United Nations Environment Programme

Northwest Pacific Action Plan (NOWPAP)

Pollution Monitoring Regional Activity Centre (POMRAC)

Report

Microplastics abundance in river runoff and coastal waters of the Russian part of NOWPAP area

NOWPAP POMRAC, 2019

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1. Introduction

1. 1. Background

The threat of contamination of water environment with plastic waste has recently become one of the most discussed issue due to potential of polymers to contain and emit persistent toxic substances and plasticizers, in addition to widely discussed physical impacts of these items on marine biota. The most discussed aspect of marine litter is the problem of accumulation of microplastics, formed as fragments of larger polymer items (secondary microplastic) or small scale polymer items (primary microplastic) sized between 1 μm to 5000 μm (0,001 mm and 5 mm), and particles sized below 1 μm called nanoplastics, which can be included into the trophic chains in the ocean due to their specific properties.

The land-based sources of plastic contamination of the marine environment require thorough consideration. It is widely known that basic sources of plastic entering the sea are improperly managed landfills, unauthorized dumping sites in the river basins and in the coastal areas, sewage and stormwater, and rivers. It is possible to discuss impacts of some point sources by analyzing morphological composition of microplastic particles in various segments of coastal water areas and learning some regularities of their distribution. However, it is difficult to assess share of each source in the total inflow of plastics to the ocean without more detailed data. Since 2016 NOWPAP POMRAC collected data related to microplastic contamination in coastal water of the Russian part of NOWPAP, first publishing a case study of microplastic contamination in the coastal marine water area in the Russian part of NOWPAP region under the RAP MALI activity in 2018 ("Microplastic Pollution in the coastal water of the Peter the Great Gulf: content and distribution. The first stage of survey"). POMRAC activity 'Microplastics abundance in river runoff and coastal waters of the NOWPAP region' was approved by the 21 IGM in 2017 as part of the activities on WG2 – River and Direct inputs of contaminants into the marine environment of the NOWPAP region. Its basic idea is to assess inflow of microplastic particles with rivers discharging into the marine area of NOWPAP and finding relations with plastic contamination in the adjoining coastal waters. This report describes the results of work performed under the abovementioned activity in 2017 and during biennium of 2018-2019, and follows findings indicated in previous POMRAC technical report #13.

1. 2. Objective of the activity

Specific objective of this activity is to trace possible impact of rivers on microplastics quantity and composition in the coastal waters within the Russian part of the NOWPAP region and to obtain background information on the distribution of different kinds of microplastics in these rivers. We also try to reveal possible impact of seasonal factor on river discharge and distribution of the contaminant in the coastal marine environment and geographical peculiarities of such distribution.

The regular seasonal surveys in the Russian Far East is a basis for the case study. These surveys were organized to reveal microplastic particles in the rivers and coastal seawater of the study area, describe their quantities, type/size characteristics, distribution, and possible sources. The analysis of collected and processed samples of microplastic particles was carried out using equipment Raman spectroscopy of NSCMB FEBRAS (National Science Center of Marine Biology).

The following steps were taken to achieve the objective of this project:

1) To compare existing data on microplastics quantity and composition in the coastal water within the NOWPAP region, including further collection of the background information on the quantity and composition of plastic particles in the coastal water of the Russian part of the NOWPAP region.

2) To obtain data on the concentrations of microplastics in the rivers of the Russian part of the NOWPAP region and try to assess the microplastics input to the sea with river runoff. Collecting similar existing data from other NOWPAP countries might allow to estimate the role of river runoff in the microplastics transport.

3) To assess and analyze current methods of sampling microplastics in the seawater and fresh water and the sample treatment protocols applied in NOWPAP countries, considering possible development of general guidelines/recommendations for microplastic monitoring in NOWPAP;

4) To assess the possible impacts of river discharge, urban areas, landfills, tourism, fishery, etc. on contamination of marine ecosystems with microplastics; to share national data and to carry out related survey in the Russian part of NOWPAP.

This study is directly related to the activity of NOWPAP POMRAC on setting Ecological Quality Objectives (objective 5: “Marine litter does not adversely affect coastal and marine environments”). According to the structure of the EcoQOs, further studies of microplastic contamination should include impacts of litter on marine life by monitoring of trends in the amount and composition of litter ingested by marine animals. In this aspect, patterns of coastal microplastic pollution, especially registered hot spots, would be useful as spatial criteria for further studying of contamination of aquatic life with plastic litter.

2. Selection of sampling sites

The Peter the Great Gulf is an important economic area, consisting of three larger bays, i.e. Amur Bay, Ussuri Bay, and Possiet Bay, and smaller bays, such as Nakhodka, Strelok, etc. and covering 9,000 km2 of water. With its coastal zone being a home for more than one million people, it is the place for intense operation of several large seaports, as well as fishery and aquaculture enterprises. It is also important for wildlife conservation, hosting several natural marine protected areas (most of these belonging to the Far Eastern National Marine Biospheric Reserve). Maintaining good health of ecosystems in the gulf is an important condition for further sustainable development in the Russian part of NOWPAP.

