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THE IDENTIFICATION AND UNDERSTANDING OF THE RESILIENCE OF THE WATERSHED

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Abstract: This paper analyses how catchment resilience can be used to manage and regulate catchments. Catchments are complex systems with interrelated natural, social, and technical aspects. The resilience of the river basin is the ability to maintain its characteristic state in the system after hydrological disturbances, such as drought and floods, but not only.
Keywords: catchment, resilience, flooding, concept

1. INTRODUCTION

Floods are a major problem at the global level, caused mainly by climate change, urbanization, deforestation of large areas, etc. To deal with the growing threats, it is essential to understand flooding resilience, how watersheds can withstand, and especially how to recover after floods.

The resilience of the river basin is the ability to maintain its characteristic state in the system after hydrological disturbances, such as drought and floods, but not only.

As a result of climate change, the frequency of floods is increasing, and their intensity is continuously increasing. Compared to other types of disasters, even at the moment, floods are in first place in terms of the number of human victims. According to a UN analysis, 15% of the total human casualties resulting from natural disasters are caused by floods.

2. RESILIENCE WATERSHED

This study aims to identify, understand, and analyze flood resilience at the level of the basin area with different characteristics and, thus, help to develop effective intervention strategies for sustainable development.

Watershed resilience represents the condition and interactions of the terrestrial and aquatic components of a watershed in both the built and natural environment, including wetlands, streams, rivers, lakes, forests, grasslands, urban areas, and farmland [18], [19].

This watershed resilience brings an important geospatial and resource-focused perspective on ecological resilience management [17].

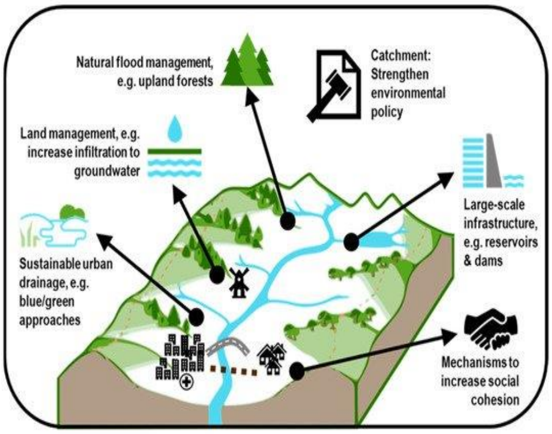

Figure 1. Perspectives on River Catchment Resilience

Figure 2 shows these three sub-systems as coupled in an inextricable way. The catchments are complex systems with interrelated natural, social, and technical aspects.

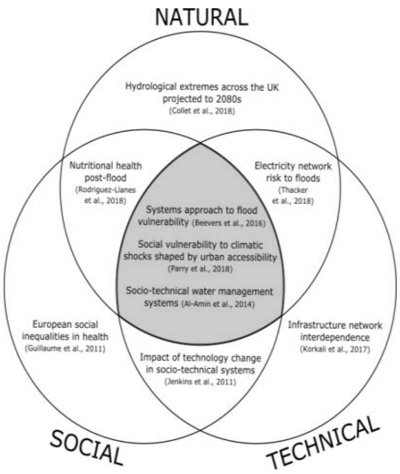

Figure 2. Interacting natural-social-technical sub-systems occurring within a catchment

To be able to understand how different water bodies respond to anthropogenic pressures from the watershed, its parameters such as land cover, slope, soil types, etc. have been analyzed to explain the impact.

As human reliance on resources grows worldwide, scientists and policymakers have begun to change the

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way they study water in social-ecological systems, focusing on the connections between human society and the environment rather than on the dynamics of just one component [15], [16]. (figure 3)

The comparison of the resilience index based on the flooding volume and flooding damage is shown in Figure 3 [12].

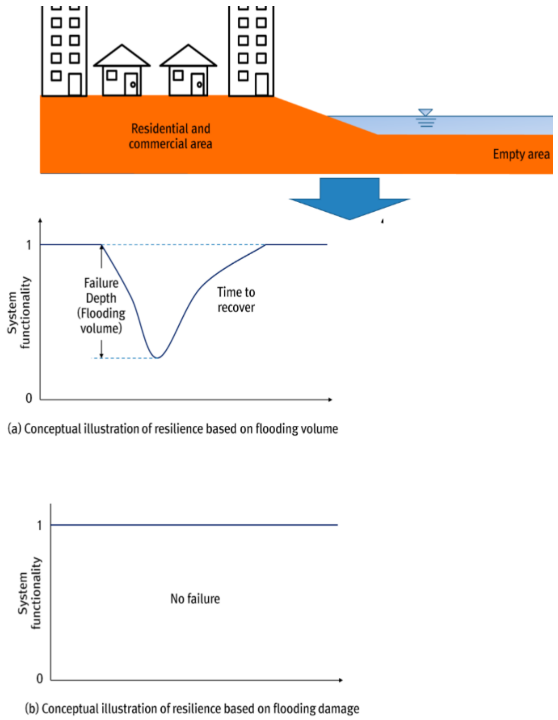

Figure 3. Comparison of resilience index based on flooding volume and flooding damage

