Modelling microplastics transport, the beginning and new challenges

Arianna Varrani

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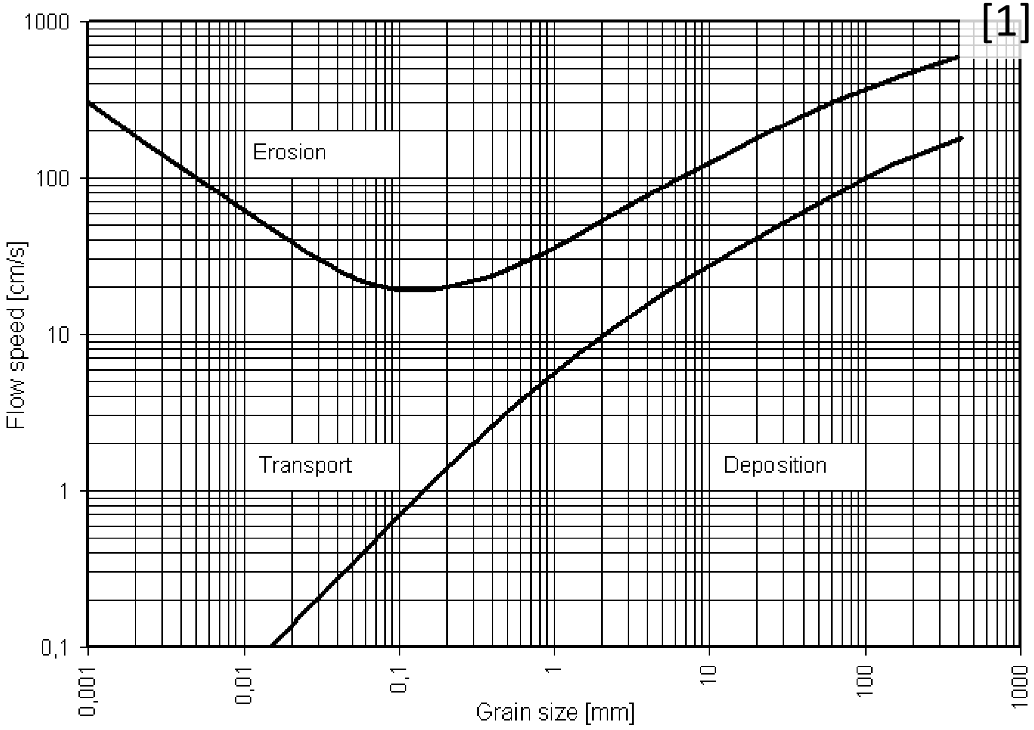
When does transport begin

Onset of transport experimentally-derived diagram, Hjuström, F. (1932).

