Research Summary

Surface water flood forecasting for urban communities

Scotland's centre of expertise for waters

KEY FINDINGS

- This research addressed the challenge of surface water flood forecasting, producing the UK's first operational surface water flood risk forecast with a 24-hour lead time. It delivered a novel method for forecasting the impacts of flooding in real-time and increased knowledge on communicating uncertainties in flood risk. This was successfully piloted in Glasgow at the Commonwealth Games in 2014.
- The project methodology has been developed to use nationally available datasets and a transferrable approach, helping urban areas in Scotland improve their resilience to and preparedness for future flooding.
- A real-time forecasting system for surface water flooding from intense rainfall needs to use models that represent surface runoff production, surface water inundation and movement, and how water travels via surface and sub-surface pathways, including urban sewerage and drainage networks. Ensemble rainfall prediction models are key to quantifying uncertainty in forecasting the rainfall that causes surface water flooding.
- Detailed surface water flood inundation models exist and are widely used in design and research activities, but none were found to be ready for real-time use. The Grid-to-Grid (G2G) distributed hydrological model was chosen for use in the Glasgow Pilot as it can provide ensemble forecasts of surface water flooding, and takes account of the intensity and pattern of rainfall, land cover and slope, and antecedent conditions.
- The novel approach to impact assessment links surface runoff to the severity of flooding impacts on people, property and transport, using information based on SEPA's Regional Pluvial (rainfall-related) Flood Hazard maps.
- G2G was operated over a 10km by 10km area encompassing Glasgow's East End and the main areas of activity for the 2014 Commonwealth Games. The research team developed an operational application (FEWS Glasgow) to support running the model in real-time and reporting on the likely impacts of surface water flooding. A new Glasgow Daily Surface Water Flood Forecast was designed and produced based on operational requirements and emergency responder feedback.

INTRODUCTION

In recent years there have been regular occurrences of pluvial flooding in Scotland, caused by intense rainfall over urban areas in amounts that exceed the capacity of drainage systems. Real-time surface water flood forecasting in urban areas is particularly challenging because of its origins in convective rainfall. Such rainfall results from instability of the atmosphere, and is often highly localised and notoriously difficult to forecast. As runoff and drainage processes in urban areas are highly complex, forecasting surface water flooding demands sophisticated modelling approaches to capture the full picture.

When this research began, the existing surface water forecasting capabilities of the Scottish Environment Protection Agency (SEPA) included alerts for broad areas. Alerts are based on both indicative rainfall thresholds and local hydrometeorological knowledge. No formal surface water forecasting models were in use.

RESEARCH UNDERTAKEN

SEPA has a commitment to increase understanding of surface water flooding mechanisms and to develop appropriate forecasting and warning capabilities. The project was driven by requirements under SEPA's Flood Warning Strategy to create surface water forecasting capabilities that are at the forefront of science developments in Scotland; and specifically to scope the development of hydrological modelling capabilities in urban areas to forecast (in real-time) surface water flooding.

The overall aim of the project was to review the current state-of-the-art in surface water flood forecasting for urban communities and to develop a potential methodology for real-time surface water flood forecasting in Scotland. This methodology was to be tested through a pilot application for a known flooding area in Glasgow's East End, operating in real-time to provide strategic flood guidance during the 2014 Commonwealth Games. The project would assess how the method could be integrated into SEPA's existing flood forecasting platform, FEWS Scotland, and assess how it could be rolled-out to other areas, including identifying any barriers to roll-out.

WHERE NEXT?

The methodology of the Glasgow Pilot has been developed to use nationally available datasets and a transferrable approach. Formal assessment of the probabilistic tools will take longer, but identified benefits of using the new approach include (i) indicating flood risk is unlikely for Glasgow when regional guidance does, and (ii) in providing early warning on the timing, likely impacts and possibility of flooding to a specific urban area. Case study analysis of system performance proved extremely useful and, for two surface water flooding events observed within the Games, found to perform well within expectations.

This project provided an operational system that proved useful to SEPA and the wider community and the Glasgow Pilot was a success. As a result, a wider roll-out to other urban communities across Scotland is being considered along with an opportunity for further refinement and development of the tool guided by the user feedback. Planning will include taking account of any constraints (technical, resource and communication) associated with providing this new guidance to urban communities on surface water flooding hazard.

RESEARCH TEAM AND CONTACTS

The research was carried out by a consortium of research providers:
Centre for Ecology & Hydrology, Wallingford: Robert J. Moore and Steven J. Cole: **The James Hutton Institute**, Aberdeen: Sarah Dunn and Sohan Ghimire: **Met Office**, Exeter: Brian W. Golding, Clive E. Pierce and Nigel M. Roberts
Scottish Environment Protection Agency, Perth: Linda Speight

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