Water, soil, and plants are the main components that determine land field productivity. This variety of forms affects the quality and the quantity accepted by the interior rivers, determining the increase of flow, erosion, silting, and pollution.

In parallel, the land field use modification affects the water retaining duration and the stages of precipitation generation: surface runoff, the quantity of water retained in soil, evaporation, and groundwater (phreatic).

For studying the dependency between factors that contributes to the water ecosystem dynamics are made field measurements for the characteristic of ecotones and is realized a correlative analysis in order to visualize the interaction between those.

3. RESULTS

The intensity of natural hazards, such as floods, is exacerbated by deforestation, poor management of water resources, etc. (Figure 4).

In Romania, there are three categories of hazards: climatic and hydrological (storms, hail, floods, drought, etc.), geomorphological (landslides, collapses, land subsidence, etc.), and seismic (earthquakes).
[http://www.siguranta.ro/full/glosare_105_2.html]

Figure 4. Barzava River flooding of 2005

In April 2005, the rivers in the Banat hydrographic area recorded the highest elevations in the entire series of observations, which had the effect of spilling the dikes on the Timiş and Bârzava rivers.

At the beginning of the period 14-26 April 2005, in a time interval of 24 - 36 hours, in entire Banat Hydrographical Area registered rainfalls of 60-95 l/mp, their effect overlapping the snowmelt in the mountainous area (Ţarcu mountains – Timiş River Basin) which resulted in precipitations equivalent of 169-473 l/mp, the runoff being eased towards the riverbeds by the soil saturation because of the previous precipitations.

The heavy rainfalls between 19-22 April led to new flood waves overlapping the first one's c On April 17, 2005, up to 40 l /m2 precipitations warnings are received and on April 19 a new hydrological forecast is sent previewed by a warning regarding the possibility of dike overtopping and breaching on Timiş River in the border area. (figure 5)

The impact was inevitable, so that on April 20, 2005, around 12.00 o'clock the dykes collapsed causing two breaches (figure 6).

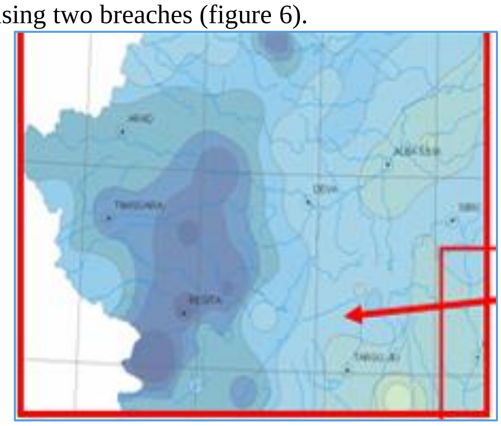

Figure 5. The monthly amount of precipitation, April 2005

Figure 6. The breaches on River Timiş

It was estimated that the volume of water entering the premises protected by the right dike of the Timiş River was approx. 250 million cubic meters and the flooded surface is approx. 25,000 ha, which in lowland and flat terrain would correspond to an average depth of 1 m. (figure 7)

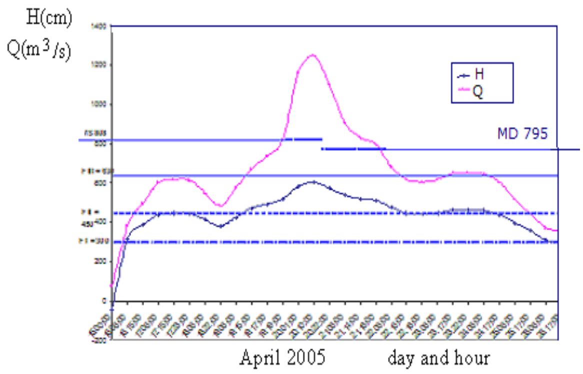

Figure 7. The levels and discharges hydrograph on Timiş river at Şag for 15 - 26.04.2005

The risk evaluation covers risk perception and the decision regarding the tolerance of a safety risk. The measures of risk contain structural measures and nonstructural measures – structural for the reduction of moment floods and future floods.

