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Hydraulic and morphological model investigation of the River Oder along the Polish-German border

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Motivation / Background River Oder Border Reach

Extent of the border reach:

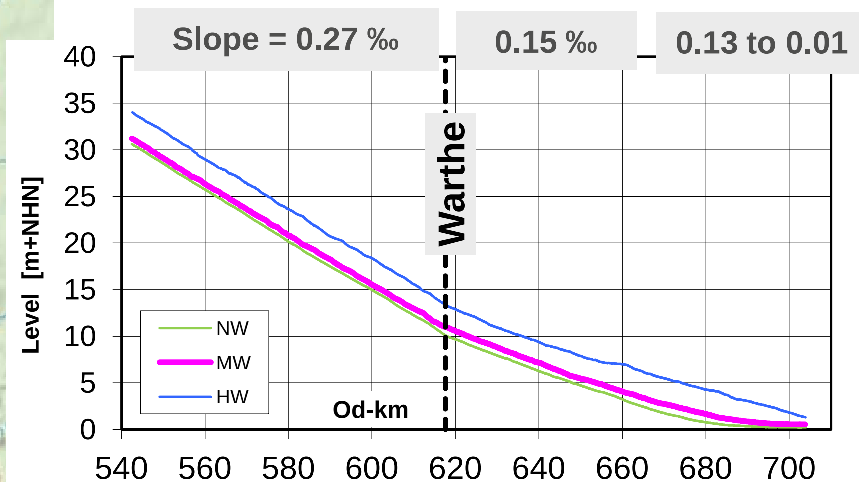
- confluence of Lusatian Neisse (Od-km 542, 4)
- bifurcation of Oder and Westoder (Od-km 704,2)

Length of the Border reach: 160 km

Main confluence: River Warthe

MQ upstram of river Warthe = 290 m³/s

MQ downstram of river Warthe = 500 m³/s



Problems in the Border Reach

- **River training system of groynes, longitudinal dykes and bank protection (mainly end of 19th, beginning of 20th century).**
- **Maintenance of training structures on both river banks were conducted by the national (Polish and German) riverine waterway administrations.**
- **Insufficient maintenance in last decades leads to a degradation of shipping conditions:**
  - **For commercial shipping,**
  - **For ice-breaker operations (flood protection).**

Motivation / Background Task force

The difficulties in ice-breaker operations leads to a Polish-German thesis paper about a bilateral treaty for measures to improve shipping conditions.

A task force was built with representatives of:

- RZGW Szczecin (Regional Water Management Authority, Poland)
- WSV (Federal Waterways and Shipping Administration, Germany)
- BAW (Federal Waterways Engineering and Research Institute)
- ZUT Szczecin (West Pomeranian University of Technology Szczecin)

Mandate of task force:

- To redesign and update the concept of the river training system.
- Scientific work conducted by BAW.

Motivation / Background The aim of the project

- Development of a new river training system for the border reach of the Oder river to substantially improve the nautical conditions, especially for ice breakers.
- The existing training structures (groynes, longitudinal dykes) must be integrated in this new system in the best possible way.
- Minimise the maintenance and building effort on the structures.
- Minimise negative effects on high water level.
- Minimise negative effects on FFH area (ecology) due to building activities.

