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Assessing the use of satellite rainfall estimates for flood design/warning applications in mountainous basins

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Mitigation of flood risk relies primarily on two main components that include flood control structures and flood warning procedures. Development of both elements at a certain area requires fundamental knowledge on the “flood history”, commonly represented by flood frequency curves (FFC). Derivation of FFC requires a rather long (usually >10yrs) record of hydrological observations, which is missing in many flood prone areas globally. For example, mountainous areas, which are particularly prone to flooding, are usually not covered by observational networks even in the case of developed countries. As such, designing flood prevention structures and early warning systems is hampered by observational limitations. A potential solution to this problem is offered by combining hydrologic models with global satellite precipitation products. The available record of passive microwave driven satellite precipitation products currently reaches 15yrs, which if coupled with a hydrologic model could be used to generate a hydrologic record that is long enough to support FFC construction. However, such an approach needs to be examined with caution given the large uncertainties associated with satellite rainfall estimation.

This work focuses on the evaluation of three widely used satellite-rainfall products (3B42RT, CMORPH, PERSIANN) and their gauge adjusted versions (i.e. 6 products total) for the development of FFC in the mountainous basin of Upper Adige, Northeast Italy. Specifically, satellite-rainfall products are used as rainfall forcing in the ARFFS (Adige River Flood Forecasting System) to simulate hydrologic response for basins in the region over a period of 10 years (2002-2012). Simulated hydrologic time series are then used to develop FFC and these are compared against the FFC derived from the available discharge observations over the same period. Results are also contrasted to FFC derived using in situ gauge rainfall measurements as rainfall forcing in the ARFFS system. The methodology is applied to both medium size (<1000km2) and large (>1000km2) basins to investigate potential scale dependence of the results. Furthermore, development of a flood warning procedure based on satellite-based FFC is examined. Results show that propagation of satellite-rainfall error, mainly underestimation, in simulated flood estimates has a significant effect in simulated flood magnitudes, which consequently affects the accuracy of the derived FFC. However, for many of the products examined the relative ranking of the severity of flood events was quite accurate, which means that flood warning procedures could be potentially developed using threshold-based warnings.