FLOOD HAZARD MAPS AND FLOOD RISK MAPS

Fundusze Europejskie
Infrastruktura i Środowisko

State Water Holding Polish Waters

Unia Europejska
Fundusz Spójności

LEGAL BASES

Flood hazard maps (FHMs) and flood risk maps (FRMs) are planning documents that must be developed under Directive 2007/60/EC of the European Parliament and of the Council of 23 October 2007 on the assessment and management of flood risk (Floods Directive). Maps shall be reviewed, and if necessary updated, every six years.

In Poland, FHMs and FRMs are prepared on the basis of the Act of 20 July 2017 - Water Law and the Regulation of the Minister of Maritime Economy and Inland Navigation of 4 October 2018 on the development of flood hazard maps and flood risk maps. The State Water Holding Polish Waters is responsible for the preparation of FHMs and FRMs projects. Maps concerning sea waters, including internal maritime waters, are prepared by the directors of maritime offices. The minister responsible for water management authorizes FHMs and FRMs and submits them to the authorities specified in the Water Law.

OBJECTIVES OF THE FLOOD DIRECTIVE

The purpose of the Floods Directive is to reduce the adverse consequences for human health and life, the environment, cultural heritage and economic activity associated with floods. Flood hazard and risk assessments are required for appropriate risk management and planning flood prevention measures. For this purpose, a preliminary flood risk assessment (PFRA) is prepared, which determines the areas of potential significant flood risk. Next, for these areas flood hazard maps and flood risk maps are prepared. They constitute the basis for the development of flood risk management plans, including a sets of technical and non-technical measures, which aim to reduce the adverse consequences of flooding.

The Floods Directive requires address all aspects of flood risk management focusing on prevention, protection, preparedness and public information. Knowledge about flood hazard and flood risk is extremely important, as it contributes to the proper spatial planning and development, thus reduction of the adverse consequences of flooding. Flood hazard areas presented on FHMs are taken into account in spatial planning. As a result, residents and local authorities can make informed and responsible decisions concerning the location of investments.

DEFINITIONS

- **FLOOD** - the temporary covering by water of land not normally covered by water, in particular caused by rivers, reservoirs, canals and the sea, excluding floods from sewerage systems.

- **AREAS OF POTENTIAL SIGNIFICANT FLOOD RISK** - areas indicated in the preliminary flood risk assessment for which the potential significant flood risk exist or is likely to occur.

- **FLOOD HAZARD AREAS** - areas which could be flooded with a certain probability or as a result of an extreme event, presented on flood hazard maps.

- **SPECIAL FLOOD HAZARD AREAS** are:
  - areas where the probability of flooding is medium (1%),
  - areas where the probability of flooding is high (10%),
  - areas between the shoreline and the embankment or natural high bank with built-in flood embankments, as well as islands and alluvials, which constitute cadastral parcels,
  - technical belt of the seashore which forms the zone of mutual direct influence of the sea and the land.

FLOOD HAZARD

- the possibility of flooding with a certain probability on a given area.

FLOOD RISK

- the combination of the probability of a flood event and of the potential adverse consequences for human health and life, the environment, cultural heritage and economic activity.

AREAS AND TYPES OF FLOODS FOR WHICH MAPS ARE PREPARED

Flood hazard maps are prepared for the areas and types of floods identified in the preliminary flood risk assessment.

As a result of the update and review of PFRA (2018), areas of potential significant flood risk and types of floods presented below, have been identified.

FLUVIAL FLOOD

Flooding of land by water originating from rivers, streams, mountain streams, canals, lakes, including floods arising from melting snow.

