



XXXII

# International School of Hydraulics

28 - 31 May · 2012 · Łochów · Poland

HYDRAULIC PROJECT WŁOCŁAWEK  
Design, studies, construction, operation problems



WOJCIECH MAJEWSKI

Institute of Meteorology and Water Management  
Committee of Water Resources PAS

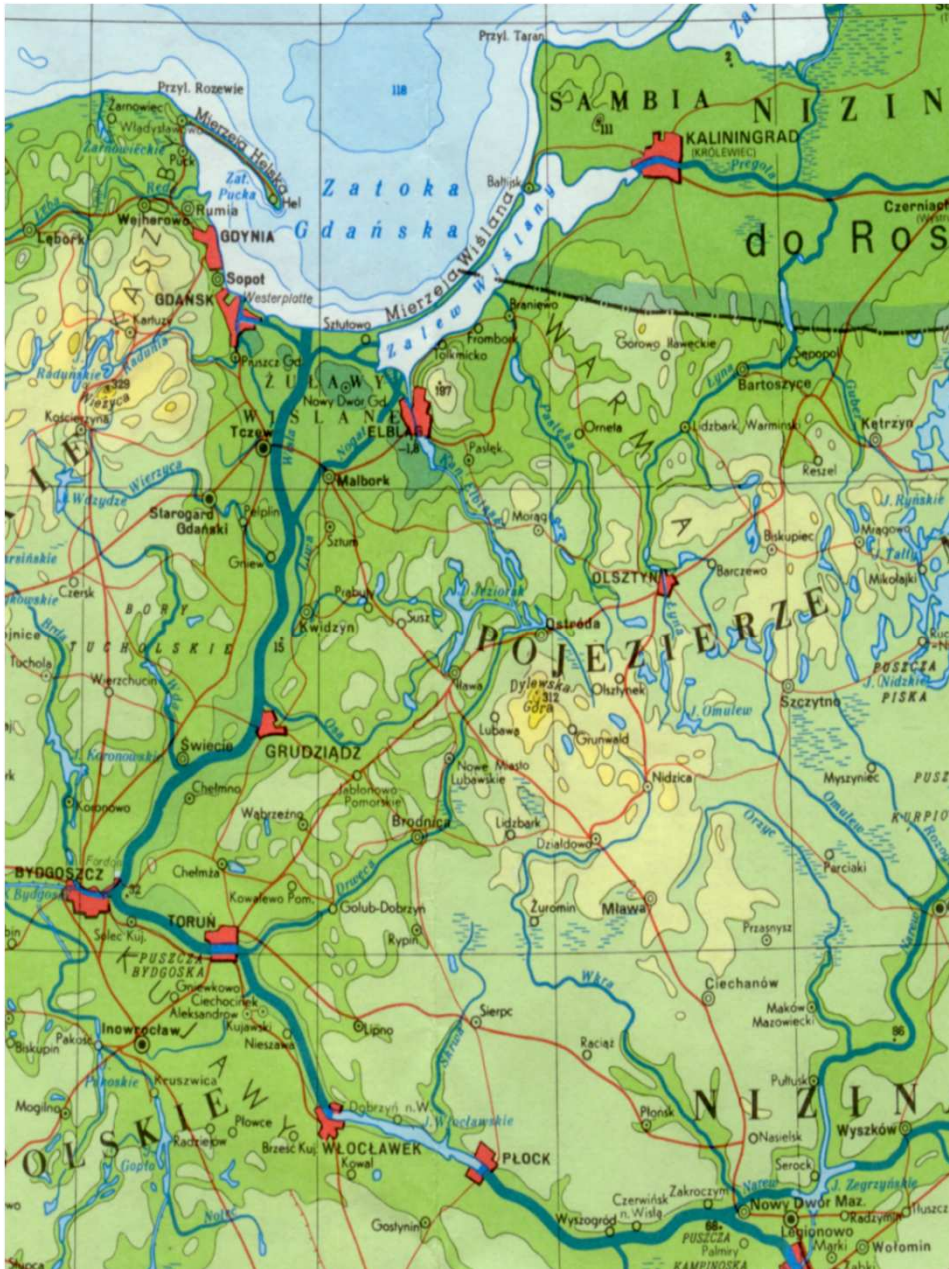


## THE SCOPE OF PRESENTATION

- Why presentation about hydraulic project Włocławek
- Lower Vistula and the concept of its development
- Concept of the Lower Vistula Cascade
- Hydraulic project Włocławek, design
- Hydraulic Project Włocławek, hydraulic model studies
- Hydraulic Project Włocławek, construction
- Exploitation of the project, benefits and hazards
- Controversial problems
- Present proposed solutions
- Conclusions



