

PLANNED RESEARCH DESCRIPTION AND METHODICS OF THE IMPACT OF BUILDINGS IN A FLOOD PLAIN AREA DURING FLOODS

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Abstract: This contribution presents a description and a methodology of planned future research, which will deal with the impact of buildings during floods. For the area of interest was selected part of the watercourse Jevíčko basin around town Jevíčko. There is an industrial complex of REHAU Company in the town, which is planned to be expanded. The processing will be done using the modelling program FLO-2D and 1D HEC-RAS to determine how the complex will be affected by flood flows. Then will be proposed measures to enhance the protection of people and property will be proposed and these options will be compared with each other.

Key Words: flood, basin, active zone, model, property protection

INTRODUCTION

Floods are a long-term topic that is connected to man since the beginning of his existence. This topic is still current and will always remain current. We find ourselves in a period of climate change that is accompanied by periods of extreme droughts followed by immense floods. Floods are a natural part of natural processes both locally and globally. Why are they so negatively perceived from a human standpoint now? First, it is necessary to consider the intensification of agricultural production and a comprehensive conversion of watercourses fertile floodplains to an agricultural soil. Originally, small human settlements on our territory were historically concentrated around the watercourses. With time settlements expanded and at the time the Industrial Revolution began the development of industrial buildings. This awkward layout of towns and villages remained until today, when the current scheme will only change with the difficulty. The man and his actions have to be adapted to floods. Therefore, the man must consider this fact when designing buildings, in land use and in planning. At the moment, these activities are projected into the legislation and long-term planning at the level of state, counties, municipalities and other constituents. Legislation should influence the physical and legal people, professionals and laymen.

The problem of floods is not just a problem of the Czech Republic, but it is one of the global problems. Flood modeling is the modern way to determine the flow of water through built-up area during floods (Chen et al. 2012, Costabile et al. 2015).

The main objective of this study is to determine how expansion of the REHAU company industrial complex in Jevíčko will affect water flow during floods and formulation of general conclusion. REHAU company industrial complex, which will be spread, focuses on the production for the automotive industry. The complex will be expanded to the west of the existing one, which has an area of 2.14 hectares and will have approximately twice as much acreage after the enlargement. Matrix of Boskovice furrow valley in which is Jevíčko is located consists of arable land with a minimum of forests and permanent grassland. This area has been historically inhabited and industrially used and is interesting by its morphology and location of historical residential development on the hill and industrial development below the hill into the flood plain area of stream Jevíčka, Malonínský and Žlíbecký stream.

Basic terminology

Flood - a temporary significant increase of a level of a watercourse caused by sudden increase of a flow or temporary decreasing of the channel flow rate (Kravka 2009). The flood is also characterized by the culmination flow, volume and shape of the flood wave (Patera, Kašpárek 2002).

Types of floods – Act n. 254/2001 Coll., Water Act, divides the floods on the *natural* and *exceptional* floods. *Natural* flood may be caused by natural events such as snowmelt, rainfall and run of the ice. *Exceptional* floods are caused by other factors, notably by the failure of the hydraulic structure that may lead to the accident (rupture) or emergency solution of the critical situation on the hydraulic structure (Portál veřejné správy ČR 2015).

Flood plain area - Standard ČSN 75 0101 (Czech Technical standard) defines flood plain area as administrative designated area, which may be flooded by water in the event of natural flood. The water office is obligated to determine their range on a proposal of the watercourse administrator (ČSN 75 0101 2003).

Flood protection means measures to prevent and to eliminate damages during the floods on life and property of citizens, society and the environment carried out mainly by systematic prevention, increase of the river basins retention capacities and influence during the floods (ČSN 75 0101 2003).

Flood protection measures in the basin must be understood as part of comprehensive protective measures in the basin, whose main objective is to increase the accumulation and retention of water in the basin, land erosion protection and flood protection of endangered areas (Hrádek, Kuřík 2003).

Previously was applied primarily "centralized" approach to flood protection. That consisted of in realization of isolated structural measures mainly of a technical character. This approach has been closely linked with other sectors such as energy, drinking water supply and recreation. Today are more and more often applied integrated flood protection measures. The main feature of this approach is a comprehensive flood protection solutions across the entire basin rather than isolated measures mainly of a technical type (Jeníček 2009).

