



Scenarios of flood hazards caused by dam disasters

Innovation in Disaster Risk Reduction, Krakow, Poland, 9-11th of May

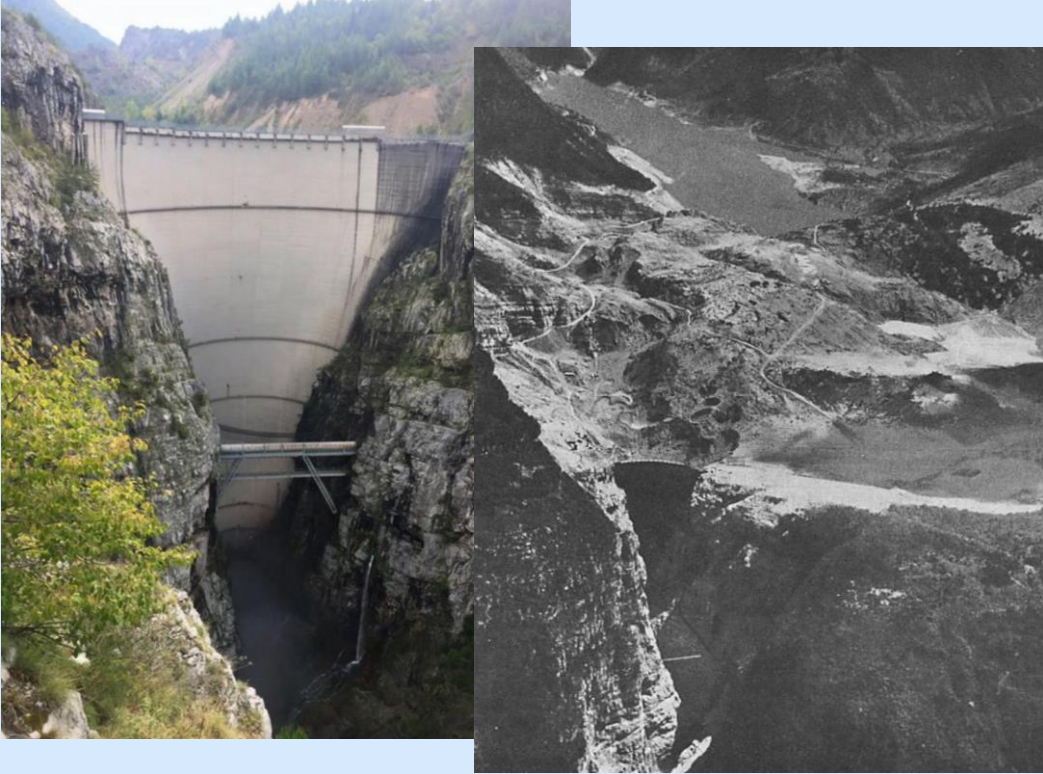
Each dam, from the moment of filling the water reservoir, poses a potential threat to the areas located below. The threat affects the population, infrastructure and the environment in equal measure.

Dam disaster is most likely to occur in the first few years after construction, and then increases again over time due to the aging of the structure. The aging of dams and the associated increase in the risk of catastrophes is starting to be a serious problem around the world. This also applies to Poland, where more than half of the existing dams are over 50 years old, and the financial resources for their proper maintenance are systematically decreasing.

Dam disaster is defined by the International Commission on Large Dams (ICOLD) **as the collapse or displacement of a part of a dam or its subsoil, as a result of which the structure cannot hold water.** This is generally associated with significantly increased runoff posing a threat to life and property in the river valley below the dam.



Vaiont dam (ITA) – 1963 (1917 death people)
Malpasset dam (FRA) – 1959 (423 death people)
Teton dam (USA) – 1976 (11 death people)

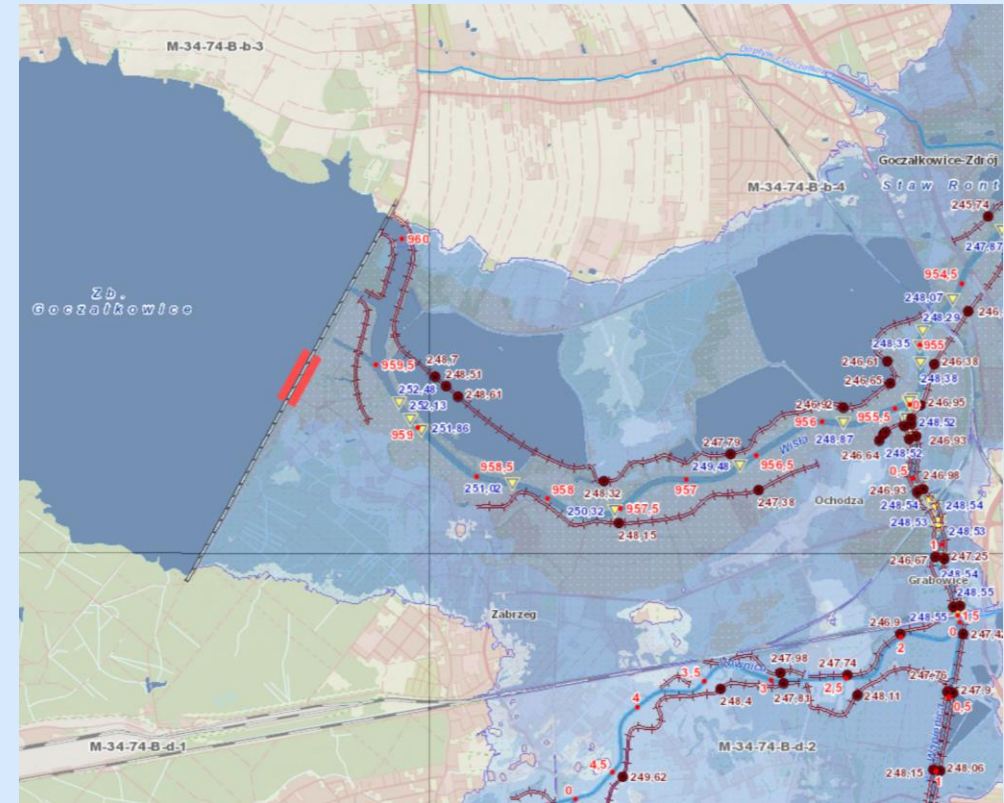


Directive 2007/60/EC of the European Parliament and of the Council on flood risk assessment and management (Flood Directive) entered into force on November 27, 2007. This Directive obliged the Member States to develop:

