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Changes in distribution and types of plastic debris in urban river shores, Ulaanbaatar city, Mongolia

Dolgormaa Munkhbat[1], Masayuki Kawahigashi[1*], Batdulam Battulga[2], Burendelger Sainjargal[3], Bolormaa Oyuntsetseg[3]

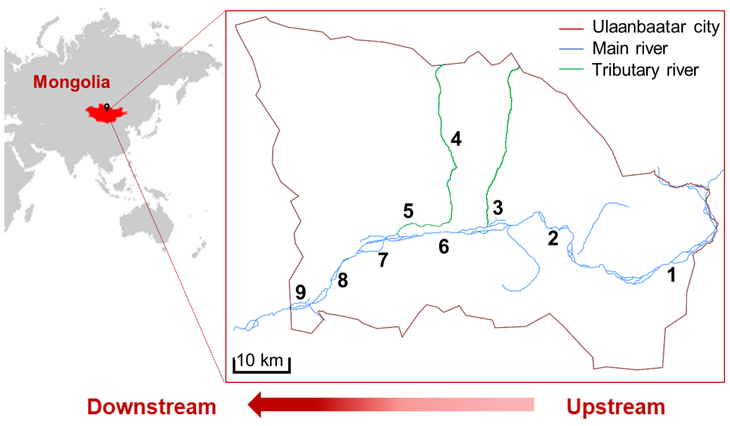
[1]Department of Geography, Tokyo Metropolitan University, Japan
[2]Nuclear Science and Engineering Center, Japan Atomic Energy Agency, Japan
[3]Department of Chemistry, National University of Mongolia, Mongolia

Abstract

Plastic waste can be transferred to the river by wind, flood, and unexpected artificial disposal, which gives a negative impact on the environment and human health. Rivers collect plastic wastes from their watersheds according to geographical factors. Therefore, characterization of plastic waste distribution and composition with respect to land-uses can be useful to understand the fate of plastic wastes. Plastic debris surveyed at the main (Tuul river) and tributary river shores in Ulaanbaatar (UB) city, Mongolia from the upperstream to downstream to understand behavior of plastic waste along the major river in the urbanized city. Sampling areas are divided into the apartment and housing/ger (traditional yurt) area, industrial and camping areas. The composition of collected plastics along the Tuul river in the UB city was composed of 63% micro, 15% of meso, 18% of macro, and 5% of mega-sized plastics on the number basis. Foam and films were dominant in the material-based fractions. Especially, polystyrene foams occupied 99% of micro and 72% of meso-sized plastic fractions, whereas the film type makes up 55% of macro and 77% of mega-sized plastics. From the viewpoint of sampling location, foam and fiber types of microplastic were less in the upperstream of Tuul River, but higher amounts of foam and fibers were found at downstream of the river. Polystyrene foams transported easily with river flow and wind coupling with their degradation process because of their least density and smaller sizes. Although films were abundant in housing/ger areas, foams distributed everywhere along the rivers. Conversely, industrial areas released the least number of plastic wastes. Plastic waste distribution along branch tributaries was different from the Tuul River shore. Macro and Mega plastics tended to distribute along the shore of tributaries connecting to Tuul river. The size distribution may vary according to catchment area and types of land-uses.

Introduction

- Location: Mongolia, north-east Asia
- Population: 3.3 million
- Total area: 1,564,116 km²
- Sampling site: Urban city Rivershore



Sampling site characteristics

- 45% of total population live in the capital city
- Capital city is 0.3% of the Mongolian territory
- Low amount of surface water

Problems

- Over-population in the capital city
- Lack of waste management

Objective of the study

- To evaluate the distribution of the plastic debris across main and tributary Rivershore in the urbanized city from upperstream to downstream,
- To understand the distribution behavior with respect to the land-use or upperstream and downstream part.

