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Rainfall and Runoff Process Simulation Model Using HEC-HMS (Case study Catchment Basin Hospice)

[1]Reza Saadati Farokhsha, [2]Ehsan Saadati Farokhsha

[1]M. A., Department of Civil Engineering, Islamic Azad University, Shooshtar Branch, Shooshtar, Iran
[2]M. A., Department of Civil Engineering, Islamic Azad University, Khomein Branch, Khomein, Iran

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ABSTRACT

Today, GIS has been widely applied in various sciences. Especially in the fields of that spatial and temporal data are used at high levels. The sciences can be referred to the water resources that depend directly to the temporal and spatial data and information layers. In the hydrology and flood of an area specifically investigate the role of various factors such as the physical characteristics of the watershed and drainage basin hydrology, soils, vegetation, land use etc. is very important. Another point is that the simultaneous effects of these factors on the amount and timing of peak discharge at the watershed outlet using various additional programs offered by GIS will increase the accuracy and saving time. Hec-GeoHMS additional program has the ability to determine the physical characteristics of the drainage basin, and an outlet for use in HEC-HMS model. In this study, using the digital map, a digital layer of physical, hydrological basins monastery, is derived by extension from Hec-GeoHMS. In order to identify areas contributing runoff, the basin is divided into several sub-basins. We conclude that precipitation occurred at the beginning of the year 89 to May 1390 is composed of only two sub-basin runoff. In this study, seven rainfall events between April 1386 and May of 1390 were examined. Among them randomly selected 4 events and were simulated in the HEC-HMS program. Model Basin, precipitation losses SCS from curve number method and the conversion of rainfall to runoff and base flow SCS unit hydrograph method with a fixed monthly amount and the meteorological models, precipitation data using the entering data into the model and simulated rainfall - runoff has been done. After calibrating the model using the objective function of the error percentage in peak flow, determining the calculated optimal values of the fitted curve number, initial mortality was estimated precipitation and latency. In order to validate the model, two other rainfall events were used to calculate the optimum accuracy that was confirmed by simulated flood hydrograph in the two events. The results of this research can be important for the effective area of the basin runoff, considering the amount of moisture condition CN, high sensitivity to changes in catchment rainfall amounts of casualties among the best values in the calibration, high accuracy compared to the simulated peak flow runoff production can be mentioned.

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INTRODUCTION

The phenomenon of flood is one of the most complexes and most destructive natural events that more than any other natural disasters endanger the human life and property, and economic and social conditions of a society. In fact, flood is increasing the height of the water out of rivers and floodways and water handling and the occupied part of it is plain river flooded the area, which can cause damage to buildings and public facilities and human and animal waste, in some cases flooding due to rising water levels will affect the lake or sea in which case, the strong winds can be provided. When snow and rain, some water is absorbed by the soil and plants, the percentage of current remaining evaporates and is called runoff. Flood occurs when soil and vegetation cannot absorb rainfall and therefore a natural channel throughput stretch of river runoff is not generated. On average, approximately 30% of rainfall becomes runoff and snowmelt rate increases. Floods that occur in a different region called flood plains around the river forming.

River floods usually result from intense rainfall, which is sometimes combined with melting snow. River floods without the early warning or flood nasty little stream is called flood. The steep casualties of floods that occurred in small areas join major rivers are generally higher than flood casualties.

Corresponding Author: Reza Saadati Farokhsha, M. A., Department of Civil Engineering, Islamic Azad University, Shooshtar Branch, Shooshtar, Iran.

Advances in Environmental Biology, 8(9) Special 2014, Pages: 244-252

In Iran, the flooding is considered one of the most familiar words and culture that will lead to significant losses. Studies show that over a forty-year period (1331 to 1370), annual growth events of floods, is about 4 percent, and financial losses caused by about 6 percent. The trend of increased flooding in five decades shows that the number of floods in the past decade compared to the decade 30 to 70 is almost 10 times [7].

Goals:

This study has:

• achieving catchment hydrological behavior of the parameters affecting runoff using a hydrological model HEC-GoeHMS

• establish an appropriate basis for the development of the model and its use in other similar basins, and no statistics

• Evaluation of the hydrological losses in small watersheds

Literature:

Internal Investigation:

In Iran, several studies have examined the use of HEC-HMS model, Radmanesh *et al*., [12] were examined for predicting floods from rainfall in the Yellow River Basin, located in southwestern Iran, HEC-HMS model, the results suggest the proper fit of peak flow hydrographs were observed and simulated hydrographs. The difference in time to reach the peak in all cases studied, equal to or less than one hour, respectively.

