

SMARTER MODELLING OF EXTREME EVENTS

Dr. Gordon Woo

GIRO, Liverpool

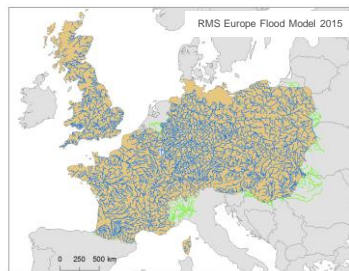
22nd October 2015



More and more computation



**More
Comprehensive**



**More
Extensive**



**More
Granular**

Beyond natural hazards

BPA bisphenol-A ♻️

Uses:

- Cash Register Receipts
- Chemical coating on Thermal Transfer Paper
- 40% of all thermal paper uses BPA.
- Used as a liner in canned goods.
- Used in Baby Bottles.
- Used in many other Plastic Bottles and Food Containers.

Problems

- Easily transfers to skin and can be absorbed into bloodstream easily.
- Leaches into the contents of the containers.

Linked to:

- Fertility Problems
- Cancer
- Early Puberty
- Genital Abnormalities
- Abnormal Breast Development in Males.
- Cardiovascular Diseases
- Diabetes Type 2
- Liver Problems

Banned in:
Maryland, New York and Canada

Keyword Search:
BPA Soft Weapons

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Zero-Day Exploit

COUNTDOWN TO DARKNESS

"To much of our critical national infrastructure hinges on technology which is so fragile that a zero-day bug in the wrong hands could lead to any security hole attack. I'm not, for a moment, going to speculate on what or how that attack may come, but suffice to say that the potential is there; the threat is real!"
—David Uhlir, Managing Director, NCS Software

Rob Stein (Rogue Shooter)
Marcus H. Sachs Technical Editor

FOREWORD
BY DAVID UHLIR



Andreas Lubitz



The direct action of the co-pilot in the tragic crash of Germanwings Flight 9525 on 24 March 2015 raises again the question: **why didn't this happen before?**

On 29 November 2013, a Mozambique Airlines plane flying from the Mozambican capital Maputo to Luanda in Angola crashed, killing 27 passengers and its six crew. The pilot locked himself in the cockpit keeping out the co-pilot.

Landslide in Ronchi di Termeno, northern Italy, 21 January 2014

The district of Ronchi,
is located at an
altitude of 318 m.





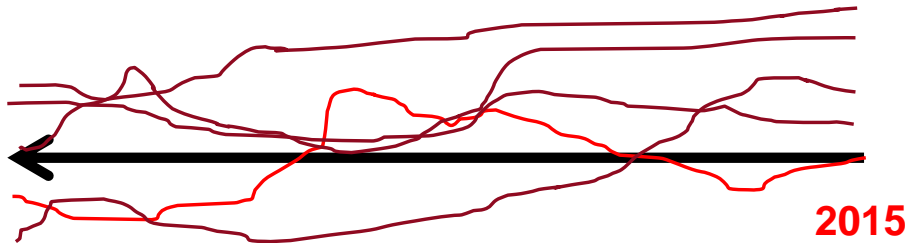
The surprised local head of emergency management stated that the 2014 event was a completely unforeseen slide that came out of nowhere.

On 23 March 2014 on a hillside in Washington State, a mudslide engulfed the village of Oso.

43 people died.



Stochastic modelling of the past



What dynamical perturbations would have transitioned a system to a disaster state.

How likely were they?

Counterfactual history

Catastrophes are extreme events.

In all branches of catastrophe science, history is a vital data resource because catastrophes are rare.

But much can be gleaned from a detailed study of catastrophes that might have been.

'History, harmless history, where everything unexpected in its own time is chronicled on the page as inevitable. The terror of the unforeseen is what the science of history hides.'

Philip Roth

The Plot against America



In October 1938, Charles Lindbergh was presented by Goering with the Service Cross of the German Eagle for his contributions to aviation.



