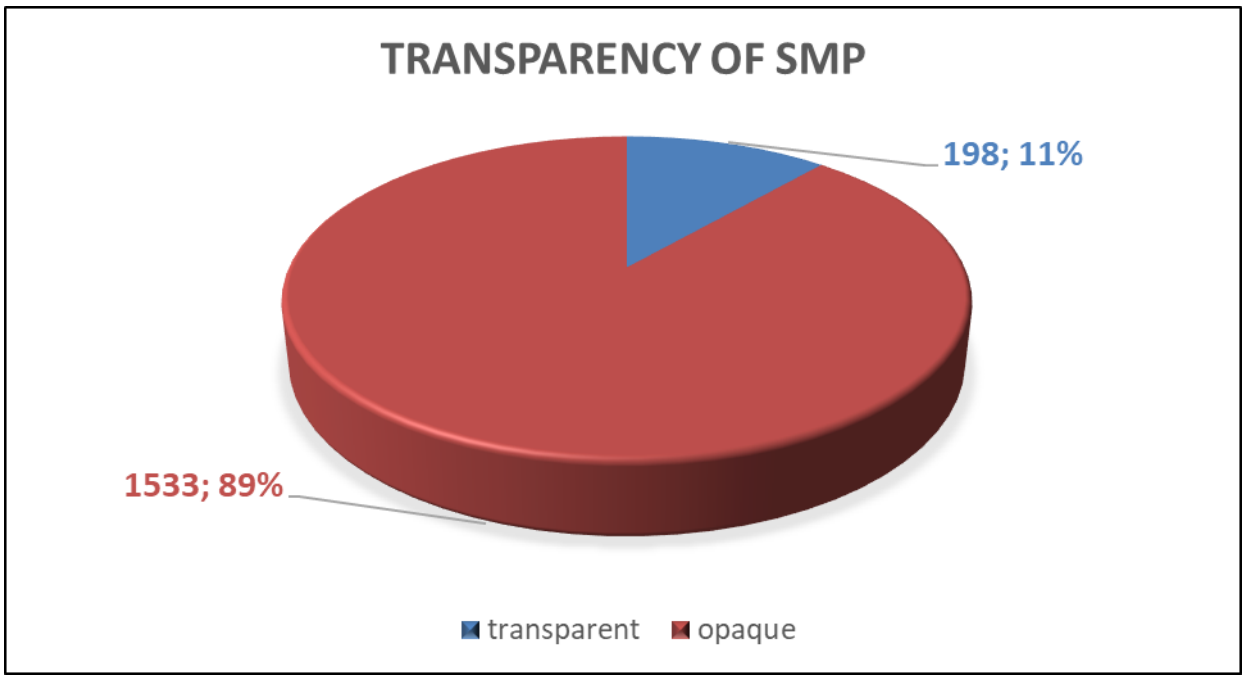

Figure 15 - Transparency of SMP. The values in the graphic represent the number of items for each established category and the respective percentages over the total (rounded up).

2.4 Micro Plastic from Sea Surface Layer (> 300 µm)

For what concern the micro plastic from sea surface layer (mP-SSL), separated from the samples collected in Po Delta pilot site, 1225 items were identified in 4 samples analysed.

Of the 1225 mP-SSL isolated, 751 items pertain to the beaches of the northern sector (Rosolina Mare and Porto Tolle Municipalities – Rovigo, Italy), while 474 items pertain to the beaches sampled in the southern sector of Po Delta (Goro and Comacchio Municipalities – Ferrara, Italy) (Fig. 16).

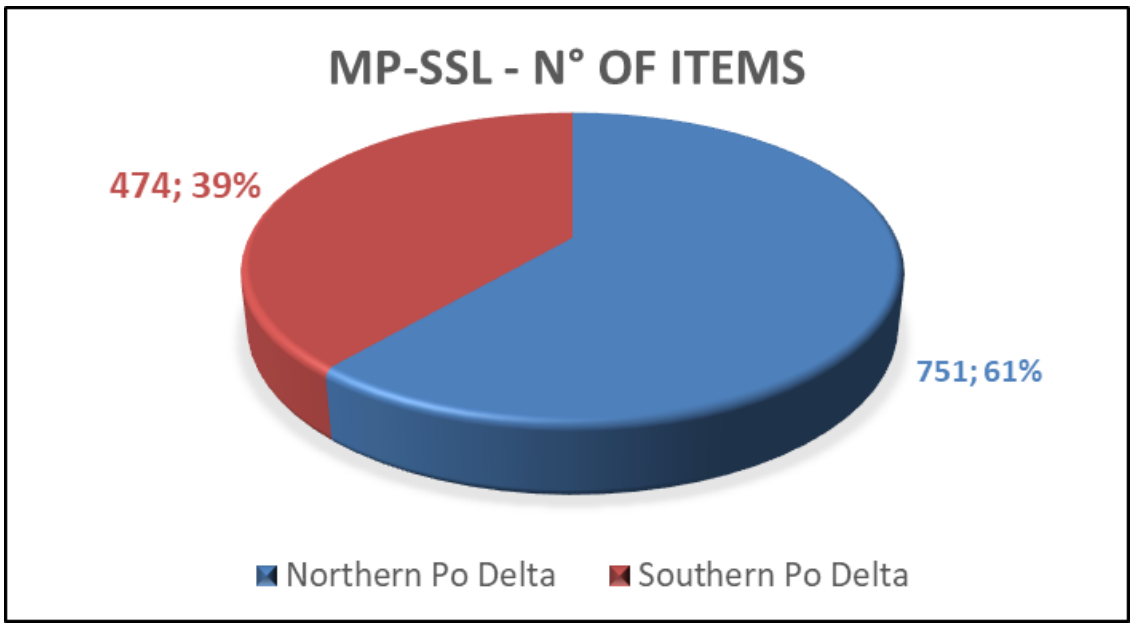

Figure 16 - MP-SSL items from Po Delta area, Italian pilot site of NET4mPLASTIC Project. The values in the graphic represent the number of items for the two categories (Northern Po Delta and Southern Po Delta) and the respective percentages over the total (rounded up).

