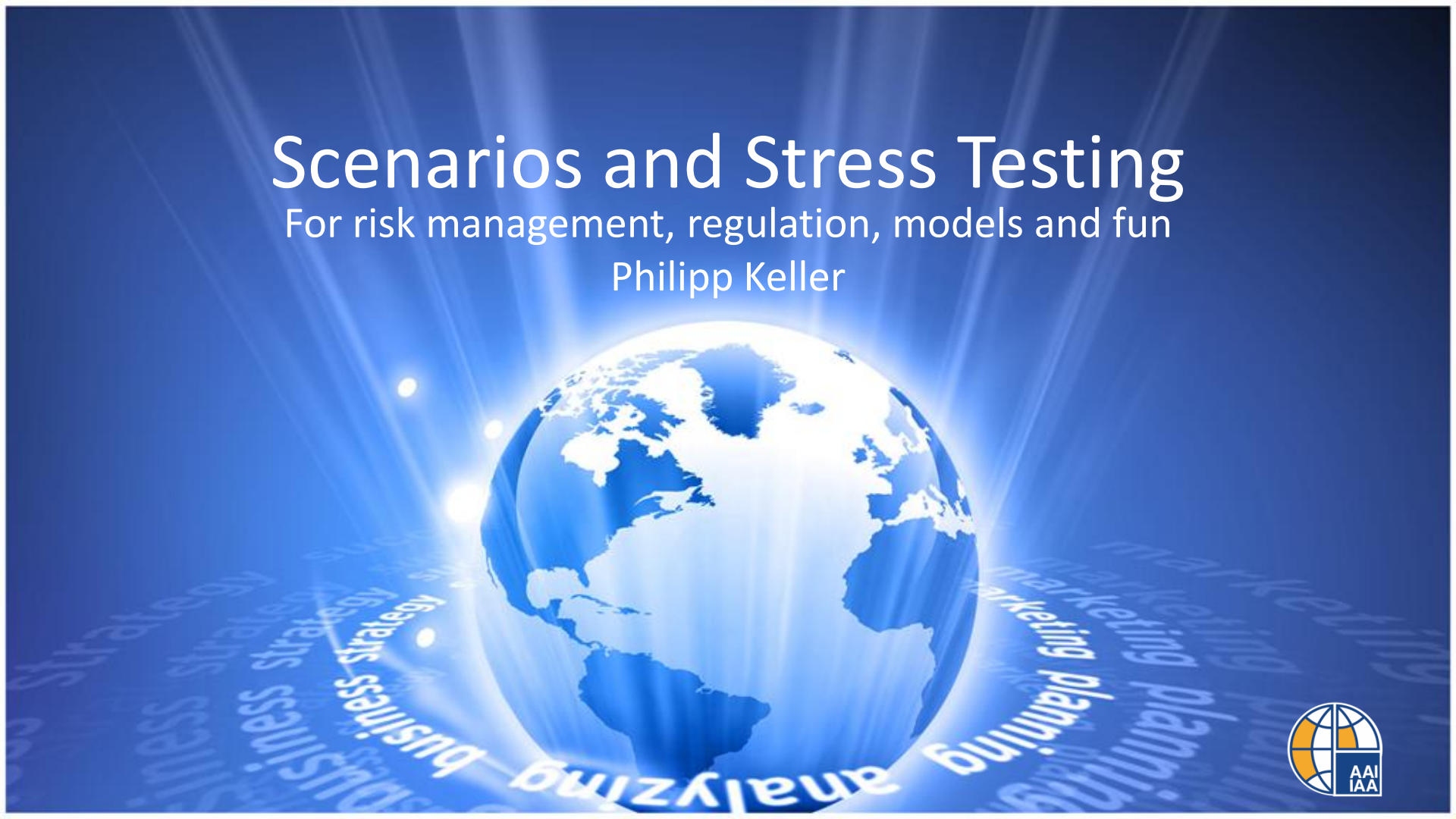
Scenarios and Stress Testing