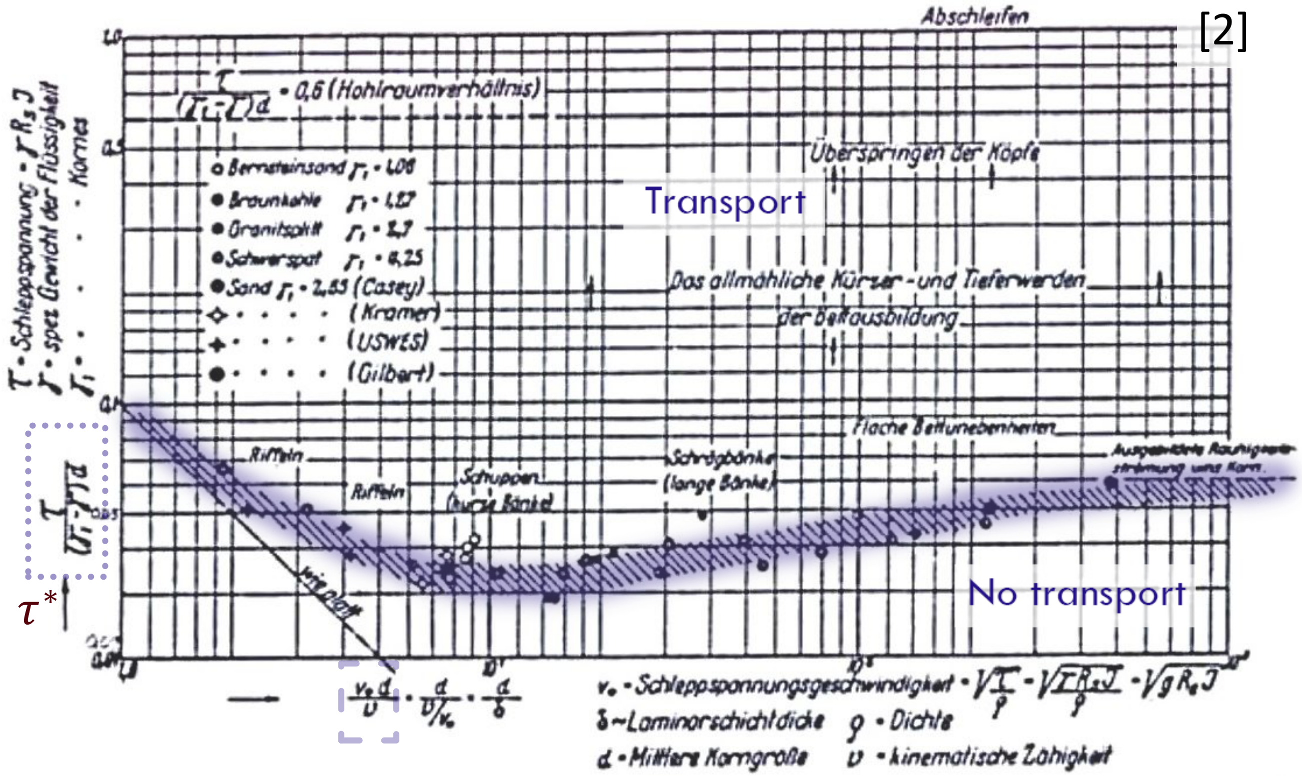
[1]



valid for 1 m depth

Onset of transport experimentally-derived diagram, Shields, A. (1936).

[2]



