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On the estimation of the design flood of different dams in Sardinia (Italy)

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The problem of the hydraulic safety of existing dams is becoming crucial due to the recent increase of floods. In Sardinia dams were built for both electric production and water supply for irrigation and civil uses during the 1920-1960 period. Recent floods showed a significant increase in magnitude and frequency, supporting the hypothesis of a hydrologic climate change. Are the existing dams still safe?
For answering the question 1) an hydrologic model is implemented and widely tested with hystorical floods, 2) a method for estimating the flood hydrograph with return period of 1000 years and 3) the hydraulic safety of existing dams is tested.
The case study are the Rio Mogoro river basin (area of about 255 km2) located in central-western Sardinia (Italy), the Tirso river basin (area of about 3100 km2) and the Flumendosa river basin (area of about 1017 km2). In the Rio Mogoro there is a gravity dam built in 1934 with a volume of 11.31 million of cubic meter; in the Tirso there are three important dams with a total volume of about 800 million of cubic meter that cover a big part of the region, while in the Flumendosa basin are present two dams with a total volume of about 360 million of cubic meter.
In the first part of this work the rainfall and discharge data of historical floods were acquired so that a fully evaluation of the hydrologic model has been performed. The distributed hydrologic model is an event model (FEST) which assesses runoff through a simplified approach based on Soil Conservation Service equations and runoff propagation through the Muskingum-Cunge approach.
Then the design flood of return period of 1000 years is estimated using a synthetic design hyetograph and FEST. For estimating and checking hydrograph characteristics statistics on observed flood hydrographs (i.e. local statistics) were evaluated: the peak flow, the time and duration of the peak and the volume of the flood. Local statistics are further compared with regionalized statistical methods for flood predictions. Furthermore local statistic of the rainfall IDF curve are analyzed, highlighting an interesting increase of rainfall extreme in the mountain East Sardinian rain stations (daily rainfall of almost 600 mm in December 2004). In this way synthetic hyetograph and hydrograph are estimated for the design flood of return period of 1000 years.
The results show that the flood increases with the position of the peak of the hydrograph due to the soil saturation; the time peaks of the hydrograph and of the flood hydrograph are different: it depends on the propagation in the channel and on the soil permeability.
In the last part of the work we use the hydrograph flood of the project calibrated to verify the safety of the dam for a return period of 1000 years. From these analysis the dams of the considered basins will be overflowed by a rain with a return period of less than 100 years.