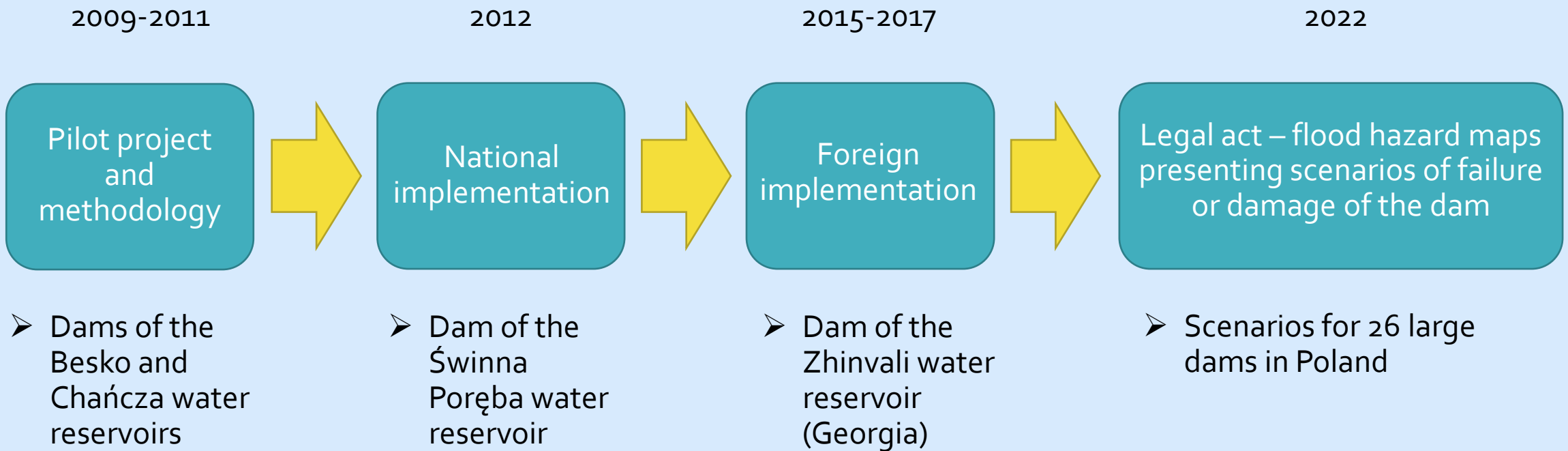
- preliminary flood risk assessment
- flood hazard maps and flood risk maps
- flood risk management plans

The dam disaster generates a high flood risk and is included to an extreme event. Therefore, its possible consequences should be taken into account at the stage of developing flood hazard maps.

Article 88d sec. 2 p. 3c of the Polish Water Law Act: *"flood hazard maps present in particular areas covering areas at risk of flooding in the event of destruction or damage of the dam structures"*.



Mapping of flood hazards caused by dam disasters – chronology of actions in Poland





Project PLo456 "Flood hazards resulting from dam disaster"

The project was implemented thanks to the support provided by Norway through co-financing from the Norwegian Financial Mechanism.

Project budget:

- EUR 434,746 – costs of the entire Project
- EUR 369,534 – co-financing from the Norwegian Financial Mechanism

Implementation of the project:

- July 2009 – April 2011

Project participants:

- Regional Water Management Board in Krakow
- Institute of Meteorology and Water Management

The main objective of the Project was to determine the flood hazard zones in the valleys of the Czarna Staszowska and Wisłok rivers, created as a result of hypothetical dam disaster of the Chańcza and Besko water reservoirs.

The scope of the project included:

- development of dam disaster scenarios
- calculation of the speed of the flood wave
- determination of the time of arrival of the wave to specified places in river valleys
- determination of the water depth in the flooded zone
- identifying endangered facilities and infrastructure

Based on the experience gained from the implementation of the Project, a methodology for analyzing flood hazards caused by dam disasters was developed.

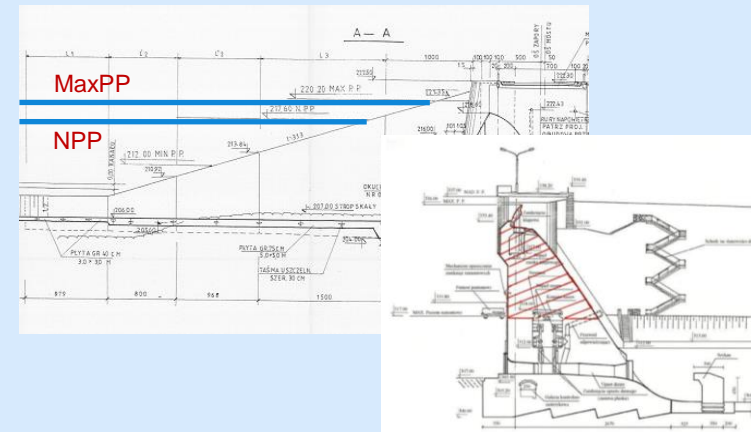
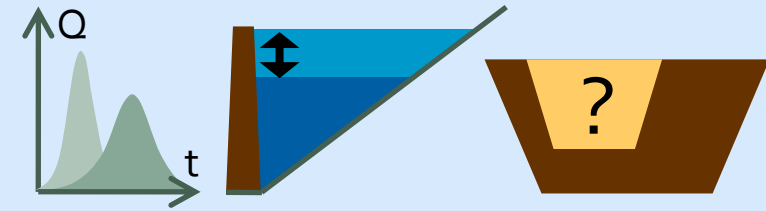


