Sednet Dubrovnik, 04 2019

Quantifying hydromorphological impacts with regard to Ecosystem Services

Case study Lower Rhine

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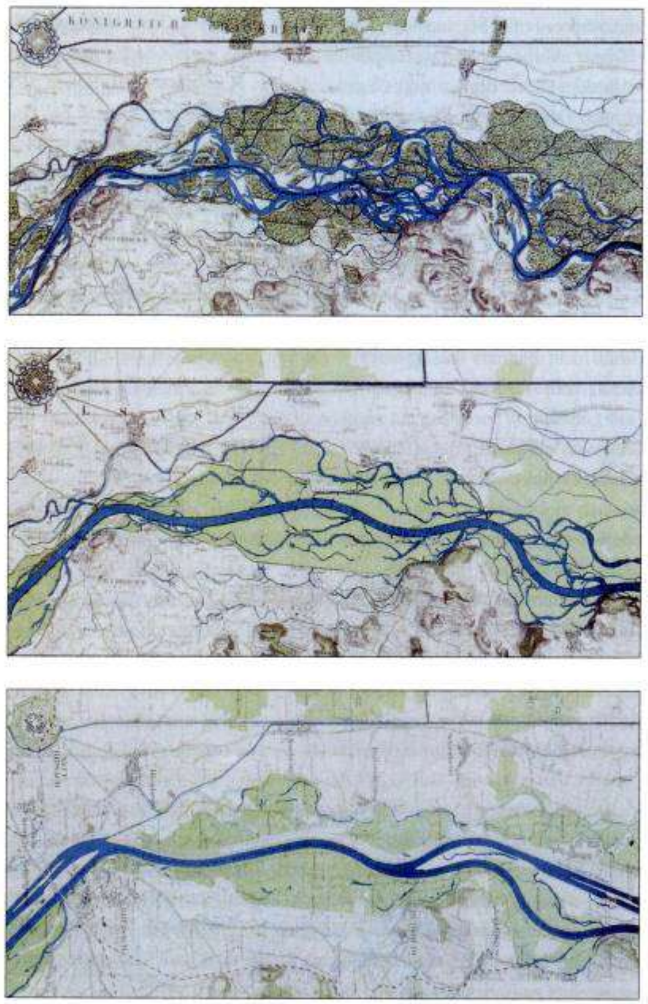
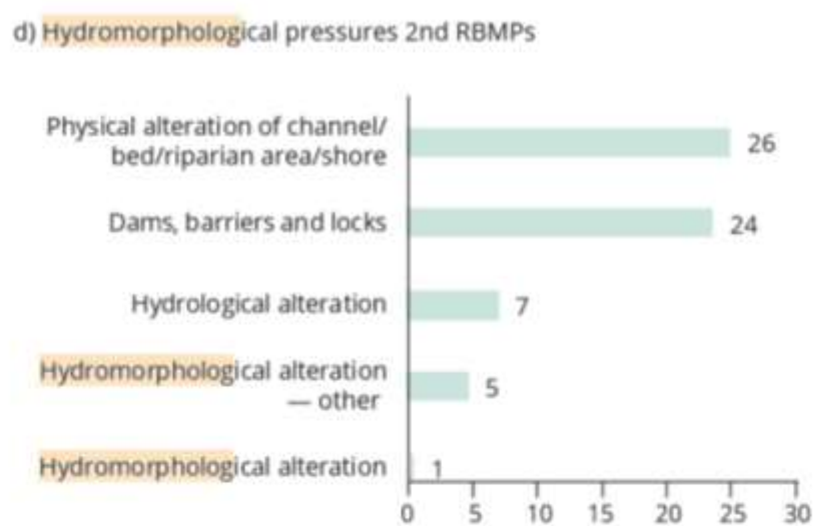
Hydromorphology of waterways



