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Hydrological Characteristics of the Lost River in the Ruoergai Wetland, China

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Abstract

In order to understand the hydrological characteristics of a lost river in wetland, the flow rate of the river and the groundwater table of the riverside in the lost river were investigated in Ruoergai wetland, Sichuan Province, China. The subject river of study had a general shape of the channel profile, which was an exponential curve for ordinary rivers. From the data of flow rates and groundwater tables, it became clear that this river increased in its flow rate from the spring point on the hill slope toward downstream, and rapidly decreased in it at the disappearance point in the wetland. The river was hydrologically characterized by the rapid disappearance due to the suction effect at the disappearance point in the wetland, where the river water was conducted through many holes (hydrological pipes) to the subsurface aquifer. It was considered that an extensive aquifer with a high hydraulic conductivity exists.

Key word: Lost river, Hydrological characteristic, Wetland, Losing stream, Gaining stream, China.

1. Introduction

The Ruoergai wetland, situated in the Huanghe River basin, is located northwest of chengdou in Sichuan Province, China. The wetland is situated at a height of more than 3400 m a.s.l. and surrounded by the mountains which are more than 4000 m a.s.l. The scale of this wetland is approximately 100 km (E-W) by 200 km (N-S). There are many marshes in the wetland, with a total marsh area of 2700 km^2 (Chai et al., 1963). In this wetland, peat soil is widespread due to the cold, wet climate, the flat landform, and poor drainage. There are many lost rivers, the water flow starts from the spring at the foot of the mauntain and disappears into the wetland.

The lost river is such a river. The water flow exists in the upper stream but downstream, with the exception of flood times, it disappears before the water reaches a sea or lake (Kaizuka, 1981). These rivers are commonly found in a river basin having a dry region with a high potential evapotranspiration rate in the downstream area or a fan region composed of extremely permeable sediment. In these lost rivers, many interesting hydrological phenomena exist but only very limited studies have been performed so far.

As a part of studies on the ecology and formation process of peatland in China, we measured the rate of flow and surrounding water table at the lost river in the Niurenchiu, Ruoergai. This paper describes this hydrological data and discusses the hydrological characteristics of the lost river in Niurenchiu.

2. Study Area

Niurenchiu is located approximately 20 km north of Ruoergai City. At the Ruoergai City, the mean annual temperature is 0.7°C and the mean total precipitation is approximately 650 mm for the 24 years of 1957-1980. Fig. 1 shows a topographical view of the study area in Niurenchiu. The southwest area, where *Kobresia tibetica* and *Carex mexeviana* are predominant, is a wetland at 3440 m a.s.l. But there is no surface water in this wetland because the groundwater table is under the ground surface. In the northeast area where *Poa*

