

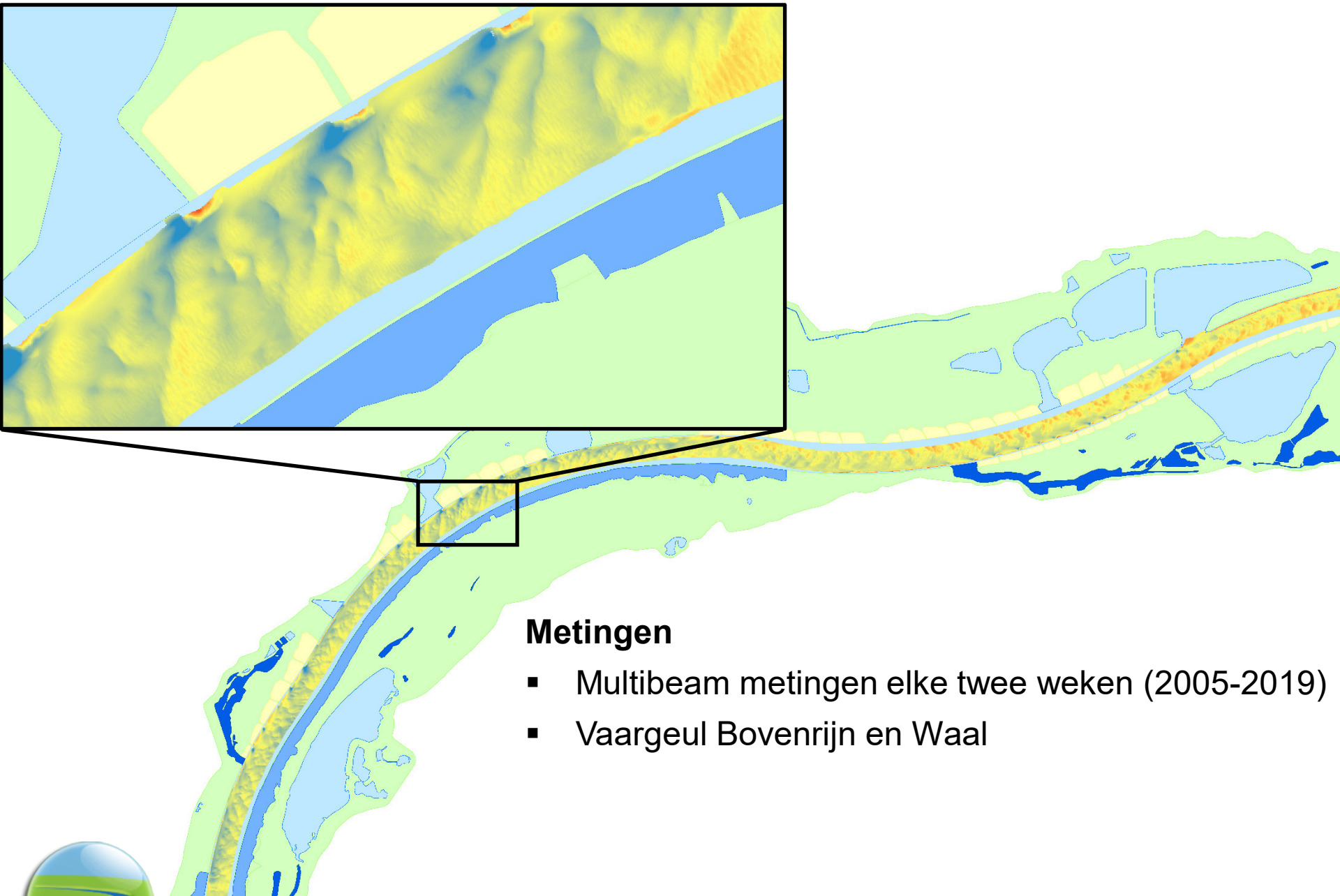
Riviermorfodynamiek en interventies



Riviermorfodynamiek en interventies

- Wat doet de rivier?
- Hoe kunnen we maatregelen inpassen?

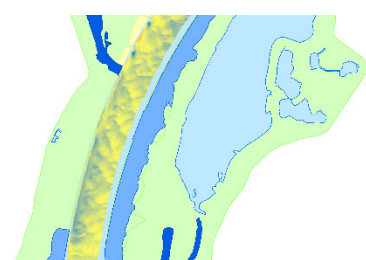
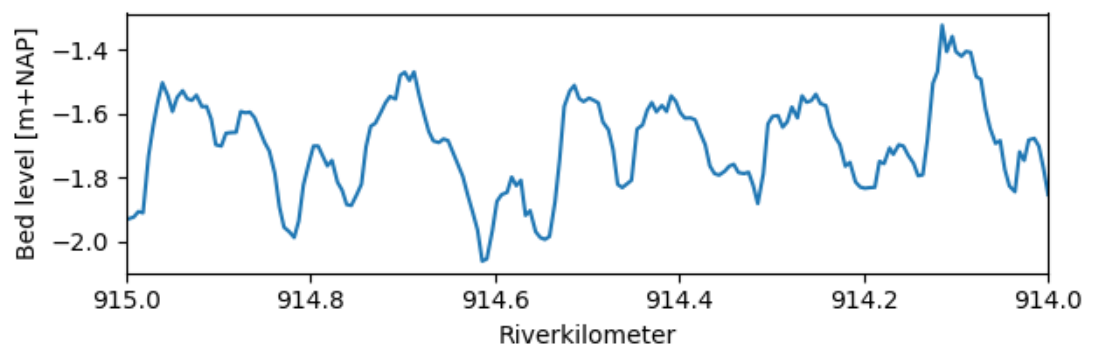
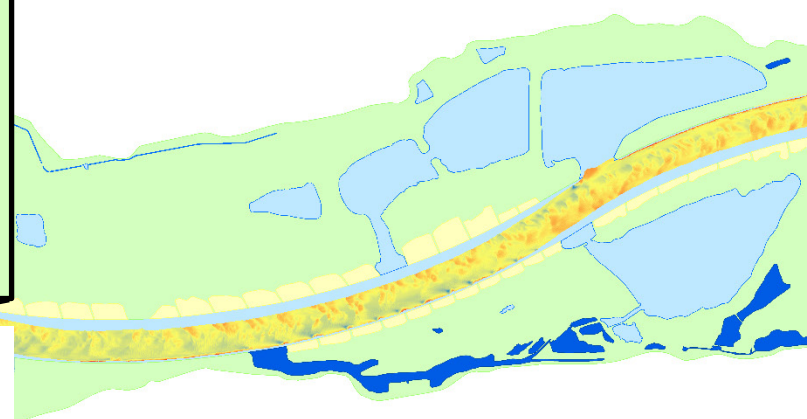
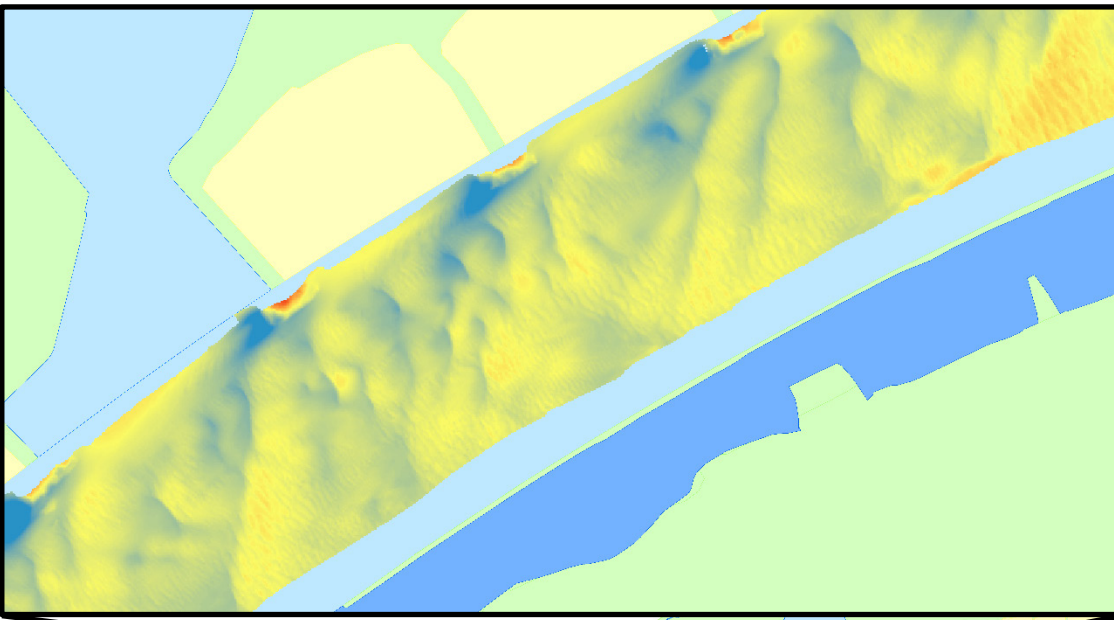




