INVESTIGATING THE CHANGE IN RIVER BED MORPHOLOGY UNDER THE INFLUENCE OF BLOCKAGE

PHYSICAL MODELLING IN A CURVED LABORATORY CHANNEL

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Main Research Objective

The primary goal of this research is to investigate the impact of a blocking element on hydrodynamics, sediment transport and bed reconstruction in a meandering river.

Tasks highlighted to achieve the main objective

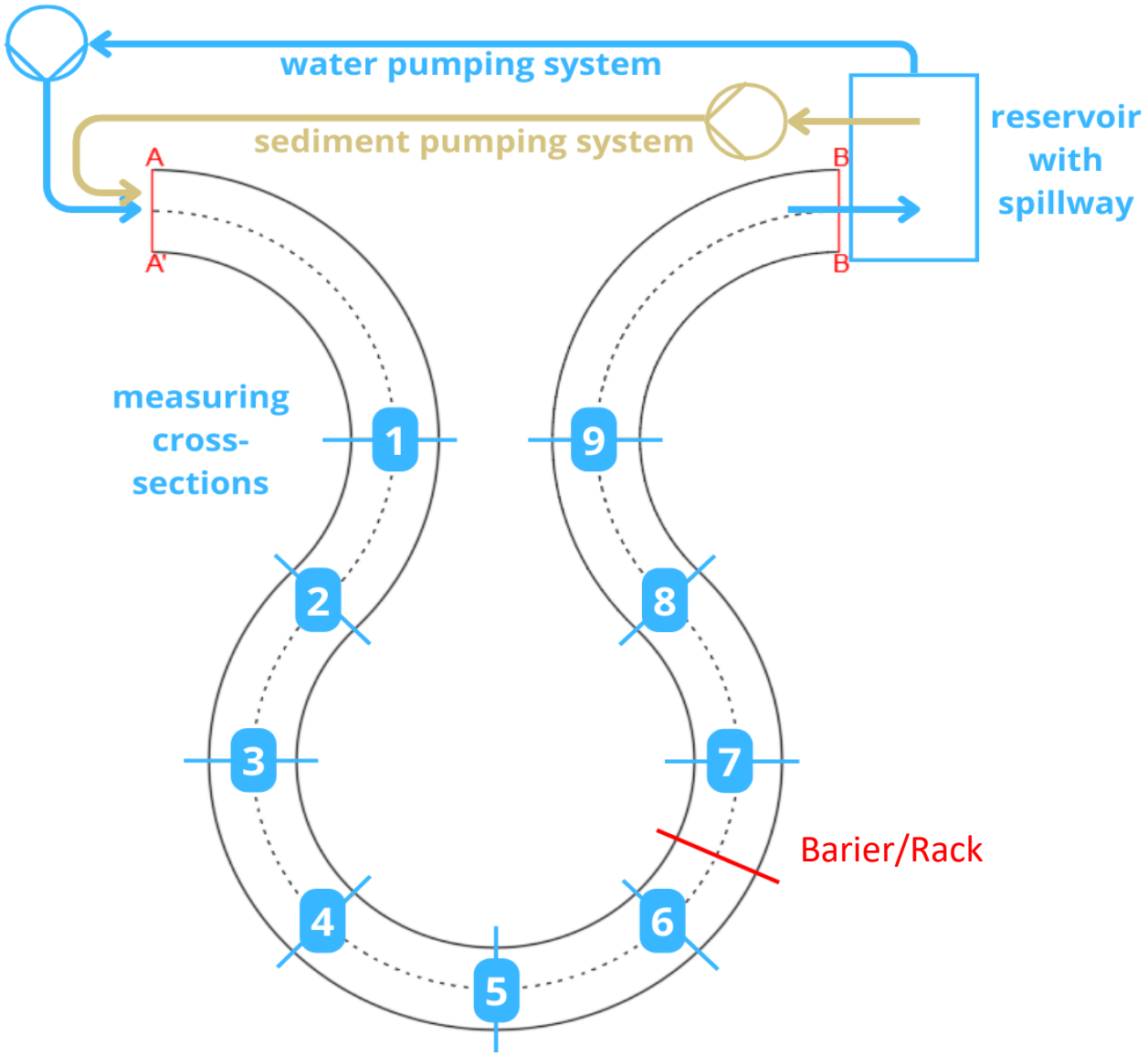
1) Design, construction, and commissioning of a meander channel with a 270-degree bend
2) Planning and execution of physical modeling of sediment transport in a closed circuit with different types of blockages (e.g., Ice jams or plastic waste)
3) 3D measurement of water velocity
4) Granular size distribution of bed sediment

