Abundance of plastic debris across European and Asian rivers

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- **The first transcontinental overview of plastic transport**
- Observational evidence that, for the sampled rivers, Asian rivers transport considerably more plastics towards the ocean than European rivers.
- 24 locations measured in 7 countries

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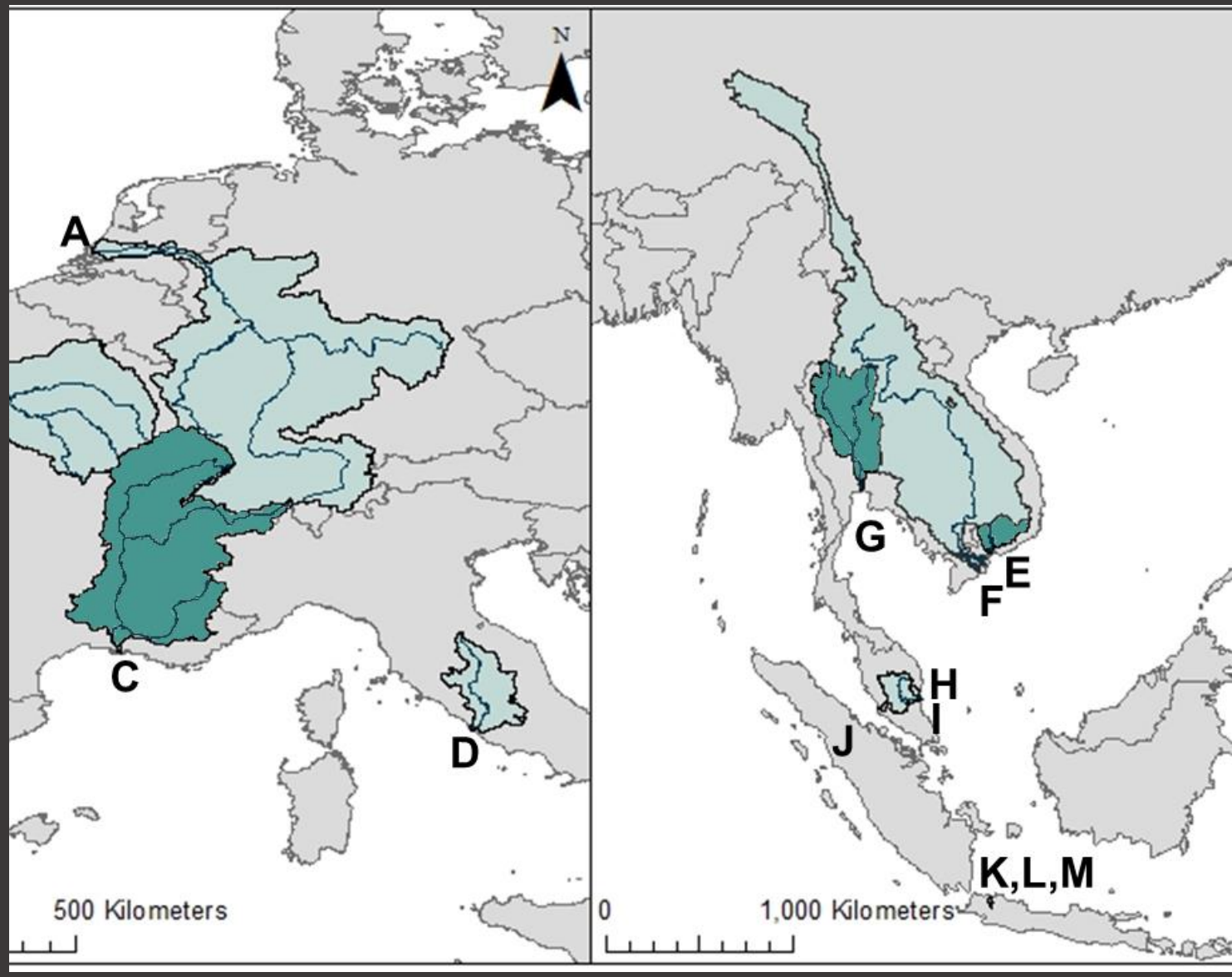
Research area