Metingen

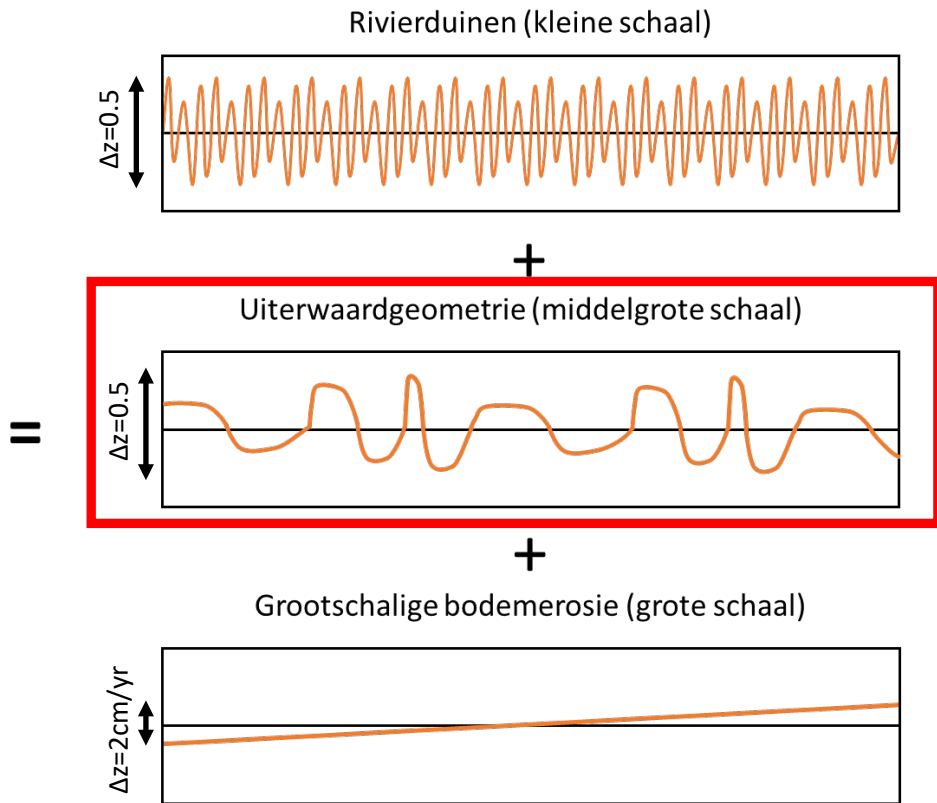
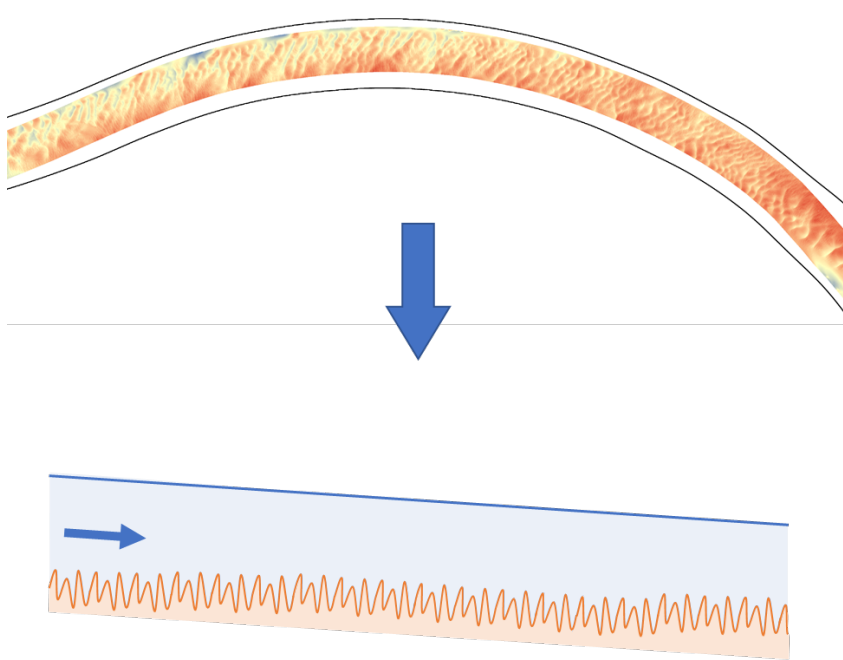
- Multibeam metingen elke twee weken (2005-2019)
- Vaargeul Bovenrijn en Waal





1D langspriefel





FILTEREN

- Wavelet transformatie
 - Identificeren van golflengtes in tijd en ruimte

Bodemvormen: $\lambda = 20 \text{ m} - 100 \text{ m}$

Kribben: $\lambda = 200 \text{ m}$

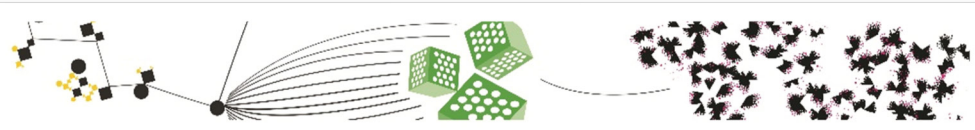
Nevengeul: $\lambda = 500 \text{ m} - 10 \text{ km}$

Uiterwaardgeometrie: $\lambda = 500 \text{ m} - 10 \text{ km}$

Grootschalige bodemverandering: $\lambda > 10 \text{ km}$



LANGSDAMMEN



The initial morphological impact of the longitudinal dams

Pepijn van Denderen¹, Emiel Kater², Luc Jans² and Ralph Schielen^{2,3}

¹T.p.vandenderen@utwente.nl (1) University of Twente, The Netherlands (2) Rijkswaterstaat, The Netherlands (3) TU Delft, The Netherlands

INTRODUCTION

Longitudinal dams (LTD):

- Constructed in 2015 over 10 km
- Groynes removed and channel width reduced
- Larger water depth during base flow conditions
- Expected aggradation over 10 km and scour downstream due to the discharge withdrawal.

Goal:

Quantify the spatial and temporal bed level changes at the longitudinal dams over time.

METHOD

- Calculated width averaged longitudinal profile based on bi-weekly multi-beam measurements of the navigation channel
- Calculate bed level variations relative to the time-averaged profile (2005–2014)
- Apply wavelet filtering [1, 2] based on the spatial scale of the bed level variations:

Type of bed level changes	Wavelength
Bed forms and scour at groynes	< 300 m
River interventions	500 m – 30 km
Large-scale bed degradation/aggradation	> 30 km

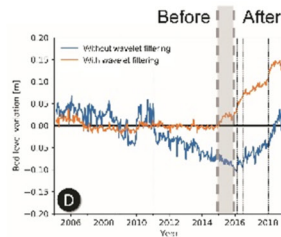
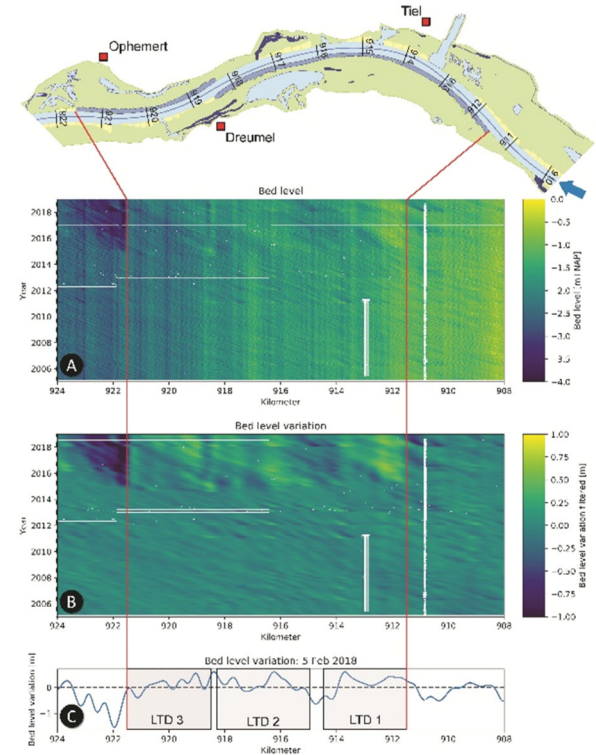
RESULTS

A: shows the width averaged bed level in the navigation channel and its variation in space and time.