According to the data of the International Commission of Large Dams (ICOLD), the main causes of earth dam disasters are the overflow of water through the dam crest and internal erosion of the dam body. The main cause of disasters in the case of concrete dams are foundation problems (i.e. internal erosion of the subsoil and too low shear stress resistance of the soil).

- In the case of the earth dam (Chańcza), scenarios connected with the dam body disaster as a result of water overflowing the dam crest or hydraulic failure were analyzed
- In the case of the concrete dam (Besko), scenarios connected with damage to individual concrete sections, caused by failure of the subsoil, were analyzed

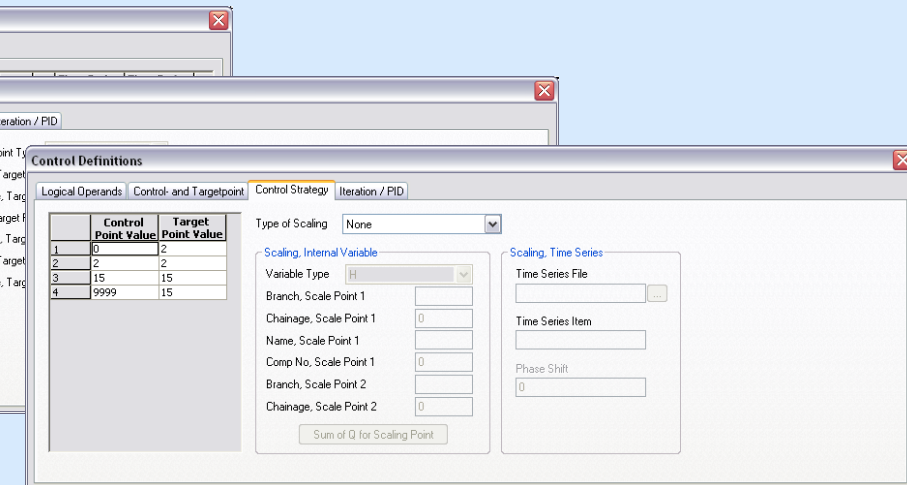
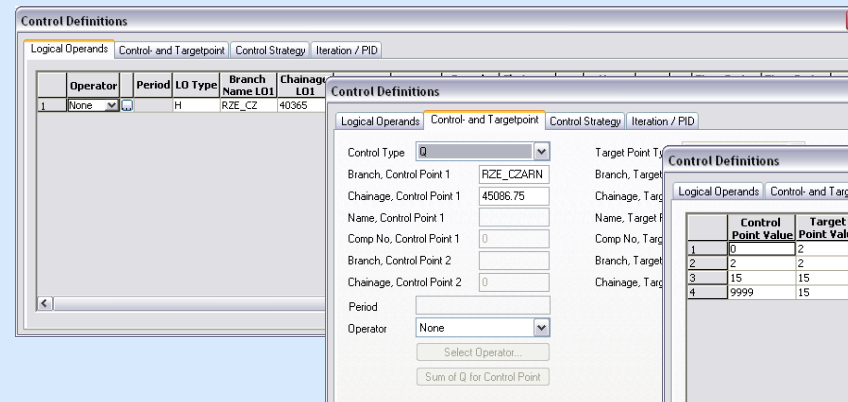
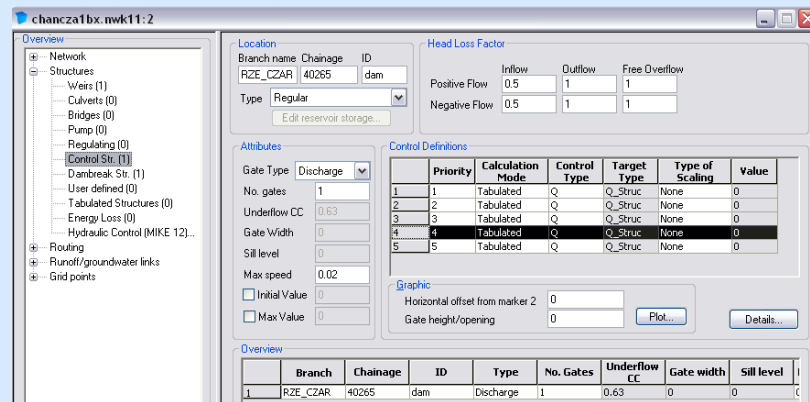
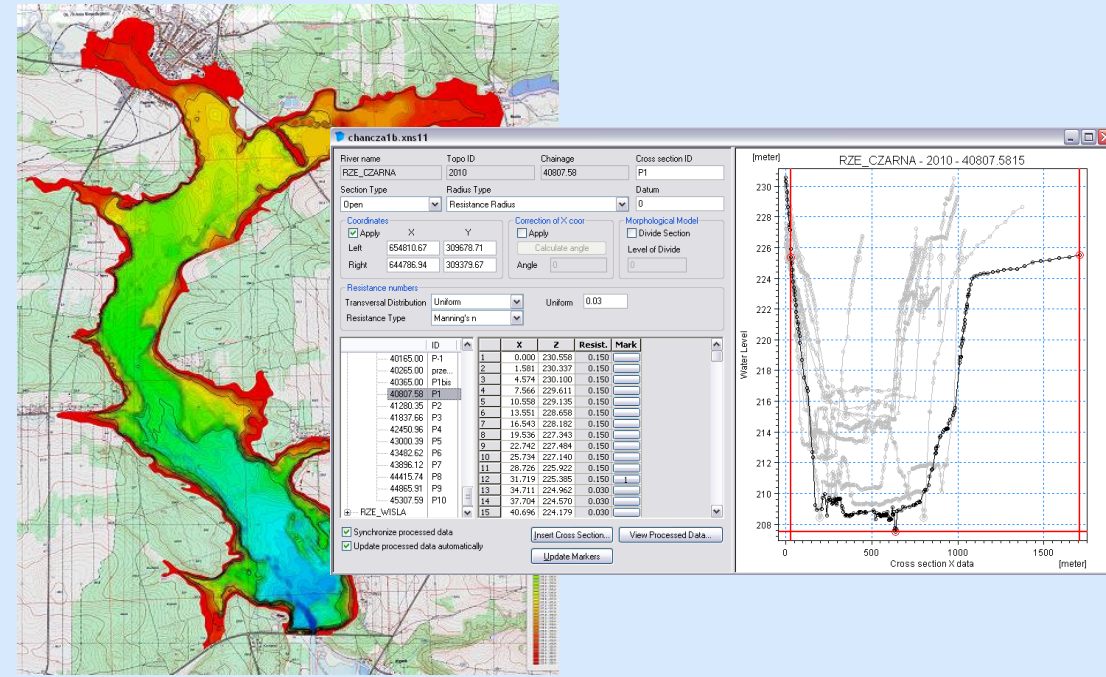
Additionally the following factors were assumed:

