Coastal flood forecasting: model development and evaluation

Science Summary SC050069/SS1

This project is developing improved methods for surge, nearshore wave and coastal flood forecasting (CFF) in England and Wales. These new methods work by modelling the movement and properties of water (hydraulics) in different areas, ranging from offshore, through the nearshore and surf zone, to its action at coastal defences. This report describes developing and evaluating the new models, whilst a second report due in autumn 2008 will discuss how well the models can forecast coastal floods.

The Environment Agency is responsible for fluvial and coastal flood forecasting for England and Wales, whilst the Met Office has responsibility for offshore forecasting for the UK. Although offshore forecasts can be used to estimate the likelihood of coastal flooding, this is a complex procedure and is handled differently in different Environment Agency Regions. It involves combining wave and surge forecasts with the action of waves in the surf zone, the effect of wind, waves and still-water level (SWL) in causing beach movement, overtopping and breaching, and the probability of damage to people and property. What's more, this must be done with a high level of accuracy and reliability and far enough in advance to allow actions to be taken.

This report describes the development of a novel approach to the handling of a large number of uncertainties, including uncertainties in what might appear to be fixed values, such as toe depth and crest elevation. This involves a large number of Monte Carlo simulations, each with a series of random draws to provide realisations of each of the uncertainties. At each stage in the modelling chain, through the offshore, nearshore and shoreline zones, this provides a distribution of each forecast parameter, at each time step and at each prediction point.

The report makes a number of recommendations for the future:

Decision support tool. Forecasters, warners and emergency services take a series of decisions about warnings and which actions to take to reduce damage to people and property. These are usually triggered when certain thresholds of wave height, SWL and/or overtopping rate and volume are crossed. However with probabilistic forecasting, there would be different probabilities of exceeding different thresholds at different locations and for different variables – potentially an order of magnitude more information than at present. A decision-support tool could help to assess the relative importance of different bits of information, to concentrate the forecasters' judgement on the most important items.

Fluvial or urban flood forecasting. The novel Monte Carlo approach developed to model uncertainty in CFF may have application in fluvial or urban flood forecasting.

Collating experience. It is not possible to define a single set of mean overtopping rates, peak overtopping rates and/or peak overtopping volumes that represent an unambiguous set of hazards. In each case, the hazards depend on land use, number of people, animals, vehicles and/or buildings in the area, and the potential to move people or assets to safer places or to close promenades or highways. The authors therefore recommend that the Environment Agency work with the Maritime District and other owners to collate experience with overtopping-rate forecasts and warnings, and to combine these with new data on overtopping rates and damage or hazard.

Inundation modelling. Inundation modelling is a natural follow-up to this project and would bring the forecasts a step nearer to addressing receptors (people, buildings and other assets) and consequences (deaths, injuries and damage to property). The biggest benefit would be gained from linking this to advances in breach modelling, taking account of realistic breach initiation, and the development of the breach-flow hydrograph.

Sea bed level changes. Wave action at most sea defences around the UK is influenced by seabed levels in front of the defences, particularly for combinations of lower still water levels with higher wave conditions.

Changes in local bed levels during a storm or series of storm events could significantly influence wave conditions at the defence, and hence the overtopping response. Further work is therefore suggested to derive realistic estimates of bed level changes pre- and post-storm. These potential changes could then be incorporated into future CFF models.

This summary relates to information from Science Project SC050069 reported in detail in the following output:

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