Neshat and Sedghi [10] estimated the runoff using SCS soil conservation and HEC-HMS basin model Gardens - Property Khuzestan. In this study we characterized how were considered and studied the results of the estimation of rainfall into rainfall excess under the curve number CN with two different methods, one of the methods used to estimate the CN index of soil and vegetation and other surface observations and hydrological conditions associated with flooding, citing estimates from the CN method. Using the phenomenon of rainfall - runoff observations, relative to the calibrated HEC-HMS model was calculated action by the CN, the result of the curve number method, the model is consistent with the observed curves showed no results.

Shabanloo and Hamrang [14] showed in a study of flood hydrograph estimated by the models of integration and distribution in the catchment basin By HEC-HMS and HEC-GeoHMS programs, it is closer to the formation of surface flow hydrograph and precipitation formation in a modified distribution method ModClarc integrated approach towards the SCS hydrograph recorded in the basin.

Mahmudian *et al*., [9] conducted def. river flow modeling and Seyvan province using HEC-HMS model. The final results presented show that the HEC-HMS model has been developed, capable of good things, especially flood warning is blue. The results obtained in the Kur Basin and Seyvan, and the calibrated HEC-HMS model was successfully implemented. The researchers suggest a more accurate calibration can be the difference between model results and observations below.

External Research:

Suwanwerak [16] aims to develop and refine hydrologic model HEC-1 and GIS impacts of land, used changes on floods in the past and further and examined the effects of land use change on lowland basin upstream catchment flood model to assess and concluded that the loss of forests in the upstream watershed increases flood levels downstream of the basin.

Singh [15] with his research concluded that the runoff in a catchment depends on multiple factors, including how to watershed characteristics, dynamics, precipitation, infiltration and soil moisture conditions in the watershed have previously pointed out.

Razi in studies of flood estimation using a modeling system HEC-HMS Johor River, Malaysia based on 10-year study (2006-1996) showed the Johor River floods, the error in measured simulated flood peak SCS method and observed is equal to 4 percent of HEC-HMS based on the proposed an example that can be used as a tool for estimating peak flows.

The Study Area:

Hospice catchment area of 44/3611 hectares distances of approximately 120 kilometers from the provincial capital (Kermanshah) is located 70 kilometers from the city of Hamadan. Qavrud basin of River Basin is in the northern province of Kermanshah. Dinawar River Basin is located in the southern part of it. Basin is widespread at 80/56 47 34 ° to 37/31 53 34 degrees north latitude and 20/57 to 11 47 to 77/44 15 47 degrees east longitude. The project area was the north of the Han missing the mountain from the south to the mountains and mountains Doubreh fan Zal, the West and East Mountains of Mount Qyth missing minerals leads to growth. Inside the monastery in rural areas include Upper, Lower hospice, hospice center and Bagher Abad. Position towards Iran and Kermanshah hospice basin is presented in Figure 1.

Advances in Environmental Biology, 8(9) Special 2014, Pages: 244-252

Zal Wall Mount with Height mm inner height shall be considered as the most important. Catchment basin environment 26/30 km, the highest elevation of 2484 m and a minimum height of 1671 meters above sea level in the region is its output.

Road access to the project area through the falcon - Kamyaran located in the western part of the city is possible after driving 38 km to the village monastery in the middle of the middle reaches of the basin Access to different parts of the basin by way of sand and earth.

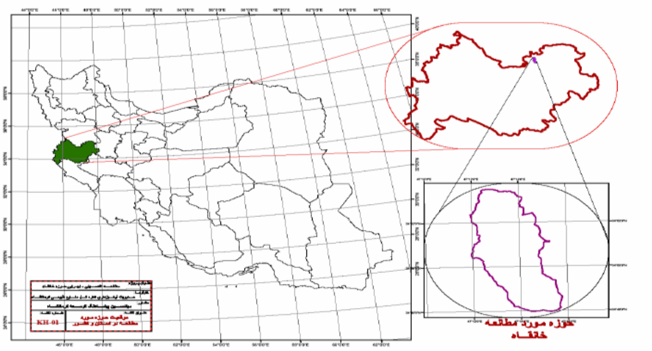

Fig. 1: The location of the basin towards the convent and province.

