Numerical Model of Transitory Flood Flow in 2005 on River Timis

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Numerical Model of Transitory Flood Flow in 2005 on River Timis

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Abstract. The paper presents numerical modelling of fluid flow transiting on the Timis River, downstream Lugoj section - N.H. COSTEIU, the occurrence of accidental flood waves from 4 April to 11 April 2005. Numerical simulation aims to estimate water levels on the route pattern on some areas and areas associated respectively floodplain adjacent construction site on the right bank of Timis river, on existing conditions in 2005. The model simulation from 2005 flood event shows that the model can be used for future inundation studies in this locality.

1. Introduction

The paper describes the numerical modelling transit extraordinary flood of 2005 when it reached a peak flow Qmax = 1247 m³/s. During this period, the weir discharge at hydro node Costeiu (N.H.Costeiu) was under reconstruction and half from the cross section of flow of the Timis River was block at N.H Costeiu. In Figure 1 and Figure 2 are illustrated the case study areas after the big flood event from 2005, and some of the flood effects can be noticed.

Figure 1. Upstream right riverside breach view

The existence of execution chamber works for dry construction elements influenced negatively flood transit flows through surface weir discharge at N.H. Costeiu. From this cause a supplementary Remu effect was created upstream, and a right side overbank flow was produced in the future buildings...
complex establishment. After water withdrawal, the flood defenses sizes were extended, as it they are today.

![Figure 2](image1.jpg)

**Figure 2.** View of the downstream right bank, with view of alluvial material and massive concrete blocks after 2005 flood event

2. **Numerical model building**

In order to build the hydrodynamic model, geometrical data were required, such as river reach plan view, river length, cross sections and geometrical data of each river cross section. For riverbed modelling were used 49 small cross sections (only with the main channel, between lateral embankments) and 49 long cross sections (including the floodplains). For this case study the length of River Timis was of 8000m.

On the right side riverbank, at about 300m of the embankment, a building was created, in order to simulate the future buildings complex: a logistic warehouse, parking places, offices, administrative building, and site management accesses. Related to construction land is arable town, located at an average rate of approx. 115.30 m.a.s.l., spans a total area of 180.190 m² (Figure 3). The supplementary flood defenses size is included in the terrain measures.

![Figure 3](image2.jpg)

**Figure 3.** Case Study Plan View

In order to generate the hydrograph flow, was used the hydrograph flow shape of 2000 flood event, with a maximum flow value of $Q_{max} = 1247$ m$^3$/s. It was chosen an amplification coefficient of 1.015 which was applied in the performance of software package HEC-RAS line 5.0, generating the synthetic flood wave that will reach the maximum probable flow of approx. 1247.19 m$^3$/s. From the Lugoj gauging station was obtained the measured data flow value $Q = 10.30$ m$^3$/s, in 10.11.2015.

For the model geometry were used 49 cross sections measured terrain data, and 294 supplementary interpolated cross section, obtained from a 3D shape digital terrain model of study area. The cross section interpolation was generated automatically in HEC-RAS 5.0 software package, at a distance of 25m between two consecutive cross sections. In Figure 4 is presented the 3D Shape DTM wich was used as initial data for model building. As it can be seen, the elevation curves are presented too.
3. Model simulation

In the program, the identification of profiles [2], [3], is made by using a standard counting milestone, and its name is a numerical value, a real number. This method is useful in generating new interspersed sections (automatic interpolation sections) or in their thickening by various methods of linear interpolation between the two cross sections of topographical known.

To monitor the water discharge over the crest of the dam defense on the left bank of Timiş, were introduced two side structures fictitious spillway - weir spillway, with a runoff coefficient $m_d = 0.248$, configuration of the route of the crowning determined by the points derived from raising the terrain (the longitudinal profile of the left bank). On the right bank, in the reconstruction of the embankment against floods (the extension after the 2005 floods), introduced a structure spillway fictitious - weir spillway, and a runoff coefficient $m_d = 0.248$ configuration route canopy determined points of the topographic survey (of the longitudinal profile on the right side).
To monitor water volumes transiting fictitious structures and flood related areas were introduced three real polders (labelled: Polder No.1, Polder No.2 and Polder No.3) characterized by possible storage volumes (resulting from contour surface plan measurement).

In Figure 5 is shown the geometrical model plan view, with the cross sections and the two polders. Two polders (Polder No.1 to Polder No.2) are interconnected. This connection is necessary if we analyze the visible contours of terrain configuration in Figure 4. The connection between the two polders (area related) is a fictional connection type structure, characterized by an overflow threshold leakage wide, with a flow coefficient $m_d = 0.375$.

The fictive lateral structures on the Timis left riverbank are named with "4.68" structure connected with Polder no.1, "2.900" structure connected with Polder no.2, and "2.770" structure connected with Polder no.3.

The generated cross section from interpolation are marked with "*", and are presented in Figure 5. The roughness coefficient distribution is variable in the river cross section, and is different for main channel $n = 0.035$, flood plains $n = 0.065 - 0.075$ and protected riverside banks $n = 0.015$ (concrete).

