Lone C. Mokkenstorm

The potential of passive microwave satellite data for flood early warning systems in Malawi

Early warning systems can support humanitarian operations by forecasting hazard impacts and aid to release funds before disasters take place. One challenge humanitarian organizations currently face, however, is a lack of historical and real-time data to set up such a system. Whereas optical satellite remote sensing data has been used in the past to address these issues, cloud cover and infrequent satellite overpasses often yield this data suboptimal for this purpose. This study therefore investigates whether openly available, coarse-resolution, passive microwave satellite data −which is less impeded by cloud-cover and is measured on a daily basis− can be effectively used for early warning systems for floods in the Shire River and the North Rukuru River in Malawi. Two alternative indices were calculated from the raw data and further studied.

Flood Detection
Firstly, the potential for detecting both river discharge and individual flood events was assessed. At both study sites, the indices detected a seasonality similar to that of the observed discharge, as long as the satellite data pixel studied was sufficiently far from a large water body. The indices were moderately correlated to discharge in the Shire River, but not in the North Rukuru River. A comparison of the satellite data to an impact database with flood events showed that the indices did not detect the majority of registered floods, although this is likely a consequence of the method used to determine the threshold of what 'counts' as a flood.

Flood forecasting
Satellite data from the upstream part of the river catchment could unfortunately not be used to forecast the satellite signal and hence the flood events downstream, as the correlation between the two was strongest without a time shift. If it would have been stronger with a time shift of at least one day, this would add time to the window available to give out early warnings. Therefore, a forecasting model was set up using *just* the satellite data from the downstream point of interest. Statistically, this model showed to have sufficient accuracy with a lead time up to nearly three days, but a test conducted with a historical flood event showed that this model would, in practice, not have triggered an early warning before the flood event happened. Overall, the passive microwave system presented in this thesis had a stronger relationship with discharge in the study area than the existing global runoff model GloFAS does. As it also does not require extensive input data when used as an early warning system, we suggest that when perfected, the PMRS-method is implemented in a coupled solution, including a remote sensing-model, a global forecasting model and a more detailed national model. The use of these systems could offer early warnings in data-scarce regions and at a variety of lead times, which has the potential to make humanitarian aid in response to floods faster and more efficient.

Keywords: Physical Geography, Ecosystem Analysis, Early Warning, Riverine Floods, Humanitarian Work, Impact-based Forecasting, Malawi
Original title: *Behind the early warning: Improving impact-based forecasting of riverine floods in Malawi using passive microwave remote sensing*

Advisors: **Andreas Persson, Marc van den Homberg**
Master thesis, 30 credits, in Physical Geography and Ecosystem Science, 2020
Department of Physical Geography and Ecosystem Science, Lund University. Student thesis series INES nr 528