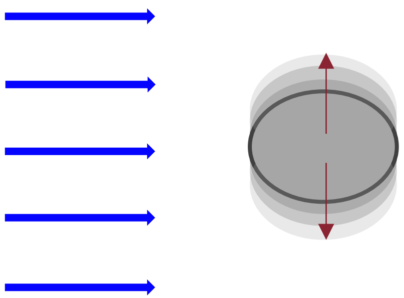
valid for homogeneous beds

Engineering

Distinguish transport from non-transport

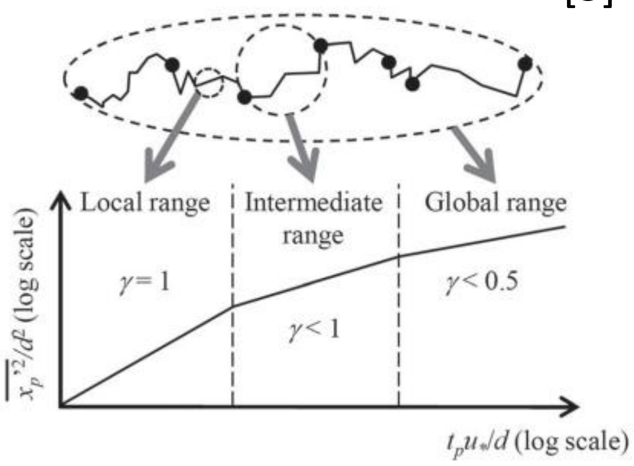
Kinematics

oscillations

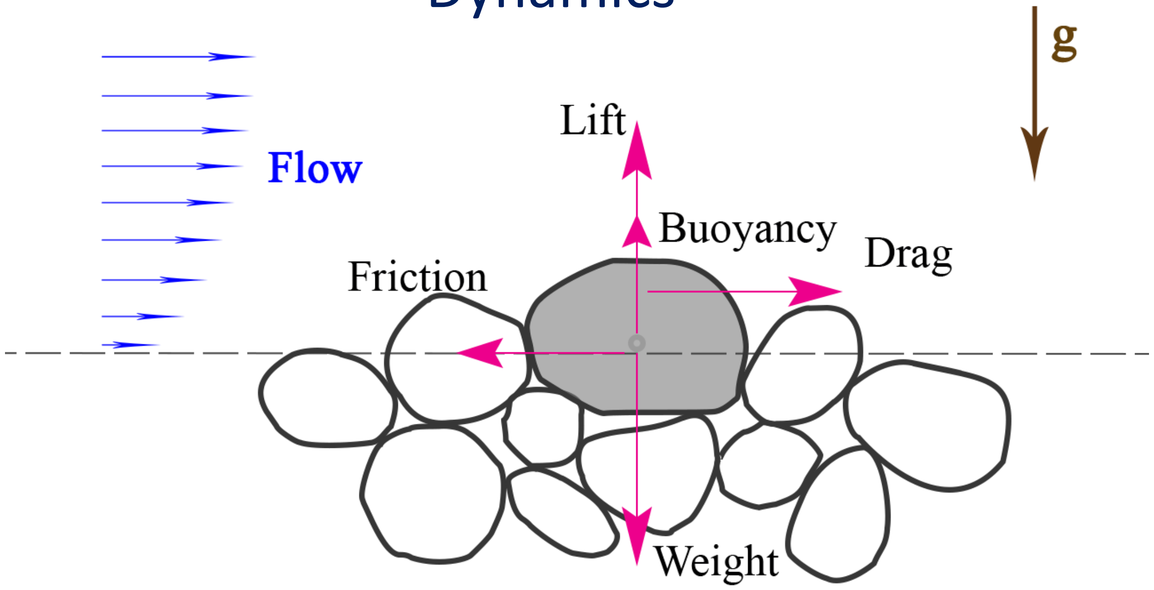


particle trajectories

[3]