# LOWER VISTULA (LV)



- Catchment of LV within 5 voivodships
- Terrain of RZGW Gdańsk and Warsaw
- Length of the section 391 km
- Important cities: Płock, Włocławek, Toruń, Bydgoszcz, Grudziadz, Tczew, Gdańsk, Elbląg
- Discharges (Cross-section Tczew):
  - max. 7840 m<sup>3</sup>/s
  - average 1060 m<sup>3</sup>/s
  - min 253 m<sup>3</sup>/s
- Trained river section
- New Vistula Channel 1895 r.
- Important ecological corridor, national parks, protected areas, landscape parks, NATURA 2000
- Important problems – ice phenomena
- Catchment of the LV -12% of Poland area
- 1/3 of Poland's hydro-energy potential
- Important navigation route (international) E40 and E70

# PLANNED LOWER VISTULA CASCADE

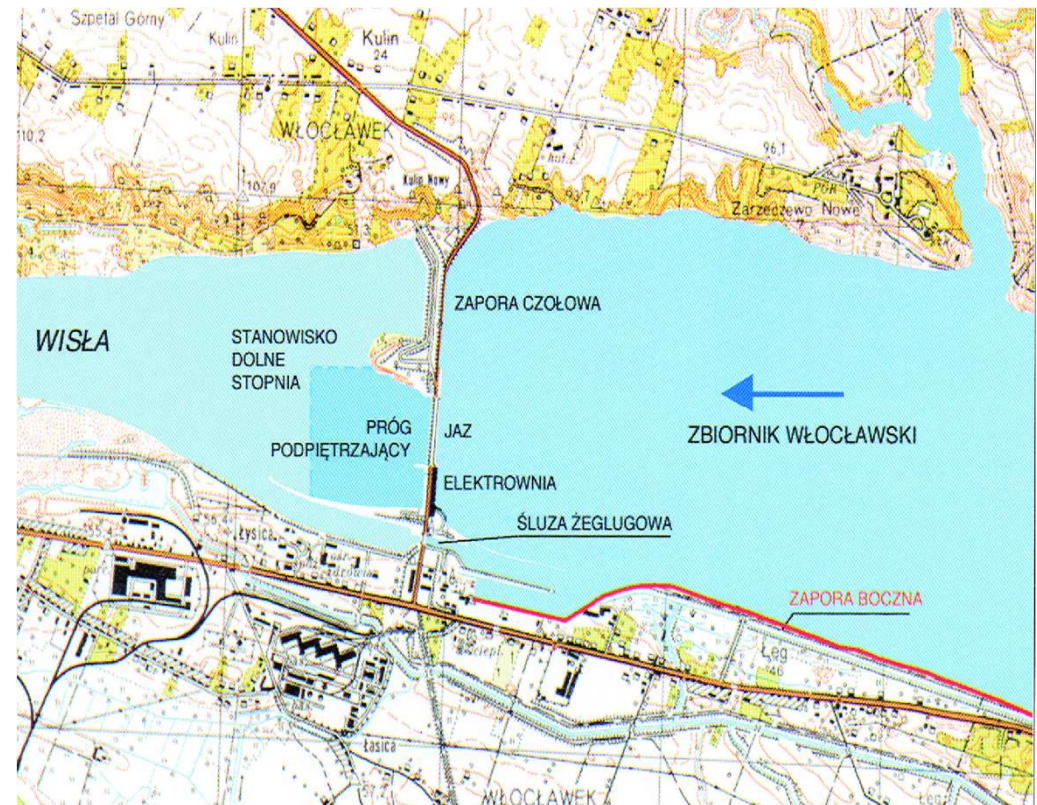


- Planned total capacity 1300 MW
- Planned electric energy production in the average year 4200 GWh
- Inland navigation
  - cargo navigation
  - recreational navigation
- Water intakes (industrial, municipal and agriculture)
- Improvement of flood risk protection
- Improvement of water quality discharged to the Baltic Sea



