t2.12 Flood risk assessment: the tyranny of the database

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Catastrophe modelling and GIS

Catastrophe models have been used to analyse property portfolios of the insurance industry for over a decade, developed first in the US for earthquake and hurricane and subsequently for UK windstorm and coastal flood. Such development was prompted by catastrophic events (e.g. severe storms of 1987 and 1990) and made possible by increasingly powerful computer technology, availability of applications for handling geographic data and electronically captured portfolio data, by location, that could be used as input.

Geographic Information Systems (GIS) technology has been fundamental to such models in allowing the spatial combination of hazard data, vulnerability functions and value at risk usually captured by postcode of policy holder. The models allow a movement from focus on physical event to focus on loss, whose frequencies and severities are not directly correlated. Severe flooding of large areas of agricultural land is not as costly as minor flooding in urban centres, for example. Having analysed the distributions of hazard parameters of a representative set of historically damaging events (for example storm track, windspeed, wind direction, pressure etc) such distributions can be sampled and combined many thousands of times in stochastic 'Monte Carlo' simulations whilst maintaining observed parameter patterns and correlations that pertain to physical laws. In this way, using the statistical leverage of the law of large numbers, a much fuller range of possible events can be examined which captures the most potentially damaging parameter-combination events at their appropriate probability of occurrence.

Level of resolution and data aggregation

A distinction should be made between models being used for establishing levels for reinsurance protection (the insuring of insurers by reinsurers by paying premiums for risk transfer) and using models for the primary rating of individual insurance policies. We are all familiar with the rapid assessment of insurance premium by provision of postcode over telephone or internet, but to what extent are we spatially distinguished from our neighbourhoods with respect to model resolution?

This fundamental issue of zonal GIS, the 'ecological fallacy' of having to assume equal spread of a quantity across a zone in the absence of more detailed information, has been termed 'postcode blight' when zones are seen to comprise of radically heterogenous elements, e.g. higher motor insurance in areas of London, consideration of subsidence, etc. Assessment of natural hazard risk across Europe usually takes place in some aggregated form rather than at a risk by risk basis. This may be due simply to the availability of (electronic capture of) full postcode data or a consequence of combining legacy computing systems deriving from the many mergers and acquisitions which have characterised the insurance industry in recent years.

One answer for insured portfolio data is clearly to use the highest level of resolution available, which for the UK (in the absence of (x,y) geocoding of each property) is the full postcode unit, e.g. EC1R 3AD. For the UK, of the February 2001 data release there were 26.7 million postal delivery points (94% of these being residential) in 1.7 million postcodes, averaging 16 letter-boxes per full unit postcode.

The key question however, is what is the spatial resolution of the hazard modelling being applied to such portfolios? If all of the hazard values within a postcode district or 1km grid cell that are reported at full unit postcode are the same, this does not count as full unit postcode modelling.

The requirement for greater or lesser spatial resolution will depend upon the nature of the peril, be it theft, windstorm or flood. Intuitively flood risk is relatively straightforward to analyse, being primarily driven by elevation, but this ignores not only patterns of precipitation but also antecedant conditions (e.g. saturated or frozen catchments providing more rainfall runoff into river networks) and crucially human activities such as the building of flood defences, their condition, flood water management (e.g. reservoirs) and also urban drainage systems. A few flooded houses can lead to considerable insured losses and anecdotally, one end the street can be affected while the other is not. Thus high level resolution modelling is required to capture all of the key drivers of flood loss and also, unlike site-specific engineering analyses, national analysis is required, needing vast amounts of geographic data in a very data-hungry process.

Flood insurance

The UK is unique in providing flood (and wind) cover as a standard inclusion to household insurance, dating back to a gentleman's agreement between government and the insurance industry in the 1960s after severe flooding swept the country. Insurers have guaranteed to provide flood insurance to all who purchase general property cover which allows the small contributions of the many to support the misfortunes of the few by slight additions to everyone's premium. But flood is not a risk that everyone is equally exposed to, if at all. In the past there was a lack of accurate statistics regarding natural hazard loss or models to analyse and assess this hazard. With perils being considered individually however (e.g. separately from windstorm), the prospect of 'anti-selection' arises, whereby only those exposed would want to purchase protection for the risk, greatly changing the ratio of premium received to claims incurred.

The ever increasing sophistication of catastrophe modelling (still a very young science however) and application to insurance portfolio databases allows, at a certain level of resolution, 'good' risks to be distinguished from 'bad risks'. Such activities have allowed the development competitive advantage between insurers in attempts to match premium more closely with risk and be more profitable in the process.