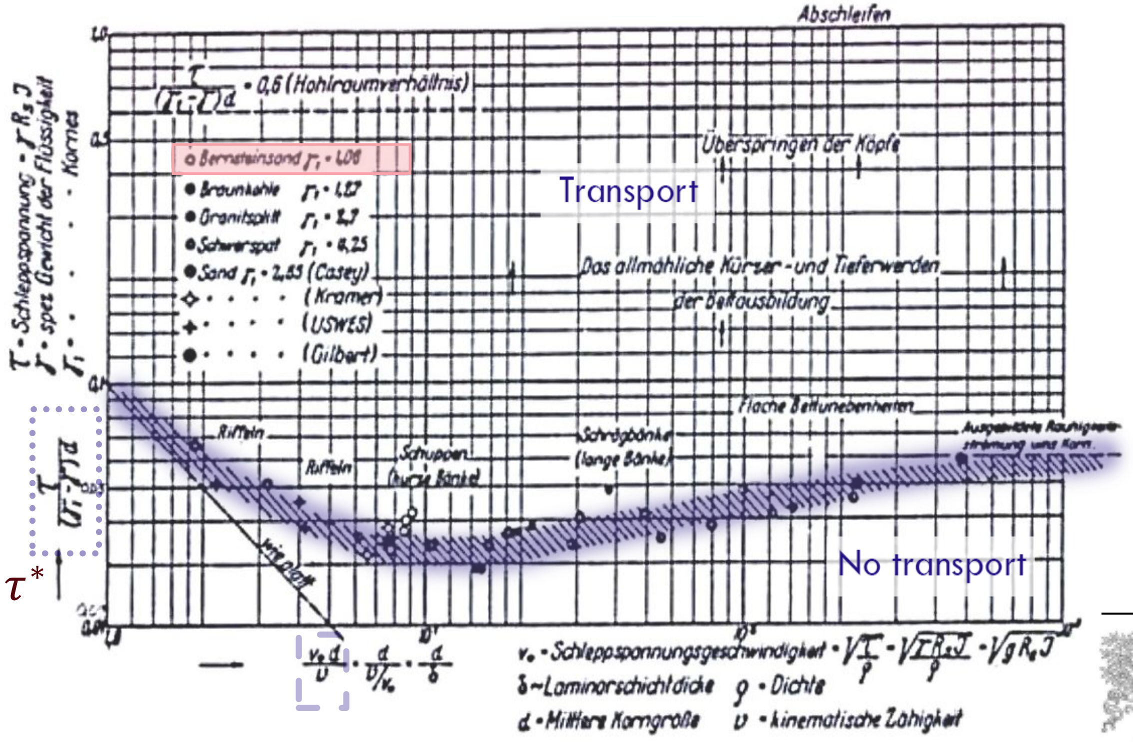
Dynamics



$$Active\ force \propto \tau_b$$

$$Friction \propto (\rho_{grain} - \rho_w) g d_{grain}$$

The sediment analogy framework



$$\rho_{amber} = 1.05 - 1.15\ g/cm^3$$

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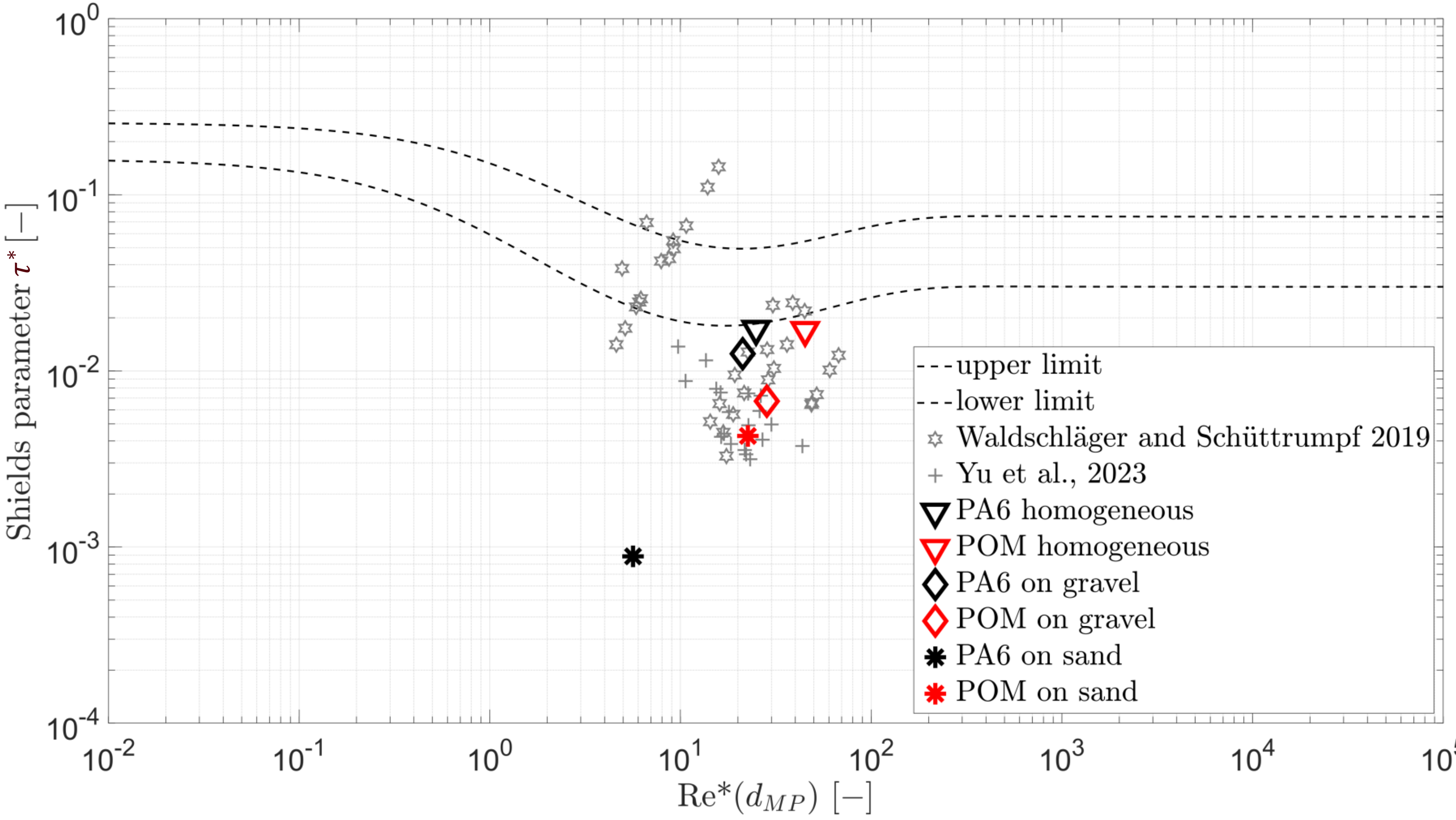
Learning from natural sediments to tackle microplastics challenges: A multidisciplinary perspective

