COMPARISON OF RAINFALL-RUNOFF MODELS FOR FLOOD FORECASTING

The purpose of this R&D project was to provide information and guidance to the Environment Agency on the choice of rainfall-runoff model for use in different river catchments for flood forecasting purposes.

The project had two phases. Part 1 was a literature review of all model types used for flood forecasting. The aim of the Part 1 Report was to give a basic understanding of the types of model available, and to highlight their similarities and differences. The report recognised that whilst there are many "brand-name" models there is much similarity between many of them. A small set of model functions is common to many models and they differ only in the detail of their configuration. The report also gives details on the selection of models for more detailed intercomparison.

Part 2 was the more detailed assessment of the performance of different types of model. Eight models were selected for this phase, using data from nine catchments from the 8 regions of the Agency. The catchments chosen for model assessment were designed to provide a diverse number of scenarios for model application: upland and lowland catchments, urban and rural, and differing geology.

The models chosen for comparison encompassed those used operationally by the Agency, together with one overseas model and a simple distributed model previously developed for the Agency. The models chosen were: Thames Catchment Model (TCM), Midlands Catchment Runoff Model (MCRM), Probability Distributed Moisture model (PDM), US National Weather Service Sacramento model (NWS), Isolated Event Model (IEM), a simple Transfer Function (TF) model, a constrained form of TF model (referred to as the Physically Realisable Transfer Function (PRTF) model), and the Grid Model.

Model performance was assessed using R^2 and a Threshold CSI (Critical Success Index) statistics. The R^2 statistic was used to provide a broad guide to model performance for flow forecasting. The Threshold CSI statistic was used to judge the performance of a model to correctly forecast the exceedence of a flow threshold. This is particularly relevant when model forecasts are used to trigger flood warnings. Forecasts were also judged more informally via hydrograph plots and scatter plots of observed and forecast flood peaks. Whilst forecast accuracy was the focus of the model assessment, other issues were considered such as ease of model configuration, initialisation and calibration.

Whilst the main assessment of model performance used raingauge estimates of rainfall as input to the models, weather radar was used for rainfall inputs for three of the catchments, both in raw form and with raingauge calibration, to provide some information on model performance using different input data.

The form of model assessment used in this study, employing long continuous records at a fixed 15-minute time-step, typically eight months in duration, meant that was difficult to emulate the operational performance of TF and PRTF models as used in the Agency. Within the Agency these models use baseflow separation, variable model order, and variable time-step. In some applications in the Agency there is also the opportunity to manually adjust the model parameters affecting the volume, shape and timing of the forecast as the flood develops, which was not possible to replicate in this study.

The results reported in this study relate to TF/PRTF models used without baseflow separation, using an automated method of model parameter adjustment and using a fixed model time-step and model order. Results given in the Part 2 report, relating to TF/PRTF models should be interpreted against these constraints and background.

Overall, the results suggest that no one model consistently out-performs all others across all catchments. Each model gave good performance in the right situation, with the choice of which model to use depending on the complexity of catchment response. Use of radar data gave as good, and sometimes slightly better, results than using raingauge data alone, provided the radar was functioning well, and raingauge calibration generally helped.

Recommendations on possible model use in each Agency region are given. Opportunities for further research on model formulation and configuration, updating schemes, and catchment-scale rainfall estimation are identified.

The information from this R&D project is principally for use by Environment Agency staff involved in the selection of models for flood forecasting purposes. Some of the information may be used in future R&D work, such as that led by the National Flood Warning Centre. The information contained in the reports may also be of interest to Agency staff involved in hydrological modelling in other fields, such as water resources.

This R & D Technical Summary relates to information from Project W5-005 contained in the following outputs:

R & D Technical Report W241: Comparison of different forecasting models, Part 1: Literature review of models. ISBN: 1 857 05396 6

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Copies of the Technical Report are available from each Regional Information Centre (Library) or the National Information Centre in Bristol, and externally from the Environment Agency R&D dissemination Centre, c/o WRc, Frankland Road, Blagrove, Swindon, Wiltshire SN5 8YF, Tel: 01793 865012, Fax 01793 513562

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