



Politechnika Krakowska
Cracow University of technology

Cracow large system of temporary, mobile, demountable barriers

**EUCOLD WG Levees & Flood Defences - Webinar on
temporary / mobile / demountable flood defences**

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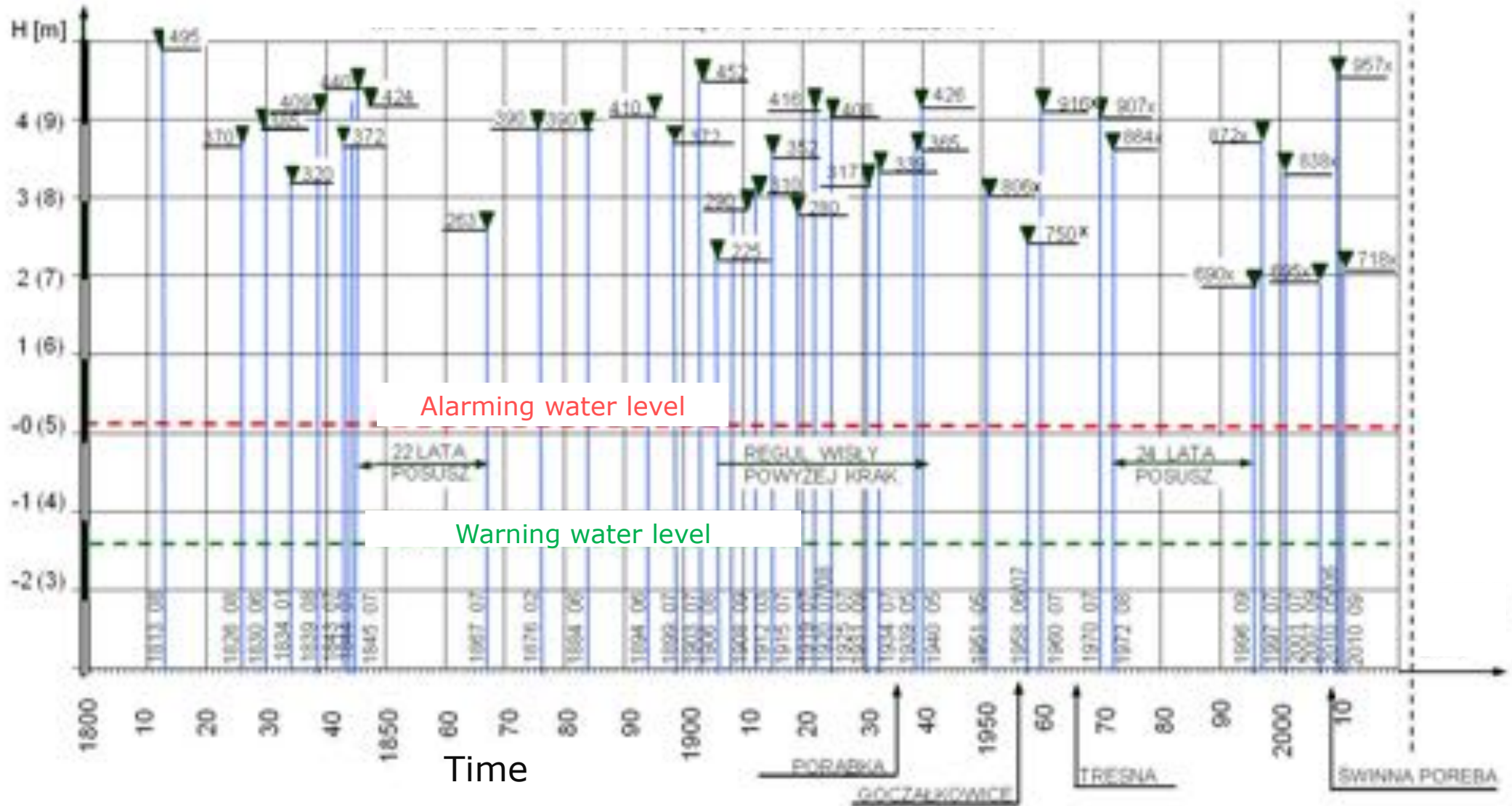
Cracow and Vistula river



