Catastrophe modelling in R

S. Eppert, D. Lohmann and G. Morrow
KatRisk LLC

July 15, 2013

KatRisk

Outline

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

KatRisk

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 ...

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 ...

- 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 occurence in 10,000 simulation years

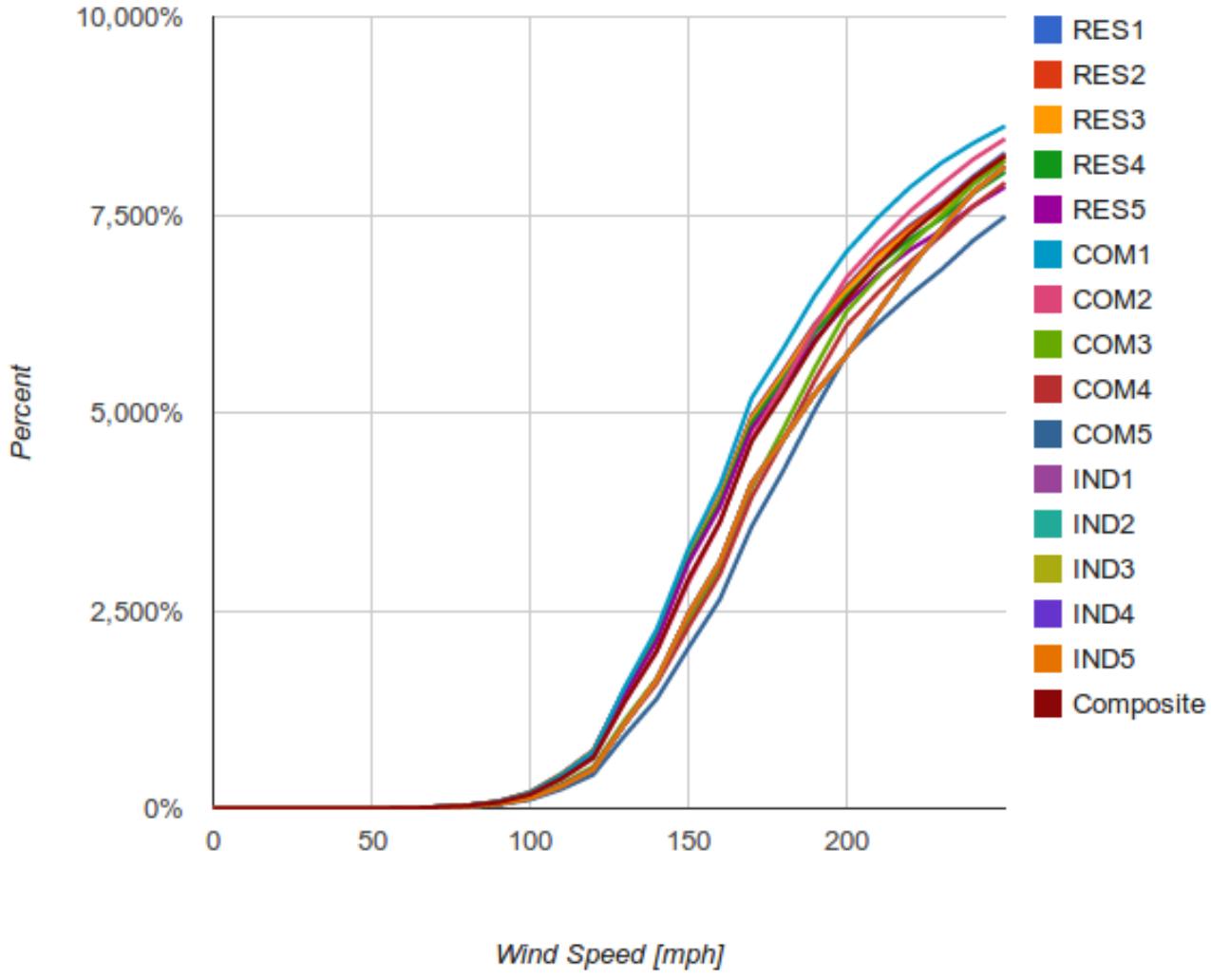
EventID	Rate	Lon	Lat	Magnitude
1	1e-6	-121	38	7.2
2	1e-6	-119.5	39	6.8
3	2e-6	-120.2	37.2	6.1
...				

Exposure

Supplied by user.

