

Catastrophe modelling in R

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Outline

- ▶ Introduction to Catastrophy Modelling
- ▶ Implementation in R
- ▶ Demonstration of Prototype

About Us



KatRisk provides catastrophe risk management products with a focus on open science and open source software. We provide comprehensive solutions which allow you to incorporate your own knowledge. <http://www.katrisk.com>



Stefan has co-founded KatRisk in 2012. He has 8 years experience in building catastrophe models and using R. Stefan holds a MSc in hydrology.



History of Cat Modelling

- ▶ AIR (1987) and RMS (1988) founded
- ▶ 1992: Hurricane Andrew
 - ▶ \$16B insured loss
 - ▶ 11 insolvencies
- ▶ 1994: Northridge Earthquake
 - ▶ \$12B insured loss
- ▶ 1996: First Cat Bonds, rating agencies require cat loss info
- ▶ 2001/2002: WTC and first terrorism model
- ▶ 2005: Hurricane Katrina
 - ▶ \$40B insured loss
 - ▶ 0 insolvencies

Why Cat Models

Actuarial Pricing based on Loss Experience

- ▶ Fit frequency and severity distribution to past claims
- ▶ Calculate loss distribution
- ▶ Use for pricing, portfolio management, reinsurance ...

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- ▶ Catastrophes are rare events
- ▶ Spatial differentiation in risk
- ▶ Spatial correlation

Catastrophe Models

Cat Models extend a company's loss experience with a synthetic event set.

- ▶ Fixed set of unobserved but realistic events
- ▶ Calculate hazard intensity for all exposed locations
- ▶ Calculate resulting damage to buildings
- ▶ Apply financial structures to model payout
- ▶ Output Event Loss Table ('ELT') and loss distribution

Event Set

The model prescribes a set of hazard events which will be applied to all portfolios.

- ▶ Frequency distribution (Poisson, neg. Binomial) and event rate
- ▶ time of occurrence in 10,000 simulation years

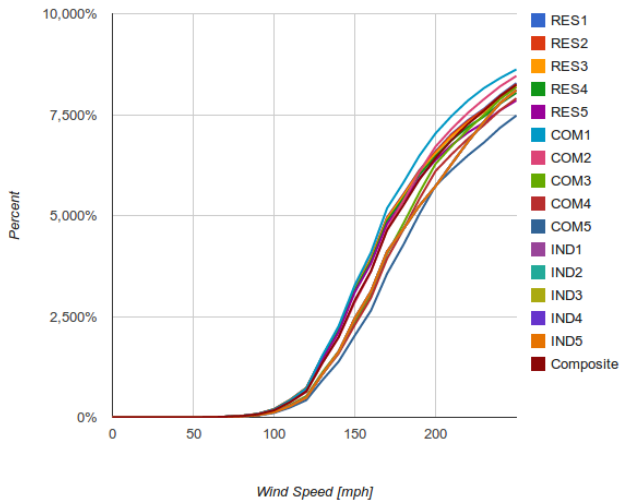
EventID	Rate	Lon	Lat	Magnitude
1	1e-6	-121	38	7.2
2	1e-6	-119.5	39	6.8
3	2e-6	-120.2	37.2	6.1
...				

Exposure

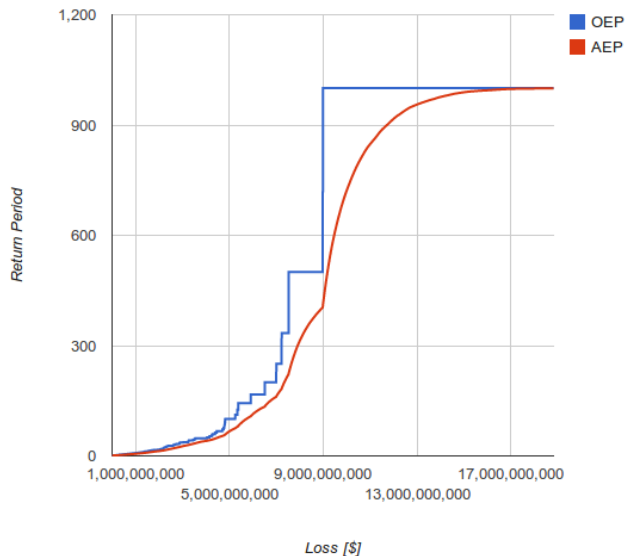
Supplied by user.