KHR 1993

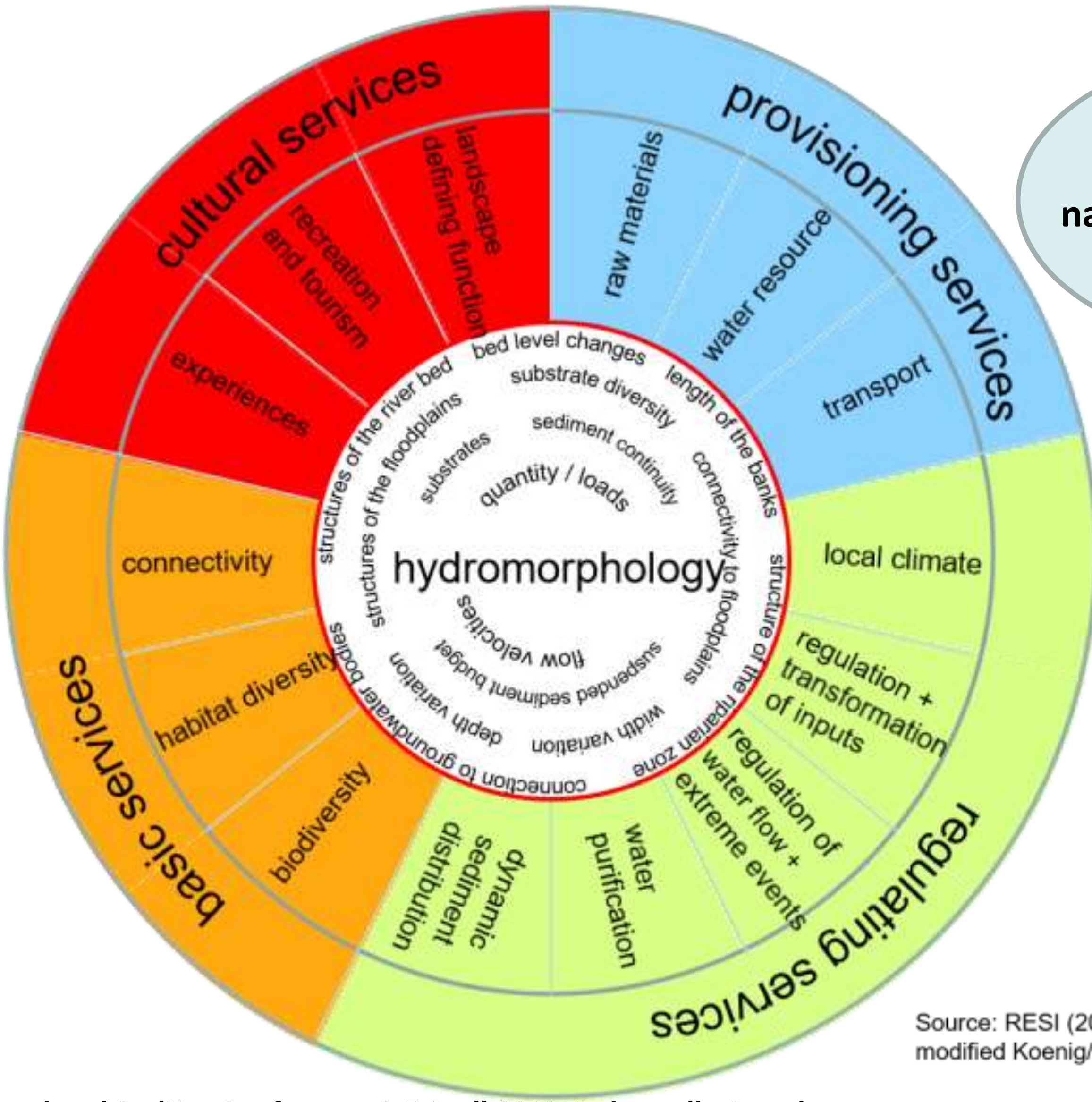
….82% of navigation channels in a hydromorphologic bad condition

The main significant pressures on surface water bodies are hydromorphological pressures (40 %), ……



EEA report 2018

Ecosystem Services



Add. benefit of ES navigation & hydropower

Source: RESI (2018), CICES (2019), modified Koenig/Quick/Luetz (2019)

Evaluation hydromorphological changes

- the German Federal Institute of Hydrology (BfG) generated **Valmorph** = eVALuation of MORPHology
- a Module of the Integrated Floodplain Response Model (INFORM) on behalf of the Federal Ministry for Transport. Valmorph can also be used independently to INFORM
- a **quantitative method** for the **identification of hydromorphological conditions & modifications** of surface waters, their riparian zones and floodplains
- applicable for **all surface water categories**,

Federal Waterways, Germany.
Source: Cron (2017).

Valmorph

- based on **representative hydromorphological indicators** (of the WFD as well as sediment / habitat related)
- for each indicator under consideration a quantitative **survey, calculation and assessment methodology** was developed (indicator specific statistical procedures)