NATURAL EXCEEDANCE SCENARIO

EMBANKMENT FAILURE SCENARIO

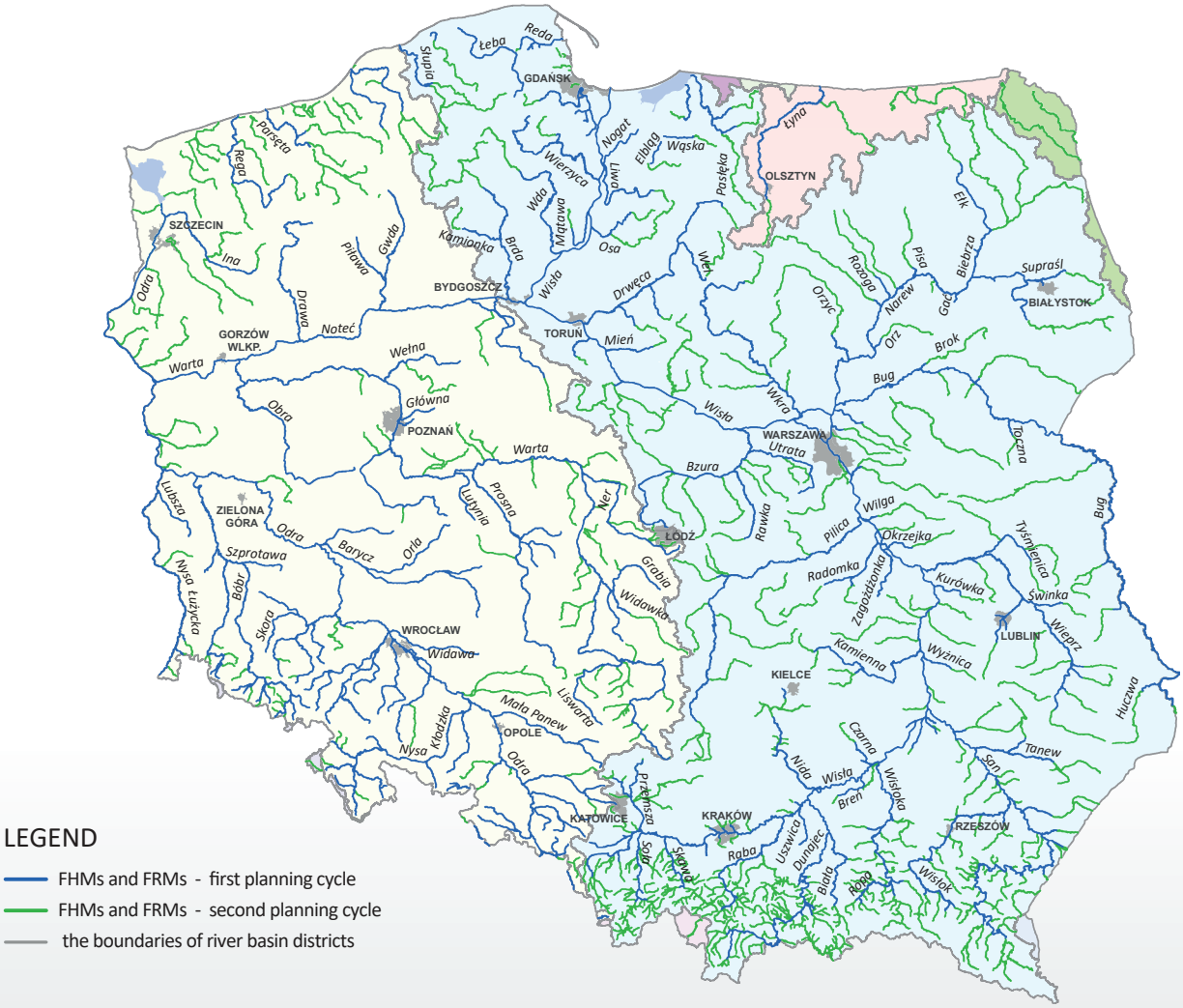
SEA WATER FLOOD

Flooding of land by water from the sea, the estuaries and coastal lakes (natural exceedance scenario and embankment failure scenario).

FLOOD CAUSED BY HYDROTECHNICAL STRUCTURES

Flooding of land by water arising from the failure of dams.

SCOPE OF FLOOD HAZARD MAPS AND FLOOD RISK MAPS



LEGEND

- FHMs and FRMs - first planning cycle
- FHMs and FRMs - second planning cycle
- the boundaries of river basin districts

In the first planning cycle (2010-2015), FHMs and FRMs were prepared for about 14 400 km of rivers. As a result of the review and update of the preliminary flood risk assessment prepared in 2018, an additional rivers were indicated as areas of potential significant flood risk. New FHMs and FRMs are prepared for about 14 500 km of rivers in the second planning cycle.

In total FHMs and FRMs are prepared in Poland for about 29 000 km of rivers. FHMs and FRMs from the sea cover the entire Polish coast.

In 2018 maps, developed in the first planning cycle, were reviewed in order to identify significant changes in flood risk and flood hazard and indicate the maps to be updated.

The following factors were taken into account:

- flood protection investments and other causing changes in flood risk,
- methodological assumptions changes,
- verification of input data used in the first planning cycle,
- comments of administrative authorities reportedin the first planning cycle.