B: shows the bed level variation around the time-averaged bed level. The wavelet filtering is applied. The largest aggradation occurs at the upstream end of each dam and scour at the downstream end. The degradation in the main channel parallel to the dams is unexpected. At the downstream and large scour occurs, as expected.

C: The bed level variation (5 Feb 2018) relative to the time averaged bed level in relation to the three dams after the peak flow event of 2018.

D: The average bed level change over the length of the dams with and without wavelet filtering.



DISCUSSION & CONCLUSIONS

- The wavelet filtering makes it possible to distinguish between various contributions of bed level changes.
- Aggradation occurs over the length of the intervention and is sufficiently large to oppose the large-scale degradation.
- Very large scour occurs at the downstream end of the intervention.

Remaining questions:

- What is the effect of dredging during the construction?

Acknowledgements

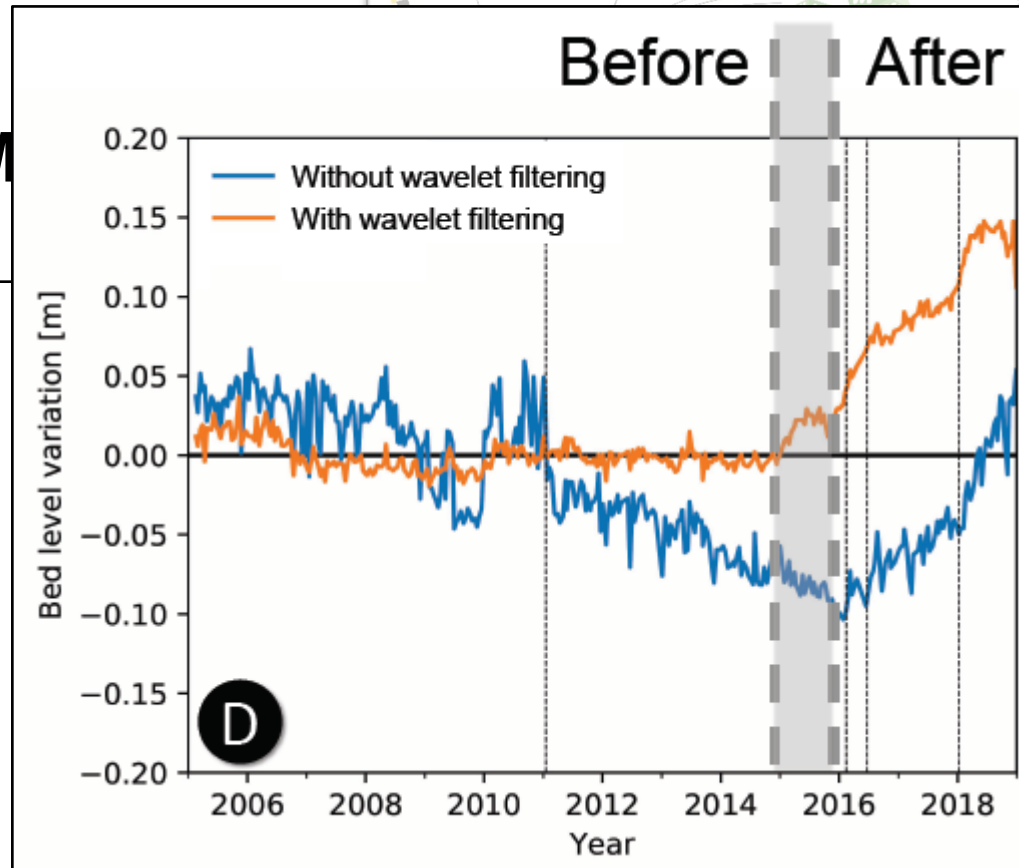
This research is supported by TIO De technologie (2016/17), the Ministry of Infrastructure and Water Management (Rijkswaterstaat) and by the Netherlands Organisation for Scientific Research (NWO) which is partly funded by the Ministry of Economic Affairs, under grant number P22-2-A (Flow Care Resilience Program) project number 12516. This research has benefited from discussions within the network of the Netherlands Centre for River studies.

References

1. Torrence, C., and G.P. Compo, 1998. A practical guide to wavelet analysis. *Journal of Climate*, 11, 1173–1179.
2. Caltanzer, R. et al., 2013. Discrimination of bed forms scales using robust spline fits and wavelet transforms: Methods and application to synthetic signals and field data of the Rio Parana, Argentina. *Journal of Geophysical Research*, Earth Surface, 118, 1461–1478.



LANGSDAM

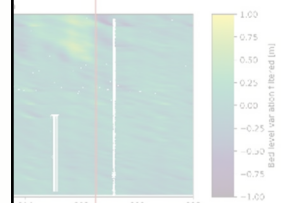
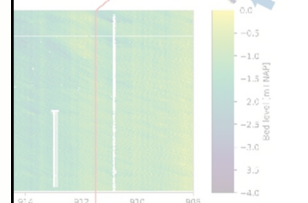


D

Longitudinal dams

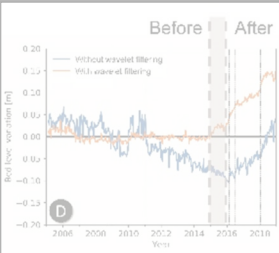
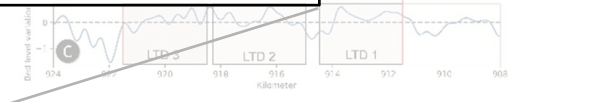
Alph Schielen^{2,3}

(3) TU Delft, The Netherlands



C: The bed level variation (5 Feb 2018) relative to the time averaged bed level in relation to the three dams after the peak flow event of 2018.

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Acknowledgments
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References

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2. Callenberg, B. et al., 2018. Discrimination of bed forms using robust adaptive filters and wavelet transforms: Method and application to synthetic signals and field data of the Rio Raura, Argentina. *Journal of Geophysical Research: Earth Surface*, 119, 1481-1493.