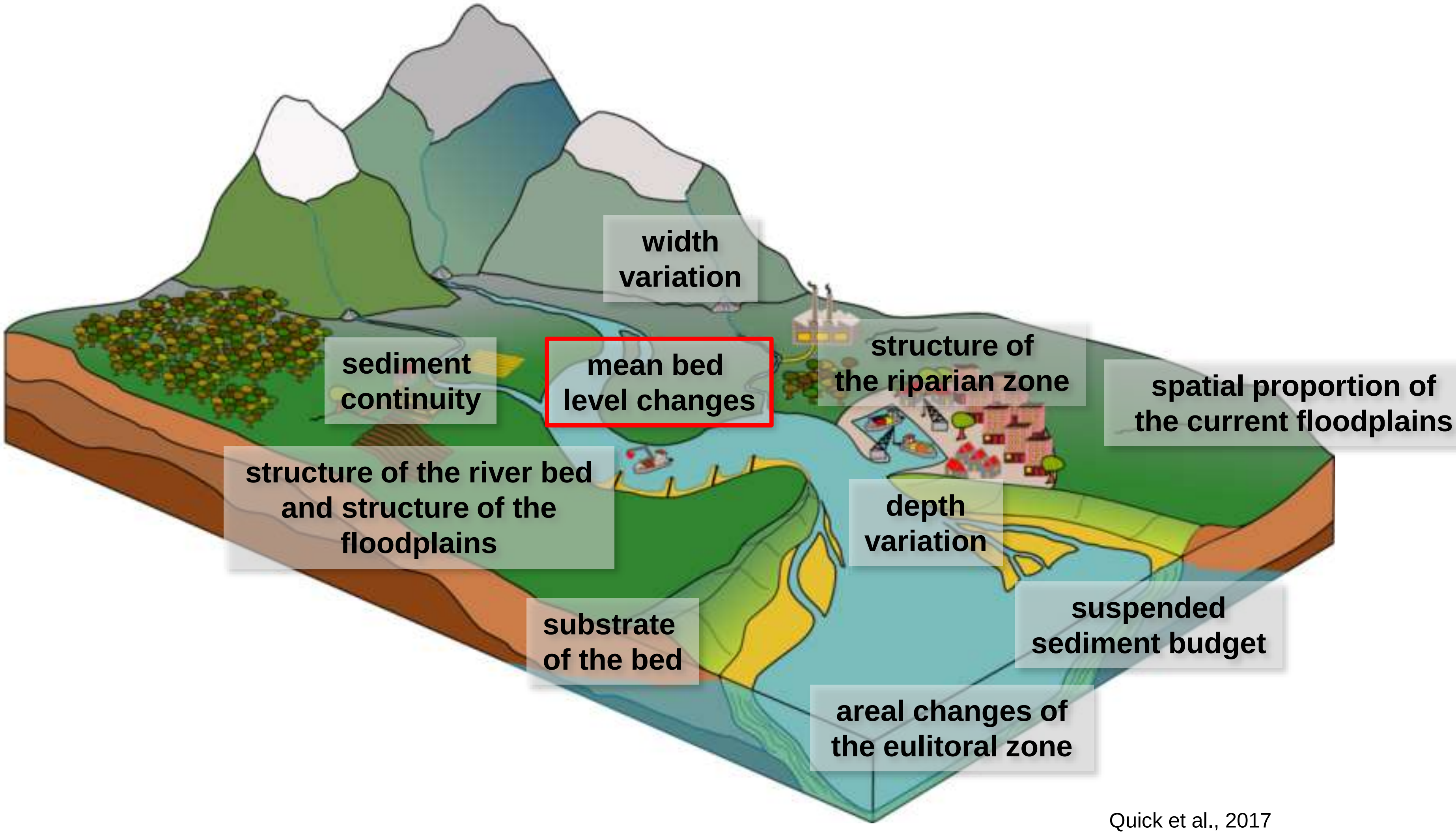

BfG-1910

Report

The hydromorphological classification tool Valmorph 2 for large and navigable surface waters

Instruction Guideline Report: http://doi.bafg.de/BfG/2017/BfG-1910-ENG.pdf

Indicators of Valmorph



Quick et al., 2017

Mean bed level changes

Bundesanstalt für Gewässerkunde

- expressed and determined as change rate, i.e. level changes over time [cm/a]
- based on comparison of different time epochs
- a measurement for possible sedimentation processes or erosion processes within a defined period of time

Waterways show mostly erosive regimes due to course regulations, shortening, bed and bank fixation, cross structures, embankment, …..

