ASPECTS REGARDING THE LAY-OUT OF THE FLOOD STRIPS AND THE ELABORATION OF HAZARD MAPS FOLLOWING THE SUBSIDENCE OF HYDROTECHNICAL WORKS

ASPECTE PRIVIND TRASAREA BENZILOR DE INUNDABILITATE ŞI ÎNTOCMIREA HĂRŢILOR DE HAZARD ÎN URMA CEDĂRII LUCRĂRILOR HIDROTEHNICE

***BOBOC V.* [1]*, *BIALI Gabriela*[1], *SÂRBU G. C.*[1]**
Corresponding author e-mail: valentinboboc.hgim@gmail.com

Abstract. *Current climate change, materialized by the increase in the number of extreme rainfall phenomena, combined with increasing anthropogenic activity (massive deforestation), causes the flood process to appear more and more often and with increasing impact on the human component and its habitat, causing hydrological accidents. . These accidents are called hydrological hazards. Hydrological hazards are natural phenomena, which imply the existence of water, which have a direct negative influence on people's lives, on society and on the environment as a whole. The results of the flood study can be better used if integrated into a GIS model. By over lay technique, all data of interest can be stored, with specific representations of levels, speeds, times, and other elements of the evolution of the phenomenon.*
Key words: dam, hazards, modelling, breach, flood strips

Rezumat. *Schimbările climatice actuale, materializate prin creşterea numărului de fenomene extreme asociate precipitaţiilor, coroborate cu activitatea antropică tot mai intensă (defrişări masive) determină ca procesul de viitură să apară din ce în ce mai des şi cu impact din ce în ce mai mare asupra componentei umane şi a habitatului acesteia, producand accidente hidrologice. Aceste accidente poartă numele de hazarde hidrologice. Hazardele hidrologice sunt fenomene naturale, ce implică existenţa apei, care au o influenţă negativă directă asupra vieţii oamenilor, asupra societăţii şi a mediului înconjurător, în ansamblu. Rezultatele studiului de inundabilitate pot fi mai bine utilizate dacă sunt integrate într-un model GIS. Prin tehnica over lay-urilor, toate datele de interes pot fi stocate, cu reprezentări specifice pentru nivele, viteze, timpi şi alte elemente privind evoluţia fenomenului*
Cuvinte cheie: baraj, hazard, modelare, breşă, benzi de inundabilitate

INTRODUCTION

The risk issue of hydrotechnical constructions gains other dimensions compared to other engineering domains. Any damage caused by the destruction of these constructions may reach the level caused by the major natural disasters.

[1]"Gheorghe Asachi" Technical University of Iasi, Romania

They have serious diffusion effects, which is why the risk assessment must be done with maximum responsibility (Biali, 2013).

With all the technical progress, both in terms of theoretical methods and the means of prospecting and realization and of control in execution and exploitation, according to statistics, accidents increased in number (Crăciun *et al*, 2011).

The failure of a hydraulic structure, important event that may occur during its existence, is a very complex phenomenon, both in terms of cause and the manner in which it is conducted. Regarding the time interval, this phenomenon can take place within a longer or shorter period of time. The slow or sudden character is given by the way the limit state is reached, state in which the construction collapses (Abdulamit, 2009)

From the statistical studies made, it results that the average risk of destruction of a hydrotechnical structure is about 0.5% and the risk of shutdown for a long period, due to accidents is about 2% - 3%. From the analysis of dam breaking, it was found that the percentage of destruction risk is much higher in dams of small heights than in the ones of large heights. Dams from local materials are less secure than concrete ones because they are subjected to specific phenomena related to construction materials, such as uneven settlements (Hartford and Baecher, 2004).

In a study done by the International Committee on Large Dams (ICOLD) on damages in hydraulic structures, it was concluded that the geological, design, execution and operation risk factors, are a fact proven by the destruction of about 2 % and serious damaging of other about 6% of the approximately 16,500 existing dams in the world (Abdulamit, 2009).

Dams and hydraulic structures in general, are today the subject of special attention and rigorous controls in terms of security.

MATERIAL AND METHOD

The effects of damage to hydrotechnical constructions are due to downstream damage due to breakage waves and the decommissioning of storage lakes.

