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Evaluating the Impact of Land Use Change on Increasing Runoff in Khorramabad Watershed Via HEC-HMS Model

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Extended Abstract

Introduction: Various problems regarding watershed issues that have occurred because of human activities and economic development, are attracting increasing attention. Subsequently, many researchers are concerned about the effect of land use change on runoff which depends on the size, average slope, and the watershed's baseline land cover characteristics. Moreover, the extent of the land-use change effect on simulated runoff depends on the hydrological model used and the processes considered in this regard. Any change in Land Cover and Land Use (LCLU) would affect the runoff characteristics of a drainage basin to a great extent, which, in turn, influences the region's surface water and groundwater availability, leading to further changes in LCLU. Therefore, it is necessary to evaluate the effect LCLU changes on a region's runoff characteristics in general and on small watershed levels (sub-basin levels) in particular.

Land use changes in developing countries usually affect forests and national reserves. This is due to human activities such as creating settlements, developing agriculture, and encroaching on forestlands. Poor hydrological measuring infrastructure and lack of expertise are amongst the main factors which prevents a comprehensive analyses of catchment scenarios and their impact on the environment. Changes in climate and land use/cover (LUC) play an important role in altering the runoff trend. Climate change influences the runoff and the regional water balance by affecting precipitation and temperature rates. While precipitation is particularly crucial in determining the amount of water for runoff, temperature mainly affects evapotranspiration, which is regarded as a kind of loss for runoff formation. Moreover, changes in LUC influence the runoff routing trend.

For instance, the destruction of a forest may affect soil permeability and further alter the runoff generation trend. On the other hand, an increase in impermeability of the surface areas' soil because of urbanization can decrease the infiltration rate and concentration time, leading in turn to an increased in surface runoff. As changes in runoff considerably affect water resources, investigation of the runoff responses to climate and LUC changes is essential for the preservation pf local ecology and sustainable utilization of water resources. Furthermore,

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environmental scientists and local planners need a model for estimating the impacts of land-use change on groundwater recharge, water supply, and wetland hydrology.

There are several evidences indicating that changes in land cover have influenced the hydrological regime of various river basins. Furthermore, the effects of climate change on hydrological cycle and the runoff behavior of river catchments have largely been discussed in recent years. However, it is currently not clear how, to what extent, and at which spatial scale such environmental changes are likely to affect storm runoff generation, and consequently on the rivers' flood discharges. Changes in Land Cover and Land Use (LCLU) affect to a great extent the runoff characteristics of a drainage basin, which in turn, influence the surface and groundwater availability of the area, leading to further change in LCLU.

Land use/land cover (LULC) change is a dynamic and complex process that can be exacerbated by a number of human activities, including an increase in human population and population response to economic opportunities. While in the past, the rivers' corrective operations were focused on building constructs for controlling the rivers' flow and implementing construct operations, hydrological consequences of climate change and land use changes, flood plains' economic and ecological developments, and the alteration of social views regarding rivers' safety and ecological functions have directed the attentions to the more sustainable use of rivers. Unfortunately, river systems have not been monitored with sufficient spatiotemporal resolution over long periods to deal with the above-mentioned issues through field observations alone. Therefore, to make appropriate management decisions for watershed basins, the effect of land use change on runoff should be evaluated based on hydrological models.

Materials and methods: To assess the impact of land use changes on the Khorramabad watershed's hydrological behavior, land use map, CN and the runoff coefficient maps was prepared for 1985, 2000, and 2016, using Landsat satellite imagery. Moreover, HEC HMS computer model was used for modeling rainfall-runoff.

Results: The study's results showed that the change in the region's land use, especially the reduction of forest lands and increase of urban areas, has led to an increase in peak-flow discharge, an increase of runoff volume, the reduction of concentration time and lag time, the reduction of the time required for reaching the hydrograph time, and decrease of the watershed's runoff, with the watershed's peak discharge changed by 54.195 to 150 percent in 1985-2000 period, 82.867 to 210.714 percent in 1985-2016 percent, and 18.594 to 24.285 in 2000-2016, period, and the concentration time and the flood's peak discharge time changed by -6.99 and -5.02 percent in 1985-2016 period, respectively. Furthermore, the results of implementing the model on precipitations with return periods indicated that with an increase in return time, the amount of discharge changes decreased. For instance, in 1985-2016 period, the increase in the discharge rate in return times of 2 and 100 years was 22.55 and 16.87, respectively.

Discussion and Conclusion: Land use changes vary in different parts of a land, including the conversion of forest lands to agricultural ones, ranch and agricultural lands to residential and urban areas, and agricultural lands into abandoned ones. In the north and northwestern part of the basin, severe destruction of forests and their conversion to agricultural lands, and in the south and southwestern part of the basin, the conversion of agricultural and rangeland lands into residential and urban areas was observed. Moreover, CN has particularly increased in these areas under the influence of land-use changes.

Keywords: HEC HMS Model, Peak discharge, Runoff volume, Return period.