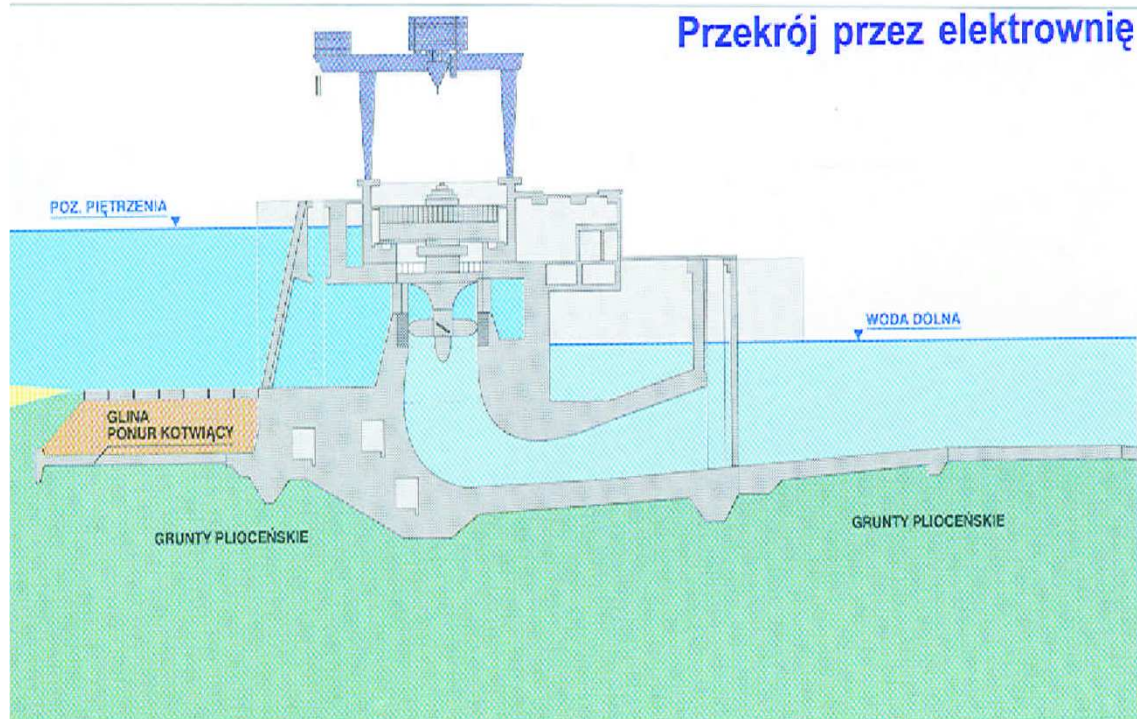
# HYDRAULIC PROJECT WŁOCLAWEK - DESIGN

- Design was completed by Hydroprojekt and Energoprojekt
  - Main purpose electric energy production and navigation
  - Main parts: weir 10 bays x 20 m, hydraulic power-plant 6 Kaplan turbines with generators 160 MW, annual energy production 750 MWh, navigation lock (6 mil. tons per year)
  - Run-of-river reservoir NPP (57,30 m), volume about 400 mln m<sup>3</sup> (at present 370 mln m<sup>3</sup> due to sedimentation), length 40 – 55 km
- 
- Additional passage over Vistula
  - Side dams
  - Fish pass
  - It was assumed that next hydraulic project will be built in about 5 years and will stabilize downstream water level
  - In the design the appearance of ice phenomena was taken into account and their consequences





# HYDRAULIC PROJECT WŁOCLAWEK - DESIGN



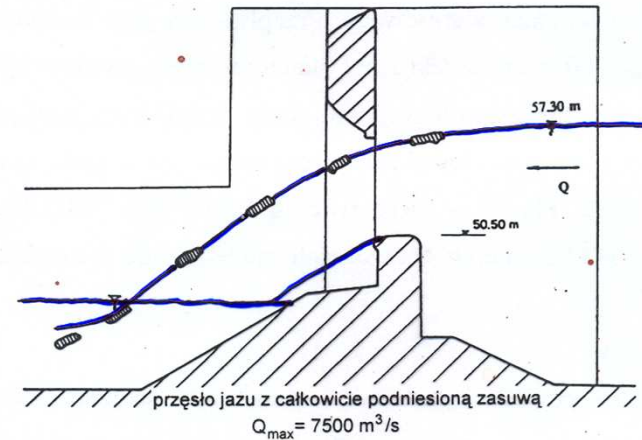
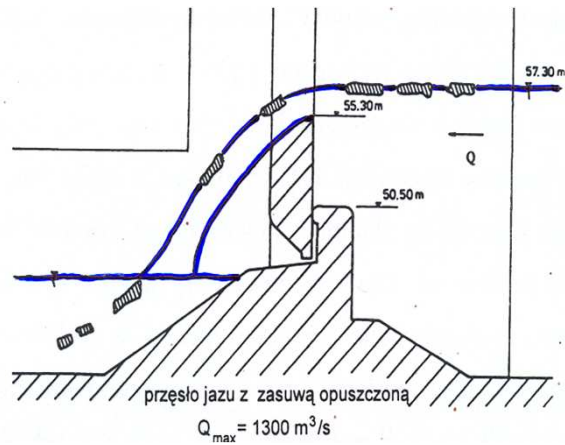
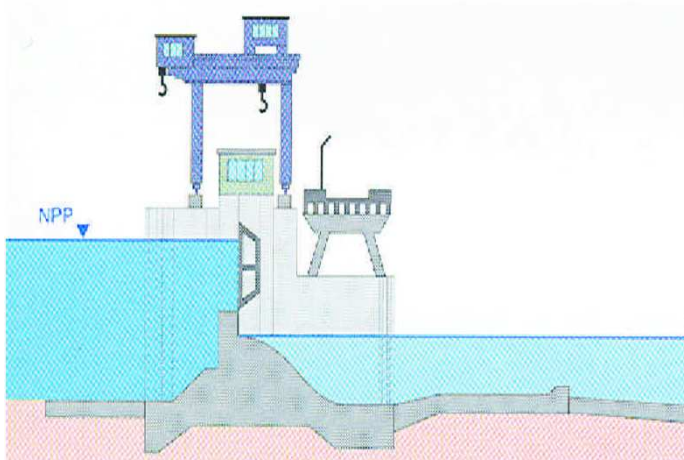
## Hydraulic power-plant

