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RUNOFF AND INTERCEPTION SIMULATION IN THE NATORI RIVER BASIN

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1. INTRODUCTION

The interception by some types of vegetation may be a considerable portion of the annual precipitation, although the effect of vegetal cover is unimportant in major floods. In this study, the amount of precipitation intercepted by vegetation in the Natori river basin was investigated using a vegetation map and the grid-based runoff model. Also the discharge variation according to interception procedure was investigated.

2. RUNOFF MODEL

2.1 Runoff model

A conceptual watershed system of runoff model is presented in **Fig. 1**. The grid-based model is composed of three tanks laid vertically in series. The flow on the overland is conducted by the kinematic wave method and the river routing is computed by the dynamic wave method.

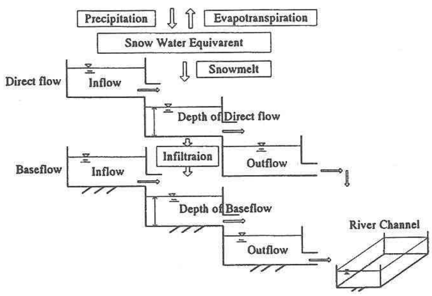


Fig.1 Runoff model

2.2 Interception Procedure

In this study, an interception procedure was added in the runoff model. The interception of precipitation is computed as a function of the cover and the storage available for the vegetation type. It is assumed that losses from interception storage are proportional to evaporation data.

$$PTN = PPT * (1.0 - COVDN) + (PTF * COVD) \quad (1)$$

where PPT is total precipitation received on grid(mm), COVDN is seasonal cover density, and PTF is precipitation falling through the canopy(mm)

PTF is computed by

$$PTF = PPT - (STOR - XIN) \qquad PPT > STOR\text{-}XIN \quad (2)$$

$$PTF = 0 \qquad PPT \leq STOR\text{-}XIN \quad (3)$$

where STOR is maximum interception storage depth on vegetation(mm) and XIN is the current depth of interception storage(mm).

3. STUDY SCOPE

The ruoff and interception simulation was carried out for the Natori river basin. Elevation and Land use map as geographical information were used. Evapotranspiration map was made using NOAA/AVHRR Data. Radar AMeDAS data and AMeDAS hourly data were employed as precipitation data. **Table 1** shows the vegetation types of the vegetation map and the ratio of vegetation type in the Natori basin used in this study. A value of storage capacity and density were assumed as **Table 2**. The density and the storage capacity of winter season were used on from November to March, that of summer season is used for rest months. The study area and the vegetation map are shown **Fig. 2** and **Fig. 3**.

Table 1 Vegetation type

No.	Vegetation type	Remark	Ratio (%)
1	Polar zone, Alpine zone		0.0000
2	Subpolar zone, Subalpine zone	Nature	0.2652
3	Subpolar zone, Subalpine zone	Substitution	0.0000
4	Quercus class	Nature	20.7084
5	Quercus class	Substitution	14.1486
6	Camellia class	Nature	0.4609
7	Camellia class	Substitution	14.6032
8	River edge, Swamp, Sand dune		0.0758
9	Cultivated land		47.0737
10	Rest		2.6643

Table 2 Interception storage and density

No.	Cover density (%)		Storage (mm)		
	Summer	Winter	Summer rain	Winter rain	Snow
1~3	1.00	1.00	1.27	1.27	2.54
4~5	1.00	0.75	1.27	0.508	2.54
6~7	1.00	1.00	1.27	1.27	2.54
8	1.00	0.25	0.508	0.508	0.00
9	1.00	0.25	0.508	0.508	0.00
10	1.00	0.50	0.00	0.00	0.00

Fig.2 Natori river basin

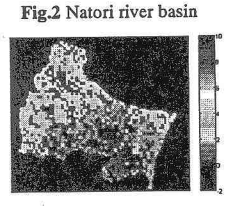


Fig.3 Vegetation map

4. INTERCEPTION RESULT

The interception simulation was carried out for 1 year(1999/07~2000/06). The result of simulation is presented in **Fig. 4.** The annual interception of precipitation by vegetation is 764mm to annual precipitation 1982mm. The interception is influenced by rain intensity. On August, it rained much but the rainfall intercepted is smaller than that of July or September. This is because of the occurrence of the heavy rain. The precipitation of about 100mm occurs from December to February and from May to June. The interception ratio is high during this period.