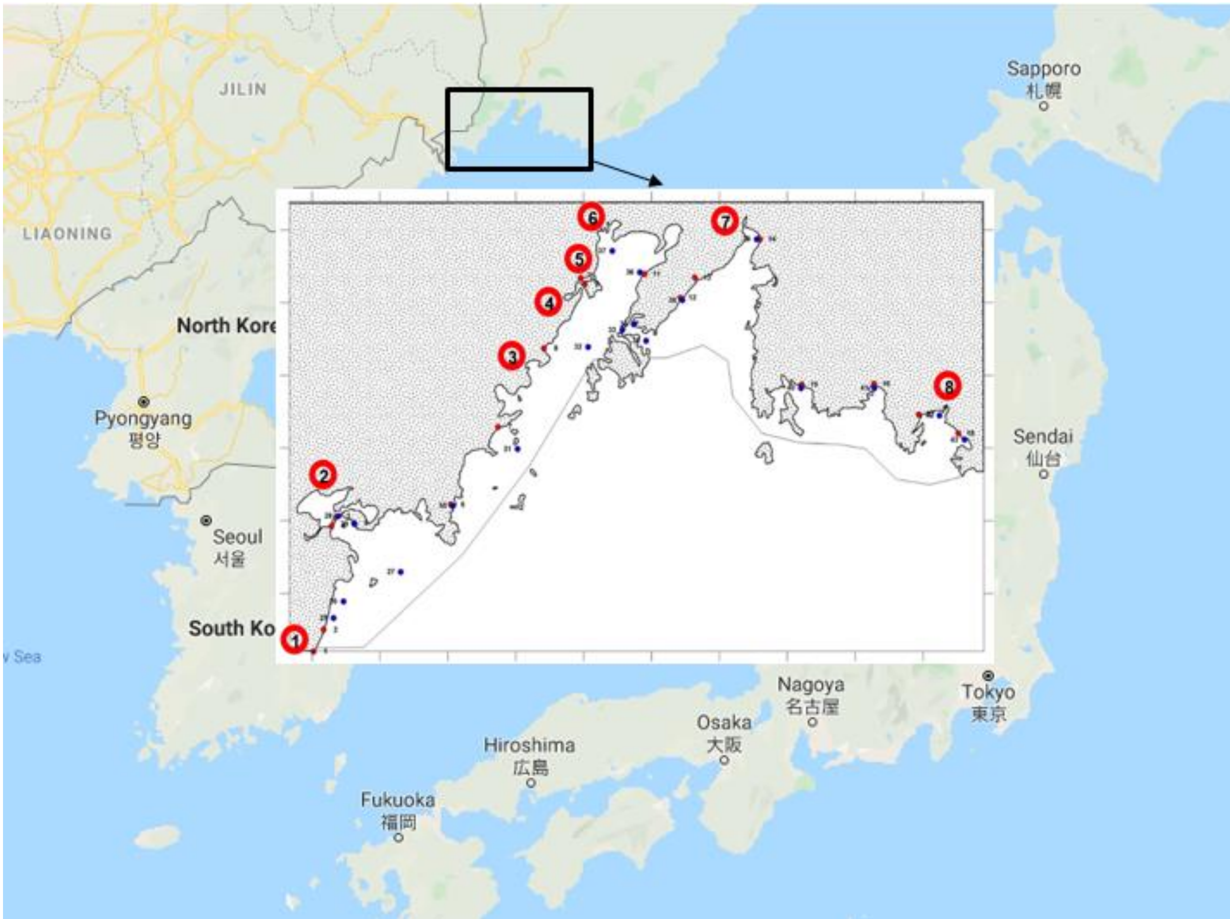

Fig. 1. Sampling sites in the Peter the Great Gulf. Red dots indicate sampling sites in the littoral water, blue dots correspond to samples from coastal water. Red circles with numbers correspond to the areas where selected rivers discharge. 1 – Tumen River, 2- Tsukanovka River, 3- Narva River, 4 – Barabashevka River, 5 – Amba River, 6 – Razdolnaya/Suifenhe River, 7 – Artemovka River, 8 – Partizanskaya River.

Considering complex task of this activity, there were selected three types of locations, including littoral water (tidal water), coastal water, and rivers. Coastal and littoral water are surveyed under the RAP MALI activity of POMRAC in 2018-2019 biennium, and rivers are specific task of this study. For the littoral, the sampling sites basically correspond to the survey carried out by POMRAC in 2016-2017, however six additional sampling locations were added for the purpose of current work (fig. 1). These locations are Tumen River mouth, Khasan seashore, Cape Nazimov (east and west), Minonosok Inlet, Srednyaya Bight, Baklan Bay, Perevoznaya Bay, Peschany Peninsula (east and west), Chaika Beach, Steklyannaya Bay, Lazurnaya Bay, Strelok Bay, Vostok Bay, Nakhodka Bay and Vrangel Bay.

In the coastal water we selected sites in proximity with Tumen River and

Razdolnaya River estuaries, near Furugelm Island, Sibiryakova Island, Russkiy Island, and in such water areas as Possiet Bay, Minonosok Inlet, Srednyaya Bight, strait between Krabbe Peninsula and Nazimov Cape, Strait Bosporus the Eastern, Ajax Bay, Diomid, Amur Bay, Ussuri Bay, Vostok Bay, Strelok Bay, Naknodka Bay, and Vrangel Bay.

Eight rivers with various characteristics of basin area size and human impacts were selected for the study, including transboundary and local, covering territories with relatively large and small population numbers and those belonging to naturally protected natural areas such as the Land of Leopard. Table 1 shows the basic parameters of the study rivers.

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Rivers	Length, km	Basin area, km^2	Average annual discharge, m^3/s
Tumen	516	33,168	215
Tsukanovka	29	175	2.26
Narva	38	332	6.24
Barabashevka	68	576	9.10
Amba	63	330	4.98
Razdolnaya/Suifenhe	245	16,830	81.3
Artemovka	73	1,460	8.8
Partizanskaya	142	4,140	36.9

Table 1. Basic hydrographical parameters of the study rivers

3. Methods applied in this study

In this study, we tried to apply the most appropriate and affordable methodology of sampling, sample processing and analysis, as far as at this stage this effort is merely an institutional task.

The sampling and analysis methods already applied by other NOWPAP members, especially Japan (Tokyo University of Marine Science and Technology, Kyushy University) and Republic of Korea (Korean Institute of Ocean Studies and Technologies), were taken into account to develop these studies.

3.1. Sampling methods

3.1.1. sampling in the littoral

In this study, we use a plankton net for the sampling in the littoral (tidal) water. It is transformed into a hand-net by attaching a retractable rod (the adjusted length is approx. 1-3 meters) to its mouth ring. The samples are collected along the selected sampling site by horizontal filtering with the net half-submerged into the water. To calculate the volume of filtered water, we apply a mechanical flowmeter (Hydro-bios, model 438-110, Germany) attached to the net mouth. The volume of filtered water is calculated based on the number of the impeller rotations and the submerged net mouth area. The samples are transferred into plastic bottles of 1000 ml. The volume of filtered water in the tidal zone depends to a considerable extent on the amount of suspended sand and algae in the sampling location. After each filtering, the net walls are rinsed at least thrice from the outside into the related sample containers to include possible remaining plastic particles. After each sampling procedure, the net is rinsed in the fresh water.

3.1.2. sampling in the coastal water

In addition to the plankton net we used a neuston net to collect water samples at the distance 100-300 m from the shoreline. Table 1 shows the basic parameters of this net.

The manta net/neuston net is considered (Hidalgo-Ruz et al., 2012) as a highly efficient tool for horizontal water sampling in sea. It is very useful for filtering of tens or hundreds cubic meters of water (depending on the mouth area) for a relatively short time (10-20 minutes). The construction of manta net provides its high buoyancy without a need to control the depth of its mouth frame, while the depth of neuston net should be controlled during the tow. We had a neuston net for the research. During the first sampling, the net was directly towed by a motor boat. Later, we attached it (with additional frame providing adjustable fixed depth) to a catamaran dragged by a motor boat. In this case, suddenly reduced towing speed did not result in the submerging of the net frame below sea surface. The average speed of the trawling was 1.5 knots, and the time was 15-20 minutes or more. The water volume was also calculated based on the number of revolutions of flowmeter attached under the boat/catamaran. As in case with hand net samples, the filtered neuston trawl was poured into plastic bottles, including water used for rinsing the net walls. After collection, the samples were brought to the laboratory for further analysis.

3.1.2. sampling in the rivers

Sampling in the rivers was carried out in spring, summer and autumn months from 2016 to 2018. When filtering water to a depth of 15 cm, as in the case with coastal waters, a neuston net with similar characteristics was applied. The net mounted on a catamaran (held with anchor against the current) was set in the middle part of stream. In all cases, the immersion depth of the net was fixed using movable frame mounted on the catamaran. The volume of the filtered water was also determined according to the flowmeter attached in the middle of the net mouth. At the end of sampling at each point, the net in the raised position of the movable frame was taken ashore and after external rinsing of its walls the filtrate was poured through an open valve into clean plastic bottles.