16 January 2013: terrorist attack on gas plant at InAmenas, Algeria



A stray terrorist bullet accidentally caused a power outage that automatically shut down the plant.

This prevented the terrorists from setting off a large explosion.

Deterministic view of history

Historical hazard experience is regarded as binary:

- a loss event either happened or it did not.



Lowestoft, Suffolk: 11 January 2015

Counterfactual disasters: resampling history

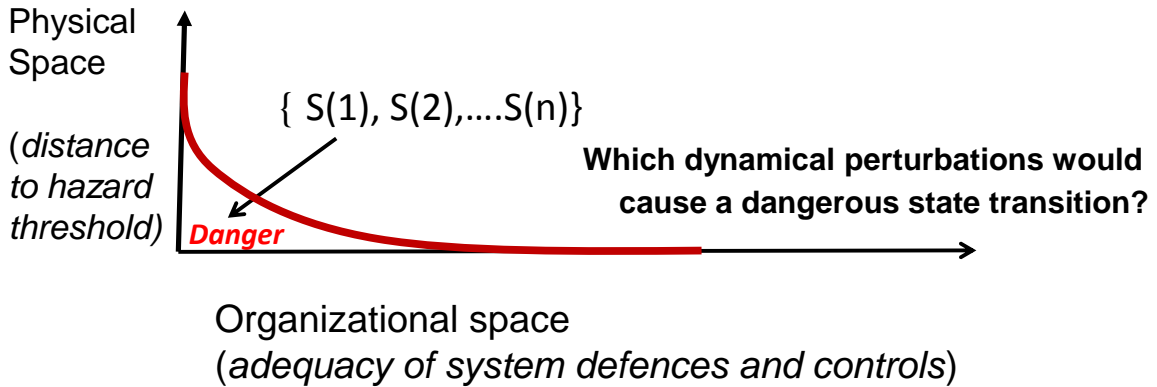
The risk state of a system can be represented in terms of n underlying risk variables, some of which may be hidden and not directly observable:

$$\{S(1), S(2), \dots S(n)\}$$

These variables include measures of both physical hazard proximity parameters, and organizational parameters, e.g. system defences and controls.

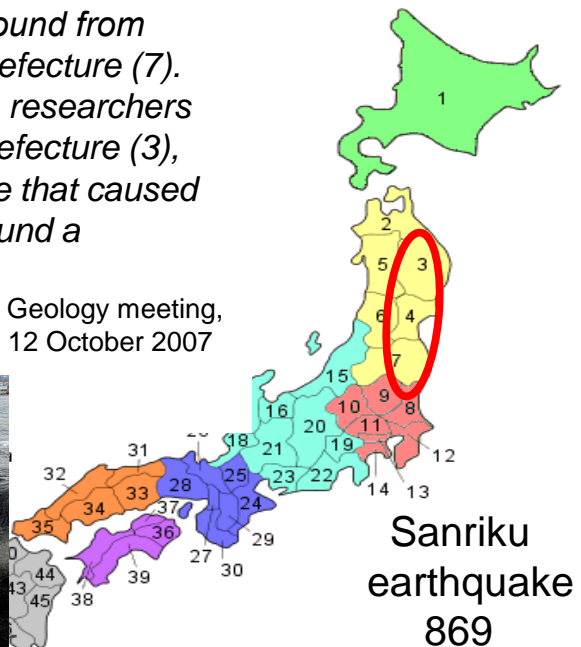
Perturbing these state variables leads to a resampled virtual disaster history.

Proximity to danger in both physical and organizational space



'Traces of the tsunami damage were found from Miyagi Prefecture (4) to Fukushima Prefecture (7). However, in the most recent study, the researchers found evidence of damage in Iwate Prefecture (3), leading them to believe the earthquake that caused the tsunami might have measured around a magnitude of 9.'

Japan Society of Engineering Geology meeting,
Osaka, 12 October 2007



Extreme windstorm impact on nuclear plant in Massachusetts

On January 27, 2015, Winter Storm Nor'Easter Juno knocked out both of the 345,000 volt transmission lines connecting the Pilgrim nuclear plant in Plymouth, Mass..