- Installed discharge 2100 m<sup>3</sup>/s
- Power of each unit 26,7 MW, waga 1200 ton
- The range of head 5,25 – 12,75 m
- Hydraulic power-plant without hall
- Discharges in project cross-section
  - $Q_{av} = 890 \text{ m}^3/\text{s}$
  - $Q_m = 8700 \text{ m}^3/\text{s}$  (1%)
  - $Q_k = 10280 \text{ m}^3/\text{s}$  (0,3%)
  - $Q_{max} = 6000 \text{ m}^3/\text{s}$  (registered)



# HYDRAULIC PROJECT WŁOCLAWEK - WEIR

- 10 bays 20 m each
- steel gates which could be lowered and lifted vertically
- stillin basin





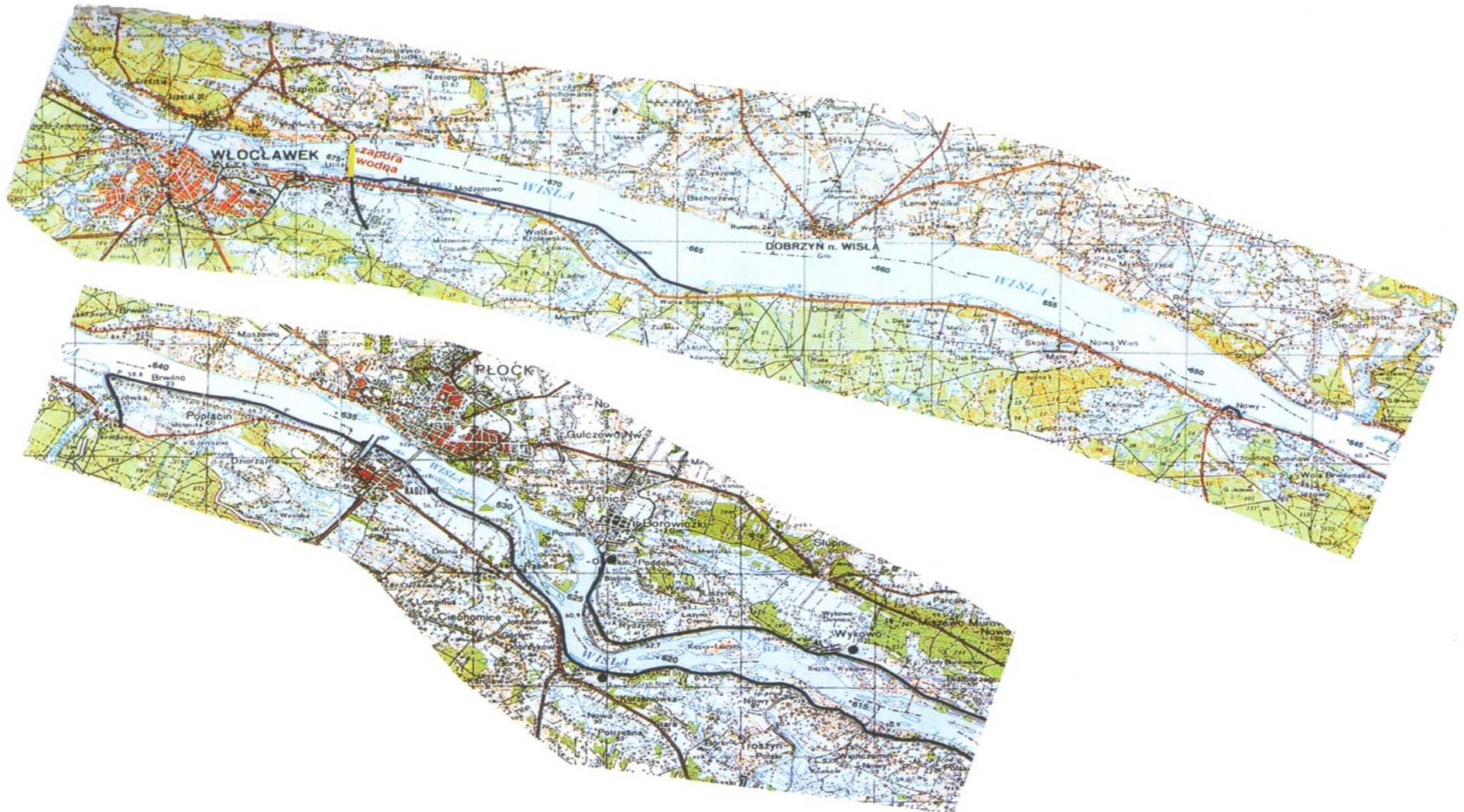
# HYDRAULIC PROJECT WŁOCŁAWEK (downstream view)