In addition to filtering the surface layer, in areas of selected rivers with a depth of more than 1 meter, samples were taken at a depth of 1-2 m to assess the vertical distribution of the contaminant. For this purpose, a submersible electric pump with a silicone hose was applied. The water was pumped into a plankton net similar to that used for sampling water on the littoral. From the net, samples were also transferred to plastic bottles for subsequent analysis.

3.2. Sample treatment procedure

The sample treatment procedure generally coincides with the NOAA sample treatment protocols (Laboratory Methods…, 2015). The following stages are included in the process:

3.3. Type/size description of microplastics

Sorting and type-size identification of the plastic particles is carried out using a stereomicroscope (Discovery V12). By size classification, the following major groups are selected for this study: 0.1-0.3 mm (smaller microplastics) 0.3-1 mm (middle size microplastics), 1-5 mm (larger microplastics), and 5-25 mm (mesoplastics). In this research, the size of the smallest microplastic particles is 0.1 mm corresponding to the sampling mesh size. The size of the plastic particles is determined using the camera application installed on the microscope. Main types of the obtained plastic are identified as follows: fibers, fragments, films, foam, and microbeads.

Fig. 2 a) suspected plastic particles in a sample from coastal water near Tumen River estuary prepared for spectra identification (4x magnification)

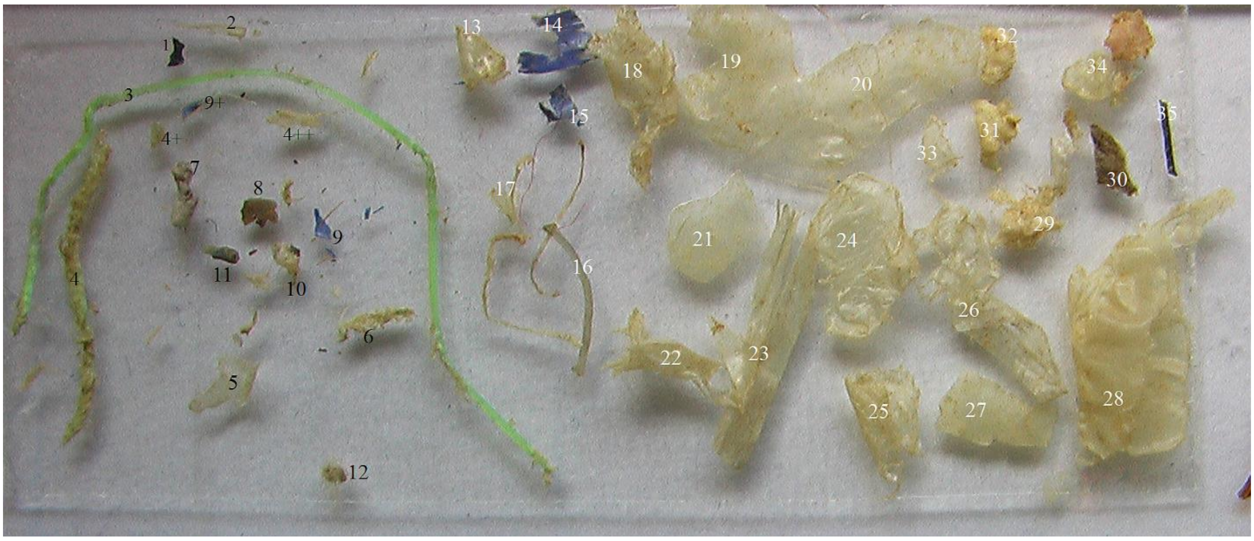
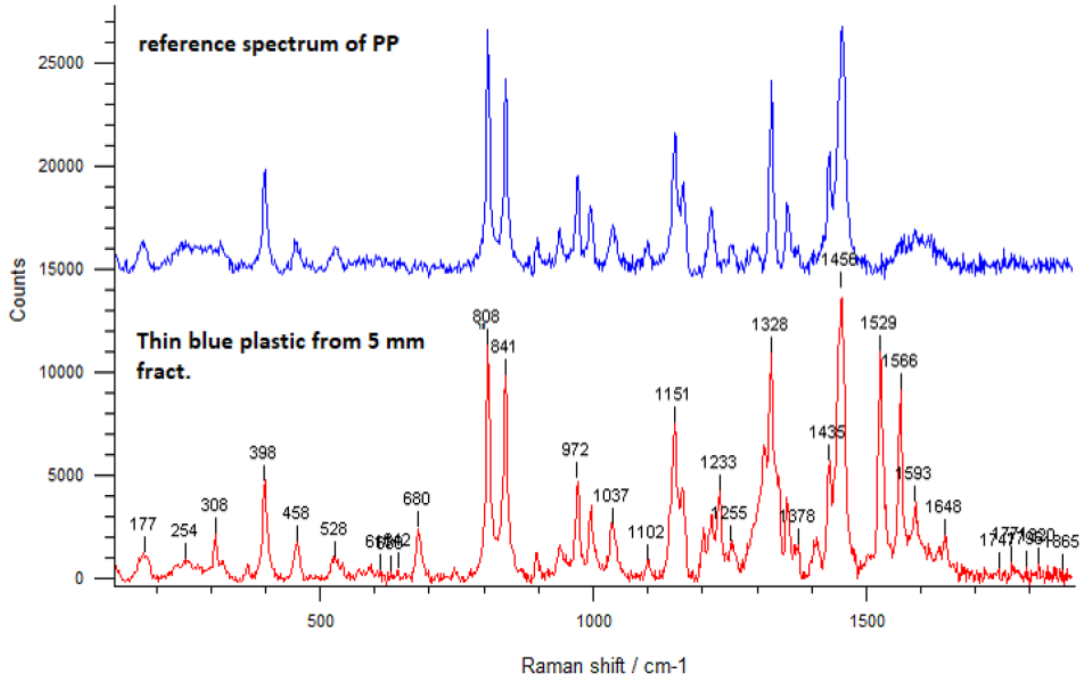


Fig. 2 b) suspected plastic particles in a sample from Razdolnaya/Suifenhe River prepared for spectra identification (4x magnification)

3.5. Polymer type identification

The Raman spectra were obtained with a spectrometric microscope (in Via Reflex, Renishaw, UK) combined with incident light microscope (Leica DM2500M, Leica-microsystems, Germany). Diode laser 532 μm was applied for excitation under 1.0 MW wattage and exposure time 0.1 s for the sequence of 100 scans. Laser spot with diameter approximately 1.6 μm was formed with the lens (20x, NA=0.4, Leica).



