Geophysical Research Abstracts
Vol. 16, EGU2014-8477-1, 2014
EGU General Assembly 2014


# Hydrological Uncertainty and Hydro-power: New Methods to Optimize the Performance of the Plant

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Hydrological uncertainty due to daily flow variability and to the effect of climate change on water resources is a critical topic in the feasibility evaluations of hydro-power projects, especially for run-of-river power plants.
The effect produced by these factors on the annual energy output of such type of plant was investigated. New methods for improving the performance of the plant are proposed, which enable the choice of the most suitable design flow (Qd) according to the hydrological features of the river, the frequency of dry and wet years in the basin and the target energy production.
The flow data of fifteen catchment basins of the Umbria Region (Italy) were processed in the form of Flow Duration Curve (FDC) and the slope of each FDC was used as an indicator of the flow regime. The values of the power developed by hypothetical plants were calculated and relationships between the flow regime of the rivers and the performance of the plants (i.e. the Capacity Factor - CF) were searched for. Results showed that CF is analytically linked to the regime flow and it depends to a great extent on it. In particular, CF decreases from a constant run-off regime to a torrential one and the greater the Qd, the greater the rate of this decrease. A procedure was developed on the basis of the equations found, which allows for the identification of the optimal Qd only using the slope of the FDC. Since no other information is required, this approach also enables hydroelectric evaluations in ungauged basins, through the use of regionalized FDCs. The validation of the procedure indicates that it provides reliable results whatever the flow regime of the river and the turbine installed at the station.
Additional analysis showed that the effect of extreme weather years on energy production is not the same for all basins and it depends on design choices. Manipulation of the data obtained by the FDCs of the driest and wettest year with a 20-year return period showed that the decrease in energy production in dry years, compared to the annual average, is linearly linked to Qd, as well as its increase in wet years. In particular, if Qd is extrapolated from the right part of the FDC the negative effect of dry years on CF can be reduced while, if it is extrapolated from the left part, the increase of flows in wet years can be better exploited to enhance CF. The procedure developed allows us to derive the characteristic linear function of the river which, together with the knowledge of climate trends in the area of interest, enables more accurate design of the hydro-power plant.