The sediment analogy framework



Transport formulas

Bedload: based on threshold conditions

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Meyer-Peter Müller (1948) bedload, generalised	$q_{b,k}^{*} = 8(\tau_{b,k}^{*} - \tau_{c,k}^{*})^{3/2}$
Wong & Parker MPM (2006) Corrected MPM	$q_{b,k}^{*} = 3.97(\tau_{b,k}^{*} - \tau_{c,k}^{*})^{1.6}$
Fernandez-Luque & Van Beck (1976)	$q_{b,k}^{*} = 5.7(\tau_{b}^{*} - \tau_{c}^{*})^{3/2}$
Van Rijn (1984)	$q_{b}^{*} = 0.015\, U\, h \left(\frac{U - U_{c,k}}{\sqrt{\Delta g d_k}}\right)^{3/2} \left(\frac{d_k}{h}\right)^{1.2}$
Bagnold (1977, 1980) Adapted by **Bridge & Dominic** (1984)	$q_{b}^{*} = a_t(\tau_{b}^{*} - \tau_{c}^{*})(\tau_{b}^{*1/2} - \tau_{c}^{*1/2})$
Wu et al. (2000)	$q_{b,k}^{*} = \begin{cases} 0.0053\sqrt{\Delta g d_k^3}\left(\frac{\tau_b'}{\tau_{c,k}} - 1\right)^{2.2} & \text{for } \tau_b' > \tau_{c,k} \\ 0 & \end{cases}$

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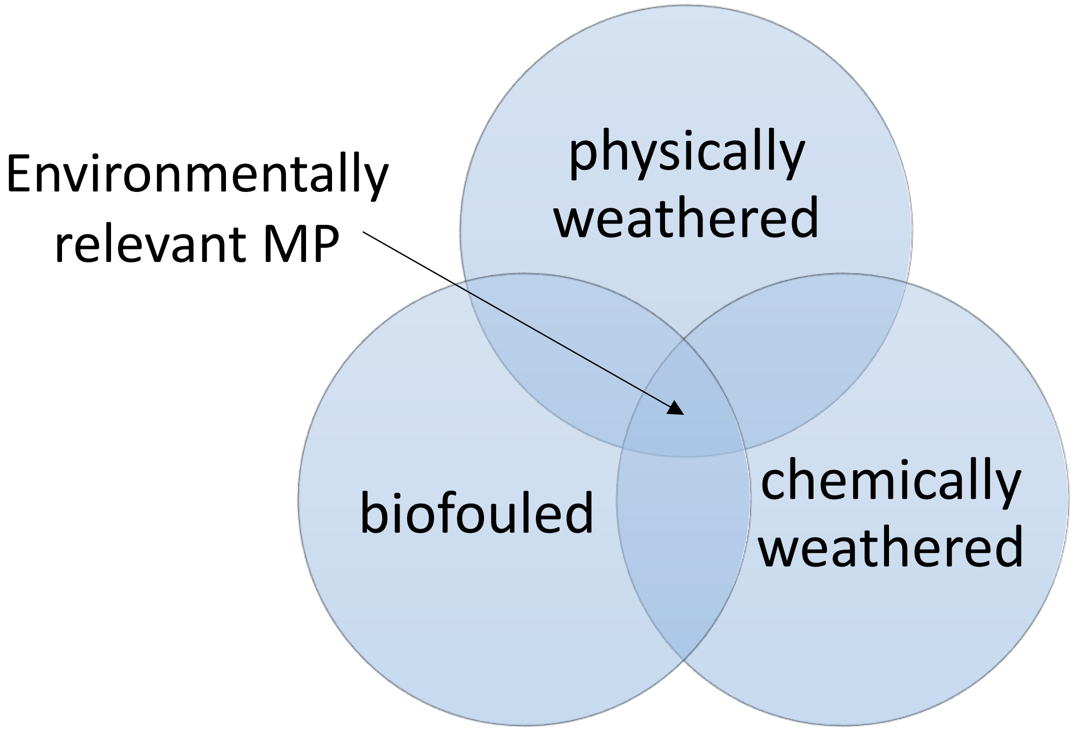
Future challenges 1