Concerning the typology of mP-SSL detected, the protocol employed allowed to identify 8 item categories (fragment, pellet, granule, filament, film, foam, other -nonplastic materials-, uncategorized plastic pieces). In particular, the most abundant typologies resulted in filaments (53,22%) and fragments (41,55%), followed by granule (3,1805%), foam (0,98%), film (0,82%) and uncategorized plastic pieces (0,24%). The remaining 2 categories of items (pellet and other -nonplastic materials-) were not detected in the analysed samples (Fig. 17).

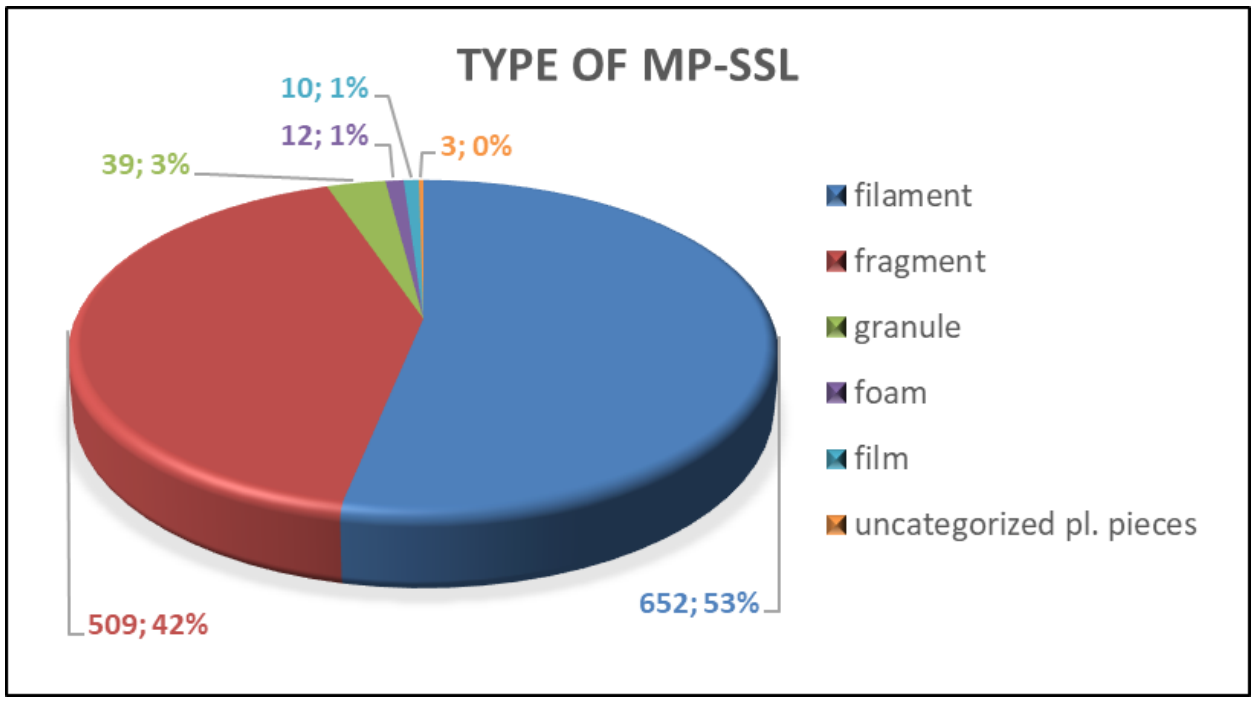

Figure 17 - Type of mP-SSL identified in Delta Po samples. The values in the graphic represent the number of items for each established category and the respective percentages over the total (rounded up).

In general, all items were measured by their main diagonal. Filaments were measured by their total length, leaving out the width. For granule was considered the measure of the diameter. For fragments, film, foam and uncategorized plastic items both length and width were measured.

The average length of all mP-SSL is 375,45 µm (Std. dev. 457,13; Min. 20,02 µm; Max. 4514,77 µm). The average width is 172,01 µm (Std. dev. 229,69; Min. 6,59 µm; Max. 1089,64 µm).

As shown in the results, although the protocol allows mP-SSL sampling greater than 300 µm in size (mesh size of the manta-net), it was also possible to identify items of smaller dimensions, probably trapped in the manta-net as aggregates to others materials (natural and / or artificial).