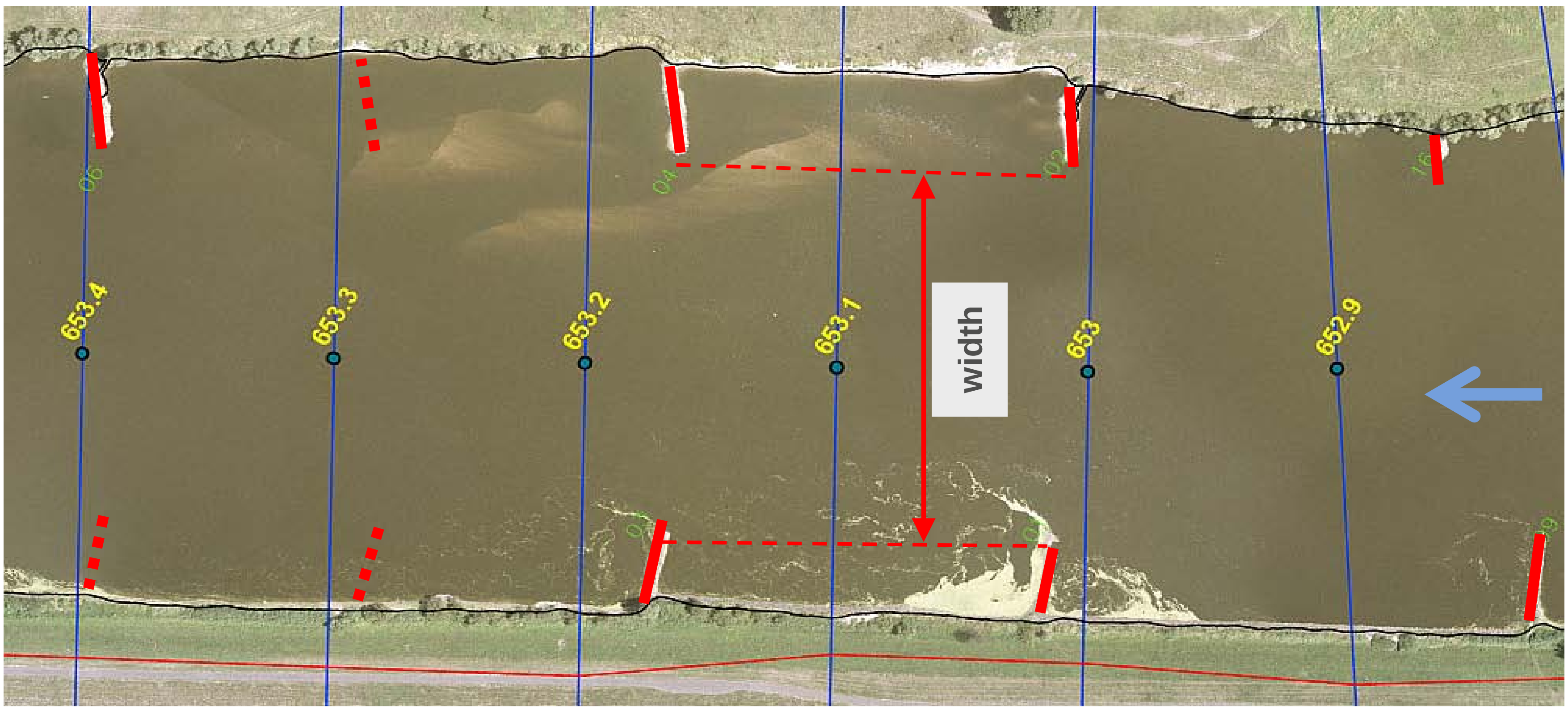
Motivation / Background The aim of the project

The nominal training structure design parameters for a river training system:

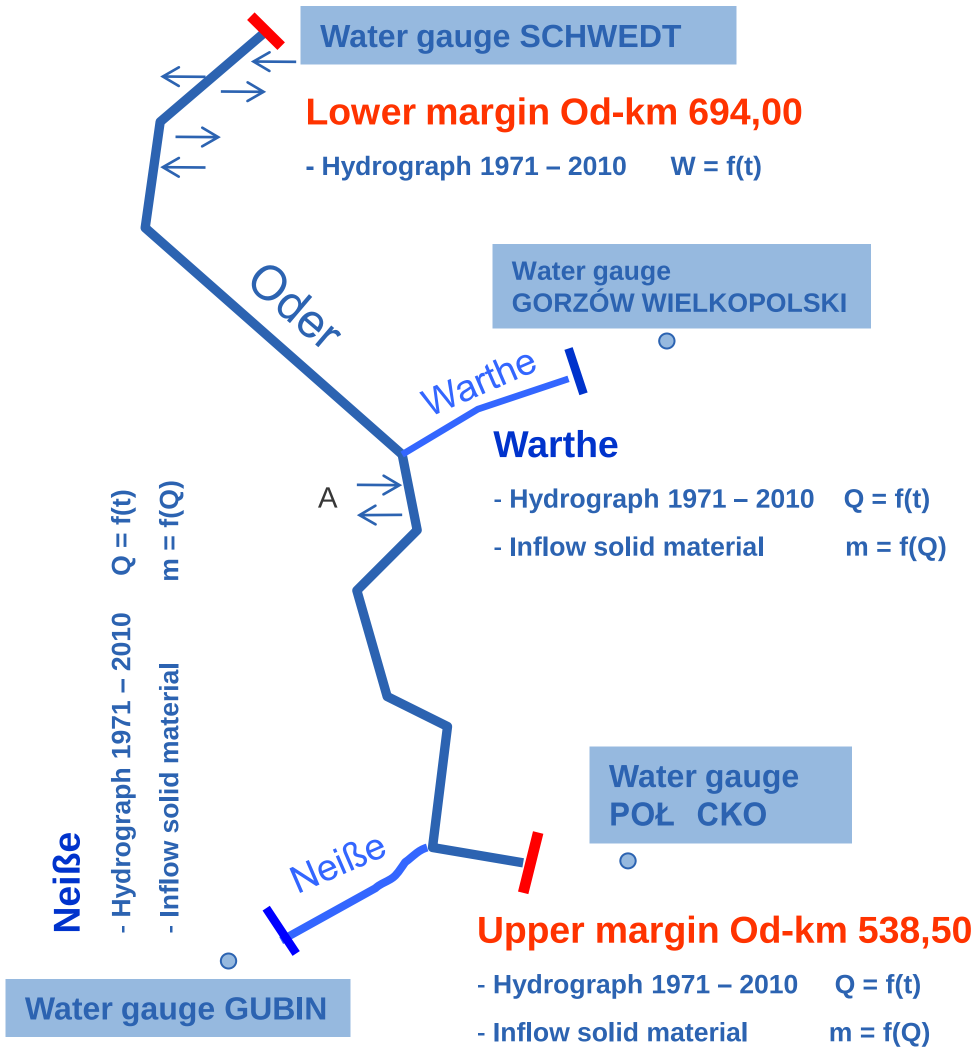
- heights, slope of structures, interval (groynes), nominal mean widths of the fairway.

The challenge within the hydraulic and morphological investigation:

- huge amount of sediment transported in form of large and highly mobile sand dunes
- prediction of changes in the river bed and in the behavior of dune movement for a 160 km long section and a time period of around 40 years.



Used modelling type



1-dimensional hydronumerical model (1D-HN)

