Advance Hydraulic Modelling of Maciovita River, Caras Severin County, Romania

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Abstract. Study case is situated in Caras Severin county. To solve theoretical problems of water movement in the river Maciovita, it requires modelling of water flow in this case. Numerical modelling was performed using the program MIKE11. Advanced computational modules are included for description of flow over hydraulic structures, including possibilities to describe structure operation. The Hydrodynamic (HD) module is the nucleus of the MIKE 11 modelling system and forms the basis for most modules including Flood Forecasting, Advection-Dispersion, Water Quality and Non-cohesive sediment transport modules. The MIKE 11 HD module solves the vertically integrated equations for the conservation of mass and momentum, i.e. the Saint-Venant equations. The input data are: area plan with location of cross sections; cross sections topographical data and roughness of river bed; flood discharge hydrograph. Advanced computational modules are included for description of flow over hydraulic structures, including possibilities to describe structure operation. After simulation with MIKE 11 results the water level in each cross sections.

1. Introduction

The right tributary of the Timiş River, the Macioviţa brook has a torrential character on the upstream side, with reduced time of concentration of the floods, a situation that favours the erosion of the banks but also the dangerous depth of the valley [3,5].

Upstream the base rock formed by hard rocks and marl comes to the surface, the banks have heights of 3.00-5.00m, there being the danger of collapse for the houses and the annexes of the household in Maciova. The shores are eroded along the entire length, with the danger of collapsing of the communal road on a length of 500 m.

In the downstream sector, due to the low slopes, the transport of loose material from the banks of the brook, and the abundant vegetation that obstructs the drainage section, there was a complete clogging of the brook, which favours frequent flooding of the area's households, as well as the devastation of the minor bed. Practically downstream to the confluence with the Timiş River, the Macioviţa streambed changed its course after each flood,destroying major agricultural land.

The Macioviţa valley development works are necessary to avoid damages caused by floods on the territory.
Figure 1. Plan view of river

For the arrangement of the Macioviţa Stream course on the studied sector, works are foreseen including:

Reprofilation of $L = 2000\text{m}$ for transiting the flow rate and stopping the trapezoidal bed climbing with the base width of $5.00\text{m}$ in the downstream sector of the locality and up to the confluence with the river Timiş. The total height of the resulting section for the level corresponding to the flow rate is $h = 1.20\text{m}$.

Consolidation of shore with gabion boxes $L = 1165\text{m}$- having the section $1.00\times1.00\times3.00\text{m}$, $1.00\times1.50\times3.00\text{m}$ and gabion mattress of $0.30\times3.00\times3.00\text{m}$, made of OB$37\ 16\text{mm}$ steel frame, disposed at $1.00\text{m}$ distance and OB$37\ 10\text{mm}$ inside, welded at $0.50\text{m}$ away, mounted on galvanized mesh $3.8\text{mm}$ with $40\times40\text{mm}$ mesh. The boxes will be filled with broken stone. The stone will be seated manually in the form of dry masonry. The boxes will bind in all directions with OB$6$ at $0.20\text{cm}$ distance. It will be applied on both sides of the creek to protect the road, the river construction, the completion of the existing works and the stopping of the material drive phenomenon.

The stone masonry parapet $L = 145\text{ml}$ - applies to the upstream sector in the area of natural fall with the base rock at the surface and the banks with heights of $0.20$-$0.50\text{m}$, to ensure the height of the calculation.

The elevation of the $1.00\text{m}$ parapet is made of stone masonry, with a width of $0.40\text{m}$ and the slope of the watered surface of $5:1$, and the one from the vertical enclosure. On the sill coronation there is a $0.10\text{m}$ thick concrete ribbon. The ground foundation is $0.80\text{m}$ deep, the concrete foundation is $C8/10$ class with a width of $1.50\text{m}$. The slope of the bed is stabilized upstream by means of $7$ gabion walls.

Wall from gabion boxes has height $0.50\text{m}$ of $6$ pcs ($L = 48\text{m}$). In order to stabilize the foot, reduce the longitudinal slope of the course, and reduce the drainage speeds and maintain the allowances for the foundations of the proposed works, thresholds will be achieved with drops of gabion boxes. The section consists of a spill threshold from a gabion box $0.50\times2.00\times4.00\text{m}$, with concrete beam block ($0.50\times1.00\text{m}$), $7.00\text{m}$ long energy dissipater made of two gabions $0.50\times3.00\times4.00\text{m}$. The boxes are trapped downstream with the $0.80\times1.50\text{m}$ concrete beam. Water berm with a length of $5.00\text{m}$ consists of rockfill blocks with gravity $> 440\text{ kg/pcs}$.