Cracow and Vistula river

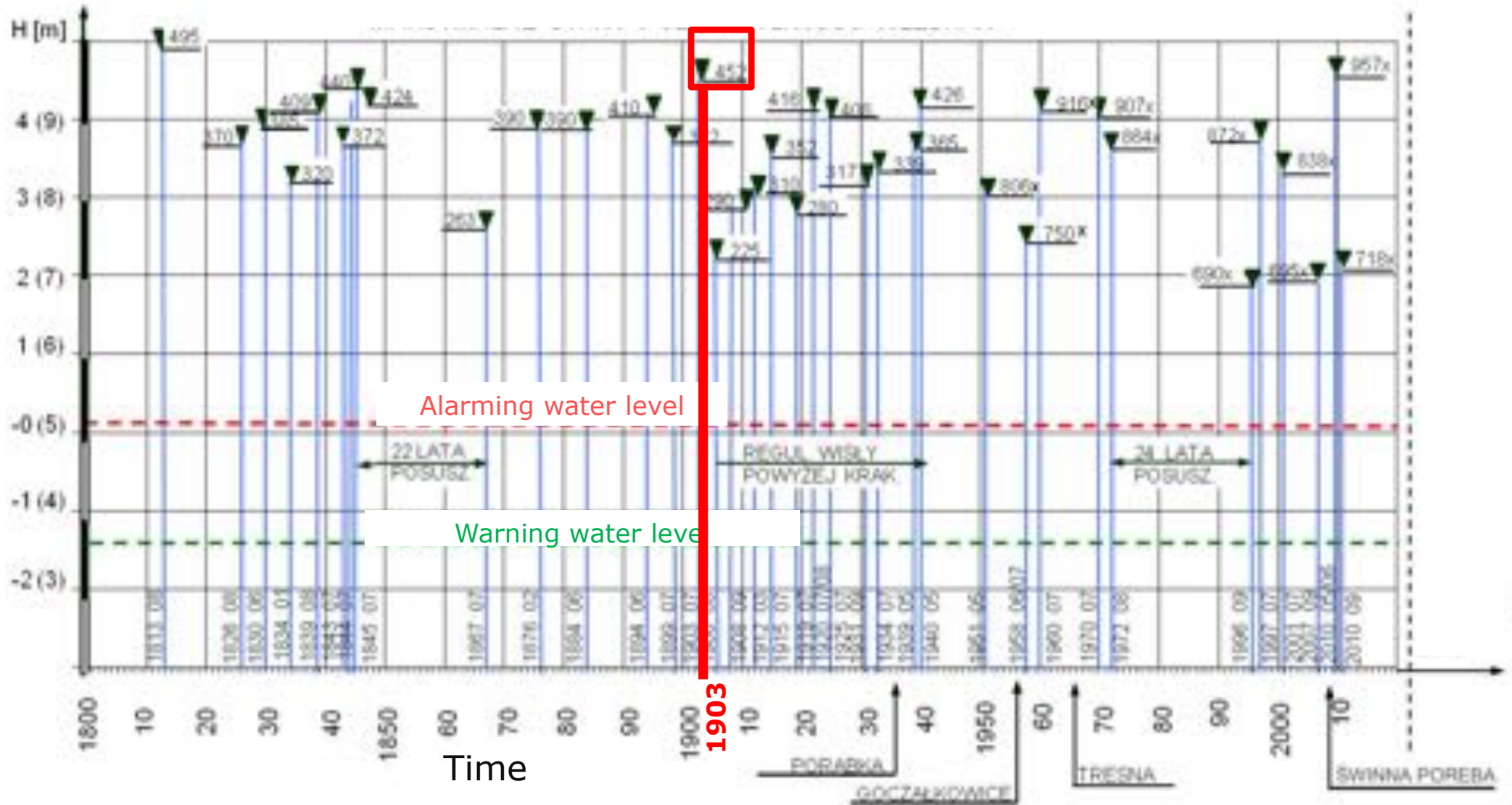


Highest floods in Cracow



New large dams which protect Cracow

Highest floods in Cracow

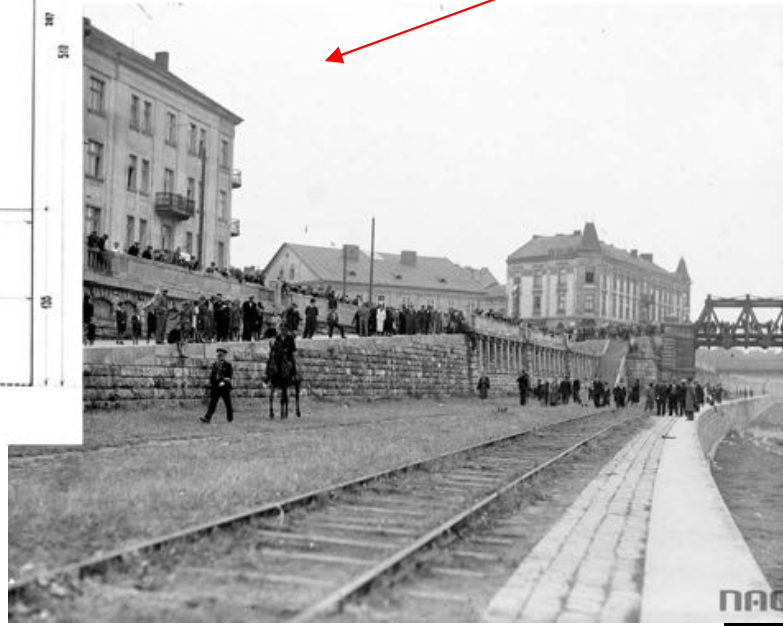
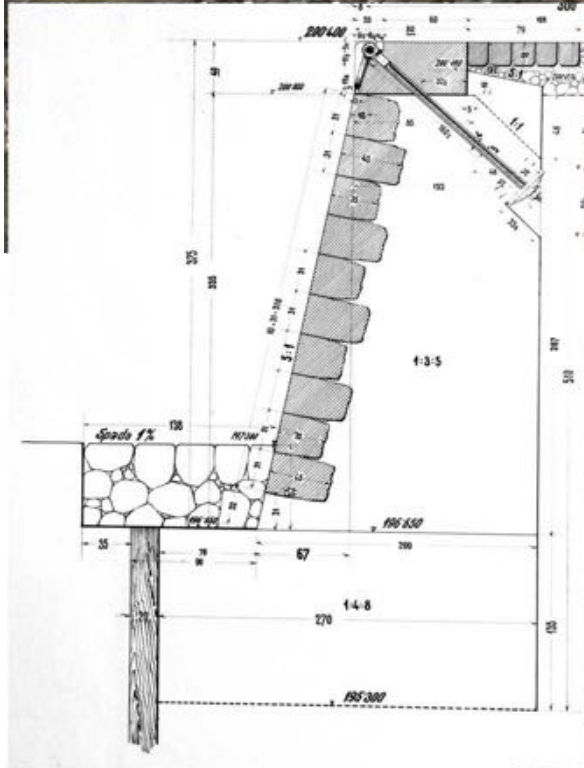


New large dams which protect Cracow

Flood in 1903



1905-1919 Construction of boulevards along the banks of the Vistula River



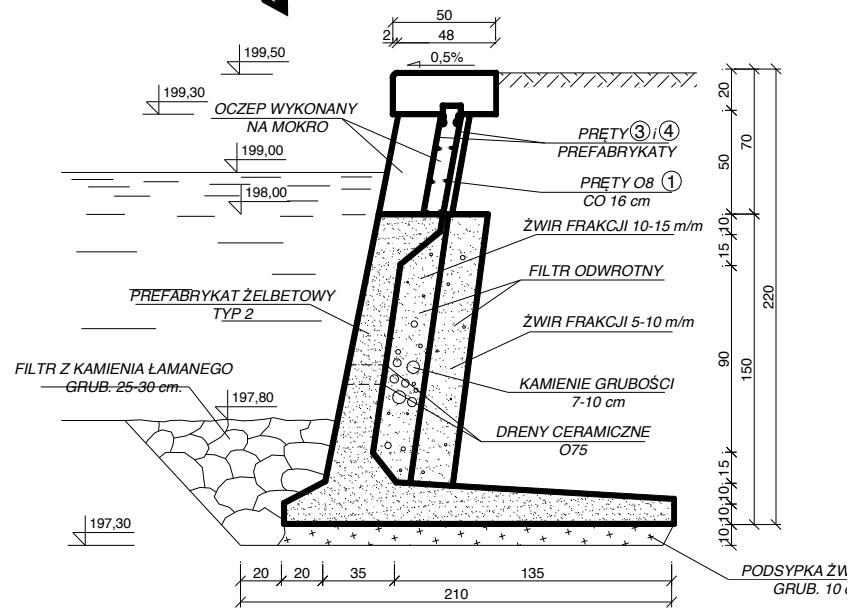
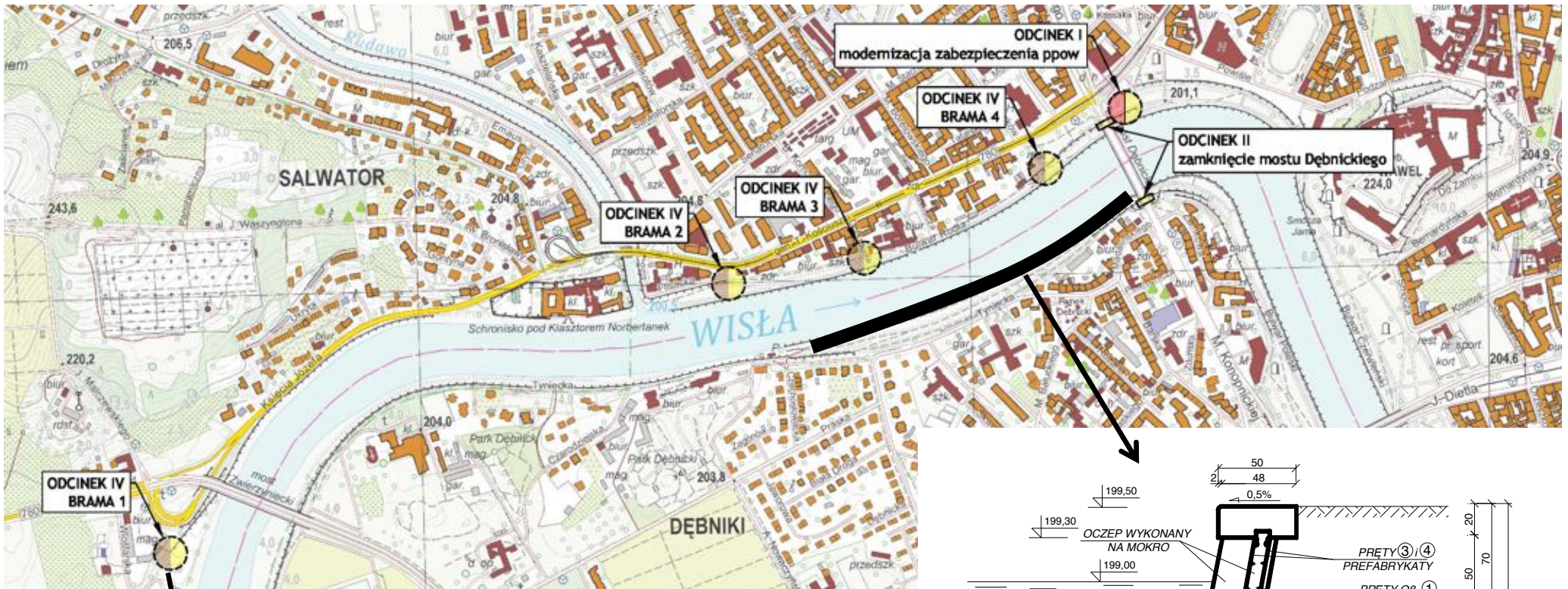
Three flood gates in old boulevards