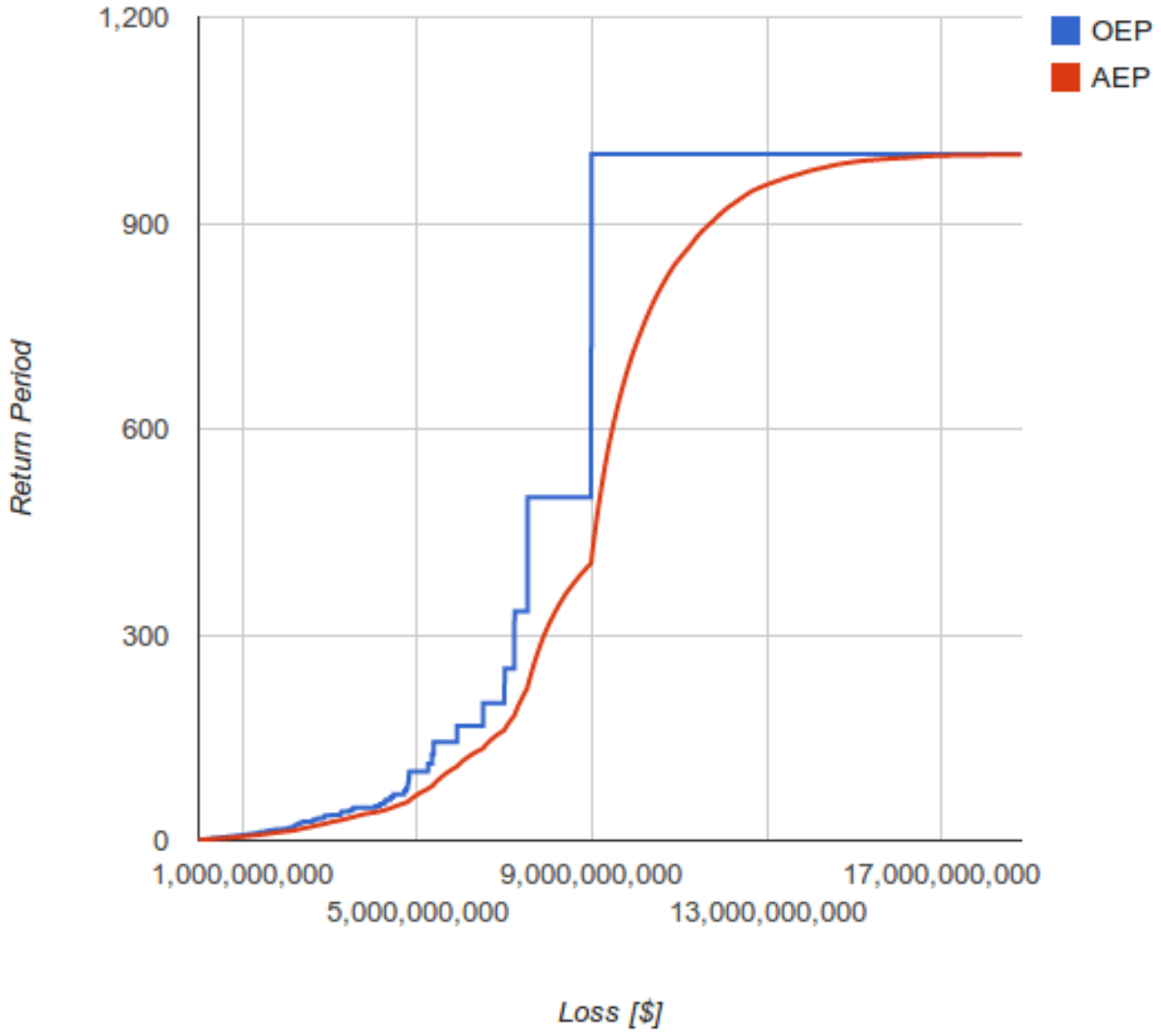
- Location
- Value
- LOB (Res / Com / Ind ..)
- Building characteristics (Terrassed, masonry, 2-stories, 1928)
- Policy terms
- Contracts