=> to classify the decoupling of river and floodplain

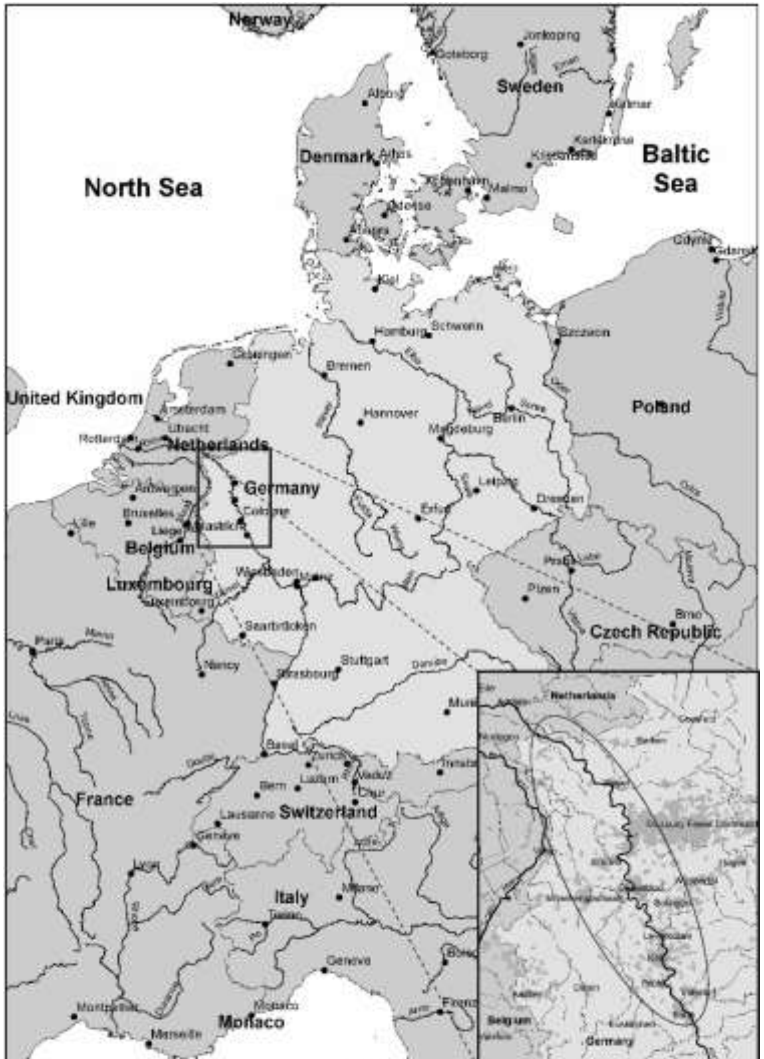
Consequences of river bed erosion

- long-term morphological changes (much faster rate than occurs naturally)
- obstacles for navigation
- danger to infrastructure (bridges, crossings,…)
- decoupling of river and floodplain (lowering of river water level & groundwater level)

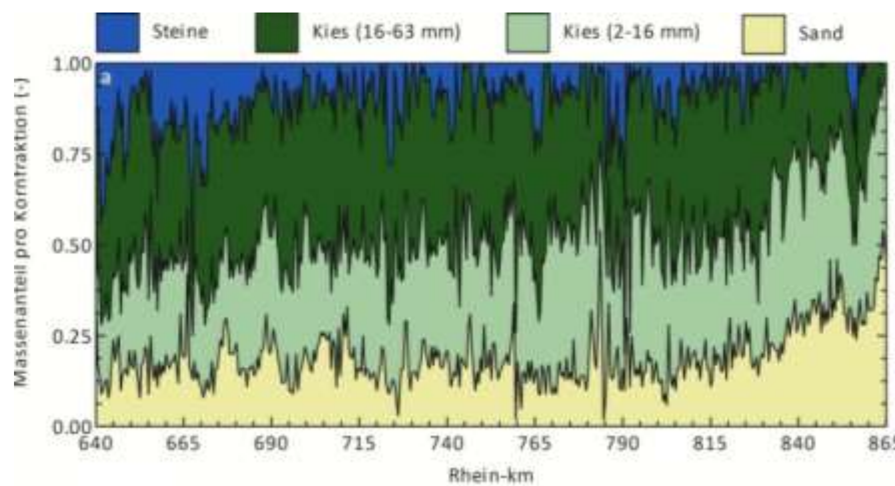
affected ES

- habitatdiversity
- biodiversity
- connectivity
- regulation of water flow and extreme events
- water resources (drinking water, irrigation)
- regulation/transformation of inputs
- experinces (aestethic, …)
- landscape defining function

