# ON THE SIMULATION OF THE EFFECT OF CHANGING THE USE OF URBAN LAND ON BASIN FLOOD RISE (*CASE STUDY: BASIN OF GERMI TOWN, IRAN*)

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**Abstract**- *In recent decades, one of the major reasons for risen flood flows in Northwest of Iran has been the changes in land use and urban land development. The goal of this paper is to investigate the role of changing the urban land use on flood rise of drainage basins. In this study, HEC-HMS hydrological model was used to evaluate the impact of land use change on peak discharge and basin flood volume in Germi Town in the Northwest of Iran. The reason behind choosing this hydrological model is because of taking into account the weather conditions, soil characteristics, and land use in simultaneous condition. In this research, hydrologic soil group maps with the HEC-HMS model are calibrated and validated in terms of runoff-rainfal data. The obtained results divulged that due to changes in land use and rangeland degradation, flood peak discharge have increased in different return periods. In addition, the simulation of two scenarios; pre-development and post-development conditions and their effects on peak flood discharge and the river normal flow were performed.*

***Keywords:*** *Land use, Urban basin, Urban flood, Runoff-rainfal data.*

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## 1. Introduction

Hydrology is related to water knowledge across the earth which is in attention of human for many years. In hydrological studies like the other branches of engineering, mathematical formulas and equations as well as experimental results for field engineering are used as the means of achieving the desired objectives. Hydrological studies are primarily difficult to achieve definitive results and this is mainly due to the relatively new science of hydrology. Therefore, the theoretical discussion, formulas and equations, engineering estimates and judgments of informed speculation of experts in this field cannot overcome all the problems of water projects. Nowadays, Runoff-Rainfall Models are extensively developed in this field and Rational Methods are gradually replaced by models for which not only the maximum discharge rate, but also the flow regime of the surface water is calculated (Giorgio, Attilio & Armando, 2005).

KosrouShahi and Saghafin (2006) used HEC-HMS model to determine the sensitivity of some of the factors affecting on flood rise of basin watersheds using the outlet hydrograph analysis of Damavand basins (Iran). The obtained results have shown that the hydrological behaviour under the basins is nonlinear respect to the output and many factors are involved in flood rise under basins from the viewpoint of effect on output flood as well as the most critical basin using the mentioned method (Howkis, 1978).

Neshat and Sedghi (2007) in a study on watershed of Bagh-Molk in Khuzestan Province of Iran, have used the data of runoff-rainfall model and HEC-HMS implementation to calculate the CN of region for which the obtained results are in accordance with the model curve (Khosroshahi & Saghafi, 2006). VieuxB.E et. al.used Vefflomodelto predict flash floods and a debris flow threatened a basin in Taiwan. The used model was able to predict water level in each point of the basin. Finally, after simulation of flow and then comparing it with the hydrograph model the capability of the model was observed. Based on this hydrograph, the output included three peak points, the model could appropriately simulate two peak points (of three points) and the third point had not proper accuracy led to rise of model error (Neshat & Sedghi. 2005 ).

Comoronic et. al., investigated the impact of land use change in flood rise of the Po River basin fill near the city of Da Bolgna. The conducted study used runoff-rainfall model and a hydrodynamic model. Results showed the effect of land use changes on the simulated hydrograph (Radmanesh, Jahangir, Abdolkarim & AliMohammad, 2005).

Radmaneshet. al., evaluated HEC-HMS model to predict runoff from precipitation in the Yellow River Basin located in southwest of Iran. In this study, six showers observed in the study area and surrounding region with six flood basin which were selected as the output. Then, the model parameters were used in the SCS method. The obtained results indicate that there is a proper fit for peak hydrograph and simulated hydrograph. The time difference between reaching the peak of the hydrograph in all examined cases is equal to or less than one hour (1972).

Amir Ahmadi and Sheeran, in a study, used a simulated hydrological model of S-HEC-HM for the rehabilitation of basin and assessment of flood hydrograph and flood sensitivity analysis in terms oftwo changing parameters of manageable geomorphology in flood including slope, and CN. The results stated that the cooperation of basins in output flood is not essentially in proportion of basins discharge. The study was done in Krone Plain in the east part of Isfahan, Iran (1975).

Kamali, Bahari and SeyedJamshidMousavi, in the research focused on the basin of the Samar River in Gorgan, Iran, carried out by connecting the HEC-HMS model meta-search algorithm to optimize the PSO parameters of the model with the minimum error of the model prediction with single and multi-objective models. The results demonstrated the importance of choosing the objective function in the optimal values of the model parameters (1973).