Vulnerability



KatRisk

Exceedance Probability (EP) Curves



KatRisk

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

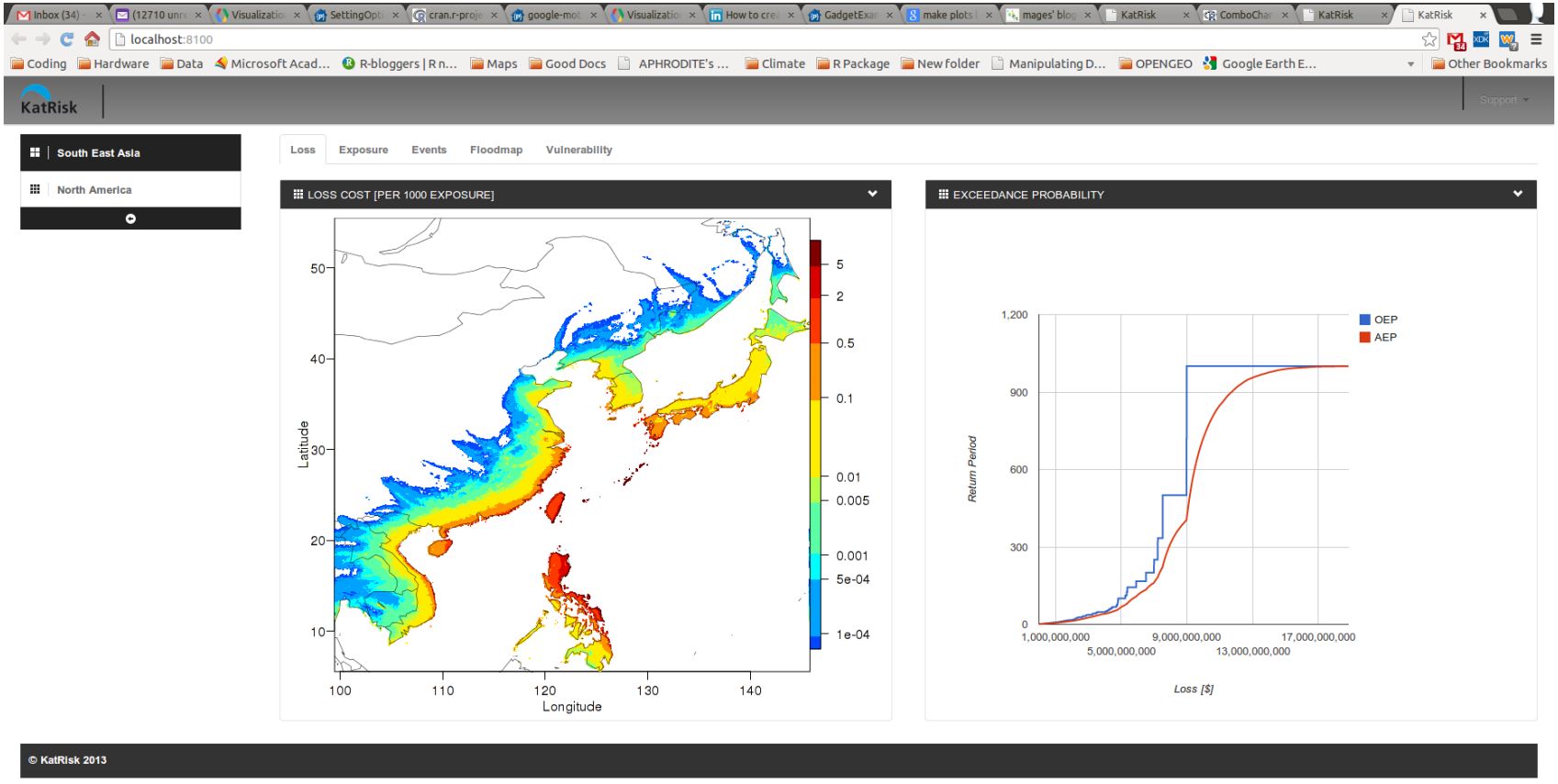
Three big vendors dominate the market with closed-source software and data formats.