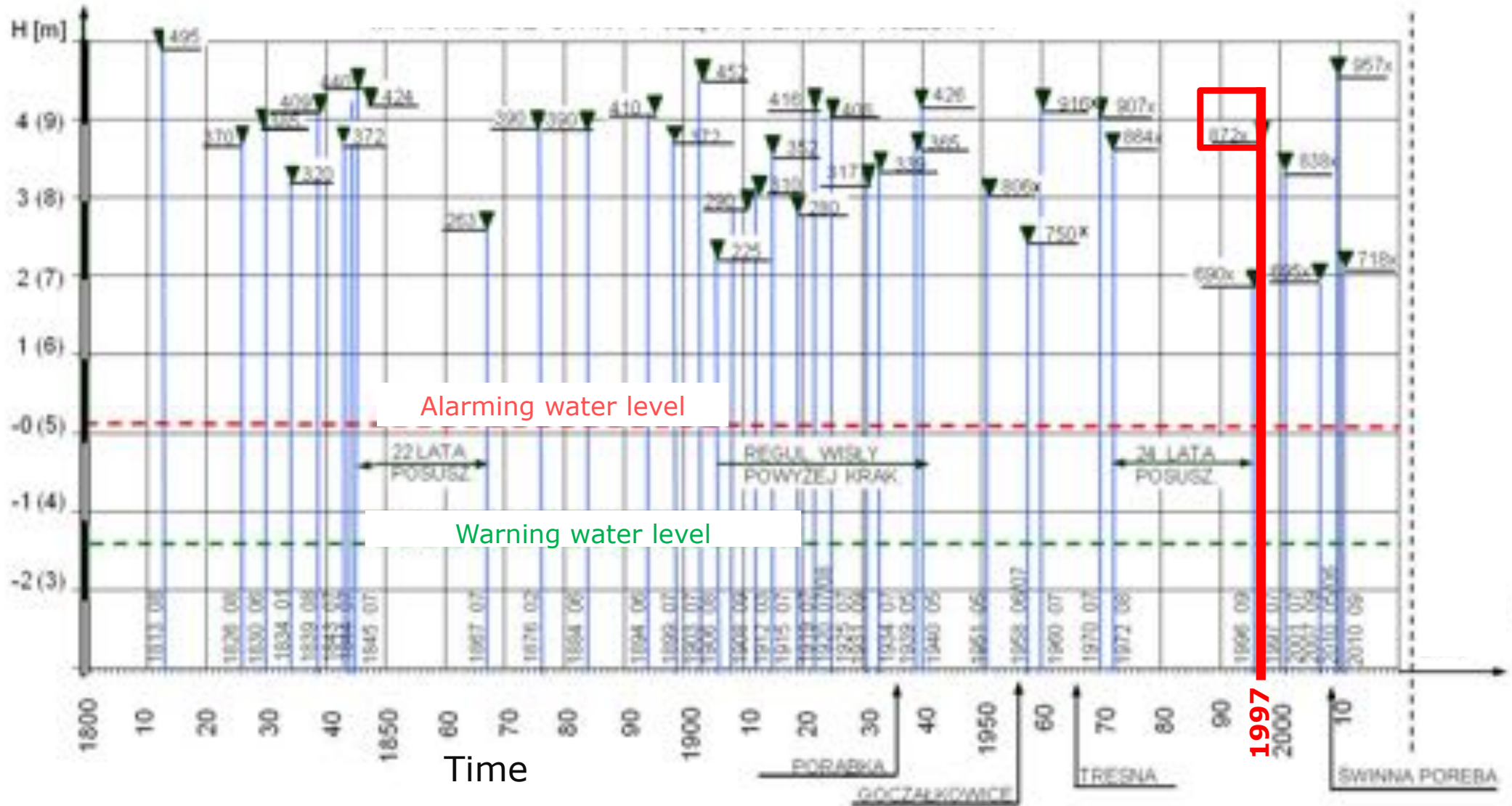
1934-40 Construction of levees along Vistula in Cracow



50s Construction of modern boulevards



Highest floods in Cracow



New large dams which protect Cracow

Flood in 1997 (p<1%)

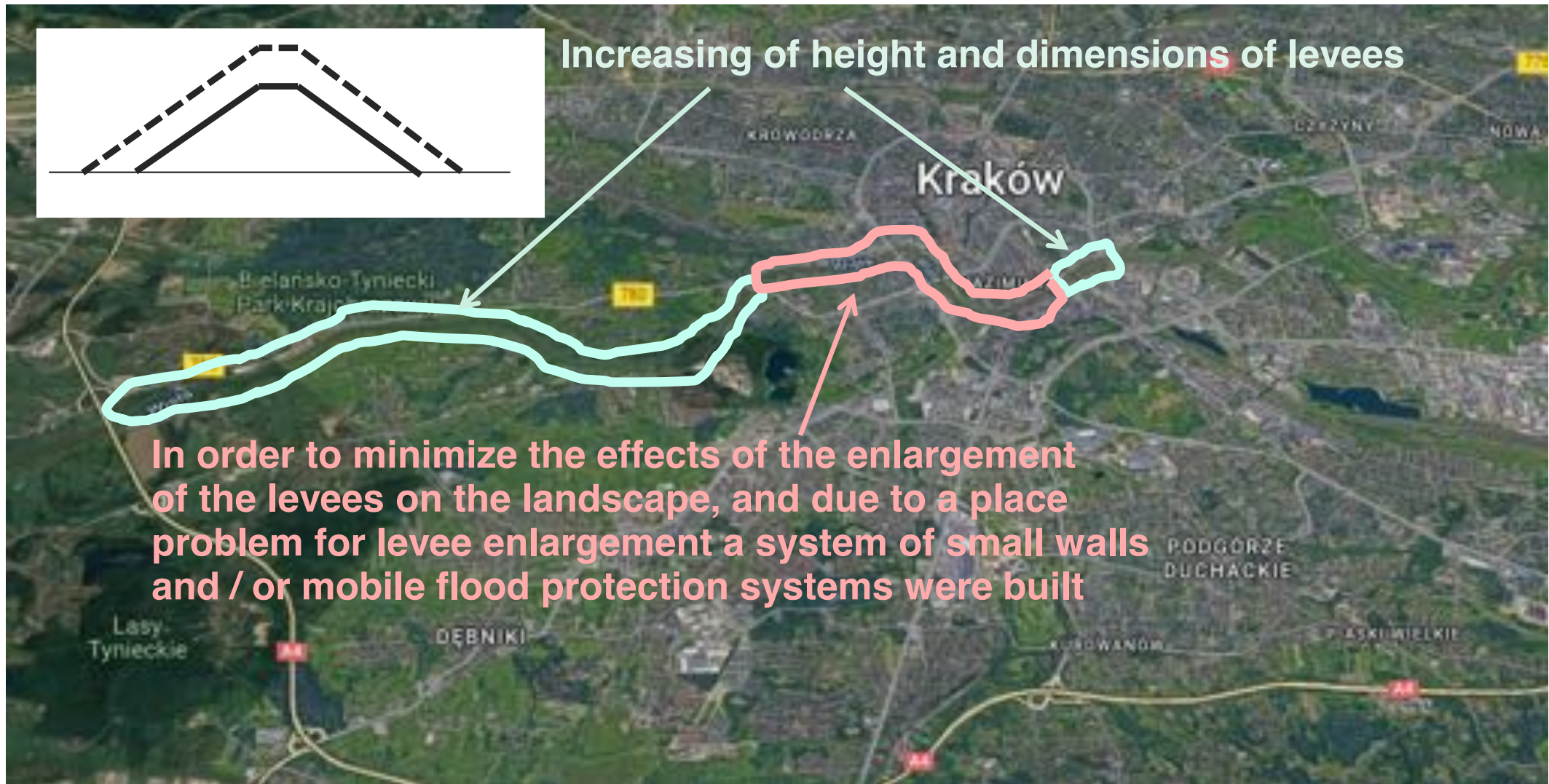


Flood risk map for $p=0,2\%$ (1 per 500 years), discharge 3100 – 3600 m³/s



1999-2003 Increasing of height of levees and flood walls along Vistula river in Cracow and around it

