Using Stochastic model for choosing a reinsurance cover

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26/04/2013

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Outline of the presentation

1. **Why using a stochastic model**
2. Making of the stochastic model
3. Which risk measure to use
4. Other measures: Return on Risk Adjusted Capital, Ceded ROE, creation of value

Principle of insurance is to reduce extreme volatility

Concept of Insurance

- Without insurance:

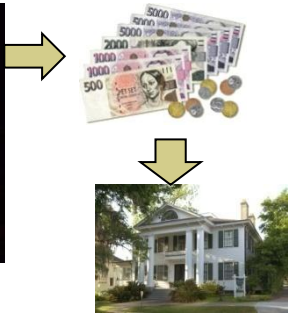



- Year 1 (Rich)
- Year 2 (Rich)
- Year 3 (Rich)
- Year 4 (Homeless)

- With insurance:

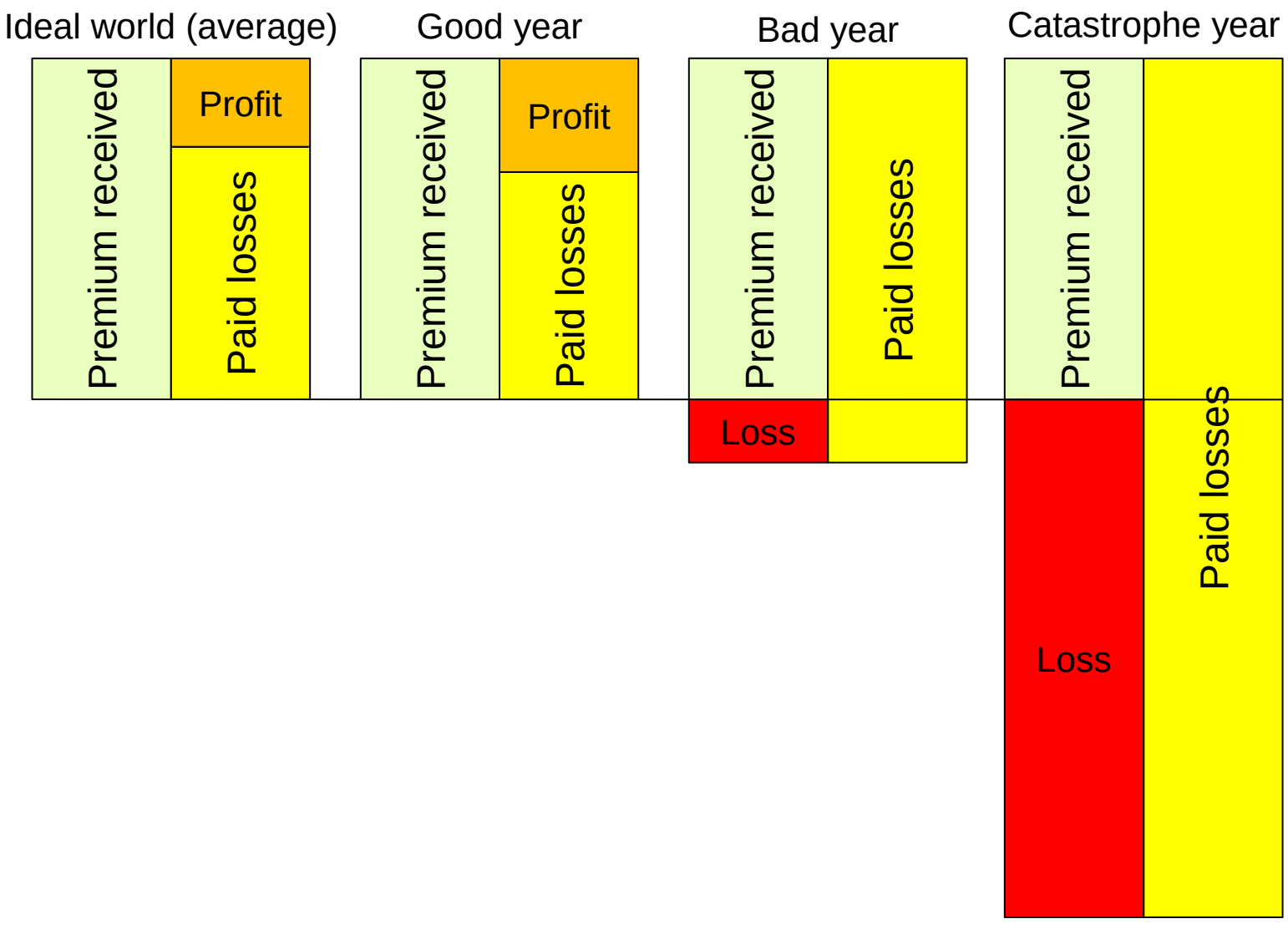






- Year 1 (99.9% Rich)
- Year 2 (99.9% Rich)
- Year 3 (99.9% Rich)
- Year 4 (99.9% Rich)

