Bulletin of Glacier Research 5 (1987) 25–28

Stream water temperature observations in Langtang Khola, Nepal Himalayas

Masakazu Suzuki[1], Yoshihiro Fukushima[1], Katsuhisa Kawashima[2], Takeshi Ohta[3], Hideaki Motoyama[2] and Hiroshi Kubota[4]

1 Faculty of Agriculture, Kyoto University, Kyoto 606 Japan
2 The Institute of Low Temperature Science, Hokkaido University, Sapporo 060 Japan
3 Faculty of Agriculture, Iwate University, Morioka 020 Japan
4 Karter Art Landscape Ltd., Chuoh-cho, Meguro-ku Tokyo 152 Japan

(Received December 25, 1986)

Abstract

Measurement of stream water temperature at Kyangchen in Langtang Khola, Nepal Himalayas, has been made from July 1985 to July 1986 as a factor to describe hydrological conditions in high altitude watersheds having glaciers. Daily mean water temperature is 3°C to 6°C on almost all days in spring, summer and autumn, and 0°C to 2°C in winter. Daily mean water temperature is higher than air temperature from late October to late May. The water temperature of the Langtang Khola at Kyangchen has a gentle seasonal variation attributed to the large contribution of the water from glaciers throughout the year with a constant water temperature of nearly 0°C.

1. Introduction

As part of a hydrological study in a watershed in high mountain regions having glaciers, stream water temperature together with the discharge rate and meteorological factors were measured at Kyangchen in the Langtang Khola main stream, Nepal Himalayas, from July 1985 to July 1986.

Stream water temperature of the Langtang Khola was measured from the late monsoon season to the post-monsoon season in 1982 and was reported by Yamada *et al.* (1984). However, the information about the seasonal variation in the stream water temperature in this watershed is as yet uncertain.

2. Study site and instrumentation

Langtang Khola Watershed is situated in the northern part of central Nepal, and is the head water area of the Trisuli River in the Narayani River System. The Kyangchen hydrological observation site (S1) is located at 3840 m a. s. l., 15 km downstream from the end of the Langtang Glacier (Fig. 1). The catchment area of the Langtang Khola at the observation site is 333 km^2.

Water temperature was measured at the hydrological observation site from July 10, 1985 to July 5,

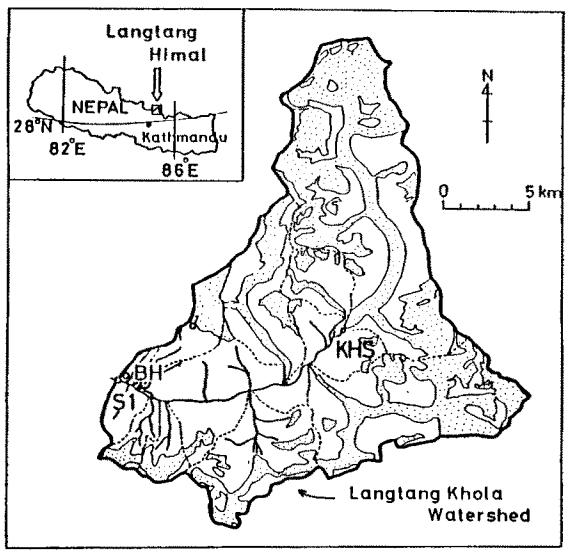

Fig. 1. A map showing the study area, the Langtang Khola watershed
Note: S1 : Hydrological Station at Kyangchen
BH : Meteorological Station (Base House)
KHS : Hydrological Station at Kyijungphu

1986. This was done using two types of instruments, a Pt-resistance thermometer recorded by an automatic recorder (Chino ES200) and a thermistor recorded by a digital data logger (Grant SQ-8) with a handheld computer (Epson HC-20), which operated one set of instruments at a time. The records on a chart were calibrated by manual measurement with a mercury thermometer.

The discharge rate measured at the hydorological observation site, and meteorological factors, such as air temperature, solar radiation, and net radiation *etc.* measured at the observation field (BH) in Kyangchen (3920 m a. s. l.) are reported by Fukushima *et al.* (1987) and Takahashi *et al.* (1987).

In addition, occasional measurement of the water temperature was carried out at the Kyijungphu Hydrological Site (KHS, 4400 m a. s. l.), the upstream end of the Langtang Khola approximately 300 m downstream from the major spring on the foot of the end moraine of the Langtang Glacier.

3. Results of measurements

3. 1. Stream water temperature at Kyangchen

Daily mean values of the water temperature of the Langtang Khola at Kyangchen are shown in Fig. 2, together with the discharge of the Langtang Khola, air temperature and solar radiation data at Kyangchen. In the winter, stream water temperature was measured by hand twice a day because of the difficulty in maintenance of automatic recorder. In this figure, daily mean values calculated by using 24 items of data (once on the hour every hour for one day) are plotted.