Breaking waves are more dangerous than flood waves for the area immediately downstream of hydrotechnical constructions.

To determine the breaking waves that may result from the dam destruction, two hypotheses about the breakage mode have to be made:

- the duration of the breakage;
- the width of the breach created in the dam.

Modeling of dam failure can be addressed in different ways: by developing a breach at the crest level after discharge and / or failure of plant, disposed in the dam, followed by the development of a breach in the dam body (Boboc, 2014). Flood wave propagation caused by the breaking of a dam is carried out in the downstream area of the dam on a certain length that depends on the spatial characteristics. In terms of hydraulic calculation, the model is based on St. Venant equations. These equations are suffering simplifications when addressing a hydrological problem. These simplifications are induced by knowing some parameters based on previous measurements.

Analysis models of the rainfall - leakage phenomenoa analyze all leakage components, thus implicitly also in non-precipitation periods, when the water flow is formed only from the base runoff. In the internal structure of the hydrological system the continuous modeling of soil moisture is also found. So, in producing a high precipitation that will generate flood flows, the state of soil humidity is known, so the modeling of the rain-flow process is closer to reality. The Mike 11 by DHI, the NAM module (Nedbør Afstrømning Models / Rain Leakage Model) is a conceptual model that reproduces the terrestrial phase of the hydrological cycle. The model simulates surface leakage, intermediate leakage, and base leakage from a river basin. Mike 11 by DHI, NAM module (Nedbal Afstrømning Models / The Rain – drain module) is a conceptual model that reproduces the terrestrial phase of the hydrologic cycle. As input data for the model there can be used the hydrologic cycle parameters such as temporal variation of evaporation, soil humidity, aquifer recharge and aquifer water level evolution. As simulation results there can be obtained the evolution of the hydrological cycle parameters such as flow on slopes, intermediate flow and base flow (Danish Hydraulic Institute, 2014).

As a case study it was used Granicesti facility, located on the Horait brook, left branch of the Suceava River, Suceava county. In the summer of 2010 there were significant amounts of rainfall in several rounds of 2-3 days, which, in combination with high atmospheric pressures over the Russian Plain and in the central western Europe, have led to a dangerous development of hydrometeorological phenomena in Superior Siret, Suceava and Moldova river basins. The calibration of Mike 11-NAM model was done by the autocalibration procedure. It is a process that can address the most important simulated parameters (fig.1). Automated calibration routine includes nine parameters: maximum surface water quantity (Umax); maximum water content from the active area for plant roots (Lmax); surface flow coefficient (CQOF); infiltration time constant (CKIF); flow time constants (CK1,2); the threshold value of the unsaturated zone at which the surface discharge is initiated (TOF); the threshold value for initiating infiltration (TIF); time constant for base flow (CKBF); Aquifer recharge threshold limit (TG).

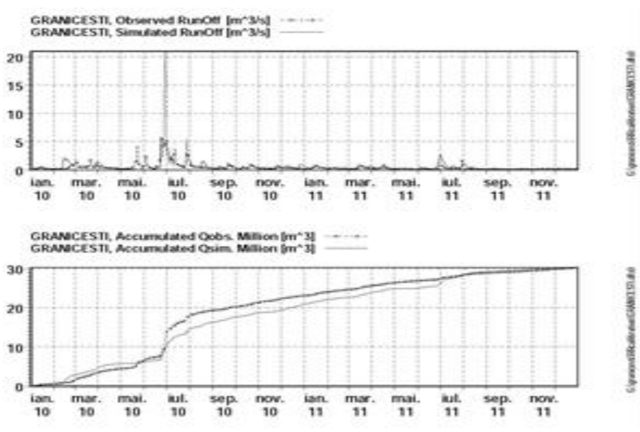

Fig. 1 Mike11-NAM model calibration result for river Horaiț hydrographic basin

RESULTS AND DISCUSSIONS

During the flood wave propagation downstream of the spilled infrastructure due to topography and large volumes of discharged water, the propagation velocities increase, according to the simulation, at a distance of 500 m from the dam at 6.0 m / s, decreasing to 5, 6 m / s at a distance of 1000 m from the dam.