Results:

Process simulation and calibration of rainfall - runoff for an area of 11/36 km.

To simulate the process of rainfall - runoff hydrological model parameters need to be entered into the model. After entering the parameter estimation and the full introduction of the basin model, meteorological model and features HEC-HMS software environment can control the hydrological calculations by the program launched after entering data analysis software, and the end of all calculations for each event can be seen from the results of various forms of precipitation.

In this paper we simulate the entire catchment area of the monastery with 11/36 kilometers performed. Observed and simulated values showed significant differences (Table 1). Attempt to resolve the dispute by model calibration using optimal operation model and was done automatically, in this case, the command automatic calibration model HEC-HMS, rainfall-runoff simulation parameters include, CN, Ia and analyzed TLag the optimization. The results show that after calibration differences between simulated and measured peak discharge values were still significant after calibrating the flow rate calculation that is almost the same peak. The results of this work are shown in Table 4-2. The simulated and observed hydrograph curve before and after calibration forms (2 and 3) are shown.

Table 1: Results of the simulation model HEC-HMS with an area of 11/36 km..

The observation volume (mm)	Observed peak (m3/s)	T Lag (hr)	IA (mm)	CN	Computational volume (mm)	Computational Discharge (m3/s)	Occurrence of rains	Amount of precipitation (mm)	Station
2/46	2/68	0/84	30/0	55/8	3/196	4/356	1389/02/02 to 1389/02/10	31	Kondooleh

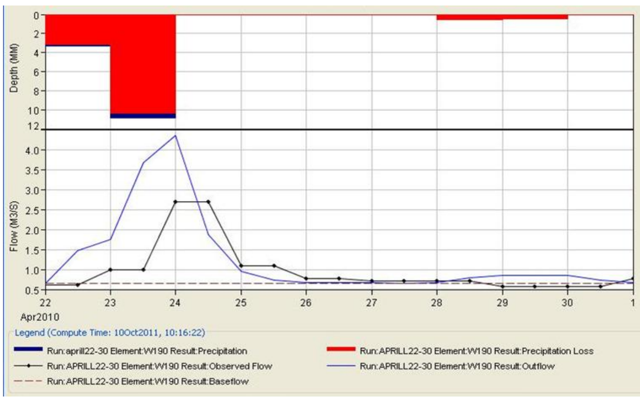

Fig. 2: Hydrograph date simulated and observed precipitation 02/02/1389 to 10/02/1389 Kndvlh station with an area of 11/36 km.

Table 2: Results of HEC-HMS model calibration with an area of 11/36 km..

observation volume (mm)	Observation discharge (m3/s)	T Lag (hr)	Ia (mm)	CN	Calculation volume (mm)	Calculation discharge (m3/s)	Occurrence of rains	Amount of precipitation (mm)	station
2/46	2/68	0/86	29/0	54/05	3/204	4/342	1389/02/02 to 1389/02/10	31	Kondooleh

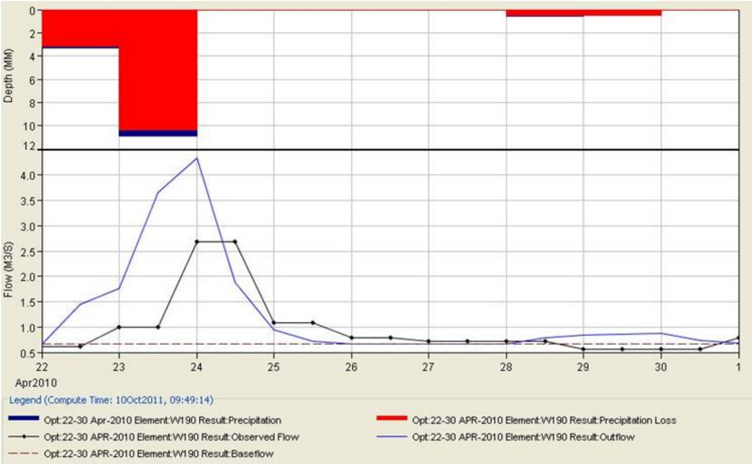

Fig. 3: Hydrograph date calibrated and observed precipitation 02/02/1389 to 10/02/1389 Kndvlh station with an area of 11/36 km.

