SEDIMENT INTERSTITIAL WATER QUALITY AND MACROPHYTE GROWTH IN A SMALL GLACIAL RIVER OF THE ANDES

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1. INTRODUCTION

Researches on the influence of nutrients on vegetation have been done in aquatic ecosystems around the world (Watson et al., 1985). Aquatic plants can obtain a variety of nutrients from water and sediments; nutrients can be uptake by shoots and roots (Barko & Smart, 1981). However, studies concerning sediment interstitial water and its influence on macrophyte growth remain unreported in the Andean glacial rivers.

Condoriri River Basin displays abundant biodiversity with rich ecosystems composed by glacier lakes, rivers and wetlands. The river of this study provides about 44% of drinking water to two major cities in Bolivia (La Paz and El Alto). Thus, it is valuable to investigate the aquatic vegetation and the sediment interstitial water quality in this river.

In this paper, water quality measurements were conducted in the Condoriri River during dry season to assess the nutrient concentrations in surface and sediment interstitial water. Macrophytes were harvested in the longitudinal direction of the river to estimate their biomass and sediments were sampled for the analysis of nutrients.

2. MATERIALS AND METHODS

Condoriri River basin has an area of 22.6 km^2, located 37 kilometers northwest of La Paz city in Bolivia in the Central Andes. The Condoriri River basin is composed of the mainstream and three lakes (Khellual Khota, Chiar Khota, and Kallan Khota). The Condoriri River watershed is characterized by a marked seasonality of precipitation between wet seasons (September-April) and dry seasons (May-August).

Seven sampling points were arranged in the Condoriri River (P1-P7) as shown in **Fig.1.** The field work was conducted to take samples of water, sediments and aquatic plants from the main river during dry season (June and August) in 2014. Sediment interstitial water was taken by an interstitial water sampler (3036-24, Miyamoto Riken) and stored in plastic bottles. For the analysis of ions and DOC, water samples were filtered in situ on collection through membrane filters of 0.45 µm pore size. Ions were determined by ion chromatography using an ion chromatograph (DX-120, Dionex) with the methods SM 4110 and SM 3111. DOC was determined by 680°C combustion catalytic oxidation method using a TOC analyzer (TOC-L, Shimadzu). For the analysis of total nitrogen (TN) and total phosphorus (TP), a 50

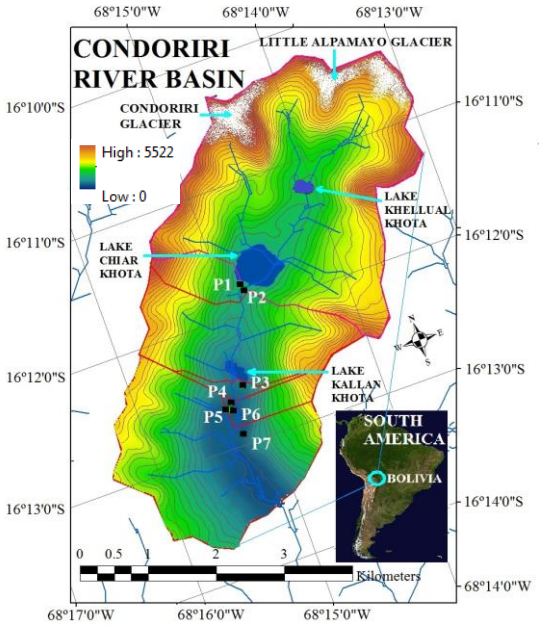

Fig.1 Field measurements of Condoriri River Basin

ml aliquot of unfiltered water sample was stored in a plastic bottle previously washed with water sample. The samples were transported and stored at 4°C in order to prevent biological reactions. TN and TP were measured using a TN-TP auto-analyzer (SWAAT, BL TEC K.K.)

For the determination of the biomass, macrophytes were harvested from a quadrat of 50×50 cm^2 by hand, from all the monitoring points (P1 to P7). In the laboratory, plants were cleaned, separated by species, dried to constant mass (at 40°C) and weighed. The analysis of nitrogen, phosphorus and organic carbon in sediments were carried out using the methodology proposed by the International Soil Reference and Information Centre (ISRIC).

3. RESULTS AND DISCUSSIONS

Fig.2 shows the results of the concentrations of silica, TN, TP, calcium, sodium and potassium in surface and sediment interstitial water in June and August in 2014. The concentrations of silica, TN, TP, calcium, sodium and potassium in the sediment interstitial water were higher than those found in the surface water at most of the monitoring points during the dry season in June and August in 2014. **Table 1** exhibits the nutrient and organic matter concentrations in the sediments and the interstitial water at the same locations. The concentrations of nitrogen, phosphorus and organic carbon were greater in the sediments than in the interstitial water at all the