Hydraulic Laboratory

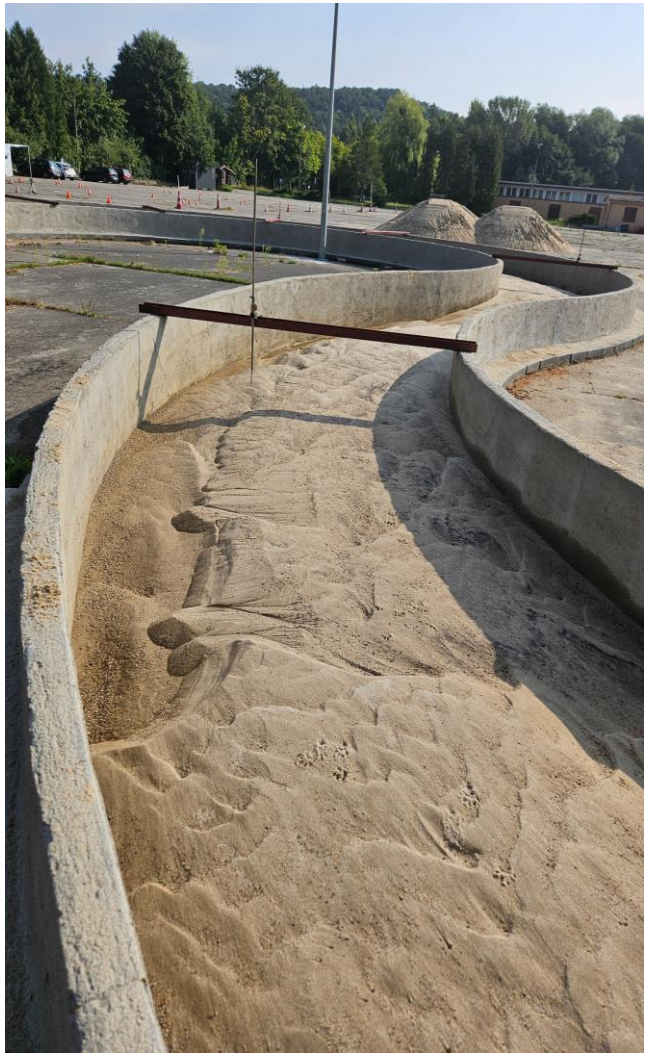
Physical model was built at the hydraulic laboratory of the Institute of Hydro-Engineering of the Polish Academy of Sciences and was financed by the institute's own funds.

- Open space of 12 000 m^3
- Water suplly system allowing up to 2000 l/s flow
- Pump accuracy 0,5%
- Automated controls over water distribution with pumping system

Physical Model



Physical Model

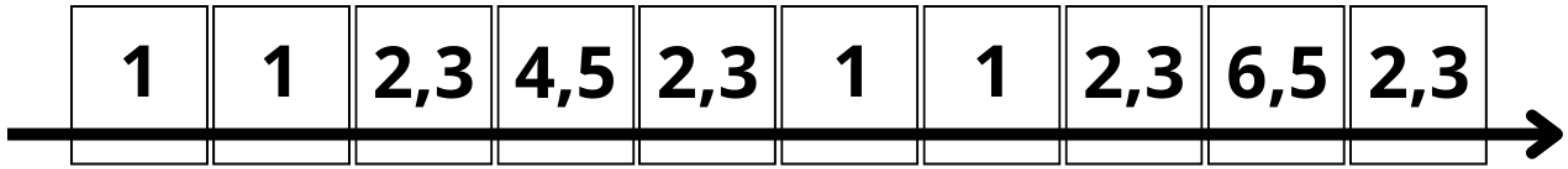


Parameters of the meandering channel:

- Channel length: 60 m
- Channel width: 2 m
- Water depth up to 0.5 m

Methodology

Sequence of tasks within an experiment



1 - Reset of the sediment layout
2 - 3D scan of the channel bottom
3 - Sediment sampling
4 - Setting the flow (40,60,80 l/s)
5 - Velocity measurements (ADV, PTV)
6 - Point 4 with the addition of blockage
□ - one working day

Methodology

Velocity measurements (ADV)

Water level gradient and flow depth

Recording bathymetric changes (scanner 3D)

Grain size tests (3 samples per cross-section)

Methodology

The blockage was caused by plastic half-litre bottles that were put in at the start of the laboratory channel.