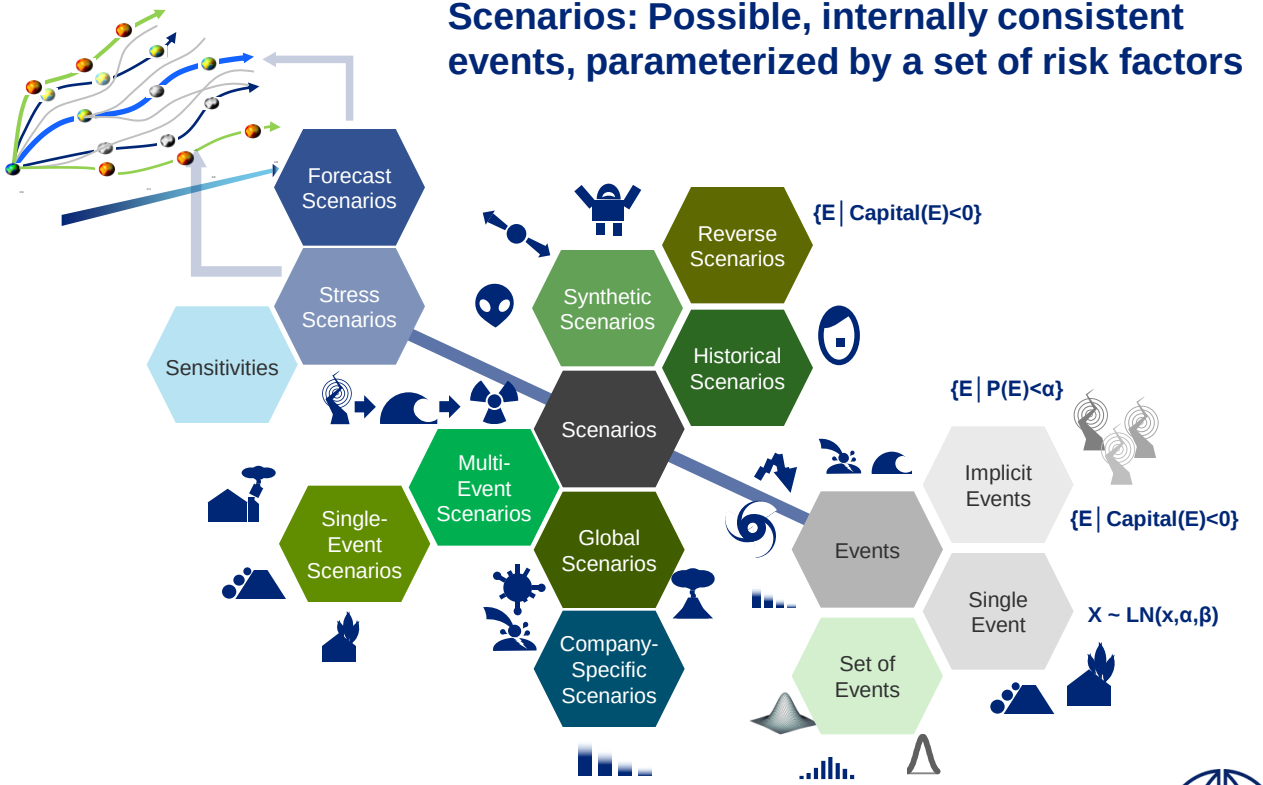
For risk management, regulation, models and fun