Daily mean water temperature of the Langtang Khola ranges from 3°C to 6°C on almost all days in the spring, summer and autumn, while it was from 0°C to 2°C in the winter. The amplitude of the seasonal variation in daily mean water temperature is smaller than that in daily mean air temperature. The stream water temperature is higher than the air temperature from late October to late May and is lower at other

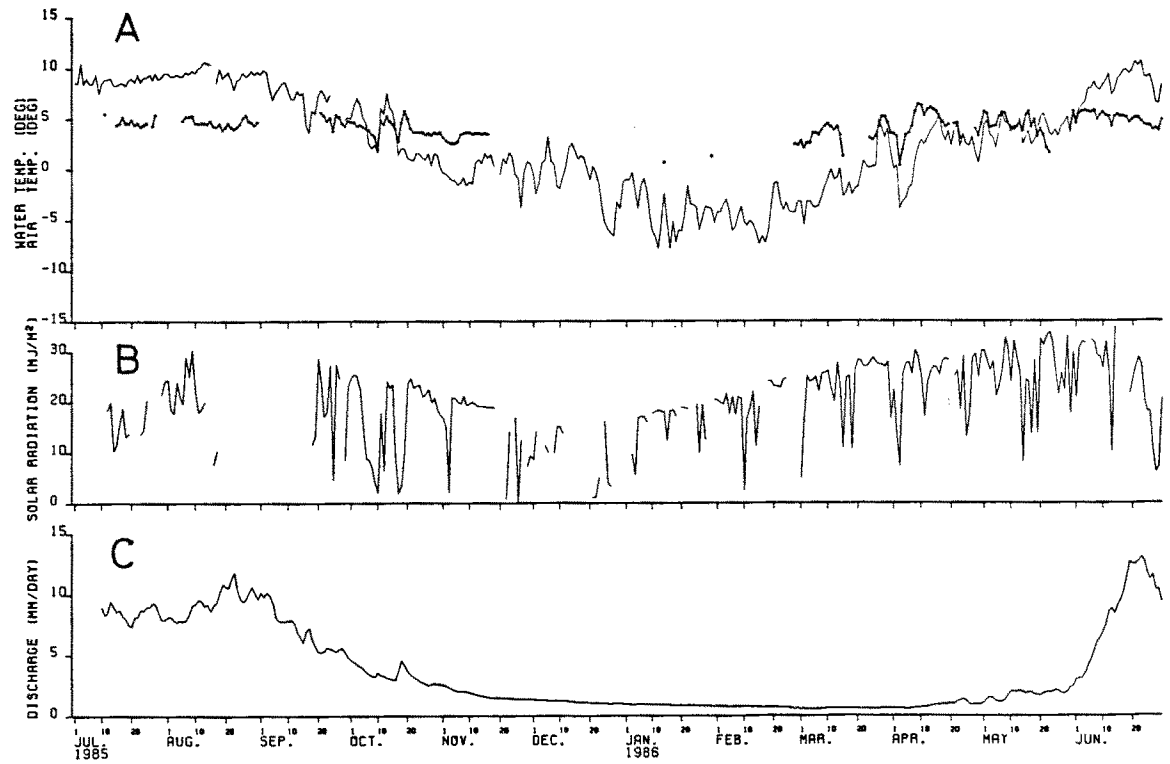

Fig. 2. (a) Seasonal variation in the daily mean water temperature of the Langtang Khola watershed at Kyangchen (thick line) and the daily mean air temperature at BH (thin line)
(b) Daily solar radiation at BH
(c) Daily discharge rate of the Langtang Khola Watershed at Kyangchen

