Improving flood predictions using data assimilation

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Flood inundation models calculate the numerical solution of equations governing the flow of water in the flooded area. The speed of water movement and extent of the inundation are strongly influenced by the flow rate of the river upstream, the texture of the surface the water is flowing across (e.g., field, road, rocks etc), the local terrain and structures such as flood defences, weirs, bridges etc. Hence the accuracy of model predictions are affected by uncertainties in the river runoff (i.e., inflow boundary conditions), the friction parameters describing the roughness of the ground, and the model representation of the terrain and other structures. Unfortunately these parameters and inflows are hard to measure in practice.

Data assimilation is a sophisticated mathematical technique for improving prediction, by combining model and partial observational data, taking account of uncertainties in the data. Conventionally it has been used in a feedback loop to update dynamic model variables (such as water velocities) whilst keeping the model parameters fixed. We have developed a new technique that also allows online estimation of the inflow and parameters as part of the data assimilation algorithm. Our technique relies on minimizing a least squares cost function (essentially minimizing the distance between the model trajectory and the observations). The technique has so far been tested in a range of simple models using synthetic data with excellent results. A rival method employs an ensemble (several model forecasts) that is updated at the time of the observation using an approximate linear theory. The goal of this project is to test both techniques in a realistic flood model, with satellite synthetic aperture radar (SAR) observations and compare their efficacy in improving flood forecasts.

Training opportunities:
This is an interdisciplinary project that will provide training in data assimilation, applied mathematics and hydrology, taking advantage of the wide range of MSc modules offered in these areas. The student will join the large and active Data Assimilation Research Centre (DARC) at Reading. In addition, the student will be able to collaborate with flood researchers from the SINATRA project funded under the NERC Flooding from Intense Rainfall programme. In particular, if a flood event occurs during the project, it may be possible for the student to join a flood action team taking field measurements.

Student profile:
This project would be suitable for students with a degree in physics, mathematics or another scientific or engineering discipline with a high mathematical content.