For what concern the colour of mP-SSL, the protocol employed allowed to identify 12 "categories of colour": white, clear-white-creme, red, orange, blue, black, grey, brown, green, pink, tan, yellow. The results achieved show that all the mentioned categories have been detected in the samples. Moreover, stereomicroscopic observations allowed to identify 2 additional categories:

- **Multicolor**: "composite" items which present more than one colour, none of which is predominant;
- **Colorless**: items with a faded aspect, which does not allow to clearly attribute them to one of the colour categories described above.

More specifically, as shown in Figure 18, the most abundant colour typology turned out to be the blue one (49.47 %), followed by:

- Colorless - 20,57%
- White - 7,51%
- Green - 4,75%
- Pink - 3,51%
- Red - 3,35%
- Orange - 3,10%
- Yellow - 2,53%
- Clear-white-creme - 2,37%
- Tan - 0,98%
- Grey - 0,90%
- Black - 0,82%
- Brown - 0,24%
- Multi-color - 0,08%

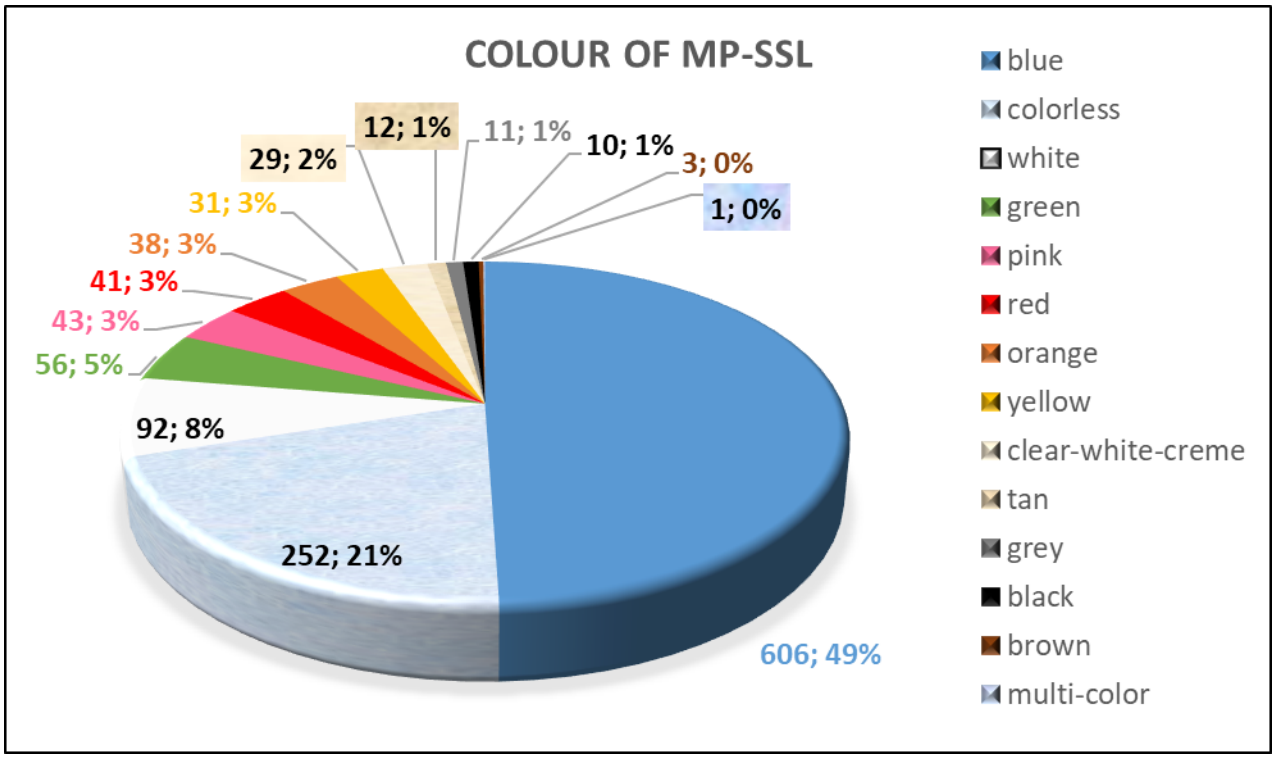

Figure 18 - Colour of mP-SSL identified in Delta Po samples. The values in the graphic represent the number of items for each established category and the respective percentages over the total (rounded up).

In addition, the aspect of the examined items was considered from the point of view of their transparency properties (Fig. 19). Results of the analyses suggest that the 63% of the determined items was transparent, while the 37% was opaque.

