Tutorial: Plastic Pollution From River to Sea

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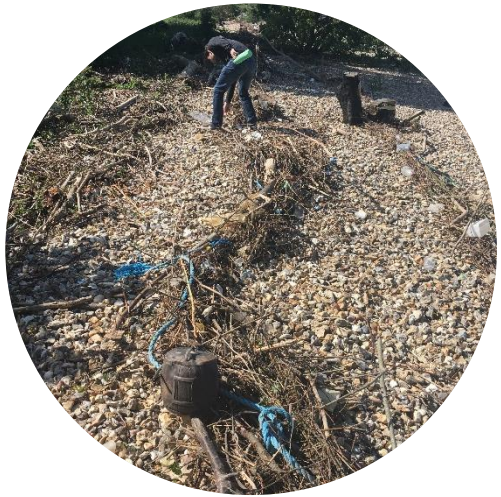

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UFZ HELMHOLTZ Centre for Environmental Research

für Naturkunde MUSEUM FÜR NATURKUNDE BERLIN

WWQA World Water Quality Alliance

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

NILE BASIN INITIATIVE INITIATIVE DU BASSIN DU NIL

Tutorial lecture

- Observations in general
- Visual counting
- From visual counting to transport/emission
- Models in general
- Lebreton et al. (2017)

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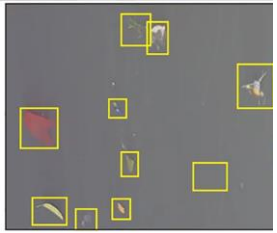
Monitoring river plastic pollution

Visual survey

Camera (+ AI)



Van Emmerik & Schwarz (2020)

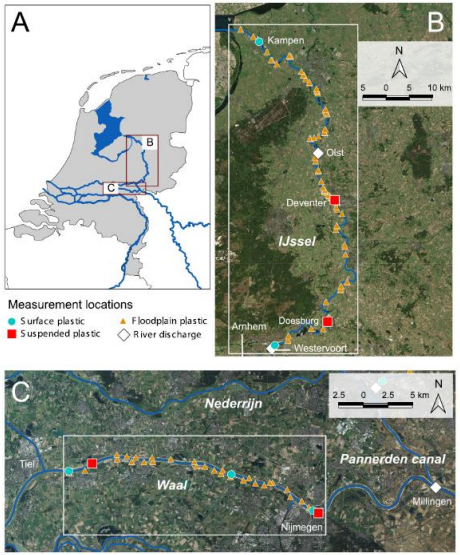
Citizen science

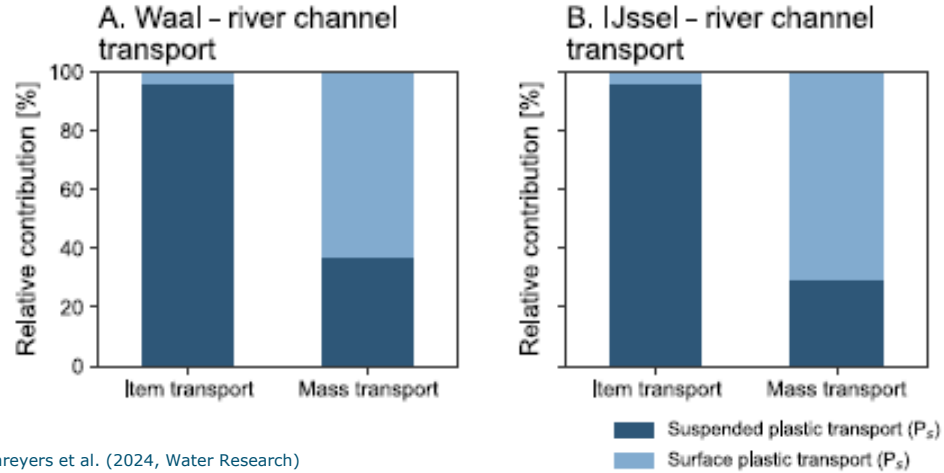
Drones

Sampling

Floating plastic

- 1-99% of total plastic
- Globally most monitored compartment
- Range of low to high-tech methods





Schreyers et al. (2024, Water Research)