Methodology

Granulometric Analysis Using a Sieve Shaker

Separates a sample into distinct grain size fractions

Enables precise determination of particle size distribution

Collection of 9 pan with a solid base

Sieves arranged from largest mesh at the top to smallest at the bottom

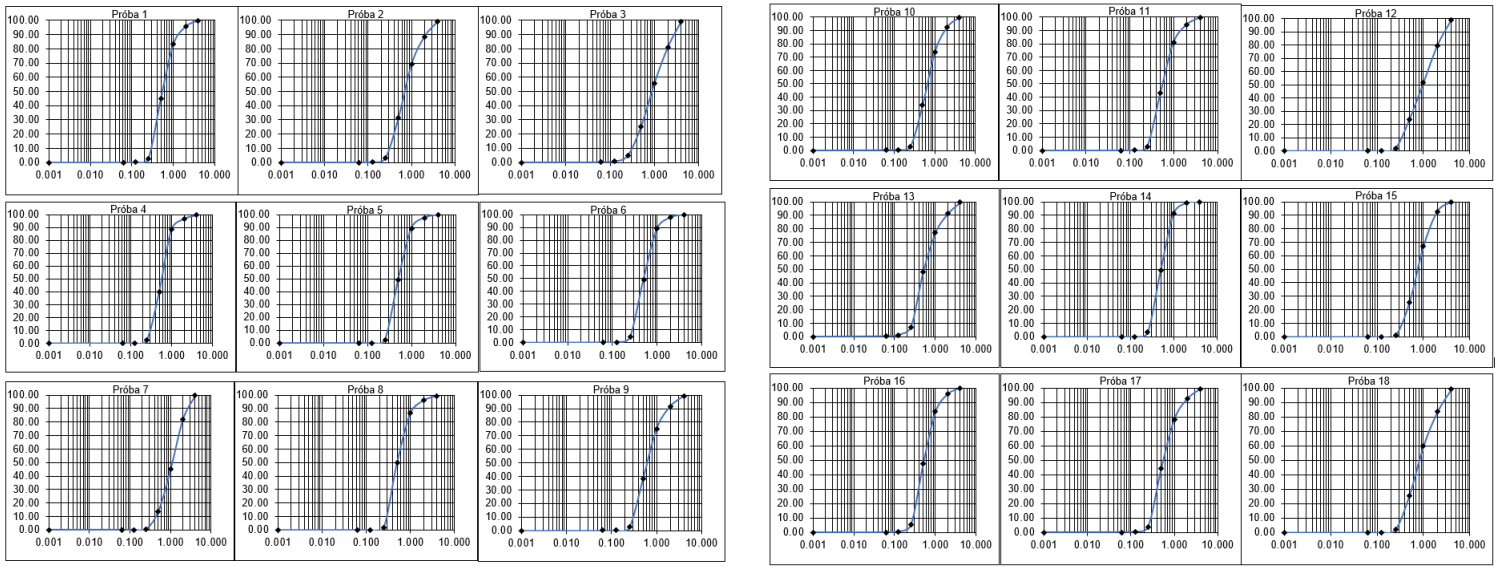
Sample is pre-dried and placed on the top sieve

Mechanism of Action

Generates vibrations and circular motions to facilitate particle movement

- Weigh material retained on each sieve
- Calculate the percentage of each fraction relative to the total sample mass
- Plot a grain size distribution curve based on the results