Paragraph 65 of the Water Act divides measures on *preventive*, *operational* and *after the flood*. To preventive measures belongs determination of flood plain areas, flood protection plans, flood inspections, organizational and technical preparation, and more. Among the operational measures are included flood forecasting service activities, activities of flood warning service, warning of flood danger, evacuation flood plain areas or flood safety work. Measures after flooding are the registration and documentation work, including the assessment of the flood situation including caused flood damage and flood recovery and rehabilitation of the area after floods (Portál veřejné správy ČR 2015).

Further measures can be classified as *technical* and *non-technical* (passive). Technical measures can include flood prevention measures of building character, e.g. construction of protective dams and construction or renovation of retention reservoirs. Passive measures can't substantially reduce the frequency of extreme flood events, however, can significantly contribute to reducing their extremity and help slowing down the flood waves (Langhammer, Vilímek 2004).

MATERIAL AND METHODS

Defining of the interest area and its brief description

For the area of interest was selected part of the Jevíčka stream basin around town Jevíčko where a solved industrial complex is located. The selected area of interest is located on the border of Pardubice and South Moravian Region and Jevíčko is its imaginary centre. Jevíčko is located approximately 15 km southeast of Moravská Třebová and 16 km northeast of Boskovice. Jevíčko was founded in the early 13th century and is one of the oldest cities in Moravia. Jevíčko has currently approximately 2,812 inhabitants (Jevíčko 2015). Historic settlement was concentrated to outpost between Malonínský and Žlíbecký stream that are east of the town flow into stream Jevíčko. Modern development has spread into the floodplain of streams and industrial and agricultural buildings directly border to the streams and are located partly in the flood areas.

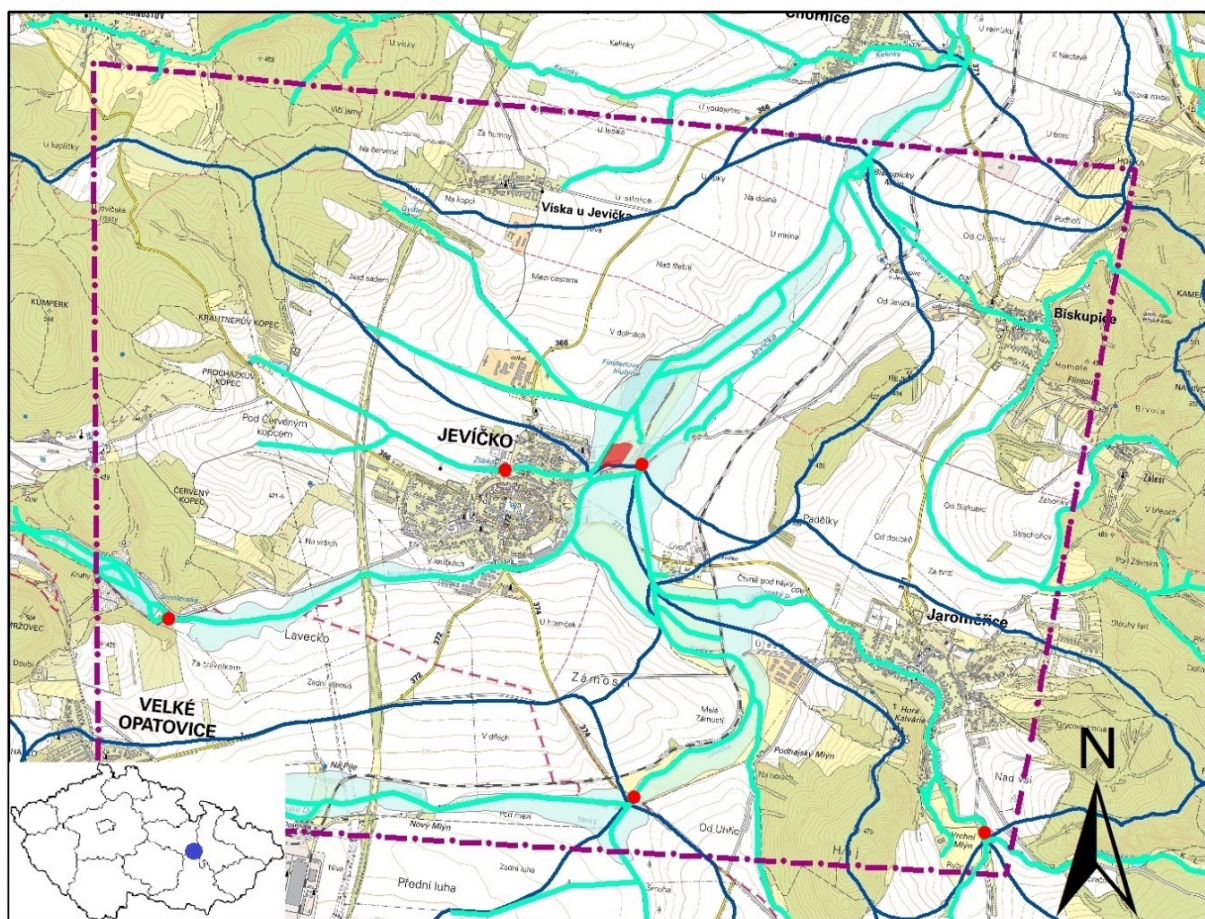
The area of interest is defined by the trapezoid which Southwestern apex is town Velké Opatovice, Southeast apex is created by the confluence Úsobrnský and Šubýrovský stream, northeastern apex is the hill Horka and the northwestern apex is village Zadní Arnoštov. Area of interest has an area of 3388