Case study lower Rhine



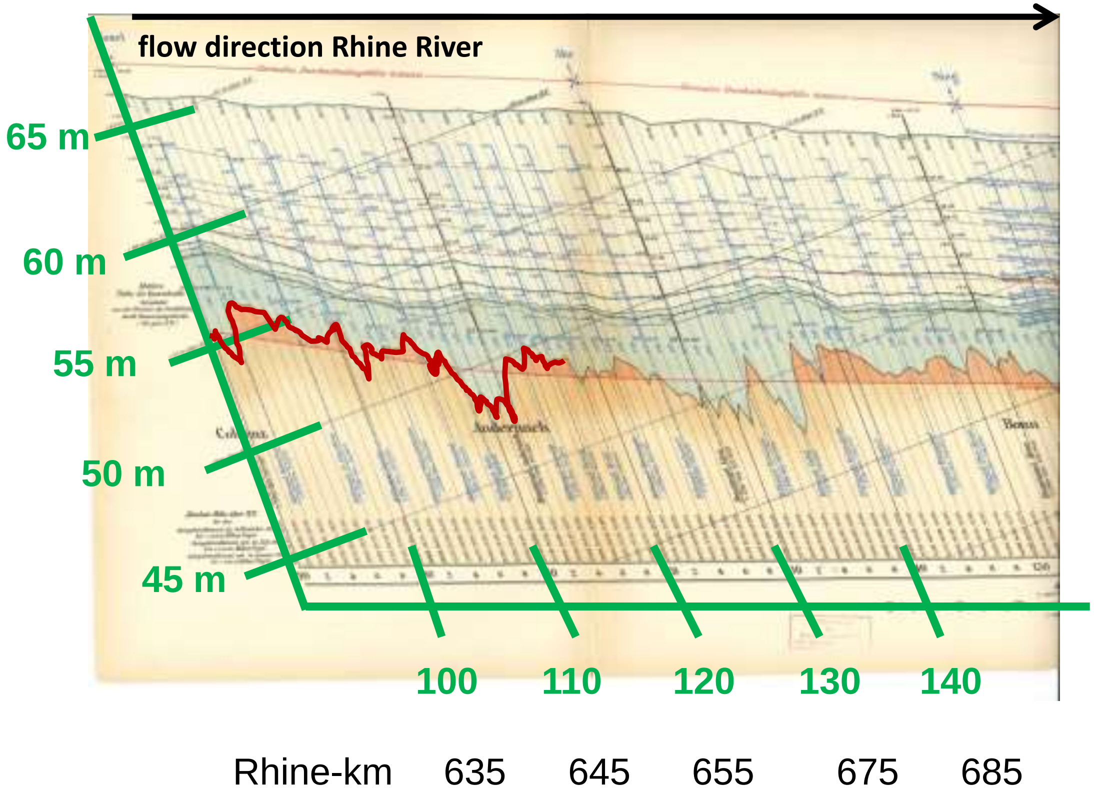
- length of 1230 km
- Mean discharge: 2300 m^3/s (german-dutch border)
- catchment size: approx. 200,000km^2
- Surface water type 10 and 20
- HMWB



Hillebrand and Frings 2017

Data set

- Current condition: data from echo sounding measurements
- Historical data für comparison condition



Digitalisation of water levels

Digitalisation river bed level
(averaged depths of cross sections)