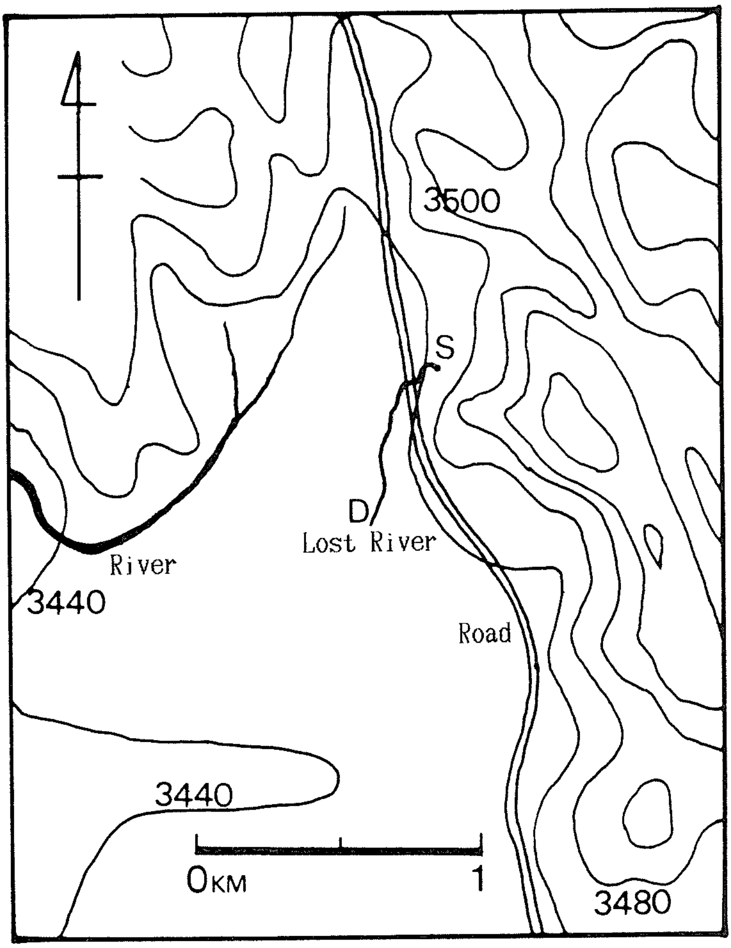

Figure 1. Study area in Niurenchiu.

charantha and *Blysmces sinocompressus* are widespread, there are hills with a relative height of 50-100 m (see Fig.1). The soil is sundy-muddy sediment containing gràvel in the hill area and peat soil in the wetland area.

The subject river of study is the lost river located at the center of Fig. 1. The river is generated at the spring point, S, and flows from S across the road to the point of disappearance, D, in the wetland. The river length is approximately 550 m.

3. Survey Method

The channel profile of the river was surveyed by using level and stuff, and the surface geometry was measured by tapeline. The volumetic flow of the river was measured at six points, at 100 m intervals along the supplemental line of channel. A photoelectric current

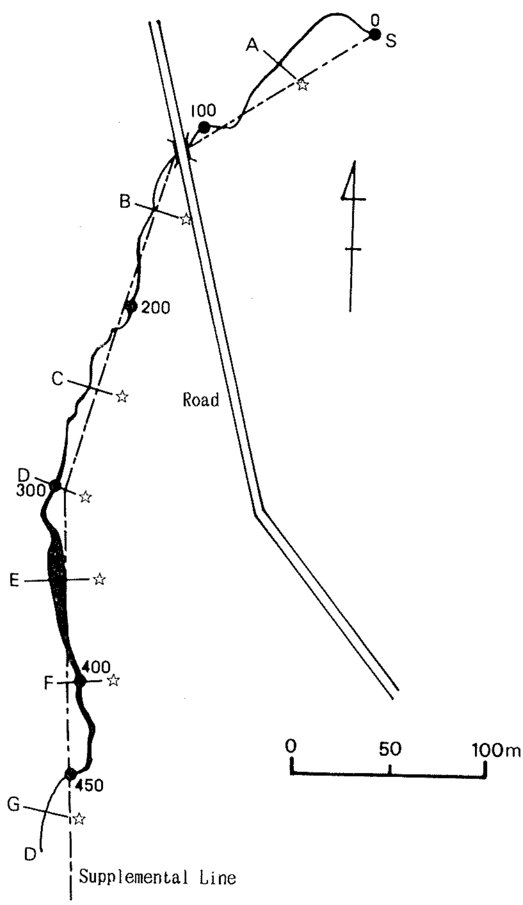

Figure 2. Channel pattern of the lost river and supplemental line.
Closed circle : points of flow measurement
Cross line : survey line of cross section

meter was used in measuring the speed of water flow. In the vicinity of the disappearance point, D, the groundwater tables were measured at eight points by using enka-biniru pipes (ϕ =3cm) and a small electric tester, and the peat was sampled to measure its hydraulic conductivity. These measurments were carried out on July 21, 1988.

Fig. 2 shows the channel pattern with the supplemental line and the points of discharge measurment.