ha. The area of interest is shown in Figure 1. Cutout of the area of interest with the details of the planned complex location is shown in Figure 2.

Geographically the area belongs into unit Boskovická furrow. Jevíčka stream that runs through the valley of the Boskovice furrow springs on southwestern edge of the village Bezděčí at an altitude of 511 m above sea level. Total length of the stream is 23.7 km and the total basin area is 236.67 square kilometres (Povodí Moravy s.p. 2015). On east of the village Petrůvka Jevíčka flows at an altitude of 300 meters above sea level into the stream Třebůvka. Among the major tributaries of Jevíčka stream in the area of interest Uhřický stream, Ůsobrnský stream, Biskupický stream and Malonínský stream could be included. From the reservoirs located in the area of interest could be mentioned reservoir Žlábka, Smolenská reservoir and Finstrelova hlubina. According to the assessment of the water body status in the Plan of the Morava River basin is the ecological condition of Jevíčka stream evaluated as unsatisfactory (Povodí Moravy s.p. 2015) (Elektronický digitální povodňový portal 2015).

An interesting feature of the area is unfinished highway embankment, which was built to connect Wrocław to Vienna. Unfinished highway runs from the north to south through the area of interest. Embankment creates a line barrier in the area and affects its runoff conditions. Another line barrier of the area is the Embankment of the railway track, which passes through the area from southwest to northeast and to a lesser extent embankments of the roads. Significant barriers are also buildings, which are located in the flood plain area and bridge constructions with limited flow profiles.

Figure 1 The area of interest on the basic map of the Czech Republic (Český úřad zeměměřický a katastrální 2015)



Legend

- Hydrometric profile
- Area border
- Basin border
- Flood plain area Q100
- Complex border
- Watercourses