The reactor automatically shut down when the second offsite power line was lost. Equipment problems and operator errors complicated the intended response.



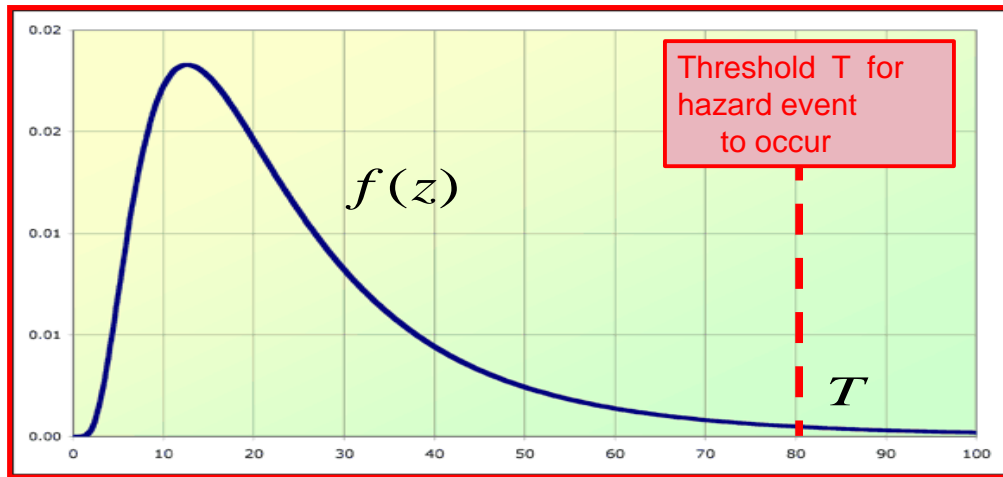
Random aspects of past events



Suppose that over a period of 10 years, there are four crisis events when a dice is thrown, with a disaster arising if the outcome is a six. The expected number of disasters is $4/6$, yielding an annual frequency of $(4/6)/10 = 1/15$.

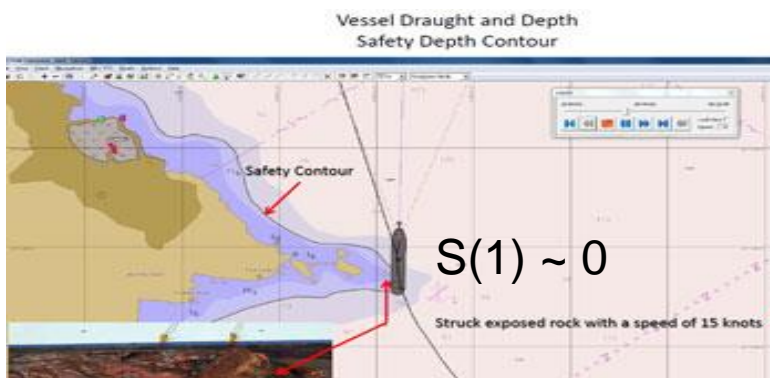
But there is about an even chance (0.48) of no disaster occurring.