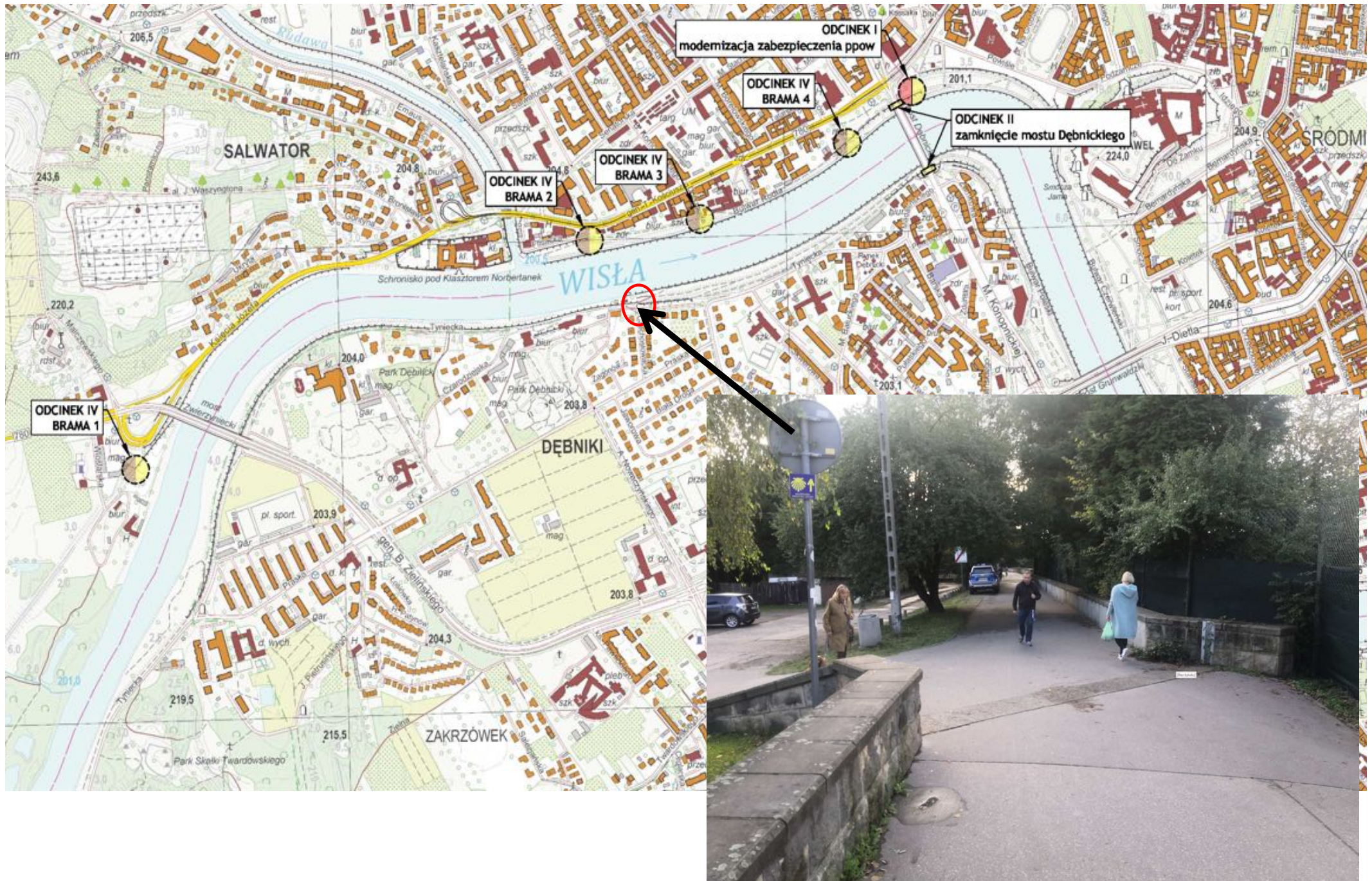
Protection against flood $p=0,1\%$ (1 time per 1000 years)



Small permanent walls and/or mobile flood protection barriers



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MOBILE FLOOD PROTECTION BARRIER



