ENVIRONMENTAL FLOW ASSESSMENT IN ANDEAN RIVERS OF ECUADOR, CASE STUDY: CHANLUD AND EL LABRADO DAMS IN THE MACHANGARA RIVER

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The high Andean rivers of Ecuador provide most of the water for irrigation, and through hydroelectric plants generate electricity for the country. The environmental flow is a management tool to mitigate the impact of a dam on ecosystems. The Ecuadorian law requires that the environmental flow remains 10% of mean annual flow in old hydroelectric stations, however advances on this area suggest this is not adequate. The objective of this research was to assess the impacts of a 10% release and establish environmental flow recommendations in the Machángara and Chulco rivers which have been dammed by the Chanlud and El Labrador hydroelectric plants, in the watershed of the Machangara River (southern Ecuador).

During twelve months physical and chemical parameters and aquatic macro-invertebrates were recorded in twelve sampling points. Data collected included: the flow (by channel geometry), temperature (with a thermometer), and dissolved O₂ (DO, electrometric method). In the laboratory of ETAPA the data collected included: pH (pH meter), NO₃−N concentration (spectrophotometer), and soluble reactive P (SRP) (spectrophotometer). Macro-invertebrates were considered suitable biological indicators in the absence of others such as native fish. Shannon–Wiener and BMWP indices were calculated.

The analysis found significant differences in some parameters, indicating a decline in ecosystem condition and relations were found between the flow, the diversity of macro-invertebrates and the concentration of dissolved O₂ (DO). Decreased flows reduce re-oxygenation due to the slow movement of water. A low and constant flow in dammed rivers (10%) causes low DO concentration, especially in the dry season. However, determining whether these impacts are unacceptable is difficult because Ecuador does not have established criteria for required ecological condition.

This deterioration in ecological conditions can be minimized by applying more modern methods of environmental flow assessment such as the basic flow methodology (BFM) that allows the variability of the river flow. In the Machangara River (3000–4000 m.a.s.l.) an environmental flow of 27–51% of the mean annual flow for the rainy season and 29–42% in the dry season were determined by using BFM. Whereas the environmental flow for the Chulco River was 15–45% of the mean annual flow for the rainy season and 15–36% for the dry season (3000–4000 m.a.s.l.).

These results partly coincide with the global estimates calculated by Pastor, Ludwig, Biemans, Hoff, & Kabat (2014), who suggested keeping between 20 and 50% of the annual mean flow. Other research in high Andean rivers like the Chinchina, Las Piedras and El Manso in Colombia indicated that environmental flows should be greater than 25% of the annual mean flow (Boodoo, McClain, Vélez Upegui, & Ocampo López, 2014; Casanova & Figueroa, 2015; Pinilla-Aguadelo, Rodríguez-Sandoval, & Camacho-Botero, 2014).

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