Wall from gabion boxes $h = 0.30\text{m}$ 1 piece ($L = 8\text{m}$). The section consists of a spill threshold from a gabion box of $0.30\times3.00\times4.00\text{m}$, with concrete beam block ($0.50\times1.00\text{m}$), a $7.00\text{m}$ long energy dissipater made of two gabion boxes $0.30\times3.00\times4.00\text{m}$, respectively $1.00\times3.00\times4.00\text{m}$. The boxes are trapped downstream with the concrete beam of $0.50\times1.00\text{m}$. 
Basic preparatory works are required - as cutting of trees in the site and scraping off the works. The proposed adjustment works preserve the existing valley route, avoiding the influence on the surrounding area.

2. Material and methods
Numerical modelling was performed using the program MIKE11. MIKE11 is a professional engineering software package for the simulation of flows, water quality and sediment transport in estuaries, rivers, irrigation systems, channels and other water bodies.

MIKE11 is a user-friendly, fully dynamic, one-dimensional modelling tool for the detailed analysis, design, management and operation of both simple and complex river and channel systems.

With its exceptional flexibility, speed and user friendly environment, MIKE11 provides a complete and effective design environment for engineering, water resources, water quality management and planning applications.

The Hydrodynamic (HD) module is the nucleus of the MIKE 11 modelling system and forms the basis for most modules including Flood Forecasting, Advection-Dispersion, Water Quality and Non-cohesive sediment transport modules.

The MIKE 11 HD module solves the vertically integrated equations for the conservation of mass and momentum, i.e. the Saint-Venant equations.

Applications related to the MIKE11 HD module include:
- Flood forecasting and reservoir operation.
- Simulation of flood control measures.
- Operation of irrigation and surface drainage systems.
- Design of channel systems.
- Tidal and storm surge studies in rivers and estuaries.

The MIKE 11 is an implicit finite difference model for one dimensional unsteady flow computation and can be applied to looped networks and quasi-two dimensional flow simulation on floodplains. The model has been designed to perform detailed modelling of rivers, including special treatment of floodplains, road overtopping, culverts, gate openings and weirs.

MIKE 11 is capable of using kinematic, diffusive or fully dynamic, vertically integrated mass and momentum equations.

Boundary types include Q-h relation, water level, discharge, wind field, dam break, and resistance factor. The water level boundary must be applied to either the upstream or downstream boundary condition in the model. The discharge boundary can be applied to either the upstream or downstream boundary condition, and can also be applied to the side tributary flow (lateral inflow).

The lateral inflow is used to depict runoff. The Q-h relation boundary can only be applied to the downstream boundary. MIKE11 is a modelling package for the simulation of surface runoff, flow, sediment transport, and water quality in rivers, channels, estuaries, and floodplains.

With its exceptional flexibility, speed and user friendly environment, MIKE 11 provides a complete and effective design environment for engineering, water resources, water quality management and planning applications. The Hydrodynamic (HD) module is the nucleus of the MIKE 11 modelling system and forms the basis for most modules including Flood Forecasting, Advection-Dispersion, Water Quality and Non-cohesive sediment transport modules [4, 6].

3. Results and discussions
Numerical modelling was performed with the program MIKE11. Site plan with the network model in this situation is shown in Figure 2.
Cross sections through the channel as topographical surveys are shown in Figure 3. According to data entry or formulated boundary conditions, namely the upstream inflow [1]. At chainage 1694 is inserted constant flow $Q = 46 \text{ m}^3/\text{s}$ and in the downstream at chainage 1037 is used curve key for downstream section of the river [2]. After running the program MIKE11 was obtained through existing channel longitudinal profile, presenting water levels along the channel, (Figure 4).
4. Conclusions

Besides the models mentioned above, have been developed over the year’s other models applied in the preparation of flood risk maps. In Romania, most flood risk maps were prepared using HEC-RAS and MIKE11 models, which show a high degree of confidence.

Throughout the Community Countries different types of floods occur, such as river floods, flash floods, urban floods and floods from the sea in coastal areas. The damage caused by flood events may also vary across the countries and regions of the Community. Hence, objectives regarding the management of flood risks should be determined by the Member States themselves and should be based on local and regional circumstances. In each river basin district or unit of management the flood risks and need for further action should be assessed. In order to have at disposal an effective tool for information, as well as a valuable basis for priority setting and further technical, financial and political decisions regarding flood risk management, it is necessary to provide for the establishing of flood hazard maps and flood risk maps showing the potential adverse consequences associated with different flood scenarios, including information on potential sources of environmental pollution as a consequence of floods.

Member States should assess activities that have the effect of increasing flood risks. Flood risk management plans should therefore take into account the particular characteristics of the areas they cover and provide for tailored solutions according to the needs and priorities of those areas, whilst ensuring relevant coordination within river basin districts and promoting the achievement of environmental objectives laid down in Community legislation.

Member States should base their assessments, maps and plans on appropriate ‘best practice’ and ‘best available technologies’ not entailing excessive costs in the field of flood risk management.
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