 Klimat Energia
Gospodarka Wodna

MOBILE FLOOD PROTECTION BARRIER



MOBILE FLOOD PROTECTION BARRIER



MOBILE FLOOD PROTECTION BARRIER



fot. KEGW

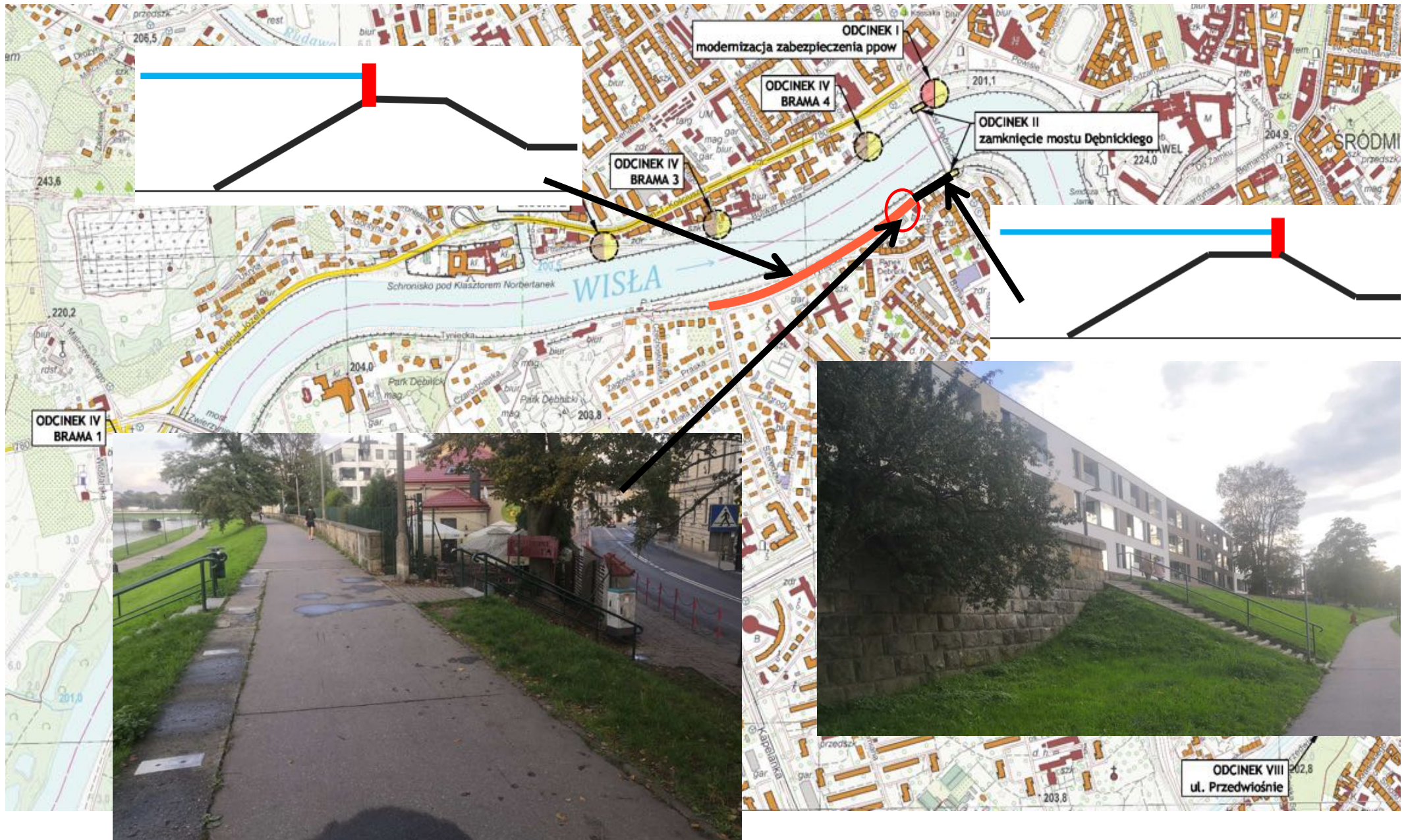
MOBILE FLOOD PROTECTION BARRIER



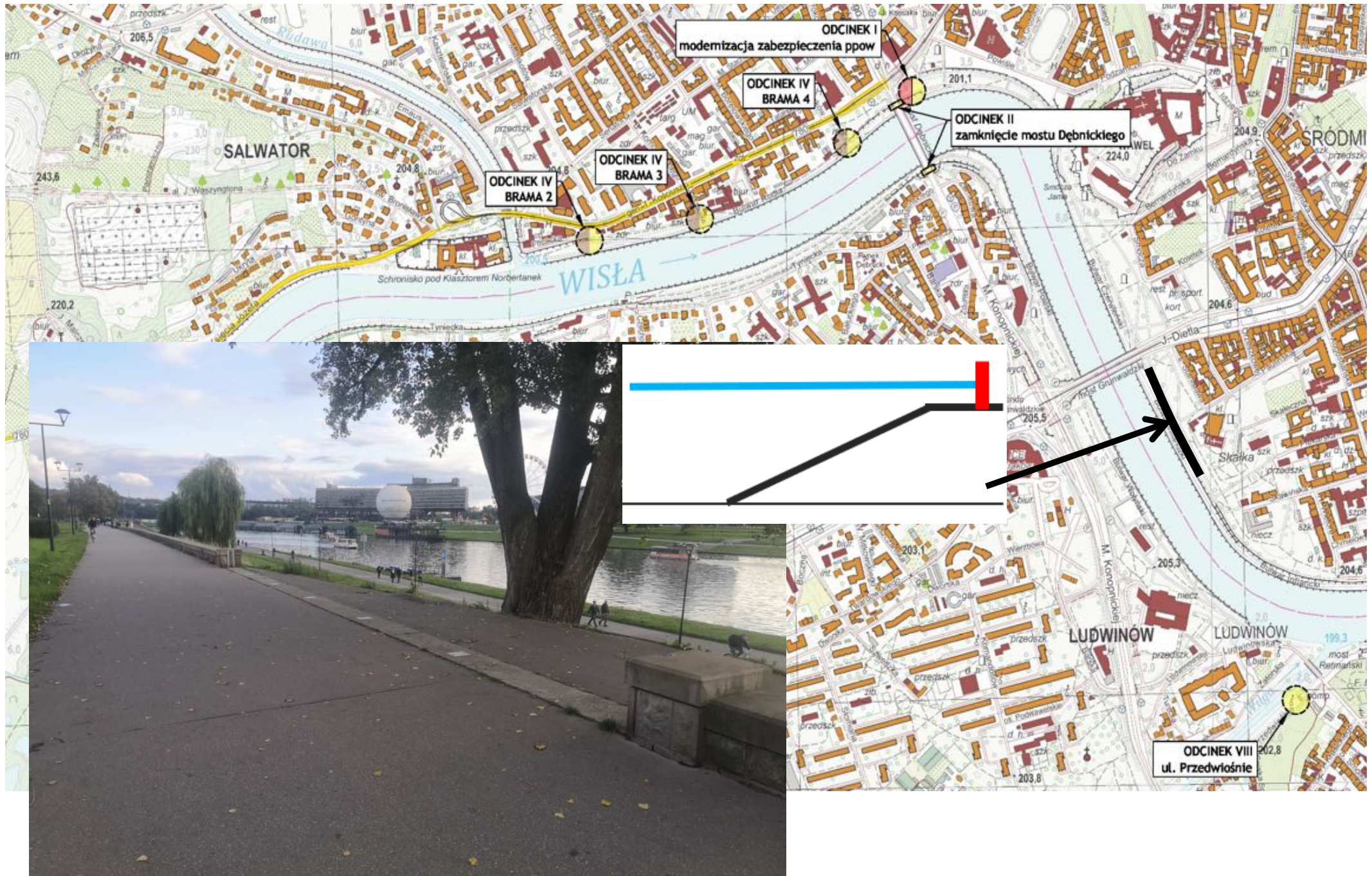
MOBILE FLOOD PROTECTION BARRIER