Results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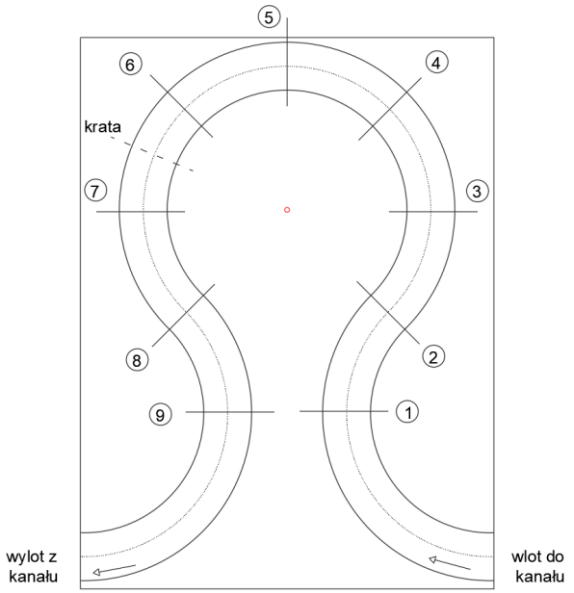
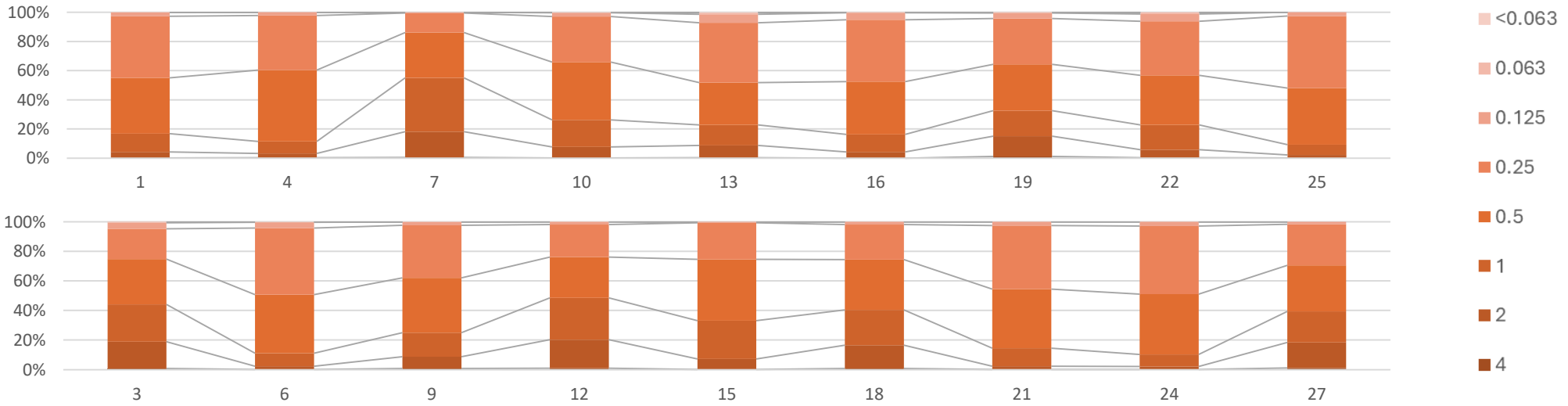
Próba 18