Process Simulation of rainfall - Runoff for an Area of 86/10 km:

Simulation results show that working with the total area of the basin model numbers will not be accepted. It seems that all the sub-basin role are considered in creating the overall runoff, but only some of them are not effectively function as runoff. W650 and W660 in the sub basin measurements carried out in the name rainfall runoff that have occurred in the other sub although good rainfall occurred in 1390, but did not play a role in causing runoff. To rectify this, two sub-productive area floods were simulated as effective area (86/10 kilometers) that is very close to the measured runoff model results. So the research has continued with the assumption that the area has 86/10 km kilometer.

In this study, four rainfall events will be validated of 5/01/1386 to 1/10/1386, the date 09.08.1387 to 13.09.1387, 02.02.1389 to 10.02.1389 date history 08/02/1390 to 16/02/1390 for simulation and calibration stations located Kodooleh case of rain the event date and the date 01/24/1386 to 28/01/1386 19/09/1389 to 25/09/1389 for basin stations for hospice the simulation (effective area 86/10 km).

Simulated and observed hydrographs of date of the rainfall are shown respectively in Figures 4 to 7. Table 4-3 indicates the peak flow values, the total losses of precipitation, total precipitation, total base flow, direct runoff of simulated rainfall in each event.

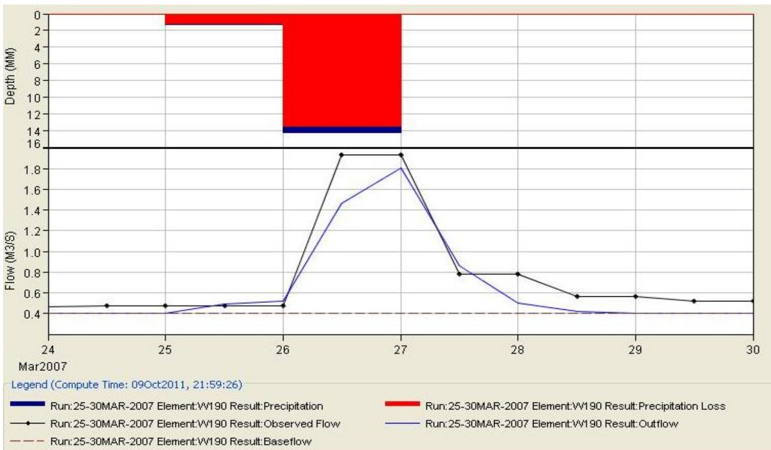

Fig. 4: Hydrograph date simulated and observed precipitation 01/05/1386 to 10/01/1386.

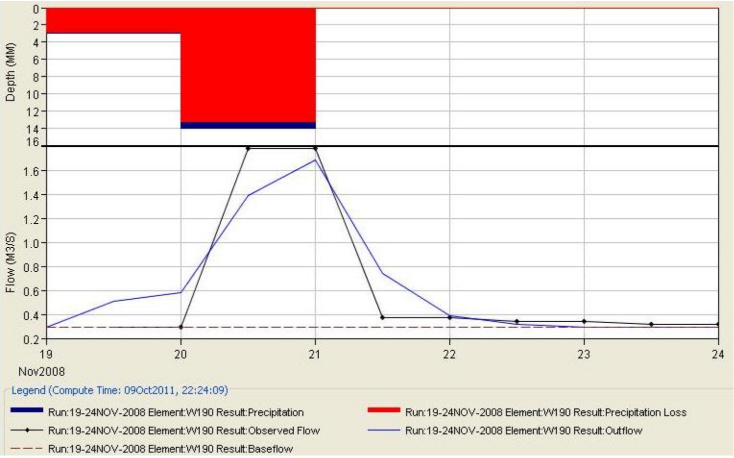

Fig. 5: Hydrograph date simulated and observed precipitation 08/09/1387 to 13/09/1387.