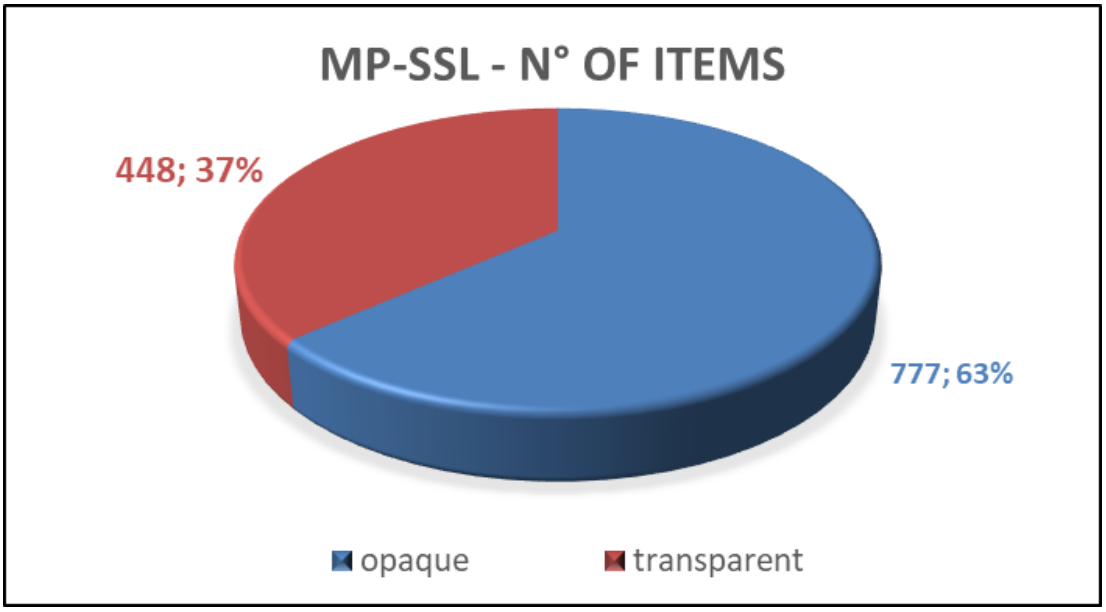

Figure 19 - Transparency of SMP. The values in the graphic represent the number of items for each established category and the respective percentages over the total (rounded up).

3 RERA - IOF – Results

Within the project NET4mPLASTIC, RERA in collaboration with IOF, carried on different kinds of sampling in the pilot sites over the Croatian Coast. Sampling methodologies are described in detail in the deliverable 4.1.1. Below are presented the results achieved regarding microplastics, sorted by sampling methods.

3.1 LMP – Large Micro Plastic (1 – 5 mm) from beach sediment

The microplastic samples from the sandy beach sediments differ greatly between stations both, in terms of the number and type of particles present. On the one hand, there are the beaches near the mouths of the Cetina and Neretva rivers (LMP-Duće, LMP-Neretva), where the concentrations of microplastic particles were generally <1 N/kg in all three samplings periods (Fig. 20). Although the number of particles is small, we can say that fragments (G103-G106) are more frequent at the mouth of Neretva River, while fragments, filaments (G113) and other particles (mainly glass; G217) are equally represented at Duće beach (Fig. 21). On the other hand, there are beaches far from urban areas or river discharges, located on the southern shores of the Pelješac peninsula (LMP-Prapratno) and the island of Vis (LMP-Zaglav) where higher concentrations of microplastics are occasionally detected. At Prapratno beach higher values were recorded in June 2021 and October 2022 (4.46 and 5.25 N/kg, respectively), while by far the highest density of microplastic particles was recorded at Zaglav beach in September 2022 (11.86 N/kg) (Fig. 20), with fragments being the most common type of particles (80.7%). For the two mentioned beaches, the presence of different types of pellets (G107-G112) is very significant, contributing 13.9% to the total concentration at Prapratno beach and 7.4% at Zaglav beach (Fig. 21). Pellets are usually used as raw material for the production of plastics, and their presence on these beaches is evidence of the strong influence of waves, currents and winds that bring them to these pristine areas, since there is no direct source of such waste nearby.

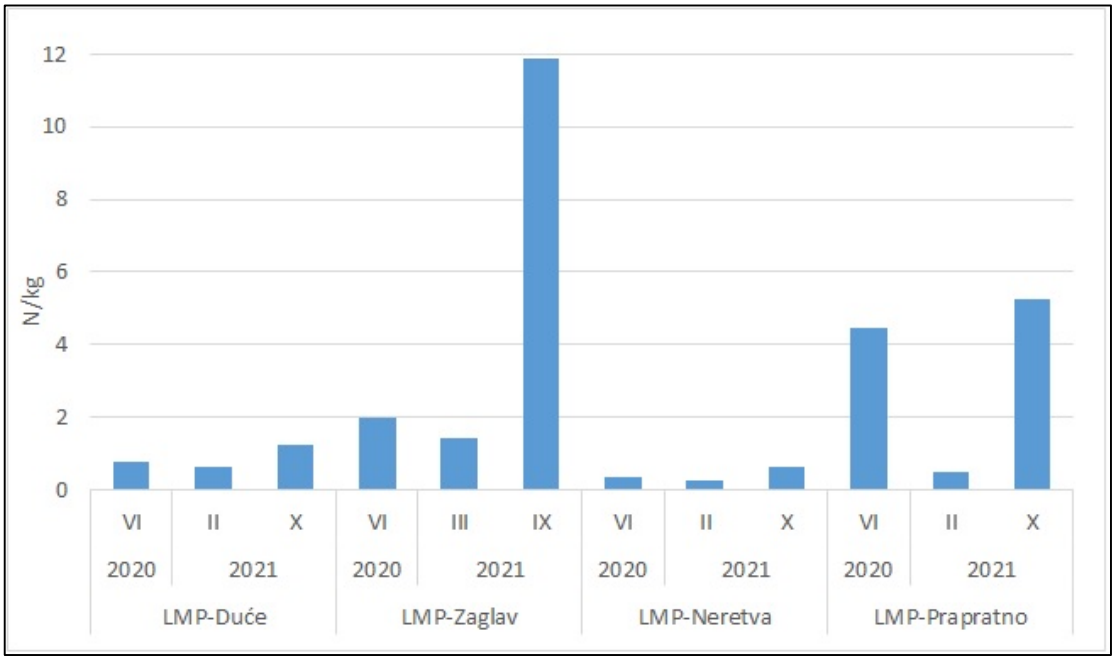

Figure 20 - Number of microplastic particles per kg of sandy beach sediment in the central (LMP-Duće, LMP-Zaglav) and southern Adriatic Sea (LMP-Neretva, LMP-Prapratno).