- 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

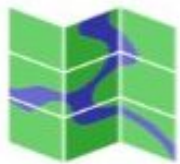
KatRisk's Cat Engine



KatRisk

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

Why choose R

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

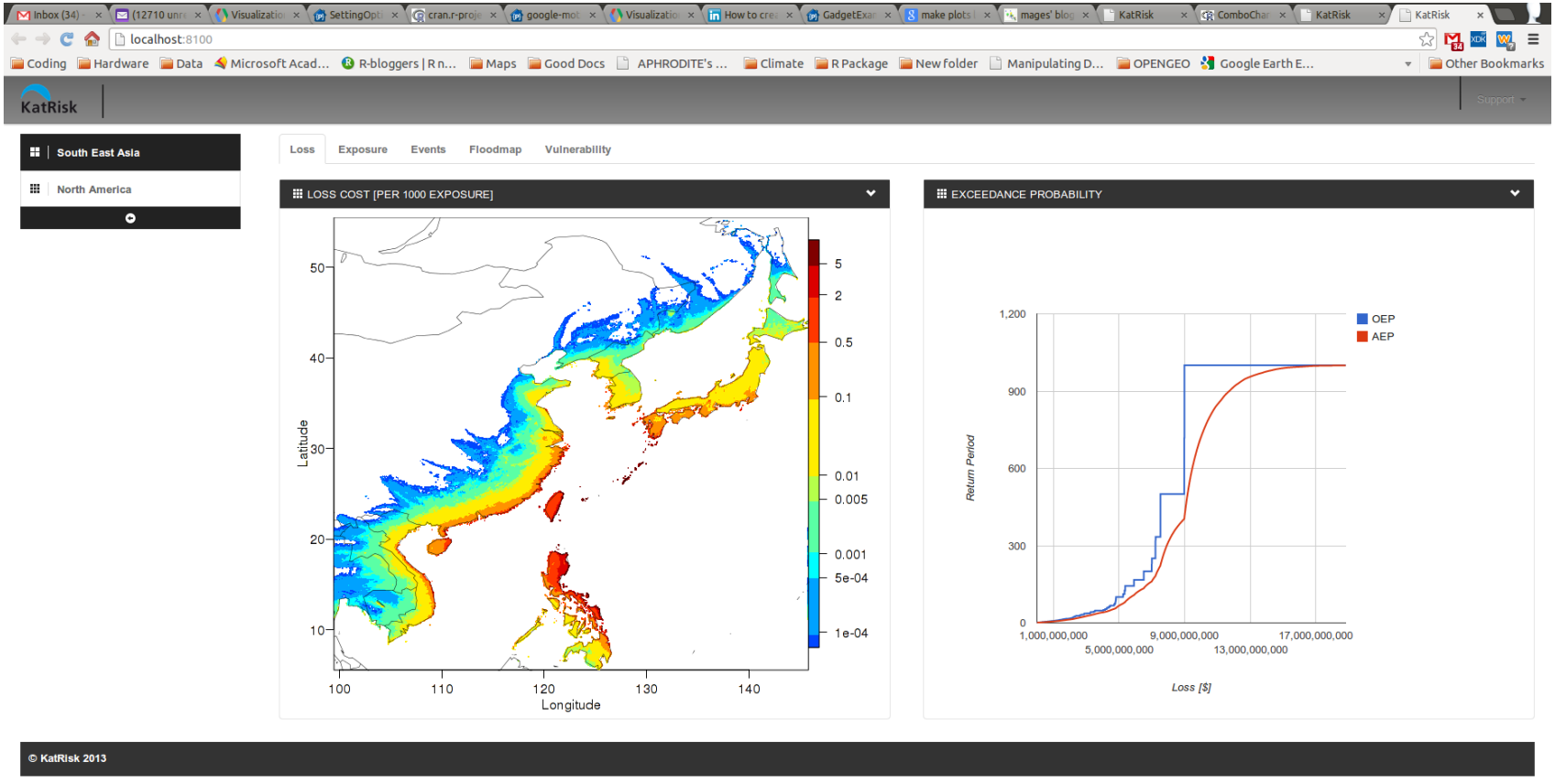
Allows users to