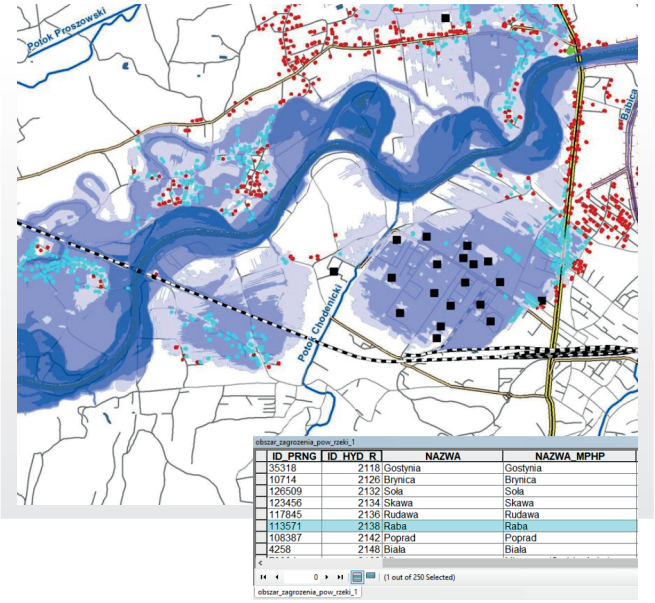
FORMAT OF FHMs AND FRMs

FHMs and FRMs are prepared in electronic form including the spatial database and cartographic version.

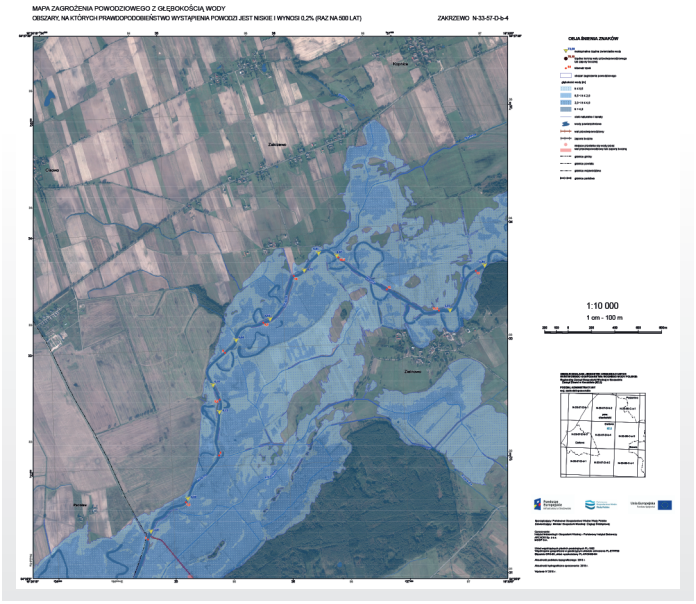
The spatial database includes vector layers in the shapefile, based on which spatial analyses can be carried out.

Cartographic version of the maps are available in two raster files: pdf and geotiff in the scale 1:10 000.

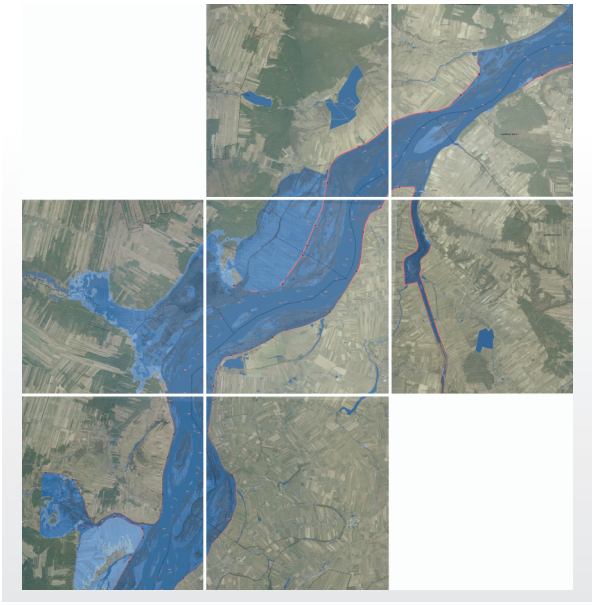
A detailed description of the maps is included in the "Methodology of FHMs and FRMs in the second planning cycle" available at: www.powodz.gov.pl.