Peak no.	Centre	Height	Width	Area	Absolute inten...	Low edge	Hi
1	176.71	1222.34	22.2783	26081	1236.04	145.108	20

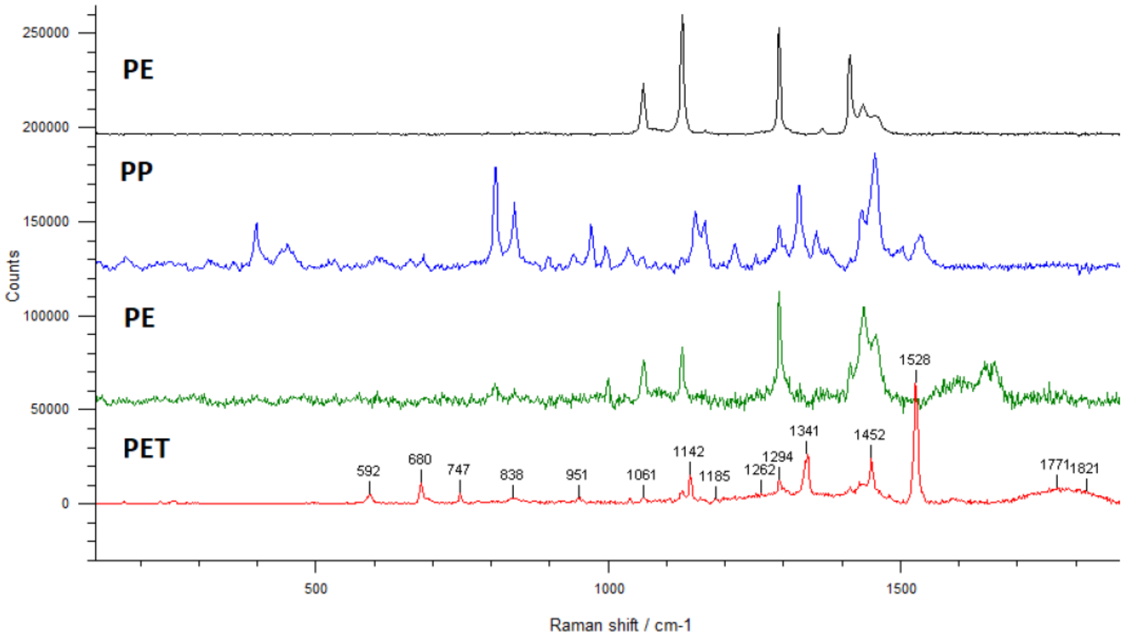


Fig. 3. Examples of Raman spectra used for identification of polymer types of suggested mciroplastics

4. Distribution of plastic particles

The highest average concentrations of the pollutant (2.763 items / m3) were observed in the Tumen River, affecting the southwestern part of the gulf, and Razdolnaya/Suifenhe (1.104 items/m3 at station 1 and 0.819 items/m3 at station 2). The plastic content in the water of the rivers Artemovka (0.060 items / m3) and Partizanskaya (0.025 items / m3 and 0.027 items / m3 at 1st and 2nd stations, respectively), which belong to the central and eastern parts of the research area, was lower. No microplastics were found in four of the studied rivers. These are Tsukanovka, Narva, Amba and Barabashevka rivers, flowing into the southwestern part of the studied water area. Table 2 shows average concentrations of different fragment types of microplastics revealed in all survey rivers.

River	Type I - film	Type II - fragment	Type III - fiber	Type IV - foam	Type V - microbead	Total amount of I-V per 1m3
Tumen	0.924	0.727	0.535	0.577	0.002	2.765
Tsukanovka	0	0	0	0	0	0
Narva	0	0	0	0	0	0
Barabashevka	0	0	0	0	0	0
Amba	0	0	0	0	0	0
Razdolnaya/Suifenhe (site 1)	0.558	0.370	0.140	0.037	0	1.105
Razdolnaya/Suifenhe (site 2)	0.358	0.206	0.236	0.020	0.001	0.821
Artemovka	0.014	0.011	0.033	0.002	0	0.060
Partizanskaya (site 1)	0.010	0.007	0.007	0	0	0.024
Razdolnaya/Suifenhe (site 2)	0.008	0.006	0.013	0.002	0	0.029

Table 2. Average concentrations of different fragment types of microplastics revealed in all survey rivers

Morphotype I (films) prevailed over the other types in the Tumen River water (0.923 items/m3), in both stations of the Razdolnaya River (0.558 items/m3 and 0.358 items / m3) and on the 1st station of Partizanskaya River (0.010 items/m3) and was registered in all contaminated rivers. Morphotype II (fragments) was not predominant in any of the studied rivers; however, its concentrations were quite high in the Tumen River (0.727 items / m3) and Razdolnaya River (0.370 and 0.206 items / m3). At the same time, it was also registered in all rivers where microplastic was contained.

In the Artemovka River and in the second section of the Partizanskaya River fibers were prevailing (morphotype III), while their concentration in these rivers, like other morphotypes, is one or two orders of magnitude lower than in the Tumen River (0.535 items/ m3) and Razdolnaya River (0.140 - 0.236 items/m3). Morphotype IV (foam) is most characteristic for the Tumen River water, where its average concentration is 0.577 items/m3), which is one order of magnitude higher than in the Razdolnaya River (0.036 -

0.019 items/m3) and two orders of magnitude higher than in other polluted rivers. In the estuary section (2nd station) of the Partizanskaya River foam was not observed.

Morphotype V (microbeads), as in the case of the coastal and littoral water of the study area, has the lowest concentration, while it was revealed only in the Tumen River (0.001 items/m3) and in the 2nd section of the Razdolnaya River (<0.001 items / m3)

Type	**Size categories**	**Maximum concentration**	**Average**	**95% confidential interval**	
				Lower	**Upper**
Film	**0.1-0.3**	0.700	0.033	0.010	0.060
	0.3-1	0.700	0.105	0.062	0.147
	1-5	1.570	0.106	0.051	0.170
	5-25	0.900	0.034	0.007	0.067
	Total	**3.200**	**0.278**	**0.144**	**0.418**
Fragment	**0.1-0.3**	0.900	0.049	0.023	0.080
	0.3-1	0.800	0.084	0.043	0.127
	1-5	0.970	0.056	0.018	0.100
	5-25	0.370	0.010	0.001	0.022
	Total	**2.000**	**0.201**	**0.098**	**0.310**
Fibers	**0.1-0.3**	0.050	0.001	0.000	0.003
	0.3-1	0.450	0.042	0.019	0.064
	1-5	0.550	0.092	0.060	0.124
	5-25	0.250	0.022	0.010	0.035
	Total	1.200	0.158	0.098	0.217
Foam	**0.1-0.3**	0.030	0.000	0.000	0.001
	0.3-1	0.150	0.010	0.003	0.018
	1-5	2.740	0.084	0.009	0.180
	5-25	0.54	0.009	0.000	0.026
	Total	3.300	0.105	0.014	0.216
Microbeads	**0.1-0.3**	0.000	0.000	0.000	0.000
	0.3-1	0.020	0.0004	0.000	0.001
	1-5	0.000	0.000	0.000	0.000
	5-25	0.000	0.000	0.000	0.000
	Total	0.020	0.0004	0.000	0.001

Table 3. Size differentiation of micro-and mesoplastics per m^3 in each studied river for all period of survey considering all fragment types