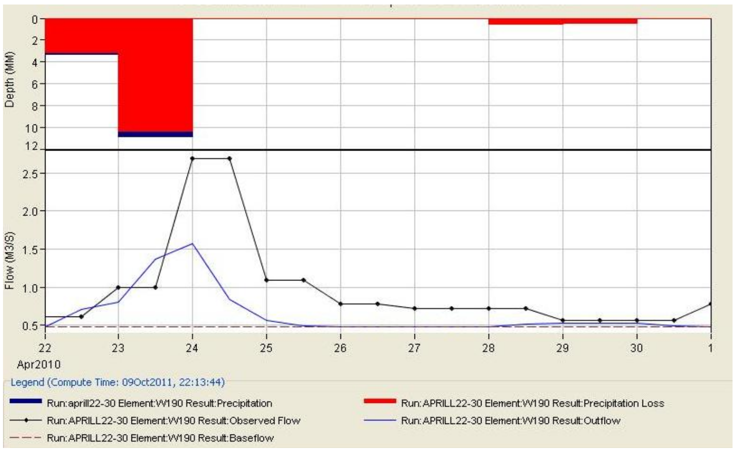

Fig. 6: Hydrograph date simulated and observed precipitation 02/02/1389 to 10/02/1389.

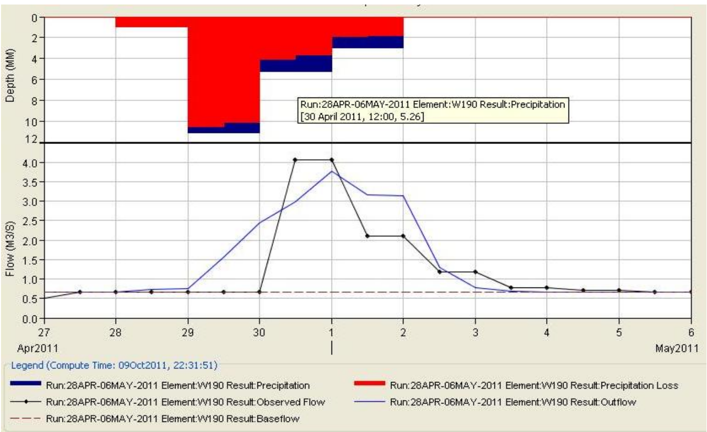

Fig. 7: Hydrograph date simulated and observed precipitation 08/02/1390 to 02/16/1390.

Table 3: Results of the simulation model HEC-HMS.

Observation is charge	CN	Calculation discharge m3/s)	Date of rain occurrence	Amount of rains (mm)	station
1/93	55/8	1/8	1386/01/05 to1386/01/10	31	Kondooleh
1/78	55/8	1/7	1387/09/08 to1387/09/13	34	
2/68	55/8	1/7	1389/02/02 to1389/02/10	30/6	
4/05	75	3/8	1390/02/08 to1390/02/16	40/7	

Advances in Environmental Biology, 8(9) Special 2014, Pages: 244-252

By comparing the observed and simulated hydrographs, the difference between the two hydrographs in terms of size and in terms of peak flow hydrograph, especially precipitation is observed in 89 year, so the next step will be calibrated parameters used in the simulation process.

Parameters of Model Calibration and Optimization of the Area 86/10 km:

Calibration is the process where the model parameters are introduced, with the aim to reach the similar results with real data and the natural. In this study, after an initial simulation model of rainfall with four previously runoffs have simulated rainfall event, the automatic and manual methods have been calibrated. Calibration is performed peak flow based on the objective function of error, because the main objective of this study is to investigate changes in peak flow. After calibration of the model parameters (CN and Ia) simulated hydrographs are closer to the observed hydrograph (Table 4).

Table 4: Results of the calibrated HEC-HMS model.

Ia (mm)	CN	Observation discharge	Calculation discharge (m3/s)	Peak discharge error(%)	Date of rain occurence	station
27/3	54/7	1/93	1/93	0/0	1386/01/05 to1386/01/10	Kondooleh
30	54/7	1/78	1/772	0/0	1387/09/08 to1387/09/13	
16/3	56/1	2/68	2/683	0/0	1389/02/02 to1389/02/10	
16/7	76	4/05	4/051	0/0	1390/02/08 to1390/02/16	

As shown in Table 3, the calculated peak values of the observed difference, so during the calibration procedure, it was tried making changes in the model parameters (CN and Ia), the observed values of peak flow values are computed. HEC-HMS model calibration results are presented in Table 4, we can see the calibration values are estimated such that the error rate with high precision is zero. Rainfall- runoff hydrograph simulated in the following four events after calibration are shown in Figures 8 to 11.