Spatial database



PDF format
complete map with legend



Geotiff format
map with spatial reference

FHMs AND FRMs PUBLICATION

According to the Water Law, the minister responsible for water management makes FHMs and FRMs public by placing them on the Public Information Bulletin website:
https://gospodarkamorska.bip.gov.pl/mapy-zagrozenia-powodziowego-i-mapy-ryzyka-powodziowego/

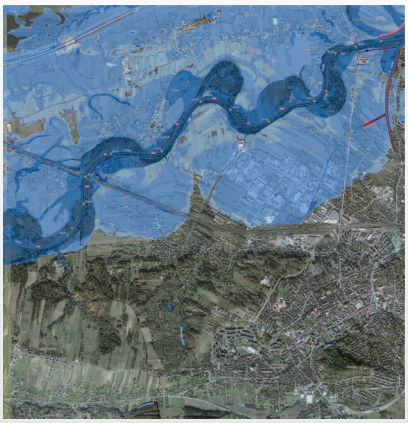
Cartographic version in PDF are available at: **http://mapy.isok.gov.pl**
FHMs and FRMs are available at map portal: **https://isok.gov.pl/hydroportal.html**

FLOOD HAZARD MAPS

THE FOLLOWING SCENARIOS ARE PRESENTED ON FLOOD HAZARD MAPS

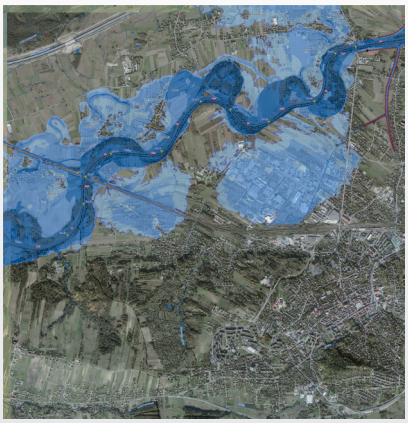
SCENARIO 1

areas where the probability of flooding is low, which corresponds to 0.2 % (once per 500 years)



SCENARIO 2

areas where the probability of flooding is medium, which corresponds to 1% (once per 100 years)



SCENARIO 3

areas where the probability of flooding is high, which corresponds to 10% (once per 10 years)

SCENARIO 4

areas exposed to flooding in the event of the flood embankment failure - estimated for the flow with the 1% probability of occurrence

SCENARIO 5

areas exposed to flooding in the event of the dam failure

FHMs do not show the historical floods extent, but present areas with a certain probability of flooding. To determine flood hazard areas, the maximum flow with a given probability of occurrence is used (calculated on the basis of maximum annual flows from the period of at least 30 years).

The 1% probability of flooding means that statistically such a flood may occur once every 100 years. However, it should be noted that this is a statistical value and does not mean that flooding with the probability of 1% occurs at 100 years intervals.

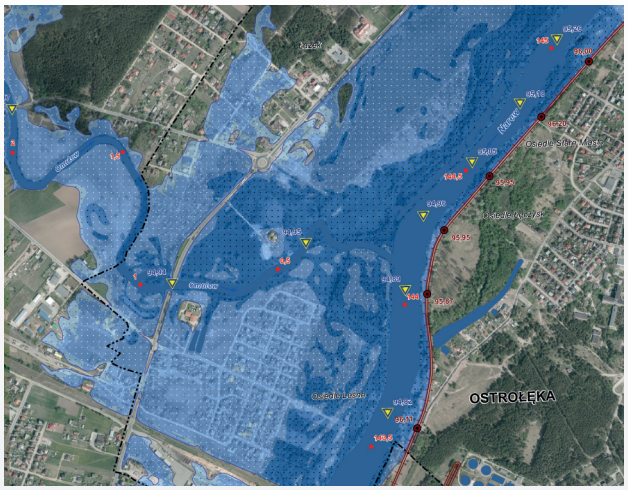
In fact, every year there is a possibility of 1:100 occurrence of at least one flood. In the Kłodzko Valley catastrophic floods occurred in 1997 and 1998. In the summer of 2010, in the Carpathian Mountains, one hundred year flood happened twice, and in addition two smaller floods.