Philipp Keller

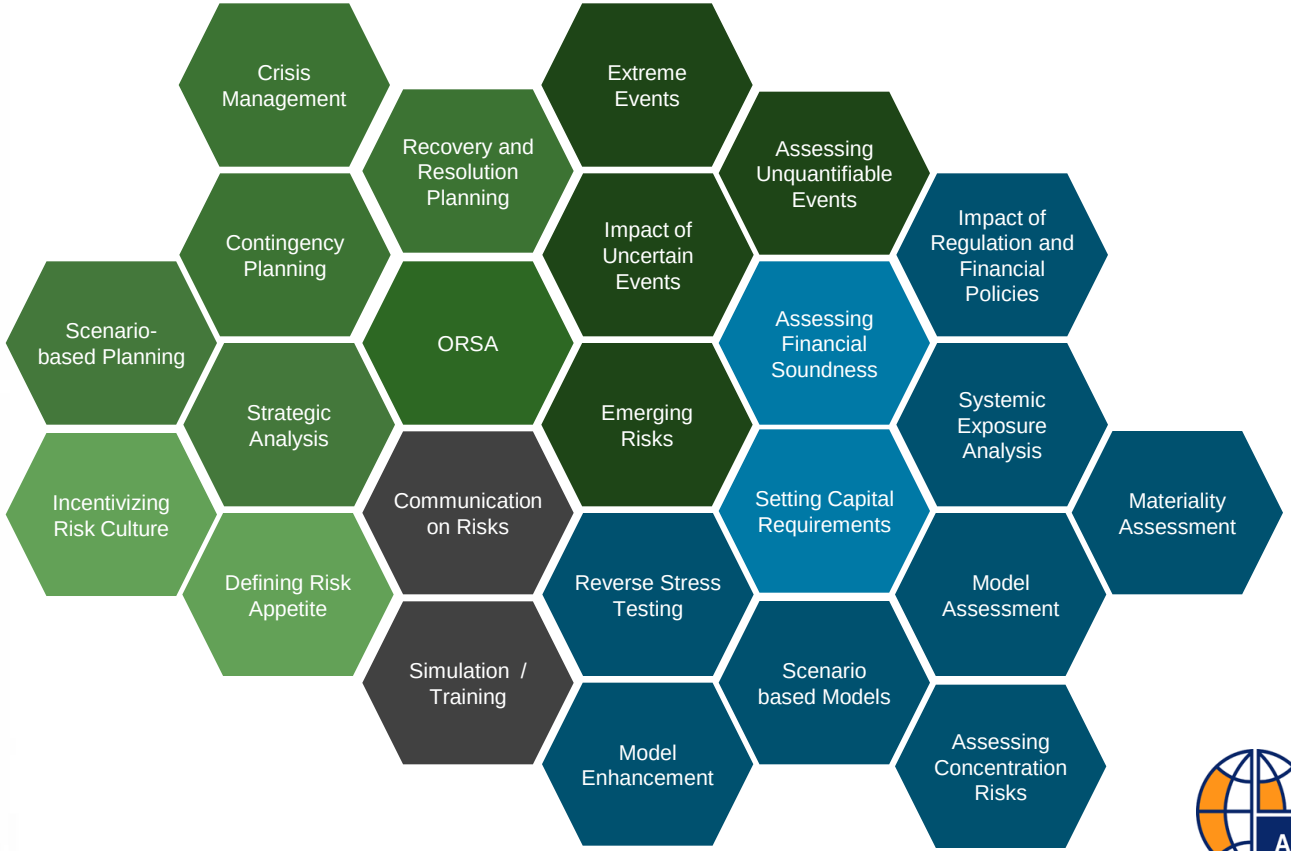


Scenarios

Scenarios: Possible, internally consistent events, parameterized by a set of risk factors



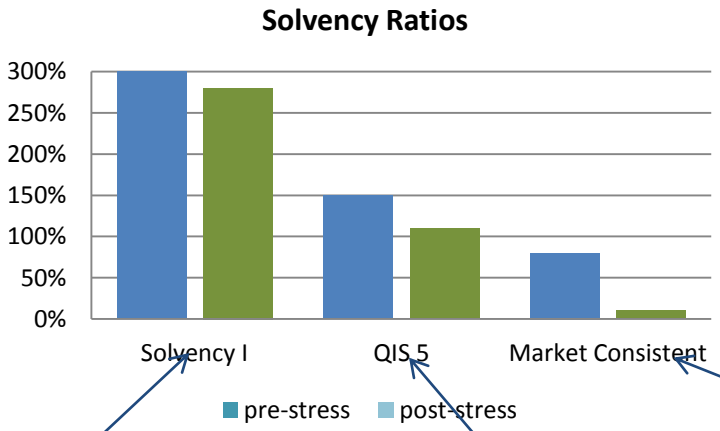
Uses of Scenarios



Scenario Analysis

The importance of valuation

- The quantification of the impact of a scenario depends strongly on the valuation standard being used.
- Illustrative Example: Solvency Ratios pre- and post stress test of a financial risk event for Solvency I, QIS 5 (using liquidity premia, matching adjustments etc.) and market-consistent



The relative declines in solvency ratios as well as the relative solvency ratios between Solvency I, QIS 5 and market consistent valuation under a realistic financial market event.