- ▶ Location
- ▶ Value
- ▶ LOB (Res / Com / Ind ..)
- ▶ Building characteristics (Terrassed, masonry, 2-stories, 1928)
- ▶ Policy terms
- ▶ Contracts

Vulnerability



Exceedance Probability (EP) Curves



Exceedance Probability (EP) Curves

- ▶ $EP(x) = 1 - F(x)$
- ▶ Occurrence EP (OEP) : maximum loss per year

$$OEP(x) = 1 - F_{max}(x) = 1 - \sum_{n=0}^{\infty} p_n F_X^n(x)$$

- ▶ Aggregate EP (AEP) : sum of losses in a year

$$AEP(x) = 1 - F_S(x) = 1 - \sum_{n=0}^{\infty} p_n F_X^{*n}(x)$$

- ▶ Calculate using pgf $P(z) = \sum p(n)z^n$ or more generally use simulation and ECDF

Marketplace

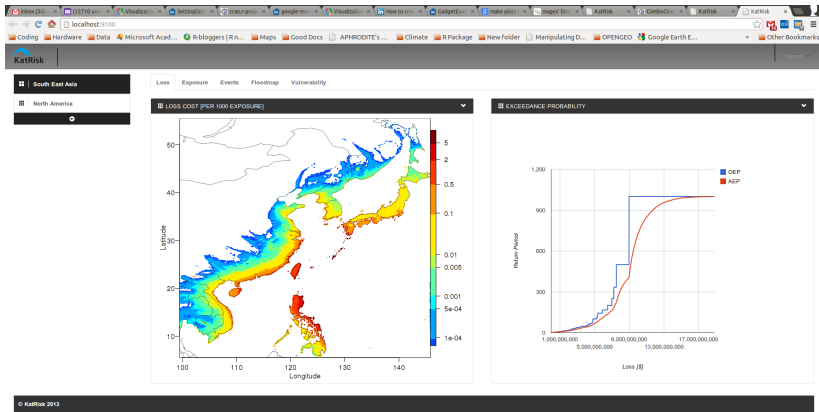
Three big vendors dominate the market with closed-source software and data formats.

- ▶ No open standard for input and output data.
- ▶ Limited documentation
- ▶ Difficult for clients to incorporate their own experience and research
- ▶ High cost of ownership and difficulty to compare models

Some initiatives to change this:

- ▶ ACORD data standards
- ▶ OASIS Loss Modelling Framework

KatRisk's Cat Engine



Technology Stack

- ▶ R - calculation, IO
- ▶ RShiny - web server
- ▶ Leaflet and MapServer - web mapping
- ▶ googleVis - interactive maps using Google Charts



Why choose R

- ▶ Concise code for statistical modelling
- ▶ Great variety of input and output options
- ▶ Existing R user base in insurance companies

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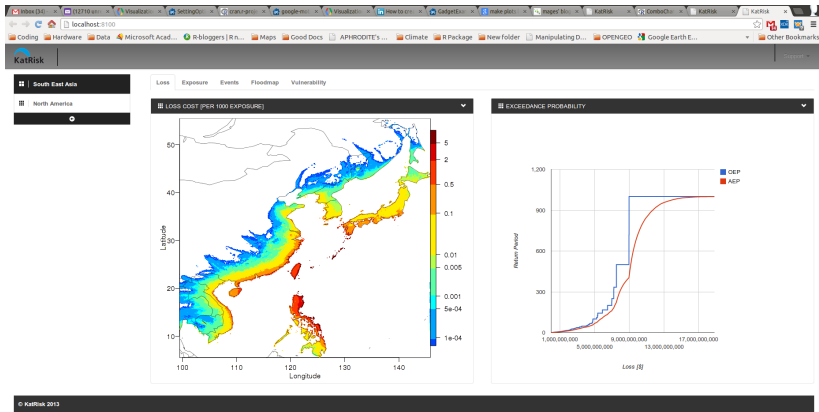
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Allows users to

