Impact on storm water runoff

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Abstract. Hydrological changes, which take place in a hydrographic basin, are due to the rapid growth of urbanization of areas both nationally and globally. Modification of waterproof surfaces, such as streets, sidewalks, parking lots, etc. causes negative changes in the hydrological cycle, as well as groundwater resources, deterioration of water quality, but also ecosystems. In recent years, climate change and poor rainwater management in urban areas have led to a major risk of flooding. This paper analyzes changes in the types of land use coverage and their impact on rainwater discharge, using ArcGIS software.

1 Introduction

The change of the land cover influences the hydrological cycle, as well as the leakage of surface and groundwater. Previous research shows that changing soil cover affects the hydrological response on a number of spatial scales, affecting both the balance between precipitation and evaporation, as well as the leakage response by changing the physical structure of the vegetation and the surface roughness [1-3].

In recent years, the rapid development of urban areas, where the presence of impermeable surfaces is high, has led to increases in volumes and surface runoff. These urbanized areas are usually composed of a variety of land coverings, such as roads, buildings, parking lots, and green spaces, the urban hydrological cycle being significantly affected by the various land coverings.

In a natural system, the surface is permeable, so that rain can infiltrate the earth, recharging the groundwater level. Urban forests help manage leakage by reducing the amount of leaks entering rainwater and sewerage systems. Trees reduce leakage through perspiration, interception, reduced soil erosion, and increased soil absorption capacity. Therefore, urban forests can reduce floods in the event of extreme rainfall, while improving the overall water quality of the city [4, 5].

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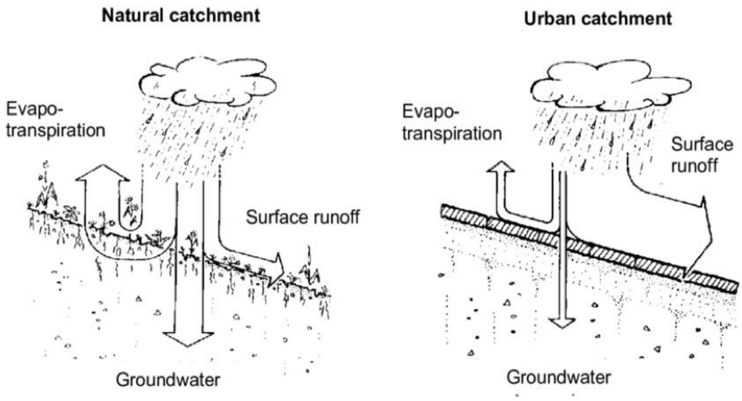

Fig. 1. The annual volumetric hydrological balance of a natural catchment (with vegetation cover) and an urbanized catchment.

The urban hydrological system is totally different from the natural hydrological system both by changes in hydrological factors and by the appearance of new elements. The waterproof areas next to the water supply network are the key elements in the urban hydrological system [6].

The development of impervious surfaces alters the hydrology of a watershed and has the potential to adversely affect water quality and aquatic habitat, and this transformation increases the amount of storm water runoff from a watershed, decreases infiltration, and alters natural drainage patterns. The significant increase in water in rivers is generally due to the leakage of water from slopes and impermeable surfaces in the urban area. The growth of impermeable areas in the urban area causes floods in the respective areas [7].

2 Methodology

The figure below shows the various processes performed in the GIS program, starting from DEM, which has an important role in the hydrological studies of the chosen river basin.

One of the most commonly used equations for calculating the peak flow in small areas is the rational formula, which has the following calculation relationship:

$$Q = \frac{C*I*A}{K_u} \tag{1}$$

where: Q = flow, m^3/s
C = dimensionless runoff coefficient
I = rainfall intensity, mm/hr
A = drainage area, hectares, ha (acres)
Ku = units conversion factor equal

The coefficient of leakage from the above equation is determined by the covering of the ground, the initial humidity of the soil, and other hydrological parameters.

In the literature, the effect of urbanization on rain floods is assessed from several perspectives, namely, one refers to the estimation of temporal variations of the hydrological characteristics of the maximum leakage due to the intensification of the urbanization processes and the other to the evaluation of the spatial changes of the flood risk areas [8].