- 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

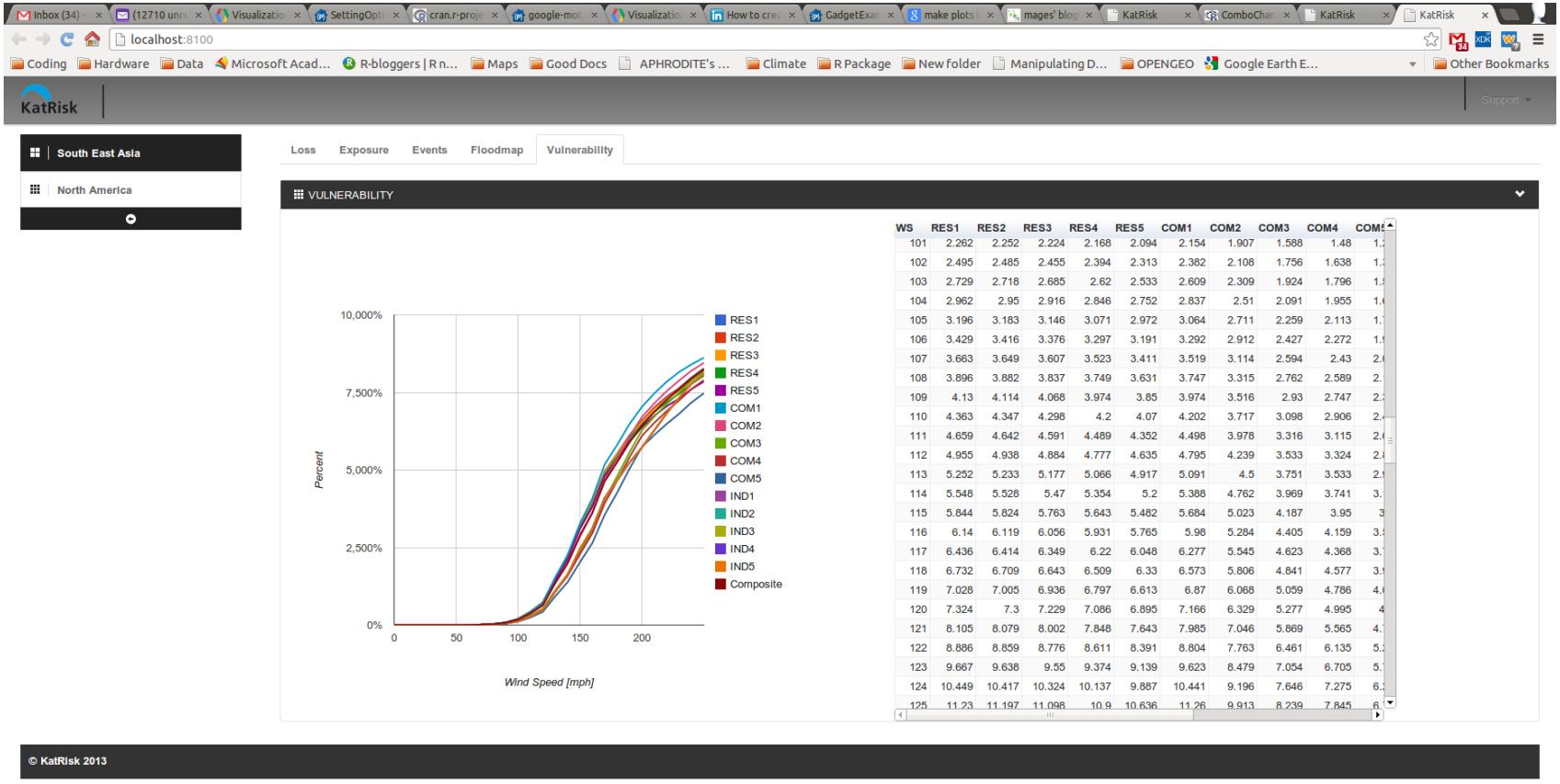
KatRisk

View Summary Statistics



