

RICHIESTA DI ATTRIBUZIONE DI UN ASSEGNO DI COLLABORAZIONE ALLA RICERCA

Richiesta di nuovo assegno di ricerca

Title: Water and flood risk management of impounded river basins

Description of the Research Project:

Dams have segmented most of the major rivers in industrialized countries, and nowadays the same is occurring in developing countries. Dams have provided undoubted benefits to the people, contributing to develop countries, supply energy, regulate water supply, mitigate water crises, reduce hydraulic risk, and defend the territory. At the same time, dams have an impact on environment and society. They represent the primary cause of loss and degradation of river ecosystems (loss of fish species, and the services these ecosystems provide to society), and a potential hazard for the downstream population in case of dam failure or malfunctioning. In the past, the design of large dams has accounted only partially the impacts consequent to the realization of such structures. For example, Ziv et al. (2012) pointed out that the design of Mekong river dams has addressed the impacts on the mainstream, neglecting those on their tributaries. The World Commission on Dams (WCD, 2000) reported that the negative impacts of dams on the environment exceed the positive ones. Dam ageing and climate changes (viz., nonstationarity of forcings) constitute indeed two important issues that are modifying the behavior of dam-reservoir systems, and the impacts that these can have on environment and population.

Dams may continue to provide valuable services, but a rehabilitation is necessary for many reasons, including (1) new hydrological safety requirements posed by increasingly risk-averse societies, also in the context of climate change, (2) changes in the downstream river and riparian system after the building of the dam, (3) poor hydrological information at the time of dam design and construction, and (4) modified priorities of watershed management after dam completion.

In Italy, there are about 550 large dams (i.e., with dam height exceeding 15 meters, or reservoir capacity larger than 1 million of cubic meters) of national interest. These dams, which had a strategic role in our economy, were built during the XIX and XX centuries (60% of these are over 50 years old) under different engineering (90% was built before the entry into force of the current technical regulations, which date back to 1982), social, economic, and possibly climate conditions from nowadays. Presently, dam managers cope with dam safety issues reducing the operational maximum level, which in some cases implies the use of only a portion of the available reservoir volume, thus limiting the related activities. An example is the Mignano reservoir on the Arda River (Northern Italy).

The aim of this project is to integrate updated knowledge on hydrologic, hydraulics, and sedimentation processes to address the water and flood risk management of impounded river basins through a holistic paradigm. In particular, the project intends to set guidelines for a functional re-habilitation, i.e. the one associated to water-related issues (leaving out structural aspects), of large dams addressing the following main topics: 1) re-think of dam design scenarios of dams taking into account modified climate conditions, and considering not only the streamflow variable, but including also sediment transport and debris inflows; 2) update of dam operation strategies in order to accommodate modified behavior of climate forcings and hydrologic variables, and modified needs; 3) update of the criteria to map hazard scenarios in downstream and riparian areas; 4) illustrate some demonstrative case studies considering post-construction assessment of dam-reservoir systems and future scenarios.

Plan of activities:

The work developed in the present research project has the objective of supporting the activity of the WP2 – Hydrological risk scenarios and safety criteria of existing dams, with particular attention to the updating of the dam design criteria for hydrological safety (A2.2). In this task, the activity of U.O. 3 is focused on the design values used at the time of dam construction with present and future multivariate hazard scenarios.

The context from which these activities originate consider that dams will continue to provide valuable services, but a rehabilitation is needed because of (1) the new hydrological safety requirements posed by increasingly risk-averse societies, (2) the changes in the downstream river and riparian system after the dam were built, (3) poor hydrological information at the time of dam design and construction, and (4) the modified priorities of watershed management after dam completion.

The research fellow's activity will in particular be concentrated on the recognition and processing of hydrological information available in the past for the basins relating to the dams considered in the case studies. This will allow to produce a photograph of the information context used at the time of construction of the reservoirs, with reference to the historical series, their temporal amplitude and the applied methodologies. The scenarios that will be recovered can then be compared with the present and future ones elaborated in the other tasks.

The analysis can make use of tools which include computing environments for data processing and statistical analysis, also geographical information system environments for cartographic processing and analysis at the territorial level.

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