- ✓ hydrological conditions in the basin of the reservoir
- ✓ volume of water in the reservoir at the time of disaster
- ✓ shape, size and location of the damage (breach) in the dam body
- ✓ principles of controlling the outflow from the reservoir in flood conditions
- ✓ synchronization of the time of the culmination of the inflow to the reservoir with the time of the beginning of the disaster



Mathematical calculations for each scenario were made in the hydraulic model developed in the DHI MIKE11 tool.

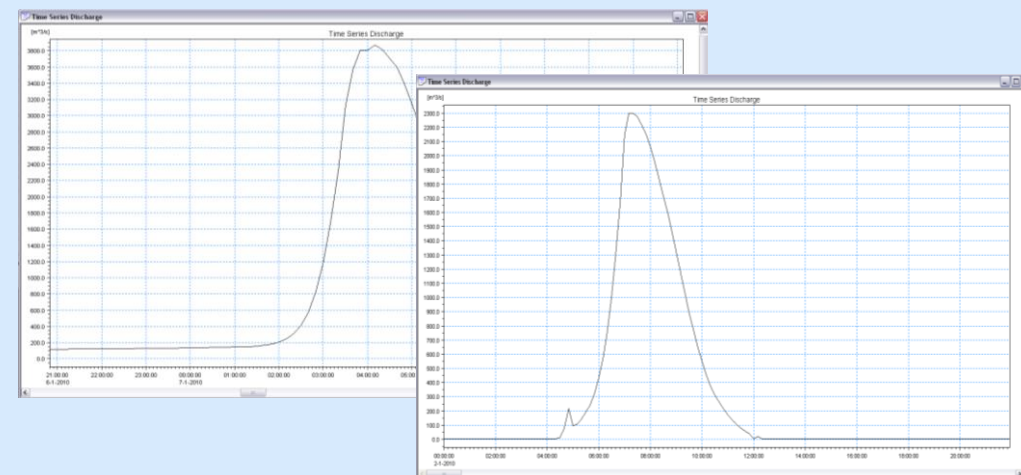
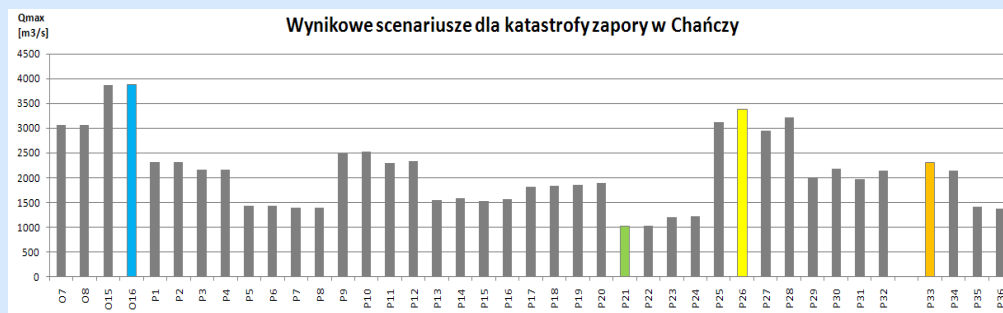
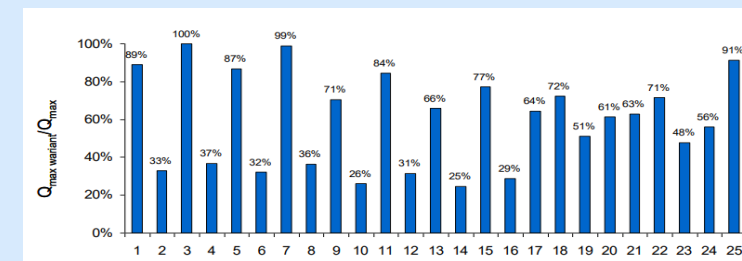
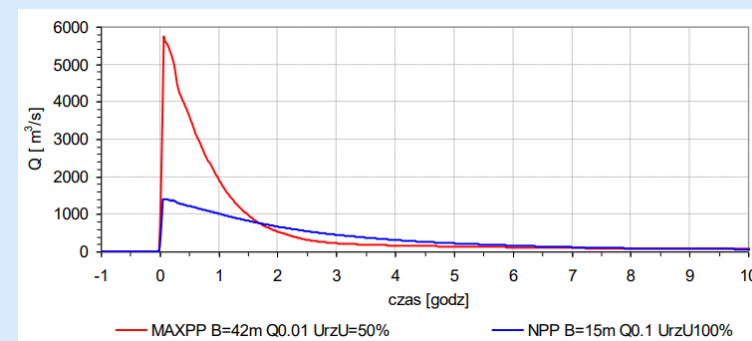
The shape of the reservoir lake was implemented in the models based on bathymetric measurements. The geometry of the dam body and spillway-outlet sections was mapped. In the models, empirical formulas were used to simulate dam crest failure. Moreover the principles of outflow control were implemented in the models in accordance with the actual Water Management Instructions for each reservoir.