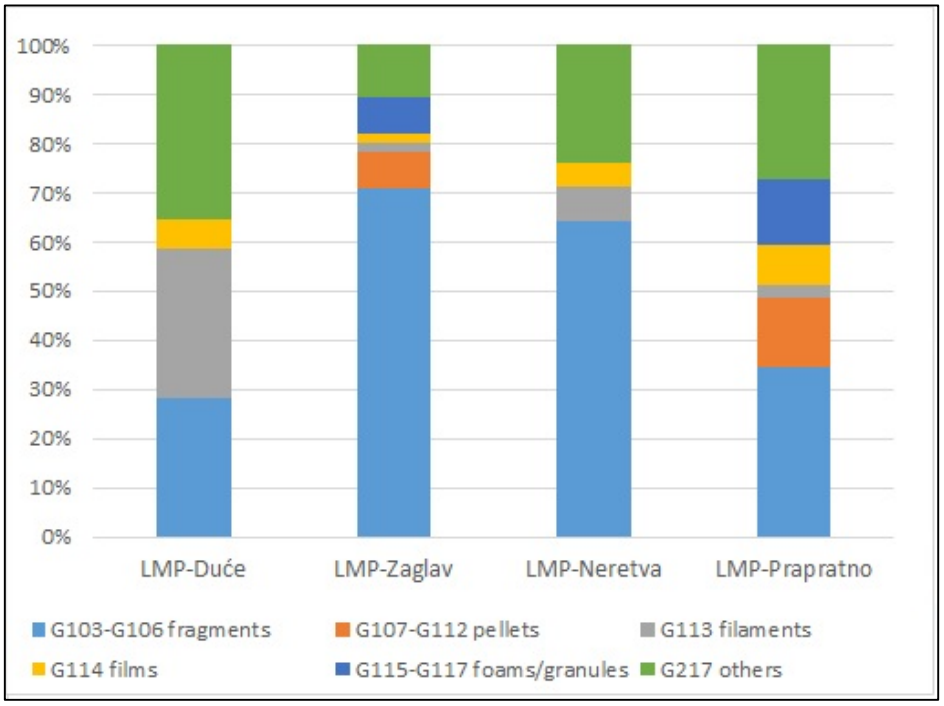

Figure 21 - Percentage contribution of microplastic categories in the sandy beach sediment in the central (LMP-Duće, LMP-Zaglav) and southern Adriatic Sea (LMP-Neretva, LMP-Prapratno).

3.2 Micro Plastic from Sea Surface Layer

Comparing the results for microplastics from the sea surface, a similar difference between the stations as in the analysis of microplastics from the sediment can be seen. On the one hand, there are stations near river mouths (MikroP-Brački kanal, MikroP-Neretvanski kanal) where generally lower concentration of microplastic particles are found (<10,000 N/km^2 during all sampling periods). In contrast, significantly higher amounts of microplastic particles were recorded at the stations characterized with open waters and more pronounced influence of sea currents (MikroP-Hvarski kanal, MikroP-Mljet). The highest concentrations of microplastic particles were recorded in July 2020 along the southwest coast of the island of Mljet (41666.67 N/km2) and in the Hvar channel (29687.5 N/km^2) (Fig. 22). Significantly lower concentrations of microplastics were observed during the spring sampling in March/May 2021 than during the autumn sampling in September/October 2021, when higher values were again observed at stations that are more influenced by sea currents and waves and where there is no obvious source of pollution. In addition to the quantitative differences between stations, there is also a qualitative difference in the composition of microplastics, i.e. the proportion of certain particles in the total number. In general, films (G114) were the most numerous particles (41.7-59,3%) at all stations (Fig. 23). While different types of fragments (G103-G106) are more abundant in the channels of Mljet and Hvar, the proportion of filaments (G113) is more significant near the mouths of Cetina and Neretva rivers. Fragments and films, which make up the majority of microplastic particles found, are secondary microplastic resulting from fragmentation of larger plastic pieces exposed to weathering conditions in the marine environment.