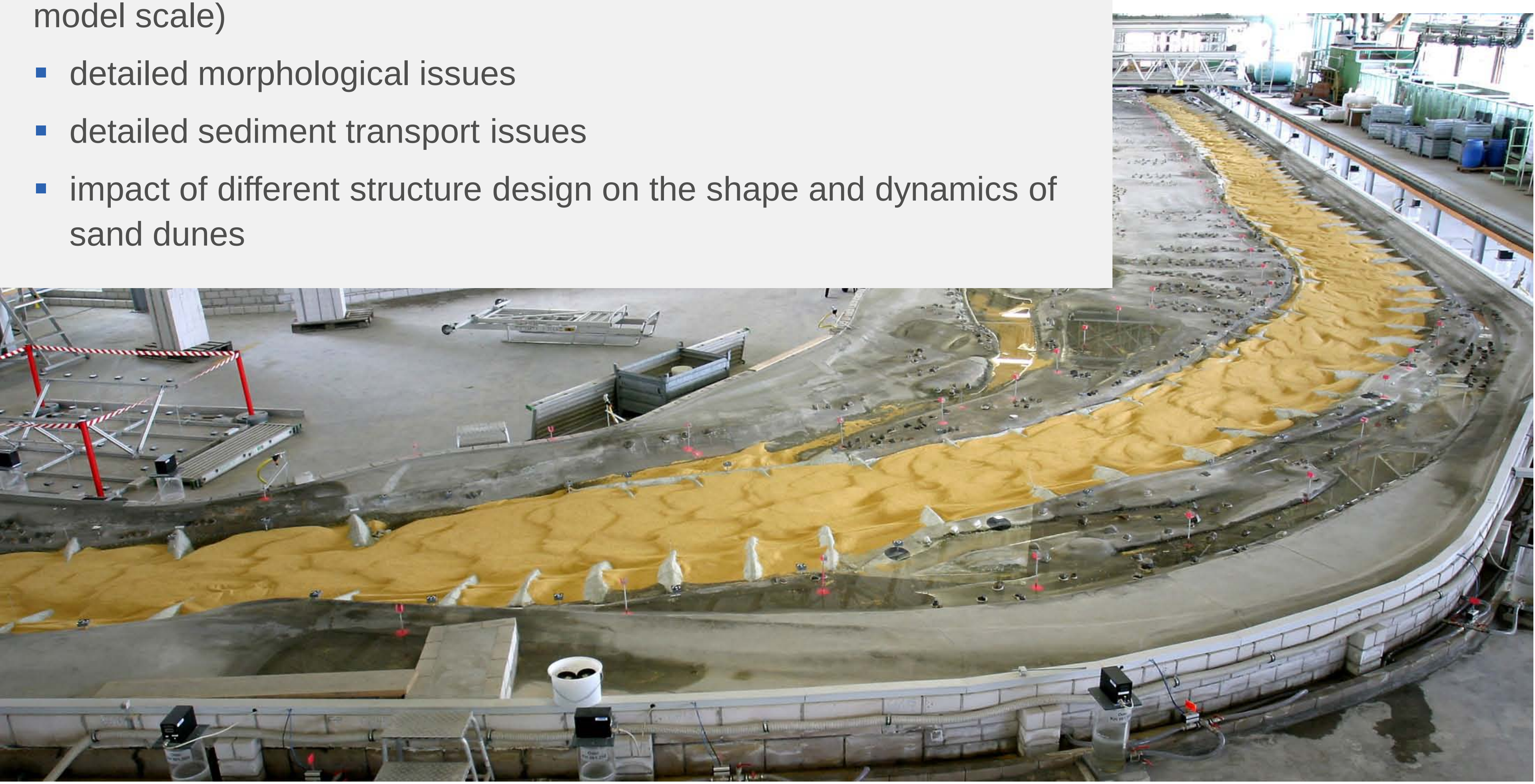
- Large scale (155 km) and long term simulations (40 years)
- Transport simulation of sediment, suspended sand and wash load
- Resulting changes of river bed
- Modification of structure design
- Modification of spatial and chronological sequences of construction sites
- Modification of climate conditions
- Accompanying dredging measures

HEC-6T (MBH Software, Inc. USA)

Used modelling type

Scale model with fully movable bed (8 km in natural scale, 80 m in model scale)

- detailed morphological issues
- detailed sediment transport issues
- impact of different structure design on the shape and dynamics of sand dunes



Used data 1D-HN and scale model

Geometry

- Bathymetry (echo-sounding)
- Flood plain (ALS data)
- Training structures, groynes, longitudinal dykes, bank protection (manual survey, Echo-sounding, ALS, stereo photogrammetric survey)

Hydrology / Climate Scenarios

- Time series from several German und Polish water gauges 1971 – 2010
- Modification in time series to simulate climate issues (synthetic wet and dry decades)

Hydraulic parameters

- Longitudinal water level measurements
- ADCP-measurements for discharge and flow velocity

Solid material

- River bed sampling
- Measurements of sediment transport, suspended sand and wash load
- Freeze core sampling

Modelling strategies 1D-HN and scale model

Calibrating phase (model adjustment with measurement data):

- Hydraulic aspects
- Sediment transport and morphologic aspects

Validating phase (model validation with measurement data):

- long term morphologic aspects

Variation phase

- Variation of nominal parameter for training structures (width, height, slope)
- Variation of chronological order of building sections
- Effects of accompanying dredging measures
- Variation of realisation time for the complete structural maintenance (13, 20, 25 a)
- Variation of climate impact (dry and wet hydrograph)