Insurers bear as well a significant risk of bankruptcy in a catastrophic year



- **Amount of loss and probability of catastrophic year?**
- Can make the insurer insolvent
- With deterministic analyzes you have information usually only up to a (slightly) bad year

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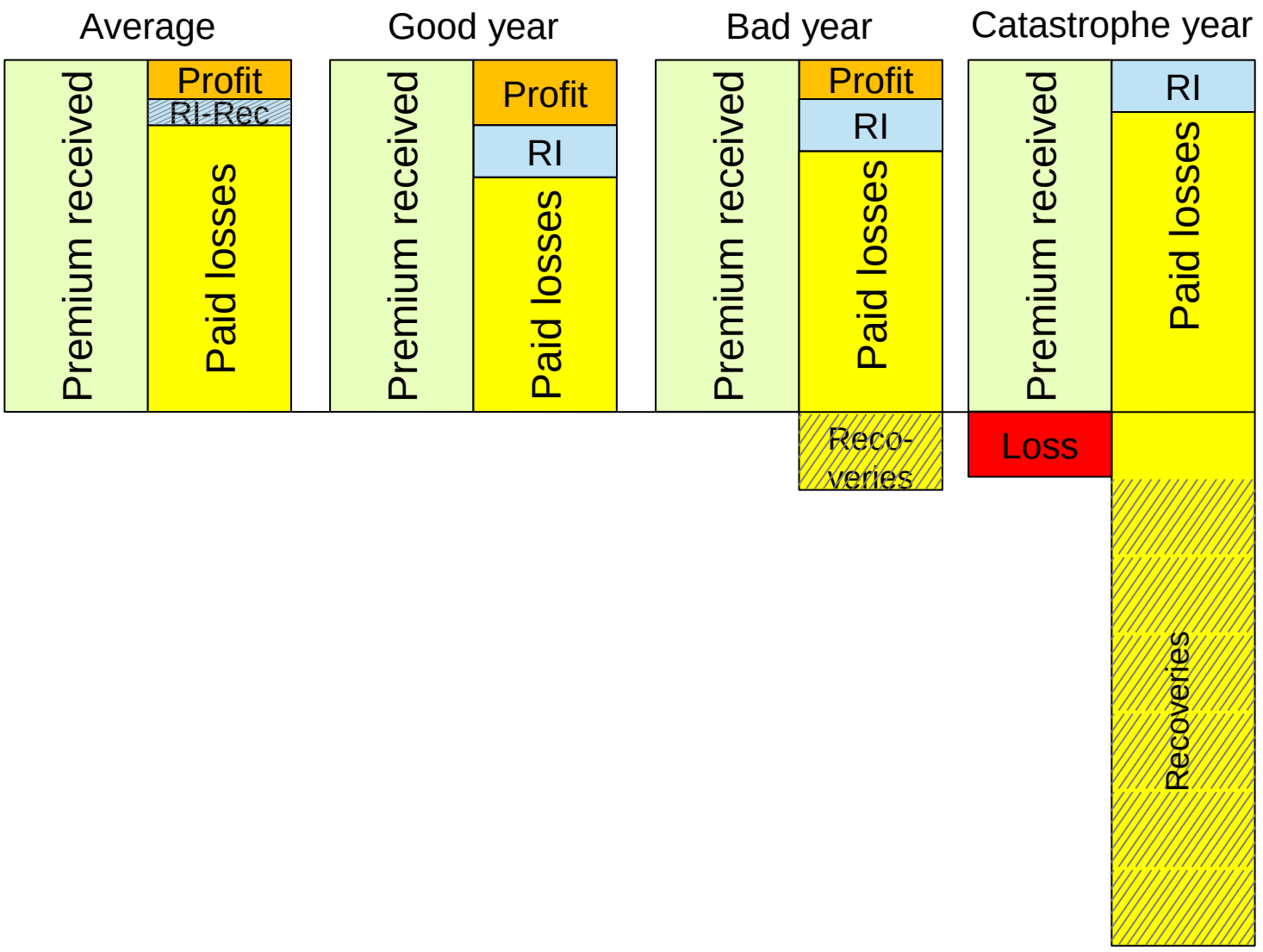
Reinsurance decreases profit on average, but increases profit in a catastrophe year