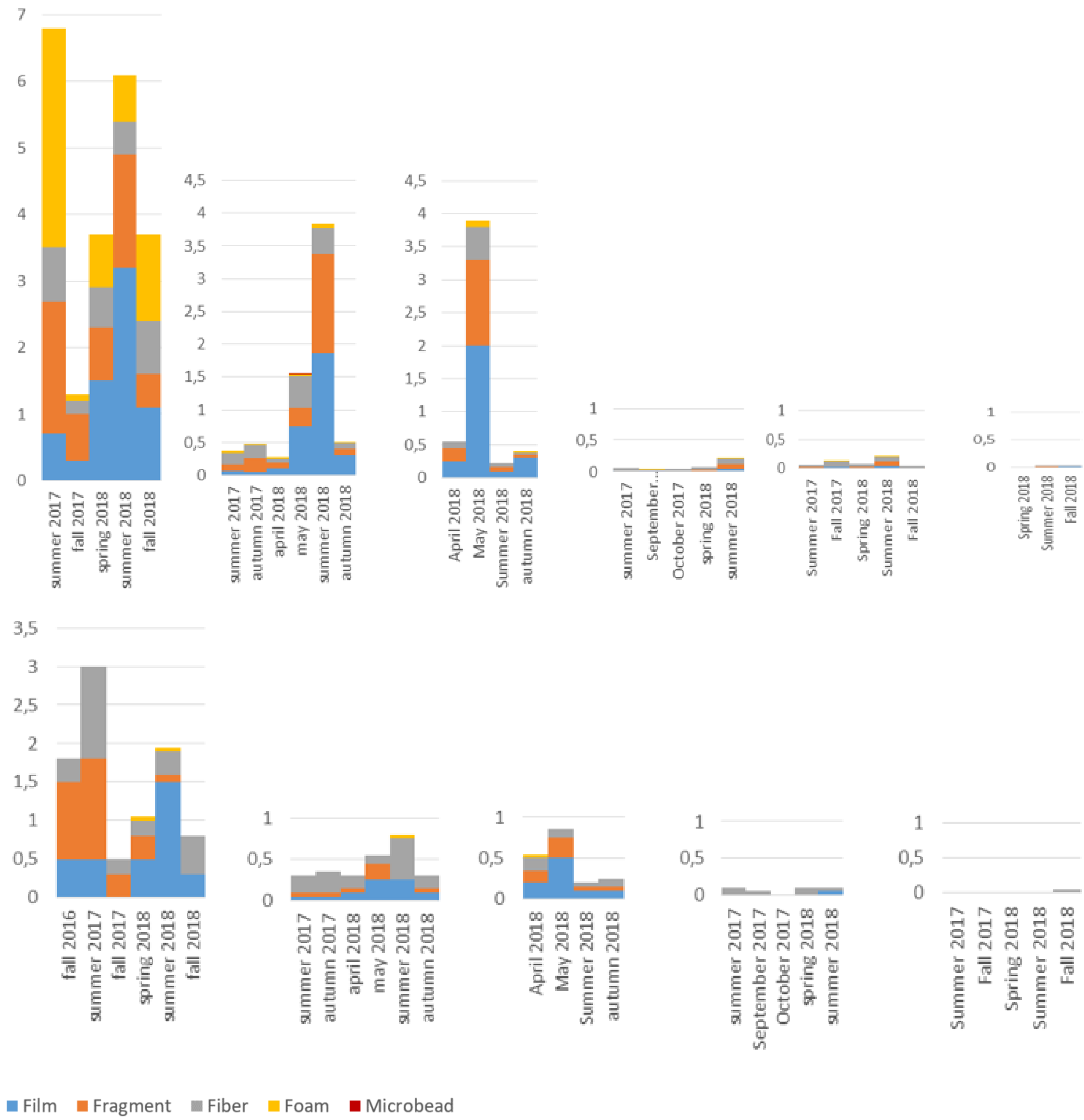


Fig. 4. Concentrations of micro- and mesoplastics in river water during different seasons

Upper line: Micro- and mesoplastics collected with neuston net in the surface layer in rivers 1) Tumen, 2) Razdolnaya/Suifenhe station 1, 3) Razdolnaya/Suifenhe station 2, 4) Artemovka, 5) Partizanskaya station 2, 6) Partizanskaya station1

Lower line: Micro- and mesoplastics collected with pump+plankton net in the sub-surface layer in rivers 1) Tumen, 2) Razdolnaya/Suifenhe station 1, 3) Razdolnaya/Suifenhe station 2, 4) Artemovka, 5) Partizanskaya station 2 (due to shallow depth of the river at station 1, no pump was applied)

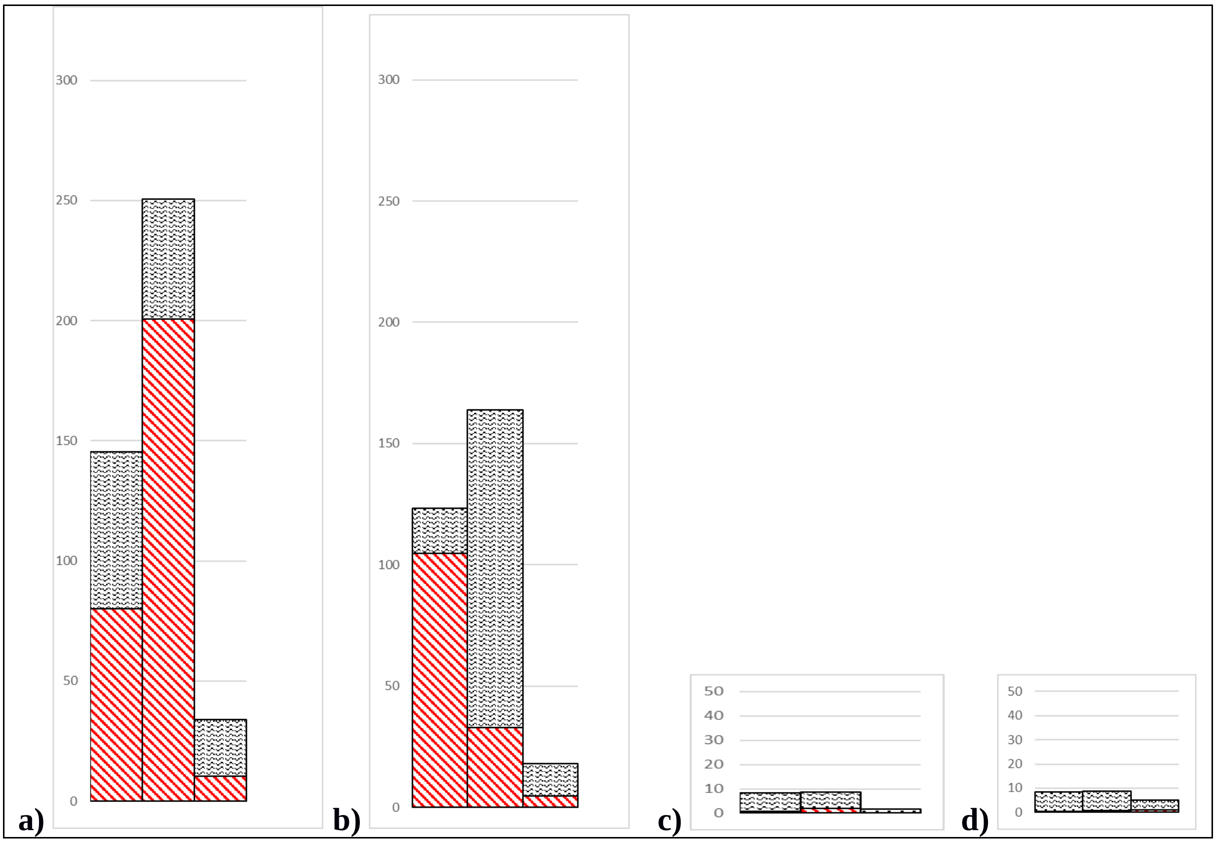


Fig. 5. Average river discharge per season (spring/summer/fall) compared to concentration of microplastics as 1 particle per 1 m^3 a) – Razdolnaya River station 1; b) Razdolnaya River station 2; c) Artemovka River; d) Partizanskaya River station 1

- volume of uncontaminated water in m^3;

- volume of plastic contaminated water in m^3

As for polymer types, the prevailing in the study area were polyethylene, polypropylene, polystyrene, polyester, nylon and fusion of polyethylene with polypropylene. Polyethylene terephthalate, polyvinyl chloride, polytetrafluorethitene, and polyurethane comprised less than 1% of all polymers (fig.. 6).