The flood hydrographs caused by the canopy discharge and the breach in the dam body (fig. 2, fig. 3) have maximum discharge values of 193 m^3/s in the dam axis, the value of which decreases as we move downstream from the dam: 180 m^3/s of dam 500 m, 168 m^3/s of 1000 m dam, 154 m^3/s of 3000 m of dam, 147 m^3/s of 5000 m of dam and 130 m^3/s of 7000 m of dam.

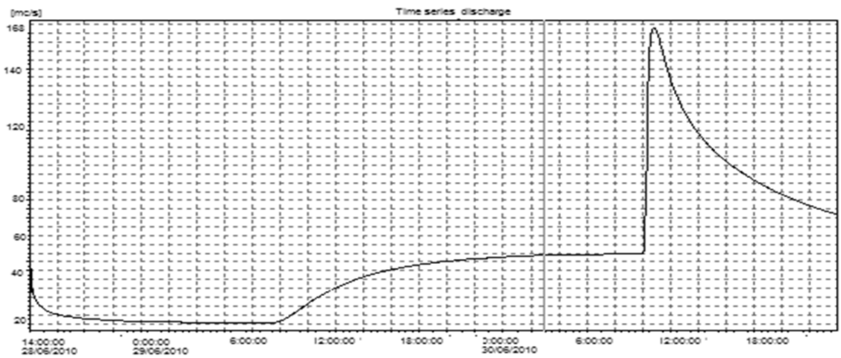

Fig. 2 Flooding hydrograph at a distance of 1000 m downstream of the dam (maximum flow rate of 168 m^3 / s)

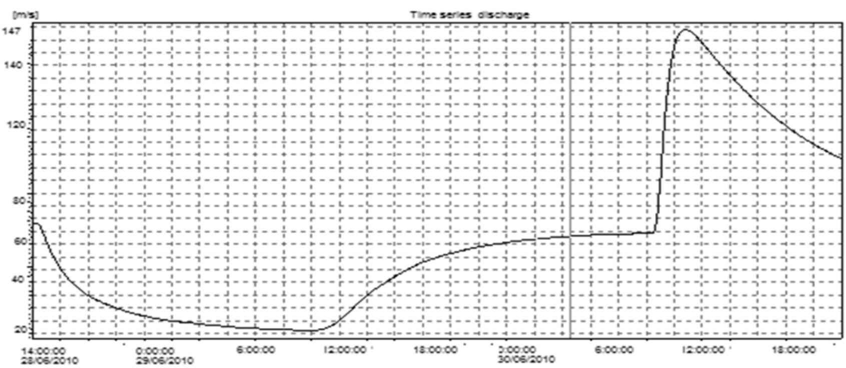

Fig. 3 The flood hydrograph at a distance of 5000 m from the dam (maximum flow rate of 147 m^3 / s)

The maximum flow in the dam shaft (193 m3/s) obtained by simulating the dam discharge is identified with the maximum flow rate with a probability of exceedance of 0.5%.

Velocity is reduced, condition that determines the attenuation phenonema in the riverbed (Boboc and Mitroi, 2016).

Between the time of the breach initiation and the one in which the lower level of the breach is reached, the water velocity reaches up to 3.0 m/s, which causes the development in height and width of the breach and the washing of the material from the dam. Structures made of local materials, that is various sorts of soils, can not avoid such erosion occurs if the discharge of the crest is produced or if breaches occur in their body. For this reason the structures designed to be discharged, are protected with coverings able to withstand erosion caused by these velocities (concrete, asphalt).

During the flood wave propagation, downstream from the discharged infrastructure, due to topography and large volumes of discharged water, propagation velocity increases, according to the simulation, at a distance of 500 m from the dam at 6.0 m/s, lowering to 5.6 m/s at a distance of 1000 m from the dam. Velocity is reduced, condition that determines the attenuation phenonema in the riverbed.

Flood strips established as a result of calculations or numerical simulations, and can be the basis for evacuation and emergency plans to protect the population and economic objectives downstream (fig 4). Also, these bands are important in making land management decisions and establishing destinations related to their use.