Non-pristine plastics

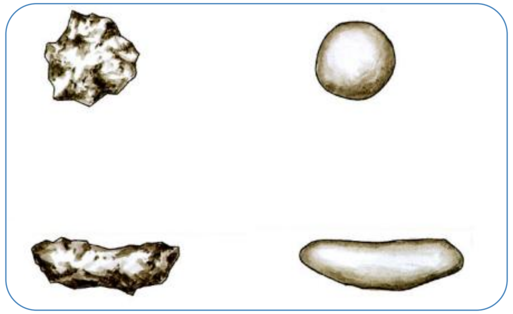


Short term vs Long term ?

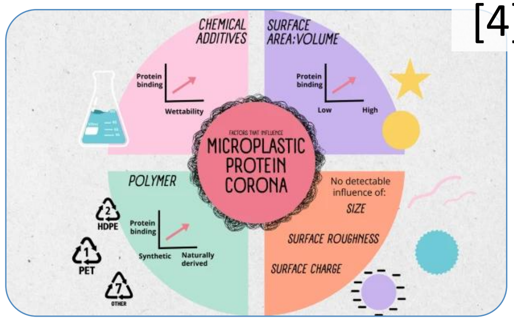
- Preparation
  - Abrasion or cryomilling
  - Incubation
  - Environmental sampling / reuse

Future challenges 2

Environmental processes

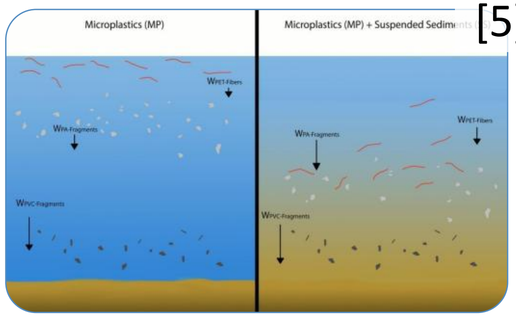


Abrasion dynamics



[4]

Development of ecocorona and Biofouling



[5]