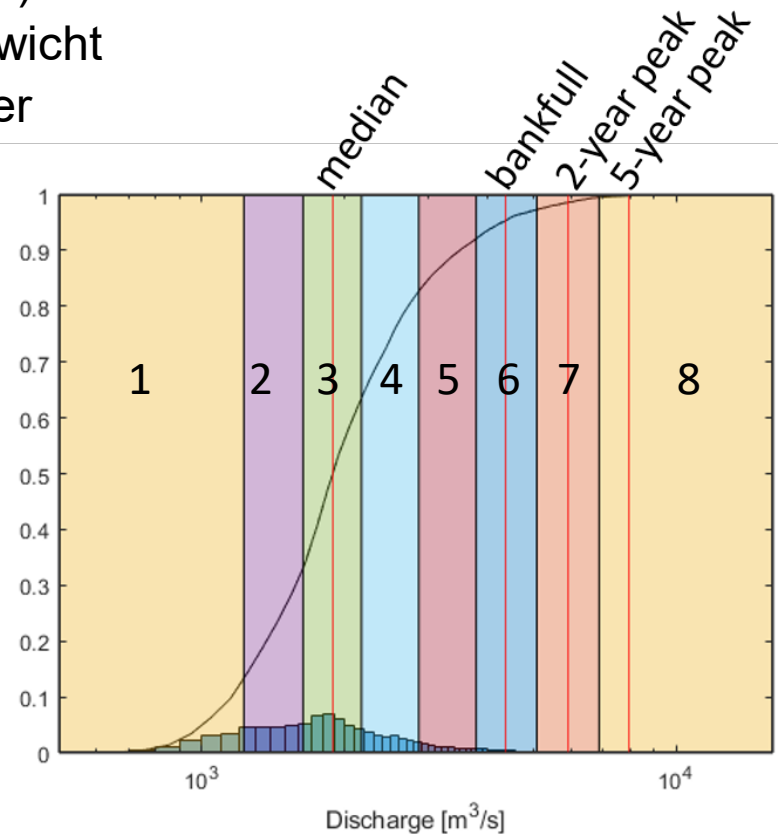


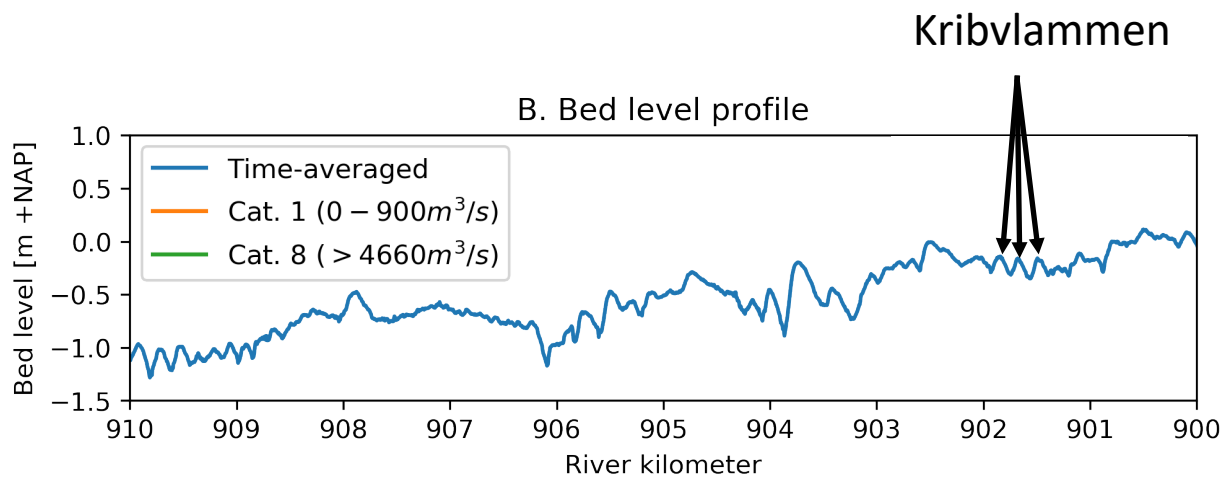
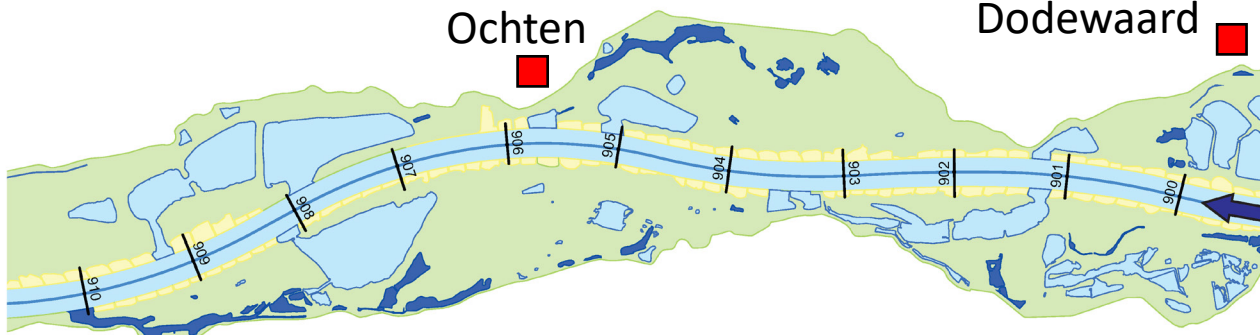
WAT DOET DE RIVIER?

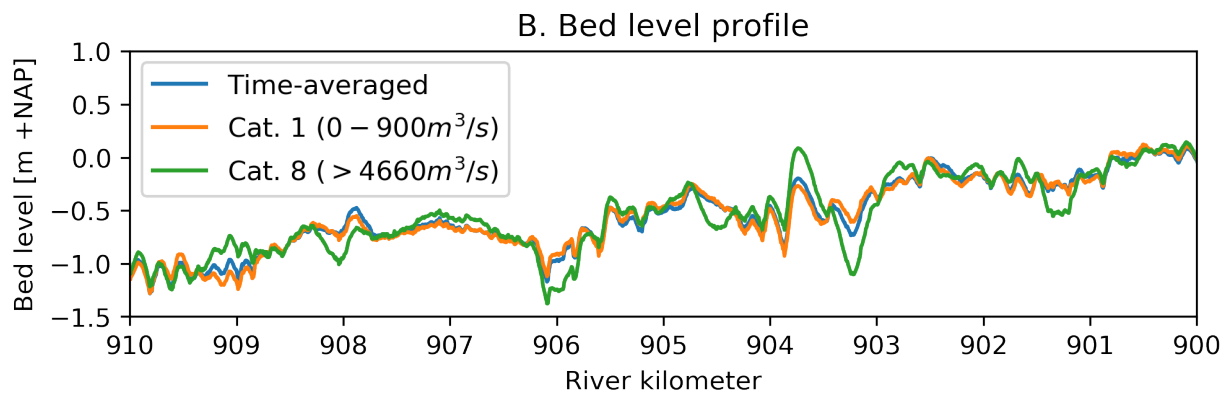
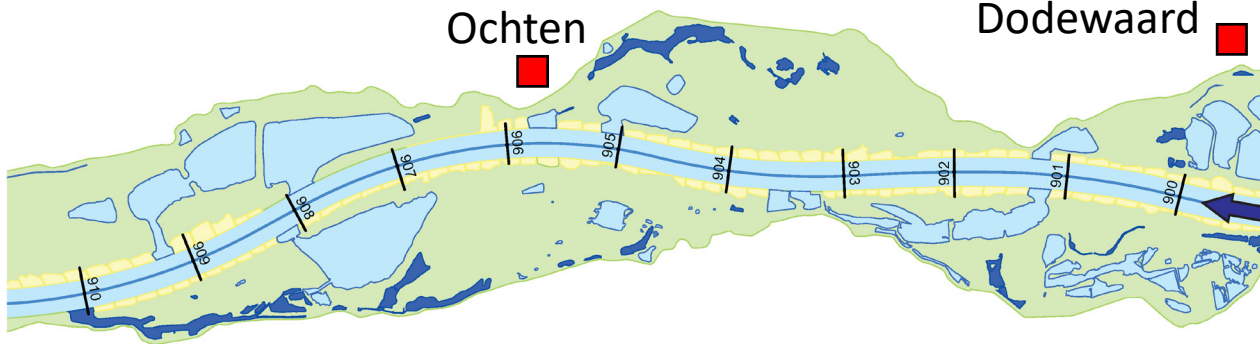
Voor Ruimte voor de Rivier (2005-2014)

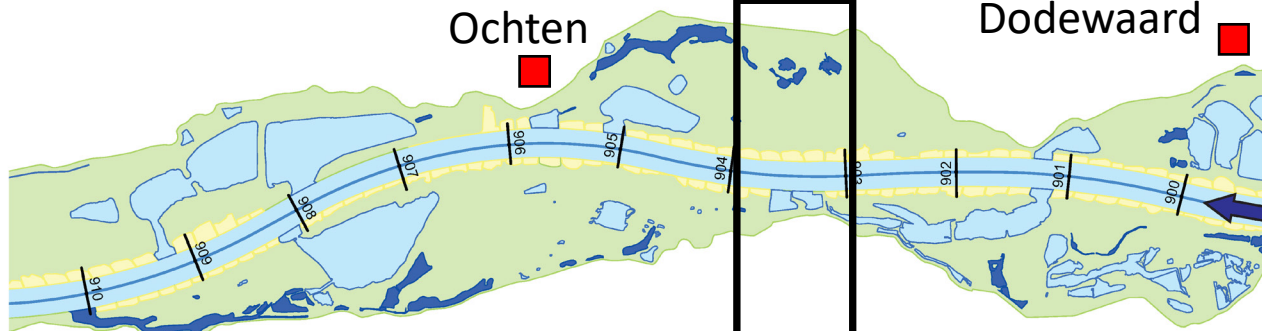
- Variaties rond het (quasi-)evenwicht
- Variaties relateren aan de afvoer