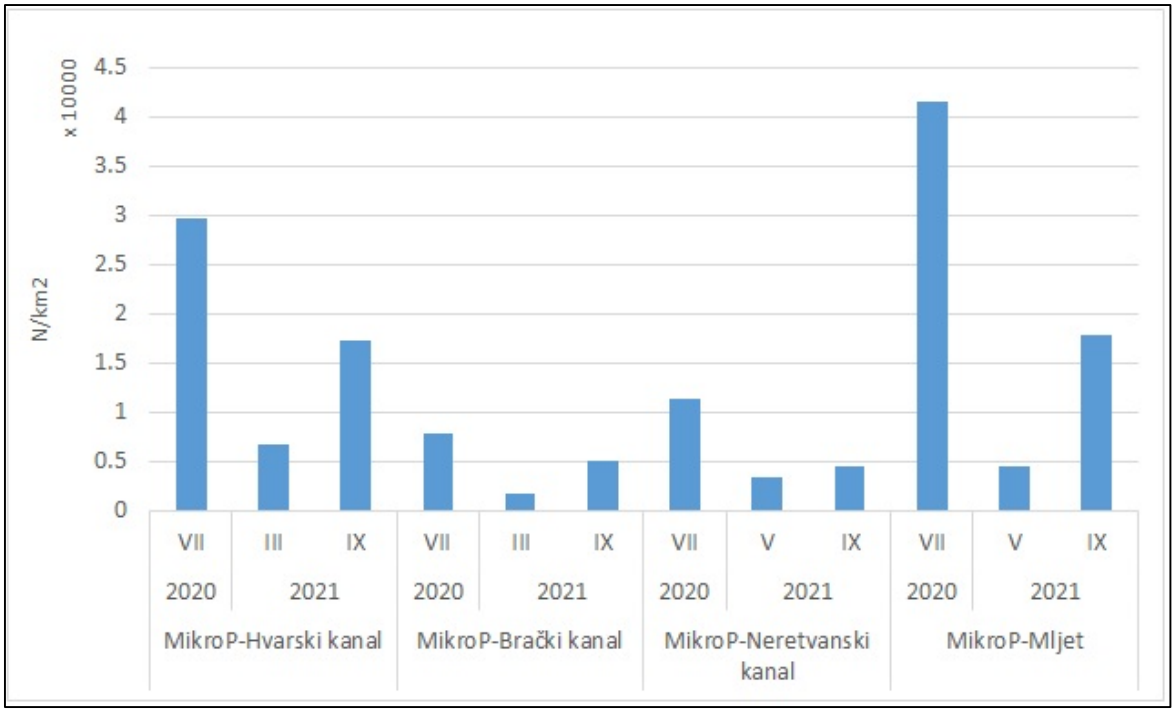

Figure 22 - Number of microplastic particles per square kilometres (N/km2) of sea surface in the central (MikroP-Brački kanal, MikroP-Hvarski kanal) and southern Adriatic Sea (MikroP-Neretvanski kanal, MikroP-Mljet).

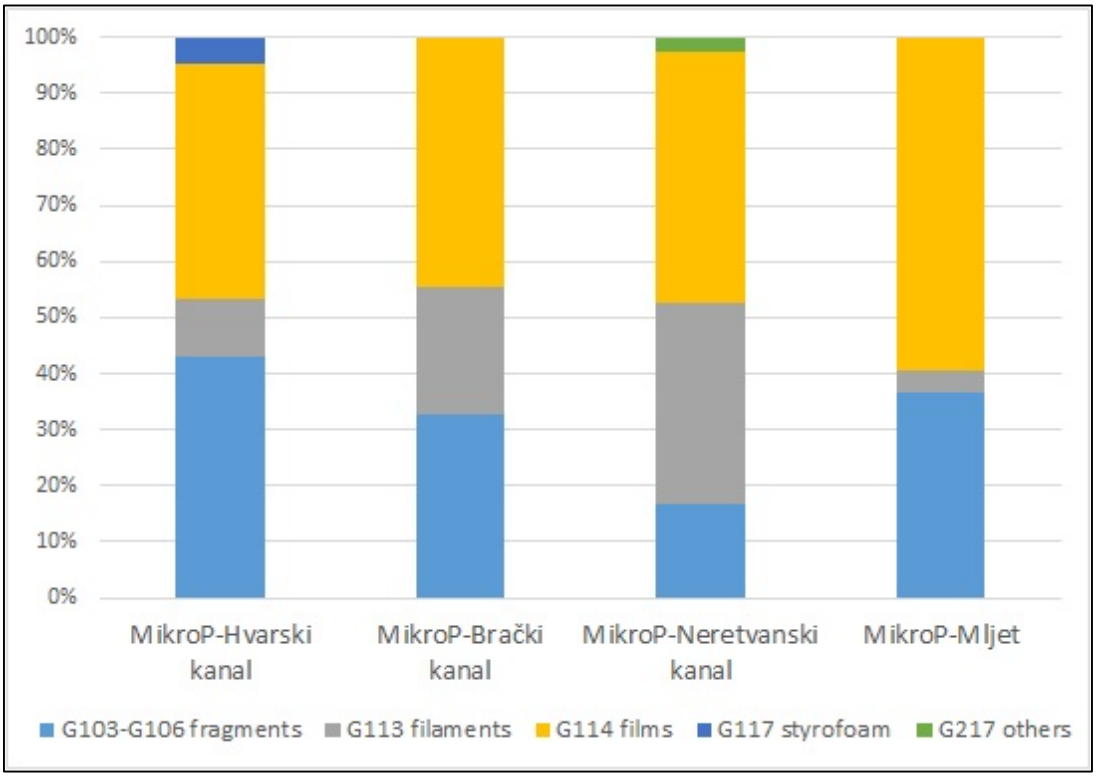

Figure 23 - Percentage contribution of microplastic categories on the sea surface in the central (MikroP-Bračkí kanal, MikroP-Hvarski kanal) and southern Adriatic Sea (MikroP-Neretvanski kanal, MikroP-Mljet).

