Plastic export from rivers into the oceans

Technologies for Observing and Monitoring Plastics in the Oceans

Nov. 26th 2018

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Rivers connect land and ocean

Rivers are major transport pathways from land to ocean

- Connect the majority of land surface with the ocean
- Naturally transport large amounts of sediments and solutes into the oceans.
Rivers connect land and ocean

- Suspended sediment load: $13.5 \times 10^9$ tons per year (95% of total sediment inputs)$^1$
- Organic carbon load: 430 million tons C per year$^2$
- Additional anthropogenic net N-input on land ~ 200 million tons per year → 25% are exported into the oceans by rivers$^3$

$^1$Milliman and Meade 1983
$^2$Schlünz and Schneider 2000
$^3$Gruber and Galloway 2008
Suspended sediment load: $13.5 \times 10^9$ tons per year (95% of total sediment inputs)

Organic carbon load: 430 million tons C per year

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25% are exported into the oceans by rivers

Mississippi River drainage basin

Midwestern farmers are tied to a Gulf dead zone

Rivers as a source for marine litter

Database:
79 sampling sites
57 rivers
Rivers as a source for marine litter

![Graph](image)

**Particle concentration** vs. **Mass concentration**

Particle concentration: Microplastic vs. Macroplastic
- n=206
- n=83

Mass concentration: Microplastic vs. Macroplastic
- n=38
- n=50
Rivers as a source for marine litter

Mississippi River drainage basin

MMPW data from Jambeck et al. 2015
Mismanaged Plastic Waste

Mismanaged Plastic Waste (Jambeck et al. 2015)
Rivers as a source for marine litter

67-90% of riverine plastics originate from 10-20 rivers

Riverine load range: 0.5-2.8 million tons per year
Midpoint estimate: ~1.6 million tons per year

Lebreton et al. (2017); Schmidt et al. (2017)
67-90% of riverine plastics originate from 10-20 rivers

Which rivers transport high plastic loads?

- Large population in the river basin
- High fraction of mismanaged plastic wastes
- Large rivers transport plastic more efficiently than smaller rivers
- Preferential occurrence of settlements at large rivers

Lebreton et al. (2017); Schmidt et al. (2017)
Flow variability influences plastic transport
Flow variability influences plastic transport

Dynamic connectivity and mobilization

- Concentrations increase with increasing discharge
- Concurrent mobilization of other particulate matter

Wagner et al. in review
Flow variability influences plastic transport

Wagner et al. in review
Rivers are sentinels for plastic sources

Construction material

Sewer emissions
Methods and technologies for plastic in rivers

- No harmonized sampling and analysis protocol (yet) → limited comparability between data
- Cameras for observing larger floating objects
- Drifters to monitor transport and travel times
Intervention technologies

- Collection of (plastic) debris from rivers
- Cost-benefit?
- Opportunity for collecting data
- Opportunity for public awareness and participation

https://www.baltimorewaterfront.com/healthy-harbor/water-wheel/
Intervention technologies?!?!

- Collection of (plastic) debris from rivers
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- Opportunity for collecting data

https://www.baltimorewaterfront.com/healthy-harbor/water-wheel/
Summary

- Plastic debris comprises only a small fraction of the total particulate material load in rivers.
- Discharge and even more loads are highly variable in time. High loads and concentrations occur at high flow.
- Highest export from large rivers in Asia and Africa → reducing export here would be highly effective.
- Monitoring plastics in rivers still in its infancy.
Thank You for your attention
## Rivers as a source for marine litter

<table>
<thead>
<tr>
<th>Global rank</th>
<th>Top-10 rivers</th>
<th>Global rank</th>
<th>Other major rivers</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Chang Jiang (Yangtze River)</td>
<td>20</td>
<td>Danube</td>
</tr>
<tr>
<td>2</td>
<td>Indus</td>
<td>50</td>
<td>Mississippi</td>
</tr>
<tr>
<td>3</td>
<td>Huang He (Yellow River)</td>
<td>53</td>
<td>Rhine</td>
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<tr>
<td>4</td>
<td>Hai He</td>
<td>90</td>
<td>St. Lawrence</td>
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<tr>
<td>5</td>
<td>Nile</td>
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<tr>
<td>6</td>
<td>Meghna, Bramaputra, Ganges</td>
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<tr>
<td>7</td>
<td>Zhujiang (Pearl River)</td>
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<td>8</td>
<td>Amur</td>
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<td>9</td>
<td>Niger</td>
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<tr>
<td>10</td>
<td>Mekong</td>
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