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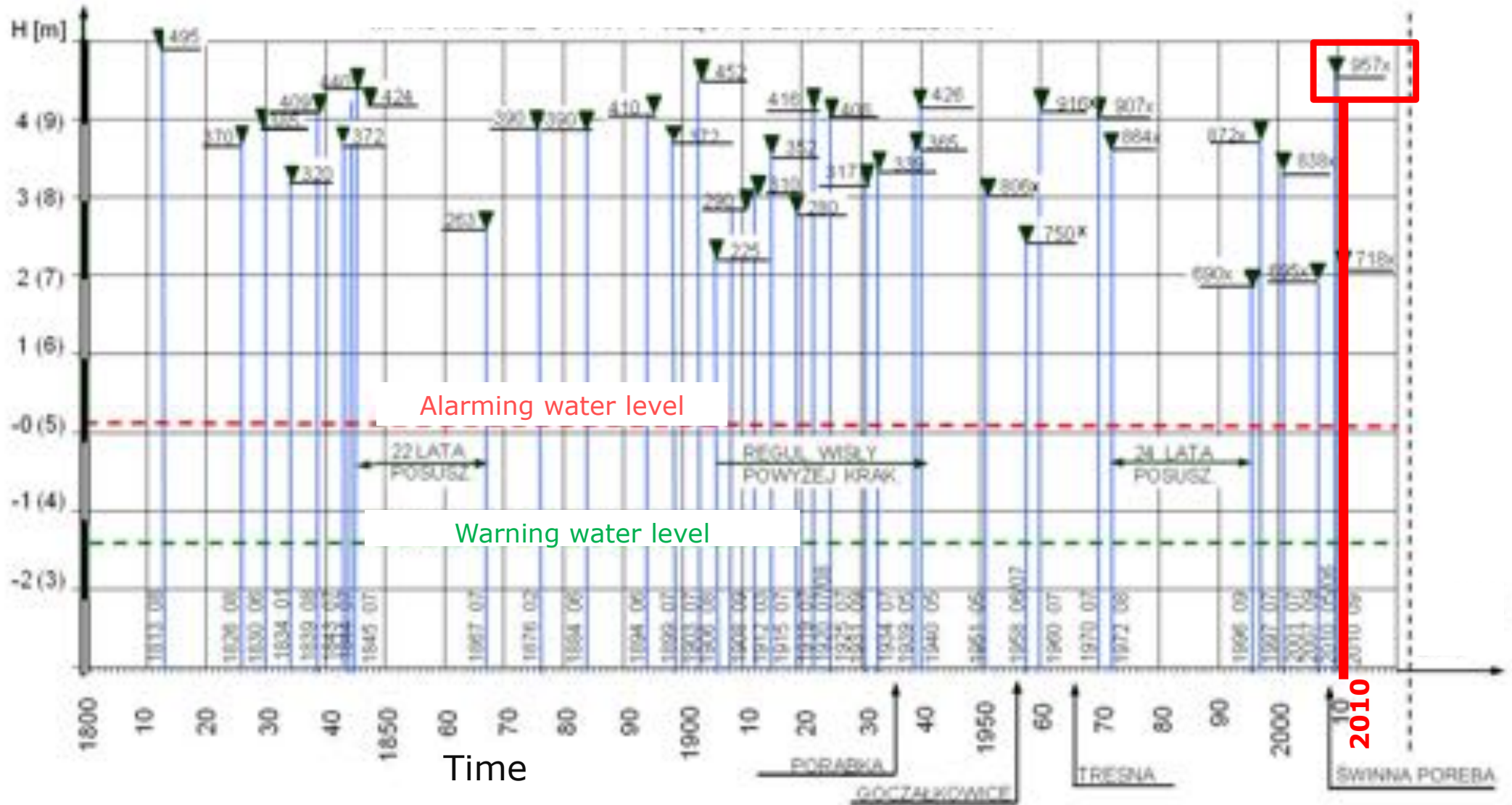
Small permanent walls and/or mobile flood protection barriers



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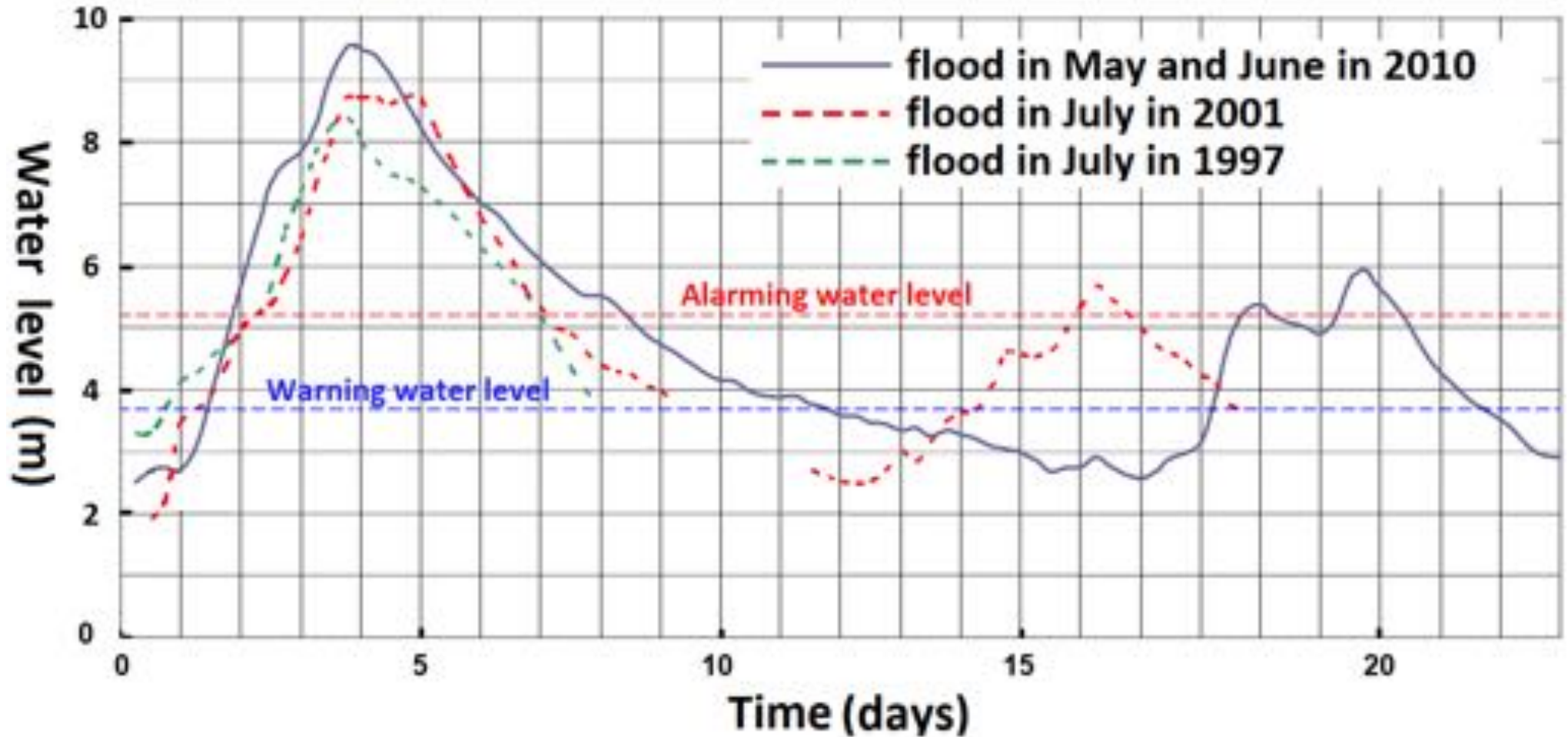
Highest floods in Cracow