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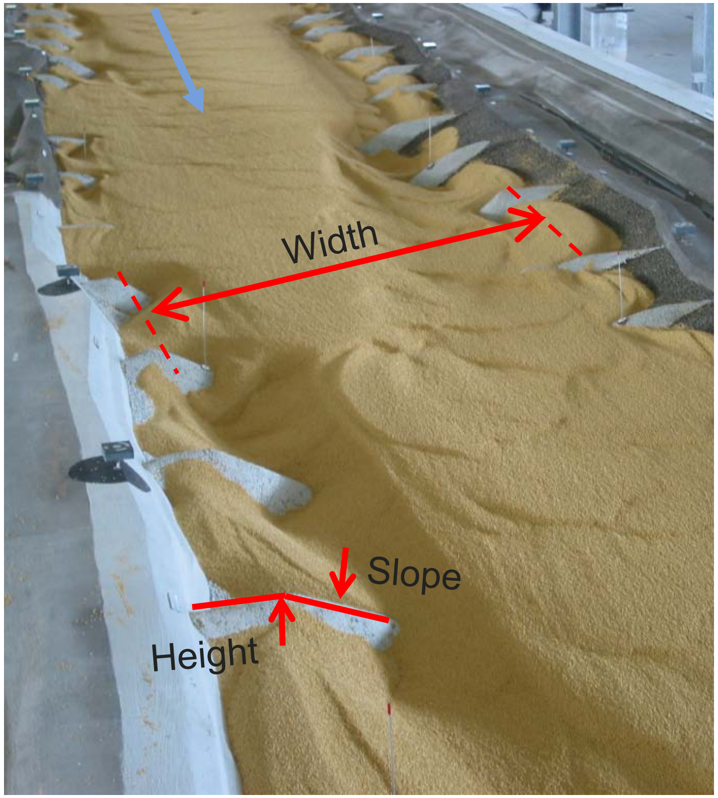
Federal Waterways Engineering and Research Institute

Results Scale Model

- Variation of nominal parameter for training structures (width, height, slope)
- Observation of changes in sediment transport and dune behaviour in detail



Today's situation


Variation SRK V1

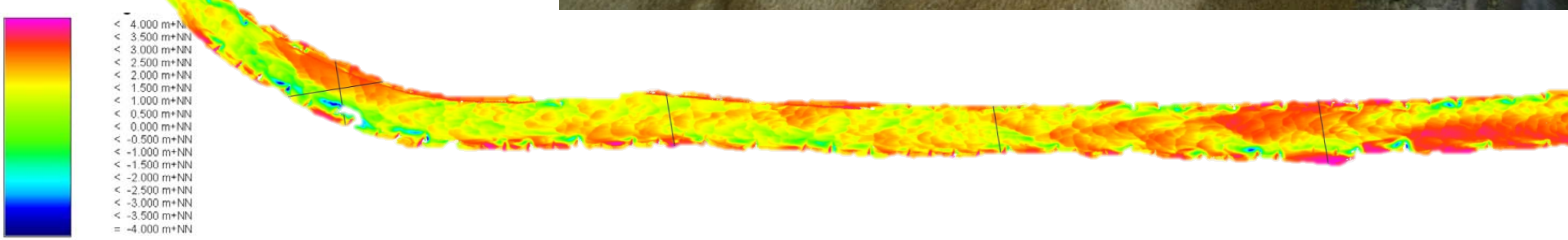
Fast motion scale factor: 15s movie = 1h model = 80 days in nature

- Water level
- Bed topography (photogrammetric system)