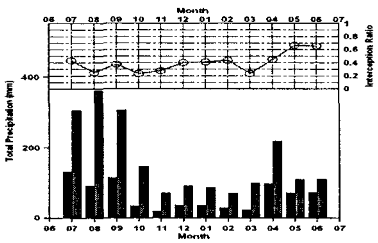


Fig.4 Interception ratio

5. RUNOFF COMPARISON

To investigate discharge variation according to interception procedure addition., monthly discharge and an error are presented in **Table 3.** The error is computed following as:

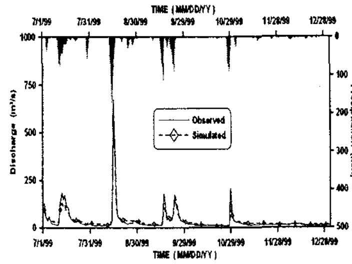
$$Er = \frac{1}{N}\sqrt{\sum_{i=1}^{N}\left(\frac{Q_{obs}(i) - Q(i)}{Q_{obs}(i)}\right)^2} \qquad (4)$$

where Q_{obs} is the observed discharge at Yokata gauge in the Natori river, Q is the simulated discharge and N is the number of day.

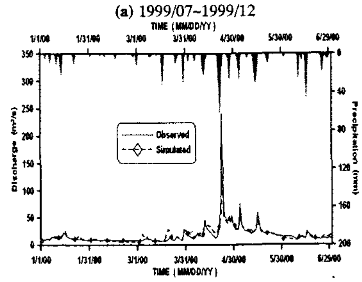
Table 3 shows that annual discharge is changed about $400m^3/s$ and the error is decreased when the runoff was simulated with the interception computation. The change of discharge is larger for the dry season than the rainy season. The simulated discharge is compared with discharge observed at Yokata gauge in **Fig. 5.**

Table 3 Discharge and error

Month	Discharge(m^3/s)			Er	
	Observed	Interception simulation		Interception simulation	
		Before	After	Before	After
7	362.52	388.20	382.02	0.545	0.475
8	240.66	201.23	201.28	0.535	0.487
9	329.87	402.88	403.45	0.413	0.338
10	1064.21	1045.73	1043.74	0.341	0.261
11	793.19	820.82	766.95	0.458	0.459
12	364.65	383.50	381.87	0.170	0.171
1	1648.59	1660.28	1580.49	0.199	0.195
2	1842.94	1971.21	1862.10	0.215	0.213
3	1347.67	1414.43	1337.05	0.603	0.602
4	686.82	662.28	630.33	0.350	0.348
5	426.25	592.17	592.47	0.168	0.141
6	367.42	398.64	398.76	0.243	0.243
Total	9474.79	9941.37	9579.71	0.385	0.358



(a) 1999/07~1999/12



(b) 2000/01~2000/06

Fig.5 Hydrograph

6. CONCLUSION

In the Natori river basin, the interception of precipitation by vegetation is estimated as 20%~65%. The interception has more or less value on the dry season. Annual interception storage is about 39% of annual precipitation.

In this study, the interception procedure has effect on discharge insignificantly. Therefore, if the purpose of runoff simulation is just a monthly runoff computation, it is considered that the above-mentioned runoff model except the interception procedure is enough to simulate.

The annual interception storage in the Natori river basin has a considerable portion of the annual precipitation. Therefore, the study on loss from interception is required to delineate the hydrological cycle in detail.

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