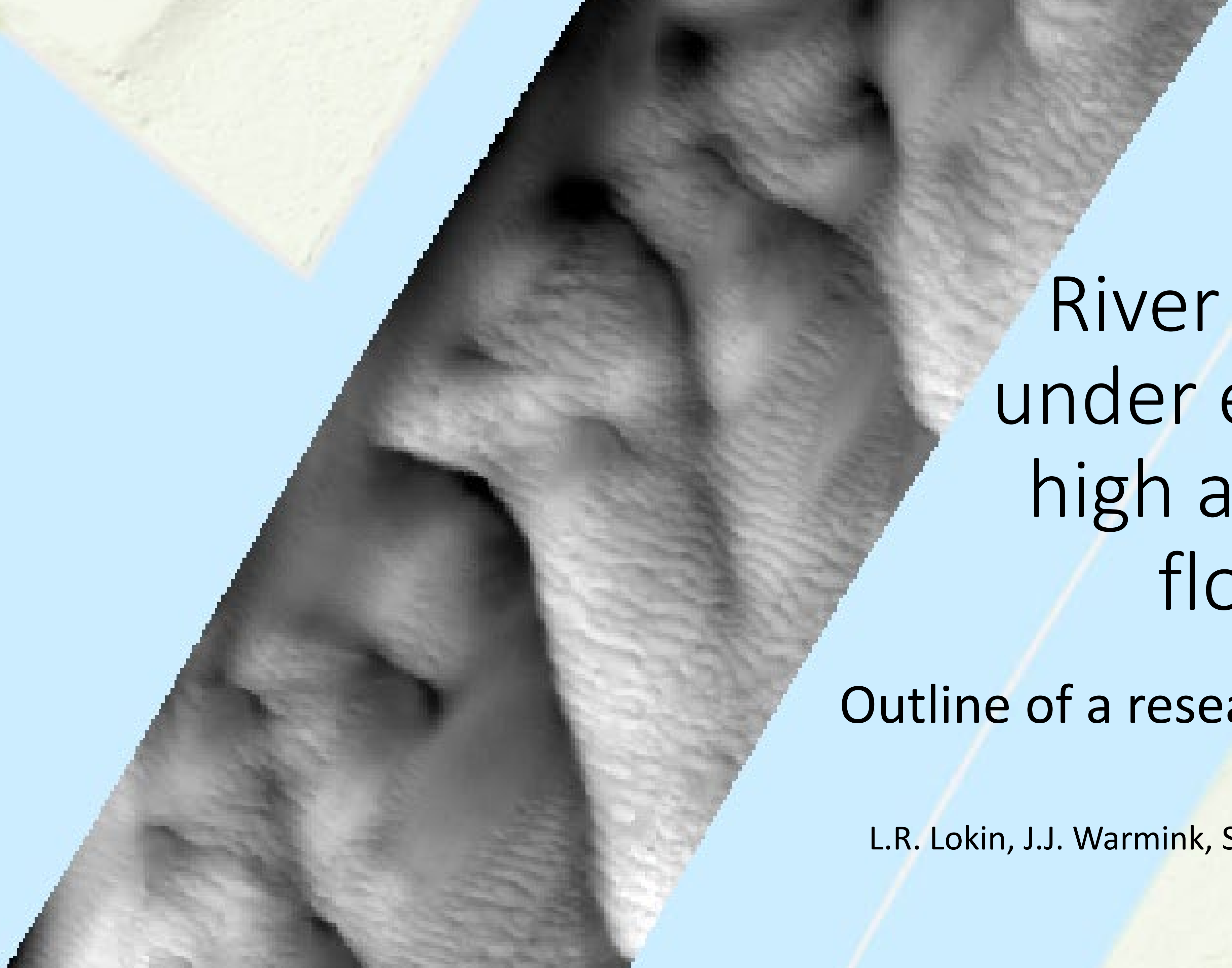


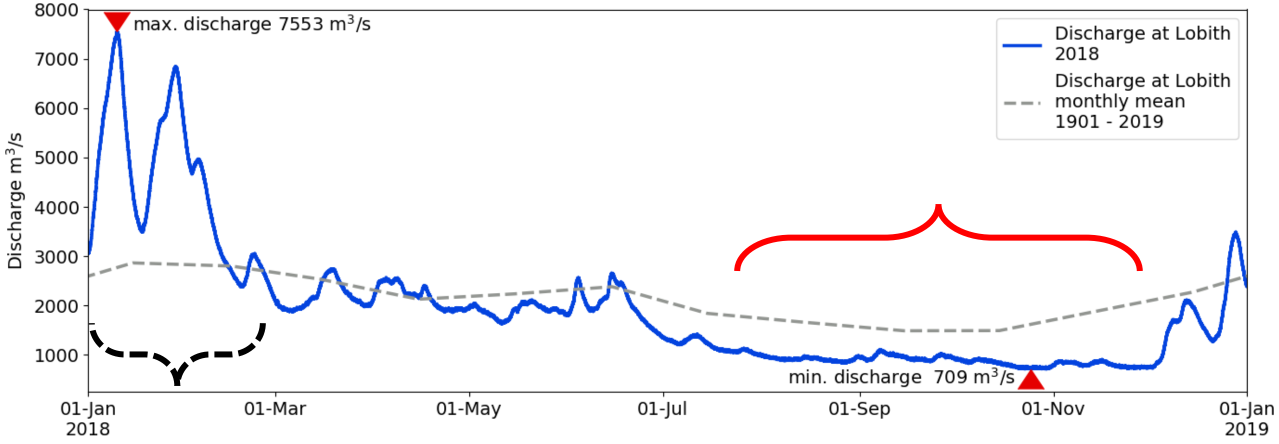
River dunes under extreme high and low flows

Outline of a research project

L.R. Lokin, J.J. Warmink, S.J.M.H. Hulscher

The evolution of river dunes in real rivers is poorly understood [1]. Especially the evolution of dunes in the falling stage of a flood wave and during low flows.

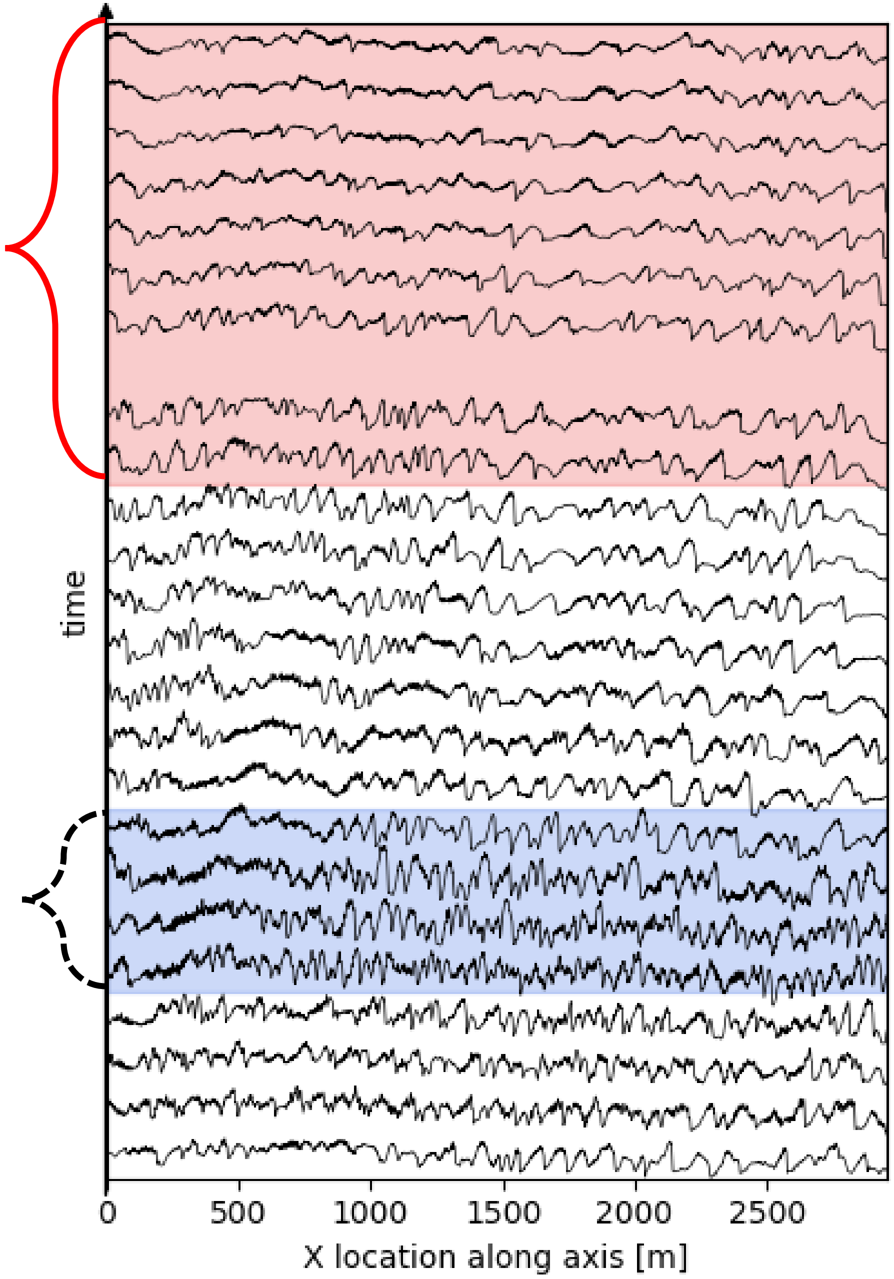
A vast data set of two-weekly multibeam riverbed measurements of the Dutch Rhine is available. The measurements are not frequent enough to track dunes throughout a flood wave. Commercial ships also measure the riverbed of the Dutch Rhine. This data is stored at CoVadem. The data set has a high frequency of measurements but only has in formation of the line each ship sails.
Combining both data sets can give information on the evolution of dune throughout a flood wave and during low flow.