Maximale afvoer tussen meting
en vorige meting

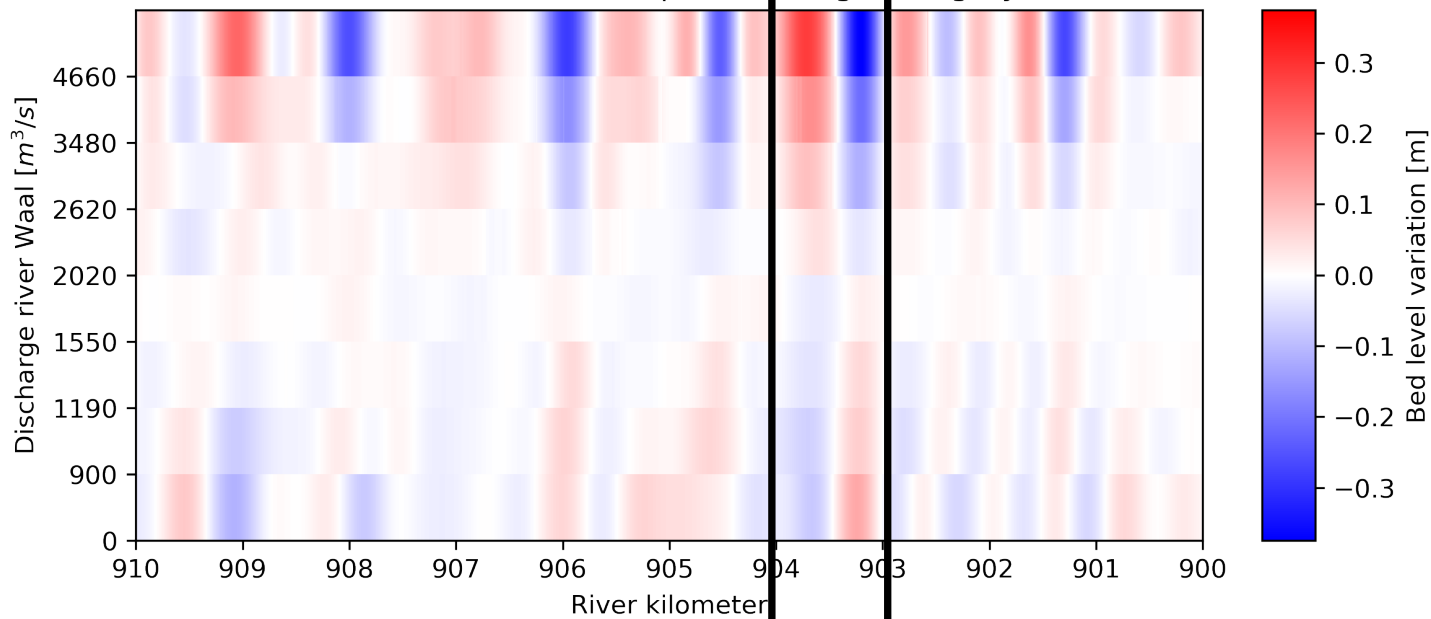




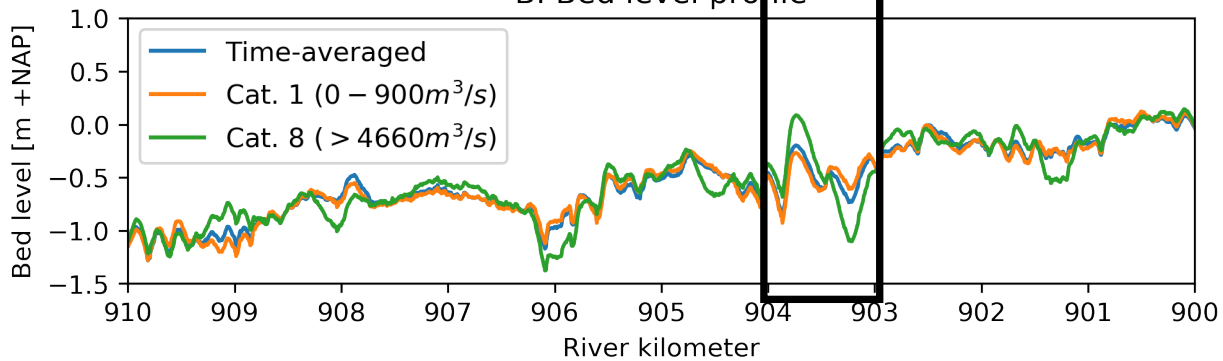


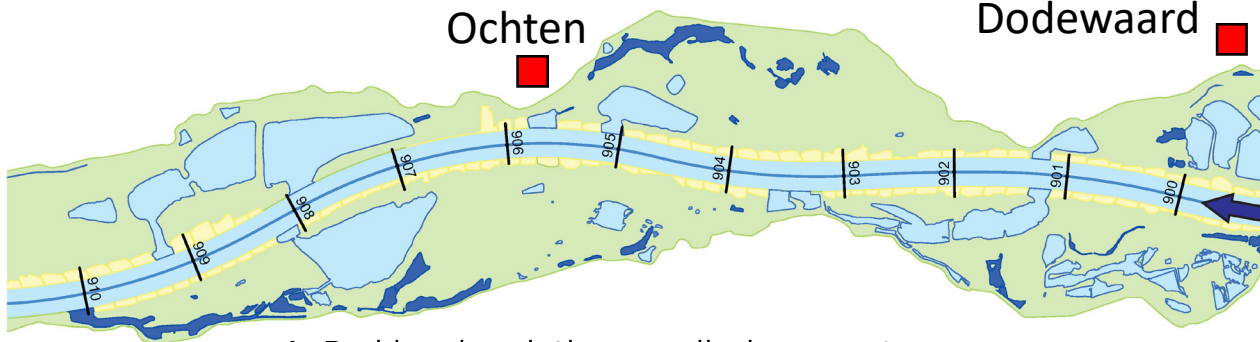


A. Bed level variation per discharge category

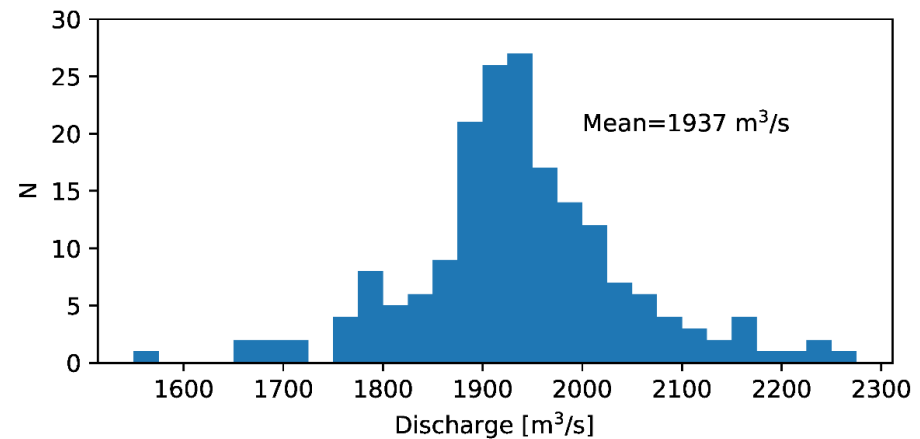
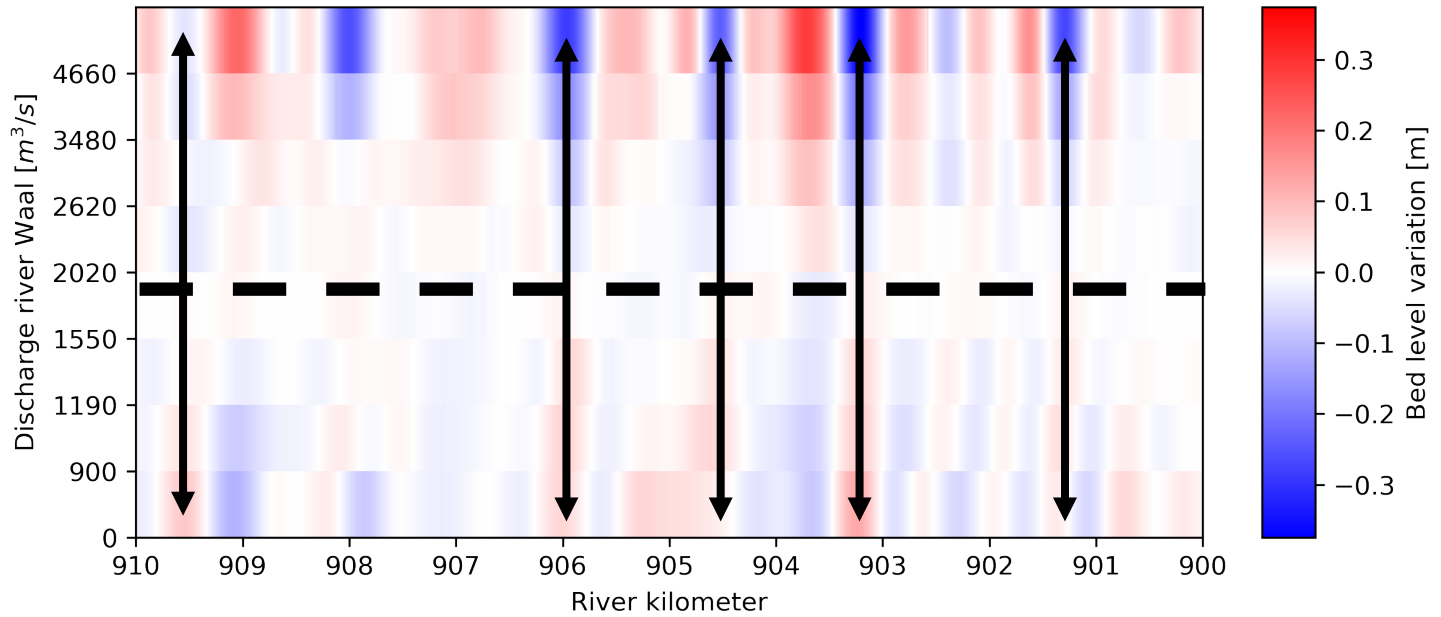