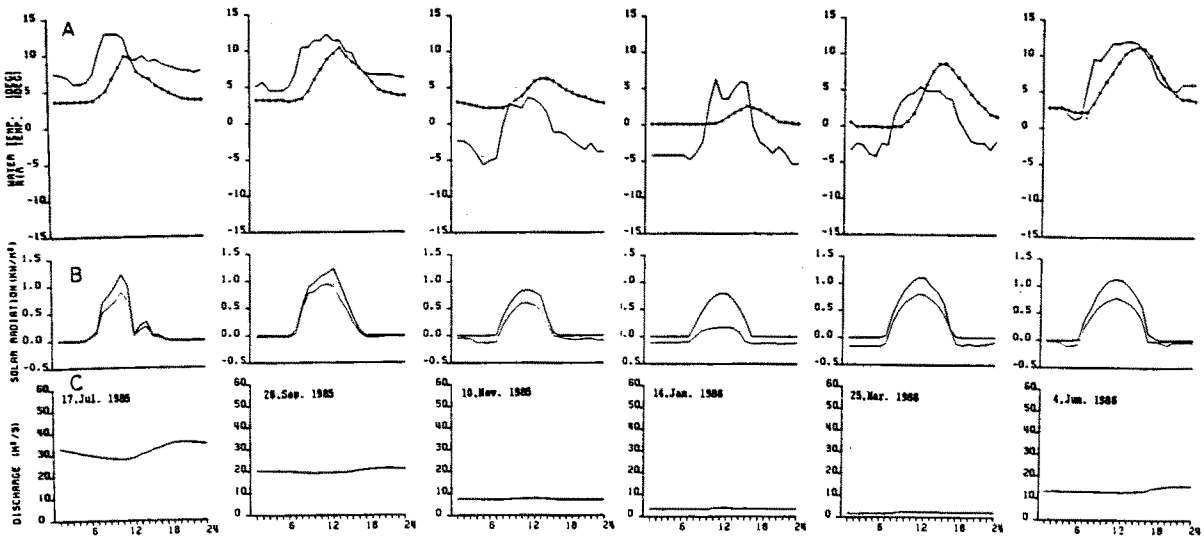

Fig. 3. Diurnal variations in water temperature, air temperature, radiation and discharge rate at Kyangchen on some selected fine days

(a) Water temperature of the Langtang Khola watershed (line with dots) and air temperature (thin line)
(b) Solar radiation (thick line) and net radiation (thin line)
(c) Discharge rate of the Langtang Khola Watershed

times at this site.

Fig. 3 shows the diurnal variations in stream water temperature, air terperature, solar radiation, net radiation and discharge rate on some selected days. The daily maximum water temperature appears at around 14h to 16h, 2 or 3 hours behind the time the maximum air temperature and the maximum solar radiation intensity appears, and more than 5 hours ahead of the time of the peak in the diurnal discharge rate. The water temperature at night is approximately 3°C in summer and nearly 0°C in the winter and spring. Therefore, the seasonal variation in the daily minimum water temperature is quite little. The other hand, the amplitude of the diurnal variation in water temperature is more than 5 degrees on fine days in the summer. The amplitude of diurnal variation in water temperature on fine days corresponds with the degree of the daytime radiation rate.

3. 2. Stream water temperature at Kyijungphu

Stream water temperature measured at Kyijungphu Hydrologycal Station (KHS) is shown in Table. 1. This table indicates that the temperature of the water supplied from the Langtang Glacier to the Langtang Khola is nearly constant, ranging from 0°C to 1°C at all times.

Table 1. Strean water temperature at Kyijungphu Hydrological Station, Langtang Khola (4400m a.s.l.)

Date	Time	Stream water temperature (°C)
7. Aug. 1985	8 : 30	0.4
	9 : 00	0.4
	10 : 00	0.3
	11 : 00	0.4
	12 : 00	0.7
8 Aug. 1985	14 : 00	0.4
	15 : 00	0.4
9 Aug. 1985	7 : 30	0.3
26 Sep. 1985	11 : 30	0.9
27 Sep. 1985	9 : 30	0.3
12 Nov. 1985	13 : 00	0.1
	15 : 30	0.2
25 Jun. 1986	7 : 30	0.5

3. 3. Discussion

The stability in the seasonal variation of the minimum water temperature suggests that stream water temperature is well preserved, unrelated to air temperature, from the upstream end to the observation site under no solar radiation condition. This may cause of the rather large volume of water discharge even in the winter, the low discharge period.

The order of time sequential appearence of the peak values in the diurnal course ; solar radiation and air temperature, stream water temperature, and dis-

charge rate, indicate that the time lag of the maximum water temperature is caused by heat exchange along the stream, while the time lag of the discharge peak includes both the travel time of the melt water in glacier and travel time along the stream, since the temperature of the melt water from glaciers into a stream is approximately 0°C even in summer, as shown in Table 1.

It can be pointed out that the water temperature of the Langtang Khola at Kyangchen has a gentle seasonal variation attributed to the large contribution of the water supply with a constant water temperature, nearly equal 0°C, from glaciers throughout the year.

Acknowledgment

This work was aided by a Grant-in-Aid for Scientific Research (chief : K. Higuchi of Nagoya University) from the Japan Ministry of Education, Science and Culture.

References

Fukushima, Y., Kawashima, K., Suzuki, M., Ohta, T., Motoyama, H., Kubota, H., Yamada, T. and Bajracharya, O. R. (1987) : Runoff characteristics in three glacier-covered watersheds of Lantang Valley, Nepal Himalayas Bulletin of Glacier Research, **5**, 11-18.

Takahashi, S., Motoyama, H., Kawashima, K., Morinaga, Y., Seko, K., Iida, H., Kubota, H. and Tradahr, N. R. (1987) : Meteorological features of Langtang Valley, Nepal Himalayas, 1985-1986. Bulletin of Glacier Research, **5**, 35-40.

Yamada, T., Motoyama, H., and Thapa, K. B. (1984) : Role of glacier meltwater in discharge from the glaciated watershed of Langtang Valley, Nepal Himalaya. Glacial Studies in Langtang Valley, Data Center for Glacier Research, Japanese Society of Snow and Ice, Publ. No. 2, 61-72.