Improved methods for national spatial-temporal rainfall and evaporation modelling for BSM

Technical Summary: FD2105

Joint Defra / EA Flood and Coastal Erosion Risk Management R&D programme

Background to R&D project

Broad Scale Modelling (BSM) has been identified by Defra/EA R&D Programme as a priority thematic area and is required to provide a new level of decision-support for strategic assessment of flood risk and flood management, including assessment of impacts of climate and land use change. To achieve this, continuous simulation hydrological modelling is needed. This represents a major development in methodology, which has, in addition to its role in BSM, important benefits for flood design practice.

This research has provided the core rainfall modelling elements required to underpin national application of continuous simulation and BSM and builds on and links to two earlier pieces of research carried out for the Department, specifically projects FD0404 carried out by CEH and FD0426/FD2103 carried out by IC/UCL.

Continuous simulation rainfall-runoff models have some important advantages over conventional event-based methods for flood estimation, but require long sequences of rainfall and evaporation data as input. This project has investigated a range of approaches for stochastic rainfall and evaporation simulation.

Results of R&D project

This project provides and validates regionally-applicable methods to generate the rainfall and evaporation sequences required for continuous simulation modelling.

The rainfall models have strengths and weaknesses in aspects of their performance, and the objective of continuous simulation modelling necessitates a trade off between different aspects of performance. The methods produced by this project have a clear potential, and are in some cases ready for immediate application.

Single-site rainfall models can be used to simulate data from individual raingauges or catchment-average time series. A comparative analysis of single site models has been made, based on representative UK raingauge data, using methods based on Poisson Cluster processes. A new 2-stage fitting procedure has been developed to improve the fitting of extremes. Joint testing of rainfall and FDF2106 rainfall-runoff methods was undertaken.

Methods were also developed to model daily sequences of Potential Evaporation (PE), conditional on rainfall, based on nationally available data products such as MORECS.

More generally, modelling of spatial rather than single site rainfall is required. A software package has been developed based on Generalised Linear Models (GLMs) to simulate the spatial distribution of daily rainfall from daily raingauge networks. Long sequences can be generated, or the model can be used to infill missing data. These models can represent spatial effects, such as topography, and climate

variability. Effects of climatic indicators such as the North Atlantic Oscillation can be incorporated to produce time varying rainfall frequency distributions. In a sister project (FD2113), these models are being used to produce daily rainfall from Global and Regional Climate Models. The project carried out tests on 2 UK networks; a further independent application to the river Ouse is reported.

R&D Outputs and their Use

Of the models developed, software is made available for those that were considered to be ready for use within the UK given the testing in this project. Clearly more extensive testing is needed. We encourage the user community (researchers and practitioners) to explore the use of these methods for application in practice, and would welcome feedback on their use and performance.

Three software products are to be made available:

- Single-site hourly rainfall model: Random Parameter Bartlett-Lewis Model (RPBLM)

- Multi-site daily rainfall model: Generalized Linear Model (GLM)

- Disaggregation of multi-site daily rainfall to hourly module: GLM with HYETOS temporal disaggregation procedure

With respect to the software, a fully integrated procedure is not yet available in suitable form for release. However, the GLM software is available as discussed above and the temporal disaggregation software is available as a package HYETOS (developed outside this programme).

Selected software developed during this project can be accessed from the project web site at:
http://www.imperial.ac.uk/ewre/research/currentresearch/hydrology/improvedmethods

The remaining modelling software discussed in the technical report is not considered to be in a suitable form for general availability at present. Selected software is available from the authors.

The recommendations arising from this project will be considered in the development of the Modelling and Risks Strategy within the Agency, for future use in Catchment Flood Management Plans (CFMPs), feasibility and design studies and ultimately as a compliment or replacement for the FEH (Flood Estimation Handbook).