4. Results and Discussion

(1) Channel profile and river flow rate

Fig. 3 is the channel profile in this river. As may be seen from this figure, the general shape of the channel for this river is an exponential curve, possessing a steep slope in the upper stream region and a gentle slope in the lower stream region. This slope is approximately that of the earth surface gradient. Fig. 4 shows cross sections of the channel at the lines shown in Fig. 2. It is apparent that the form of the cross sections become gradually flat tend as the river proceeds downstream. The tendency that the dissection is large in the upstream region is also similar to ordinary riveres. The points of difference from ordinary rivers are that the river water discharges into the wetland at point D, having the most gentle channel gradient, and that the water flow disappears there.

Fig. 5 is the rate of flow pattern of the river from the spring point, S, to the disappearance point, D, which is the 500 m point on the supplemental line. The rate of flow, as Fig. 5 shows, gradually increases from the spring point, S, up to about the 400 m point of the supplemental line, which is the boundary line of the hilly land and the wetland, and thereafter rapidly decreases from the 450 m point of the supplemental line. Thus it can be

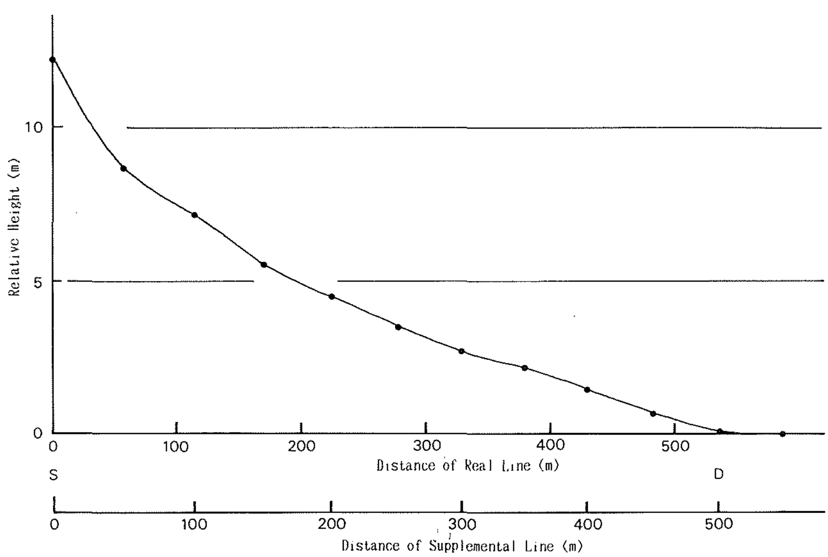

Figure 3. Channel profile in the lost river.

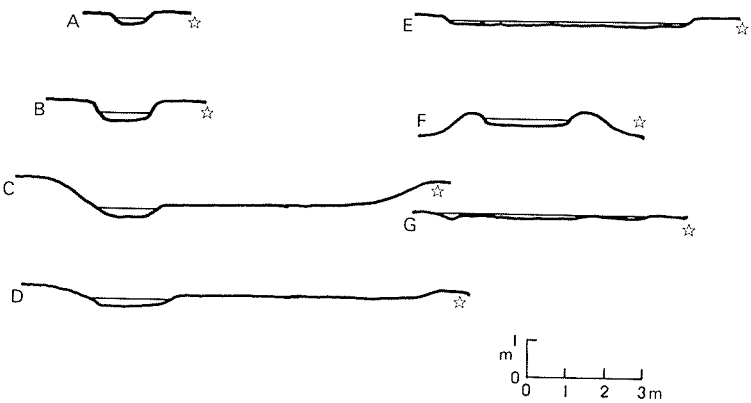

Figure 4. Cross section at the lines shown in Figure 2.