krata
wylot z kanału
wlot do kanału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60%
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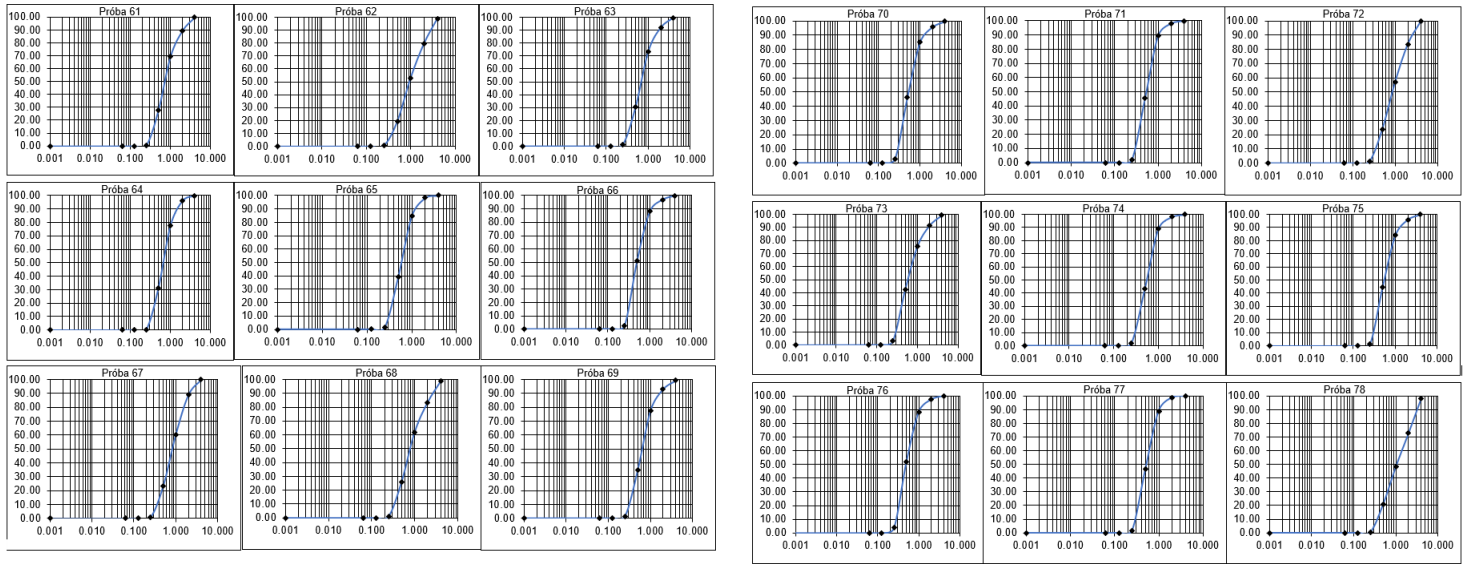
Results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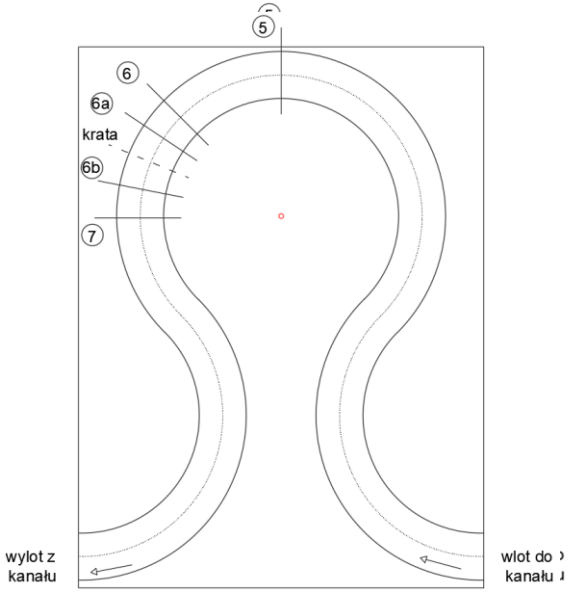
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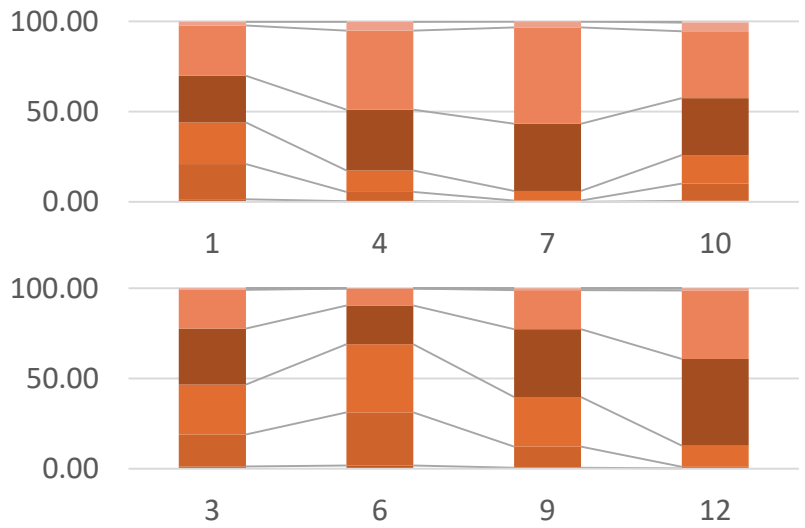
6
6a
krata
6b
7
wylot z kanału
wlot do kanału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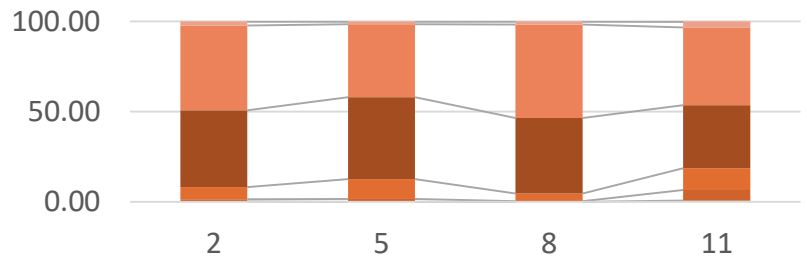
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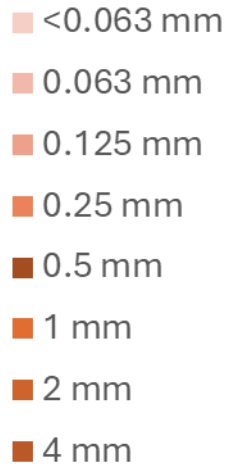
11


