

GENERATION OF FLOODS BASED ON A HYDROLOGIC MODEL

P.S. Jayaweera, K.D.W. Nandalal and U.R. Ratnayake

Department of Civil Engineering, Faculty of Engineering, University of Peradeniya

Introduction

Hydrologic models can be illustrated as simplified conceptual representations of a part of hydrologic cycle. They are primarily used for understanding hydrologic processes and for hydrologic prediction. With the present day technological development, there are many hydrologic models of varying complexity developed to simulate rainfall-runoff process. Such models could be used for many hydrology related studies including water resources assessments, water resources system operation and management, extreme flow forecasting, urban planning etc. This paper presents a study carried out to determine flood flows expected to occur in Nilwala River and its tributaries at different return periods, which could be used to develop flood inundation area along the river.

Introduction

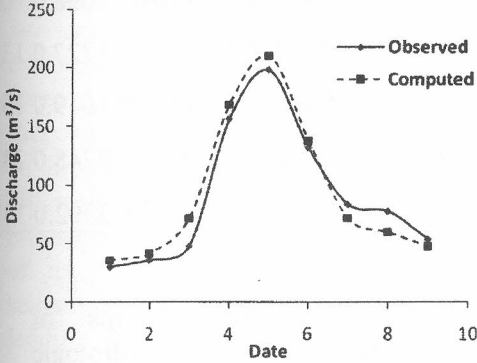
The Nilwala River is one of the five major rivers vulnerable to floods in Sri Lanka. It originates from the Sinharage highland natural forest at an altitude of 1,050 m, and flows through Deniyaya, Morawaka, Akkuressa towns. After about 72 km journey it meets Indian Ocean at Matara. It lies mainly in the Matara district within the latitudes 5° 55' - 6° 13' and longitudes 80° 25' - 80° 38'. The area of the river basin is about 1,073 km². The catchment belongs mainly to the wet zone of southern province and the annual average

rainfall of this area is between 1875 mm - 2500 mm. From a hydraulic point of view, the course of the Nilwala River consists of two very different parts. Upstream part has a steep longitudinal slope, where river bed is rocky and rate of flow is fairly high. Valley is clearly marked and floods do not cause any considerable inundation. Downstream part constitutes the study area. Southern lowlands of the basin extending inland up to about 12 km from coastline are subject to severe flooding during south-west monsoon rains and with conventional and cyclone activities.

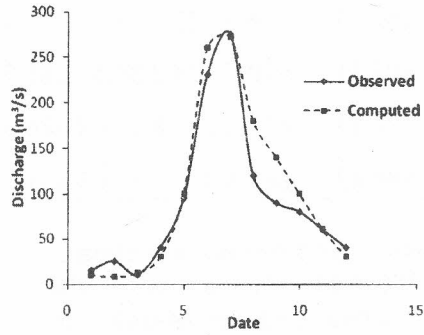
Methodology

The study commenced with the development of the Nilwala River catchment using freely available 30 m ASTER DEM data. Stream network of the river was delineated using HEC-GeoHMS model (USACE-HEC 2003), which runs on ARC-View platform. Since discharge data of the river is available at Pitabeddara, a rainfall-runoff model was developed based on the HEC-HMS model (USACE-HEC 2009a) to the sub-catchment upto that point. That model was calibrated using observed rainfall and runoff data of three extreme events on September 1974, May 1975 and May 1978. It was verified based on extreme events observed on June 1979, September 1979 and July 1984. Calibration and verification for two of the above events are shown in Figure 1. Rainfalls

at 6 stations were available for the study and areal average rainfall of the sub-catchment was determined using Thiessen polygon method. Snyder unit hydrograph method was used to transform rainfall to runoff and Muskingum method was used for flood routing along the river.



Based on the information available on historical inundation area, the points on the main river and tributaries were identified for the estimation of flood flows that are required to generate inundation area. The identified points, which are the outlets of the sub-catchments, are shown in Figure 2.



(a) Calibration: May 1975

(b) Verification: September 1979

Fig. 1. Calibration and verification of the rainfall-runoff model

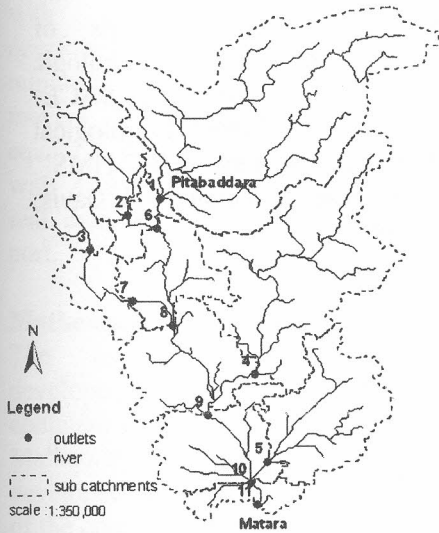


Fig. 2. Nilwala river network with its sub catchments and outlet locations

Subsequently, using the catchment parameters identified by applying the HEC-HMS based rainfall-runoff model upto Pitabaddara, models were developed to all the above-mentioned sub-catchments. The Snyder unit hydrograph method and the Muskingum method were used for rainfall-runoff transformation and flow routing. Using the rainfalls of different return periods obtained by fitting Gumbel distribution to the catchment average rainfall, discharges at the identified sub-catchment outlets were estimated based on the HEC-HMS based rainfall-runoff models developed for the sub-catchments.

Results

The discharges obtained by the model for the different return periods are presented in Table 1.

Table 1. Flows at different outlets at different flood frequencies

Return Rainfall Period (mm/day) (yr)	Flows at outlets (Peak discharge (m ³ /s))											
	1	2	3	4	5	6	7	8	9	10	11	
10	161.55	193.5	72.3	43.3	135.8	92.7	272.2	85.8	398.3	612.9	772.0	791
25	207.95	266.2	98.3	57.7	186.3	125.7	374.0	114.6	545.9	838.6	1056.0	108
50	252.55	336.0	123.3	71.7	234.8	157.4	471.8	142.3	687.7	1055.0	1327.0	135
100	307.15	410.7	148.2	84.5	285.5	189.5	574.3	168.0	838.3	1287.0	1619.0	165
500	484.87	698.4	252.8	143.8	486.6	322.7	979.1	285.7	1422.3	2177.0	2748.0	281
1000	590.43	863.3	311.7	176.5	601.2	397.9	1209.9	350.8	1757.3	2691.0	3392.0	347

Conclusions and recommendations

The HEC-HMS model with the Snyder method and the Muskingum method was observed to be suitable in modeling Nilwala River. The flows estimated for different return periods at many locations in the main Nilwala River and its tributaries based on the model could be used for the development of flood inundation areas for rainfalls of different return periods.

Acknowledgement

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References

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