# HYDRAULIC PROJECT WŁOCLAWEK - RESERVOIR

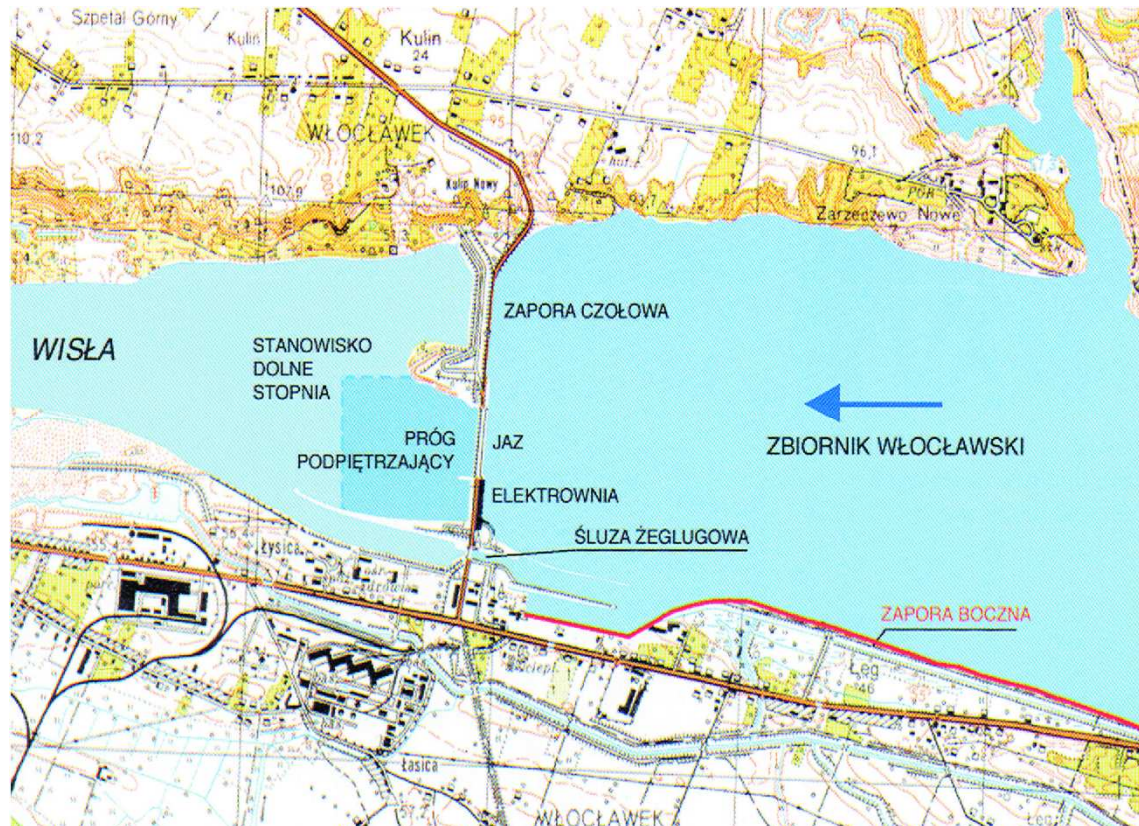
- Initial volume at the level (57,30 m) was about 400 mln m<sup>3</sup> (at present 370 mln m<sup>3</sup>), length 40 – 55 km