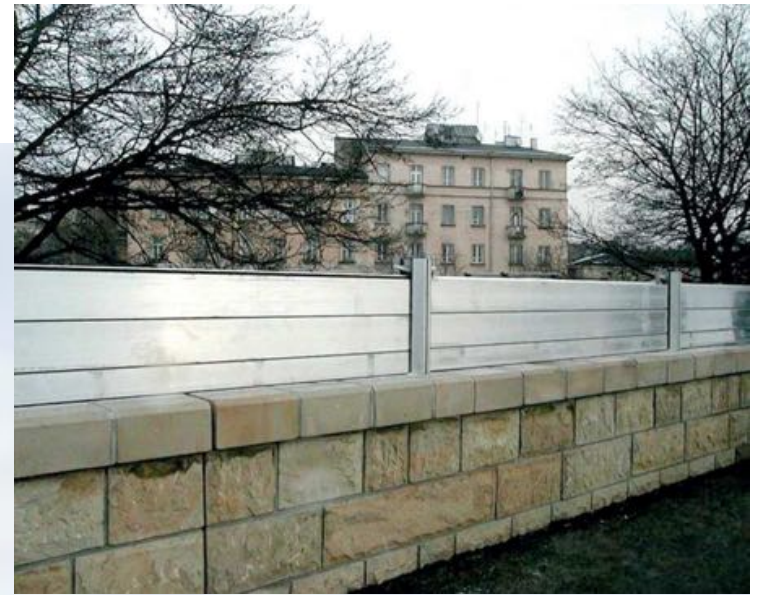
New large dams which protect Cracow

FLOOD in 2010 – largest in the modern history

Flood ,only' p= 1%, heighth 9,57m, discharge 2300 m³/s



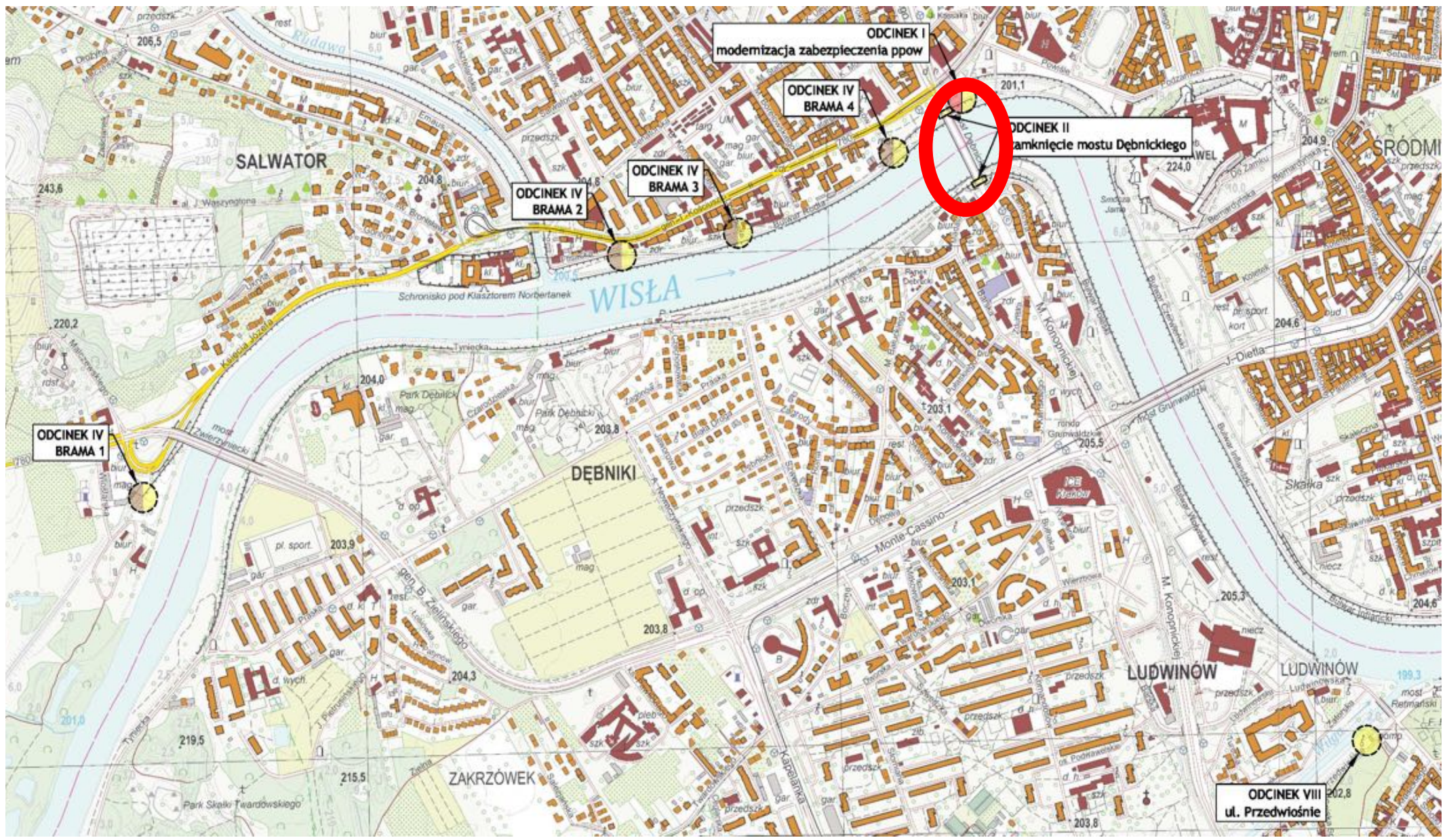
FLOOD in 2010



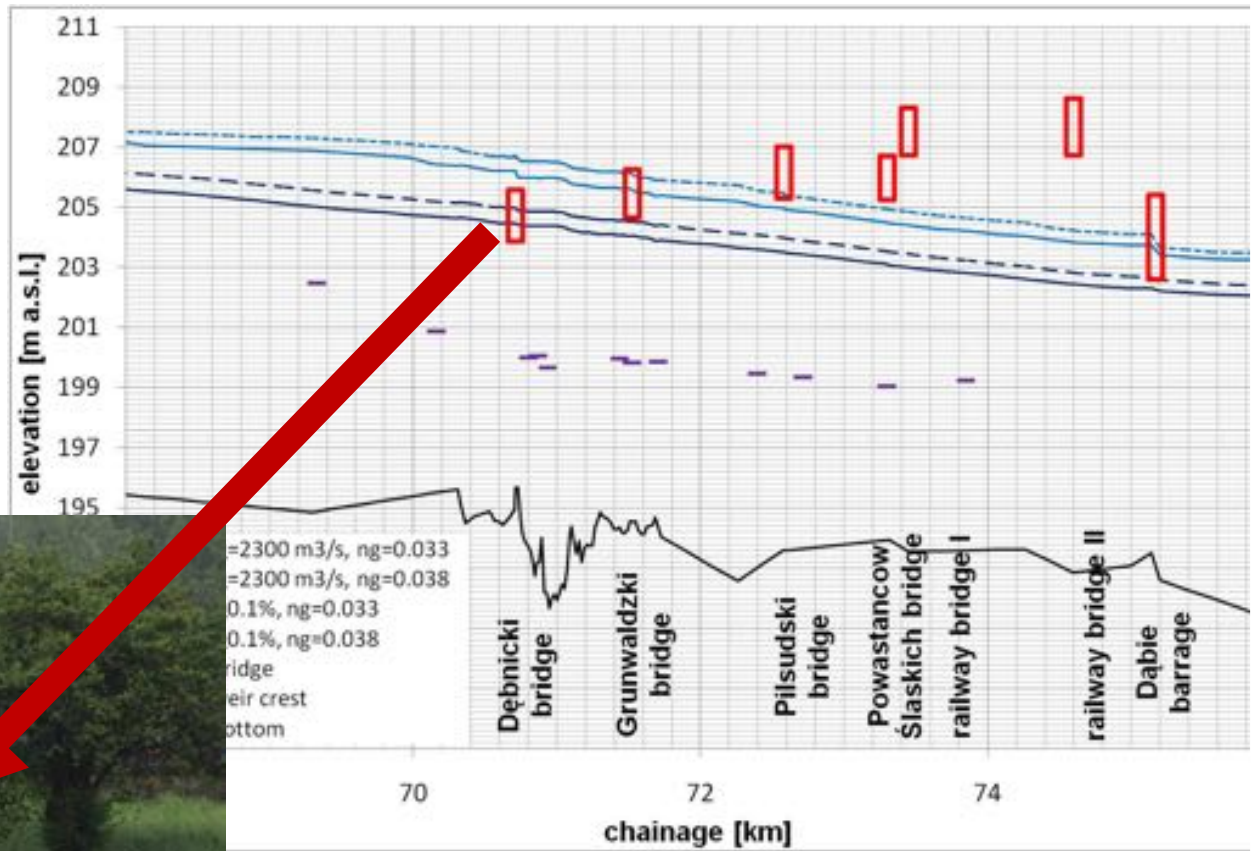
FLOOD in 2010



Problem of Dębnicki bridge during flood in 2010



Problem of Dębnicki bridge during flood in 2010



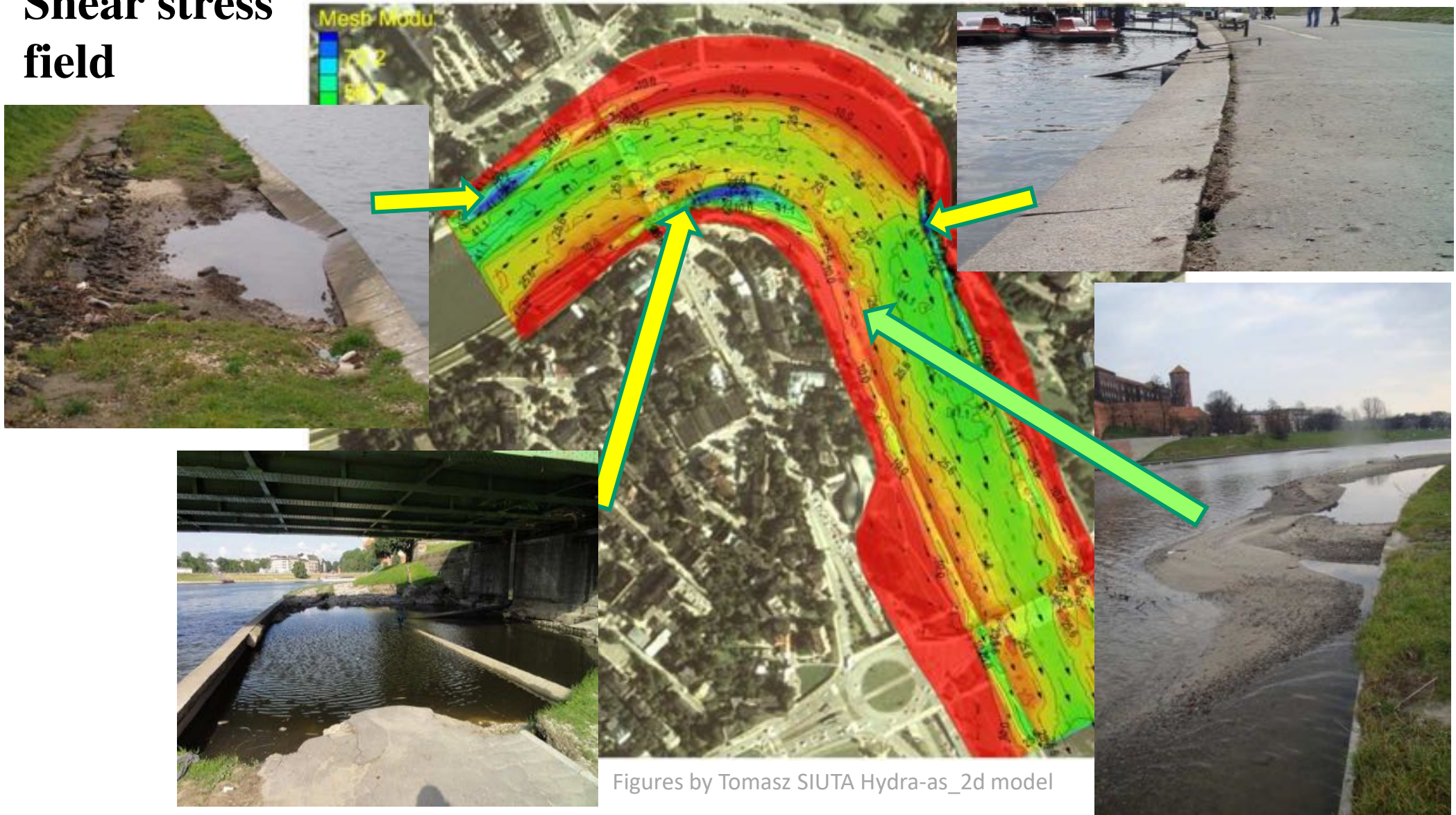
Figures by Tomasz SIUTA
Hydra-as_2d model