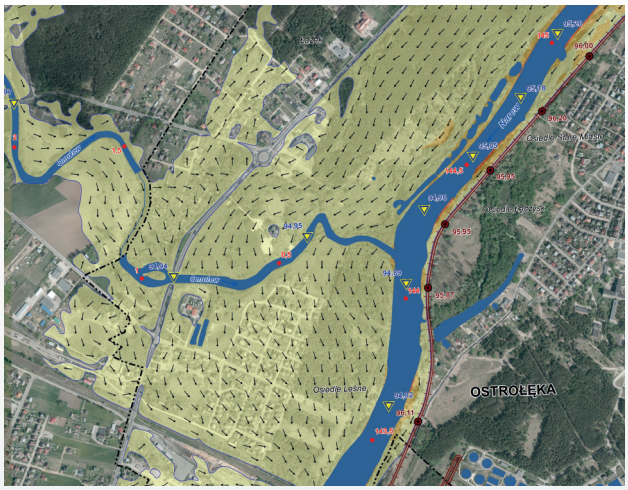
For flood hazard areas (shown on FHMs) the water depth, the flow velocity and direction of water flow (for cities with poviat rights) are presented at intervals determining the degree of threat to people and the way of impact on constructions. In addition, maximum water levels and embankment elevations are presented.

Cartographic version is prepared separately for each scenario
in two sets:

FLOOD HAZARD MAPS
with water depths

FLOOD HAZARD MAPS
with flow velocity





WATER DEPTHS

≤ 0,5 m
low hazard to people and buildings

0,5-2 m
medium hazard to people (possibility of evacuation to upper floors of buildings), but high damages

2-4 m
high hazard to people and very high damages

> 4 m
very high hazard to people and very high or total damages

FLOW VELOCITY

≤ 0,5 m/s
low velocity; water has a small impact on buildings

0,5-1 m/s
medium velocity; water has a moderate impact on buildings, is a threat to people

1-2 m/s
high velocity; water has a big impact on buildings, is a serious threat to people

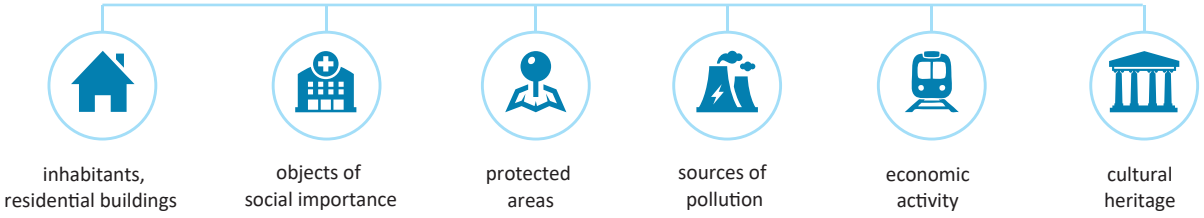
> 2 m/s
very high velocity; water has a very big impact on buildings, may damage structures of static objects, is a very serious threat to people

FLOOD RISK MAPS

Flood risk maps show the potential adverse consequences of flooding for human health and life, the environment, cultural heritage and economic activity.

Flood risk maps present objects important from the point of view of flood protection and information necessary to assess flood risk and potential consequences of flooding.

EXPOSED ELEMENTS



The adverse consequences for **human health and life** are presented by showing the estimated number of inhabitants potentially affected, residential buildings and objects of social importance, as well as the depth of water determining the degree of threat to the population.

FRMs present **protected areas** (including: surface and groundwater abstractions, abstractions protection areas, bathing waters, national parks, nature reserves, Natura 2000 areas), **objects which may cause significant pollution in the case of flooding** (including industrial plants that require an integrated permit, plants may cause major industrial accident hazards), as well as other potential sources of water pollution (including wastewater treatment plants and wastewater pumping stations, landfills, cemeteries).

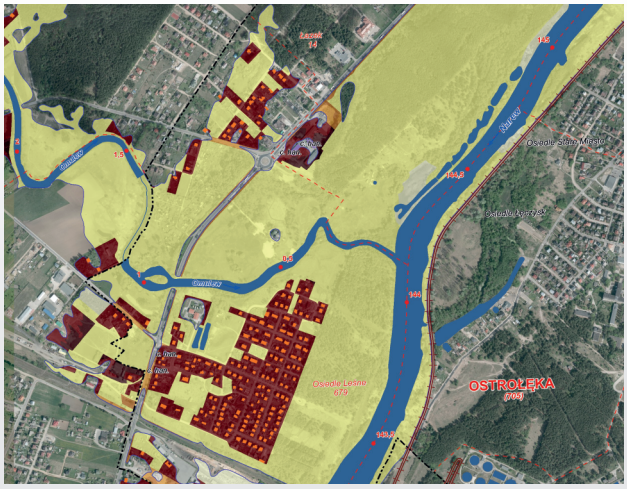
The types of **economic activity** are defined by land use classes: residential areas, industrial areas, transportation areas, recreational areas, as well as forests, arable lands, grassland, surface waters and other areas.

