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New open-source model offers accessible method to estimate windstorm damage

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A study presents an open-source model for estimating the extent and impact of windstorm damage in Europe. Unlike others, the model relies not on insurance data but on data that is publicly available, and, therefore, offers a useful and accessible tool for predicting risk and performing post-disaster assessment. The researchers apply it to storms that have taken place in western Europe, highlighting the most vulnerable countries and coastal areas.

Due to their potential to cause costly damage to insured assets, windstorms are extensively studied by the insurance industry. In 2010, for example, storm Xynthia caused damage in western Europe to the value of €5 billion. Most wind studies, however, use insurance data, which is not freely accessible; as this limits the opportunities for a study to be replicated; but the researchers behind this study set out to create an open-source model based on publicly available data.

The model uses a framework where risk is defined as a function of hazard (the probability and strength of an event with potential to cause harm), exposure (the value of the assets subject to the hazard) and vulnerability (the susceptibility of the assets). Hazard data was derived from storm footprints developed by the UK Met Office[1], [2], while exposure data was based on building footprints from OpenStreetMap (OSM) combined with datasets indicating building and construction types (e.g. agricultural, concrete). The levels of potential damage were indicated by 'fragility curves'[3] — which define when damage occurs for different types of building — and associated reconstruction costs, adjusted to reflect the relative wealth of a given region. Finally, a sensitivity analysis highlighted the effect of each parameter, permitting fine-tuning of the model.

The researchers applied the model to 53 past storms in Europe, revealing that the worst-affected countries were the United Kingdom, Ireland, Germany, France, the Netherlands and Denmark. The modelling also produced a chart of total annual losses (€) for the most-damaged countries from 1981 to 2013. This showed that as a result of several major storms — Herta, Wiebke, Vivan and Daria — 1990 was the worst-hit year, with damage exceeding €13.3 billion (bn). These values expose Germany, which was also badly hit in 1999, as the most vulnerable country across the study period and region.

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New open-source model offers accessible method to estimate windstorm damage (continued)

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The analysis also mapped the average annual storm damages in Europe over the past 40 years and confirms that coastal regions are most at risk (as most violent storms are generated at sea). The model suggests that Denmark and the Baltic countries (Estonia, Latvia and Lithuania), however, are also often affected inland. More surprisingly, it also indicates that certain parts of Italy, the Czech Republic, eastern Spain and inland Poland are particularly vulnerable, although the researchers call for further modelling to confirm this result. Additionally, they use their model to produce maps of selected storms — such as Ulli (2012) and Xaver (2013) — with levels of damage colour-coded (with darker colours representing worst-hit areas, which they confirm to be largely on far-western coastlines – such as Ireland).

The researchers say it is difficult to compare their results to those from models based on insurance data, as each is calibrated differently. Nevertheless, they observe that most findings agree with the individual storms and impacts recorded in the Extreme Wind Storms[4] (XWS) catalogue, an existing database of storm tracks and insured damages estimates. The model calculated that cumulative damages caused by Storm Erwin were €2.15; Klaus — €2.23; Ulli — €0.17; and Xaver — €1.24 bn respectively. XWS reports the damages to be €1.82, €2.9, €0.17 and €0.74 bn, respectively. The model tends to calculate lower damages than XWS, especially between 2007 and 2010. A possible explanation for this might be that the resolution of wind footprints used was not high enough to capture storms' local behaviour.

Gaps in OpenStreetMap (OSM) coverage are another limitation. Although extensive, the researchers acknowledge that rural areas and some countries are less represented (e.g. Spain and Portugal), according to comparisons with the EU building database. The researchers state that the model[5] could be applied to any region where suitable data is available, and could be transferred to other hazards such as flooding.

1. Maisey, P., Becker, B. & Steptoe, H. (2017) WISC Storm Footprint (Gridded Windfeld) Description. Copernicus Climate Change Service.

2. See: Copernicus, C3S Operational Windstorm Service

3. Fragility curves, which are usually based on insurance data, were the most important parameter in the open-source model. Collecting such data would be costly for government agencies, but the researchers note that it would improve disaster risk-reduction efforts if it were publicly available.

4. Roberts, J. F. et al. (2014) The XWS open access catalogue of extreme European windstorms from 1979 to 2012. Nat. Hazards Earth Syst. Sci. 14: 2487–2501

5. The researchers emphasise the open-source nature of this study and invite others to participate in improving the model (all source code is available on Github).