Problem of Dębnicki bridge during flood in 2010



Problem of erosion during flood in 2010

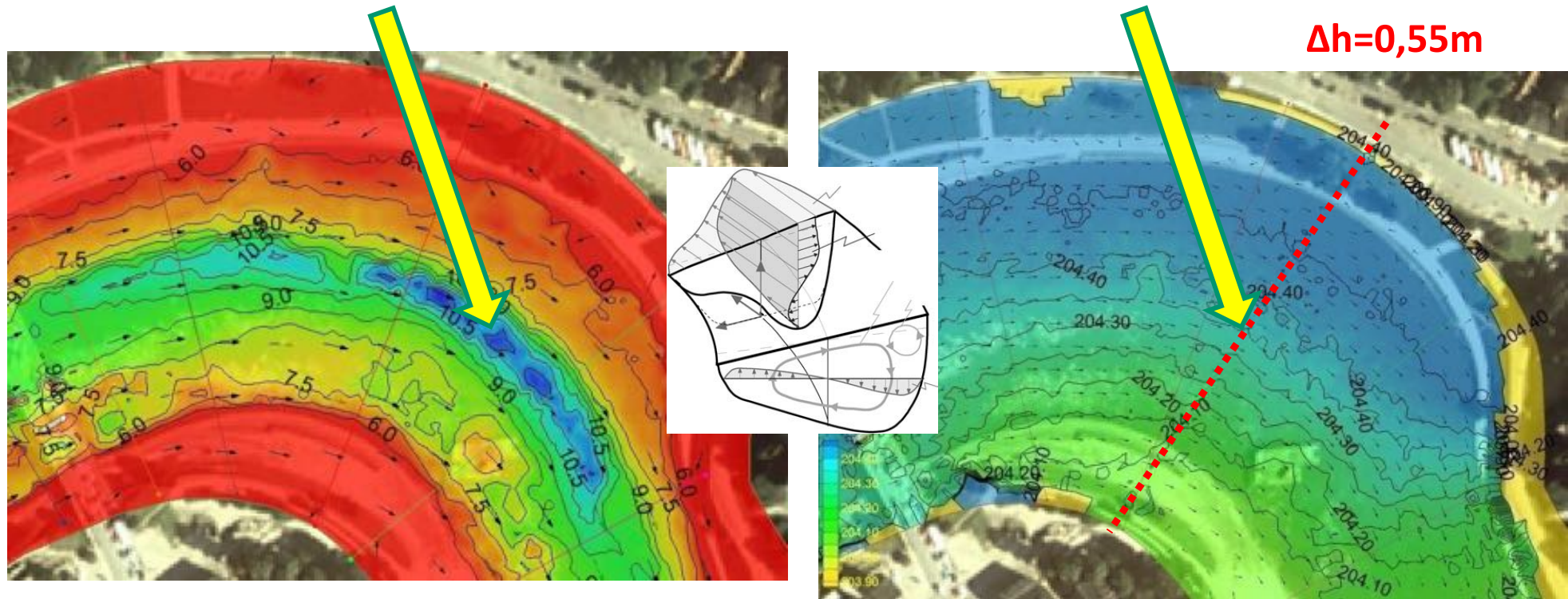
Shear stress field



Problem of erosion during flood in 2010

The lowest bottom elevation zone

The zone of the biggest transversal slope of water surface



a) depth field

b) water surface elevations

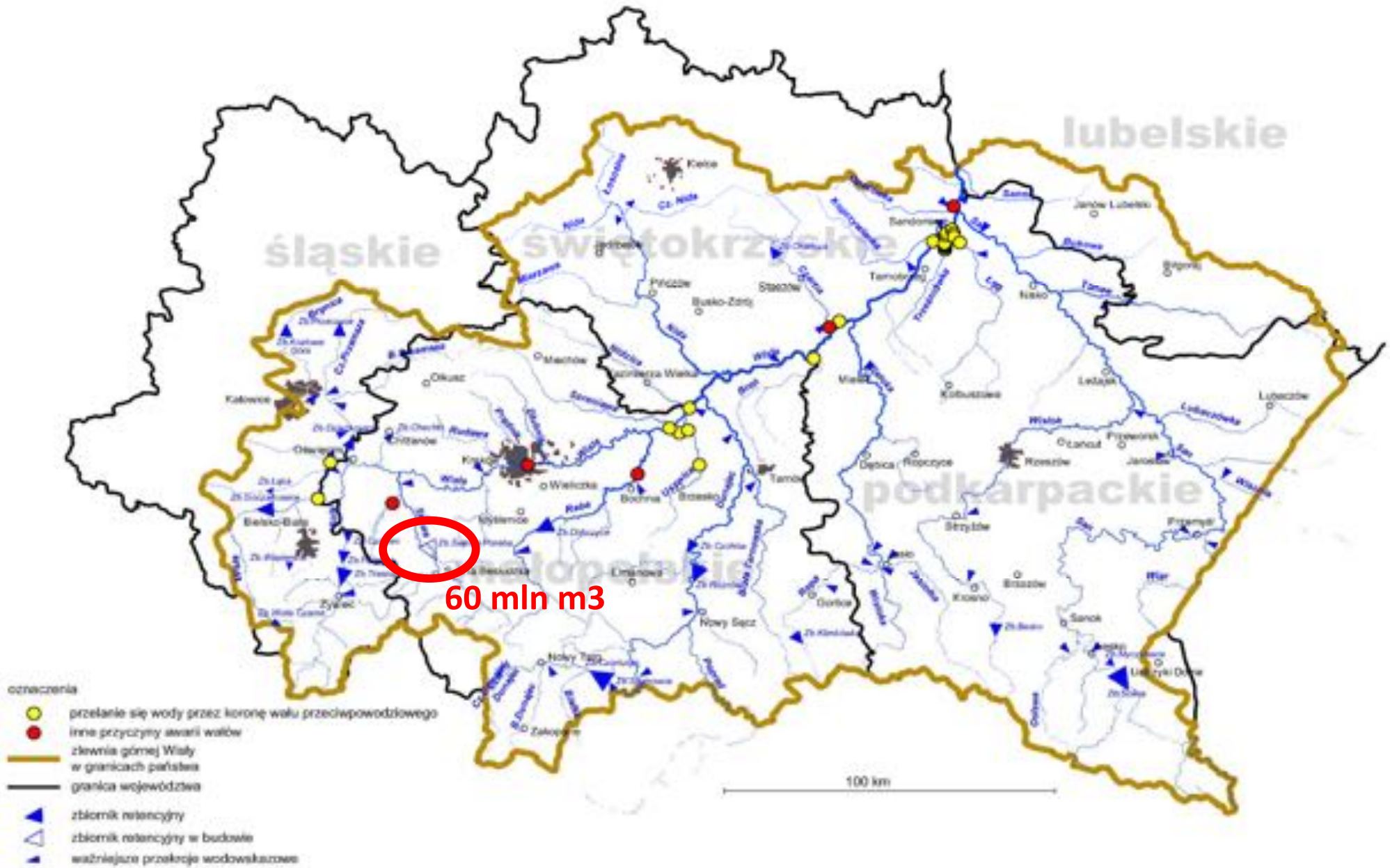
Figures by Tomasz SIUTA Hydra-as_2d model

FLOOD in 2010

Unexpected local levee breake probably due to internal erosion



Effect of Świnna Poręba dam (some tens of centimeters)



Effect of three levees breake above Cracow (some tens of centimeters)



CONCLUSIONS

- **System of small permanent walls and/or mobile flood protection barriers built over existing boulevards and levees was chosen:**
 - to protect Cracow against flood $p=0,1\%$,
 - to minimize the negative impact of the enlargement of the levees on the landscape,
 - due to a problem with a limited place to widen the levee
- **This system is a good solution, comparing the significant effect of flood protection to the funds spent and the relatively short time needed to improve the flood safety of the Cracow city**
- **The water level in Cracow during flood in 2010 was significantly reduced by the Świnna Poręba dam and by three failures of the levees on the Vistula river before Cracow**
- **Water level during flood in 2010 ($p=1\%$) wasn't enough high to touch new system of mobile flood protection barriers**
- **However for a long term the risk of floods grater than $p=1\%$ in Cracow should be limited. This may endanger the safety of the Dębnicki Bridge and it cause significant damages to the bed and boulevards
For this reason, work is currently underway to develop a large polder system before Cracow**



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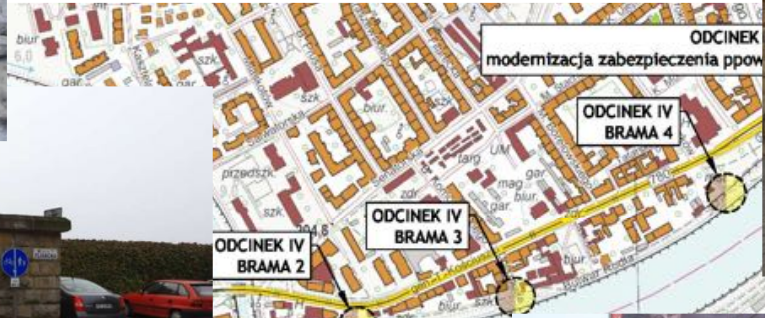
Thank you for your attention

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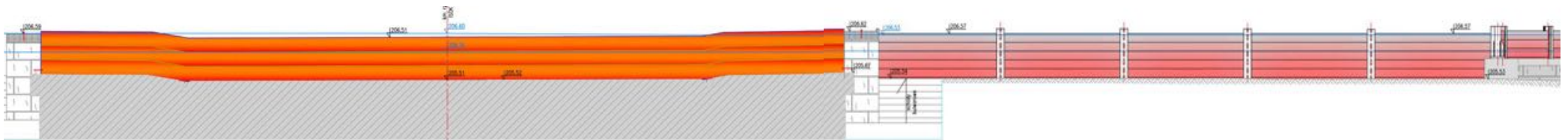
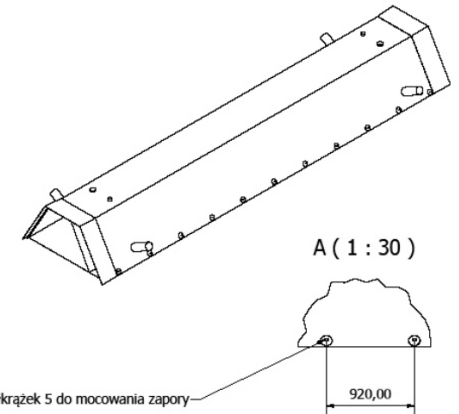
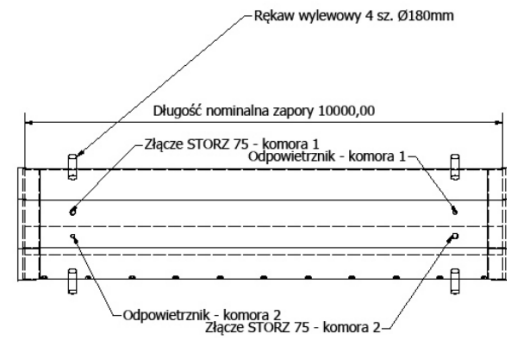
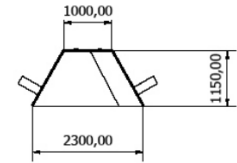
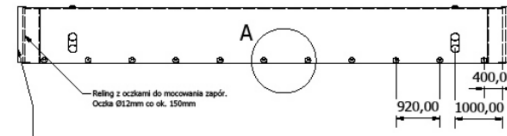
Upgrade of some hot spots in Cracow local protection system after flood in 2010

New flood gates in old boulevards



Upgrade of some hot spots in Cracow local protection system after flood in 2010

New mobile barriers for Dębnicki bridge



Upgrade of some hot spots in Cracow local protection system after flood in 2010

Small permanent wall with gabions and geomembran