The measures for pre-floods are taken before the flood's phenomena happen.

To concept can be distinguished:

- prevent the floods and the derogatory impact of floods

- the status of preparing to be the capacity of ensuring an efficient answer of the impact risk, including the favorite emitting, and preventing and the temporary evacuation of the population from flooded areas.

Post-flooded measures –contain all the decisions and actions taken after the natural hazard phenomena. Climate change will lead to an intensification of the hydrological cycle causing more severe droughts in some regions and floods in others.

The integrated management of water resources is based in accordance with the provisions of the Framework Directive 2000/60 of the European Union, the Management Plan of the river basin. With the help of these management plans carried out over a certain duration at the river basin level, we identify the measures taken to achieve good water status to use them sustainably.

The activities for the implementation of the Water Framework Directive (DC 2000/60 / EC) and the Directive on the assessment and management of flood risk (2007) represent important challenges for ensuring the management of water resources in the context of sustainable development.

Restoration and enhancement of degraded or lost wetlands, riparian areas, and floodplains within priority watersheds to improve flood and drought resiliency.

Along with the increase in the number of the population and economic development, the way of valorization of the lands located in the flood zone, which in some situations have become very valuable, has also changed.

Figure 8. Banat River Basin flooding of 2005

Besides the ecological and social effects, must take into consideration and the economical effects produced by accidental floods, are determined by the destruction of buildings, commercial, and industrial places, roads, dams, etc. The floods have indirect consequences on underground water too. (figure 8)

Evaluation of the impact on the environment determinate floods may contain enumeration and quantitative estimation of the indirect effects, and estimation of the qualitative effects. From the point of view of the floods at hydrometric stations in Banat River Basin, it is observed that most of the floods occurred between February and June.

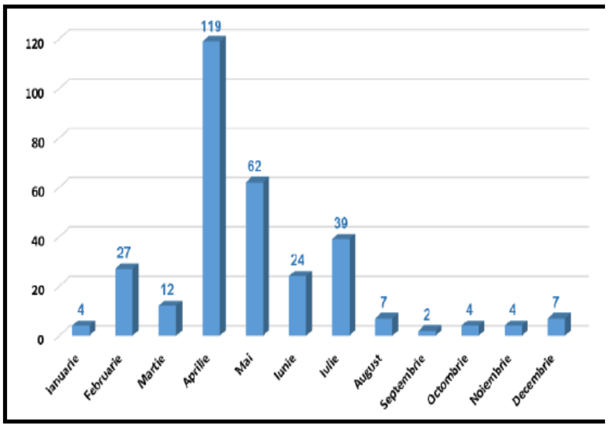

Figure 9. Floods recorded at the hydrometric stations in the Banat area

Ecological effects of the floods, pollution of water, alluvial deposits on the affected lands, and biotope modification of the flooded areas, influence in a negative way the environment.

Taking into consideration the multitude of direct or indirect effects of floods, the evaluation of the damages is a very delicate operation. (figure 9)

The April 2000 flood was of pluvial-naive origin, with its formation contributing to both the amount of precipitation and the snow layer existing at that time. On April 5, between 5 and 10, the first kernel of the rain was produced with 200 mm / m2 and with high intensities. In April 5 interval, the second nucleus of the rain occurred, the rainfall quantities ranging from 43.1 to 121 mm in mountainous areas and high hills and between 8.6 - 41.1 mm in plain areas.

4. DISCUSSIONS. CONCLUSIONS

The management of situations created by high waters is an important factor in the population protection activity for all countries of the world and especially for the highly developed ones.

From the developed analysis, it can be distinguished a set of specific conclusions about the resilience process:

- Water Framework Directive gives a large framework to the development process of the program of measures in order to reach the water good status or the water's ecological, potential;
- using specific modeling programs based on knowledge rules creation for the ecological functions can ease the cost-efficiency analysis of the programs of measures by reducing time and the personnel involved in the process;
- it can be proposed a set of specific measures for each alteration type, that can then pass through the cost-efficiency analysis steps for personalized prioritization function of local, hydrologic, hydro morphologic, economic, and social conditions.

To have efficient management of the situations created by high waters, all the countries of the world have developed warning methods, standards, norms, and regulations that are increasingly perfected on the basis of which the bodies responsible for the management of these situations act.

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