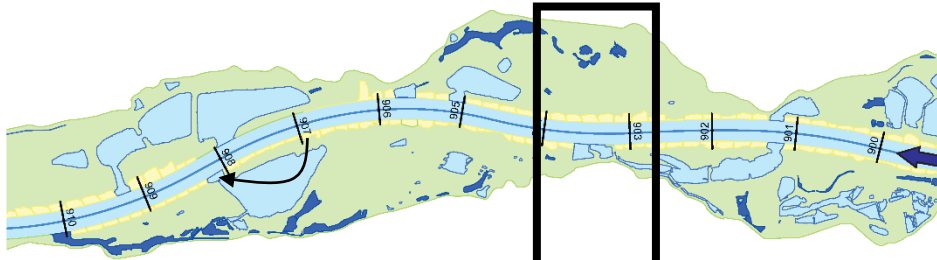
B. Bed level profile



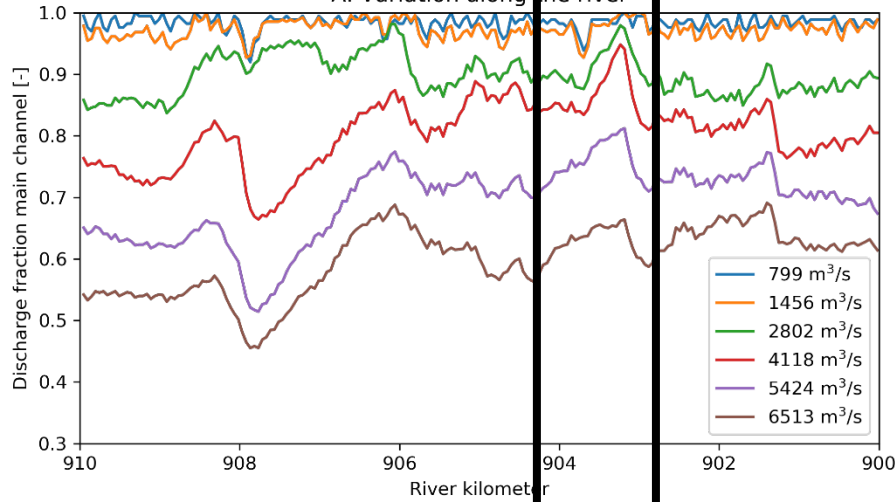


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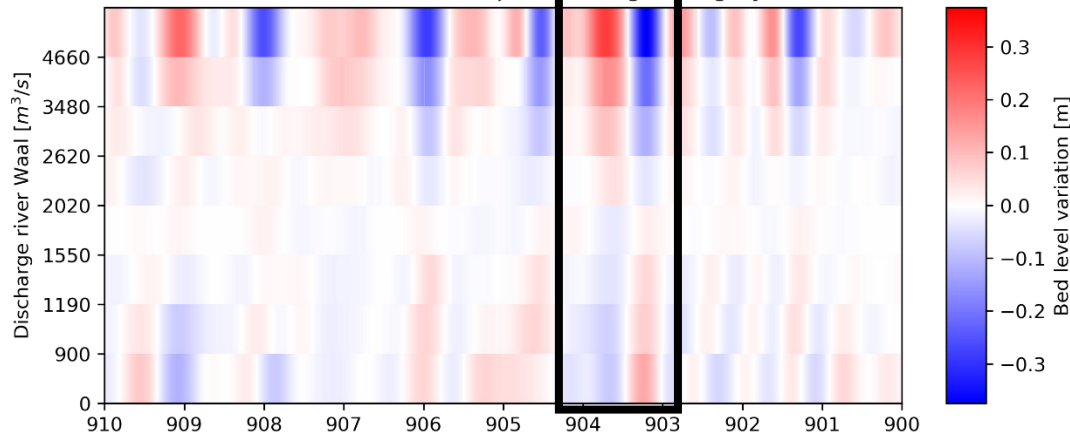




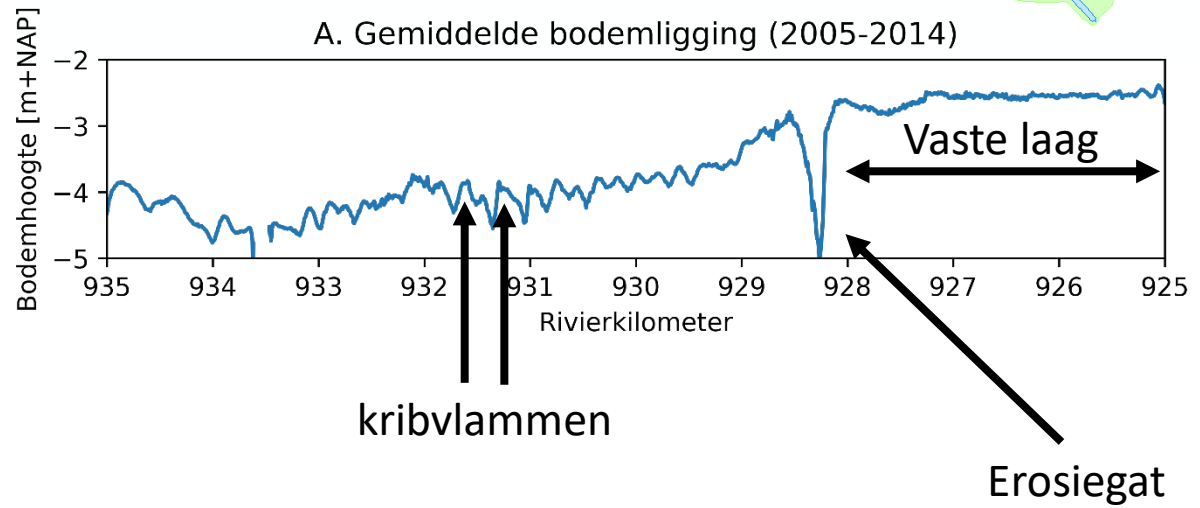
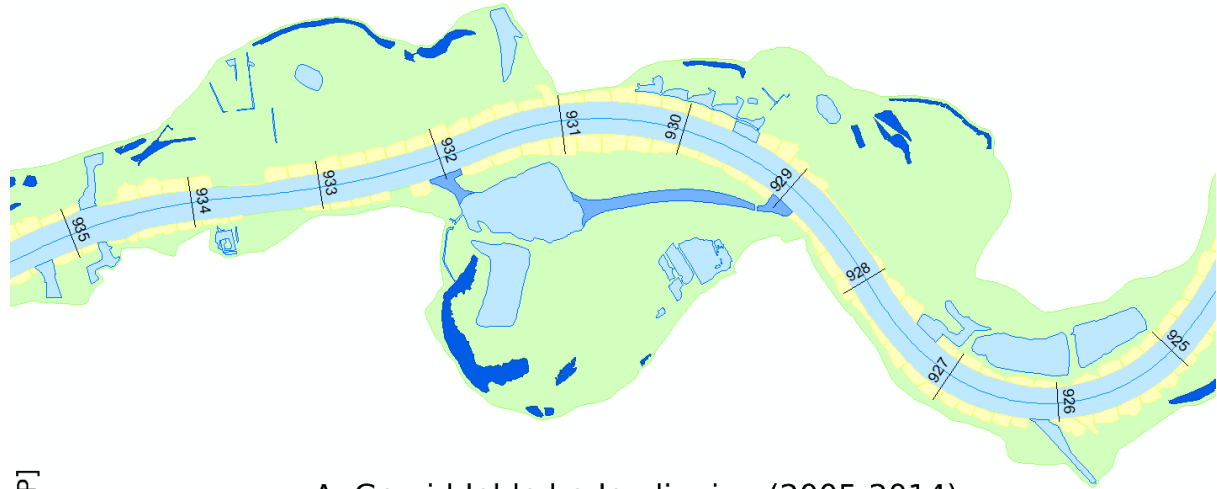
A. Variation along the river