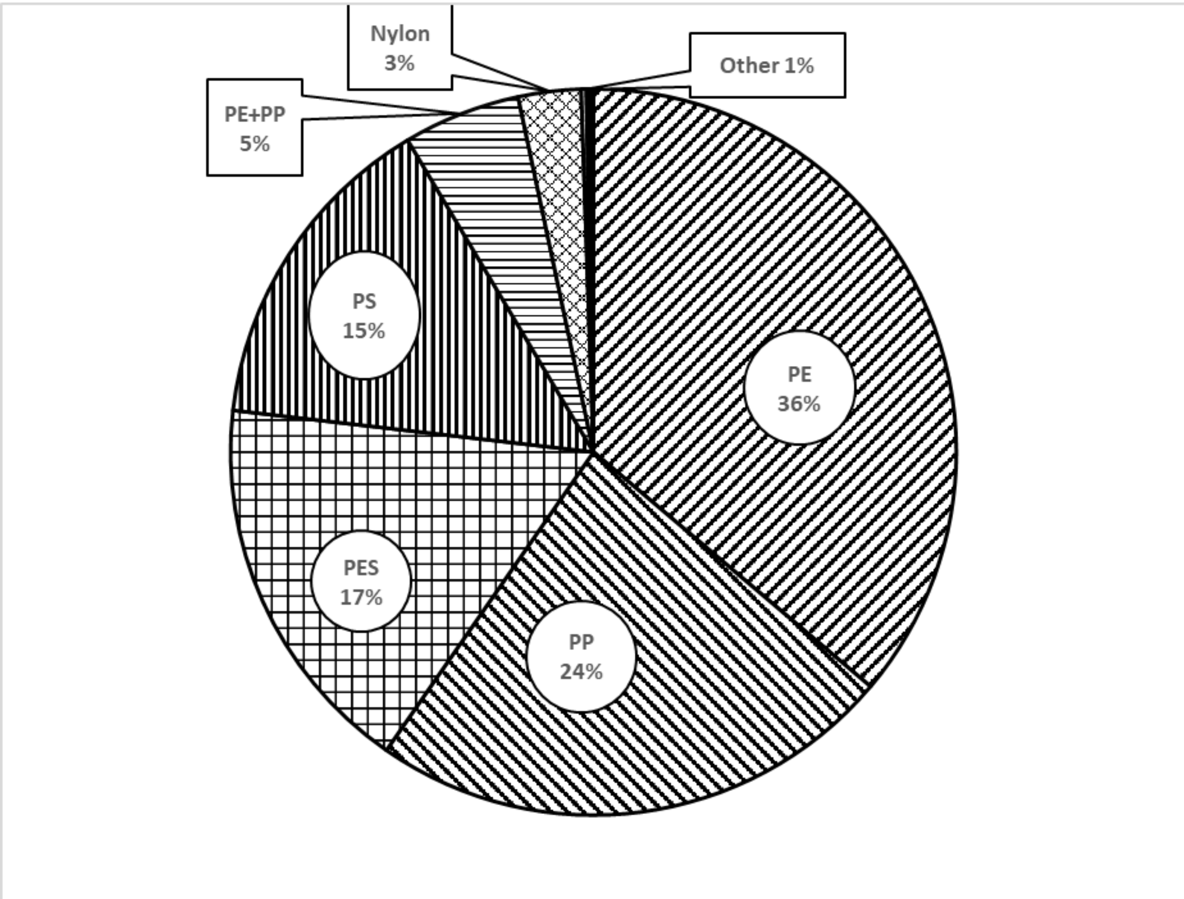


Fig. 6. Ratio of basic polymer types detected in all selected rivers

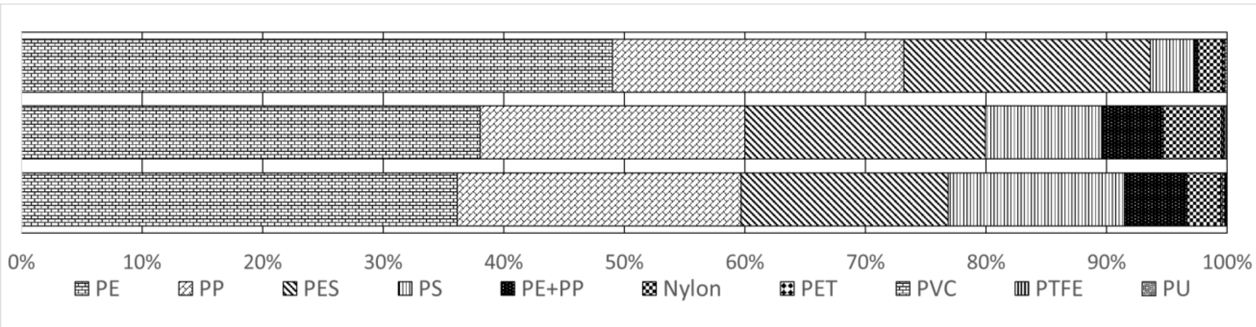


Fig. 7. Comparison of polymer composition in coastal water of the Peter the Great Gulf (upper line) with this parameter in littoral water (middle line) and rivers (lower line).

Polymers	Fragment types					
	Film	Fragment	Fiber	Foam	Microbead	Total in $1m^3$
Polyethylene	0,156	0,111	0,0008	0	0,000462	0,268
Polypropylene	0,085	0,080	0,008	0	0	0,174
Polyethylene + Polypropylene	0,033	0,005	0	0	0	0,038
Polystyrene	0,001	0,002	0	0,104	0	0,108
Teflon	0,0004	0	0	0	0	0,0004
Polyvinylchloride	0,0007	0,0009	0	0	0	0,001
Polyethylene terephthalate	0	0,0009	0	0	0	0,0009
Nylon	0	0	0,020	0	0	0,020
Polyester	0	0	0,127	0	0	0,127
Polyurethane	0	0	0	0,0009	0	0,0009

Table 4. Polymer composition in the study rivers corresponding to the shapes of microplastics

4.1. Hotspots

The key sources of marine pollution with plastic materials (75-90%) are believed to be land-based (Mehlhart and Blepp, 2012; Nelms et al., 2017, Duis and Coors, 2016). A significant contribution to pollution is made by rivers (Lechner et al., 2014; Mani et al., 2015; Kataoka et al., 2018; Lahens et al., 2018). In addition, sources may include wastewater, recreational activities and coastal landfills (Culin and Bielic, 2016), not excluding the possibility of atmospheric transport of fibers and small fragments (Free et al., 2014; Dris et al., 2016).