## 2. Materials and Methods

### *2.1. HEC-HMS Model*

Model HEC-HMS, a model for simulating the hydrological basin, works in Windows environment and the original model is HEC-1 which has been used for many years in the basin of different countries, including Iran, to simulate the watersheds. HEC-HMS model for flood simulation consisting of two major models: runoff-rainfall model (Loss method transform) and flood drainage model selection process (Routing method). This model to transform the rainfall to runoff model used constant value methods, SMA model (Soil Moisture Accounting), networked model of SMA, curve number method (Cure Number), networked curve number method, the method of Gurden-Amptand zero loss method. Clark hydrograph method (Clark unit Hydrograph), cinematic wave, Clark mode Hydrograph (Mode clarkUH), Snyder hydrographs, S user hydrograph, the user unit hydrograph and unit hydrograph, SCS were used for the conversion of runoff to hydrograph model. In this study, according to information from the

district in order to calculate losses of different use, the method of curve number and to convert runoff to the SCS hydrograph were used. HEC-HMS model used standard Hi chon Musking umKonj method, Lag Time, Muskingum, Modified pulse, MuskingumKonjof eight points and the cinematic wave for the detection of flooding in streams.

### 2.2. *Case Study*

The study area is located in Ardebil province which is of catchment basins of the watershed in northwest of Iran. In this part of study, the basin of Germi Town is considered for the following aims:

- Understanding the morphology and physiography of the basin
- Determining the maximum water flow during flood

According to the visits of the study area and the evaluation of maps of areas, areas from which the surface water flows through the main channel discharge will be determined.

### 2.3. *Determination of hydrologic soil groups and curve number (CN)*

Vegetation coverage of basin together with identification of soil type and its permeability are important in estimating the curve number of the watershed. Therefore, based on classification in SCS method for the four soil hydrologic groups A, B, and D of the curve number CN for each sub-basin were studied.

### 2.4. *Rainfall intensity*

Intensity of precipitation for which the time is equal to the duration of the basin concentration is considered for discharge calculations. Thus, based on the division of the city into different sub-basins, time of concentration is calculated for each of the main and secondary lines. Then by the curve of intensity-duration-frequency stations and the choice between the 25-year return floods with the maximum rainfall intensity is chosen so each sub0basin calculation as follows:

Table 1.Amount of rainfall intensity based on the duration

| Sub-basin | Calculated concentration time (minute) | Maximum rainfall Intensity |
|---|---|---|
| Sub-basin 1 | 76.01 | 21.96 |

| | | |
|---|---|---|
| Sub-basin 2 | 79.67 | 19.51 |

The amount of rainfall intensity or duration (which is selected to be equal to concentration time) for each basin and sub-basin is determined. According to calculations the maximum rainfall of 20 mm per hour is considered to be the maximum rainfall intensity in the calculation of maximum runoff estimations.

## 3. Results and Discussion

Germi Town is located in the northwest of the Ardabil Province, Iran, in orbit 48 degrees 3 minutes east longitude and 39 degrees north and 1 minute. Catchment areas of the city are divided into two sub-basins 1 and sub-basin2.

Rainfall data from the most severe rainfall occurred in Germi Town has been recorded. In this part of paper, the basin hydrologic response of Germi Town during the shower was simulated. Using HEC-HMS model for the simulation of a project is dependent on the model and the data imported. To introduce the loss calculation, catchment runoff and base flow of Germi Town the methods of American soil conservation SCS, and SCS unit hydrograph model and Protozoan subsided were utilized. at first, a model with a current condition was created and then implemented, after that the effects of urban development on Germi Town basin model were imported and finally the results were compared. According to Figure 1 schematic of the catchment basin of Germi Town consists of two sub-basins; Subbasin-1 and Subbasin-2, two elements of interval Reach-1 and Reach-2, a binding element which is called Junction. Intervals 1 and 2 are depicted as the East Branch and West Branch, respectively, and the focus point or the outlet of basin has been shown that is the link or element Junction. After creating the physical elements of basin, the weather information is embedded into the model for which the rainfall hyetograph is shown in Figure 2. After entering data related to loss, runoff, base flow and interval Run model, the results were obtained.