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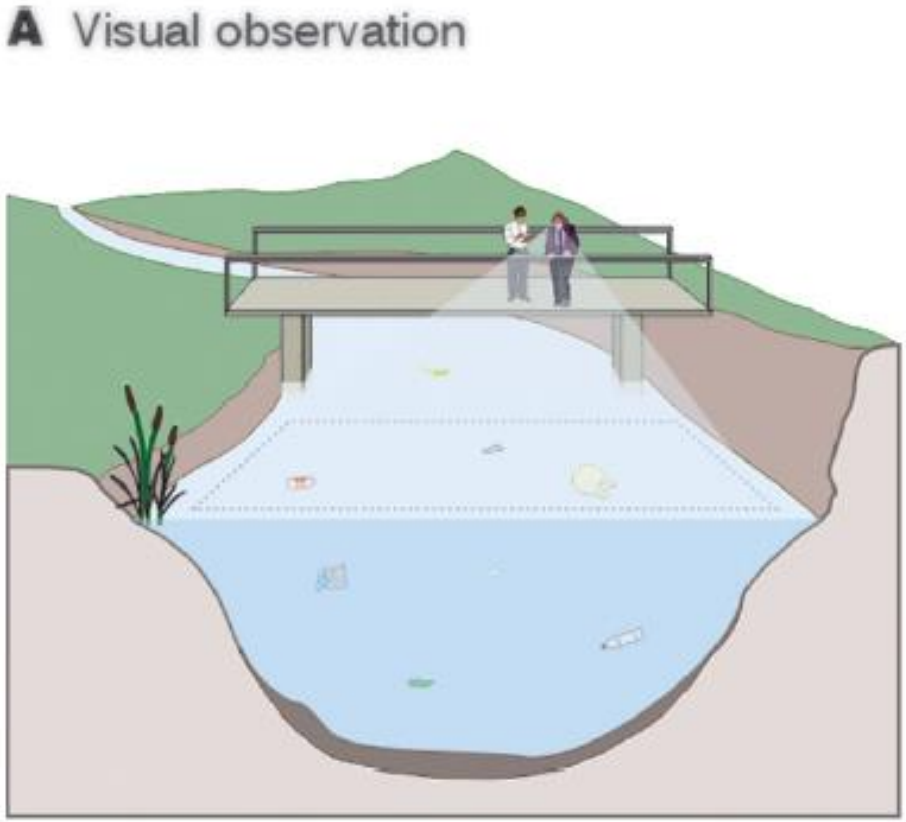
Visual counting for floating plastic

- Counting floating items from bridges
- Total items or specific categories
- Express plastic transport in items/hour
- Extrapolation to mass, and to share below the surface