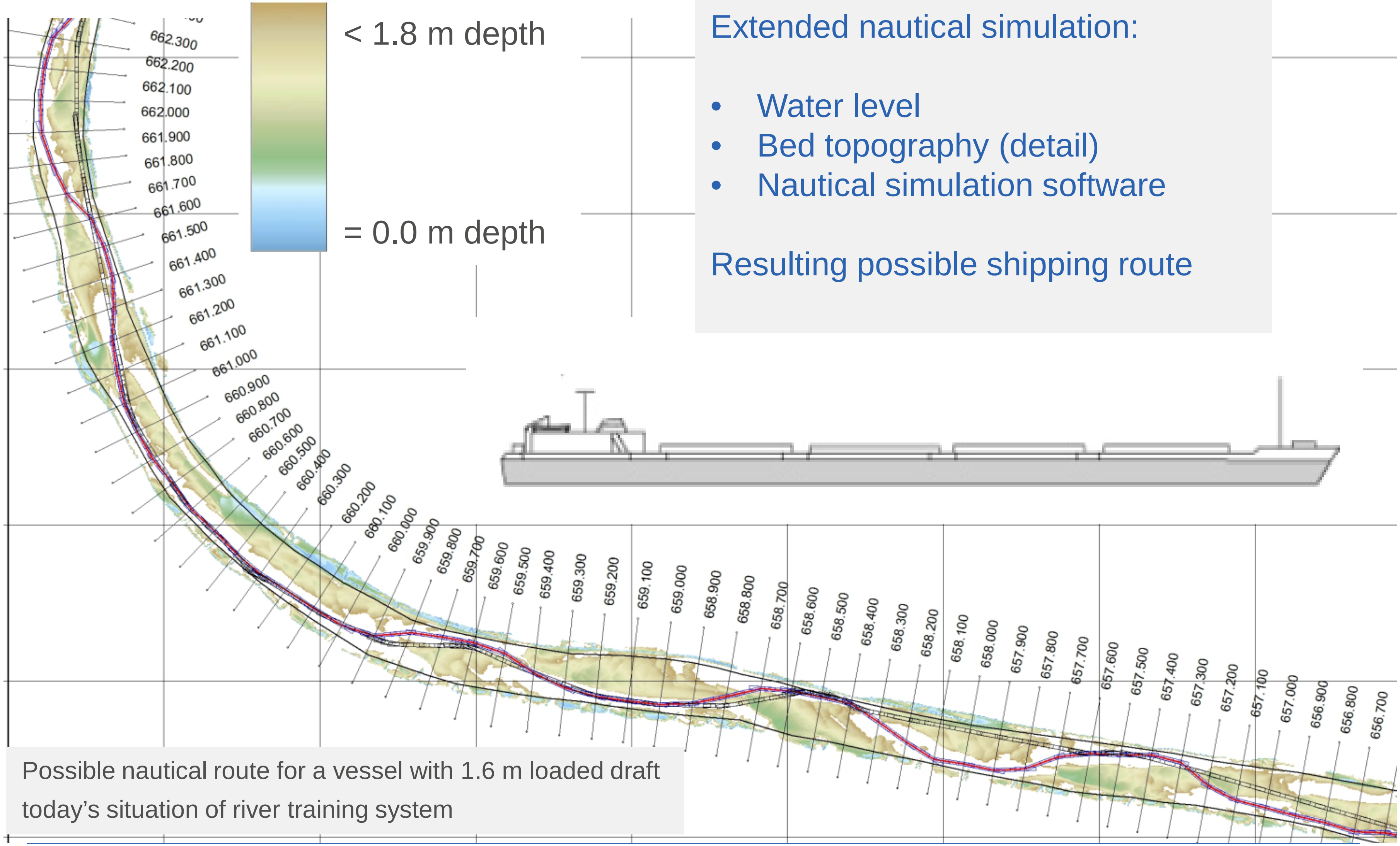
Basic Data Analyses (mean values):

- Changes of water level
- Changes of mean bed level
- Resulting depths

Comparable with 1D-HN results



Results Scale Model



Extended nautical simulation:

- Water level
- Bed topography (detail)
- Nautical simulation software

Resulting possible shipping route

Possible nautical route for a vessel with 1.6 m loaded draft today's situation of river training system

