

Producing a prototype Insurance Industry catastrophe model of groundwater flooding using OpenMI

The British Geological Survey (BGS) and Loughborough University have created an OpenMI composition to produce a prototype “plug and play” Catastrophe (CAT) model for groundwater flooding in the Berkshire Downs. The tools used to produce the composition are available in FluidEarth (www.fluidearth.net). The composition has been produced for the NERC funded PURE (Probability Uncertainty and Risk in the Environment) Experimental Zone project (<https://connect.innovateuk.org/web/pure>). PURE is jointly funded by NERC (www.nerc.ac.uk), EPSRC (www.epsrc.ac.uk), the Environment Agency of England and Wales (www.environment-agency.gov.uk) and the UK's Technology Strategy Board (<http://www.innovateuk.org/>).

CAT models are stochastic, event-set based computer models. They have been used for the last 25 years by the insurance and reinsurance industry to assess risk by estimating likely losses from extreme events, whether natural or man-made. Most CAT models are ‘black boxes’ which limit the level of user inspection. New European regulations (Solvency II) require firms to understand the assumptions made in any CAT model used as part of their solvency calculations, resulting in the industry pushing for greater transparency from the modelling community. They need clarity on the assumptions included in CAT models; for example, which components are well constrained and which dominate uncertainty? Picking and choosing components of loss models from multiple vendors will be one key way to gain insight into this. The prototype has demonstrated the utility of using OpenMI in creating the required flexible, component based system.

At their simplest, CAT models combine three ‘building blocks’: Hazard, Vulnerability and Exposure elements.

- A. Hazard - maps defining the occurrence, probability, and depth of water during groundwater flooding events.
- B. Vulnerability - relationship of flooded depth to economic damage.
- C. Exposure - distribution and repair cost of insured properties.

These three elements can themselves be broken down into smaller OpenMI compliant components each representing part of the system. The potential then exists for components to be switched in and out (“plug and play”) and the variability between models used to assess uncertainty. Prototype CAT models for under-explored hazards be also be quickly developed. This work is the first attempt to link groundwater flow models with economic models. It proves that OpenMI can couple environmental process-based models with the financial models that simulate the economical impacts of environmental change.

The prototype groundwater flooding CAT model involves seven components, which are listed below and illustrated in Figure 1.

1. Regional groundwater flow model driven by rainfall recharge (derived from rainfall and other variables) - ZOOMQ3D (MaBSWeC model in Figure 1): An OpenMI compliant regional Marlborough and Berkshire Downs and South-West Chilterns (MaBSWeC) ZOOMQ3D groundwater flow model.

2. Groundwater flooding depth calculation (FloodDepth in Figure 1): Calculates the depth of groundwater flooding across the area from the output of the groundwater model.
3. Flood event database compiler (EventDatabase in Figure 1): Generates discrete flooding events based on the outputs from component 2.
4. Hazard component (Hazard in Figure 1): Generates maps of maximum water depth, which drives damage, for each flooding event.
5. Vulnerability component (Vulnerability in Figure 1): Calculates the damage costs to different house types for each groundwater flooding events. End-users can provide different vulnerabilities through this component.
6. Exposure component (Exposure in Figure 1): Passes exposure information, i.e., the location(s) for evaluating the loss due to groundwater flooding. This component allows insurance companies to specify the properties that they insure.
7. Loss component (Loss in Figure 1): Calculates the occurrence exceedance curves which provides the user with their overall loss estimate based on a return period.

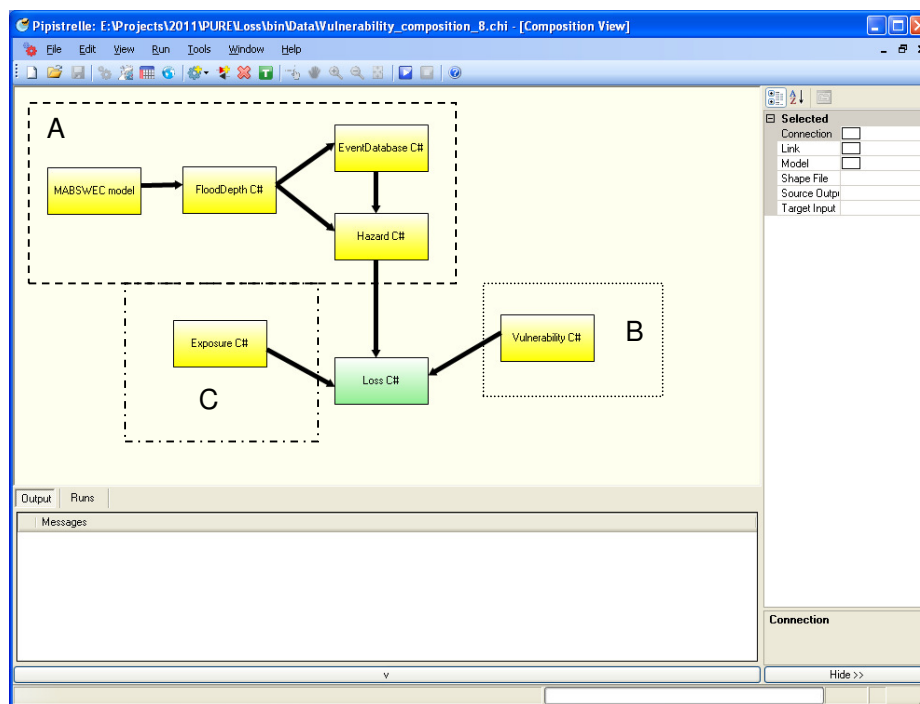


Figure 1. The groundwater flooding CAT model composition as represented in Pipistrelle. Letters A-C refer to main building blocks of a catastrophe model described above.

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