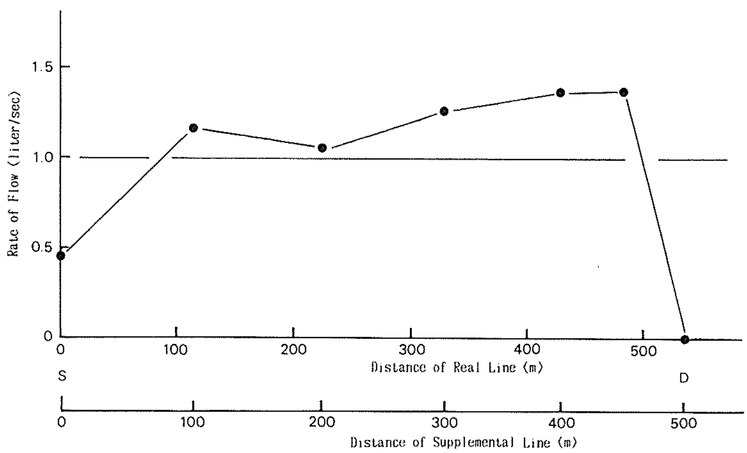

Figure 5. Rate of flow pattern of the lost river for July 21, 1988.

said that the section from the S to about the 400 m point is a gaining stream and the subsequent section is a losing stream. The gaining stream section is in a sloped area at the foot of hilly land and the losing stream section is in a wetland area. From these facts, it can be said that the water flow of this river does not gradually disappear as it proceeds downstream but rapidly disappears at the wetland. In other words, this lost river is characterized by the suction effect of the wetland.

Fig. 6 shows the rate of flow increase per unit river length. Negative values indicate a decreased rate. From this figure, it can be also understood that most of the absorption of river water occures in the wetland area.

(2) Groundwater conditions in the downstream

Fig. 7 shows the groundwater conditions and the water levels of the river in the downstream area. The contours of groundwater table clearly show that the downstream of this river has a losing stream pattern. Calculated from the mean gradient of the water table

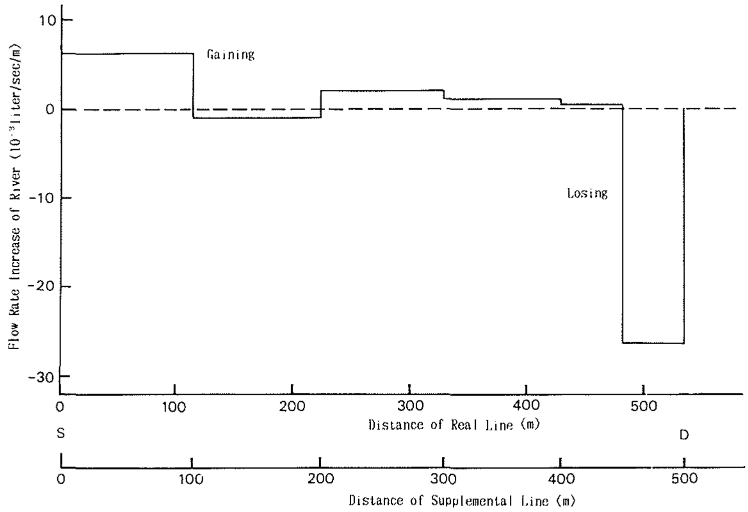

Figure 6. Rate of flow increase per unit length in the lost river for July 21, 1988.

(=1/100), the mean width of the channel (=1m), and the hydraulic conductivity of the peat in this region (4.5×10^{-4}cm/s), the quantity of water lost from the river in the section from 400 m point to 450 m point of the supplemental line is approximately 0.002 liter/s. As for the measured rate of flow, the water, at a rate of 0.02 liter/s, flowed into the river in this same section. The two values of -0.002 and $+0.02$ liter/s are within the range of observational error. As a result, though the downstream area has a losing stream pattern, there is little water being lost in the 400-450 m section. It can be said that almost all loss of river water occurred in the last 50 m (from the 450 m point to 500 m point of the supplemental line) of the river. It is considered that the section of 400-450 m line is the transition area to wetland and the last 50 m section is completely wetland area.