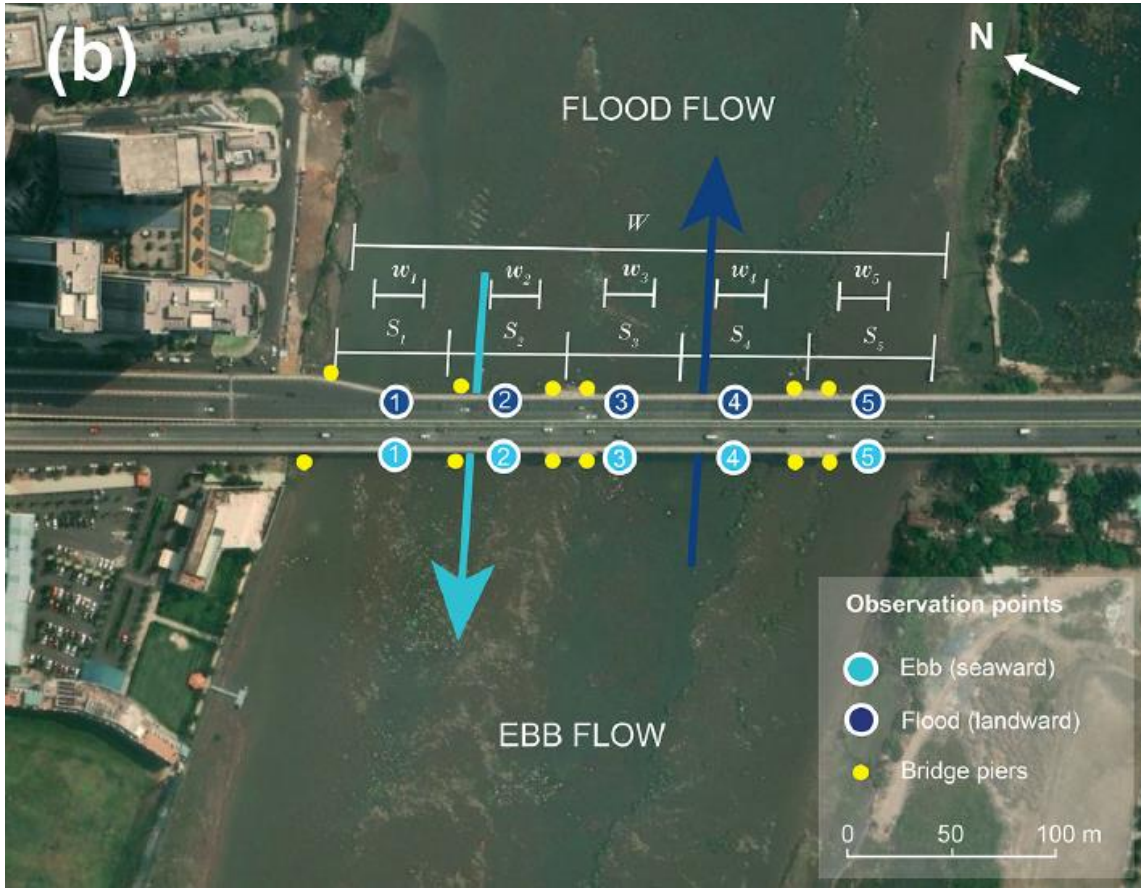


Hurley et al. (2023)

Visual counting for floating plastic

River width coverage

- Typically between 10-100%
- Cross-sectional variation



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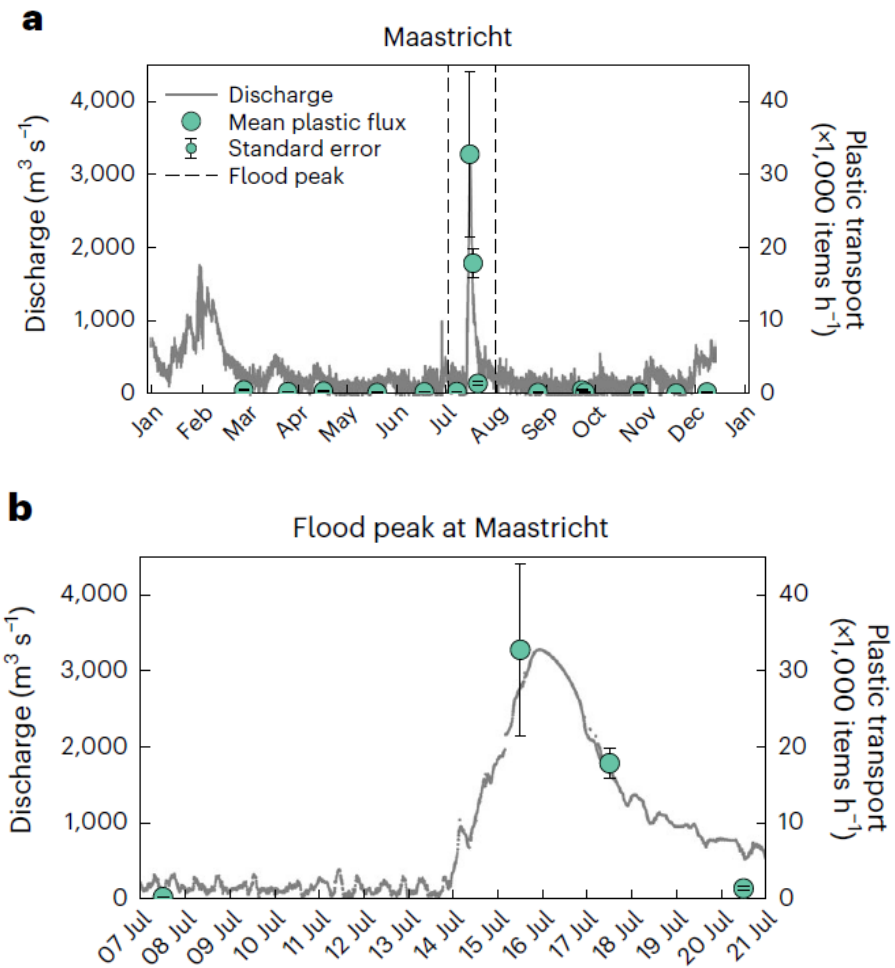
Van Emmerik et al. (2018), Schreyers et al. (2024)