<0.063 mm
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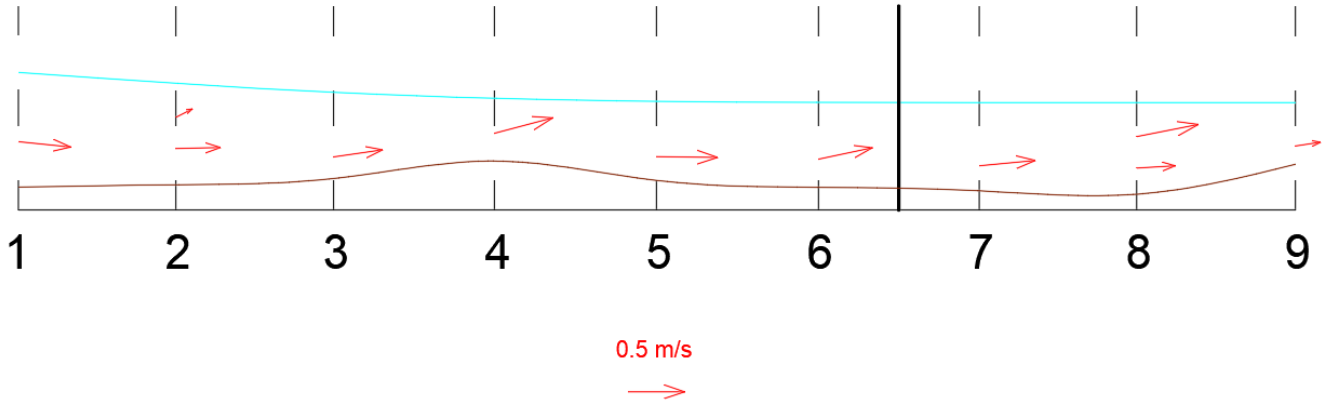
0.25 mm
0.5 mm
1 mm
2 mm
4 mm