3.2.1 Marine drone field campaign

A concentration of 14473.7 N/km^2, or 8.9 x 10-5 N/L, was determined in the sample from the station near Katalinića brig outflow. A slightly higher concentration was found in the sample from the station near the Stobreč outflow, 17565.9 N/km2, or 10.8 x 10-5 N/L (Fig. 24). Filaments predominated in both samples, 72.7% at ST1 station and 42.9% at ST2 station. In the samples collected by the small Manta net, significantly less microplastic particles were found, only 1 filament at station ST2, and at ST1 station, 6 particles were found of which 4 (66.7%) were filaments and 2 (33.3%) angular fragments.

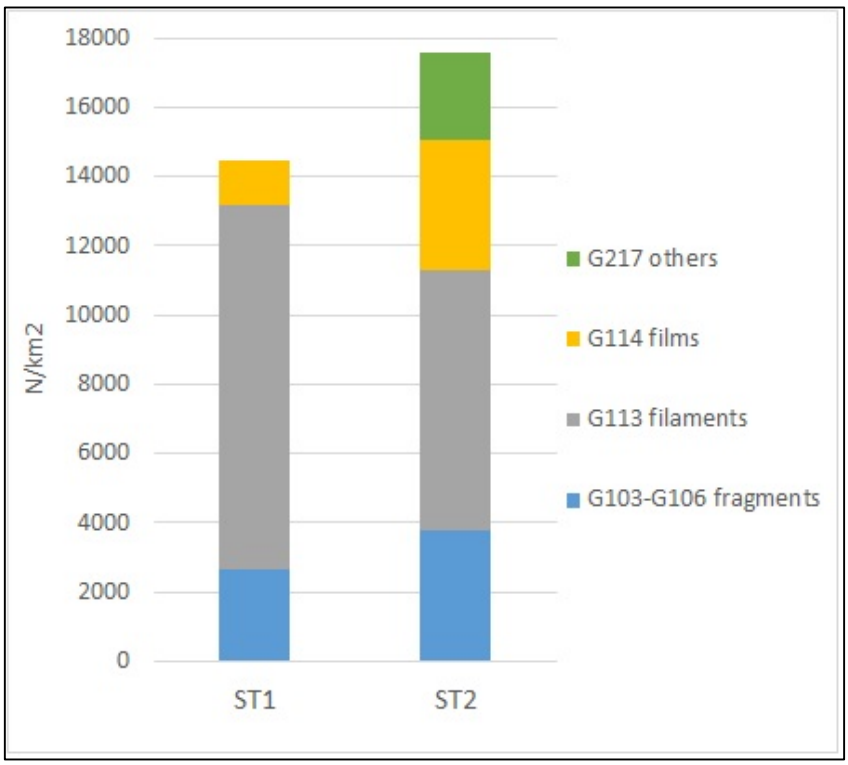

Figure 24 - Percentage contribution of microplastic categories on the sea surface sampled with big Manta net near Katalinića brig (ST1) and Stobreč (ST2) sewage outflows.

3.3 Discussion of the data collected in Split area

The conclusions that can be drawn from the results of the investigations of beach sediment and sea surface microplastics in the Split area can be considered separately for the stations near the mouths of the rivers Cetina and Neretva and for the stations that are more influenced by the prevailing sea currents and winds. At these other stations, which do not have land-based sources of pollution such as landfills, sewage discharges, industrial plants and river discharges nearby, higher concentrations of microplastics were found, both at the sea surface and in the sediment. It can be concluded that the main contributor to the amount and distribution of litter, including microplastics, in this area is the litter brought by sea currents and southerly winds from distant areas. Contrary then expected, lower concentrations of microplastics, both in sediment and at the sea surface, were found at stations near the river mouths.

4 TIPH - Results

The TIPH-team performed some sampling campaigns for beach, sea-surface and biota marine litter and MP data collection, in different sites close to Rijeka, 5 times in 2021 and 2 times in 2022 (including both beach and sea-surface sampling). The chosen beaches, that are in very touristic places, were almost perfectly clean, both in summer and spring season (less than 100 ML items). Probably, due to the presence of high tide that often submerge one of the sites, it appears almost clean due to the currents that transport marine litter away from the shore. Also analysing sea-surface samples, it was hard to find marine litter. For MPs in beach sediments, water and biota the most abundant category was filaments.

4.1 MP from Beach Sediment (< 5 mm)

Microplastic items were collected and analysed on three sandy beaches in Rijeka area: Meline beach in Soline bay on the Island of Krk, Rajska plaza in Lopar on the Island of Rab and on the beach on the Island of Susak. The dates and the locations of sampling are described in the Deliverable D.4.1.1. Results from Meline beach in Soline bay on the Island of Krk were discarded latter. The sand particles are very small so it was very difficult to separate microplastic items from sand particles. In this report only the results of the analysis of the samples from Rajska plaza in Lopar on the Island of Rab and the beach on the Island of Susak are discussed.

On the two beaches in total 91 plastic items were found that were smaller than 5 mm. On average there was 1 microplastic item per $1m^2$ found in July 2021 and 7 microplastic items per $1m^2$ found in September 2021 on the beach on the Island of Susak. Similar results are recorded at the Rajska plaza in Lopar on the Island of Rab. In May 2021 on average there were 2,33 microplastic items per $1m^2$ found on that beach and in September 2021 there were 7,2 microplastic items per $1m^2$ found. Results show us that more microplastic items were found at the end of the bathing season in September on both beaches than at the beginning of bathing season. 67% of the total number of microplastic items found on both beaches were filaments. Dominant colour of microplastics was white. There were 55% of white microplastics of total number of microplastic items collected on both beaches.