Visual counting for floating plastic

Duration and frequency

- 1-30 min per observation
- Daily to monthly
- Hydrology may be relevant



Van Emmerik et al. (2023, Nature Water)

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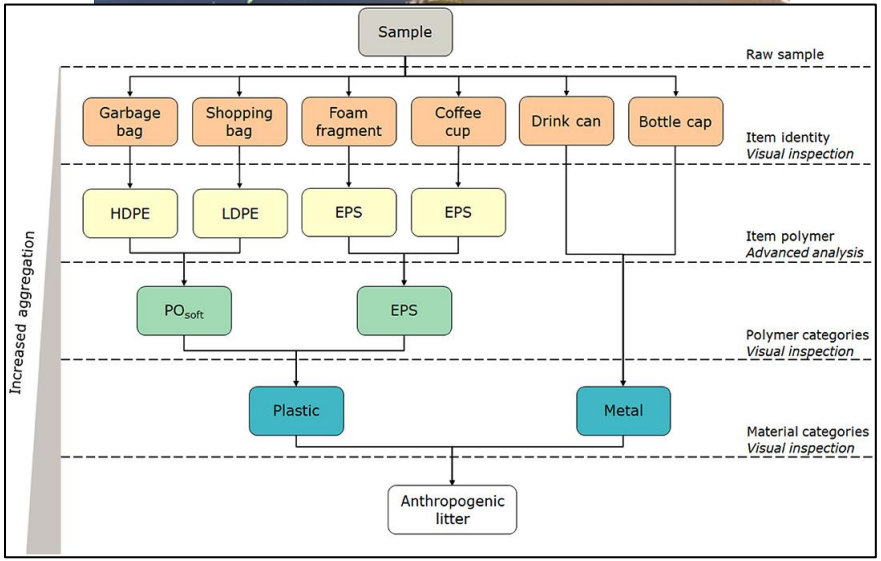
Visual counting for floating plastic

Categorization

- Single category to detailed item lists
- Depends on flow velocity and plastic concentration



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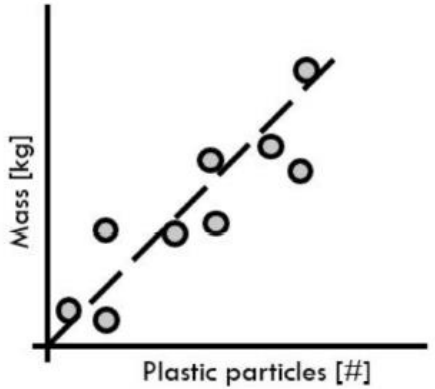
Visual counting for floating plastic

Extrapolation

- Item-to-mass conversion



$$M = F \cdot \overline{m}$$

Mean item statistics

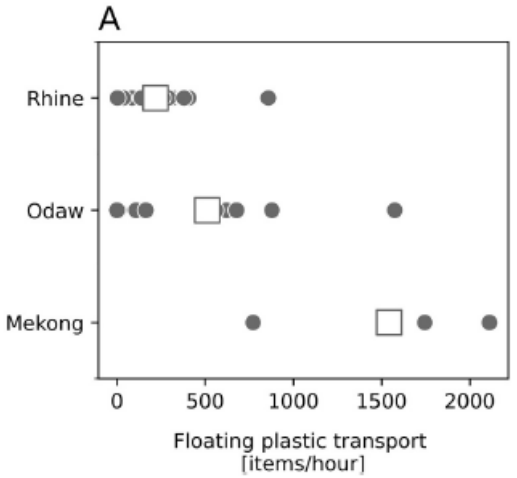
$$M = \sum_{j=1}^{16} F_j \cdot \overline{m_j}$$