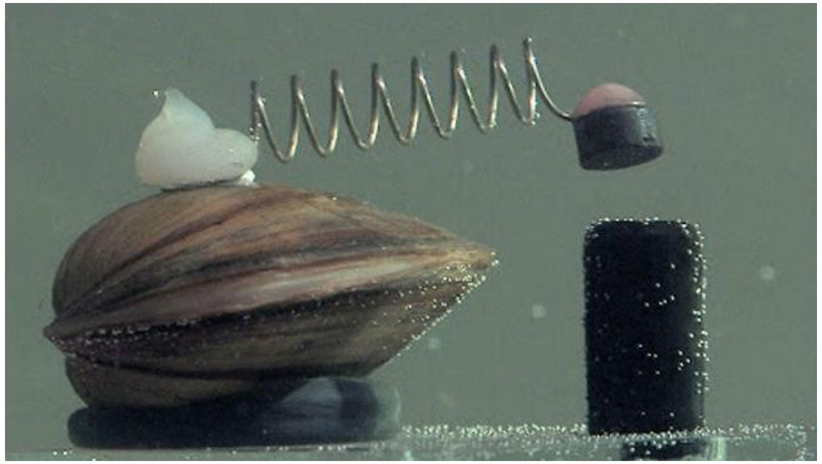
Interaction with suspended (sediments, OC, etc..)

Future challenges 3

Environmental conditions

Freshwater with solutes

Drought Normal regime Flood



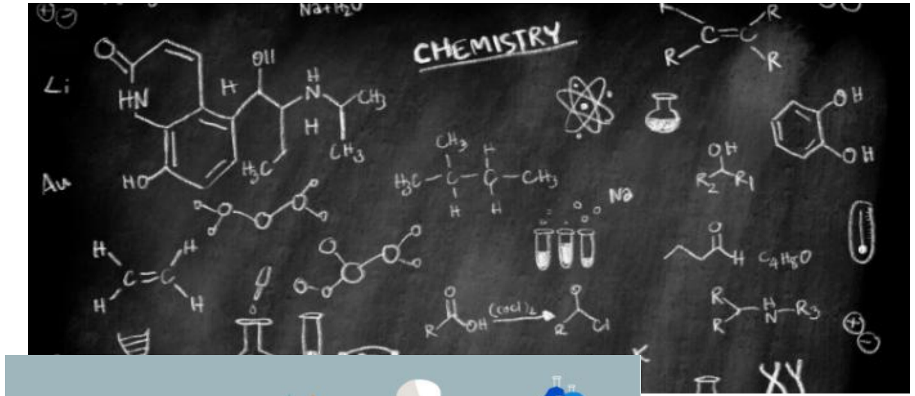
Warsaw water quality for the supply system is monitored with the help of clams

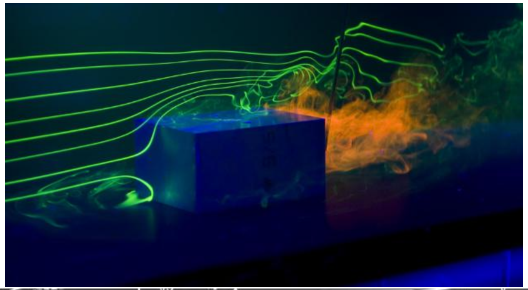
Turbidity caused by a small flood, „white waters“ are visible

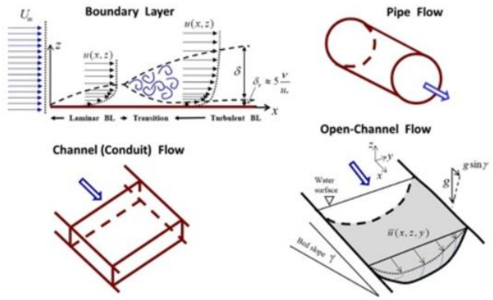
Present challenges

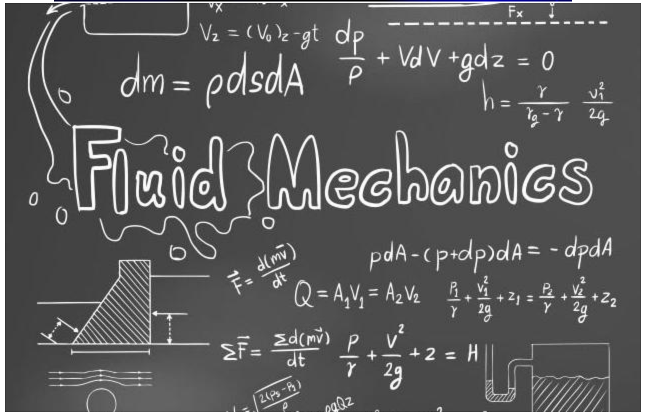
Terminology

- Language translation (on top of English as non- native language barrier)