Our survey shows that riverine discharge of microplastics is evidently an important factor in the land-based pollution and can be calculated, however more data is required to make detailed comparison to impacts of other land-based sources due to a number of reasons.

Based on the data obtained in the sea area, three main sections are distinguished (fig. 8), differing in degree and nature of pollution. This is 1) the south-western section, located from the mouth of the Tumen River (i.e., on the western border of the bay) to Baklan Bay; 2) the central section, which includes the internal waters of the Amur and Ussuri bays, and 3) the eastern section, which covers the water area from Strelok Bay to Nakhodka Bay. These sites, in turn, are affected by three types of sources, classified here as transboundary, transitional (sources of pollutant not identified or mixed) and internal (direct impact of adjacent territories).

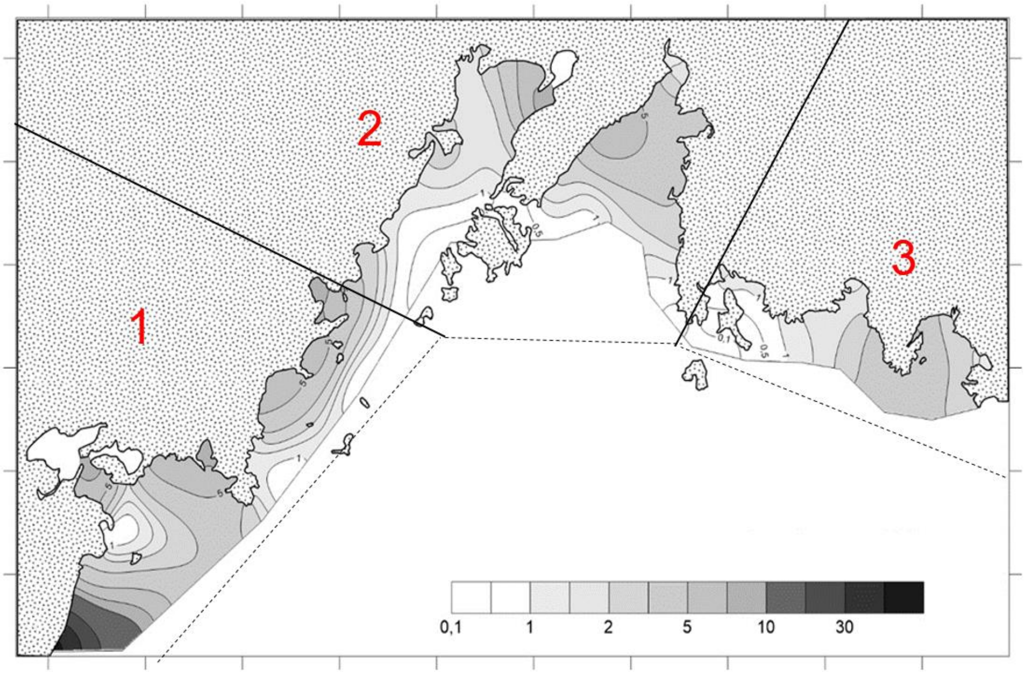


Fig. 8. The water area of the Peter the Great Gulf divided into three geographical sections: 1) the south-western section 2) the central section and 3) the eastern section,

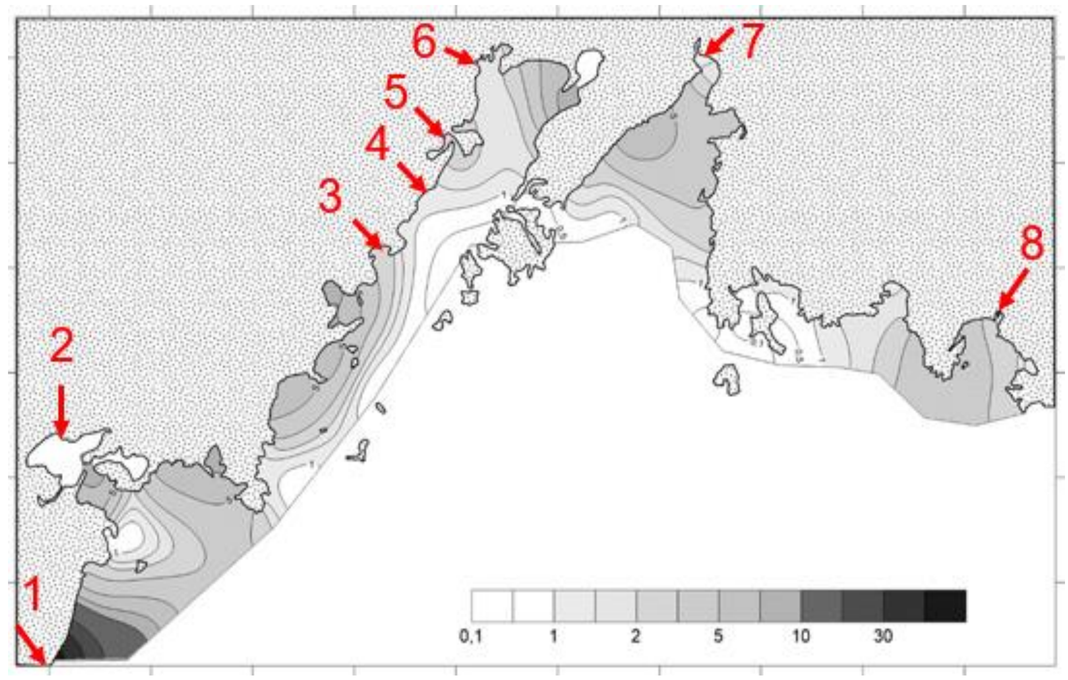
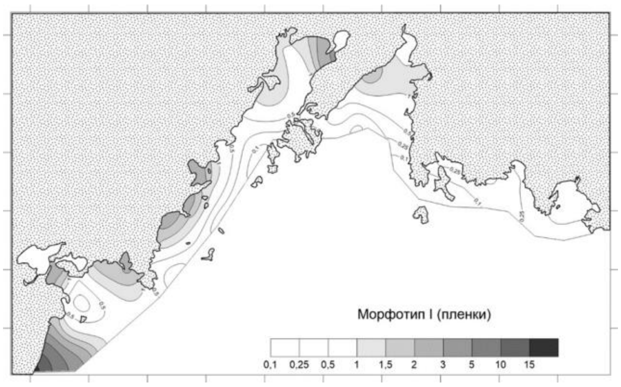
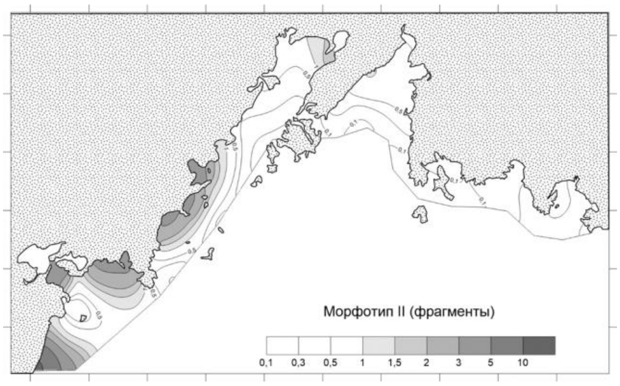