Results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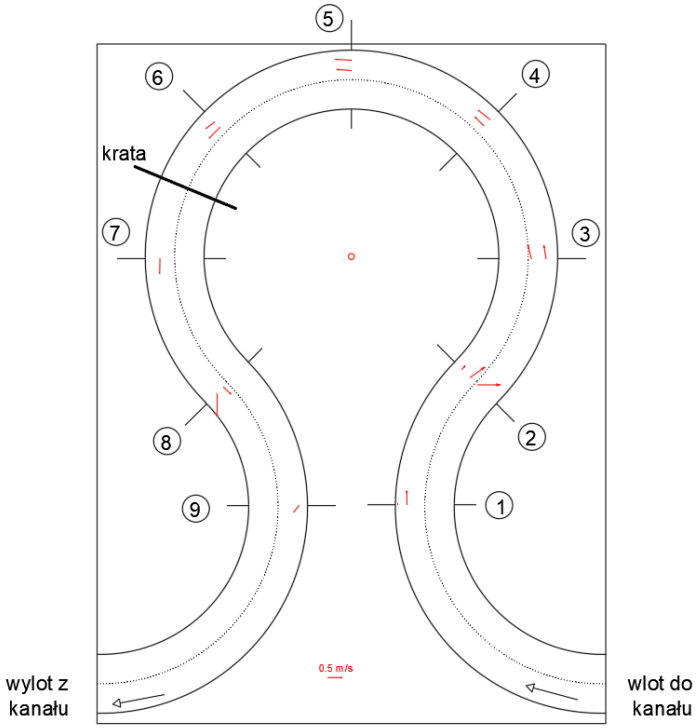
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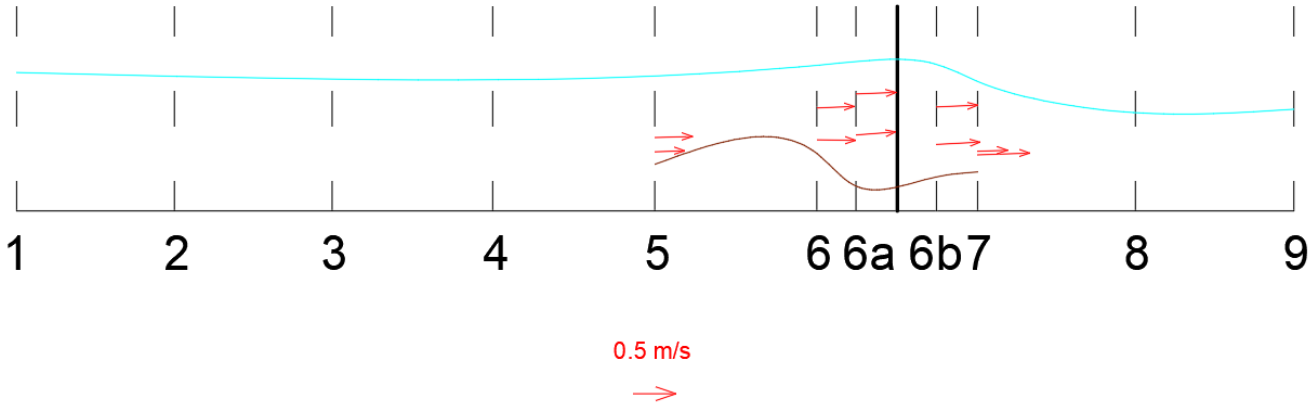
wylot z kanału
wlot do kanału