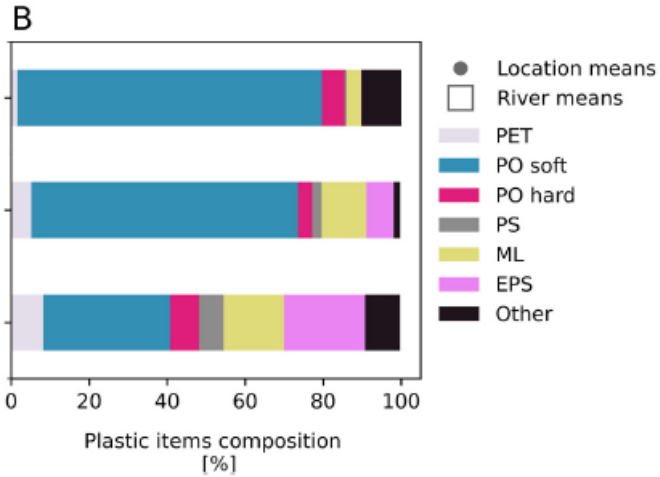
Category specific statistics

Van Emmerik et al. (2018), Vriend et al. (2020)

Overview of output

- Plastic transport [items/h]
- Plastic composition
- Net transport at downstream river locations
- Scalable and comparable





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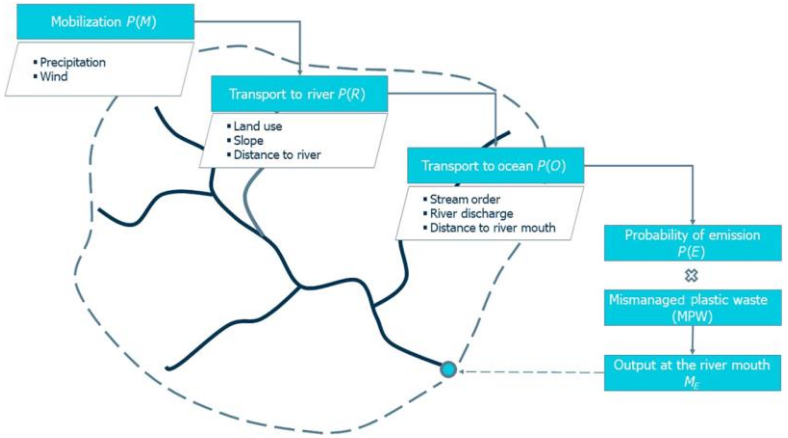
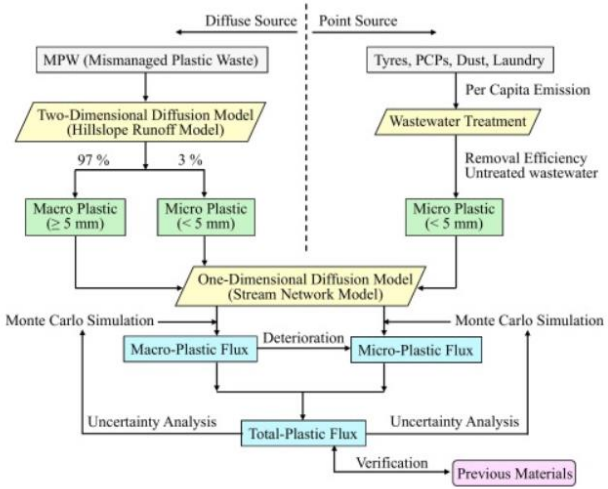
Van Calcar & Van Emmerik (2019),
Van Emmerik et al. (2023)

Emission modeling

- Conceptual models
- Physical models



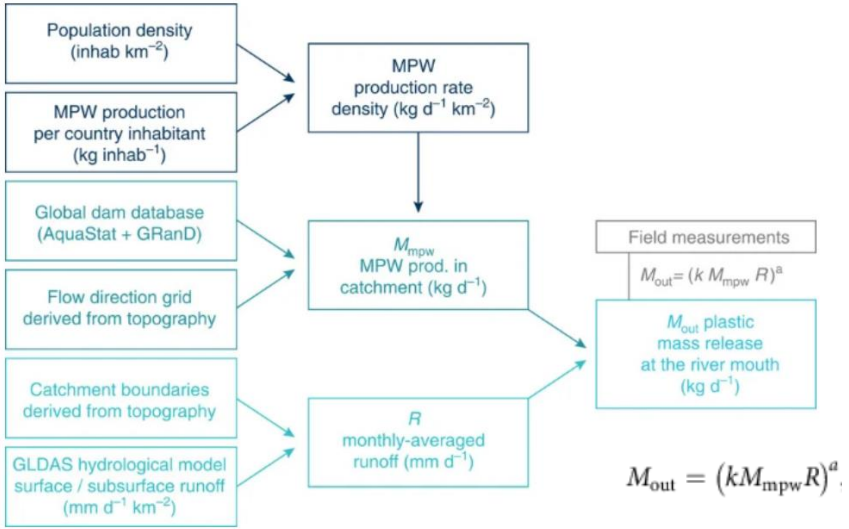
$$P(E) = P(M \cap R \cap O) = P(M) \times P(R) \times P(O)$$