Discharge of the Rhine at Lobith (Dutch border) throughout 2018. High discharges in January and February,

July till October: extreme low discharges in the Rhine

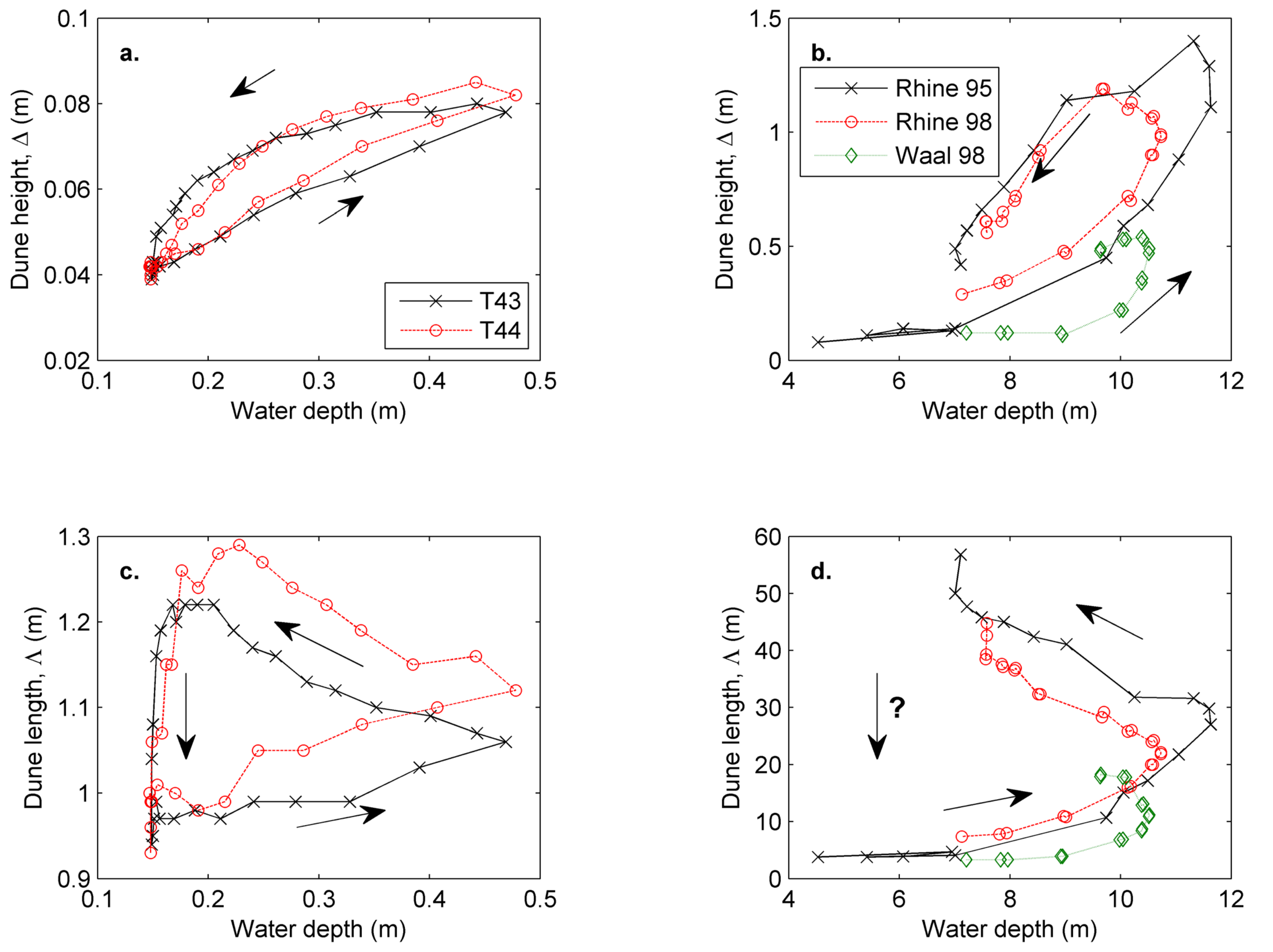
Two consecutive flood waves in January and February