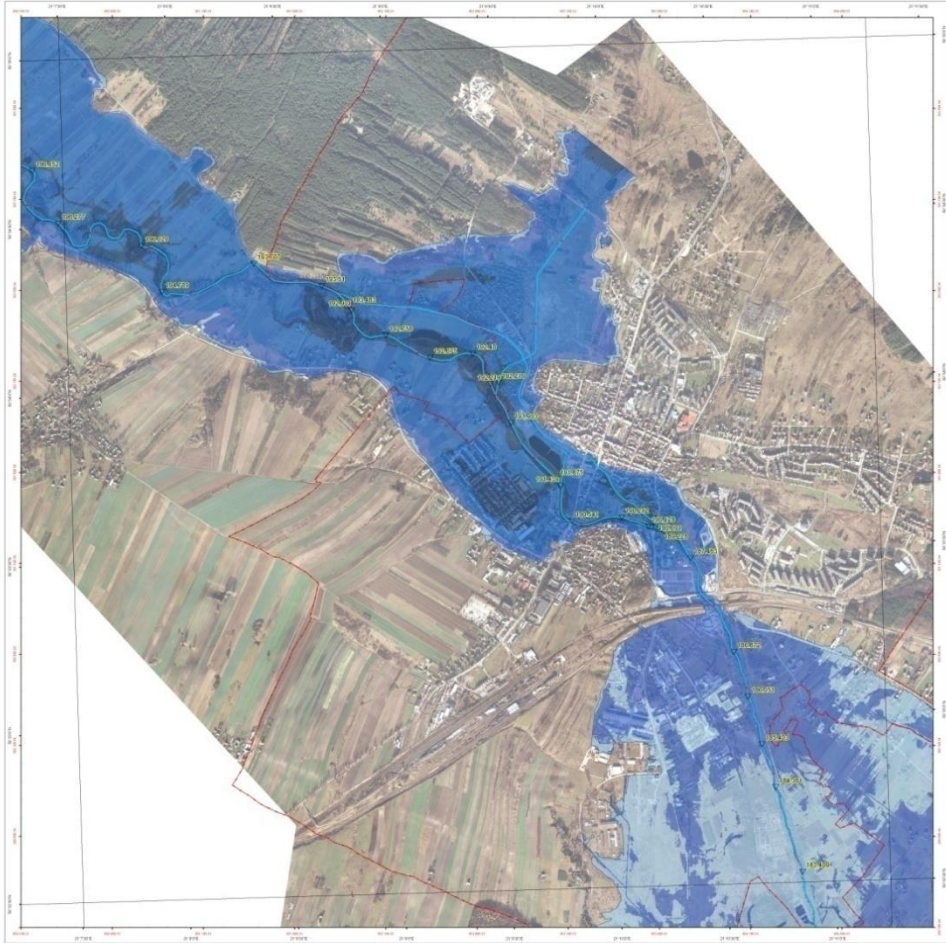
As a result of model calculations, a total of 72 scenarios for the earth dam in Chańcza and 25 scenarios for the concrete dam in Besko were obtained.

For each of the dams, a hydraulic model of the valley below was developed, based on which flood zones with water depths were generated for the most representative scenarios.

Based on the results of hydraulic modeling, maps showing the time of arrival of the flood wave front to specific places in the valley below the dam were also elaborated.



Zagrożenie Powodziowe Powstałe w Wyniku Katastrofy Zapory Zbiornika Wodnego w Chańcicy
Rzeka Czarna Staszowska, M-34-55-A-d-1 - STASZÓW