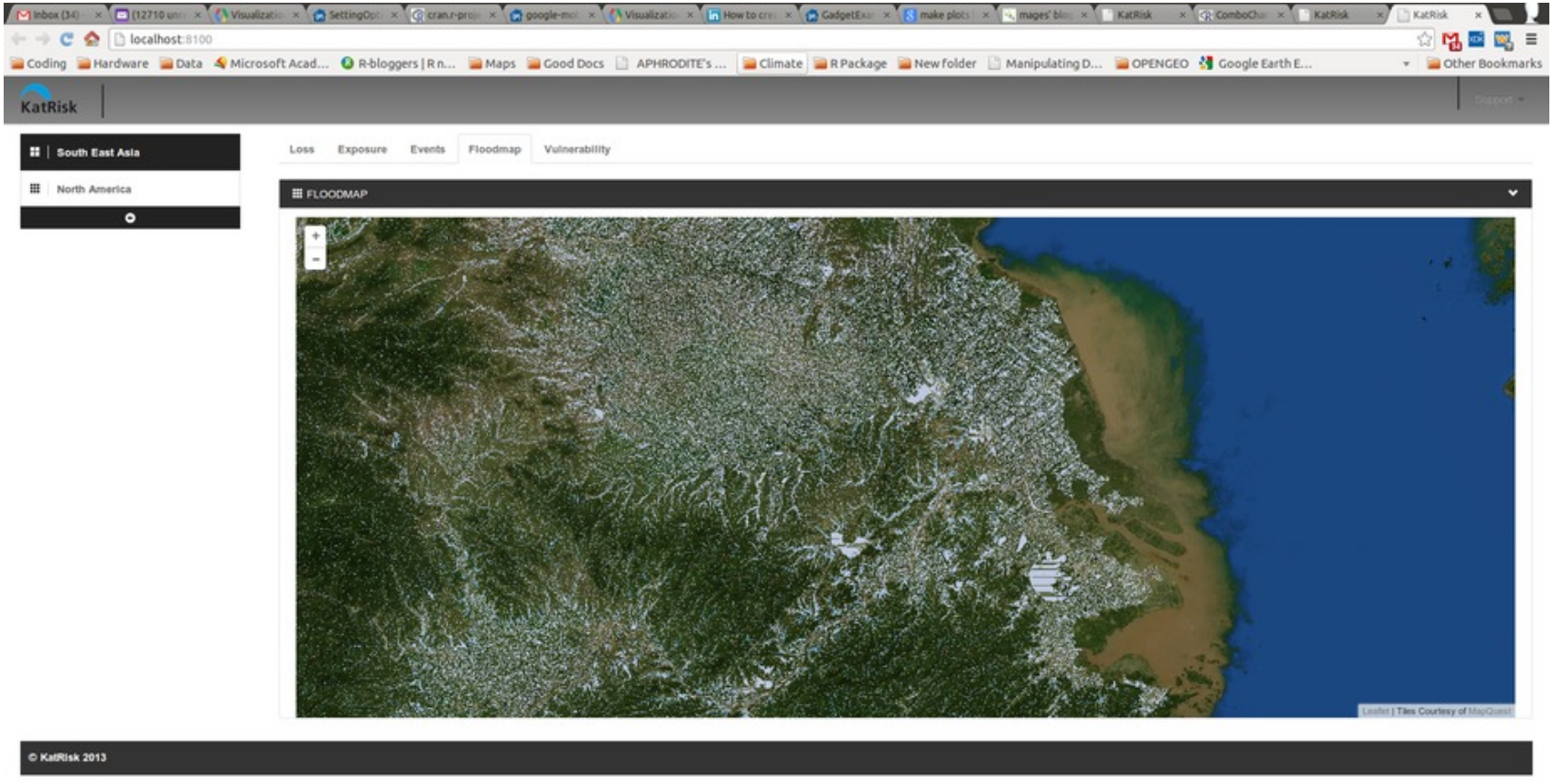
KatRisk

See and Edit Vulnerability



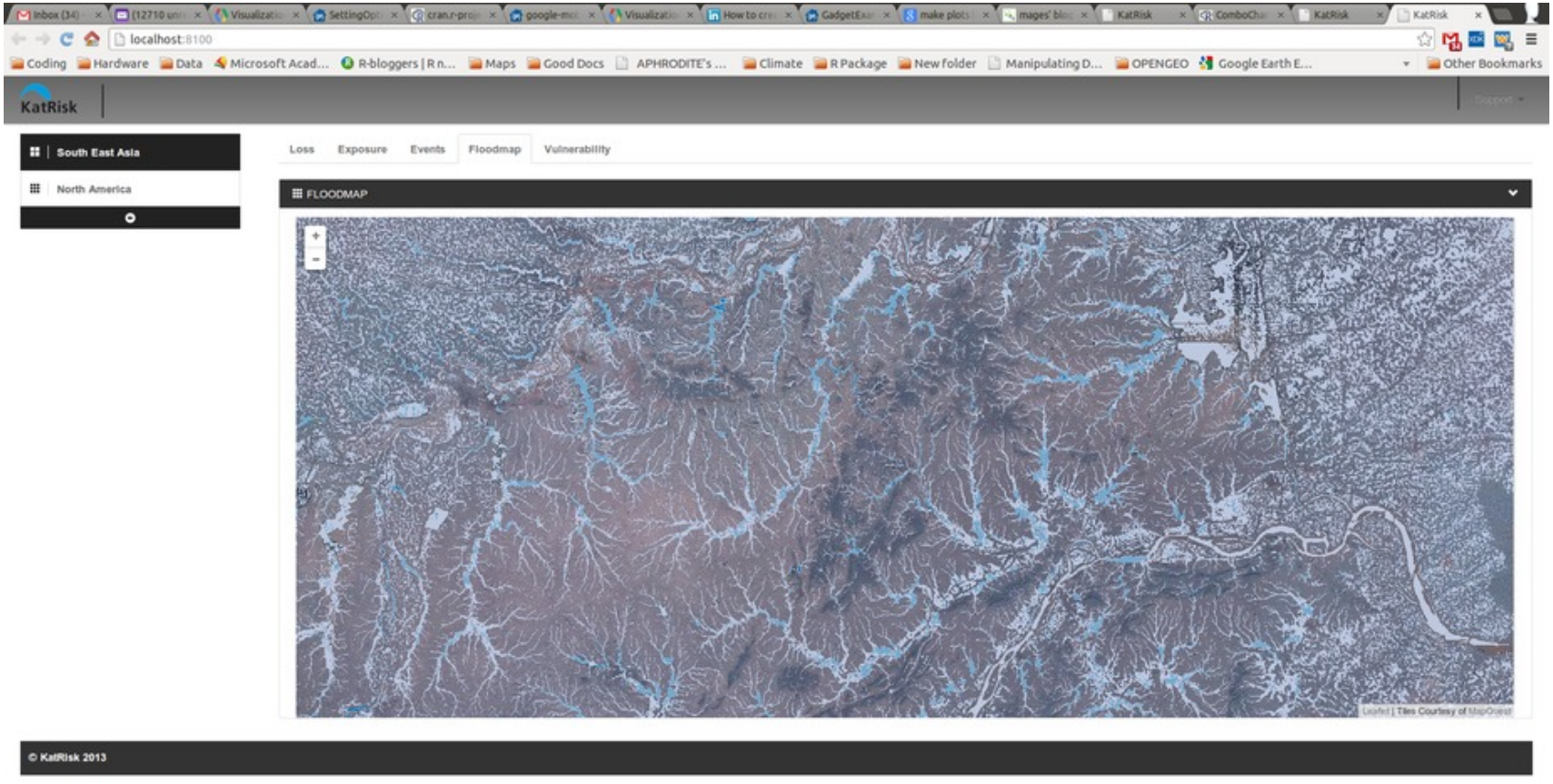
KatRisk

Zoom into details



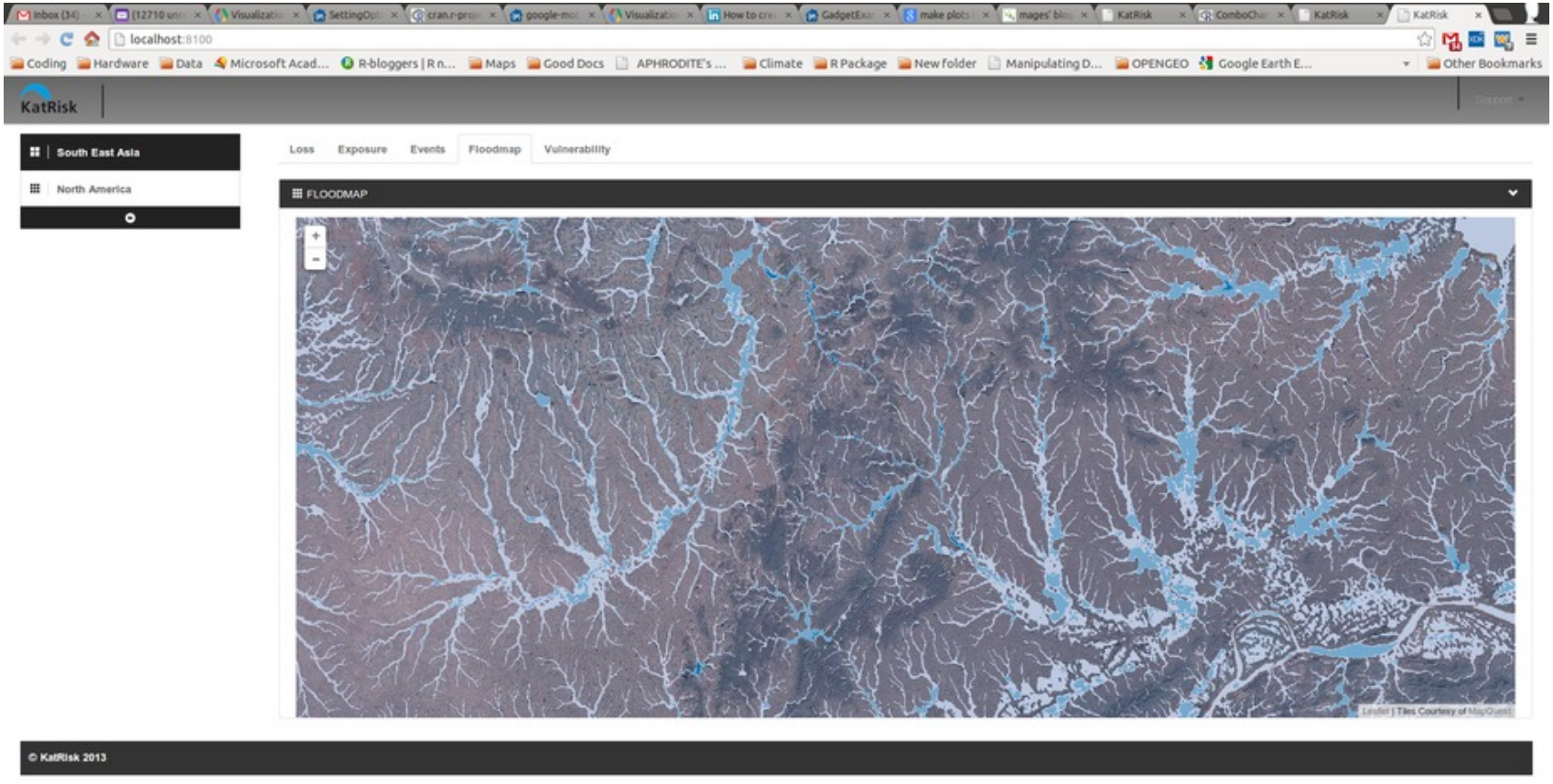