Figure 3 depicts the total hydrograph of the Germi Town's basin in the output point. From this figure, the effect of each sub-basin in flood rise and the effect of both sub-basins on the output point are obvious. Figures 4 and 5 illustrate the influence of each basin together with Hydrograph of rainfall in individual fashion. As shown in this figure, the effect of sub-basin 2on flood rise compared to sub-basin 1 was more and the peak discharge was 4.28 cubic meters per second.

This is likely due to urban coverage and the high steep of this part of the town which has less permeability such that the rainfall is changed to be runoff. Because of time delay in creation and transmission of flood in sub-basin due to the temporary storage in the path the path routing is also simulated and the results are given in figures.

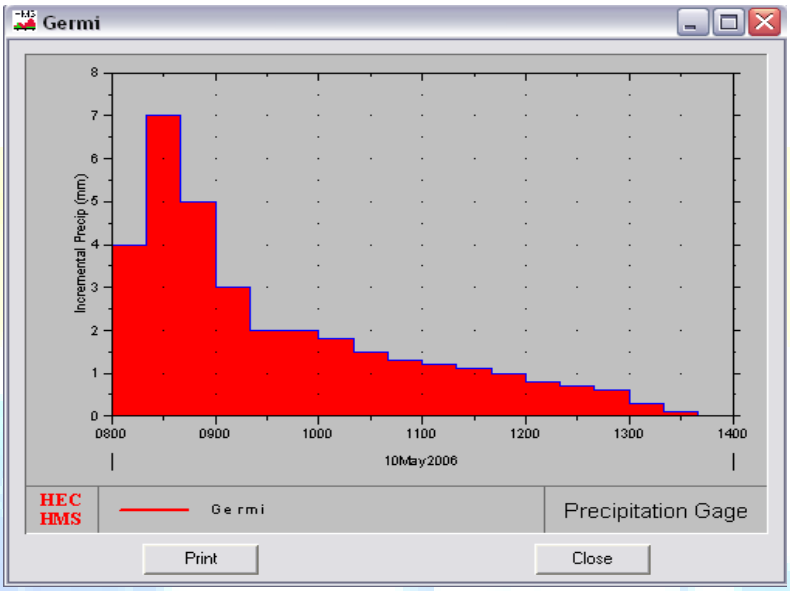


Figure 1. Hyetograph of the rainfall in weather station

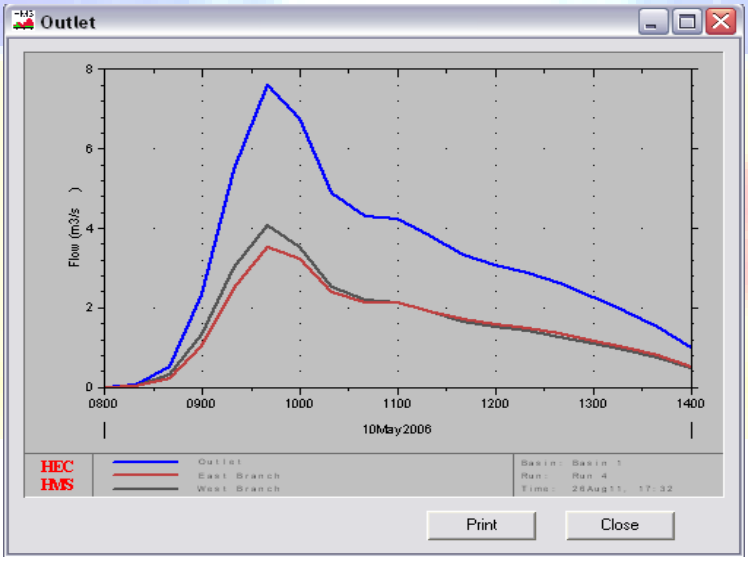


Figure 2. Total hydrograph of Germi Town's basins in output point

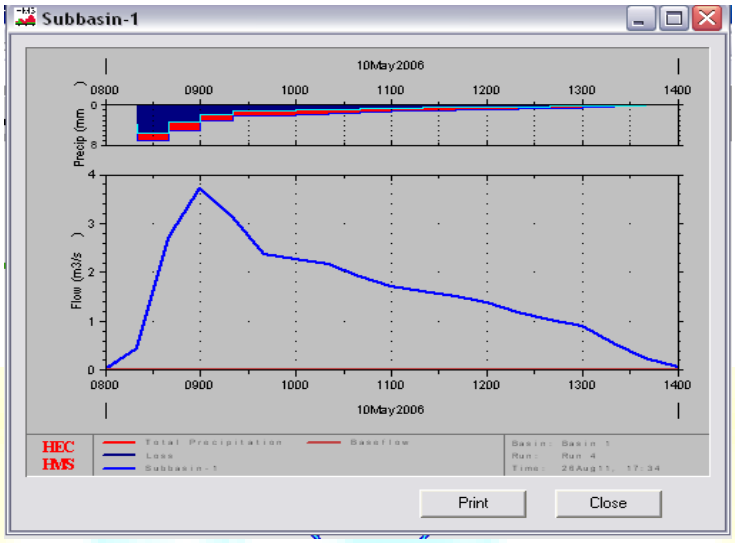


Figure 3. Hydrograph and Hyetograph of the sub-basin 1

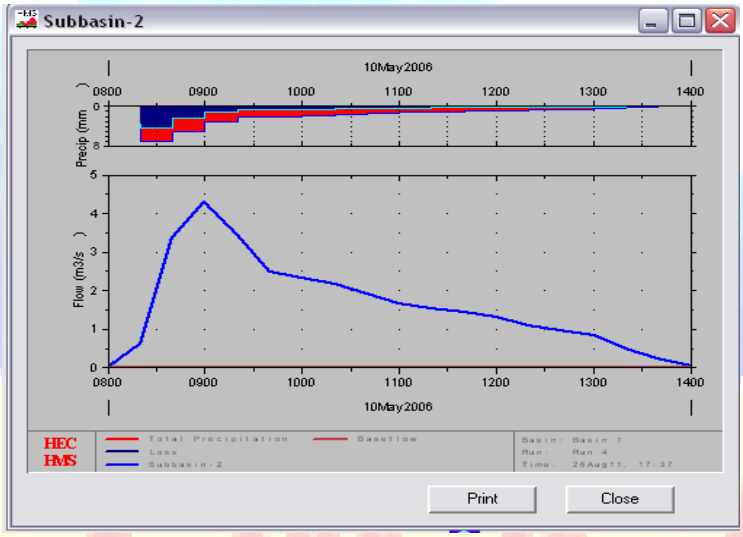


Figure 4. Hydrograph and Hyetograph of the sub-basin 2

The process of development in Germi Town for sub-basin 1 is done more than for sub-basin 2, bad topography conditions in the sub-basin 2 has made impossible the urban development in this area. Thus, the process of urbanism in the Germi Town basin is considered in sub-basins 1 and 2 with the changes in the values of the used parameters.

In this mode, by fixing the meteorological model and control characteristics, a modified basin model in which the urban development is considered will be created. After hydrological analysis of new mode basin, the comparisons of results reveal that urban development effect on hydrological response in Germi Town basin.

**Table 2. Comparison of the elements involved in the urban development in two modes**

| | Before development | After development | |