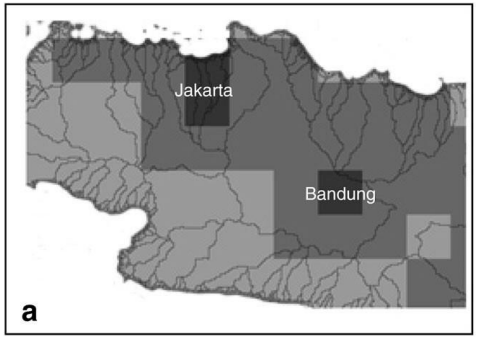


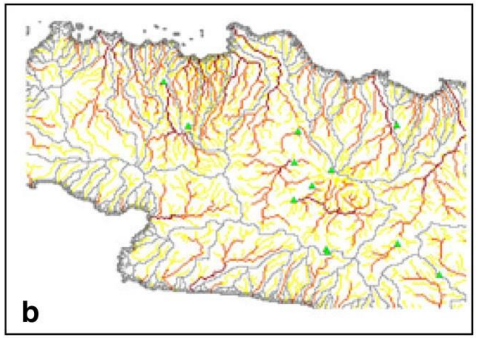
$$M_{\text{out}} = \left(kM_{\text{mpw}}R\right)^{a}$$

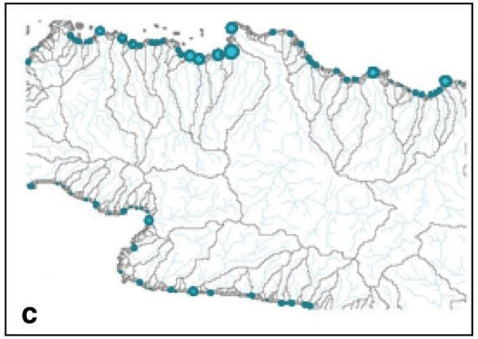
Conceptual emission model

- Emission as function of mismanaged plastic and runoff
- Two model parameters, accounting for fraction of transport and non-linearity