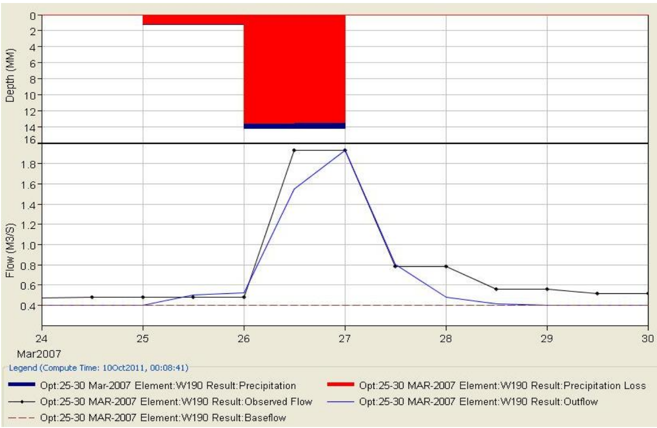

Fig. 8: Observed hydrograph and precipitation calibrated date 05/01/1386 to 10/01/1386.

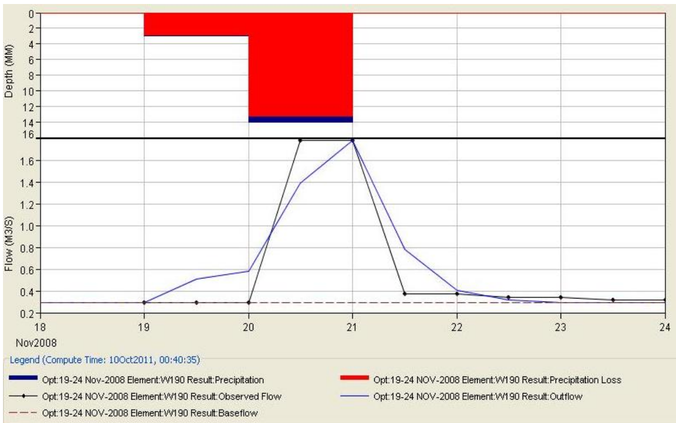

Fig. 9: Observed hydrograph and precipitation calibrated date 09/08/1387 to 09/13/1387.

Advances in Environmental Biology, 8(9) Special 2014, Pages: 244-252

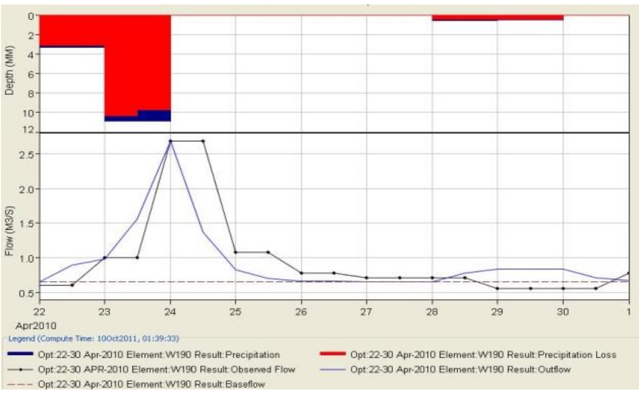

Fig. 10: Hydrograph date calibrated and observed precipitation 02/02/1389 to 10/02/1389.

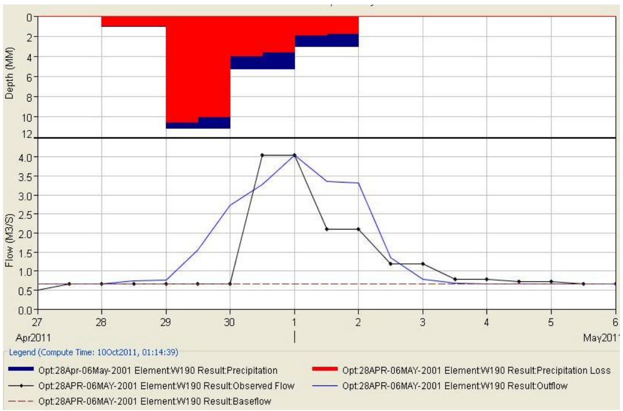

Fig. 11: Hydrograph date calibrated and observed precipitation 08/02/1390 to 16/02/1390.