River catchments (indicated in green) and rivers (indicated in dark blue) included in this study. In some cases, the catchment areas cover more then one country. In this case, the country mentioned here is the country where the river mouth is located. A Rhine (The Netherlands), B Seine (France), C Rhône (France), D Tiber (Italy), E Saigon (Vietnam), F Mekong (Vietnam), G Chao Phraya (Thailand), H Pahang (Malaysia), I Klang (Malaysia), J Kuantan (Malaysia), K Ciliwung (Indonesia), L Pesanggrahan (Indonesia), and M Banjir Kanal Timur (Indonesia).



Methods

Plastic transport observations:

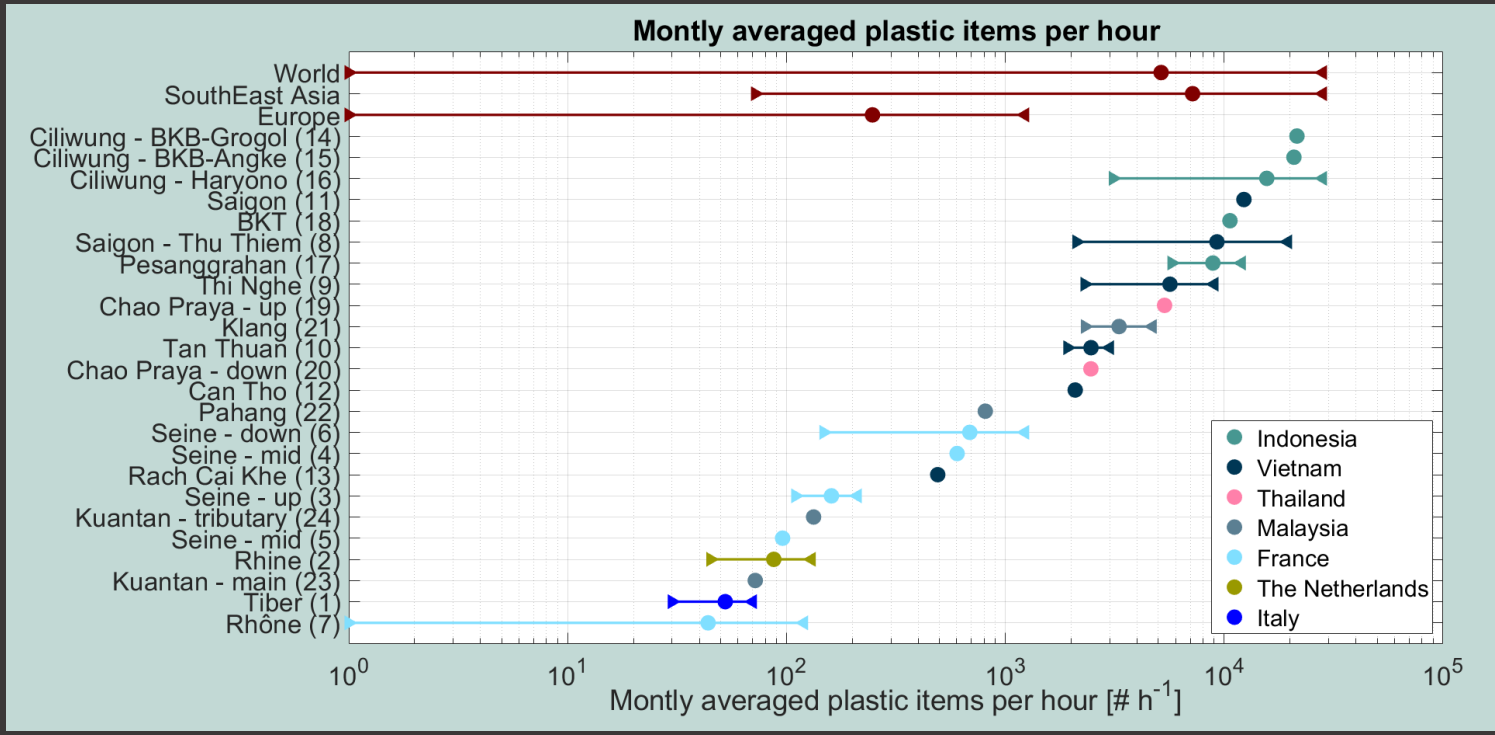
- Visual counting

Plastic composition observations:

- Net sampling
- Litter traps
- Visual observation

Results and discussion

- Plastic transport varies up to 5 orders of magnitude in terms of plastic items per hour.
- Mean amount of plastic items per hour:
  - Southeast Asian locations: $7.1 \cdot 10^3$ items·h^{-1}
  - European locations: $2.5 \cdot 10^2$ items·h^{-1}
- Variations in monthly mean plastic transport within one river:
  - In rivers with the longest data series (Saigon, Ciliwung, Klang, Seine, and Rhône), we demonstrate that plastic transport can have an intra-annual variation of at least one order of magnitude.
  - Differences between measurement locations: downstream and upstream.



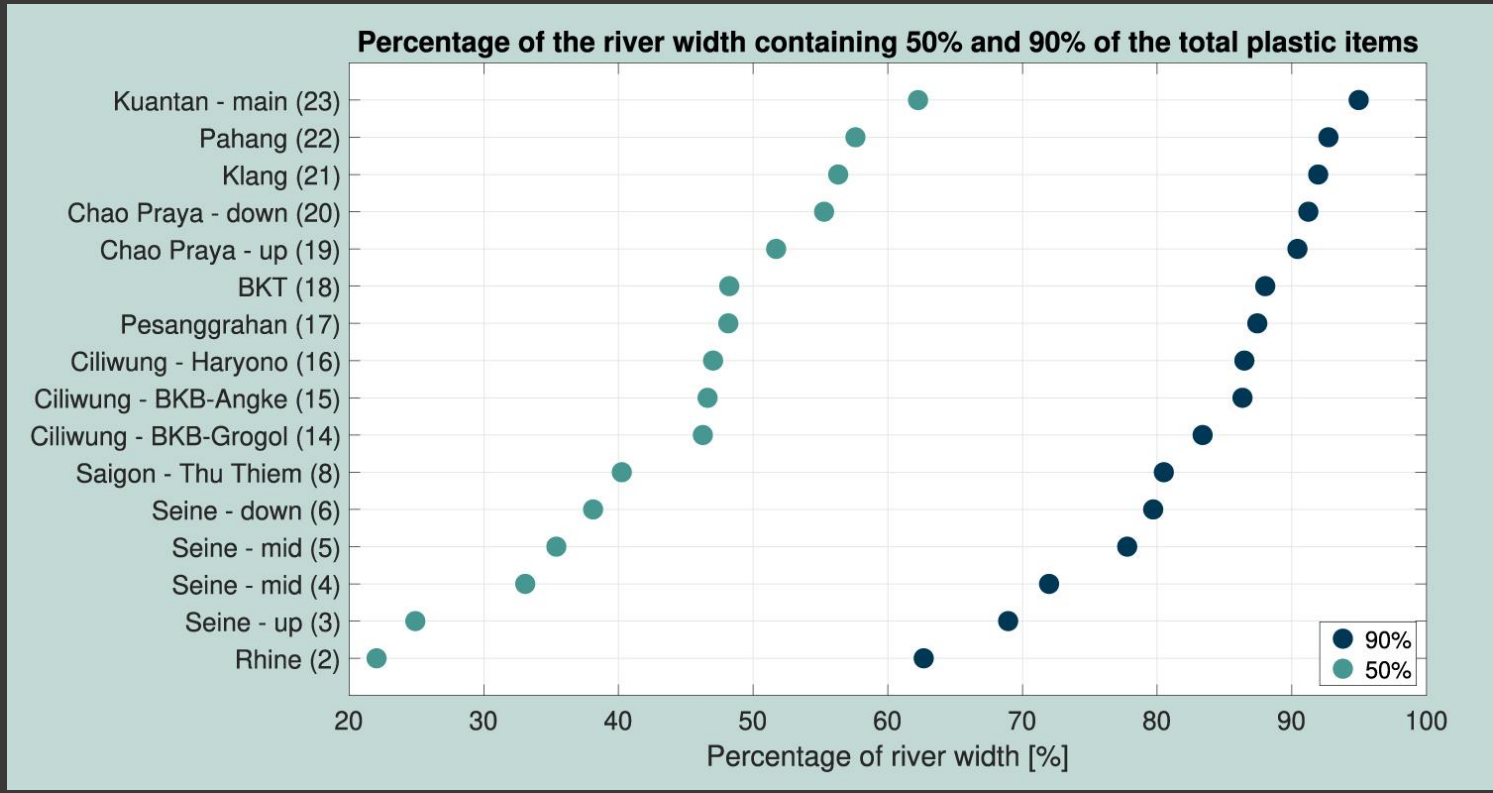
The top three bars show means taken over all rivers (world), the Asian rivers and the European rivers. Eleven rivers were measured multiple times in a year. For these rivers, the circle corresponds to the yearly mean and the bar corresponds to the minimum and maximum monthly mean.