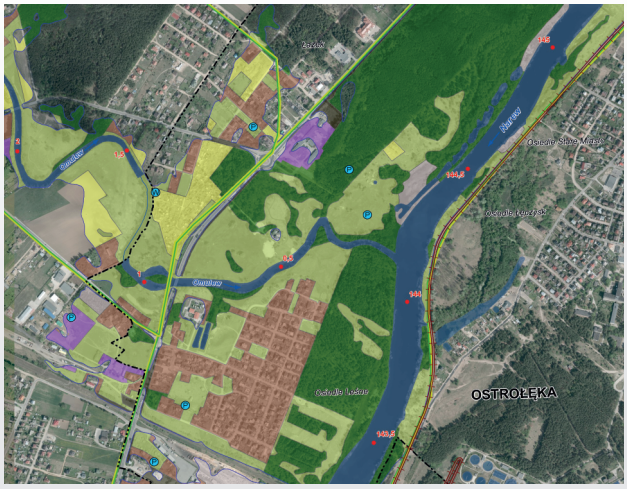
FRMs also include **areas and objects of cultural heritage** such as immovable monuments, museums, open-air museums, libraries, archives, extermination monuments, UNESCO World Heritage Sites.

Input data used to develop FRMs have been obtained from institutions responsible for thematic data.

Cartographic version is prepared separately for each scenario in two sets:

- **FLOOD RISK MAP** - potential adverse consequences for human health and life and the values of potential flood damages
- **FLOOD RISK MAP** - potential adverse consequences for the environment, cultural heritage and economic activity





PROCESS OF DETERMINING FLOOD HAZARD AREAS

Determination of flood hazard areas (FHAs) presented on FHMs is a very complex process. It requires the use of a various data: geodetic, topographic, photogrammetric, hydrological and other. The accuracy of FHMs is determined by quality and validity of data. The acquisition and preparation of this data is very expensive and time-consuming.

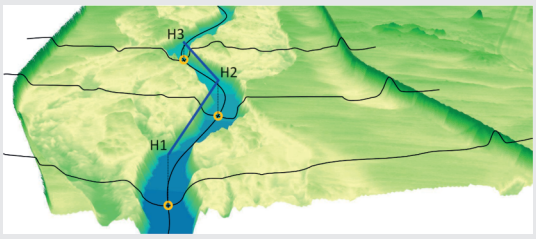
Flood hazard areas are determined using geographic information systems (GIS), on the basis of water surface elevation calculated using the hydraulic model. The development of the model requires the use of specialized software and is based on a schematic representation of reality allowing for the simulation of flooding.

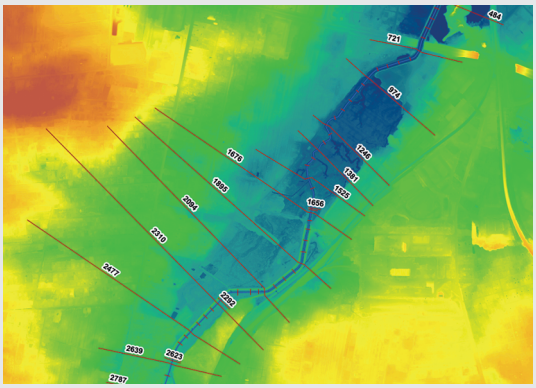
Hydraulic modelling is carried out for a catchment area, taking into account the impact of the associated river network. The changes made in the upper part of the catchment affect the areas situated downstream.

The digital terrain model (DTM) and the digital land cover model are used to determine flood hazard areas. DTM comes from airborne laser scanning (LIDAR), with the vertical accuracy of < 20 cm and spatial resolution of 1 m.

The stages of determining flood hazard areas are presented below.

