Geophysical Research Abstracts
Vol. 17, EGU2015-11780, 2015
EGU General Assembly 2015

Flood hazard maps from SAR data and global hydrodynamic models

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With flood consequences likely to amplify because of growing population and ongoing accumulation of assets in flood-prone areas, global flood hazard and risk maps are greatly needed for improving flood preparedness at large scale. At the same time, with the rapidly growing archives of SAR images of floods, there is a high potential of making use of these images for global and regional flood management.

In this framework, an original method is presented to integrate global flood inundation modeling and microwave remote sensing. It takes advantage of the combination of the time and space continuity of a global inundation model with the high spatial resolution of satellite observations. The availability of model simulations over a long time period offers the opportunity to estimate flood non-exceedance probabilities in a robust way. The probabilities can later be attributed to historical satellite observations. SAR-derived flood extent maps with their associated non-exceedance probabilities are then combined to generate flood hazard maps with a spatial resolution equal to that of the satellite images, which is most of the time higher than that of a global inundation model. The method can be applied to any area of interest in the world, provided that a sufficient number of relevant remote sensing images are available.

We applied the method on the Severn River (UK) and on the Zambezi River (Mozambique), where large archives of Envisat flood images can be exploited. The global ECMWF flood inundation model is considered for computing the statistics of extreme events. A comparison with flood hazard maps estimated with in situ measured discharge is carried out. An additional analysis has been performed on the Severn River, using high resolution SAR data from the COSMO-SkyMed SAR constellation, acquired for a single flood event (one flood map per day between 27/11/2012 and 4/12/2012). The results showed that it is vital to observe the peak of the flood. However, a single event may not be sufficient for flood hazard mapping.

First results are promising on the potentiality of the method. The approach aims at addressing, trough integration, respective weaknesses of the two components of the method: coarse spatial resolution and high uncertainty of global numerical models and discontinuous data acquisitions over comparatively short time periods for SAR remote sensing observations. In the one hand, this approach has the interesting merit of being independent from ground data. On the other hand, it still is of paramount importance to improve the skill of global inundation modelling for reliably estimating flood occurrence probabilities. This is critical point since errors in the model are directly transferred to the resulting hazard map. Also, the spatial and temporal sampling of satellite observations needs to be increased, to provide more detailed and more reliable maps. This aspect can nowadays be addressed combining data from several space missions, such as Sentinel-1 and Cosmo SkyMed constellations.