Probability distribution function for key dynamic hazard parameter



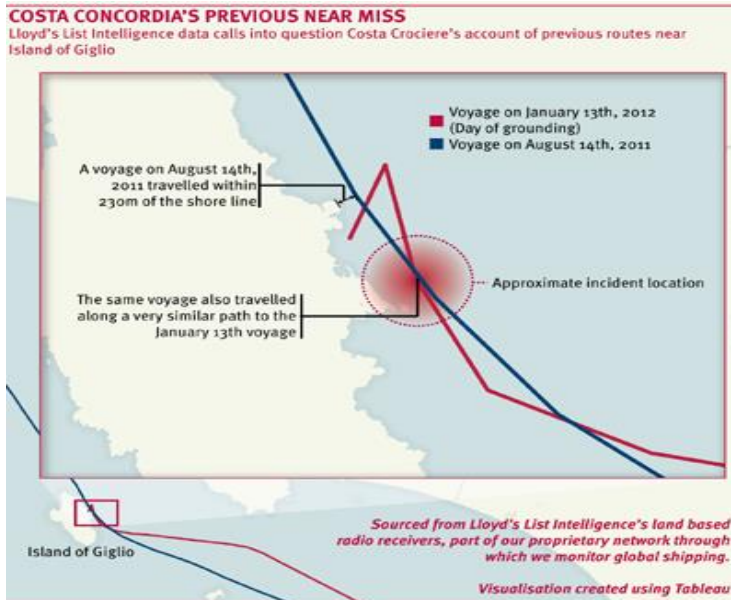
Costa Concordia: 13 January 2012

Navigating right on the
safety contour



\$2 billion catastrophe
maritime insurance loss

Costa Concordia previous near miss



This route was something of a cruise ritual, especially practised around the feast of San Lorenzo, 10th August.

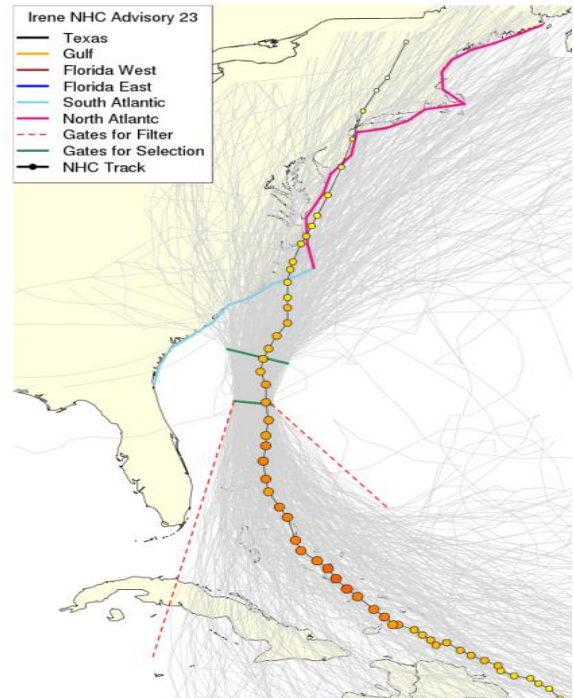
Hurricane Irene: August 2011



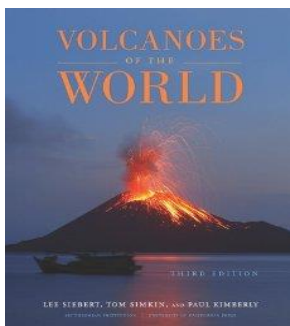
As of August 25th, 2011,
a counterfactual analysis can be
undertaken to assess the likelihood
that the insured loss from Hurricane
Irene might have been in excess of
\$50 billion.

This is estimated from an RMS study
of the possible track evolution of the
hurricane as it funnelled through the
track selection gates marked in green.

This likelihood is estimated to have
been in excess of 1%.



Counterfactual volcano hazard analysis



In the 1994 edition of 'Volcanoes of the World', published by the Smithsonian Institution, the known volcanic eruptions are catalogued.

However, unrest periods are not given so much attention.

The Montserrat volcano appeared to be dormant since 1630....

Montserrat volcano hazard



Montserrat provides a practical application for counterfactual analysis.

Volcano-seismic activity damaged buildings in the 1890s, 1930s and 1960s.

Site hazard: American University of the Caribbean School of Medicine



The government of Montserrat granted AUC land near the capital Plymouth, where a new campus was built. Classes at its new campus in Montserrat began in January 1980.

On September 17, 1989, Hurricane Hugo hit the island, severely damaging the campus. The Montserrat campus was rebuilt and reopened in September 1990.

A large volcanic eruption then forced it to close.

**A stochastic analysis of historical events
should prepare actuaries better
for future next generation risk management.**



*'The farther back you can look,
the farther forward you are likely to see.'*

Winston Churchill

Questions

Comments

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