Runoff characteristics of two sub-catchments in Tono area

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1. Introduction

Tono Geoscience Center, JNC has been routinely monitoring several catchments and subcatchments (Fig.1). Some of these catchments and subcatchments (hereafter called catchment) can be considered similar in their basic runoff generation mechanism (Gautam et al.[1)]). They differ in the scale of their topographic features such as width, channel length, area, and drainage network characteristics etc. Recently, Gautam et al.[2)] have utilized soil moisture information from a hillslope and used it in a runoff estimation for a catchment (II) in the Tono area using an artificial neural network (ANN). To transfer the model parameters (here in this case weights) to other areas for the problem of runoff estimation may not be feasible due to scale problems. One of the solutions to this problem can be to reformulate the ANN models for different catchments considering different possible scenarios of inputs namely, soil moisture and/or other meteorological variables. The other alternative can be to formulate an ANN model considering the topographic features as well. This may help towards formulation of a more general ANN model. However, prior to formulation of any type of ANN model, a comparison of catchment characteristics is warranted, which is the concern of this paper.

2. Runoff characteristics of the catchment II and V

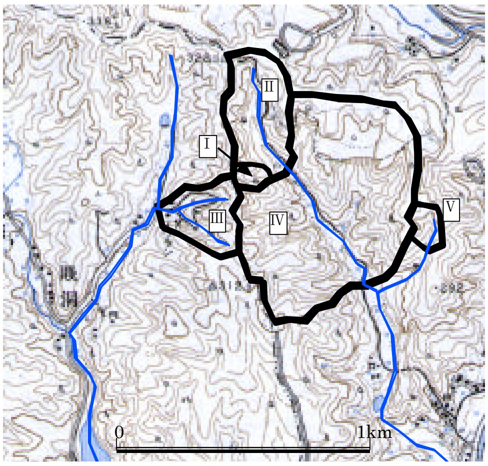

Fig.1 JNC-monitored catchments, Tono area

In order to evaluate the general characteristics of these two catchments (II and V with an area of 11.4 ha and 1.5 ha respectively) some stormflow events of some months (April-July) of 1999 are considered. Fig. 2 shows a comparison of specific discharge (discharge per unit catchment area) for two relatively large storm events of April and June respectively. The catchment II shows higher specific discharge and a persistent nature compared to catchment V. To evaluate the runoff characteristics in more detail, the delayed flow component is separated from the quick flow (storm flow) by using the technique proposed by Hewlett and Hibbert[3)]. In this method, the delayed flow component of the hydrograph is taken as constantly rising from the initial flow at a fixed rate of 0.33 lpm/ha-hour. Table 1 shows the amount of delayed flow and storm flow components along with their ratio. It is clear from Table 1 that during the small storm flow events delayed flow contributes significantly to the total runoff. Relatively little difference is seen between the ratio of the contribution of delayed flow in these two catchments. In the small storm flow events, the small catchment (V) has a larger ratio of quick flow than the catchment II. However, during the larger events considered in the study, the quick flow percentage of catchment II is higher than that of the catchment V. An interpretation is that during large storm events, the hydraulic conductivity of the larger area is higher as more macropores and or any preferential flow pathways in the large catchment are activated. This causes an increase in the total contributing area as well. The quickflow index defined as ratio of total quick flow (QF) to total rainfall (P) for these seven events shows that catchment II is more responsive to rainfall than the catchment V. Although, many storm events need to be considered before generalization of the catchments, nevertheless with analysis of the preliminary data, catchment II can