Bed profiles, center of the Waal (Rhine) river near Dreumel (NL) Nov '17 – Oct '18. Data: Rijkswaterstaat

Hypotheses

- The decay of dunes lag the decelerating flow. Dune height adapts faster to varying flow conditions than the dune length
- Dune decay primarily happens by means of superimposed dunes, which will eventually become the primary dunes



Hysteresis loops of the dune height and length during flood waves. a) and c) Dune height and dune length during a short (T43) and long (T44) flood wave in flume experiments [1]. b) and d) Dune height and dune length during a short the flood waves of 1995 and 1998 in the Dutch Rhine and Waal [2]. Figure based on [3]

Research method

- Derive the statistics of dune height, dune length and lee slope angle of each multibeam measurement.
- Divide the river in sections, in longitudinal and transverse direction, using spatial and temproral patterns in dune statistics
- Assign CoVadem Tracks to the sections and derive the dune heigth, dune length and lee slope angle statistics for each river section
- Relate the derived statistics to the flow parameters: water depth and discharge.
- Track dunes and superimposed dunes to derive the physical processes.

Expected outcomes

- Description of the physics playing are role in the decay of river dunes
- Statistical description of the dune length, height and lee slope angle related to the governing flow conditions
- A method to consistently analyze riverbed elevation data, that consist of multibeam and single beam data

I will use the insight from this research to build a river dune prediction model.

Acknowledgement

This research is a part of the research program *Rivers2Morrow* (2018-2023). *Rivers2Morrow* is focusing on the long-term development of the Dutch river system and its response to changing conditions such as river discharges, sea level rise and human interference. Universities, research institutes, NGOs, consultancy companies and government agencies that participate in this program are all working together on gaining knowledge in order to improve operations, maintenance and policies. *Rivers2Morrow* is financed by the Directorate-General for Water and Soil Affairs and Directorate-General for Public Works and Water Management (Rijkswaterstaat), both being a part of the Dutch Ministry of Infrastructure and Water Management All measurement data was made available by Rijkswaterstaat. Our words of gratitude for collecting and sharing this data go out to technical staff of Rijkswaterstaat/.

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