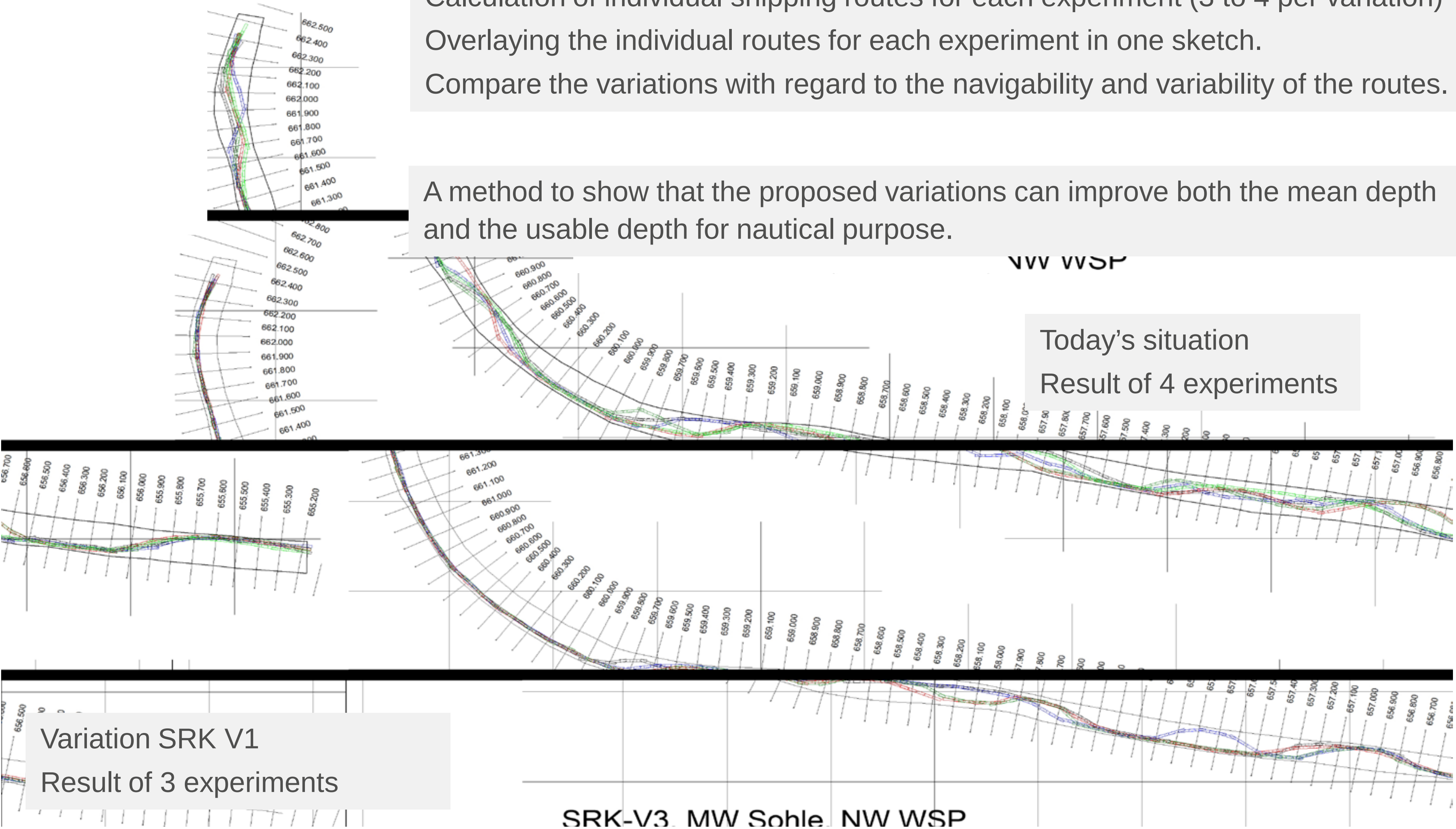
Results Scale Model

Calculation of individual shipping routes for each experiment (3 to 4 per variation)

Overlaying the individual routes for each experiment in one sketch.

Compare the variations with regard to the navigability and variability of the routes.

A method to show that the proposed variations can improve both the mean depth and the usable depth for nautical purpose.



Today's situation

Result of 4 experiments

Variation SRK V1

Result of 3 experiments

Conclusion / outlook

A set of nominal parameters for a new and updated river training system (groynes, longitudinal dykes and bank protection) could be found that meet the requirements for:

- A constant minimum depth of 1.8 m for 80% of time upstream and 90 % of time downstream of the river Warthe confluence.
- With minimal effect on high water level.
- And with consideration of variations of chronological order, realisation time, dredging measures, climate impact, minimal building effort and side effects on FFH areas.

- The use to two different model types was useful and necessary regarding the complexity of river morphologies.

Conclusion / outlook

Abkommen
zwischen
der Regierung der Bundesrepublik Deutschland
und
der Regierung der Republik Polen
über
die gemeinsame Verbesserung der Situation an den Wasserstraßen
im deutsch-polnischen Grenzgebiet
(Hochwasserschutz, Abfluss- und Schifffahrtsverhältnisse)

Umowa
między
Rządem Rzeczypospolitej Polskiej
a
Rządem Republiki Federalnej Niemiec
o wspólnej poprawie sytuacji na drogach wodnych
na pograniczu polsko-niemieckim
(ochrona przeciwpowodziowa, warunki przepływu i żeglugi)

A bilateral treaty between Poland and Germany is now signed.

A new task force to carry out the river training work is established.

The planning of the final regulation line for each river bank is in progress.

The project presumably finishes in 2028.

Thank you for your attention

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