THE USE OF RADAR, NOWCAST & NUMERICAL WEATHER PREDICTION IN RAINFALL RUNOFF MODELLING IN SCOTLAND

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ABSTRACT

Flood forecasting in Scotland is continually developing. Radar, nowcast and deterministic and probabilistic numerical weather prediction (NWP) are used in rainfall runoff modelling at national and catchment scales. This paper uses a recent case study to illustrate the value of these forecasting approaches and the challenges associated with providing flood warnings to communities at risk from flash flooding.

INTRODUCTION

Flood forecasting in Scotland has developed significantly in recent years. This has been driven by improvements in both hydrological and meteorological capabilities.

A range of precipitation observations and forecasts are used in rainfall runoff modelling.

At a catchment scale a blend of radar and rainfall nowcasts are used in lumped catchment-scale runoff models (Cranston and Tavendale, 2012).

On a national scale a mixture of deterministic NWP and blended ensemble prediction are applied in the CEH Grid-to-Grid (G2G) hydrological model (Maxey et al., 2012).

A significant concern in Scotland is communities at risk of flash flooding. Here precipitation forecasting skill is essential. However the mountainous landscape and varying radar coverage means providing a flood warning service to these communities is a challenge.

COMRIE CASE STUDY

The village of Comrie in Perthshire is a community at risk of flash flooding. On the 19th November 2012, over 100 properties were impacted by flooding from the Ruchill Water.

Figure 1. Tayside Fire & Rescue coming to the aid of residents in Comrie (Source: Tayside Fire & Rescue)

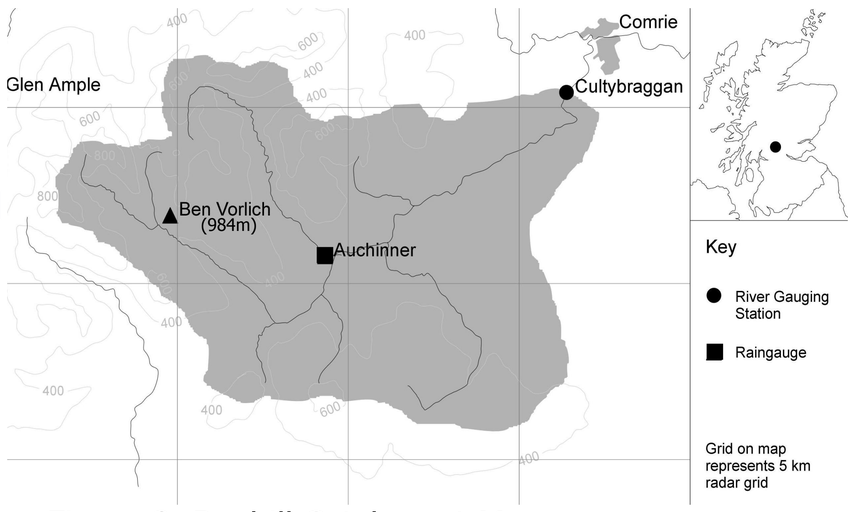

Figure 2. Ruchill Catchment Map

The Ruchill catchment is small (104km^2). The steep topography means the catchment is affected by orographically enhanced rainfall. This can cause difficulties in rainfall observations when relying on a single raingauge and radar (Cranston & Black, 2006).

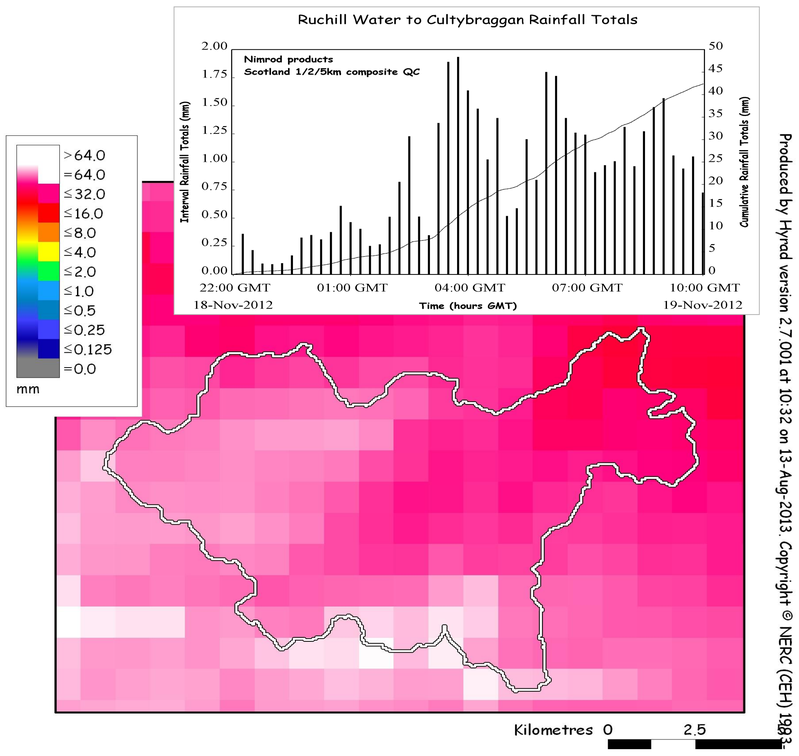

Figure 3. 12 hour Rainfall Accumulation in the Ruchill Catchment from 22:00 18/11/12 – 10:00 19/11/12

GRID-TO-GRID

Figure 4 shows the hydrological predictions from the CEH Grid-to-Grid model compared to the observed hydrograph at Cultybraggan gauging station. The peak flow forecasts at Cultybraggan were under-estimated when using both the deterministic and ensemble (MOGREPS-R) rainfall predictions.