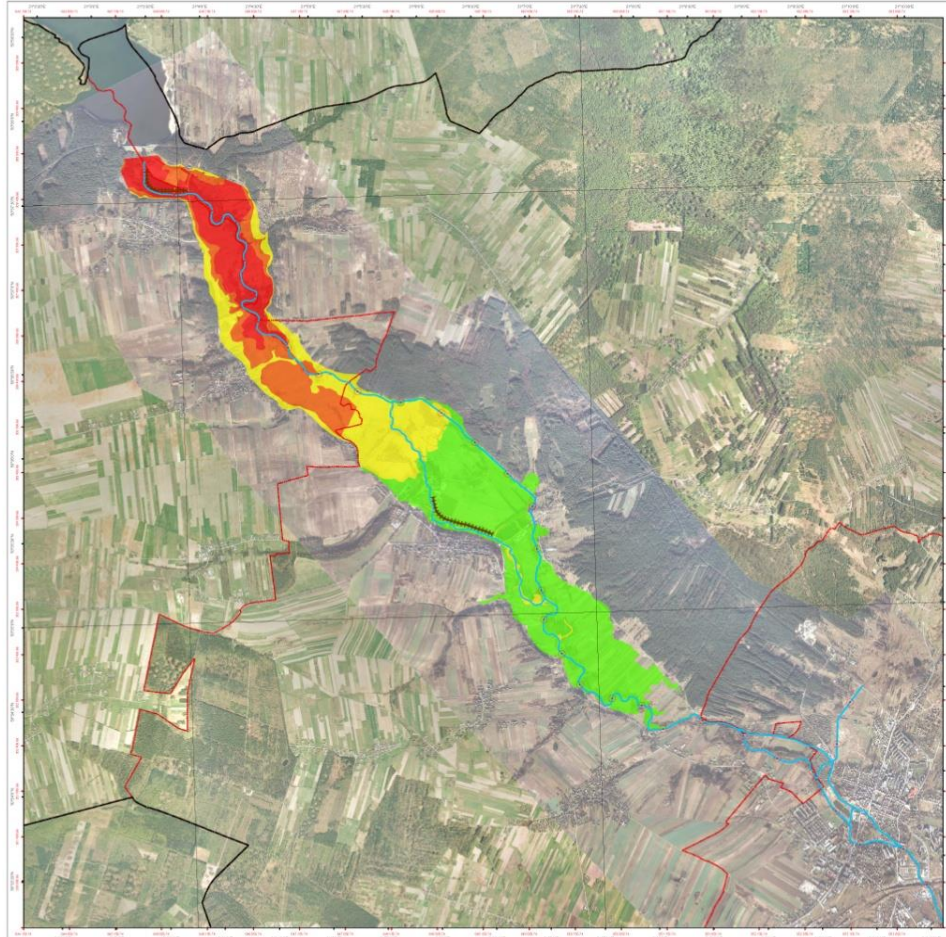


Wzrostki projektowe w skali 1:5000 Wzrostki prognozy i plany w skali 1:50000 Skala GRS-01: poziom odniesienia Rzeczni 86

Kraków, 31-03-2011

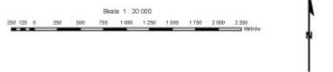


Propagacja Fali Powstałej w Wyniku Katastrofy Zapory Zbiornika Wodnego w Chańcicy
Strefy zalewu po 30 minutach, 1 godzinie, 2 godzinach i 3 godzinach od momentu katastrofy zapory Chańcicy; Scenariusz – PIP_Qbiol_maxPP_centra_208; dopływ do zbiornika – Qbiol; Hzbiornik – MaxPP; uszkodzenie – środek prawego korpusu; rzędna przebiecia – 208 m n.p.m.

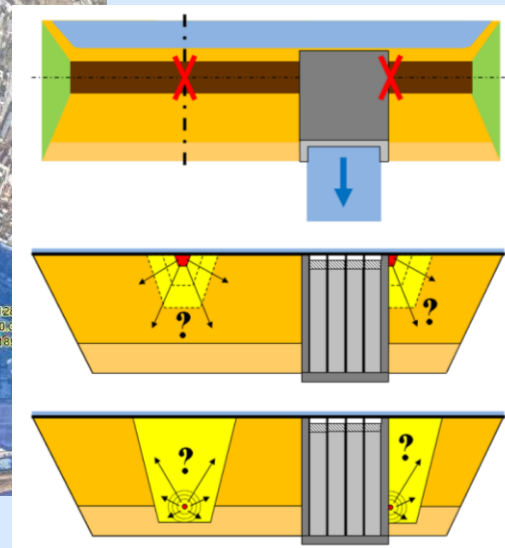
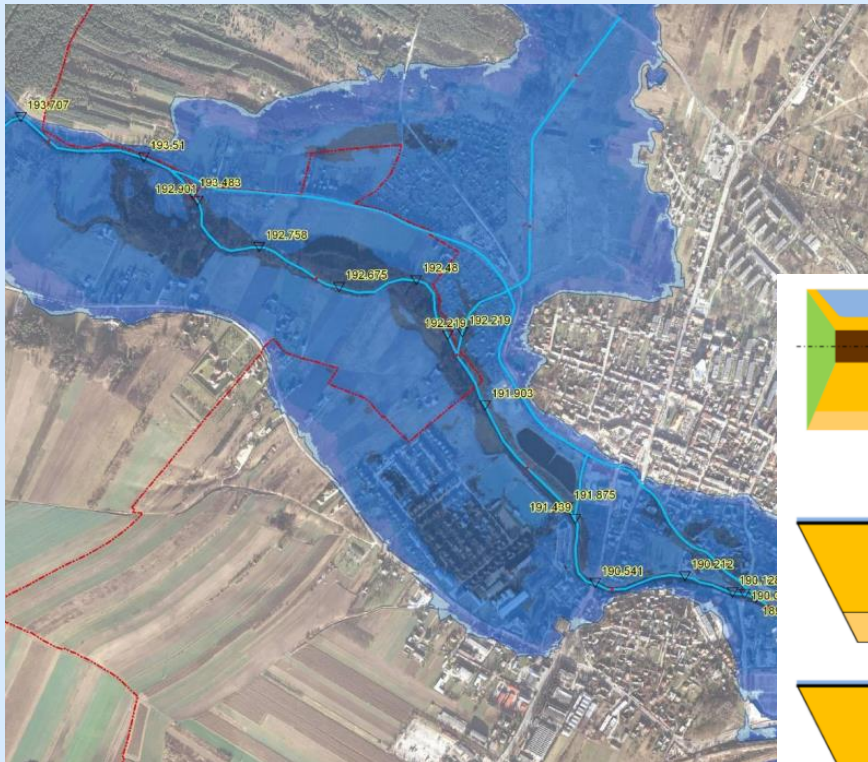



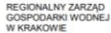

Wzrostki projektowe w skali 1:5000 Wzrostki prognozy i plany w skali 1:50000 Skala GRS-01: poziom odniesienia Rzeczni 86

Kraków, 31-03-2011




According to the assumption, as one of the key results of the Project, the "Methodology for the analysis of flood hazards caused by disasters of dams over 15 m high" was developed.