- Owing to quantification of risks by stochastic models, the insurer can define its reinsurance cover
- Unless reinsurers are subsidising company's business, you will always have lower expected profit on average compared to the case with no reins.

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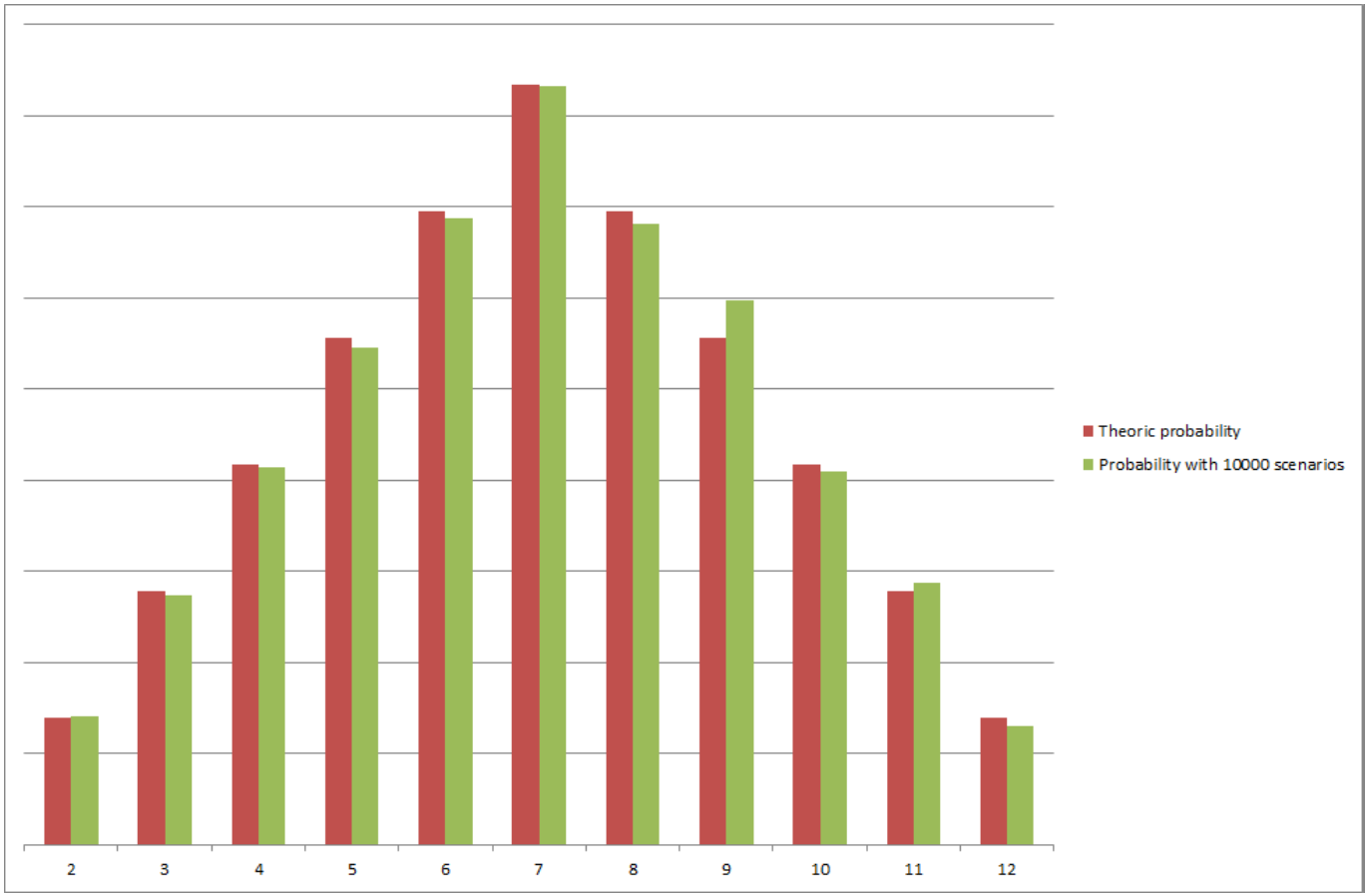
Amounts possible and Probability