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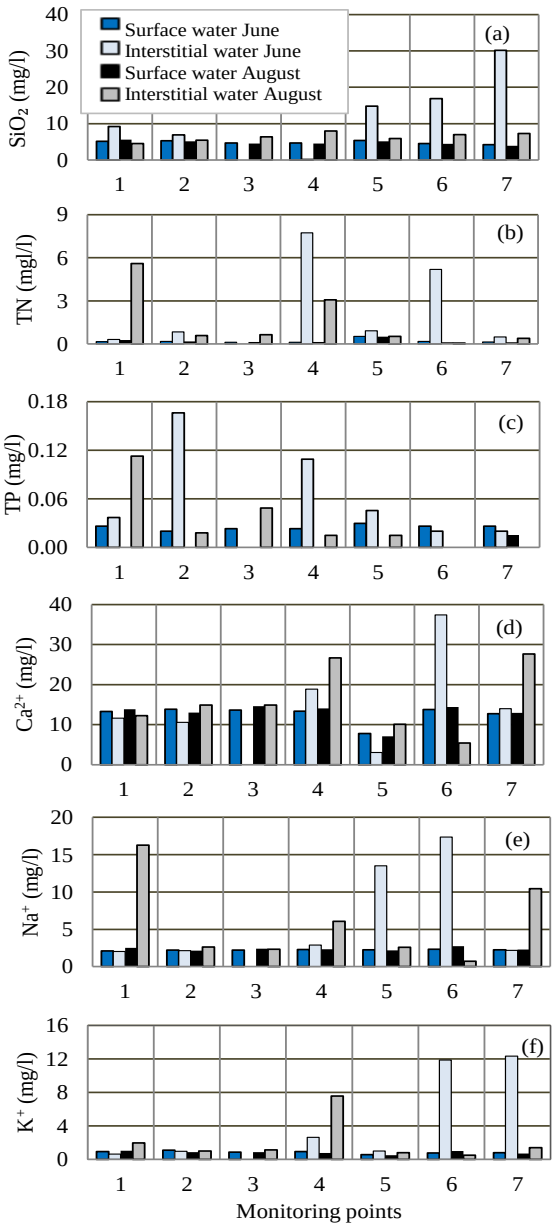

Fig.2 Nutrient and ion concentrations in surface and sediment interstitial water: (a) silica, (b) total nitrogen, (c) total phosphorus (d) calcium, (e) sodium and (f) potassium in the Condoriri River basin in 2014.

sampling points. According to these results, sediments were the principal source of TN, TP and organic carbon in the Condoriri River basin. The transport of dissolved materials across the sediment-water interface, as well as within the sediment, was an important factor influencing the water quality of the river. Sediments increased the nutrient concentration of the interstitial water and, consequently, the interstitial water affected the nutrient concentration of the overlying water.

Because of the normally greater abundance of nutrients in sediments and in interstitial water compared to the surface water at most aquatic systems, sediments provide a potentially large source of nutrient supply to aquatic macrophytes (Barko & Smart, 1981). Seasonal and spatial variations of the macrophyte biomass are exhibited in **Fig.3.** This

Table 1 Nutrient concentration in the sediments and in the interstitial water at seven monitoring points in the Condoriri River basin.

Nutrient	Units	P1	P2	P3	P4	P5	P6	P7
Nitrogen								
Sediment TKN	($mg \cdot g^{-1}$ dry wt.)	7.8	8.0	3.4	7.0	7.3	3.8	4.6
Interstitial TN	($mg \cdot l^{-1}$)	5.60	0.60	0.65	3.08	0.54	0.07	0.40
Phosphorus								
Sediment	($mg \cdot g^{-1}$ dry wt.)	4.6	1.7	2.2	1.3	1.4	1.0	2.8
Interstitial TP	($mg \cdot l^{-1}$)	0.11	0.02	0.05	0.01	0.01	0.01	0.01
Organic carbon								
Sediment	($mg \cdot g^{-1}$ dry wt.)	33	63	100	150	100	68	64
Interstitial DOC	($mg \cdot l^{-1}$)	9.75	5.41	1.72	15.53	1.62	1.32	5.26

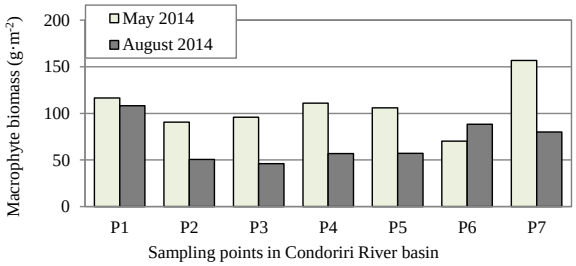

Fig.3 Macrophyte biomass in the Condoriri River basin during dry season in 2014.

variability was related to changes in the nutrient concentrations in interstitial and surface water (**Fig.2)**. Molecular diffusion within interstitial water seems to be of fundamental importance in effecting the exchange of dissolved constituents across the sediment-water interface and to influence to the growth of the aquatic plants. Translocation may result in high concentration of nutrients and metals accumulating in the roots and shoots of the aquatic plants.

4. CONCLUSION

Nutrient concentrations in sediments and interstitial water were greater than those found in the surface water at most of the monitoring points in June and August in 2014. Consequently, sediments were an important source of nutrients for the aquatic plants. Nutrient variations in interstitial and surface water influenced on the growth of the macrophytes in the Condoriri River basin.

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REFERENCES

Barko, J. W., & Smart, R. M. (1981). Sediment-based nutrition of submersed macrophytes. *Aquatic Botany*, *10*, 339-352.

Watson, P. G., Frickers, P. E., & Goodchild, C. M. (1985). Spatial and seasonal variations in the chemistry of sediment interstitial waters in the Tamar estuary. *Estuarine, Coastal and Shelf Science*, *21*(1), 105-119.