Wsparcie udzielone przez Norwegię
 poprzez dofinansowanie
 ze środków Norweskiego
 Mechanizmu Finansowego

INSTYTUT METEOROLOGII
 I GOSPODARKI WODNEJ
 

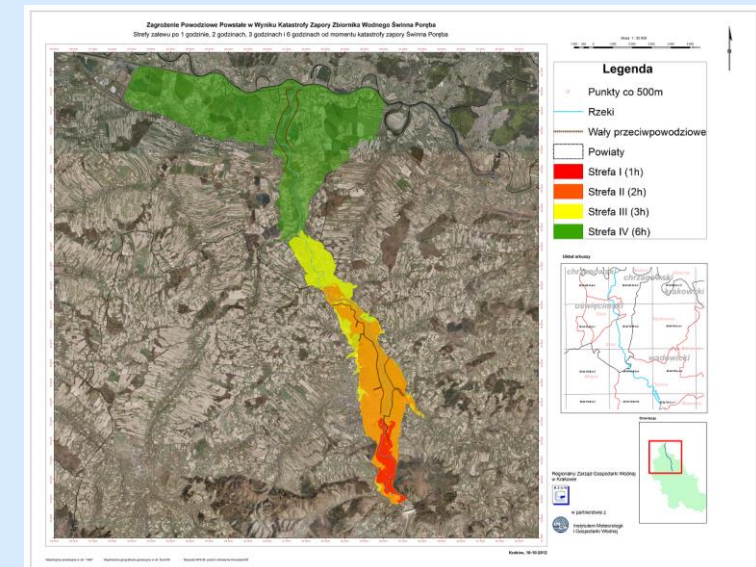
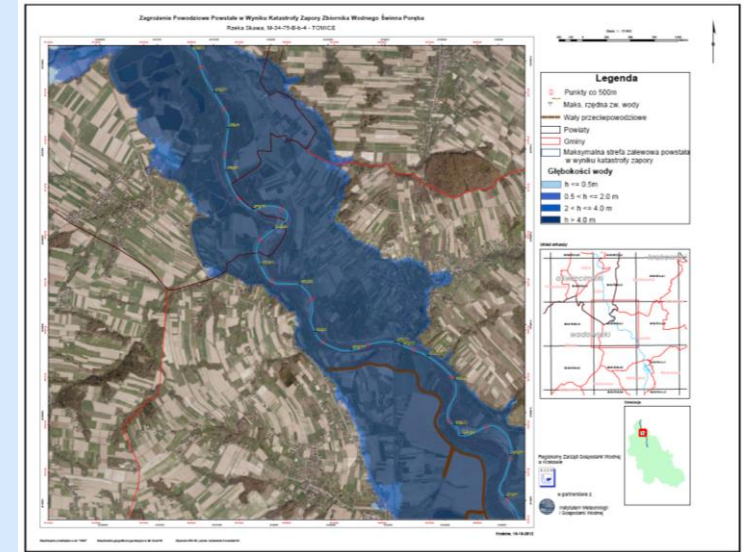
**"Metodyka analizy zagrożeń powodziowych
 spowodowanych katastrofami zapór
 o wysokości $H \geq 15m$ "**

*Projekt PL0456
 „Zagrożenia powodziowe powstałe w wyniku katastrof budowli piętrzących”*

Kraków, marzec 2011 r.

Based on the results of the Project, in 2012 a national implementation was carried out on the Świnna Poręba water reservoir, where 20 disaster scenarios were developed for the earth dam of the reservoir.

During the calculations, the reservoir was in the final phase of filling process. The reservoir was officially put into operation in July 2017.



Project implemented in 2015-2017 by the Polish Center for International Aid (Grant within Polish Aid - Development cooperation programme of Ministry of Foreign Affairs of Poland in 2015, 2016, 2017):

