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Open Drainage and Detention Basin Combined System Optimization

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Introduction: Since flooding causes death and economic damages, then it is important and is one of the most complex and destructive natural disaster that endangers human lives and properties compared to any other natural disasters. This natural disaster almost hit most of countries and each country depending on its policy deals with it differently. Uneven intensity and temporal distribution of rainfall in various parts of Iran (which has arid and semiarid climate) causes flash floods and leads to too much economic damages. Detention basins can be used as one of the measures of flood control and it detains, delays and postpones the flood flow. It controls floods and affects the flood directly and rapidly by temporarily storing of water. If the land topography allows the possibility of making detention basin with an appropriate volume and quarries are near to the projects for construction of detention dam, it can be used, because of its faster effect comparing to the other watershed management measures. The open drains can be used alone or in combination with detention basin instead of detention basin solitarily. Since in the combined system of open and detention basin the dam height is increasing in contrast with increasing the open drainage capacity, optimization of the system is essential. Hence, the investigation of the sensitivity of optimized combined system (open drainage and detention basin) to the effective factors is also useful in appropriately design of the combined system.

Materials and Methods: This research aims to develop optimization model for a combined system of open drainage and detention basins in a mountainous area and analyze the sensitivity of optimized dimensions to the hydrological factors. To select the dam sites for detention basins, watershed map with scale of 1: 25000 is used. In AutoCAD environment, the location of the dam sites are assessed to find the proper site which contains enough storage volume of the detention basin and the narrower valley. After the initial selection of dam sites, based on the reservoir volume to construction volume ratio of each dam site, best sites were selected to have the higher ratio. The layout of the main drainage scheme that is responsible for collecting and transferring overland flows of farmlands and reservoir outflows was designed. In order to simulate the hydrological processes in upstream watershed and flood analysis, HEC-HMS model which is an extended version of HEC-1 was used as hydrologic model. The optimal combination of open drainages and detention basins was also developed. Watershed in terms of detention basin dams, topography and drainage were divided into 19 smaller sub-basins. The downstream agricultural basin due to the slope and drainage area was divided into 27 sub-basins. Regarding available information of the watershed, SCS method was used to calculate losses and to convert rainfall to runoff hydrograph. In this section Muskingum flood routing method was used considering its accuracy. In the present optimization model, the total cost of the combined system of dams and open drains used as the objective function. It is function bottom outlet diameter which is minimized by using optimization model. Other factors of the simulation model such as dam height and drainage dimensions were defined as function of the diameter of the bottom outlet of dams. After determining the optimal dimensions of the combined system of open drainage and detention basins, a sensitivity analysis was performed on hydrological factors.

Results and Discussion: After optimization of the dimensions of open drainage and detention basin integrated-system, sensitivity analysis was carried out on the dimensions of system for variation of flood simulation parameters such as rainfall, curve number and lag time. The error of estimated rainfall effected far less than the curve number (CN) on the optimum dimensions and cost. 10% variation of the rainfall depth caused respectively, 7%, 8% and 10% error in optimum dam height, drainage optimal depth and total cost. Lag time was identified less important effect in the determination of optimal dimensions. As its 10% changing produced 10% error in optimal dimensions costs.

Conclusions: The research results showed that curve number is the most important factor in determining the optimal size and cost. As with 10% error in the estimation of curve number caused error rates of 21%, 25% and

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24% of the optimal dam height, the optimal depth of the drain and minimized costs, respectively.

Keywords: Hydrological model, Optimal depth of drainages, Optimal height of dams, Optimization