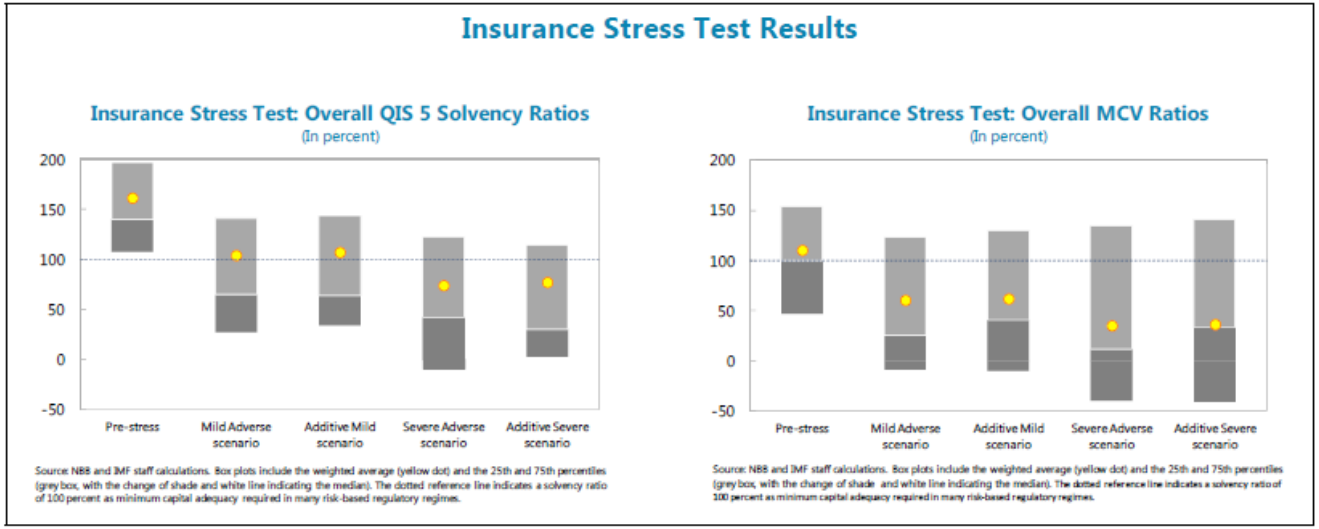
Solvency I ratios barely react to the stress test

QIS 5 solvency ratios react more but dampeners mitigate effects of stress events

In a market consistent framework, the impact of the scenario is strongest

Scenario Analysis

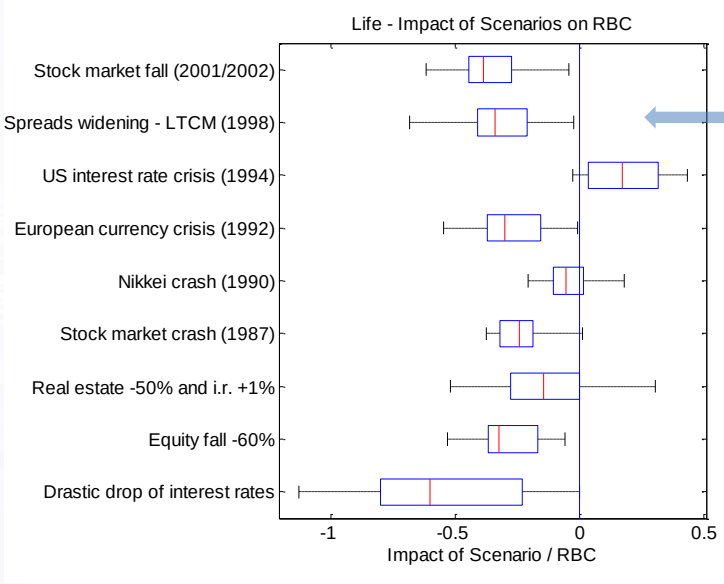
Regulatory uses: The IMF



Source: IMF Country Report No. 13/124, May 2013: Belgium Financial System Stability Assessment