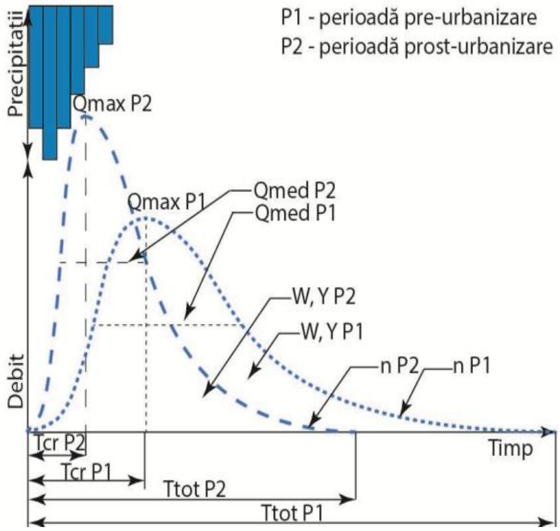

Fig. 2. Hydrograph of floods in the pre- and post-urbanization period.

3 Results and discussions

The impact of land use in this method can be assessed by assessing the shape of the flood hydrograph. It was chosen as the urban study area, Timisoara locality (Fig. 3), for which maps for the years 1990 and 2018 were extracted from CORINE Land Cover.

Fig. 3. The study area – Timisoara.

Vegetation is extremely important for rainwater drainage, as it promotes infiltration and prevents erosion. Based on satellite images of land cover, and river basin soil, it is analyzed how over the years the impermeability area changes and what is the impact on the water leak in the urban area.

The specialized literature shows that, in developed basins with significant residential, commercial, and industrial areas, the general watershed impermeability often exceeds ecological stress thresholds.

This development can dramatically alter the hydrologic regime or watershed as a result of increases in impervious surfaces, and the impacts of development on hydrology may include increased runoff volume and peak discharges, decreased runoff travel time, reduced stream baseflow, increased flow velocity during storms, etc. Deforestation, urbanization, and other land use land cover activities can significantly alter the seasonal and annual distribution of soil loss and surface runoff.

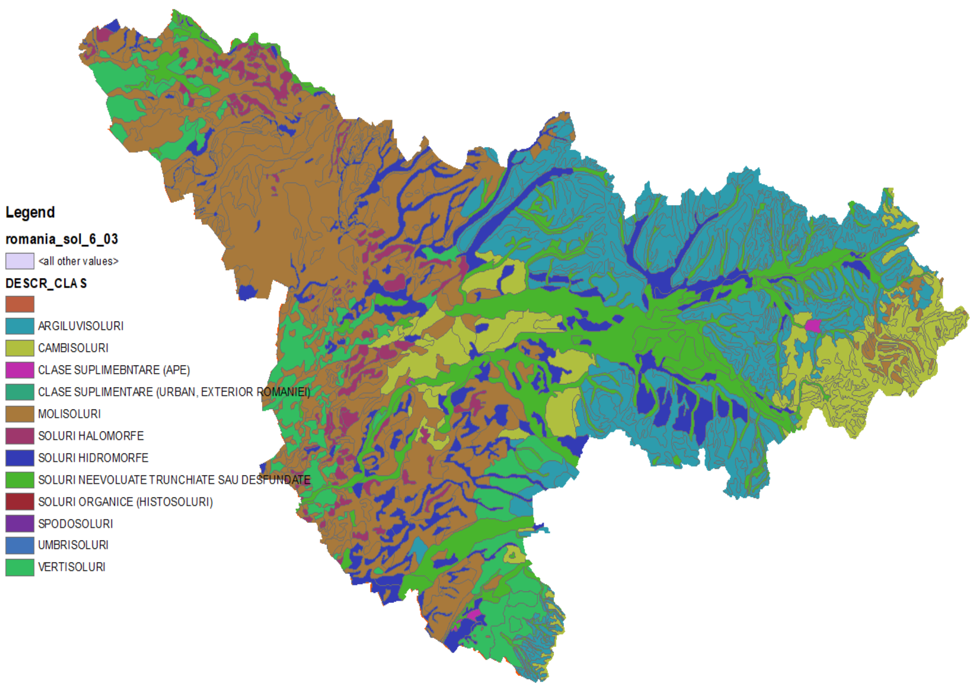

Fig. 4. The map soil of Timisoara.