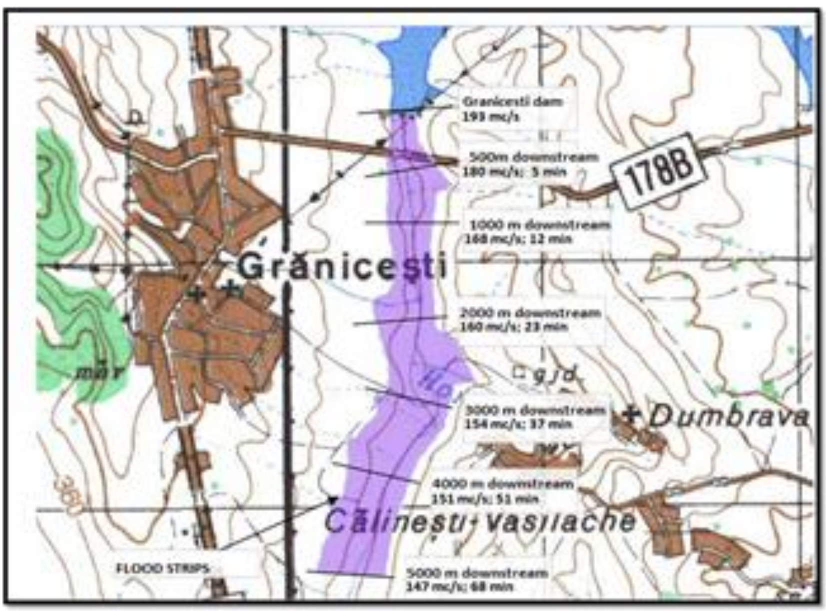

Fig. 4 Flood strips established for the downstream area the Granicesti dam

CONCLUSIONS

1. The results of the flood study can be better used if integrated into a SIG model. By over lay technique, all data of interest can be stored, with specific representations for levels, speeds, and times. Hazard maps and flood risk maps are developed according to Directive 2007/60 / EC. (www.rowater.ro)

2. The flood hazard map is an overall map that for each probability of overtaking should include the following elements: the flood limit, which represents the water extension for each case considered, the depth or water level for which 3 classes (water depth below 0.5 m, water depth between 0.5 m and 1.5 m, water depth greater than 1.5 m).

3. The existing global and European flood identification methodologies focus on complex analytical software geoinformatics, software that requires a wide range of input databases.

4. The effect of the spatial and temporal scale, tells its word on the prediction procedure a flood or flood. Therefore, it should be taken into account that by enriching the data fund hydrometric and information on how to use the reception basin, the floodplains for different probabilities of overtaking, it needs to be reassessed.

REFERENCES

1. **Abdulamit A., 2009** – *Safety of Dams in Romania - Proceedings of 23rd ICOLD Congre*ss Q91, R12, Brasilia;
2. **Biali Gabriela, 2013 -** *Integration of the informational layer on the use of lands In Găiceana Hydrographic Basin, with GIS Type Software*, Buletinul Institutului Politehnic Din Iaşi, Universitatea Tehnică „Gheorghe Asachi” din Iaşi Tomul LIX (LXIII), Fasc. 3-4, 2013 Secția, HIDROTEHNICĂ
3. **Boboc V., Mitroi R., 2016 -** *Modeling of earth dams failure, Revista Lucrări ştiințifice, USAMV Iaşi, Seria Agronomie*, vol. 59, nr. 2, pp 23-28.
4. **Boboc V., 2014** - *Cercetări asupra inundațiilor produse în urma cedării barajelor de pământ,* Teza de doctorat, Universitatea Tehnica Gheorghe Asachi din Iasi;
5. **Crăciun I., Giurma I., Giurma-Handley C-R., Boboc V., 2011** - *Evaluating the Climatic Changes in the Hydrological Flow Regime of the Moldavian Areas,* Environmental Engineering and Management Journal, Vol. 10/no.12, 1983-1986, ISSN1582-9596;
6. **Hartford D., Baecher G., 2004** - *Risk and uncertainty in dam safety, Thomas Telford Press*, London;
7. *****, Danish Hydraulic Institute, 2014 -** Mike 11, *Reference Manual; User Manual*
8. **8.** ***, http://www.rowater.ro/HHHRI/HHHRI.aspx