AQUATIC VEGETATION AND PRIMARY PRODUCTION IN A RIVER DOWNSTREAM OF A TROPICAL GLACIER

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1. INTRODUCTION

Researches on water quality and the influence of the vegetation and primary production have been done in many rivers and lakes around the world (Mitchell, 1988). Changes in the phytoplankton, periphyton and macrophytes biomass were estimated in some aquatic ecosystems (Fisher et al., 1976). A large body of literature exists on the limnology of streams, but studies have rarely been oriented to obtain information on primary production in tropical rivers (Davies et al., 2008). In fact, aquatic plants and their relation with primary production in glacier rivers and lakes of the Andes were barely investigated.

Condoriri River Basin, in which this study focuses, displays abundant biodiversity with rich ecosystems composed by glacier lakes, rivers and wetlands completely different to other surrender areas like the Altiplano. Further, this river provides drinking water to two important cities in Bolivia, La Paz and El Alto. Thus, it is valuable to investigate the aquatic vegetation and primary production in this river.

In this paper, water quality measurements were conducted in the target river during two completely different seasons: dry and wet, to determine variations on dissolved oxygen and temperature and to assess the primary production. Macrophytes were harvested in the longitudinal direction of the river to estimate their biomass.

2. MATERIALS AND METHODS

Condoriri River basin is located 37 kilometers northwest ward from La Paz city, Bolivia, in the Cordillera Real of the Andes. This watershed is situated between 4400 m and 5300 m above sea level, and it has an area of 22.6 km^2. **Fig.1** shows the map of the basin with the arrangement of the sampling points in this study. The Condoriri River basin is composed of the mainstream and three lakes (Khellual Khota, Chiar Khota, and Kallan Khota). Further, it is characterized by a marked seasonality of precipitation and cloud cover with a wet season associated with intense solar heating of the Altiplano surface (September-April) and a dry season with clear skies during winter (May-August).

Seven sampling points were arranged in the Condoriri River (P1-P7) as shown in **Fig.1.** The field work was conducted to measure physicochemical parameters in the stream water and to take samples of aquatic plants from the main river during dry season (July and August) and wet season (February). Parameters in situ like dissolved oxygen and temperature were recorded during February (5th to 7th and 19th to 20th) and August (16th to 19th and 22nd to 25th) in the points P1 and P6 in 2013. Both parameters were measured using two dissolved oxygen and temperature loggers (HOBO® Dissolved Oxygen Logger U26-001) with a 10 minutes temporal resolution and in water depth of 0.5 m.

For the determination of the biomass, macrophytes were harvested from a quadrant of 50x50-cm by hand (emerged and submerged plants), from all the monitoring points (P1 to P7) in July (2012), February (2013) and August (2013). In the laboratory, plants were cleaned to remove sediments and macro invertebrates, separated by species, dried to constant mass (at 40 °C) and weighted. A rough estimation of the covered area by plants was done in every sampling point from the river.

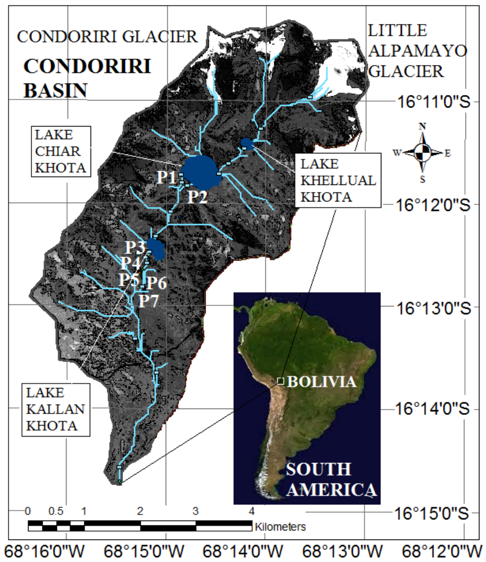

Fig.1 Field measurements of Condoriri River Basin

3. RESULTS AND DISCUSSIONS

Fig.2 and **Fig.3** show the variations of solar radiation, water temperature, dissolved oxygen, net primary production and ecosystem respiration in the wet season of February and the dry season of August in 2013. The values of solar radiation were variable during wet season compared with those during dry season. This is likely to be caused by major presence of clouds in summer, which intercepted the sun radiation. On the other hand, water temperature, dissolved oxygen and metabolism exhibited different trends with high variability in dry season. In fact, the effect of the ecosystem respiration over metabolism was evident in winter and insignificant in summer. Light availability, water temperature, nutrients, discharge and water level may influence the photosynthetic activity of the aquatic plants in the river.

