Geophysical Research Abstracts,
Vol. 11, EGU2009-11719-1, 2009
EGU General Assembly 2009


# Improved mapping of flood extent and flood depth using space based SAR data in combination with very high resolution digital elevation data

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Due to their capability to present a synoptic view of the spatial extent of floods, remote sensing technology, and especially synthetic aperture radar (SAR) systems, have been successfully applied for flood mapping and monitoring applications during the past decades. However, the quality and accuracy of the flood masks and derived flood parameters highly depend on the geometric precision of the satellite data as well as on the classification accuracy of the derived water mask. The incorporation of high resolution elevation data from LiDAR measurements for example can help to improve the plausibility and reliability of the flood masks. On the basis of the improved flood masks more sophisticated parameters such as inundation depth can be derived.

A cross section approach is presented that allows the dynamic fitting of the position of the flood mask profiles according to the underlying terrain information from the DEM. The method was tested on the River Severn (UK), for which TerraSAR-X stripmap data with 3 meters pixel spacing acquired during the 2007 summer flood are used in combination with a LiDAR DEM of 2 meters pixel size. Initially, the cross sections were established perpendicularly to the major flow direction along the 7 km reach of the River Severn. The profile spacing was set to 50 meters. For each cross section profile the water level was extracted at the position of the left and the right border of the flood. On the basis of the longitudinal profile, which contains the sequence of all cross section profiles, a moving average was applied on the water levels in order to get a smooth water surface and to reduce single outliers. However, in case of obvious irregularities in the water levels illustrated in the longitudinal profile and caused by misclassification the respective cross-sections had to be excluded from further analysis. It must be taken into account, that the approach is mainly affected by possible classification errors in the dimension of more than a few pixels. Major causes are flooded vegetation or urban structures which lead to an underestimation of the true water level because of higher backscatter values than a plain specular water surface. Also a rough water surface caused by wind or precipitation can result in higher backscatter values and thus misclassification of land instead of water. In these cases the water level can not be retrieved in a reliable manner.

In the averaged water surface of the longitudinal profile, variations in the successive water levels due to small scale thematic/geometric errors could be balanced and a smooth and more realistic water surface was generated. Subsequently, each of the cross section flood profiles were trimmed or extended according to the modified water level from the longitudinal profile, and thereby the remotely sensed flood profiles were fitted onto the underlying topography. Having achieved coherence between the water surface and the topography, the flood depth could be derived and mapped. The resulting flood extent was compared against aerial photography taken 15 hours prior to the satellite pass and showed good agreement.

Finally, the performance of the matching technique and scaling effects as well as the potential and the constraints of the approach are evaluated and discussed. In this context the demand for satellite-based high resolution SAR data and high resolution elevation data are stressed. The proposed semi-automatic method has been developed in the context of the rapid mapping of flood parameters, such as flood extent and flood depth, as contribution for disaster management operations or the rapid estimation of flood damages. The requirements of such applications are fulfilled by the fact that computation time is negligible and data requirements are low, i.e. only remote sensing data and high resolution topographic data are needed. The proposed method stands in contrast to hydrological modeling approaches which are more complex with respect to data requirements, parameterization

and computation time. However, both approaches can benefit from each other in terms of cross-comparison and validation.