Results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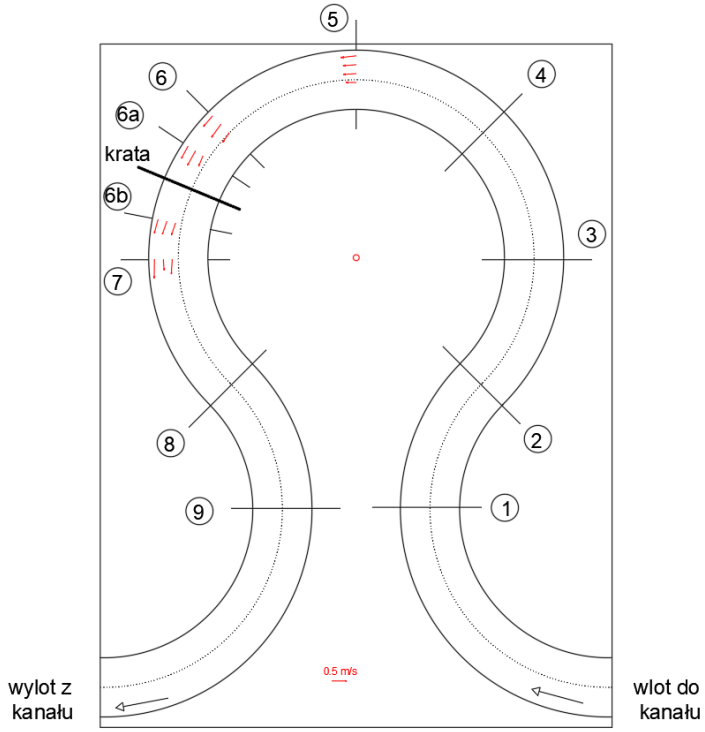
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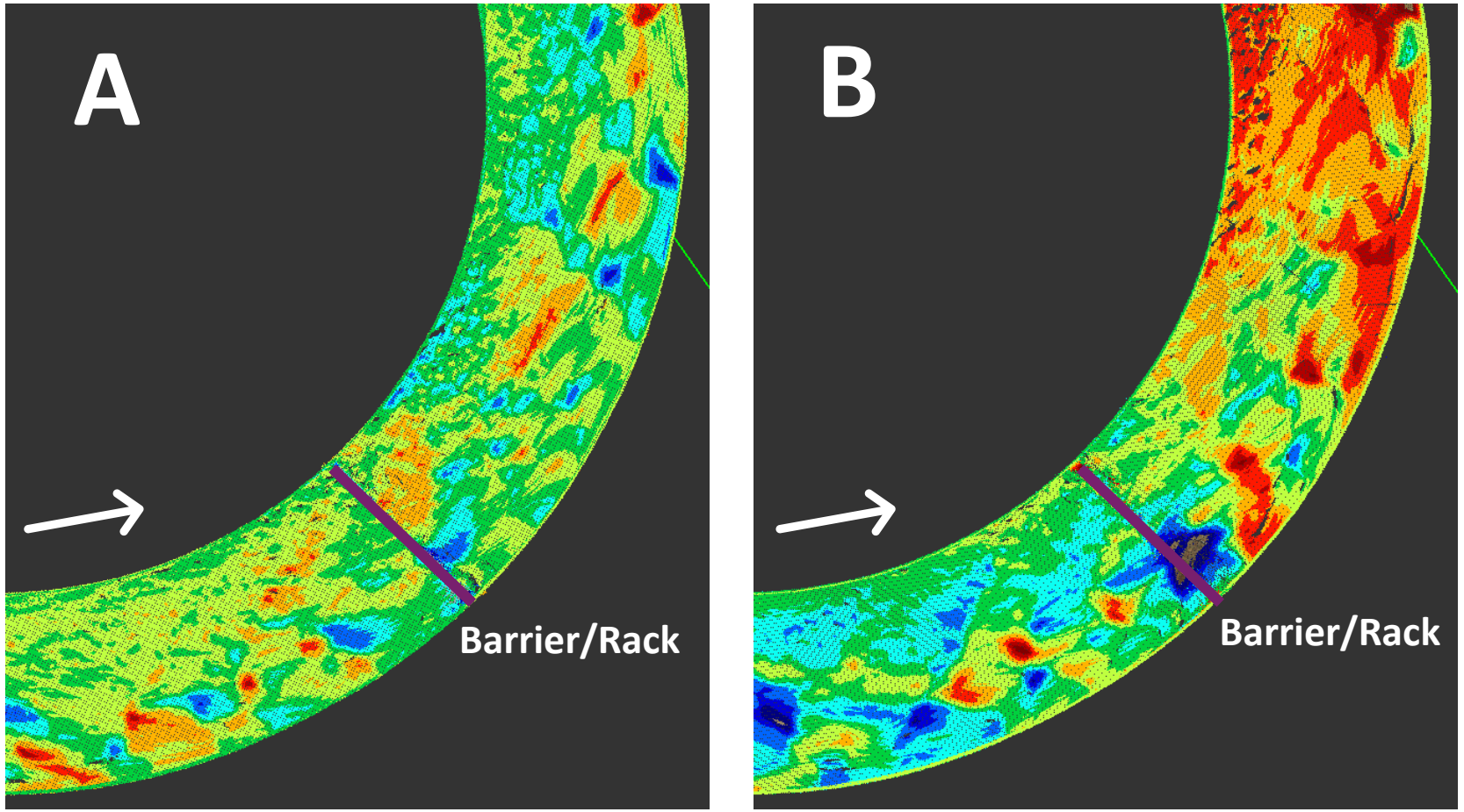
0.5 m/s
wylot z kanału
wlot do kanału

Bathymetry



Maps comparing the initial state of the bathymetry with state (A) after 6h of discharge at a constant level of 40 l/s and (B) after 6h of discharge at a constant level of 40 l/s with the onset of blockage.

Conclusions

1. The experiment was conducted at a large scale, allowing the reproduction of hydraulic processes without scale distortion.
2. The study focused on analyzing the impact of plastic accumulation on water flow and sediment transport.
3. The phenomenon is fully three-dimensional and must account for both the flow field in the channel bend (including dominant and secondary currents) and the processes of flow beneath and through the blockage.
4. Due to the presence of a plastic accumulation formed at the barrier, the flow pattern is altered — including a shift in the location of maximum velocity and the appearance of flow resistance at the underside of the plastic accumulation.
5. The blockage causes flow concentration, which leads to significant bed erosion.

A considerable number of additional tests are still required, and substantial effort will be needed to fully understand and quantify the observed processes.