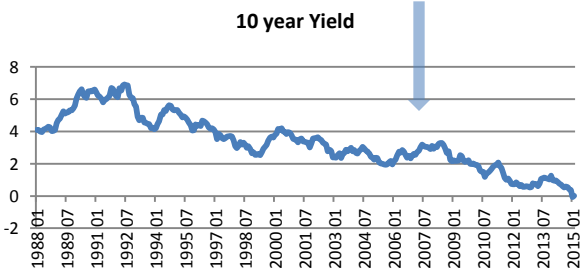
Scenario Analysis

Regulatory uses: Swiss Solvency Test 2007



High spread risk, which materialized in 2008+

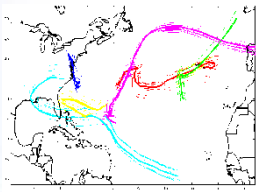
Very high risk to falling interest rates, which is materializing since the 1990s



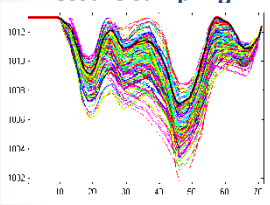
Scenarios for Modelling

Hurricane North Atlantic

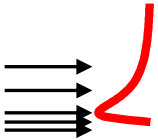
Track sampling



Pressure sampling



Uncertainty modelling

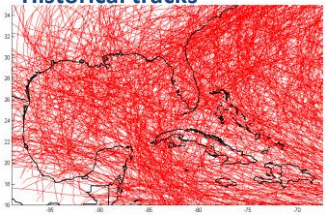


Historical data set with approximately 1’000 storm events in the last 100 years is enriched by

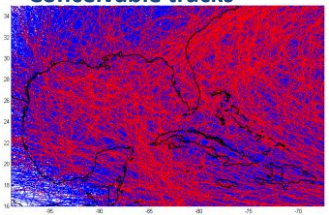
- track sampling: 9 “daughter tracks” from one “mother track”
- pressure sampling: 9 additional pressure samples
- uncertainty modelling: each event loss sampled five times

Generates 500’000 potential events

Historical tracks

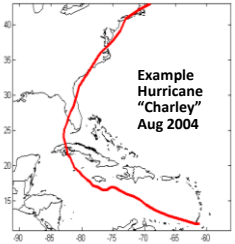


Conceivable tracks



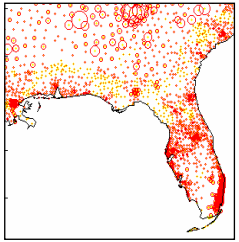
Value distribution | Vulnerability

Generation of possible events



The exposure of a portfolio towards an event is the event loss

Where situated?