4.2 Micro Plastic from Sea Surface Layer (> 300 µm)

Microplastic items were collected from the sea water surface near Susak, in front of the Rajska plaza in Lopar on the Island of Rab, in Soline bay in Klimno on the Island of Krk, in the Vinodolski kanal in three locations - near Crikvenica, Šilo and Krčki most and in Omišalj on the Island of Krk. The last sample fom Omišalj on the Island of Krk was discarded because there was too much organic material (great number of flies) inside the sample so it was impossible to clean the sample and to count microplastic items. Locations are described in details in the Deliverable D.4.1.1. Methodology used for collecting and analysing the samples is also described in the Deliverable D.4.1.1. For the collection of microplastic items

from the sea water surface a Manta net was used with openings of 300 µm. The samples were analysed in the laboratory using stereozoom microscope.

In all the examined locations we collected in total 462 microplastic items smaller than 300 µm. The dominant shape of plastic items was filament with 93% of total items collected. The dominant colour was black with 48% of total number of items collected. The average number of microplastic particles is shown in the Table 1. It is visible from the data that the average number of microplastic particles is similar in all the locations.

Table 1 - Average number of microplastics per m^2 on the sampling locations in Rijeka area.

Sampling location	Geographical coordinates	Dates of sampling	Average number of microplastic per m^2
Uvala Soline	45.164073836 N 14.61571733 E	10/06/2021	0,019198
		27/10/2021	0,026798
Lopar	44.818142 N 14.548351 E	26/05/2021	0,050996
		24/09/2021	0,038397
Susak	44.818142 N 14.743231 E	28/07/2021	0,082193
		28/09/2021	0,043197
Vinodolski kanal – Crikvenica - Novi Vinodolski	45.126460 N 14.733594 E	10/06/2021	0,027598
Vinodolski kanal - Šilo	45.161218 N 14.662726 E	10/06/2021	0,023998
Krčki most	45.2484727 N 14.5697527 E	10/06/2021	0,013199
		27/10/2021	

4.3 Discussion of the data collected in Rijeka area

Micro plastic particles were found in all the investigated locations and in all collected samples – in sea water, in beach sediment and in the mussels in Rijeka area. There were no large plastic items or any kind of litter found on the beaches or in the sea water at the time of sampling.

5 UNITS – Results

A part of samples collected by UNIFE, RERA-IOF and TIPH, it was be analysed from UNITS in order to chemically categorize the MP-items to better identify their source/origin. The methods used to identify and classify the MP-items are Image analysis, Fourier-Transform Infrared Spectroscopy and Raman Spectroscopy. The results are better described in 3 reports provided after each analysis, which are to be considered as an integral part of this deliverable. The reports mentioned are attached to this document as Annexes:

- D.4.2.2 Annex 1 – Identification and classification of plastic debris via Image analysis and Fourier-Transform Infrared Spectroscopy and Raman Spectroscopy (November 2019).

This document reports on the analysis carried out on samples collected by the University of Ferrara and sent to the University of Trieste for analysis on November 2019.

- D.4.2.2 Annex 2 – Identification and classification of plastic debris via Image analysis and Fourier-Transform Infrared Spectroscopy (Rev.0 30/09/2021 - Rev.1 06/10/2021).

This document reports on the analysis carried out on samples collected by the University of Ferrara and sent to the University of Trieste for analysis on June 28, 2021. Collection sites were: Po Delta Pescara and Teramo.

- D.4.2.2 Annex 3 – Identification and classification of plastic debris via Image analysis and Fourier-Transform Infrared Spectroscopy (09/06/2022).

This document reports on the analysis carried out on samples collected by Croatian partners and sent to the University of Trieste for analysis on May 04, 2022. Collection sites were not specified but can be speculated from the names on the sample holders (Rab, Susak, Klimno).

6 Output indicator target

One of the target-output envisaged by NET4mPLASTIC project was the identification of 10.000 plastic items collected in the beach sediment, sea surface and biota sampling ("3.3O3 Microplastic waste collected in marine areas").

The target can be considered achieved, as 11.149 micro plastic items were collected and identified along the Italian and Croatian coasts of NET4mPLASTIC project pilot sites (Tab.2).

Table 2 – Micro plastic Items collected by NET4mPLASTIC Project Partners.

SAMPLING TYPE	ITEMS N.
Biota	58
MP from Sea Surface Layer	1.719
MP from Beach Sediment (< 5 mm)	91
SMP from Beach Sediment	7.420
LMP from Beach Sediment	544
MESO LITTER	502
TOTAL	11.149

Please note that that the description of locations and the dates of samplings on beaches and sea surface are included in the Deliverable 4.1.1. For the determination of number of micro plastics in mussels, the method used is described in the Deliverable 4.4.3.

7 Annexes

Annexes list:

- D.4.2.2 Annex 1 - Identification and classification of plastic debris via Image analysis, Fourier-Transform Infrared Spectroscopy and Raman Spectroscopy
- D.4.2.2 Annex 2 – Identification and classification of plastic debris via Image analysis and Fourier-Transform Infrared Spectroscopy
- D.4.2.2 Annex 3 – Identification and classification of plastic debris via Image analysis and Fourier-Transform Infrared Spectroscopy