Results and discussion

- Most of the plastic items (90%) are distributed over more than half of the river width (69% – 92% of the width). Plastic is often not concentrated in specific segments of the river.

- For some locations, such as Ciliwung (BKB-Grogol), most plastic can be found in the middle of the river. For other locations, such as the Rhine and Chao Phraya, most plastic can be found at the outer sides of the rivers.

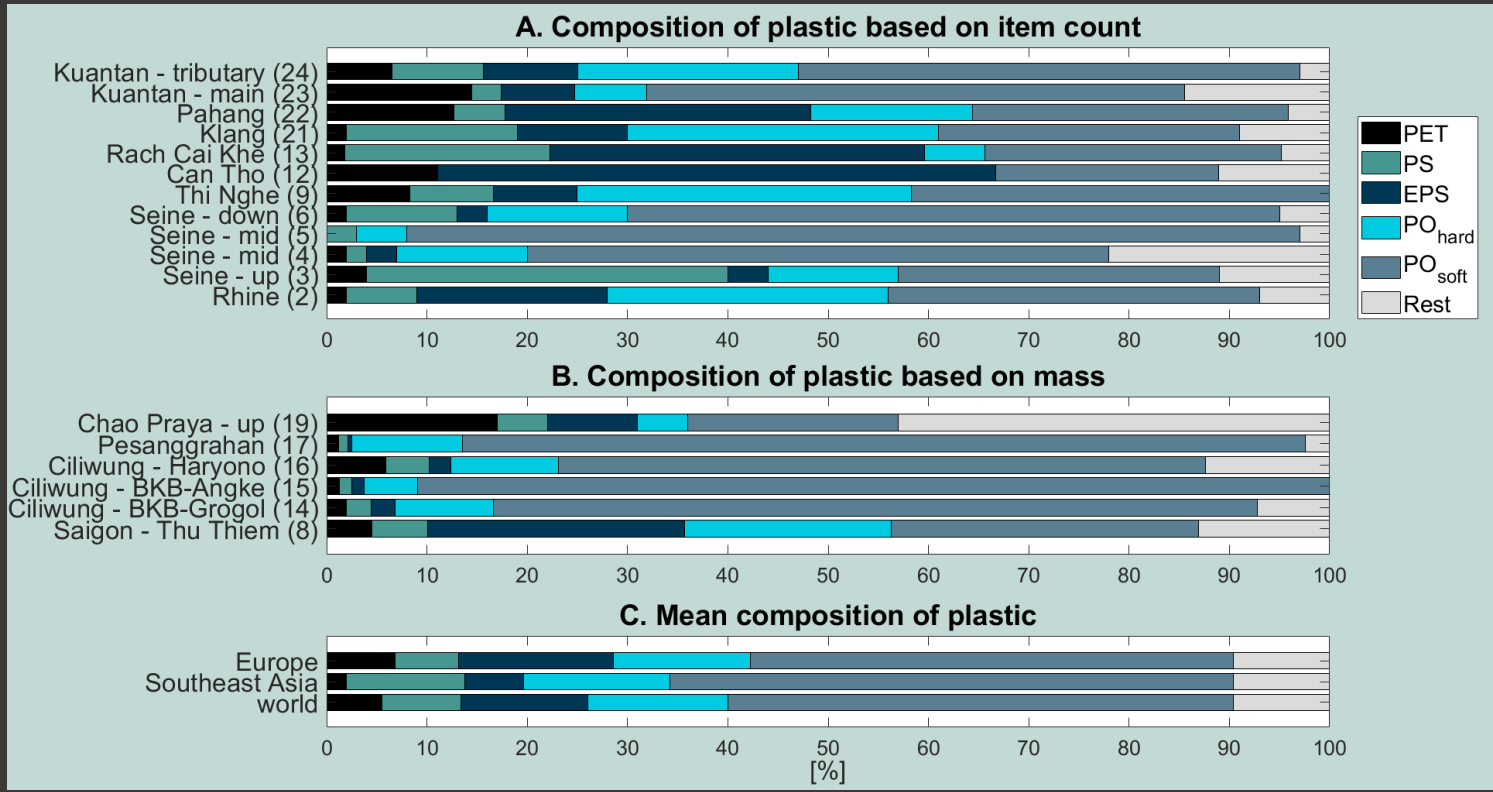
- The spatial variation of plastic debris is influenced by environmental characteristics, such as wind and river curvature, and by anthropogenic factors, such as navigation and hydraulic infrastructure. Site specific insights can be used to locally optimize plastic recovery strategies. The variety of the plastic transport and distribution demonstrates the complexity of the transport in urban areas.