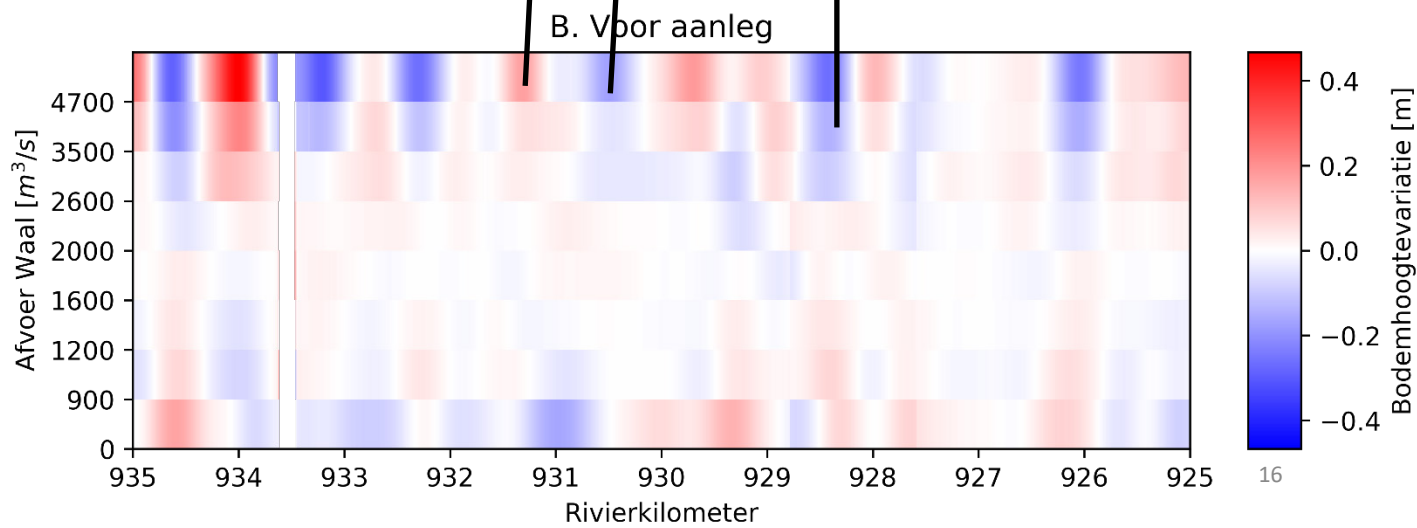
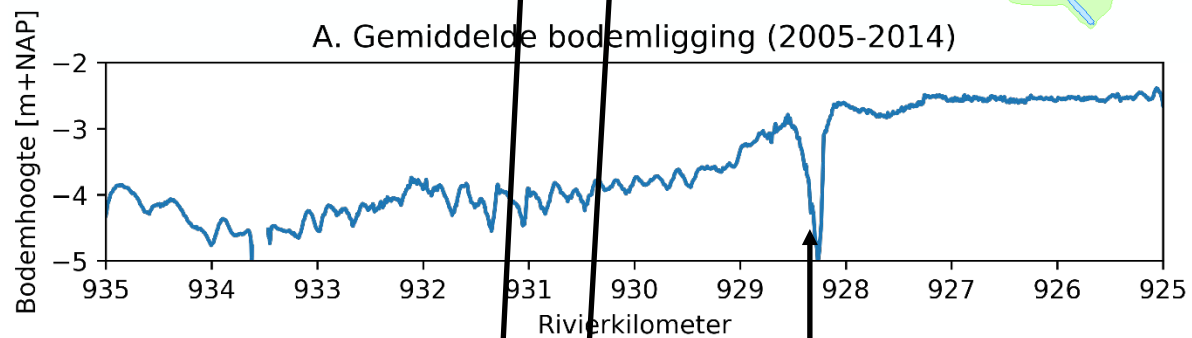
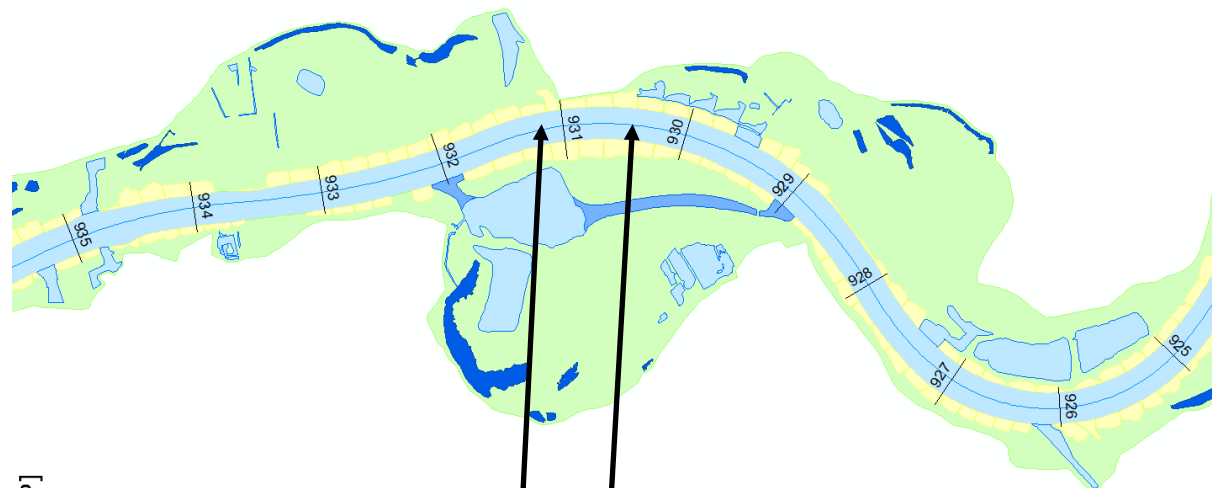


