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Development of a model to estimate individual building vulnerability to floods

Nicholas Walliman (1) and Raymond Ogden (2)

(1) Department of Architecture, Oxford Brookes University, Oxford, United Kingdom (nwalliman@brookes.ac.uk), (2) Department of Architecture, Oxford Brookes University, Oxford, United Kingdom (rogden@brookes.ac.uk)

The likelihood that buildings will be flooded and the frequency and severity of the inundation is calculated as part of the general flood predictions for urban and other areas. However, in order to estimate the vulnerability of an individual building, it is necessary to examine the possible types of flood damage that the building will suffer. As the range of possible damages is so large and difficult to estimate, it is necessary to be selective in any method devised to estimate flood damage to buildings and limit the factors to those that can be realistically calculated. This paper, developed in the context of the current EC FP7 project FloodProbe) discusses the current estimation methods used in the UK, Germany, USA and Australia, and suggests ways to improve on these to make a model capable of estimating damage to individual buildings.

Calculations are normally limited to tangible costs expressed in financial terms. The direct costs, particularly the structural costs, should be the focus of the predictions, they being directly related to the physical fabric of the buildings and relate directly to the structure, construction and materials employed. These are relatively easy to survey and record accurately at various levels of detail by building specialists such as architects and surveyors. The contents of the building and their value, vulnerability to flood damage is more likely to be known by the building occupant, and can also feature strongly in the calculations. This is likely to be the case also for external items and contents. As indirect costs, the clean-up costs are also likely to be possible to estimate with reference to the likely effects on the building and its contents, though the amount of flood debris will depend on the type of flood and surrounding buildings, objects and vegetation. The other indirect costs can only be estimated by the building users according to the severity of the flood effects on the building and with reference services they provide and nature of business and employment. This should not form part of the damage estimation with regard to the buildings, but can use this estimate to help to calculate indirect costs.

Flood damage to buildings and contents are dependent on a number of variables in relation to the flood events. The major variables are over-floor depth, velocity, rate of rise, debris, contaminant, frequency and duration of inundation and timing. Although depth is the most common variable used in the calculation of flood damage, the importance of velocity is likely to have been undervalued in countries where high water velocity is relatively rare. A small increase in velocity a can have a significant impact, particularly at greater depths.

Other variables relating to the building characteristics, such as the materials that the building is constructed from, the drying characteristics of the materials and the condition of the building prior to being flooded are also significant. To this can be added the planning of the spaces within the building (basements, level of ground floor above ground etc.), the services and their positions within the building (air conditioning equipment, circuit boards, boilers etc.), as well as the contents and their locations.

Existing estimation methods are not sufficiently detailed at the individual building scale to be reliably used for damage prediction for a particular building, so a more detailed model should be developed. However, a model that can deal with all these variables is likely to be very complex and difficult to manage, though oversimplification of the variables is likely to lead to inaccurate estimations. A balance must therefore be drawn between excessive complexity and accuracy. The function of a damage estimation model is to predict the extent of damage to a building and its contents depending on the severity of the flooding. The output of the model should express the damage in cost form. This will enable calculations to be made in order to assess the cost/benefit analysis of installing flood mitigation measures to the building and and/or its surroundings.