Sampling method

- Rivershore plastic by visual collection: 50 square meter with 3 replicates
- Plankton net sampling coupled with flowrate measurement

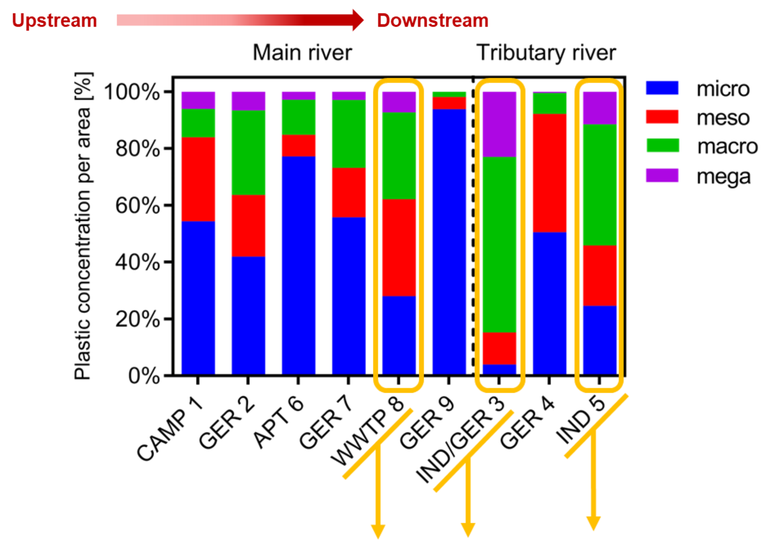
Dominant land use of sampling sites

- Camping area (CAMP) - No. 1
- Ger area (GER) - No. 2, 4, and 7 - 9
- No.8 - WWTP
- Industrial and industrial mixed area (IND) - No. 3 and 5
- Apartment area (APT) - No. 6

- Main river – 6 points
- Tributary river – 3 points

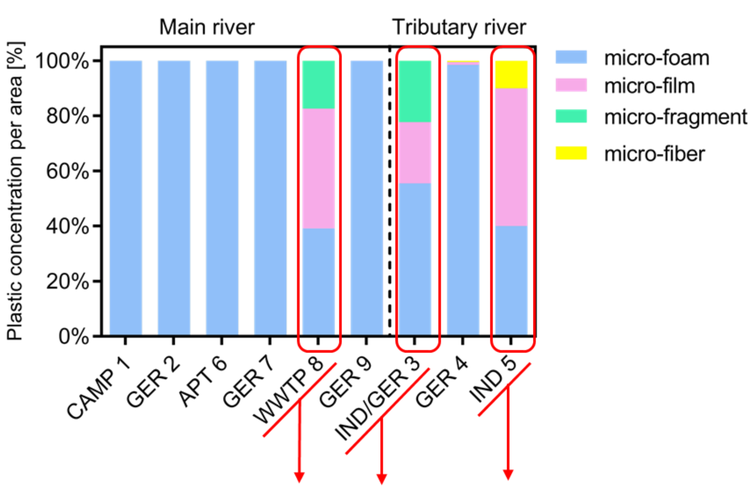
Result and Discussion

Size distribution of plastic debris



- WWTP, IND and IND/GER mixed areas released various size of plastic items more.

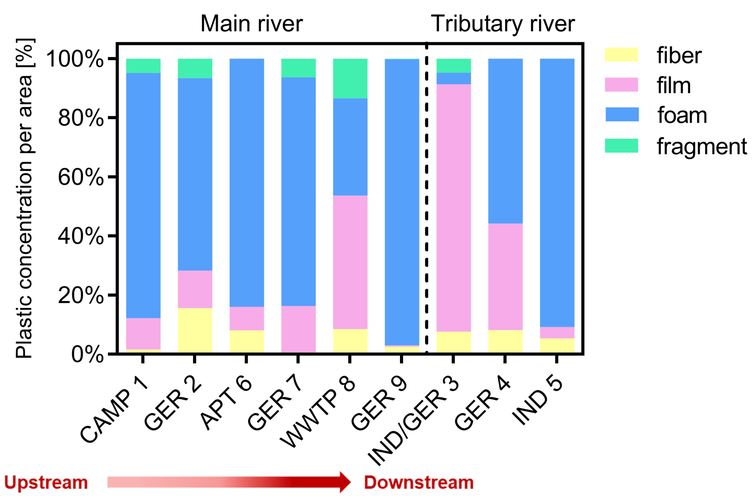
- Micro-sized plastic was the dominant across the main river except WWTP.
- Macro-sized plastic was the dominant across the tributary rivers.
- Sampling site (GER9) on downstream part of the main river collected the highest number of microplastic.



- WWTP, IND and IND/GER mixed areas showed same pattern as all plastic size included result.