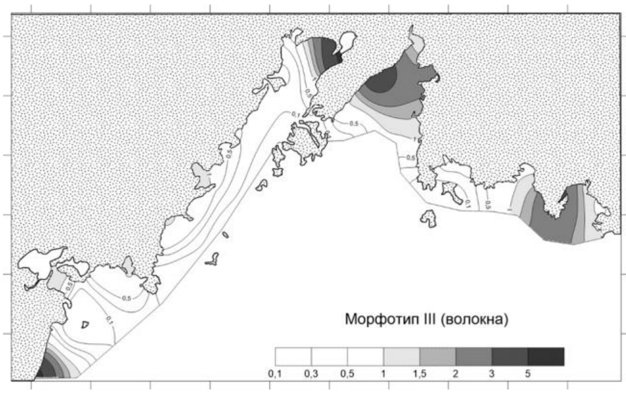
Fig. 9. Concentration of all micro and mesoplastic particles (in particles per 1 m^3) in the Peter the Great Gulf with indication of rivers discharging into the area. 1 – Tumen River, 2- Tsukanovka River, 3- Narva River, 4 – Barabashevka River, 5 – Amba River, 6 – Razdolnaya/Suifenhe River, 7 – Artemovka River, 8 – Partizanskaya River.



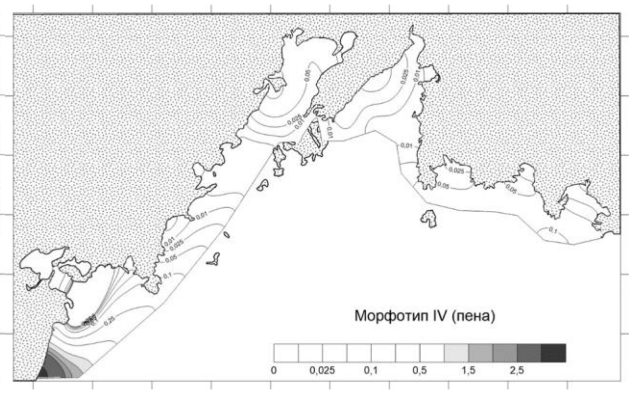
films



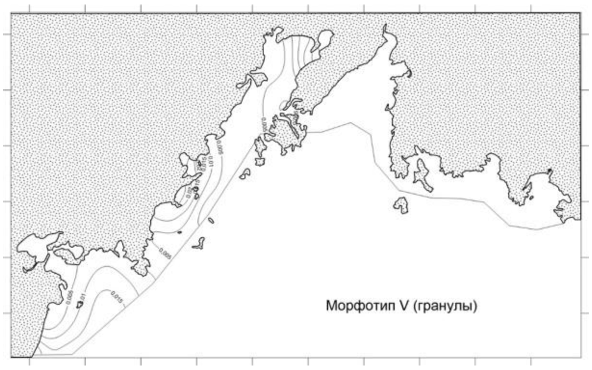
fragments



fibers



foam



microbeads

Fig. 10. Distribution of microplastic by morphological types in the Peter the Great Gulf.

The most polluted site is the western. The territory adjacent to it is sparsely populated (about 30 thousand people on an area of 4130 km2 compared to the central one, where about 780 thousand inhabitants live on an area of 5100 km2), and therefore transboundary and transitional types of sources are typical here. The transboundary factor is ensured by the runoff of the Tumen River which is evidenced to transport microplastics into the sea area and marine surface currents which are responsible for the transport of particles from the waters of adjacent countries. An increased concentration of the foam, mainly composed of polystyrene, is also probably associated with transboundary effects. Expanded polystyrene floats are widely used in aquaculture and the fishing industry of the countries of the Korean Peninsula and China, which is noted by its increased concentration in coastal waters (Kang et al., 2015). Transitional sources are characterized by the water area of Posyet Bay and the eastern part of the selected area, since in addition to the transboundary effect, which is manifested in the increased polystyrene content in water, the level and nature of pollution can be affected by mariculture and seasonal recreation. The Tumen River is However, it is unknown whether the most part of pollutant in this area goes from the river or other sources, because it is difficult to calculate the transport of plastics directly from the adjacent sea area.

The second most polluted area is the central site. According to the type of sources, local ones prevail there. The relatively high content of polymer fibers in the water indicates the impact of domestic wastewater from settlements, including the cities of Vladivostok and Artem. The presence of microbeads that are practically not registered in other areas can also be explained by domestic wastewater discharge. According to other studies, microbeads are most typical for water areas adjacent to large settlements (Isobe, 2016). In addition, industry, port activities and seasonal recreation can affect pollution, but their contribution is difficult to estimate. River runoff also affects the water area, considering the contamination of the Artemovka River. The impact of Razdolnaya River (the second most polluted river in the research area) as a transboundary source is obvious to the northwestern part of the central section. Just as in the adjacent water area, the most common shape of plastics in the river is films (consisting of PP and PE and their mixtures), which may be the result of washing away of the crushed mulching material from the agricultural land (Li et al. , 2018), or landfill erosion.

A relatively clean area is the eastern. There, as well as in the central area, local sources are most probable. In sparsely populated areas from Strelok Bay to Nakhodka Bay the pollution can be explained both by the impact of adjacent settlements, and summer recreational activities. The Nakhodka Bay washes the water area of Vostochny port and Nakhodka city, where fibers also prevail as in the central section, which indicates the direct influence of wastewater on the water area. The influence of the Partizanskaya River appears to be minimal, although some pollution has also been noted.

5. Conclusion

According to the current survey results, transboundary transport is an important factor in the distribution of plastic particles in the coastal marine water area of the Russian Far East. Besides, its impact is reflected in the river discharge, by the example of such rivers as Tumen and Razdolnaya/Suifen due to the economic importance and high concentration of population of their basins. The basic sources of plastic pollution in these rivers might be agriculture (mulching of agricultural lands with consequent plowing of the plastic cover, when land washing during rains transports plastic films into the rivers, contaminating the upper layer of stream.

Rivers flowing in less populated but urbanized areas are still considerable source of contamination, however the numbers of microplastic particles are much lower there that in larger rivers covering wide areas.

The rivers flowing in almost unpopulated areas and crossing protected natural areas are noted for absence of registered contamination, at least within the lowest size range applied in this survey (100 micrometers).

Considering the importance of the problem it worth noting that it is desirable to carry out annual seasonal monitoring to trace microplastic contamination in largest transboundary rives and selected coastal marine areas in the Far East. The results of such monitoring can be useful for further decision making to combat the contamination.

In line with this it would be useful to assess the impacts of microplastics on the most vulnerable commercial biota representatives, for example bivalve filtrators (Spisula, mussels) and most common fish species.

Further research on contamination of such parts of ecosystem as the water environment and hydrobionts is an important way forward to determine specific steps in the development of monitoring programs.

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