As a counter-example ,in France the Caisse Centrale de Reassurance (CCR) was set in 1946 as a state-owned company providing unlimited cover to protect the solvency and security of insurance companies. A 1982 law (following serious south-west floods in 1981) covers property for a range of perils, after a state of natural disaster has been decreed, for perils such as floods, earthquakes, avalanche or subsidence. Additional premium of 9% is levied nationally upon a property damage insurance policy. Windstorm is reinsured in the private market outside of the CCR 'NatCat' scheme.

Recent flooding, climate change and housing stock

The autumn floods of 2000 across the UK have been estimated by the Association of British Insurers to cost £760 million in claims with flood costs for the year costing £1 billion. Similarly, France in March 2001 saw considerable flooding in saturated catchments across the country from the Somme to the Rhone. Even though individual weather events cannot be seen as 'proving' the modelled consequences of global warming these events caused great concern at the prospect of them archetypal precursors of things to come. There is considerable natural variability within the climatic record with shorter term cycles and trends than those statistical aspects of global warming and any consideration of climate change has a minimum study window size of 30 years. However Sir John Harman, chairman of the Environment Agency has said:

"a typical flood which might now happen once in a hundred years could occur as frequently as every 10 or 20 years in the future".

Such comments are particularly alarming when compared with statistics of houses already existing within flood plains. Figures range from 1.2 million inland homes at risk of flooding (estimated insured value £35 billion, ABI) to almost 7 per cent of the UK's building stock at risk (worth £215 billion, Munich Re). Additionally 350,000 new homes have been earmarked for development on flood plains. A recent

Environment Agency overview of inland flood defences showed 43 per cent of defence structures and 36 per cent of linear barriers in England to be in fair, poor or very poor state.

Aggregation versus mutuality: the role of GIS, modelling and technology

Flood is clearly an issue which combines many actors with complicated feedbacks between their actions. One common aspect is that access to information regarding risk quantification of flood is vital to all parties and should thus be of equal public access. The possibility of 'tyranny of the database', where ever greater resolution of modelling undermines the concept of mutuality, a cornerstone of insurance is not an inevitability of the technology. It is not in the public interest for the spectre of household cover to be either impossibly expensive or withdrawn, as suggested by the ABI in its call to government to provide adequate flood defences within the next 2 years, before the industry acts upon some form of geographic analysis.

Any use of such modelling technology, particularly in attempts at high resolution rating should not ignore the inherent uncertainties involved in such work. Not only may individual data-sets have certain tolerances (e.g. vertical resolution of DEM), but hydrodynamic consequences of water movement can have many possible outcomes and anthropogenic influences could dramatically affect the composite 'flood envelope' of an event, e.g. using canals to relieve a river for example. All of this uncertainty is outside of the forecast range of climatic responses to global warming. Increased flood risk in this instance is perhaps a more reliable consequence as simply an increase in average frequencies (rather than severity as with windstorm) in enough to lead to catastrophic events with prolonged saturation of catchments.

A shared knowledge of flood risk should underpin all activities, from planning to building development to house buying to insurance. Environment Agency web-based flood maps, however low-resolution, static and indicative rather than probabilistic show the way to greater data access. Several reports have recommended greater 'joined-up' co-operation, for example:

- ACACIA, 2000, suggesting insurance operating proactively with government and the construction industry to reduce risk
- National Audit Office recent overview calling for a national system of prioritisation of flood defence works and deterring inappropriate new floodplain development
- DETR Planning Policy Guidance 25 prompting developers to pay for site-specific flood risk assessment studies and contribute to defences and sustainable drainage for new developments.
- the prophetic ABI study "Inland Flooding – Issues for the Insurance Industry", published just before the UK Autumn 2000 floods

From an insurance perspective, it does not seem unreasonable to reflect the exposure of a property to flood in part of the premium but it need not it reflect it entirely, particularly due to inherent modelling uncertainties in attempting to quantify risk. Equally, to avoid the socially undesirable 'red-lining' of flood areas, and the broader aspect of social exclusion a centralised pool system could be envisaged which would assist in sharing the flood burden. Mortgage and insurance considerations should also feature in property developer planning.

Knowledge gained about exposure to risk cannot be unlearned. Increasingly available technologies of data collection (e.g. LIDAR scanning of elevation and defences), data analysis and information distribution (e.g. interactive web application) should be combined and exploited for the benefit of the public interest – there still being plenty of room for commercial competitive advantage from how applications are leveraged. Manipulation of geographic data is central to all these activities.

Finally, one potentially useful synthesising agent could be the Water Framework Directive (2000/60/EC), adopted on 26th October 2000 which introduces the approach of integrating water and land management at the river basin level, rather than at man-made borders. Member states must prepare management and monitoring plans to be in place by 2004. Ecological principles are thus combined systematically with human activities: flood plains are not so-named for no reason. Agricultural land in such areas could thus be used to revert to its original role in absorbing and holding flood waters upstream.