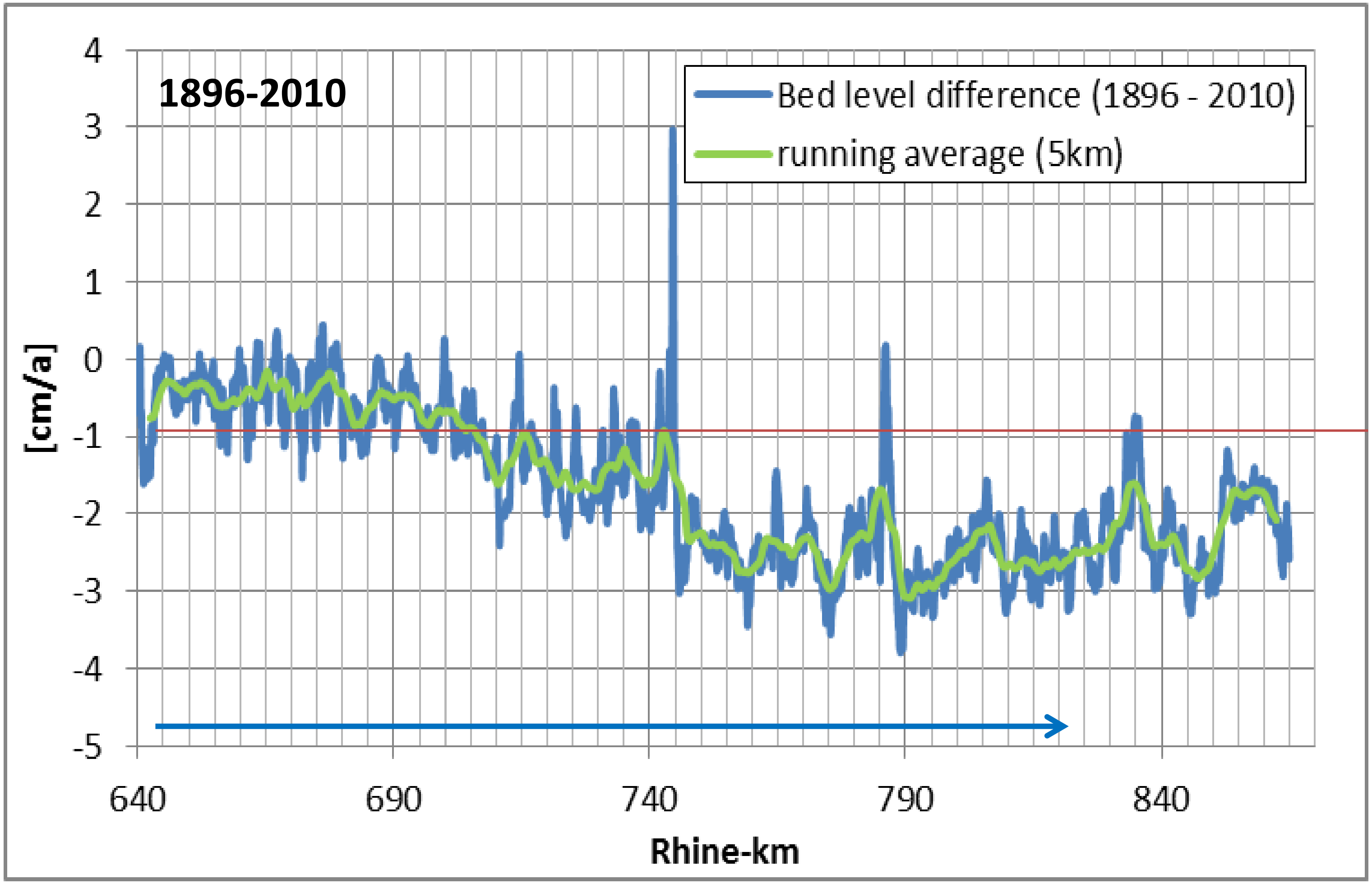
Graticule / Coordinate system

- adaption to the actual river-km
- adaption height above sea level

Source: Jasmund (1898); Quick et al. (2017); www.wasserblick.net.

Mean bed level changes

long-term channel changes



Assessment matrix

- for Class 1 a deepening of the river compared to the floodplain of approximately 0 cm is assumed: Holocene deepening rate of the River Rhine of 0.1 mm/a (Gölz 1993)
- local variations of a morphodynamically active river, are taken into account by the tolerance value of 0.25 cm/a.
- accumulations in the river bed are also valued with a 1 (> 0.0 cm/a), =>

Mean bed level changes Class	Mean bed level changes percentage deviation from the comparative condition	Mean bed level changes range (magnitudes of class intervals) cm/a	Classification
accumulation / no erosion	0 %	to - 0,25	1
minor erosion	> 0 % – 15 %	< - 0,25 to - 0,64	2
moderate erosion	>15 % – 30 %	< - 0,64 to - 1,04	3
major erosion	> 30 % – 60 %	< - 1,04 to - 1,84	4
very major erosion	> 60 %	< - 1,84	5

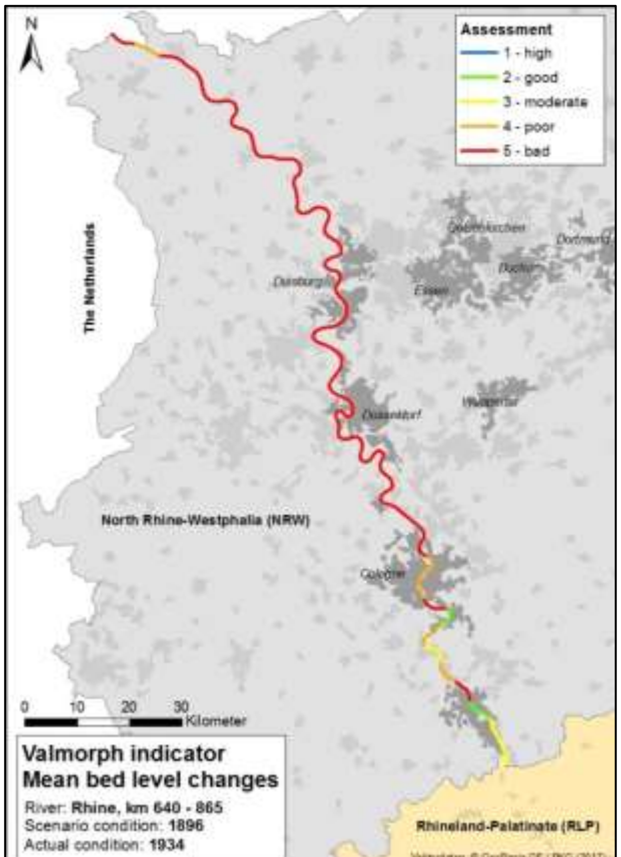
Source:; Quick et al. (2016, 2017).