STAGE 1 DEVELOPMENT OF THE MODEL



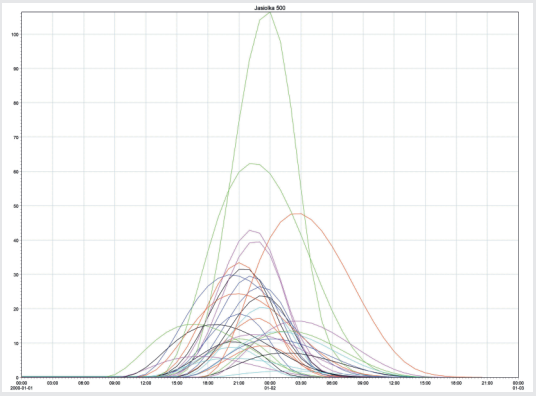


The first step in the model development is a schematic representation of the river network based on DTM and ortophotomaps. The model also takes into account river tributaries and their impact on the flood water flow. The river valley is represented by the valley cross-sections, covering the main river and floodplains. Sections are based on the result of geodetic surveys (for the river) and DTM analysis of floodplains.

In the next step all bridges and hydraulic structures relevant for the flood water flow are taken into account. The model also includes reservoirs, which allows representing flood water flows reduction as a result of water management.

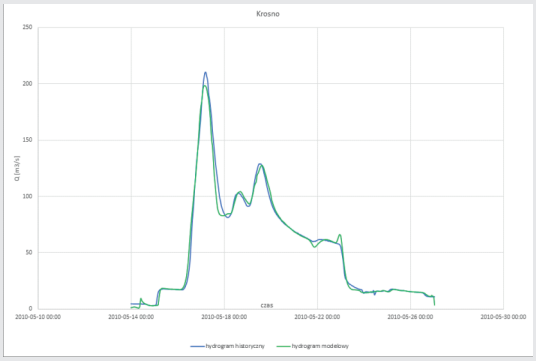
In case of a two-dimensional model, the river valley is represented using a digital terrain model.

STAGE 2 BOUNDARY CONDITIONS



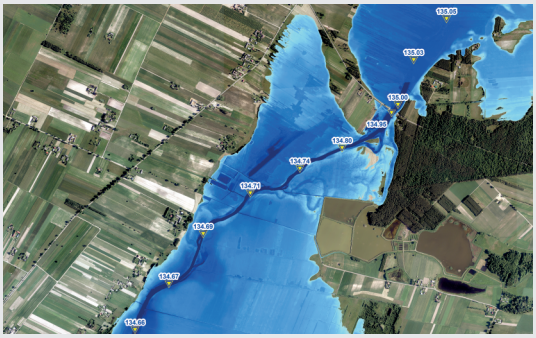
After developing the river network with all engineering structures, hypothetical floods are introduced to the model. This information is based on a peak flows for a given probability of occurrence, determined by methods commonly used in hydrology, based on historical data from at least 30 years.

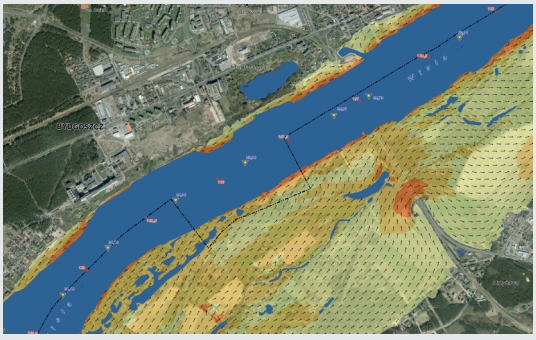
STAGE 3 CALIBRATION AND VERIFICATION



The hydraulic model is assessed in the process of calibration and verification. The results of modelling are compared with the results of observations of selected historical floods.

STAGE 4 MODEL CALCULATION AND DETERMINATION OF FHAs





The introduction of hydrological information into the model allows for calculations and simulation of the flood course.

The following modelling methods are used:

- **one-dimensional modelling (1D)** – results in the form of maximum water level in cross-sections,
- **two-dimensional modelling (2D)** – results in the form of a numerical model of the water surface and flow velocity rasters,
- **hybrid modelling (1D/2D)** – a combination of one-dimensional modelling for watercourses and two-dimensional modelling for floodplains.

The maximum water level obtained as a result of modelling are the basis for the establishment of flood hazard area using the digital terrain model.

State Water
Holding
Polish Waters

State Water Holding Polish Waters

80/82 Grzybowska Street
00-844 Warszawa

ePUAP Box: KZGW/SkrytkaESP

e-mail: mapy@wody.gov.pl

www.powodz.gov.pl

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