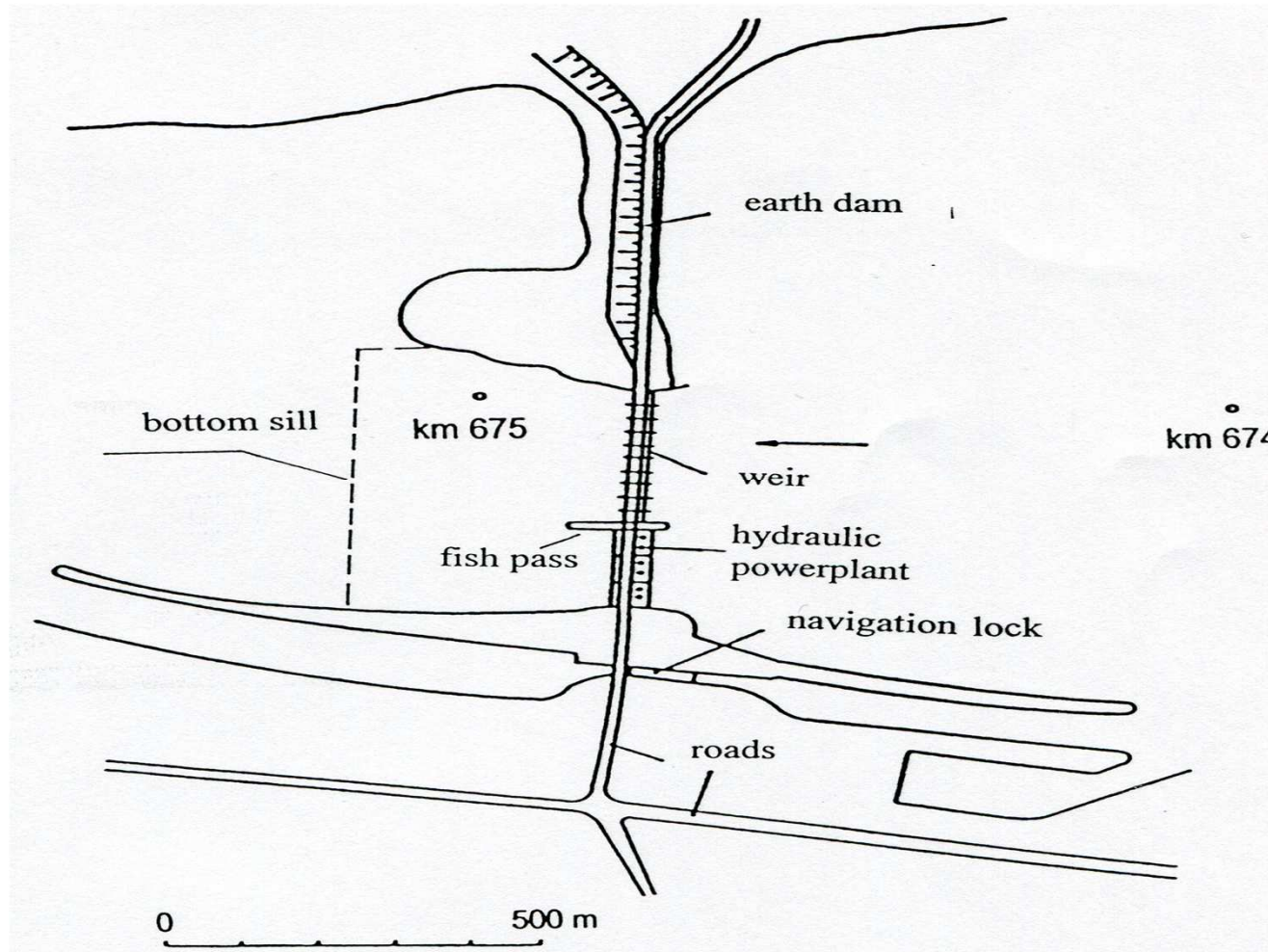
# HYDRAULIC PROJECT WŁOCŁAWEK – hydraulic model studies

- Hydraulic model studies were carried out in the Institute of Hydroengineering
- Model of the whole project (scale 1:100)
- Model of the coferdam (scale 1:100)
- Sectional model of the weir (scale 1:50)
- Hydraulic model of the navigation lock (scale 1:20)
- Hydraulic model of the closing of the river channel





