Estimation of global plastic loads delivered by rivers into the sea

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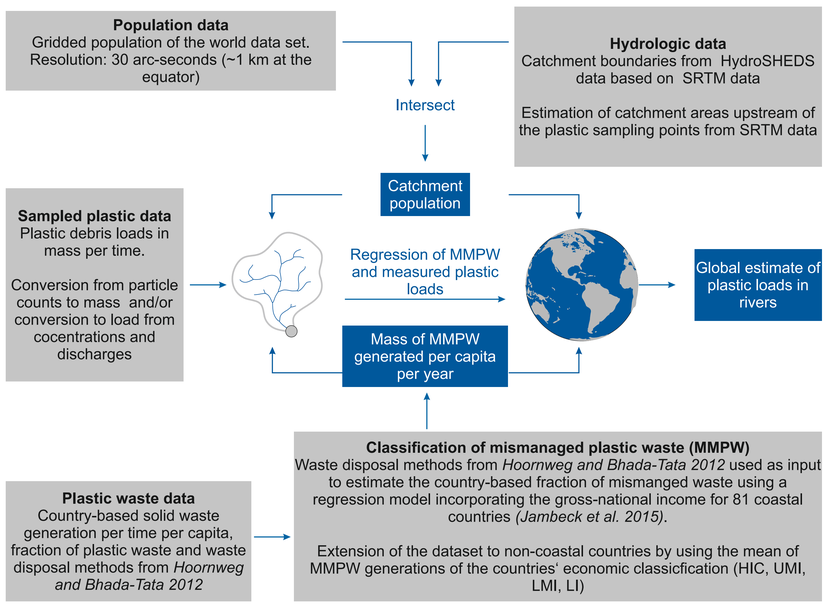
Introduction

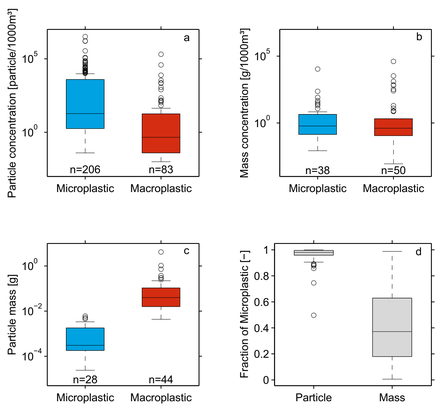
Beyond the long recognized occurrence of plastic debris in the marine environment, plastic debris has been more recently detected in fresh water environments. Particularly, the plastic pollution of rivers is interlinked with the marine environment because land-based plastic sources are considered to be a major contributor to marine plastic debris. River networks facilitate the transport of terrestrial sediments, organic carbon, nitrogen and various solutes into the oceans and thus connect most of the global land surface to the marine environment. Thus, it is likely that rivers are a also major pathway for plastic transport into the seas.

Plastic loads and concentrations in rivers depend on the characteristics of the catchment. Urban land use and population density have been shown to be positively related to plastic concentrations . The aim of the study is to synthesize data of plastic debris in rivers, to identify pattern of plastic concentrations and loads and to provide an estimate the amount of plastic exported from river catchments into the sea assuming that the entire river catchment is connected to the coastal sea via the river network. We combine observations of plastic in rivers with the amount of plastic waste generated in the catchments.