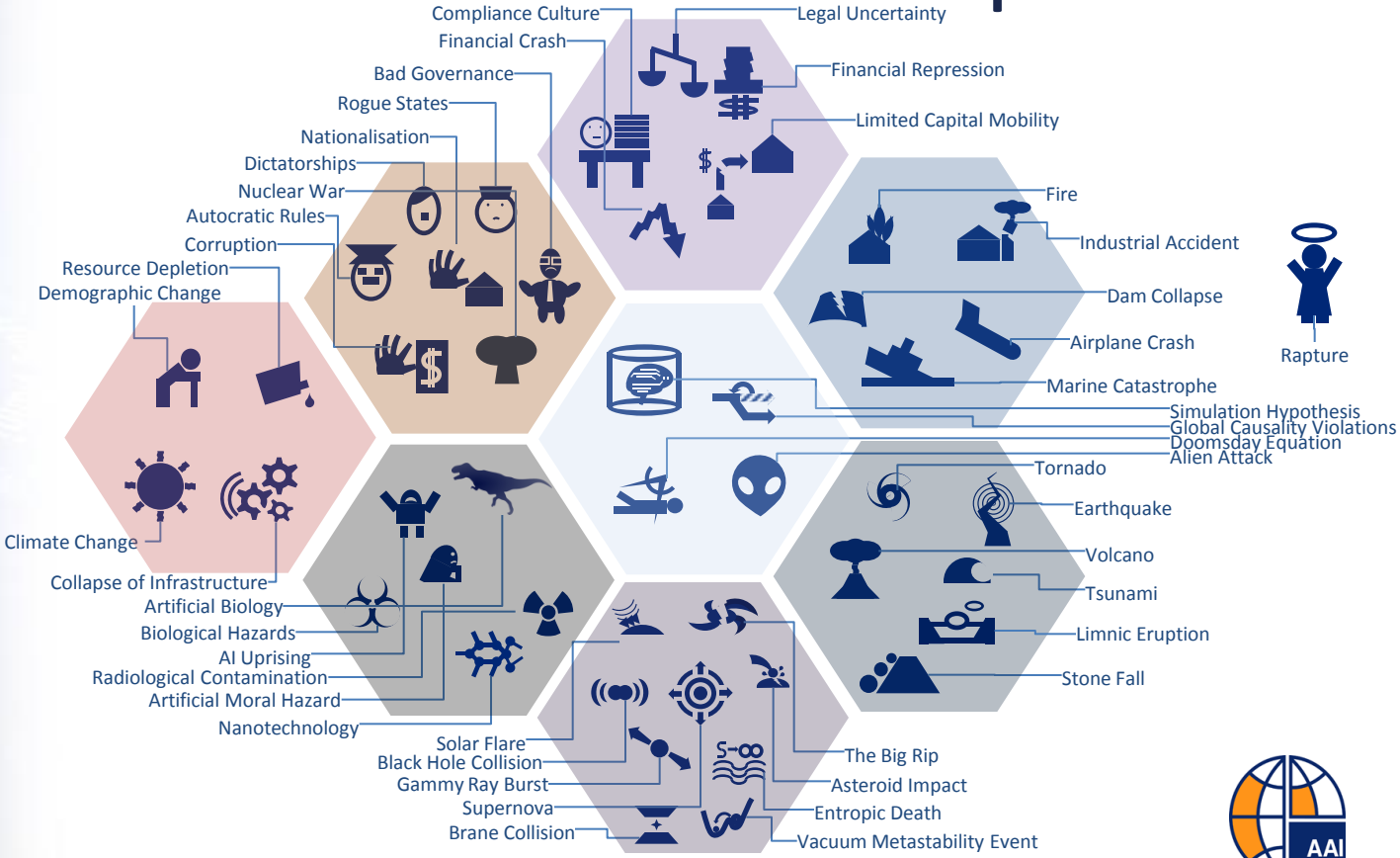
How well built?

How covered?

- Sums insured
- Cover limits
- Deductibles
- Exclusions
- etc.

Source: Swiss Re

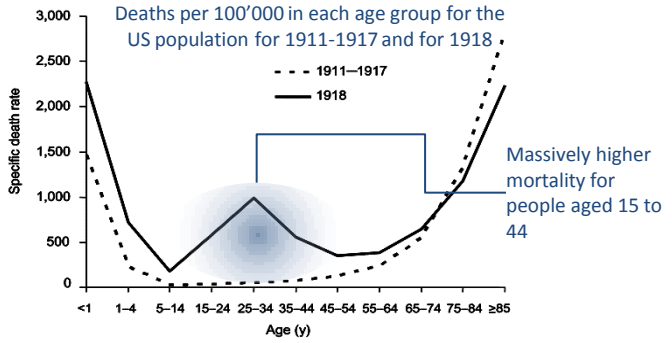
Scenarios and Catastrophes



Scenarios: Pandemics

Megadeaths by microorganisms

The 1918 flu pandemic infected 500 Mio people and killed between 50 - 100 Mio of the infected. It caused a cytokine storm (overreaction of the immune system) which led to younger adults between ages 20 to 40 to die disproportionally while children and older people with weaker immune systems were less affected. Globally approx. 30% of all people were infected, and a total of 3%-6% of the world population died.



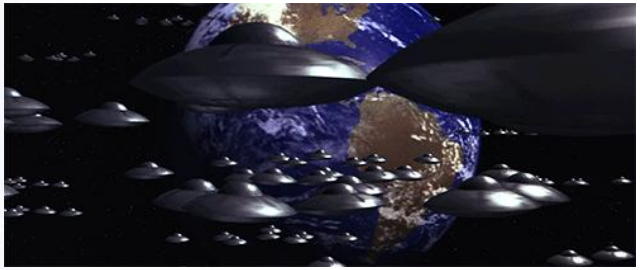
A scenario has to be specified properly for it to be useful. Assuming a multiplicative mortality increase might lead to an impact that is positive (due to annuitants dying) while in reality the impact for most life insurers would be negative.