# HYDRAULIC PROJECT WŁOCLAWEK - CONSTRUCTION



# BENEFITS AND COSEQUENCES OF THE PROJECT

## BENEFITS

- Production of electric energy, renewable and ecological, 750 GWh/year
- Aditonal road passage over Vistula
- Possibilities of water withdrawal for industrial, agricultural and domestic purposes
- Stabilization of ground water level
- Possibilities for cargo and tourist navigation
- Possibilities for the development of tourism and recreation

## CONSEQUENCES

- Change of ice regime in relation to previous river regime
- Change in sediment transport (erosion and deposition)
- Accumulation of pollutants in the reservoir (negative and positive effect)
- Problem of fish migration
- Negative ecological consequences



## ICE COVER IN 1982 (upper part of the reservoir)





# VISTULA DOWNSTREAM FROM THE PROJECT (average discharge)





## WHAT HAPPENED DURING PROJECT EXPLOITATION?

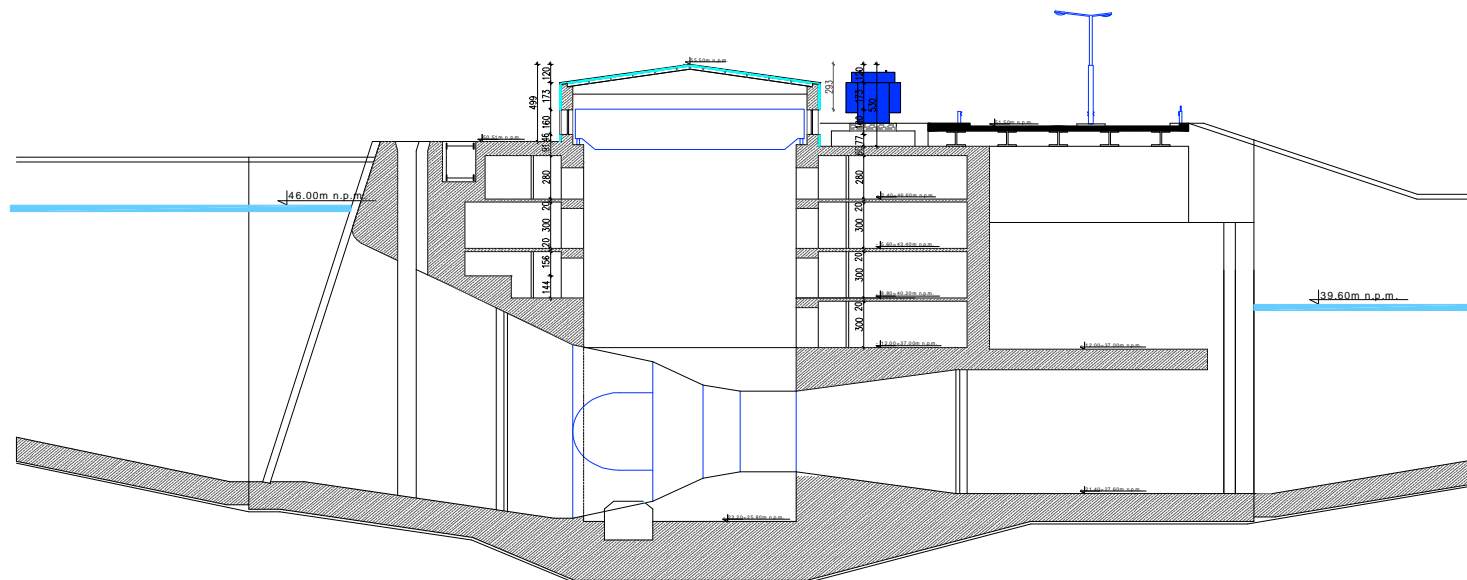
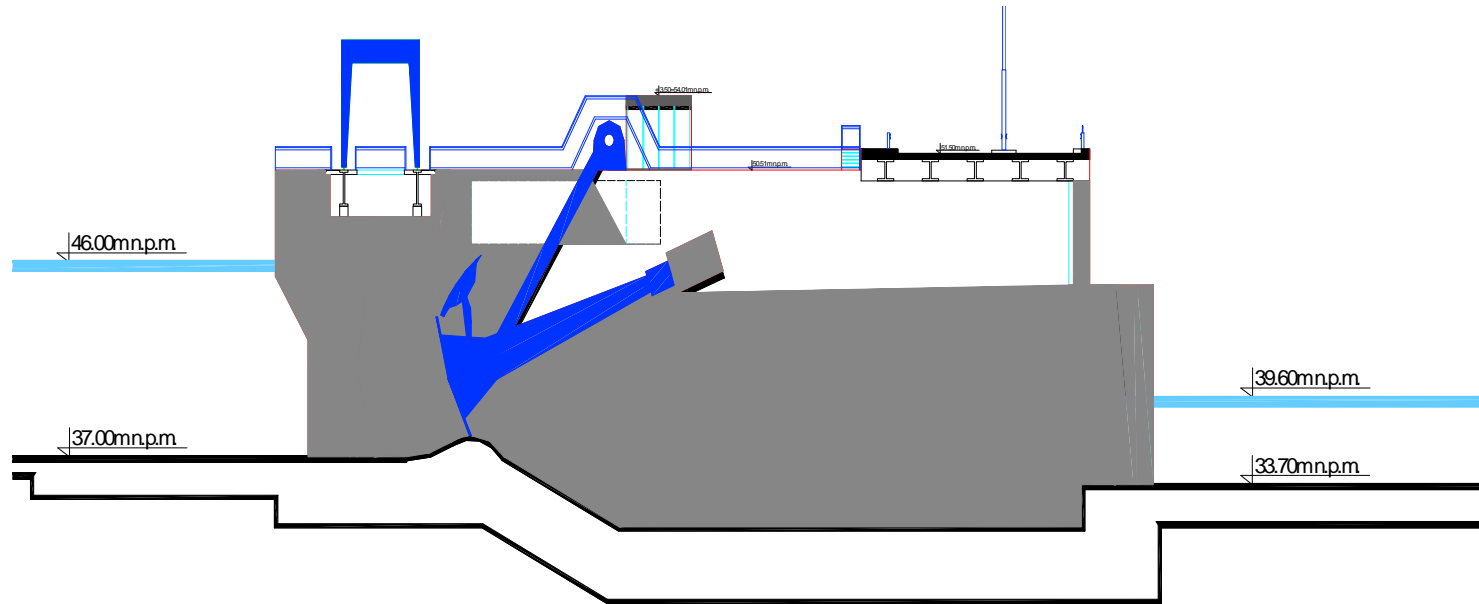
- 1970 r. Project was put into operation
- 1972 r. Technical project of Ciechocinek was prepared and the construction site was prepared
- Erosion downstream from the project and its consequences
- Discussions, conferences and proposals
  - dismantle of the project WWF
  - construction of the project Nieszawa, team of independent experts (2000 r.)
  - construction of the sill 5 km from the project downstream
  - to do nothing!
- Construction of underwater sill downstream from power plant and weir
- January 1982 r. Winter flood in the upper part of the reservoir (marshal law)
- Investigations concerning the reasons of winter flood, installation of floating ice booms
- 2010 passage of the flood (max. Discharge 6000 m<sup>3</sup>/s, attempts to diminish flood consequences
- ENERGA SA wants to develop next hydraulic project downstream of Włocławek

