Geophysical Research Abstracts
Vol. 17, EGU2015-13416, 2015
EGU General Assembly 2015

Removing the impact of water abstractions on flow duration curves

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Changes and interactions between human system and water cycle are getting increased attention in the scientific community. Commonly discharge data needed for water resources studies were collected close to urban or industrial settlements, thus in environments where the interest for surveying was not merely scientific, but also for socio-economical purposes.
Working in non-natural environments we must take into account human impacts, like the one due to water intakes for irrigation or hydropower generation, while assessing the actual water availability and variability in a river.
This can became an issue in alpine areas, where hydropower exploitation is heavy and it is common to have water abstraction before a gauge station. To have a gauge station downstream a water intake can be useful to survey the environmental flow release and to record the maximum flood values, which should not be affected by the water abstraction. Nevertheless with this configuration we are unable to define properly the water volumes available in the river, information crucial to assess low flows and investigate drought risk. This situation leads to a substantial difference between observed data (affected by the human impact) and natural data (as would have been without abstraction).
A main issue is how to correct these impacts and restore the natural streamflow values. The most obvious and reliable solution would be to ask for abstraction data to water users, but these data are hard to collect. Usually they are not available, because not public or not even collected by the water exploiters. A solution could be to develop a rainfall-run-off model of the basin upstream the gauge station, but this approach needs a great number of data and parameters
Working in a regional framework and not on single case studies, our goal is to provide a consistent estimate of the non-impacted statistics of the river (i.e. mean value, L-moments of variation and skewness). We proposed a parsimonious method, based on few easy-access parameters, of correction of the water abstraction impact. The model, based on an exponential form of the river Flow Duration Curve (FDC), allows completely analytical solutions. Hence the method can be applied extensively. This is particularly relevant when working on a general outlook on water resources (regional or basin scale), given the high number of water abstractions that should be considered. The correction method developed is based on only two hard data that can be easily found: i) the design maximum discharge of the water intake and ii) the days of exercise, between a year. Following the same correction hypothesis also the abstracted discharge statistics have been reconstructed analytically and combined with the statistics of the receiving reach, that can be different from the original one. This information can be useful when we are assessing water availability in a river network interconnected by derivation channels.
The goodness of the correction method proposed is proven by the application to a case study in North-West Italy, along a second order tributary of the Po River.
Flow values recorded at the river gauge station were affected, significantly, by the presence of a 5 MW hydropower plant. Knowing the amount of water abstracted daily by the power plant we are able to reconstruct, empirically, the natural discharge on the river and compare its main statistics with the ones computed analytically using the proposed correction model. An extremely low difference between empirical and analytical reconstructed mean discharge and L-moment of variation was founded. Also, the importance of the day of exercise information was highlighted.
The correction proposed in this work is able to give a correct indication of the non-impacted natural streamflows characteristics, especially in alpine regions where water abstraction impact is a main issue.