Application of Methodologies for Environmental Flow Determination in an Andean and a Mediterranean Basin:
Two Case Studies of the Pance River (Colombia) and Wadi River (Palestine) Basin

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ABSTRACT

The demand for sustainable water management has promoted the development of methodologies for estimating environmental flows (EF). In this paper, the EF in an Andean river (Pance, Colombia) for conservation and a Mediterranean river (Wadi-Zomar, Palestine) for restoration purposes is made. Different methodologies are applied given the objectives for each river. The authors used hydrological indices proposed for watersheds with different water regimes and adaptations and validations were made to the local context. These methods allow for estimating the EF at various points in the river and the assessment of disruption scenarios for decision-making. In the Wadi Zomar River, three sampling points were selected. The water samples were then examined for the presence of pathogens. No one indicator or simple hydrological parameter is entirely suitable for all environmental systems and pathogens. In the base flow conditions, the amount of pollutant load varied temporally according to the amount of load from point sources along the Wadi, and spatially with distance from the same sources. Significant variation was observed in response to the hydrological behavior of the catchment. The assessment for the water quality in the Zomar reflects a potentially serious threat to the environment. The results emphasize the need for regulating the seepage effluent from industries and sewage system along the stream.

Keywords: *Aquatic Biota, Ecosystems, Environmental Flow Regime, Habitat, Hydrological Year, Hydrology, Internanual Variability*

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INTRODUCTION

Water is vital for life and socio-economic development of nations; therefore, from ancient times many cities and civilizations have grown near to water ecosystems, turning them into the engine of their development, for the agriculture, industry and energy generation, among other multiple uses. Beyond the economic use of water, rivers, lakes, wetlands and aquifers play key roles for the biosphere, livelihood and cohesion of the communities, representing common natural properties that mark the identity of territories and peoples.

Most rivers in the world have been altered in structure, shape, composition and operation. Is estimated that more than 60% of larger the rivers of the world, are strong or moderately fragmented by dams, diversions and canals (Revenga et al., 2000); causing an excessive fall in flow, change in the magnitude, duration and frequency of floods, prolonged drought period and reduce periodic flooding; situations that have led to changes in river morphology, erosion, pollution and eutrophication, alteration of sediment transport, and ultimately, severe ecological changes, physical and chemical. As well the loss of ecosystem services (provisioning services, regulating and cultural) situation resulting in economic costs, because when the benefits are reduced is necessary to take remedial and repair the damage. However, higher costs are usually borne by the populations that depend directly on these services, usually the poorest. Recognizing the global value of the services that these ecosystems provide and invest in their protection, keeps the livelihoods and long-term benefits, and also to save high costs and contribute to achieving true sustainable development (Dyson, Bergkamp, & Scanlon, 2003).

In the past 30 years, the impact of the continuing unsustainable human interventions on water resources has generated a growing environmental concern, both inside and outside of our borders. Water users with political and / or economically power have successfully developed methods to quantify and justify their water needs, but this is not the case of ecosystem, silent users of the resource, which generally are ignored in making decisions on water concessions. Now is recognized that the maintenance of river ecosystems is a legitimate objective to be considered among the competing demands for fresh water (Baron et al., 2003), concern clearly reflected in the demands of society to preserve and use the environment in a sustainable way and in the different governments, that are trying to capture in their sectoral policies through laws enacted by the government and the commitments made in adhering to many international conventions (Convention on Biological Diversity, Man and Biosphere, Ramsar, etc.) (Gómez-Criado, Loné-Pérez, & Canga-Cabañes, 2000).

The increasing social demand for sustainable management of water resources has led to worldwide the development of methodologies for defining an environmental, ecological of maintenance flow or better known as "environmental flow regime – EFR"; (Cantera-Kintz, Castro-Heredia, & Carvajal-Escobar, 2009; Pyerce, 2004; Tharme, 2003), summary at least seven different names and concepts of environmental flow, reported in the literature, depending on the environmental objective to be achieved.

CASE STUDY: ANDEAN BASIN, PANCE RIVER (COLOMBIA).

Description of the Study Area

Pance basin is located in southwestern Colombia in the Andes (Figure 1), belongs to a major endemic ecosystem (Parque Nacional Natural Los Farallones de Cali). The area has the influence of the intertropical convergence strip (ITCZ), with a bimodal rainfall, with two rainy seasons, interspersed with two dry, annual rainfall of 2550 mm, and a specific flow rate of 44.26 l/s km^2, which drains an area of 72. 0 Km^2 (microbasin), has altitudes ranging between 1000 and 3500 m, which characterize it as torrential its main river (Pance), has an average flow of 3.19 m^3/s. The average temperature is 25 °C, ±

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