Percentage of the river width through which 50% and 90% of the total amount of floating plastic items was transported.

Results and discussion

- The dominant category of plastic is PO soft with a mean of 47% in Europe and 37% in Southeast Asia. However The spread between rivers is 20% – 90% of the total.
- This study endorses the hypothesis that buoyant plastic waste in oceans and rivers originates largely from multiple sources.
- The composition varies between locations in one river. This may be caused by differences in plastic consumption and management practices, as well as transport mechanisms, and other factors.
- The plastic polymer composition can provide information on the type of product that was littered. Therefore, determining the type of plastic can lead to the source of the plastic and hence to improvement of waste management and regulation.



The composition of the plastic samples for locations in Malaysia (Kuantan, Pahang, and Klang), Thailand (Chao Phraya), France (Seine), and The Netherlands (Rhine) in terms of plastic items (figure (A)) or in terms of mass (figure (B)). Figure (C) shows the mean composition for the world, for European rivers (in France and The Netherlands) and for Asian rivers (in Malaysia and Thailand). Plastic items were classified into 6 categories: polyethylene terephthalate (PET), polystyrene (PS) , expanded polystyrene (EPS) , hard polyolefine (PO hard) , Soft polyofine (PO soft), and Rest. Note that polyolfines include polyethylene (PE) and polypropylene (PP).

Main conclusions

- On average, the studied rivers in Asia transport almost 30 times more macro-plastic items than the studied European rivers ($7.1 \cdot 10^3$ and $2.5 \cdot 10^2$ items$\cdot h^{-1}$, respectively). Influencing factors on the amount of floating plastic transport are the type of waste management, location of cities, dams, and litter traps, seasonality of rainfall and river discharge, and flood events. This demonstrates the complexity of the origin and fate of riverine plastics.

- The plastic is not concentrated in a single section of the river.

- The composition of the plastic debris can vary up to 45% points for one polymer type between different rivers in the same country. The composition varies also between locations in one river.

- In our paper, we demonstrate variation in plastic transport and composition across several European and Asian rivers. The results emphasize that riverine plastic pollution is a global issue and urgent action is needed.

- Link to the article published by Environmental Research Letters, 2019:
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