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Summary of secondment at the BMT WBM flooding and environmental modelling team, London

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The Adaptation and Resilience in the Context of Change (ARCC) Network funded a secondment for Dr Sangaralingam Ahilan to join the BMT WBM Ltd, London for a month. The secondment enabled Dr Ahilan to work with a leading flood modelling experts in BMT WBM who have contributed to the national guidelines on the policy, applicability, installation, construction and management of water sensitive urban design. Dr Ahilan initiated the research collaboration with BMT WBM because the TUFLOW software which is developed by BMT WBM is widely used in the UK for flood simulation studies and outperformed 14 other 2D flood inundation modelling packages in the 2010 UK Environment Agency benchmarking study. TUFLOW's robustness, performance and wide ranging functionality make it one of the world's most powerful 1D/2D hydrodynamic computational engine. The primary aim of this collaborative research is to explore integrated flood modelling approach that could capture combined surface water and river-related flood risk in an urban catchment.

Background

"Flooding is complex process; firstly, because there are several types of floods – river (fluvial), coastal, surface water (pluvial) and groundwater; and secondly, because most floods are actually combination of these types" (House of Commons, 2015). This study focuses on fluvial and pluvial flood risk in the urban environment. In the UK, flood risk assessments are generally undertaken by 'Lead Local Flood Authorities' (LLFAs) based on flood modelling approaches. The Environment Agency collates and reviews these assessments when updating the online surface water flooding maps. Typically, a flood risk assessment is produced which reviews the risk of flooding (by modelling or by utilising existing flood risk zone designations informed by modelling). Where modelling is undertaken to inform an application, the modelling is associated with a particular return period and storm duration, which is carried out for either surface water or river related flood risk. This independent approach of flood hazard assessment causes problems due to possible interactions between surface water and river flooding sources. On average, it is difficult to define a single flow with certain likelihood of occurrence. Some of the UK's worst floods in recent years have been of this type (e.g. Tewkesbury, Leeds; July 2007 flooding costs over £100 million to the local councils).

Figure 1. Tewkesbury Abbey flooding - July 2007 (BBC, 2008)

Dr Ahilan was involved in two EPSRC funded research projects: Blue-Green City (B-GC) (EP/K013661/1) and SESAME (EP/K012770/1) which are focused on sustainable urban flood risk management in the UK cities. The B-GC project aims to recreate a naturally-oriented water cycle while contributing to the amenity of the city by bringing water management and green infrastructure together. The SESAME project aimed to understand and model the impacts of flooding on the UK's small business and the knock-on effects on the wider economy. Dr Ahilan's role in these projects was mostly involved in flood and sediment modelling in the built and natural environments.

Approach

In the first part of his secondment at BMT WBM, Dr Ahilan presented the methods and tools used in the EPSRC projects to the BMT WBM flood and environmental modelling team. This facilitated the flood modelling experts to methodically review the modelling approaches which were used in the B-GC and SESAME academic projects and suggest potential improvements. This process allowed Dr Ahilan to revise his modelling approaches and be better informed about up-to-date industry practises.

In the second part of his secondment he explored the potential methods of incorporating fluvial and pluvial flood risk in the highly developed sub-catchment of the River Aire, Wortley Beck catchment, South West of the City of Leeds, UK. Lower Wortley has experienced regular flooding over the last few years from a range of sources, including Wortley Beck River and surface water flooding. The major 2002, 2005 and 2007 flood incidents substantially affected properties both upstream and downstream of Farnley Lake as well as the important transport link of Wortley Ring Road (A6110).

The following methodologies have been considered in integrating a combined pluvial and fluvial flood risk in the Wortley Beck catchment:

- Collating and reviewing the river flow data and rain gauge data sets from the nearby Aire sub catchments.
- Using the urban runoff as a lateral inflow into the Wortley Beck river model which was obtained from the Environment Agency.
- Developing a surface water flood model for the Wortley Beck catchment.
- Exploring various flood modelling case studies which were carried out by the BMT WBM in the UK and Australia.