Mean bed level changes

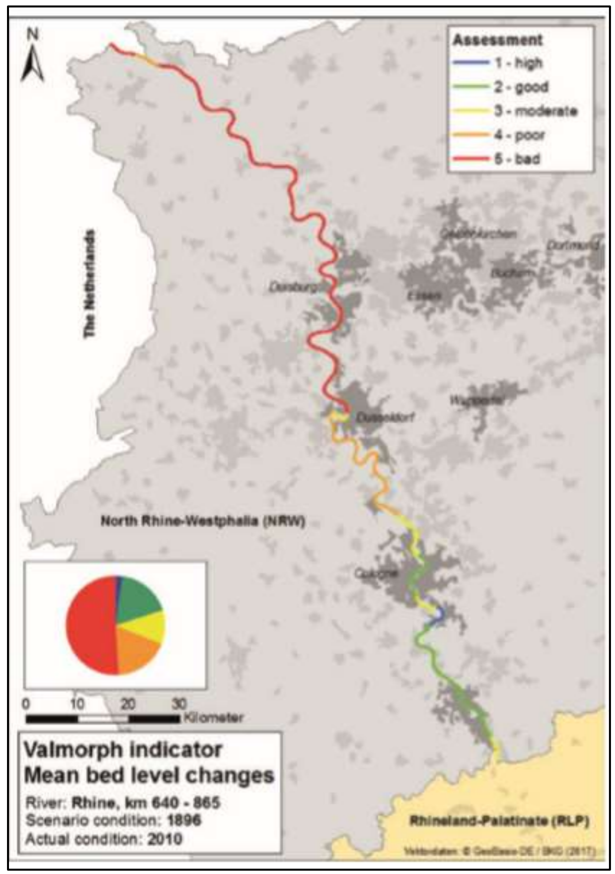
long-term channel changes
(river stretch with assessments of 5 km sections)

erosion rate
(river stretch with assessments of 5 km sections)

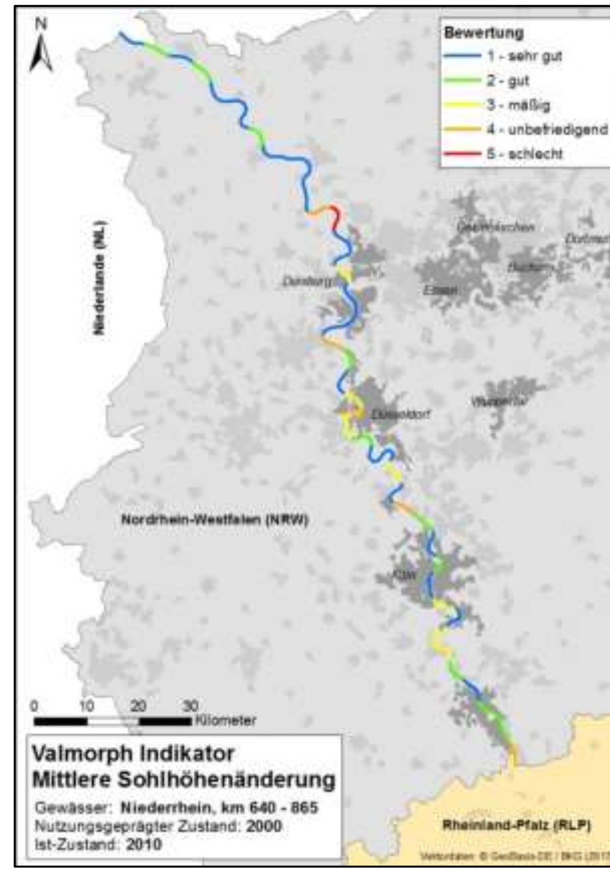
1896-1934



1896-2010



2000-2010



Source: Quick, Baulig & König (2017);and WSV (WSA Duisburg-Rhine, Abel).