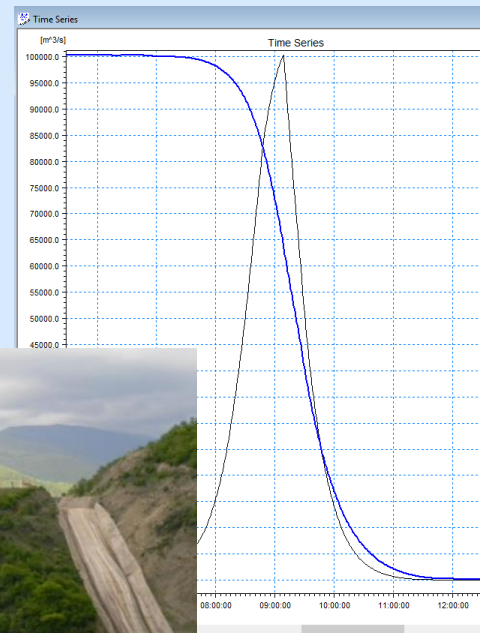
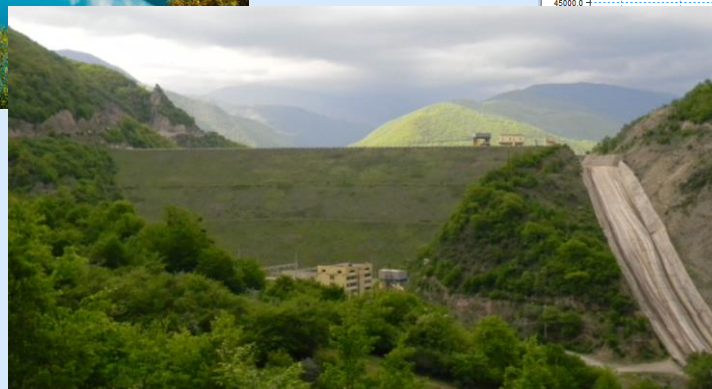
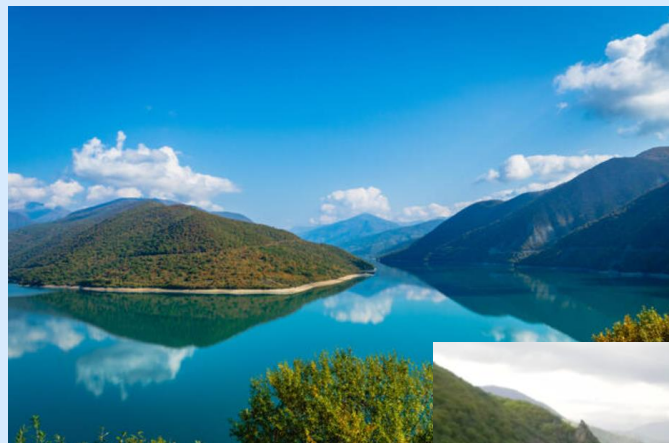
- 1st step: " Learning of hydraulic modeling against floods - preparation for the implementation of the EU Directive 2007/60/EC „
- 2nd step: "Learning of hydraulic modeling against floods - support for the competence and readiness of Georgian institutions "
- ✓ Hydraulic and hydrological modeling study, technical support & equipment
- ✓ Beneficiary: National Environmental Agency, Tbilisi
- ✓ Polish experience transfer: RZGW Cracow, CBK PAN, MGGP SA, individual experts,
- ✓ 3 - phase study, step by step, self - performing, importance of real knowledge transfer



As part of the Project (as one of the activities) scenarios of the disaster of the earth dam of the Zhinvali water reservoir on the Aragvi River were developed.



The Aragvi River is a direct tributary of the Mtkvari River on which the capital of Georgia - Tbilisi is located.



Based on the presented activities undertaken by the RZGW in Krakow over the recent years and the developed methodological assumptions, in 2022 the National Water Management Board developed and presented on the ISOK portal flood hazard maps developed for 26 large dams in Poland.

It can be assumed that it is a summary and culmination of the entire cycle of preparations for the presentation of flood hazard scenarios resulting from dam disasters, which the RZGW in Krakow started on this topic nearly 15 years ago.

ISOK Informacyjny System Ochrony Kraju

Strona główna / Hydroportal

Hydroportal

Hydroportal to publiczny portal dotyczący szeroko pojętej tematyki wodnej na terenie Polski. Umożliwia przegląd danych dotyczących ryzyka powodziowego, przeciwdziałania suszy czy prezentujący plany gospodarowania wodami. Zawiera szereg danych zebranych w jednym miejscu.

Portal publiczny

- Wstępna ocena ryzyka powodziowego (WORP)
- Mapy zagrożenia powodziowego
- Mapy ryzyka powodziowego
- Plany gospodarowania wodami
- Plany zarządzaniem ryzykiem powodziowym
- Plany przeciwdziałania skutkom suszy
- Krajowy Program Oczyszczania Ścieków Komunalnych
- System informacyjny gospodarowania wodami (SIGW)
- Hydroportal MZP i MRP w formie pdf

Fundusze Europejskie
Ministerstwo Środowiska

Unia Europejska
Europejski Fundusz Regionalny

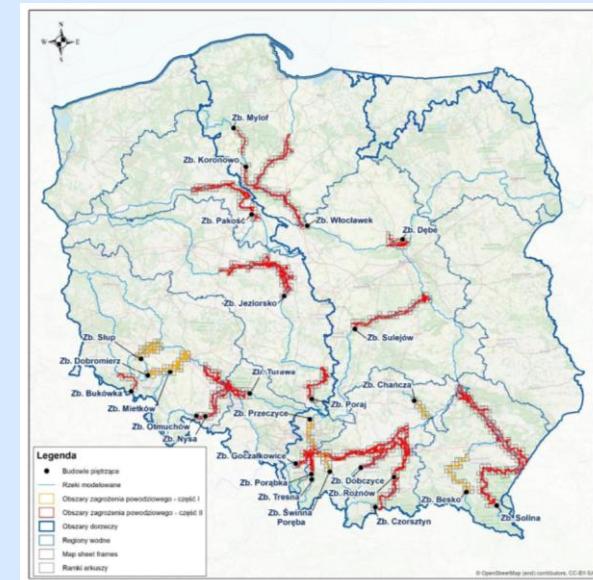
Projekt współfinansowany przez Unię Europejską w ramach Europejskiego Funduszu Regionalnego

RAPORT Z WYKONANIA PRZEGLĄDU I AKTUALIZACJI MAP ZAGROŻENIA POWODZIOWEGO I MAP RYZYKA POWODZIOWEGO

ZAŁĄCZNIK NR 10

RAPORT Z WYKONANIA MZP I MRP DLA OBSZARÓW NARAŻONYCH NA ZALANIE W PRZYPADKU ZNISZCZENIA LUB USZKODZENIA BUDOWLI PIĘTRZĄCYCH

Warszawa, 2022





Thank you for your attention

Michał Piórecki

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