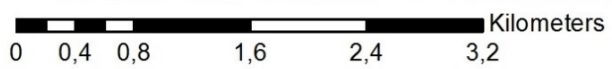
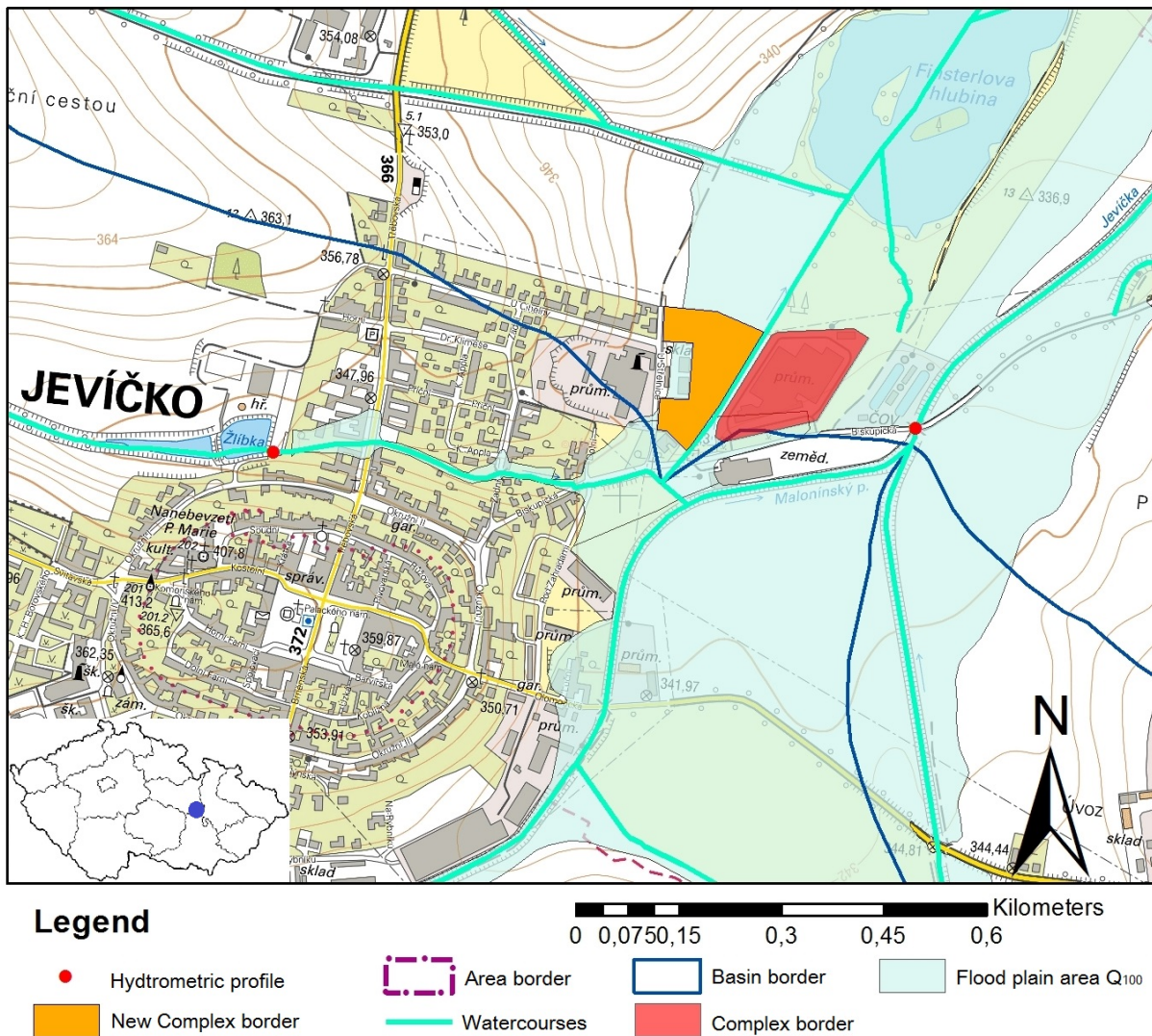


Figure 2 The area of interest cutout on the basic map of the Czech Republic (Český úřad zeměměřický a katastrální 2015)



Elaboration

In the first time preliminary work will be carried out, under which will be acquired the actual regulations, standards and literature, and then will be studied. After that will be obtained input data, which will be verified. Necessary software will be also acquired that will be used for processing data. It is expected to receive a grant for the acquirement of money and allowing the research.

An important part will be field surveys of the area of interest. That will be the basis for further processing and actualisation of the obtained data. Also will be important cooperation with Povodí Moravy s.p., Vodní díla - TBD a.s. and the town hall of Jevíčko. Results will be provided to the town hall of Jevíčko and REHAU Company.