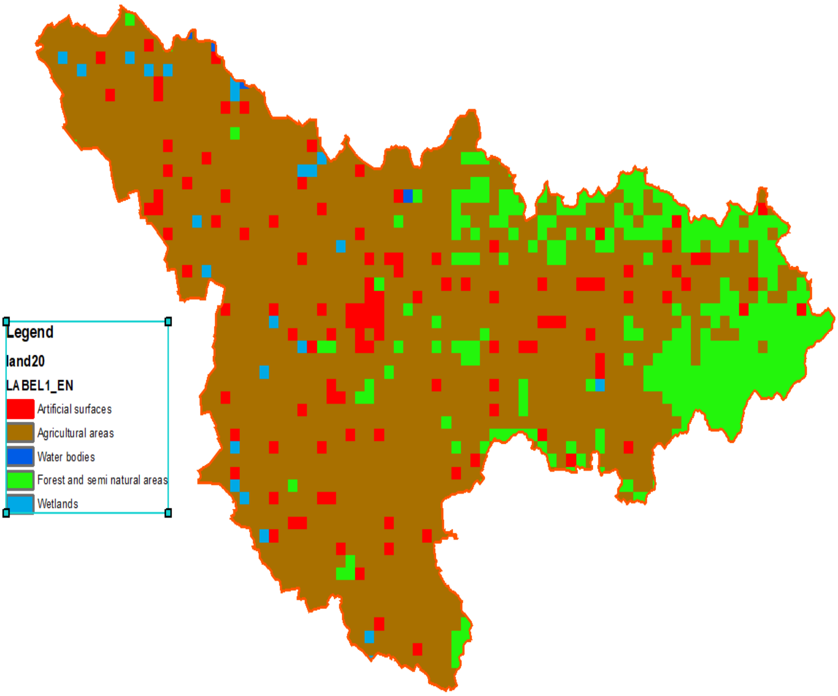

Fig. 5. The map land cover of Timisoara in the past - pre urbanization.

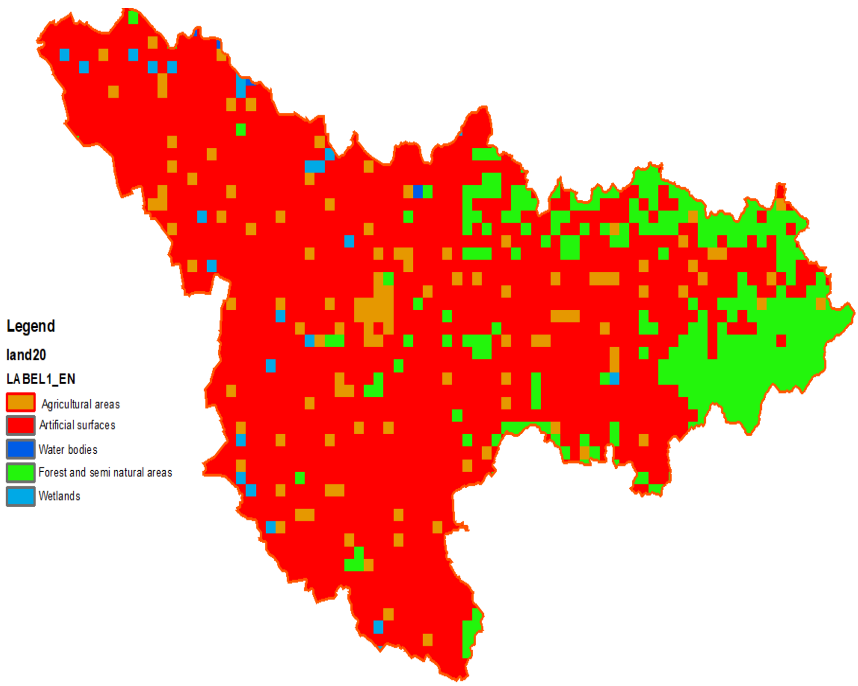

Fig. 6. The map land cover of Timisoara in the present – post urbanization.

It is observed that with the acceleration of urbanization, the coverage of the land changes, overlooking the waterproof areas, resulting in the impact of human activities on the hydrological system, because the change in LU has been recognized as a key factor affecting hydrological regimes, including urban spills and floods. Therefore, urbanization and human settlements will be threatened to exposure to floods due to the amount of leakage. The analysis of flood events in periods of high water in an urban area is essential for achieving and addressing this goal. On the other hand, the change in LU without management leads to more and more leaks in urban areas.

References

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