The rate of flow was 1.38 liter/s at the 450 m point but at the D point it was approximately zero liter/s for observation. If the flow of 1.38 liter/s is absorbed by Darcy's law at the last 50 m section of the river, the hydraulic conductivity of the peat in this region must be quite high. Even if the absorption occurred only at the D point, the same result is derived because the very large pond is needed at the D point. In the section of the last 50 m, the channel had a very narrow width of 10-20 cm and was surrounded by many small stagnant pools of water. At the D point, the water surface of the river was nearly level with the surrounding land and its width was quite broad. There were many holes with diameters of 2-3 cm in this area and bubbles occuring due to percolation of the water were observed around these holes.

From these facts, it is assumed that almost all the river water to reach the 450 m point has flowed in the channel up to the D point, where the water is led through many holes (hydrological pipes) to the subsurface aquifer. It is considered that an extensive aquifer with a high hydraulic conductivity exists in the wetland, through which the absorbed water

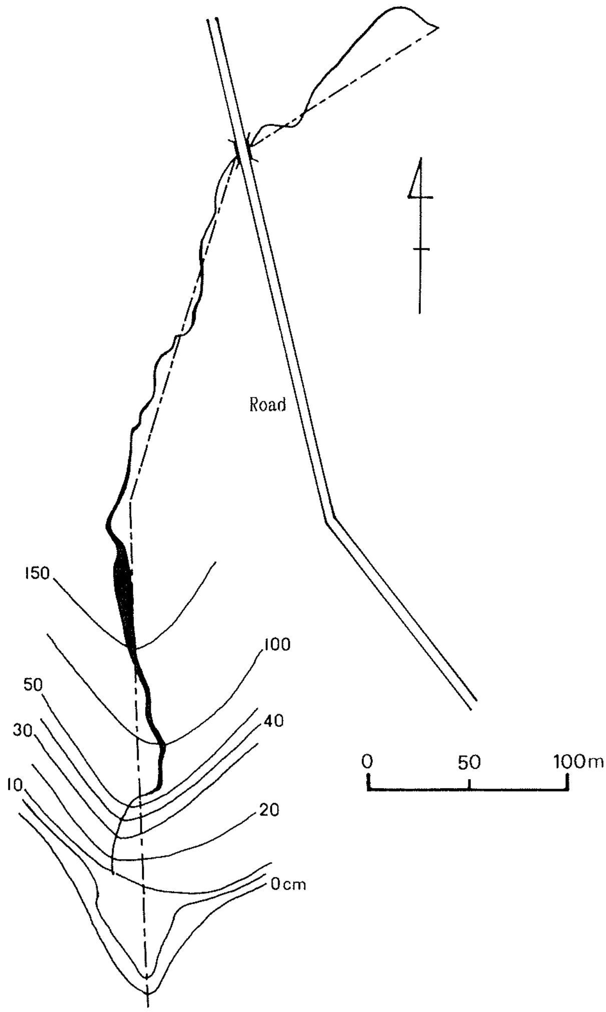

Figure 7. Croundwater conditions in the downstream area for July 21, 1988. The contours show the level of groundwater table and the water surface of river

is rapidly diffused.

As to the characteristics of this aquifer, a satisfactory survey could not be conducted due to the short observation period. In order to understand the mechanism of river disappearance, further study of the aquifer is necessary.

5. Conclusion

The lost river researched in Ruoergai wetland is hydrologically characterized by the rapid disappearance of water flow at the wetland, where the river water is conducted through many holes (hydrological pipes) to the subsurface aquifer, as opposed to a gradual downstream dissipation of flow. That is to say, the disappearance of this river is due to the suction effect in the wetland. It is considered that an extensive aquifer with a high hydraulic conductivity exists but this fact has yet to be verified.

Hereafter, it is necessary to study the details of the mechanism of river disappearance through the research based on the characteristics of the aquifer related to the geology and the evapotranspiration of the wetland.

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