|---|---|---|---|
| **Sub-basin 1** | 3.7 | 6.42 | 42% |
| **Sub-basin 1** | 4.28 | 5.65 | 24% |
| **Basin output** | 7.58 | 11.56 | 34% |

The comparison of results between peak discharges in effected elements from urban development is shown in two modes in Table 2. It is obvious that peak discharge in sub-basin 1 has increased compared to the mode before urban development at 42%. This figure is at 24% for the sub-basin 2.

The increase in the peak area ratio of urban development in the city would be about 34%, at whole. Therefore, it is required to construct appropriate structures for guiding the design and construction of surface water.

## 4. Conclusion

This model is prepared and evaluated in the studied area. After sensitivity analysis, the efficacy of the used model was examined and the following results were extracted:

1. The created flood hydrograph using sub-basins reveal that the peak discharge increases with the increase in area, then, the area increase is not proportional to the flood discharge increase and it is possible that smaller basins create large discharges.
2. Comparisons between scenarios reveal that with the dwelling urban development increases the possibility of flood rise.
3. With the change of curve number CN, the potential intense of sub-basins are changed however the increase or decrease of CN have not identical effect on flood rise of basin and the reason is behind the effect of CN on time delay.
4. With the revealed effect of sub-basins on flood potential of basin it is possible to arrange priority in improvement operation to decrease the flood hazard in terms of basins flood intensity.
5. Soil permeability of the basin has a direct relation with the runoff value such that the permeable soils create more floods while the impermeable soils act in reverse direction.
6. Soil permeability is not the only factor affecting on flood rise, and the basin shape, concentration time and geometrical parameters also effect on flood rise.

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