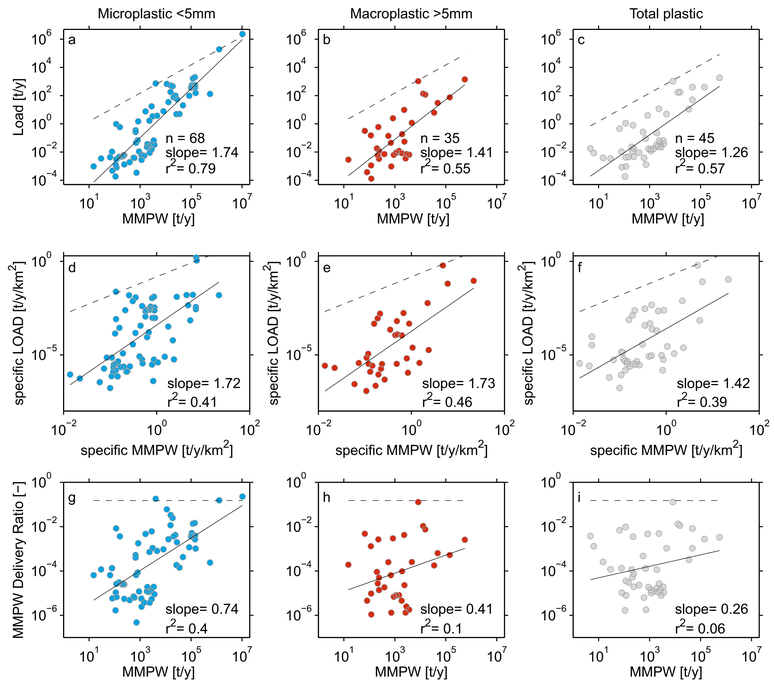
Methods



Results

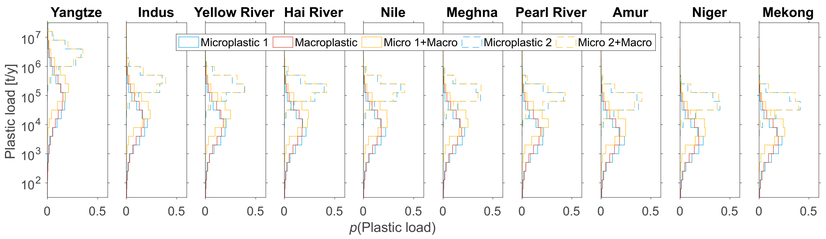


Boxplots of particle concentration (a) and mass concentration (b), masses of single particles (c) for microplastic and macroplastic (a). (d) shows the fraction of microplastic in interms of particles and mass. In each boxplot the horizontal line represents the median the box the 25th and 75th percentile.



Regression of MMPW generated in the catchments and measured plastic loads (a-c) and regression of specific (area-weighted) load and MMPW (d-f) for micro-, macro and total plastic. The bottom row shows the relationship between MMPW and the MMPW delivery ratio (observed load/ MMPW) . Dashed lines represent a hypothetical proportional modal where 15% of the MMPW to illustrate the disproportionality of plastic loads associated with larger MMPW-rich catchments.

Results



Relative frequency histograms of annual loads (t/y) of microplastic (particles < 5mm), macroplastic (particles > 5mm) and total plastic (represented as sum of micro and macro) for the top-ten rivers with highest loads.

The histograms have been obtained by bootstrapping the coefficients of the regression between observed plastics loads and MMPW. Two different regression models arise from different underlying data sets for microplastic. **Microplastic 1** consideres all microplastic data available; **Microplastic 2** only uses microplastic data which have been measured in conjunction with macroplastic. The absolute load estimates differ largely between the two models.

Independently from the absolute loads, the top-ten rivers with the highest loads contribute ~90% of the total river-driven plastic inputs into the sea. Note that if all river catchments would have a constant delivery ratio (observed load/ MMPW) the contribution of the top ten rivers would only be 58 %.

Our Message

- Plastic concentrations in rivers vary over 7 orders of magnitude
- Larger rivers export disproportionately more plastic from their catchments than smaller rivers - delivery ratio increases with river size
- Estimation of global plastic load transported by rivers is highly uncertain and ranges between $4x10^5$ - $4x10^6$ tons per year - **Ignore the numbers in the original abstract - we have new data**

References:
Jambeck, J. R.; Geyer, R.; Wilcox, C.; Siegler, T. R.; Perryman, M.; Andrady, A.; Narayan, R.; Law, K. L. Plastic waste inputs from land into the ocean. Science 2015, 347 (6223), 768–771.
Hoornweg, D.; Bhada-Tata, P. What a Waste : A Global Review of Solid Waste Management. 2012