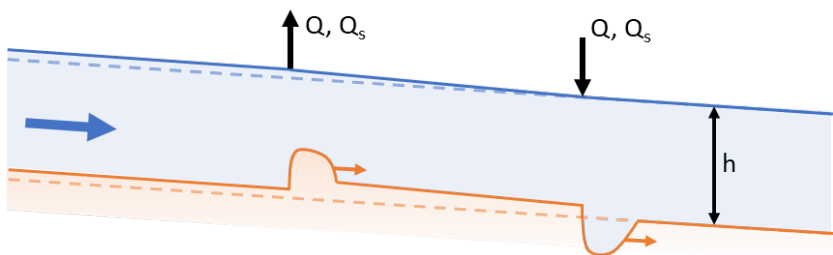
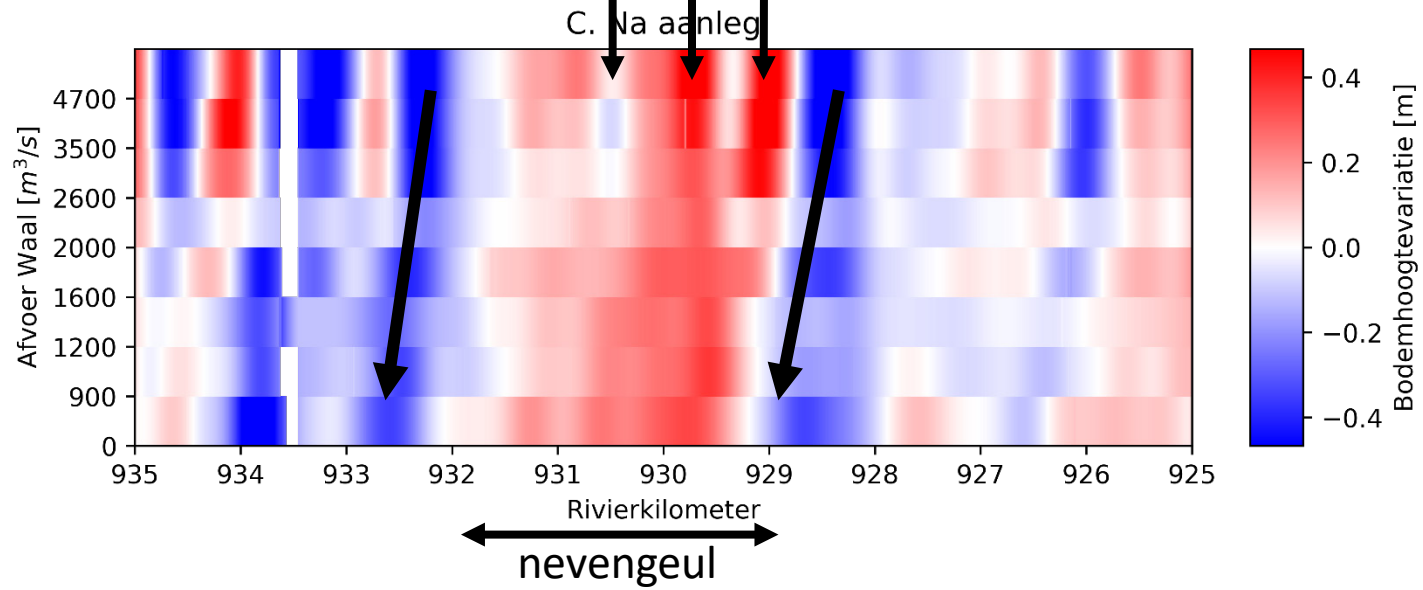
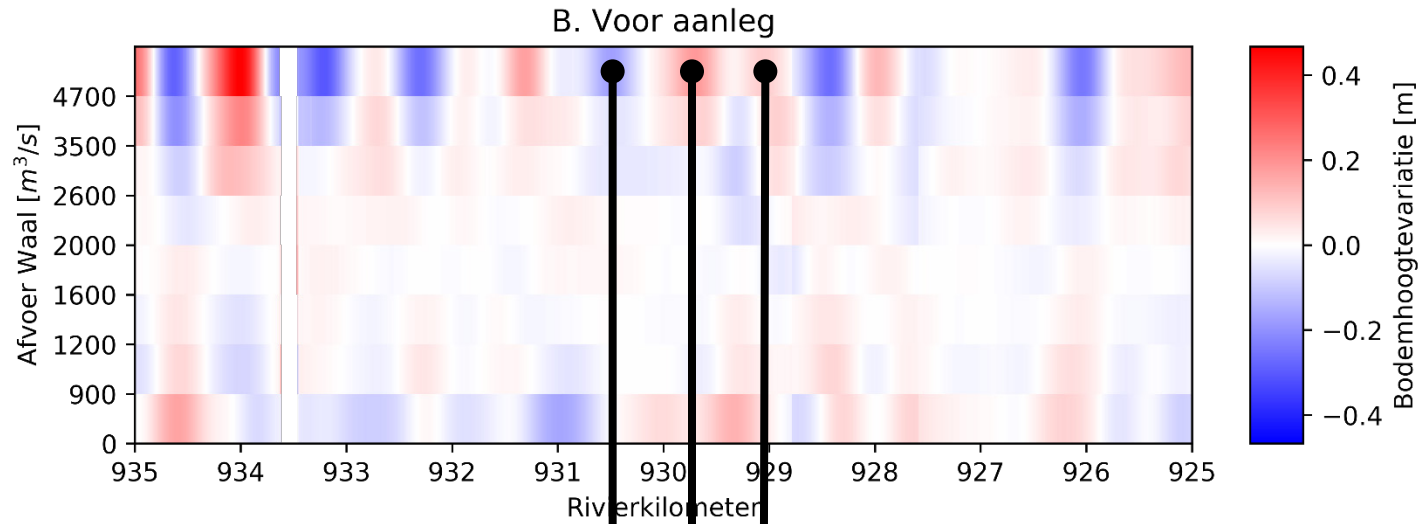
A. Bed level variation per discharge category



- WAQUA resultaten
- Afvoer door de hoofdgeul representatief voor sediment-transportcapaciteit
- Gradiënten leiden tot bodemveranderingen







WAT LEREN WE HIERVAN?

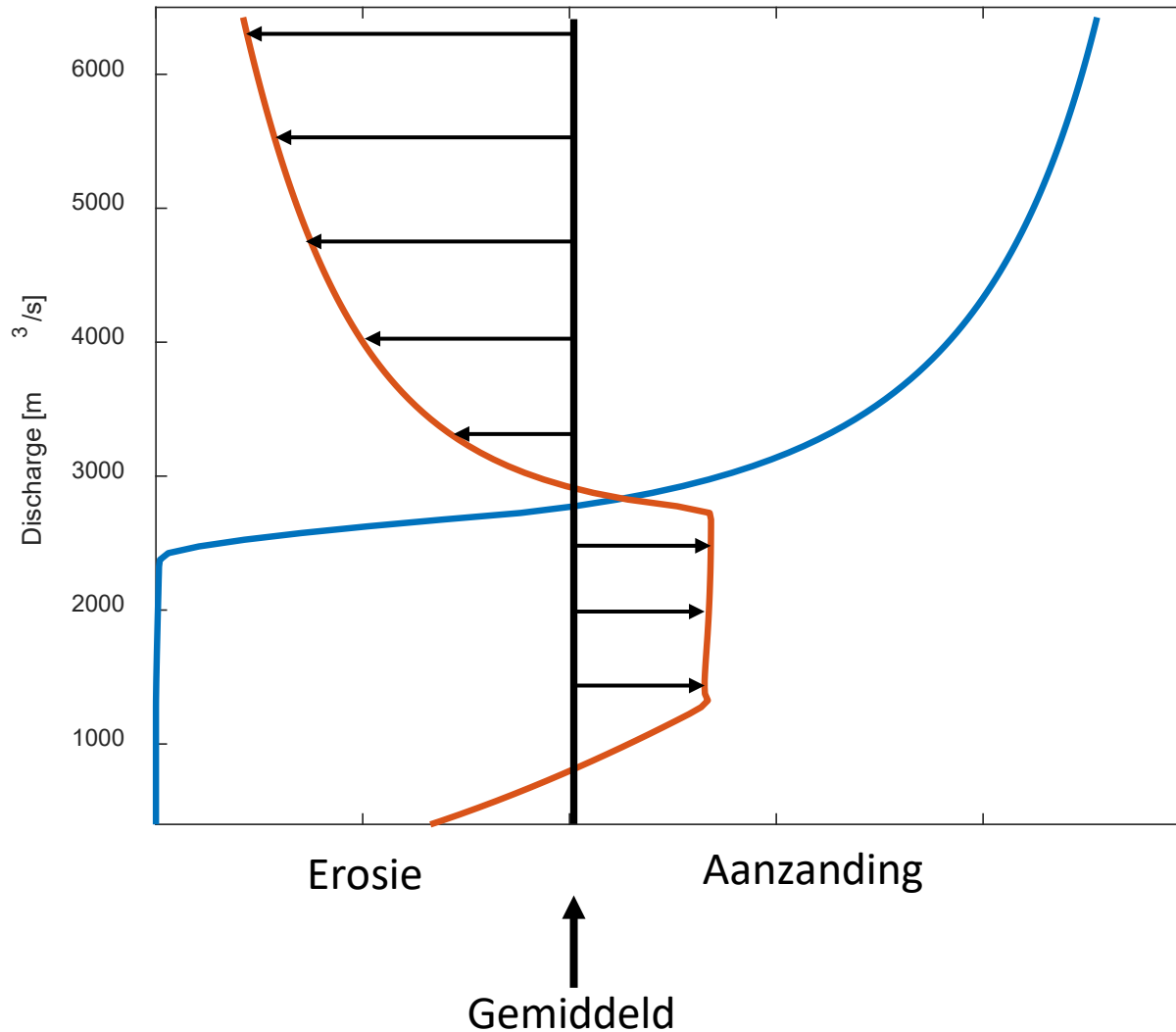
- Bodemvariatie +/- 50 cm als functie van Q
 - Verklaren van scheepvaartknelpunten
 - Verklaren baggerlast
 - Verificatie morfologisch model
 - Kansen voor de ecologie
- Bodemvariatie is veel groter dan de gemiddelde bodemverandering door een interventie (+/- 10 cm)

- Kunnen we maatregelen beter inpassen?



VERSCHILLEN TUSSEN INTERVENTIES

- Uiterwaardverlaging
- Zomerbedverbredening



WAT LEREN WE HIERVAN?

- Bodemvariatie +/- 50 cm als functie van Q
 - Verklaren van scheepvaartknelpunten
 - Verklaren baggerlast
 - Verificatie morfologisch model
 - Kansen voor de ecologie
- Bodemvariatie is veel groter dan de gemiddelde bodemverandering door een interventie (+/- 10 cm)

De referentiesituatie van de rivier kan de keuze van locatie, type en ontwerp van maatregelen ondersteunen