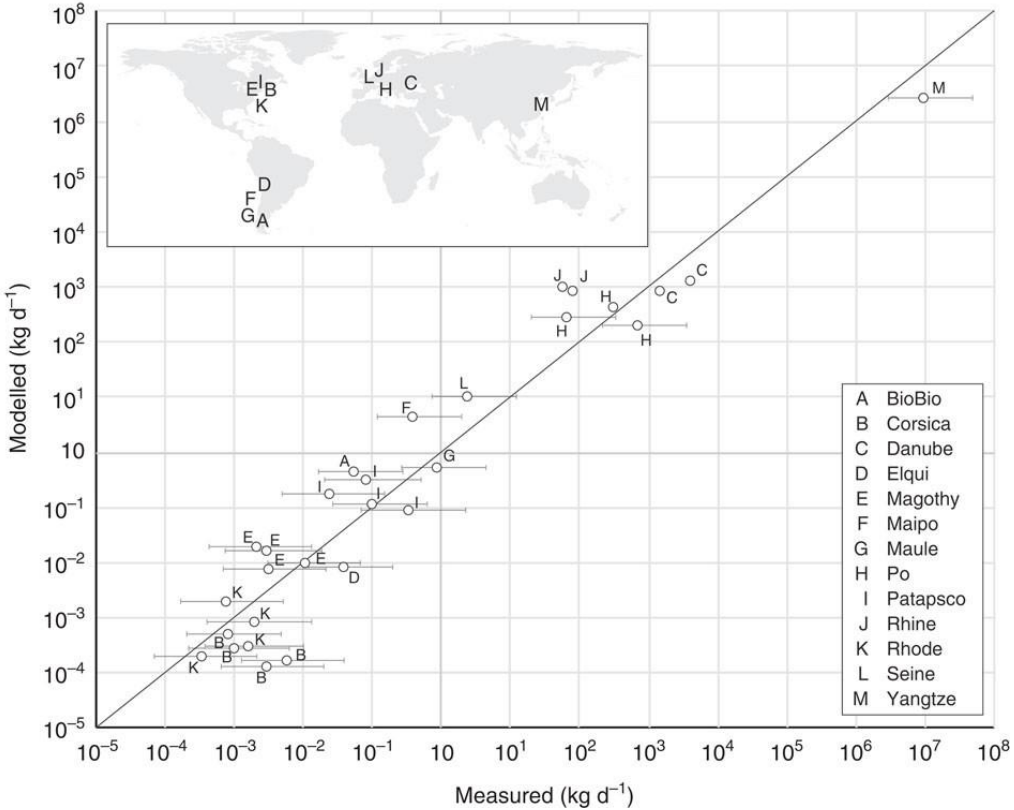






Conceptual emission model

- Use observation-based estimates to assess model performance
- Both come with uncertainties
- Global vs local calibration



Practical

Goal: Get ready to analyze your own data

- Calculate transport from observations
- Calculate emission from model
- Compare three basins around the world
- Explore correlation with discharge
- Calculate riverbank concentration

Tutorial: Calculating River Plastic Transport from Visual Counting

In this tutorial you will work with actual visual counting data to calculate river plastic transport in various rivers around the world. The calculation steps can also be used to work with your own data.

Learning outcomes

The learning outcomes of this practical are:

1. Calculate plastic transport from visual counting observations
2. Estimate plastic emission using a conceptual model
3. Compare the observation-based and model-based emission estimates
4. Explain the differences between observation-based and model-based estimates for various rivers.

What you need to hand in

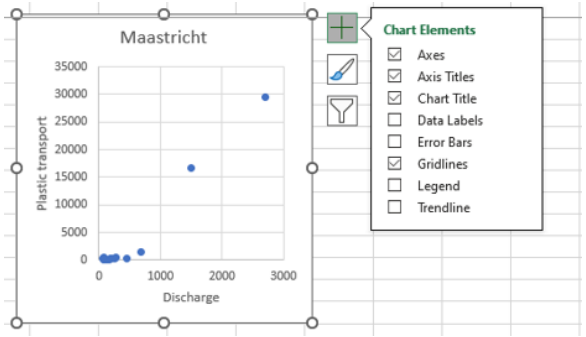
You can write down the answers to the questions, briefly and to the point, in the provided spaces on this exercise sheet.

Getting ready

- Make sure your Excel is set in English. To do this: Set up your Excel in English: File → Option → Language → English;
- Make sure that the Delimiter set to '.', instead of ','. To do this: File → Option → Advanced → Untick "use system separators";
- For the tutorial, make sure to at least finish up to the questions in 1.1.2. If that works you're all set for the practical;
- Work in pairs.

Practical tips and remarks

- Check delimiter in the equations. If comma as a delimiter does not work, try semicolon
- In the "Meuse data" sheet, the equations for columns V and W that are provided in the guide should be inverted
- In the "Meuse data" sheet, column Z: you can find the unique measurement locations in Fig. 1 of the Guide. Order them from upstream to downstream (from Maastricht to Moerdijk).
- In parts 2 and 3 of the practical, you will need to write equations with a power exponent. In Excel, the power exponent is indicated with the "^" sign. You also need to put parenthesis, so in part 2 of the practical, the following equation $M_{out} = (k * R * MPW)^a$ would be written as =(cell with k value * cell with R value * cell with MPW value)^cell with a value
- In part 3 of the practical, you need to add a trendline on a scatter plot. This is how you can do it:
use the '+' sign on the top right corner and then check the box 'trendline', then click on the arrow next to it, and select 'More options' (to display the equation on the graph, and/or change the intercept'



- In part 3 of the practical, we sometimes wrote in the practical guide 'add a new column', but usually the column header are already provided, and you just need to fill the columns with formulas.