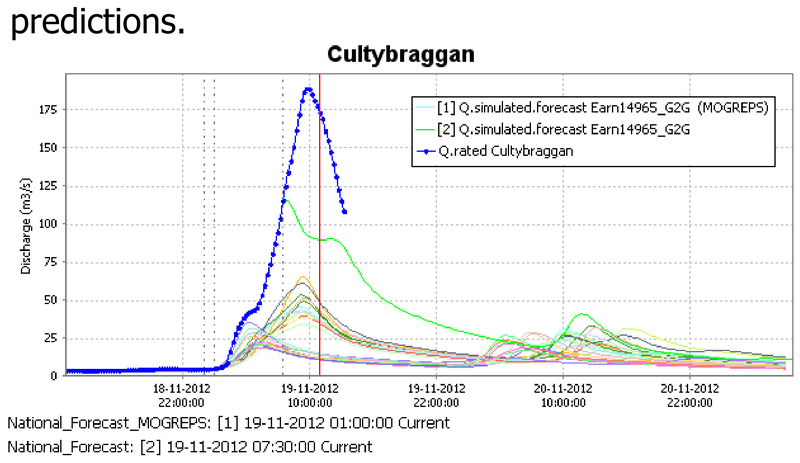

Figure 4. G2G forecast at Cultybraggan at 07:30 19/11/2012

PDM

The Ruchill Water peaked at 3.16m at 09:45am. The PDM model provided a 90 minute lead-time to the peak.

Forecast levels progressively increased but the model continued to under-predict until just before the river peaked. Analysis showed the rainfall nowcast input to the model under-predicted the higher intensity rainfall. The increase in forecast accuracy over time was being driven by the input of observed data over the course of the event

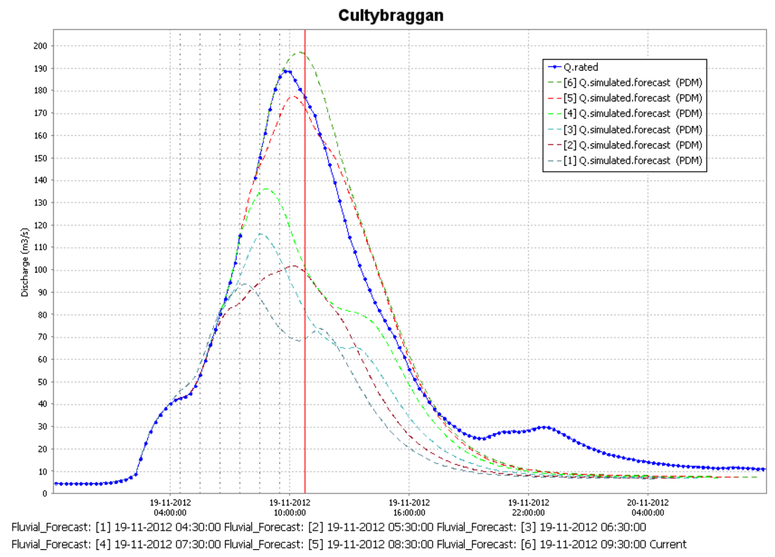

Figure 5. A selection of PDM forecasts at Cultybraggan from 04:30 – 09:30 9/11/2012

The STEPS nowcast blends radar observed precipitation with NWP forecasts. For the first two hours of a forecast radar dominates but by six hours the forecast is based entirely on NWP.

In this case it is likely both the radar advected and UK4 NWP components of the nowcast were affected by local topography and the difficulties associated with forecasting and measuring orographically enhanced rainfall. The UK4 NWP model was poor at accounting for the orographic component of the rainfall due to the 4km model resolution and parameterisation scheme used. The radar catchment averages were 30% lower than the gauged catchment average.

CONCLUSIONS

Ongoing development of flood forecasting capability is essential to continue to provide a reliable and timely flood forecasting and warning service.

In December 2012 SEPA started receiving the 1.5km UKV NWP model which better represents convective and orographic rainfall. Parallel improvements in the resolution of ensemble forecasts are also planned. A possible alternative in areas with poor radar coverage is to investigate using NWP directly in the PDM.

Past event analysis such as this is essential as SEPA continues to develop innovative approaches to flood forecasting.

References

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