On the initial river reach path 4 simulation scenarios were conducted, [5], but in this paper only one scenario is presented. This scenario represents open channel flow simulation on river Timis, after the extension works of embankments, on with an unsteady flow regime, respectively with introduction of high flow hydrograph of 2005 flood event, with a maximum peak flow $Q_{\text{max}}=1247 \text{m}^3/\text{s}$. This scenario actually reconstructs the transition flow on study case zone, from 2005.

**Figure 6.** Timis River cross section and plan view at N.H. Costeiu in 2005, before the flood event
For this case, some parts of the numerical model cross sections were blocked, as shown in the Figure 6 (right side of weir discharge), because in that time, the weir spillway of N.H. Costei was under construction, and half of Timis river cross section was blocked.

In the numerical model, to lower the embankments level, a fictive breach of 54m length was created. This was done in order to reproduce the initial condition of 2005 flood event, respectively of transitory flood flow through the area. In Figure 7 it is illustrated at "km 2.5858" cross section, the lower terrain level of 114.42 m.a.s.l., from actual measured of 116 m.a.s.l.

**Figure 7.** Longitudinal profile detail through lateral fictive structure "2.770"

In the same lowering procedure are cross section "km 2.6092" at 114.69 m.a.s.l. and cross section "km 2.5624" at 114.62 m.a.s.l. The breach length is 54.06m, it is from cross section "km 2.773"-P.15 to cross section "km 2.539"-P14. For model simulation with an unsteady regime flow, as boundary condition for the upstream cross section "km 8.004" was used the synthetic flow hydrograph, $Q_{\text{max}} = 1247 \text{ m}^3/\text{s}$, and for downstream the normal depth from "km 0.050".

4. Results and discussions

Following execution of the numerical simulations were obtained all parameters constant or variable over time regarding: levels, flows and water velocities in all cross-sections of the numerical model. In Figure 7, after numerical simulation carried out, it can be observed the detail configuration required by fictitious breach and the peak water level discharges at the maximum flood wave from 2005 to Polder Nr. 3. The water level reaches the maximum value of the breach.114.78 m.a.s.l.

The results are postprocessed and presented in graphs or tables, as it follows in figures Figure 8, Figure 9, Figure 10, Figure 11, Figure 12, Figure 13, Figure 14 and Figure 15.

**Figure 8.** Variation of the piezometric line (water levels) in the longitudinal profile

In Figure 8 is illustrated in the longitudinal profile the variation of the piezometric line (water levels) in the longitudinal profile, for hydrograph corresponding to the period of execution of N.H. Cost, namely to achieve the maximum flow of 2005 $\rightarrow Q_{\text{max}} = 1247 \text{ m}^3/\text{s}$. 

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In Figure 9, are shown the piezometric line and velocity variation in P45, P41, P39, P30, P29, P26, P8 and P5 cross sections.

![Figure 9: Variation of piezometric line and velocities in cross sections profiles](image)

In figures Figure 10-Figure 12 are illustrated the flow and piezometric line variation through main channel and lateral structures, with maximum flow of $Q= 358.45\text{m}^3/\text{s}$ for "km 4.68" structure, flow of $Q= 29.38\text{m}^3/\text{s}$ for "km 2.900 structure ", value obtained from Polder no.2, and $Q= 7.32\text{m}^3/\text{s}$ for "km 2.770" structure, value obtained at Polder no.3.
Flow and water level variation as function of time are presented in Figure 13 for all the polders connected with the lateral structures.
The maximum level reached in Polder no.1 (connected with structure "km 4.68") is 114.91 m.a.s.l, in Polder no.2 (connected with structure "km 2.900") is 114.60 m.a.s.l, and Polder no.3 (connected with structure "km 2.770") is 114.76 m.a.s.l.

In Figure 14 are presented the flow and water variation for the connection zone between Polder no.1 and Polder no.2. It can be observed that the maximum discharge obtained is $Q = 355.74 \text{ m}^3/\text{s}$.

In table Table 1 for all cross sections are shown the maximum flow, the minimum channel elevation, slope, channel velocities values.

**Table 1.** Numerical Model simulation results in each cross section
5. Conclusions

When was analyzed the graphs results it should be stated that the transit of water is in the river channel, floodplain and over the dike defense on the left bank of the river Timis, respectively over the embankment on the right bank, near the end of the breakwater defense. In conclusion, following this spill through fictitious structure "2770", in Polder No. 3 it accumulates a volume of water of approx. 69.41x10^3 m³, and its peak is about. 114.76 m.a.s.l., as in 2005 flood event. This level value occurs a flooding enclosure to construction warehouse location, at the maximum flow value through the lateral fiction structure "2770" of 6.71m³/s. The model simulation of 2005 flood event shows that the model can be used for future inundation studies near N.H. Costei establishment, the obtained data are comparable with the measured data from the event.

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