Model Validation:

After calibration model and get the new values and maximum parameters used in the model, it is time to verify new parameters that have been used for this purpose, the two rainfall events. After entering the new parameters to the model, calculated and simulated hydrographs are related to two new rainfall events, the simulated and observed hydrograph peak flows are close in magnitude, indicating the accuracy of the calibration parameters and the calibrated parameter values can be the values used in the model rainfall - runoff. Table 5 lists the date of occurrence of events used to validate the model and the observed and calculated hydrograph parameters used in the calibrated model shows two rainfalls. Figures 12 and 13 show the validation of the flood hydrograph.

Table 5: Results of the validation model HEC-HMS.

Ia (mm)	CN	Observed discharge (m3/s)	Discharge (m3/s)	Peak error (%)	Occurrence of rains	Station
25	76	2/223	2/275	-2/3	1386/01/24to1386/01/28	Kondooleh
30	55	3/125	3/164	-1/2	1389/02/10to1389/02/16	

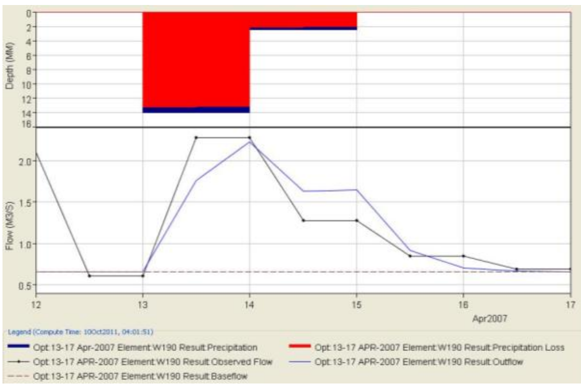

Fig. 12: Validation of a flood hydrograph and the observed precipitation Date 24/01/1386 to 28/01/1386.

Advances in Environmental Biology, 8(9) Special 2014, Pages: 244-252

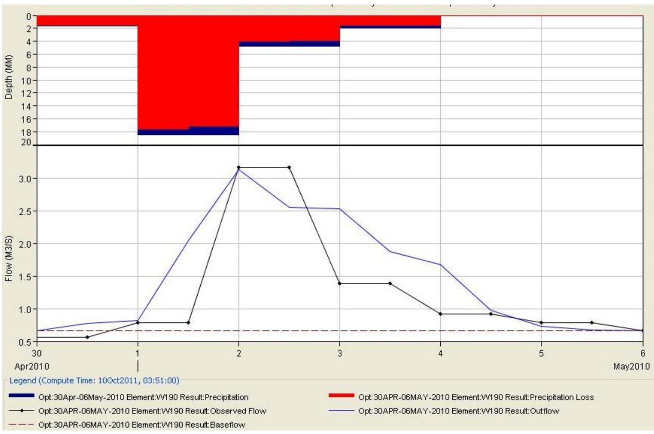

Fig. 13: Validation of a flood hydrograph and the observed precipitation Date 10/02/1389 to 02/16/1389.

Conclusions:

According to the results of investigation of the potential for runoff and flood hydrograph model of HEC-HMS basin hospice is deduced:

- Initial estimate curve numbers, earlier soil moisture, initial mortality and the effective area at the start of simulation is crucial in the formation of runoff and prevent errors in calculation of peak flows.
- The calibration phase, the goal of the simulation studies and the objective function is properly selected.
- At this stage, according to the parameter search method for optimizing the parameters is chosen correctly.
- By comparing the observed and simulated hydrographs first concluded that much difference between observed and simulated peak discharge, there is the problem of estimating parameters that are in the production of runoff, that in watersheds with the lack of statistical data to estimate these floods are used that the most commonly these simulations show very high levels and cause spending a lot of design, blue, and hydraulic structure. By optimizing these parameters to the native software can greatly improve the accuracy and performance of the costs of projects for watershed management and water resources reduced.
- In studies related to the flood, the objective function, accommodating peak in the hydrograph predicts the flow behavior index.
- Using daily rainfall data in which the temporal variations in precipitation are uncertain due to the estimation error.
- Multiple rainfall events during the last few days with the complexities of the simulated rainfall - runoff, are needed further investigation.
- Based on these results, the minimum error of flood peak discharge is estimated to be zero. These amounts represent the estimated accuracy of the model is the peak flow of flood water that can result in structural design and can be used to estimate the maximum flood discharge.

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