Outcomes

The Wortley Beck is an ungauged catchment which has limited long-term flow data sets in the study region to establish the relationship between the rainfall and flow. This prompts the exploration of available data sets in the nearby river Aire sub catchments. The flow and rainfall data sets at the nearby Aire sub catchments were obtained from Environment Agency. This process enables the understanding of the response to rainfall in the river Aire catchment.

In the first part of the study, the coupled ISIS-TUFLOW river model of the Wortley Beck catchment was obtained from the Environment Agency and revised by incorporating updated flow inputs into the model. The most recent land use data sets of the Wortley Beck catchment and updated methodologies were used to derive the flow inputs to the river model. The revised river model enables the simulation of a number of flow scenarios in the Wortley Beck catchment to investigate the associated fluvial flood risk. In the second part of the study, a rainfall runoff model for the Wortley Beck has been developed using a TUFLOW model. For this modelling, input information from Digital Elevation Model (DEM), MasterMap, soil data, etc., were obtained from Environment Agency, UK Ordnance Survey and British Geological Society. During the model development process, BMT WBM team shared their experience from a number of flood modelling studies (e.g. Drain London project, Brisbane 2007 flood modelling) which they have carried out in the UK and Australia. The detailed rainfall runoff model for the Wortley Beck catchment was calibrated with a number of historical rainfall events. The Wortley Beck river model and the rainfall runoff model enables the integration of pluvial and fluvial flood risks at any specific location in the Wortley Beck catchment.

Impact:

Dr Ahilan presented the pluvial and fluvial flood model simulation results of the Wortley Beck catchment to the Leeds city council flood risk management team at a number of occasions. The talks were well received by the senior engineers in the flood risk management team and they are interested in a follow-up study. In addition, Dr Ahilan shared part of the Wortley Beck flood simulation results through the B-GC project dissemination event ‘improving flood resilience’ which was held in Newcastle on Feb 2016 and attended by over two hundred academics, practitioners and local stakeholders. The placement gave Dr Ahilan first hand insight and experience into the urban flood modelling techniques that will significantly to his academic career focused on urban flood resilience.

As this is the complex research question in nature, Dr Ahilan develops a number of small scale academic projects to continue this research work with his research group. A number of master students and two Ph.D. students works on flood resilience and water quality improvements in the Wortley Beck catchment. The beneficial impacts of this research will initially be experienced in the case-study region (Leeds). However, the tools and methods that will be developed in this study can be adopted anywhere in the UK, so the longer-term benefits would be far more widespread.

As integrated flood modelling was not explicitly considered in the Blue-Green City project, this project provided an excellent extension to ongoing research. The knowledge and experience gained from this proposed study was embedded into the two EPSRC projects, B-GC and SESAME. This industry exposure also allowed Dr Ahilan to enhance the interpersonal skills that he need to work effectively with others – and confidence in his own abilities. This complex modelling exercise significantly enhance the urban flood modelling capacity of the School of Civil Engineering, University of Leeds. The knowledge and experience gain from the study help Dr Ahilan to develop research proposals for large scale research council funding in the area of urban flood management. Dr Ahilan is currently in the process to develop the EPSRC research project with BMT WBM on urban flood risk assessment for UK cities to sustain this initial collaboration. By bringing together academics and leading industry professionals, it is highly likely that this project will shed some light on the current flood modelling approach by concurrently incorporating future pluvial and fluvial flood risk, and sustainable urban flood risk management of UK cities.

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Dr Sangaralingam Ahilan is currently a Research Fellow at the Institute of Public Health and Environmental Engineering, School of Civil Engineering, University of Leeds. In 2017 Ahilan will take part in the EPSRC ‘Urban Flood Resilience in an Uncertain Future’ project (EP/P004318/1), which is a follow-up project to the Blue-Green Cities project in College of Engineering, Mathematics and Physical Sciences in University of Exeter.

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