KatRisk

Zoom into details



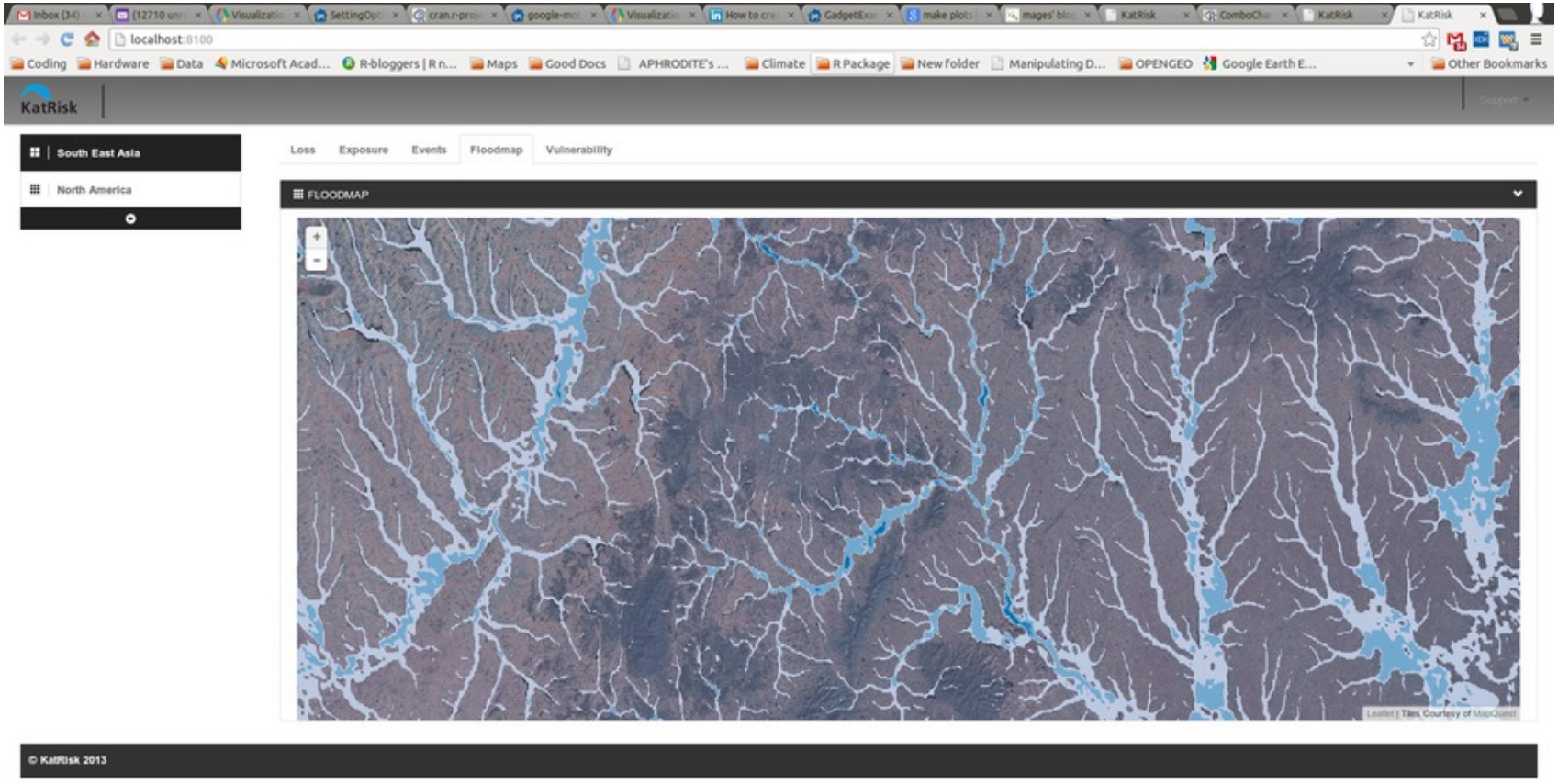
KatRisk

Zoom into details



KatRisk

Zoom into details



KatRisk