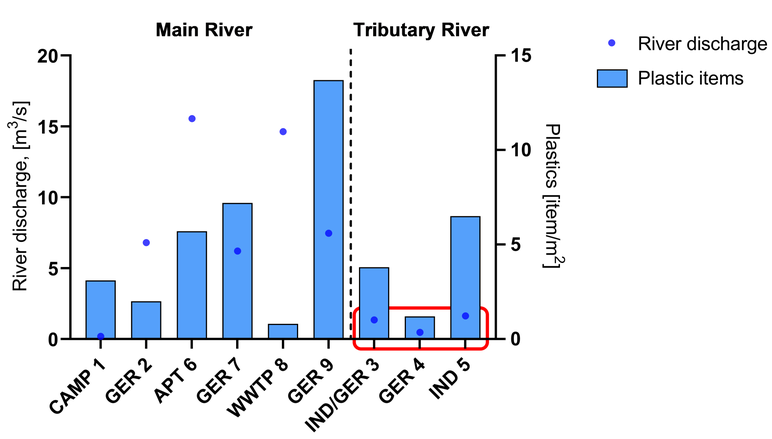
- Foam was the dominant type of microplastic in all residential areas.

Shape distribution of plastic debris



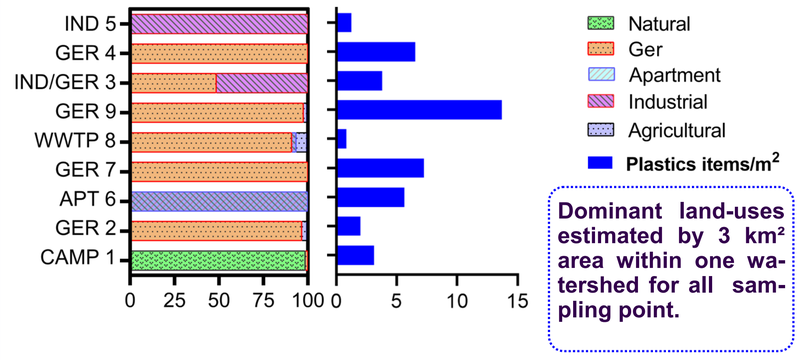
- Foam type of plastic were found abundantly in the main Rivershore except WWTP point.
- Tributary Rivershore gathered film as well as foam type of plastic.
- The number of fiber and foam type of plastics were relatively lower among the 4 types.

Hydrological influence



- The average plastic item was 4.9 items/m²
- Tributary rivers discharge were mostly lower than main river. Therefore, plastic items with bigger size may not transport easily through river during lower discharge.

Land-use influence



Dominant land-uses estimated by 3 km² area within one watershed for all sampling point.

- Residential areas released the highest number of plastic items. Industrial areas containing various type and size of plastics but less number of plastic per area.
- Especially, the distance between GER area and Rivershore is short and it can cause easier plastic waste approach to the river.
- Distribution of plastic types varies with dominant land-uses which showed the different waste source from each land-uses.

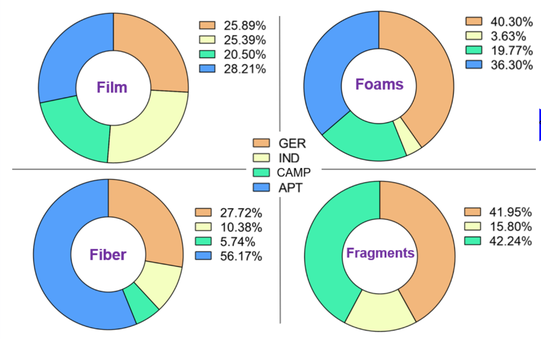


Figure shows the average plastic items per area classified by shape in 4 land-uses.

- Film type of plastic were consists of packaging or plastic bags which related to the high consumption of plastic bags in Mongolia.
- Higher amount of Foam plastic in the residential area may related to the insulation foam material from new constructing buildings.

Summary

- Micro and meso-plastics were found dominantly from the main Rivershore while macro and mega-plastics were abundant on tributary Rivershore. Bigger sized plastics gathered at lower discharge points which may explain the slower transportation process through tributary river.
- Conversely, micro-sized amount was the highest at the downstream point which could relate to easily moving when plastic size is smaller.
- Land-uses and river discharge influence the plastic debris distribution through the Rivershore. The complex distribution process may governed by waste release to the rivershore and river to rivershore during flooding or water level increase.