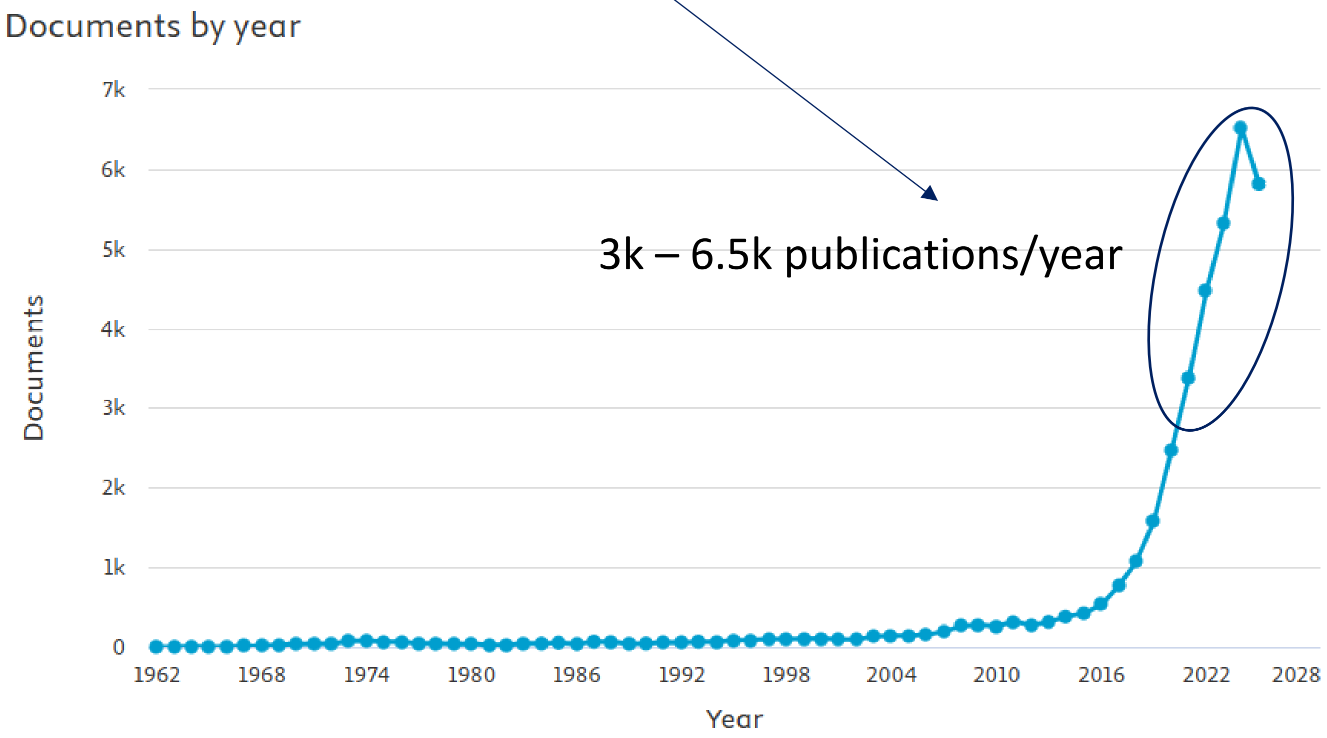






Present challenges

- Noise filtering out of this



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PLASTIC CUP

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Thank you

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SUSTAINABLE TECHNOLOGIES SUB-PROGRAMME
SUSTAINABLE DEVELOPMENT AND TECHNOLOGIES NATIONAL PROGRAMME OF MTA

DANUBE REGION strategy
Water Quality

Interreg Programme
Danube Region

Co-funded by the European Union

iNNO SED
iNNOvative SEDiment management in the Danube River Basin

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