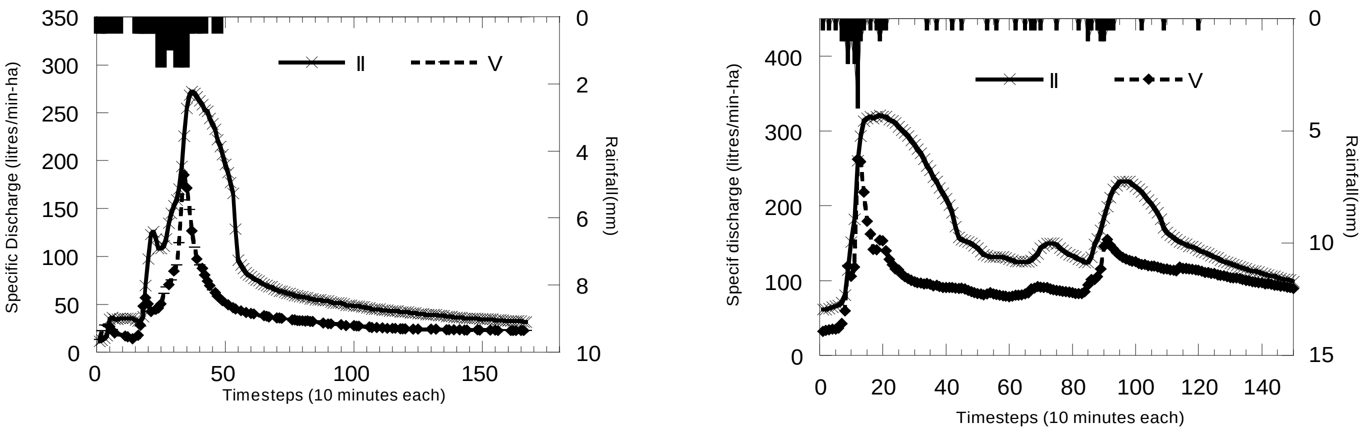

Fig. 2 Comparison of total runoff hydrograph of catchments II and V (storm events of April and June)

Key words: Runoff analysis, Artificial Neural Network, Topographic attributes, Catchment monitoring, Tono area

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Table 1

Catchments	II							V						
Events	1	2	3	4	5	6	7	1	2	3	4	5	6	7
Rainfall(mm)	5.0	9.5	19.0	9.5	10.5	34	24.5	5.0	9.5	19.0	9.5	10.5	34	16
Percentage of quickflow in total flow	0.264	0.386	**0.702**	0.289	0.427	**0.83**	**0.699**	0.323	0.425	**0.598**	0.358	0.41	**0.76**	**0.565**
Percentage of baseflow in total flow	0.736	0.614	0.298	0.711	0.573	0.17	0.301	0.677	0.575	0.402	0.642	0.59	0.24	0.435
Quickflow index	.0624	.063	0.576	.033	.068	0.44	0.235	.0295	.031	0.39	.022	.029	0.144	.071
Stormflow Duration (minutes)	620	810	2640	710	900	2290	2110	370	580	2510	500	560	1560	970
Peak discharge (lpm)	401	712	3100	279	380	3897	2509	38	85	277	31	31	162	388

be said to be highly responsive to rainfall. For the data considered in the present study the QF index for catchment II varies from 3-58% and that for catchment V varies from 2.2-39 %. With these values, these catchments can be considered some of the most highly responsive catchments in the world (Pearce et al. [4]). The reason for the large QF index of catchment II may be due to a larger percentage of hollow areas. This needs further assessment with terrain modeling. The peak of catchment II lags behind that of catchment V due to its relatively elongated shape compared to catchment V. The time difference between the peaks of these two catchments varies between 10 and 70 minutes with an average of 30 minutes. The relationship between the specific peak discharges of the two catchments is shown in Fig. 2. As can be seen, for higher peak discharges, the relationship is no longer linear. The specific peak discharge has a positive bias for catchment II for larger specific peak discharge of catchment V.

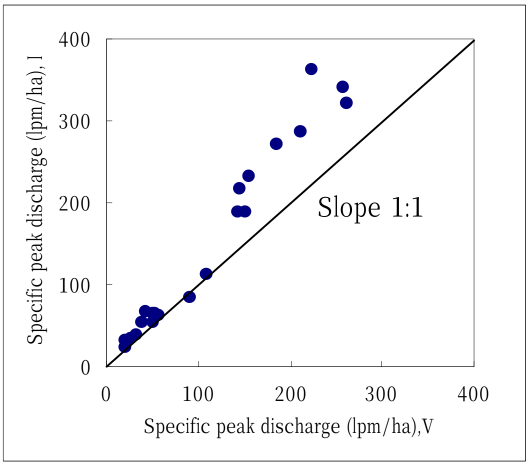

Fig. 3 Comparison of specific peak flow of catchments II and V

3. Implications for formulation of a more general artificial neural network

Many researchers in the past have established the importance of contributing factors like hillslope hollows and near surface highly conductive pathways. The importance of topography and related indices in runoff generation and formation of zones of saturation is shown in many studies (Beven and Kirkby[5], Western et al.[6]). The terrain analysis of these catchments can provide information about the percentage of hillslope hollow areas that are prone to quick saturation. We think that utilization of a range of distribution of topographic indices e.g. ln(a/tanβ), plan and profile curvature and their integral value in the catchments along with other variables mentioned earlier will be useful in the formulation of a more general ANN model.

4. Conclusions

The use of data of one catchment to other is useful for catchment monitoring purpose. In this regard, the formulation of more general type ANN that uses the general features of these catchment as an input information can be useful for the monitoring problem. The present study points towards this need by comparing general runoff behavior of two catchments in Tono area. This preliminary data analysis revealed that both the catchments show a quick response to rainfall. The larger specific discharge and quick flow index is observed in catchment II compared to catchment V. The importance of using topographic attributes is considered to explain the runoff behavior of the catchments and to be useful in the formulation of a new type of ANN.

5. References

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