Keywords: Condoriri glacier, physicochemical parameters, biomass, primary production
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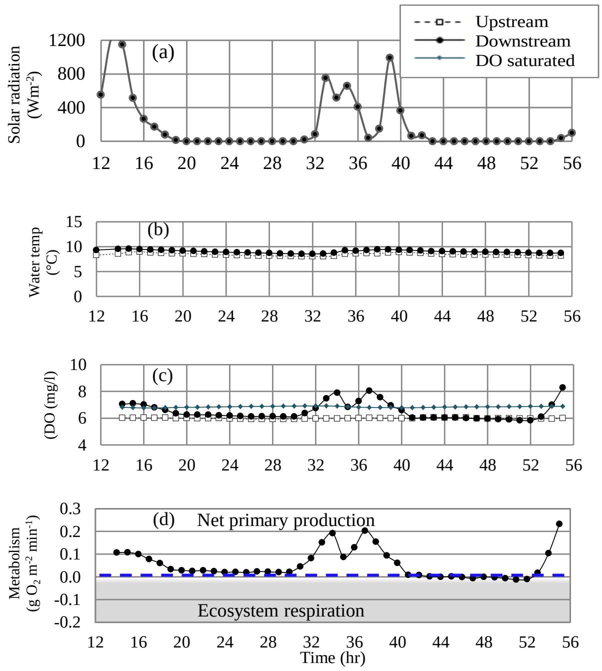

Fig.2 Hourly variations: (a) solar radiation, (b) water temperature, (c) dissolved oxygen and (d) metabolism in Condoriri River in February, 2013.

Macrophytes biomass was higher during the wet season of February than the dry season of July and August according to the results shown in **Fig.4 (a)**. The biomass of aquatic plants is closely related to primary production as shown in **Fig.4 (b)**. The presence of Lake Chiar Khota and Lake Kallan Khota at 2.9 km and 5.0 km must have some effect over the flourishing growth of macrophytes below these locations. Net primary production and macrophytes biomass were higher at P1 and P6 in the wet season

Table 1 Seasonal variations of macrophytes biomass, net primary production, respiration, solar radiation and water temperature in P1 and P6 in Condoriri basin.

Point	Month	Macrophyte biomass	Net primary production (gC/m^2d)	Respiration (gC/m^2d)	Solar radiation (W/m^2)	Day Tw (°C)	Night Tw (°C)
P1	Feb-13	221.6	28.81	3.20	466.8	9.17	8.56
	Aug-13	83.9	6.02	52.80	432.9	7.83	5.26
P6	Feb-13	187.3	11.46	3.50	329.0	8.82	8.53
	Aug-13	89.4	2.72	6.57	319.8	7.32	4.63

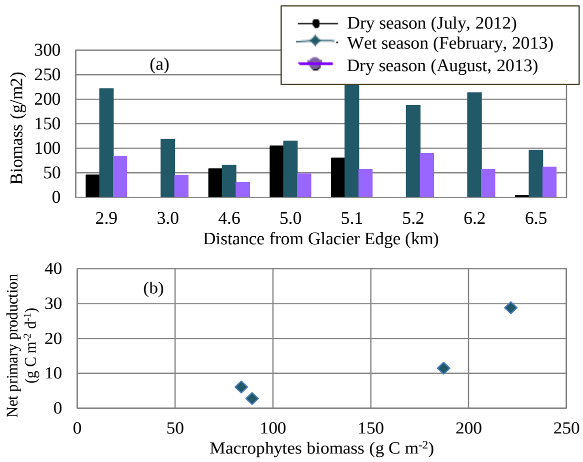

Fig.4 (a) Seasonal and spatial variations of aquatic plants biomass (b) influence of macrophyte biomass on primary production in Condoriri.

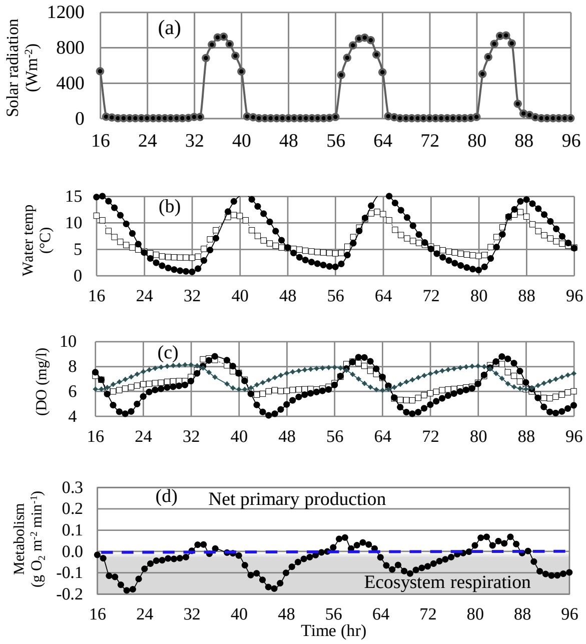

Fig.3 Hourly variations: (a) solar radiation, (b) water temperature, (c) dissolved oxygen and (d) metabolism in Condoriri River in August, 2013.

than the dry season. The highest net productivity was 28.81 g C $m^{-2}d^{-1}$ at P1 in February and the highest ecosystem respiration was 58.20 g C $m^{-2}d^{-1}$ at the same location in August in 2013, as it is shown in Table 1.

4. CONCLUSION

Primary production and macrophytes biomass were higher during the wet season in February than the dry season in August in 2013. Major photosynthetic activity of aquatic plants was found in summer than in winter.

The highest value of net primary production was 28.81 g C $m^{-2}d^{-1}$ at P1 in the wet season of February. On the other hand, the highest ecosystem respiration was 58.20 g C $m^{-2}d^{-1}$ at the same location during the dry season. Thus, seasonal changes had strong influence in the metabolism in the target river.

ACKOWNLEGEMENTS

This study was supported by JST/JICA, SATREPS (Science and Technology Research Partnership for Sustainable Development) and JSPS KAKENHI (No. 24404015).

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