# CONTROVERSIAL PROBLEMS

- All controversial problems are attributed to the reservoir.
- Ice phenomena. Change of ice regime. Flood 1982 – reservoir was blamed for this flood. Considerable amount of frazil ice formed along the river section upstream from the reservoir. Mitigation – ice booms.
- Erosion downstream from the project. Main mistake – lack of the new hydraulic project stabilizing downstream water level. Numerous problems with water intakes. Danger for the stability of construction. Underwater sill – partial solution
- Water quality. Water leaving the reservoir is of much better quality than water flowing into reservoir. Deposition of pollutants. Reservoir cannot be blamed for this situation.
- Ecological problems. Biodiversity increased. New species of fish and water fauna appeared. New valuable ecosystem was created. Problems with migrating fish. Fish pass does not operate correctly. Since 5 years project of new fish pass is being prepared?
- There is considerable opposition against construction of the next hydraulic project from all ecological organizations. WHY?



# PROPOSAL OF THE NEW HYDRAULIC PROJECT



# PASSAGE OF FLOOD IN 2010





# VISTULA DOWNSTREAM OF WŁOCŁAWEK

Discharge aprox. 5000 m<sup>3</sup>/s



## CONCLUSIONS

- Lower Vistula is very important river section from social, ecological and economical point of view
- Preparations for the the hydraulic project downstream of Włocławek are carried out
- Report – Environmental Impact Assessment is being prepared
- Procedures in this respect are very difficult (home and international)
- This project is on the terrain of NATURA 2000
- Present authorities have no concept how to solve water resources problems
- Ecological protests are good for the state authorities because they justify the idea  
TO DO NOTHING



VISTULA DOWNSTREAM OF WŁOCŁAWEK, average discharge



THANKS FOR YOUR ATTENTION