Sediment management measures

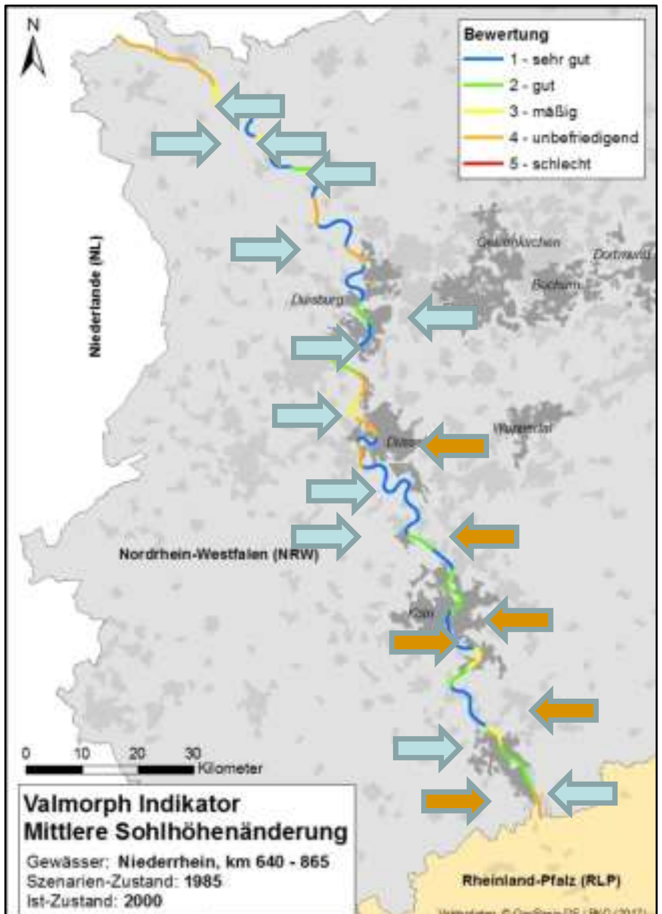
Exempl. sediment supply (1985-2010)

Exempl. stabilising measures of the river bed (1991-2010)

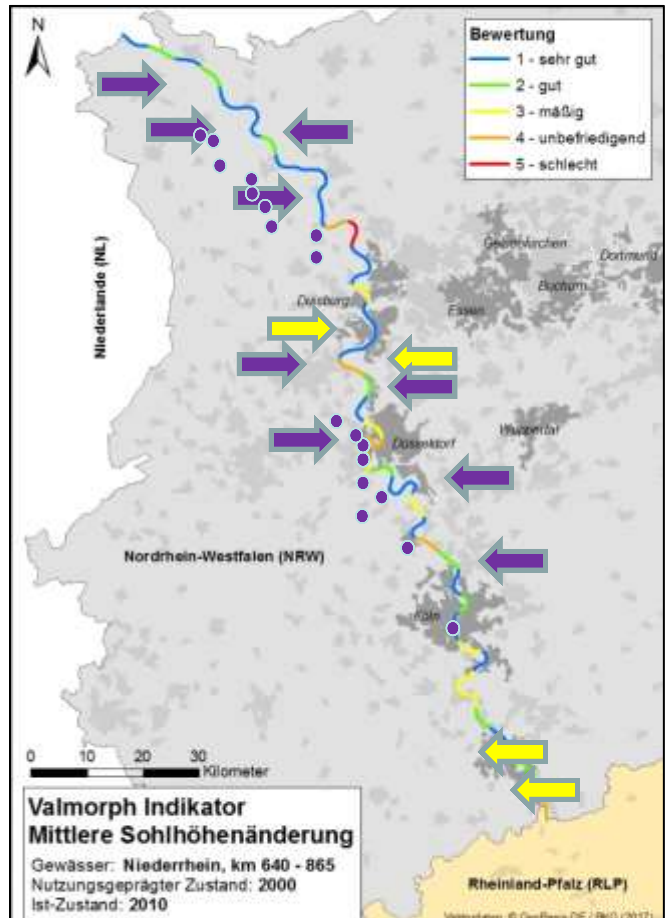
Exempl. bed load addition (since 2000)

Exempl. dredged material relocation (since 2000)

1985-2000



2000-2010



Source: Quick, Baulig & König (2017); data Messing (2008); Frings et al. (2012); Pribil (2016); BAW (2017); WSA Köln (2017); EKR (2016); Jasmund (1900) and WSV.

Conclusion and future work

- Streambed erosion is a risk for several Ecosystem Service (ES)
- Sedimentmanagement could help to reduce streambed erosion and the risk to ES
- Valmorph is a suitable tool to quantify hydromorphologic changes and show effects of sedimentmangement measures
- Further investigations on effects of different measures improving hydromorphology are necessary (restoration measures, …)
- Next steps: Assessing the costs of affected ES
  (quantification of impacts is needed and further investigations, based i.a. Horchler et al. 2016)

Thank you

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Many thanks to Melanie Luetz and Dr. Ina Quick !