Spatial-temporal rainfall modelling with climate change scenarios

Technical Summary: FD2113

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

Background to R&D project

Defra has five strategic priorities. One of these is climate change, for which a target outcome is to manage risk from flooding and coastal erosion in a way that furthers sustainable development. This project provided tools to assist in achieving this. The overall aim was to develop methods for generating artificial rainfall data incorporating scenarios of future climate change, for any location in England and Wales. Such artificial data can be used to drive simulations of catchment processes over extended time periods. The results can be used to assess, for example, likely changes in flood risk, the effectiveness of potential strategies for risk management, or the impacts of changes in land use. This approach to risk assessment and management is called 'continuous simulation'. It is data intensive: most catchments in the UK are small enough to respond to relatively localised rainfall events, and therefore rainfall data are required at fine space and time resolution, for example at individual spatial locations and at daily or hourly time scales.

Prior to this work, continuous simulation methodologies were developed in two other Defra-funded projects. Under project FD2106, carried out at CEH Wallingford, continuous simulation rainfall-runoff models were developed to represent catchment flood response to rainfall inputs; and in project FD2105, carried out jointly between Imperial College, UCL and CEH Wallingford, regionally-applicable methods for the continuous simulation of rainfall and evaporation were developed. The present project built upon the work carried out in FD2105, enhancing the methods there to enable climate change scenarios to be incorporated.

Results of R&D project

The research found that at any location in England and Wales, daily and subdaily rainfall sequences can be generated, incorporating climate change scenarios provided by state-of-the-art climate models. Changes in future rainfall can be represented as shifts in probability distributions. In southeast England, summers will tend to become drier and winters wetter under the SRES A2 greenhouse gas emissions scenario. However, not all summers will be drier, and not all winters wetter. The changes are associated with increases in storm frequencies in winter but decreases in summer. However, the intensity of rainfall within storms is likely to increase throughout the year. The combination of these changes could lead to increased risk of both floods and droughts.
An investigation was carried out into the sensitivity of results to the choice of climate model used in (1) above. It was found that this choice may affect the results substantially. It is necessary to

Environment Agency

defra
Department for Environment Food and Rural Affairs

consider information from more than one climate model when carrying out climate change impact assessments. Failure to do so will result in substantial underestimation of uncertainty, and of future risk.

Two further results are worth noting briefly;

(i) A pilot methodology was developed to combine the outputs from several climate models in a coherent and interpretable manner, thereby enabling climate model uncertainty to be accounted for in the generation of rainfall sequences. This methodology was not developed as extensively as other aspects of the project.

(ii) An investigation was carried out into the ability of regional climate models (RCMs) to represent properties of daily rainfall sequences directly for risk management purposes. It concluded that an individual RCM cannot be relied upon to reproduce rainfall properties particularly well; however, an ensemble of RCMs can be used to obtain a distribution of rainfall properties which is more or less consistent with observations.

R&D Outputs and their Use

This technical report presents methodological developments for generating artificial single- and multi-site rainfall sequences that are suitable for flood risk assessment and management. Input from climate models allows representation of changes in future rainfall, expressed as shifts in probability distributions. This report will be of use to those involved in future flood mitigation and for combining information from several climate models.

Software to implement some of the methods is available from www.ucl.ac.uk/Stats/research/Rainfall/software.html. A more user-friendly, commercial version of the daily rainfall software is currently being developed by an engineering consultancy firm, with a view to making the methodology more widely accessible to the user community in the UK and elsewhere.

This R&D Technical Summary relates to R&D Project FD2113 and the following R&D output:

R&D Technical Report FD2113/TR – Spatial-temporal rainfall modelling with climate change scenarios.
Published September 2007.

Publication Internal Status: Released Internally External Status: Released to Public Domain

Project Manager: Edward Evans

Research Contractors: Imperial College; University College London

The above outputs may be downloaded from the Defra/EA Joint R&D FCERM Programme website (www.defra.gov.uk/environ/fcd/research). Copies are also available via the Environment Agency's science publications catalogue (http://publications.environment-agency.gov.uk/epages/eapublications.storefront) on a print-on-demand basis.

PB 12527/12 TS

Further copies are available from:
Defra Flood Management, Ergon house,
Horseferry Road, London SW1P 2AL

Tel: 020 7238 6000

Info-fm:defra.gsi.gov.uk
www.defra.gov.uk/environ/fcd/research

Environment Agency

defra
Department for Environment Food and Rural Affairs