World War Z, Paramount Pictures

Monty Python and the Holy Grail, Python (Monty) Pictures

Scenarios: Attack by Aliens

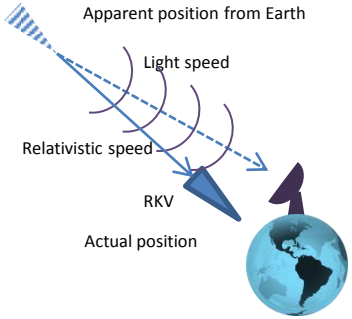
Relativistic death



Mars Attacks!, Warner Bros Pictures

Mars Attacks!, Warner Bros Pictures

Our galaxy consists of ~100bn stars and the number of planets is likely an order of magnitude higher, many of which must have the condition for life. However no signs of intelligent life have been detected yet (the Fermi paradox). One solution to the Fermi paradox is that self-replicating von Neumann machines destroy all life in order to inhibit competition. Alien civilizations then either are careful and do not emit signals or are being destroyed, e.g. by relativistic impactors (Relativistic Kill Vehicles) or by other means of planetary and solar destruction.

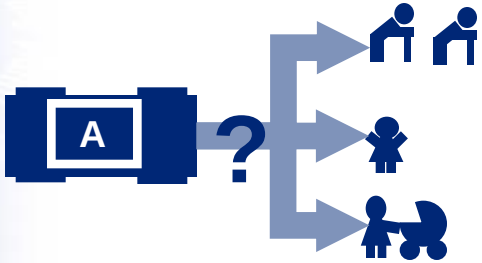


A 1kg mass impacting at 99% speed of light would release an energy of ~132 megatons or twice the larges hydrogen bomb ever exploded. The detection time would be very limited if the RKV travels close to the speed of light. Even if detected, it would be futile to destroy it since even vapour or small particles would be highly destructive.

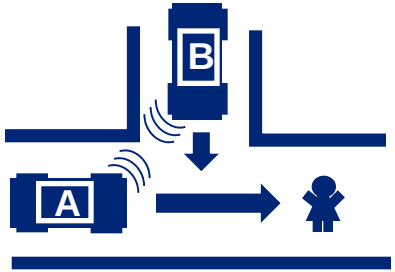
Scenarios: Autonomous Cars

Moral Dilemmas

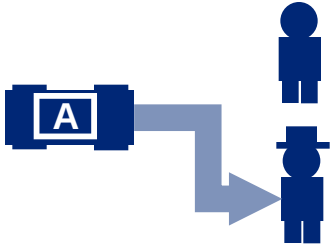
Self-driving networked cars will pose unique challenges to insurers. The programming has to cope with situations where the losses will have to be minimized and which require potential moral judgment. In addition, the type and number of accidents will change radically, requiring changes in the business model of insurers. Scenarios help to think about possible consequences, risks and opportunities.



Scenario 1: Car A has to choose between crashing into different pedestrians and has make a value judgment



Scenario 2: Car A will crash into child unless car B rams into A, killing driver B

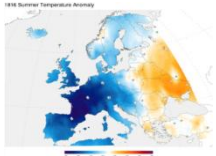


Scenario 3: Ruritania requires producers of self-driving cars to assign lower values to certain minorities

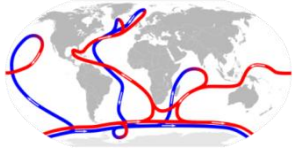
Scenarios: Tambora Eruption

Source: Wikimedia Commons

Tambora Eruption 1815



Source: Wikimedia Commons



Source: Wikimedia Commons

1818 return to normal climate situation

Shift in thermohaline circulation

1816 Summer Temperature Anomaly

Snow in June 1816 in North America

Shift in jet stream

Disruption of the Indian monsoon

100 km^3 of debris ejected into atmosphere (~10 times Vesuvius)

Global cooling, failed crops in Europe and North America and Yunnan,

Immediate local devastation, estimated deaths 70’000+

Lung infections due to sulfur acid and ashes

Floods and low temperatures in Europe

Typhus epidemics in Ireland 1816 – 1819 (40’000+ victims)

Most livestock died during winter 1816/17 in the US

Cholera pandemic in India , China and Indonesia: 1817to 1824

Doubling of mortality in Switzerland

Catastrophic collapse of ice dam in Switzerland in 1818 (Gietro Glacier)

Thank you

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