Abstract

Climatic variability associated to the ENSO has profound socio-economic and environmental impact in Colombia. In contrast to the large water availability (more than 5000 m^3 per capita) El Niño, decreases precipitation and river flows, producing almost 12 droughts in the last five decades. La Niña, generates the opposite side effect including floods and landslides emergencies, can directly affect over 500,000 people every 2 or 4 years. The sizing of hydraulic structures for these two hydro-meteorological events, can be examined using the statistical modeling of Frequency Analysis to prognostic the behavior of a hydrologic variable beyond the known record period. This approach is based on the hypothesis that time series are stationary. However, climatic variability and human induced changes on natural resources can also affect the behavior in time-based hydrologic variables. This work aims to detect and describe the variability of the extreme hydrologic indices in the Cauca river by effect of climatic and anthropogenic variations throw, non-stationary statistical modeling to improve our understanding of flooding´s risk as well as the risk associated to droughts in Colombia. The study area is the Cauca River high basin known as Valle Alto. This inter-Andean river basin has been shown strongly influenced by ENSO and it is interesting research case due the fact that the waterflow regime has been altered by a reservoir located headwaters of the basin. This system has a spatially distributed hydrological dataset for the period 1965-2015. The annual hydrologic variables are maximum daily flow, monthly average minimum flow, flood duration and low flow duration of four gage station. The explanatory variables are seven climatic indices, the probability of extreme phases of ENSO phenomenon and two reservoir indices. It is evaluated six cumulated probability distribution function commonly used in time series with positive skewness and generalized additive models of location, scale and shape (gamlss). The methodology consider: i) stationarity hypothesis test; ii) cross-correlation analyses between the reservoir storages and extreme river flows; iii) to propose to use indices to describe the reservoir influence on the water system; iv) evaluate the teleconnection between climatic indices and hydrologic variables; and v) further make detailed comparisons among different non-stationary models. The results show that incorporate the reservoir changes is better to describe the dependency of the hydrologic variables on the reservoir. Furthermore, the models suggest a better fit to both climate and human-induced changes in the hydrologic regimes. The non-stationary models exhibit and adequate adjust to the variability of the observations in time, less loss of information and normality in the residuals. The covariate models indicate that during ENSO phenomenon phases, the river flows estimated to an extraordinary exceedance probability could be significative different from those calculated whit stationary Frequency Analysis. I conclude that the flood risk in the Juanchito hydrometric station depends of the increase trends in precipitation and runoff in basin areas not regulated by the Salvajina Reservoir and by the La Niña phenomenon incidence. Due to this, the reservoir does not constrain the extreme floods. However, the increase trends in low flows depends significantly of reservoir operation, but exist a significant probability of intensification of hydrologic drought when low-level water in the reservoir and El Niño Events occur simultaneously. The hydrologic risk cannot to be controlled by the actual operation rules at the reservoir, and constitute a significant challenge for water management of the whole Cauca river basin. The findings as well as the methods have

significant meaning for current hydric resources management and the integrated hydrological risk management of an inter-Andean valley that house over 4.6 million people.