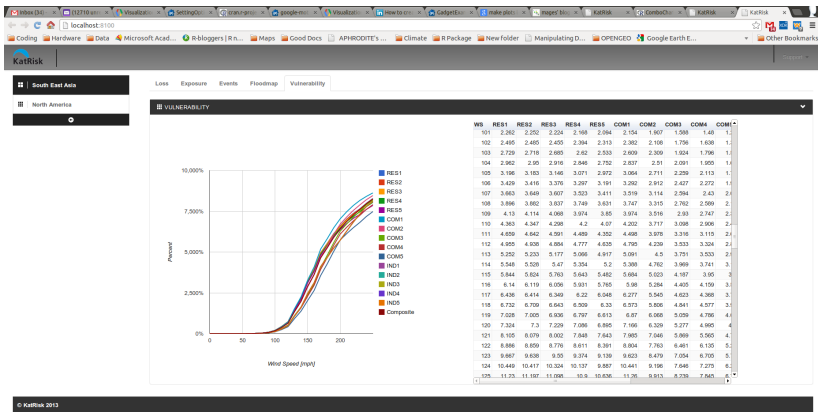
- ▶ understand results in detail
- ▶ adapt engine to fit into their workflow
- ▶ modify components of vendor model
- ▶ add custom analytics or model components
- ▶ implement internal models

Demo Video

View Summary Statistics



See and Edit Vulnerability



Zoom into details

The screenshot displays a web browser window with the URL `localhost:8100`. The browser's address bar and tabs are visible at the top. The main content area shows the KatRisk application interface. On the left, there is a sidebar with a tree view containing "South East Asia" and "North America". The main panel has a navigation menu with "Loss", "Exposure", "Events", "Floodmap", and "Vulnerability". The "Floodmap" tab is active, showing a detailed satellite-style map of a coastal region. The map features a large body of water on the right, a brownish coastline, and a dense green and white inland area. A small white box with the number "1" is visible in the top-left corner of the map. At the bottom of the map, there is a small text attribution: "Source: The Countries of the World". The footer of the application displays "© KatRisk 2013".

Zoom into details

The screenshot displays a web browser window with the URL `localhost:8100`. The browser's address bar and tabs are visible at the top. The main content area shows the KatRisk application interface. On the left, there is a navigation menu with two main categories: "South East Asia" and "North America", each with a sub-menu icon. The main content area is titled "FLOODMAP" and features a large, detailed satellite-style map of a mountainous region. The map is overlaid with a complex network of blue lines representing flood paths or watersheds. The terrain is rendered in shades of brown and grey, indicating elevation and vegetation. The map is zoomed in to show fine details of the flood network. At the bottom of the browser window, a copyright notice reads "© KatRisk 2013".

Zoom into details

The screenshot displays the KatRisk web application interface. At the top, a browser window shows the URL 'localhost:8100'. The application header includes the 'KatRisk' logo and a navigation menu with options: 'Loss', 'Exposure', 'Events', 'Floodmap', and 'Vulnerability'. The 'Floodmap' tab is selected, and a sidebar on the left shows a map of South East Asia with a red dot indicating the current location. The main content area is titled 'FLOODMAP' and features a detailed satellite-style map of a river network. The rivers are highlighted in a light blue color, showing a complex, branching pattern. A small inset map in the top-left corner of the main map area shows the broader geographical context. At the bottom of the application, a footer contains the text '© KatRisk 2013'.

Zoom into details

The screenshot displays a web browser window with the URL `localhost:8100`. The browser's address bar and tabs are visible at the top. The application interface includes a navigation menu on the left with options for "South East Asia" and "North America". A top navigation bar contains tabs for "Loss", "Exposure", "Events", "Floodmap", and "Vulnerability". The "Floodmap" tab is active, showing a detailed satellite-style map of a river network. The map features a complex web of blue lines representing waterways, set against a brownish terrain. A small inset map in the top-left corner of the main map area shows the current view's location within a larger regional context. The footer of the application displays the copyright notice "© KatRisk 2013".