All collected data will be processed by a computer and appropriate software. Models of area and water flow will be created. Subsequently, the proposals for measures will be concluded and will be selected the best solution. Then will be developed a documentation which will be evaluated and consulted. Result will be reviewed and revised.

Input data

Following input data will be necessary for model processing and a comprehensive understanding and solving the issue. All input data will be provided free of charge for research purposes.

- 4th generation of the Digital terrain model (5th generation is not available for the area) (Source: Český úřad zeměměřický a katastrální)

- Orthophotomap of the area (Source: Český úřad zeměměřický a katastrální)
- N-year flows for selected hydrometric profiles (Source: Český hydrometeorologický ústav):
 - In the dam profile of Smolenská reservoir at Malonínský watercourse
 - Below the confluence of Jevíčko and Uhřický watercourses
 - Below the confluence of Úsobrnský and Šubýrovský watercourses
 - Below a small water reservoir Žlábka in Jevíčko
- Measured profiles of bridges and other documents (Source: Povodí Moravy s.p.)
- Data from the DIBAVOD (Digital water management data base) (Source: Výzkumný ústav vodohospodářský T. G. Masaryka)
- Data from the water gauging profiles (Source: Český hydrometeorologický ústav)
- Documentation of the new complex in Jevíčko (Source: the town hall of Jevíčko)
- Historical data and data from the Jevíčko town archive (Source: the town hall of Jevíčko)
- Legislative, urban plans and other planning documents (Source: the town hall of Jevíčko etc.)
- Other data

Software

For input data processing and modelling of flood flows through the area of interest and the consequent formulation of results and outputs will be used few software programs will be used.

The program FLO 2D (two dimensional) will enable modelling of flood flows through the area of interest and modelling rupture of the water reservoir. The FLO-2D Basic is an integrated river and floodplain 2-D flood routing model. It routes flood hydrographs and rainfall runoff with many urban detail features including street flow, levees and walls and hydraulic structures. It is FEMA (Federal Emergency Management Agency) approved for Flood Insurance Studies. FLO-2D Basic can tackle many diverse flooding problems including: river overbank flooding; unconfined alluvial fan flows; urban flooding with street flow, flow obstruction and storage loss; overland progression of tsunami and hurricane storm surges; watershed rainfall and runoff; flood insurance studies and flood mitigation design (FLO-2D Software 2015).

Calculations will be made in program HEC-RAS 1D (one dimensional). HEC-RAS is designed to perform one-dimensional hydraulic calculations for a full network of natural and constructed channels. HEC-RAS also allows to perform one-dimensional steady flow, unsteady flow, sediment transport/mobile bed computations, and water temperature modelling (US army corps of engineers 2015).

Maps will be created in the Esri ArcGIS which allows data processing and use of publicly available data on WMS (web map services) servers and the subsequent creation of map outputs.

Technical drawings and model adjustments will be processed in Autodesk Civil 3D.

RESULTS AND DISCUSSION

Based on modelling of flood flows through the area of interest measures at critical points will be proposed, which is the main objective of the study.

Specific outputs will be models of flowing around objects, final map of the area, technical drawings of the complex, diagrams, calculations and solutions design and drawing of general conclusions.

The expected result is that the complex expansion in the proposed location in the flood plain area of Q_{100} will be threatened by flood flows and will need to implement the necessary measures to protect them. It can draw several solutions that will be appropriate to compare and choose the best solution for a given site. The construction will affect the active zone of Malonínský and Žlíbský stream. Several possible solutions will be proposed and best solution will be chosen. Purpose of the flood protection building will be protect human lives and property from damage.

CONCLUSION

Generally can be concluded that the best solution of the flood protection is stop building in the flood plain areas and eliminate existing structures. Another solution is to reduce the negative effects of conventional agriculture. The funds should be directed to promote prevention and long-term sustainable planning and existing faulty solutions adapt to the natural conditions. This should be strictly projected into a legislation and also the laws have to be respected in the long-run even after the governing party changes. The result would be a change in human thinking and the transformation of human concentration on one place and to further understanding of wider connections. This can be understood as a long-term process of human development as administrator of the landscape and the planet.

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