- **What is Possible?**

- **How likely is it?**

Score	Odds	Probability
2	1 in 36	3%
3	1 in 18	6%
4	1 in 12	8%
5	1 in 9	11%
6	5 in 36	14%
7	1 in 6	17%
8	5 in 36	14%
9	1 in 9	11%
10	1 in 12	8%
11	1 in 18	6%
12	1 in 36	3%

Approximation of the distribution function by throwing many times the dices



- The higher the number of scenarios the closer we get to the theoric distribution

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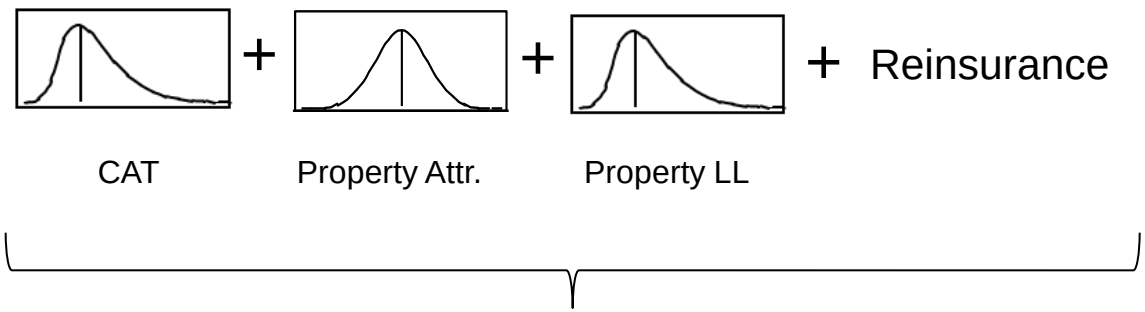
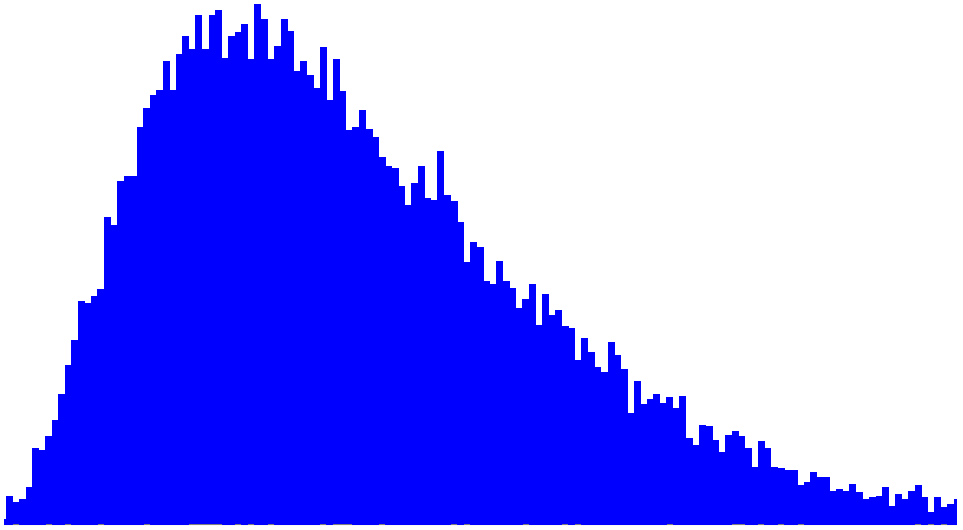
Could the extreme risk be quantified analytically (i.e. using a formula)? YES, but only in very special and simple cases or through approximations





- Impossible to analytically express results (using a simple formula) in cases of
  - Reinsurance (nonproportional, surplus treaty)
  - Heterogeneous/correlated portfolios
- Stochastic simulation (also called Monte Carlo simulation) resolves the problem
  - Splits generation of losses into pieces each described by analytic distributions
  - Applies calculations on each and every loss
  - Records results

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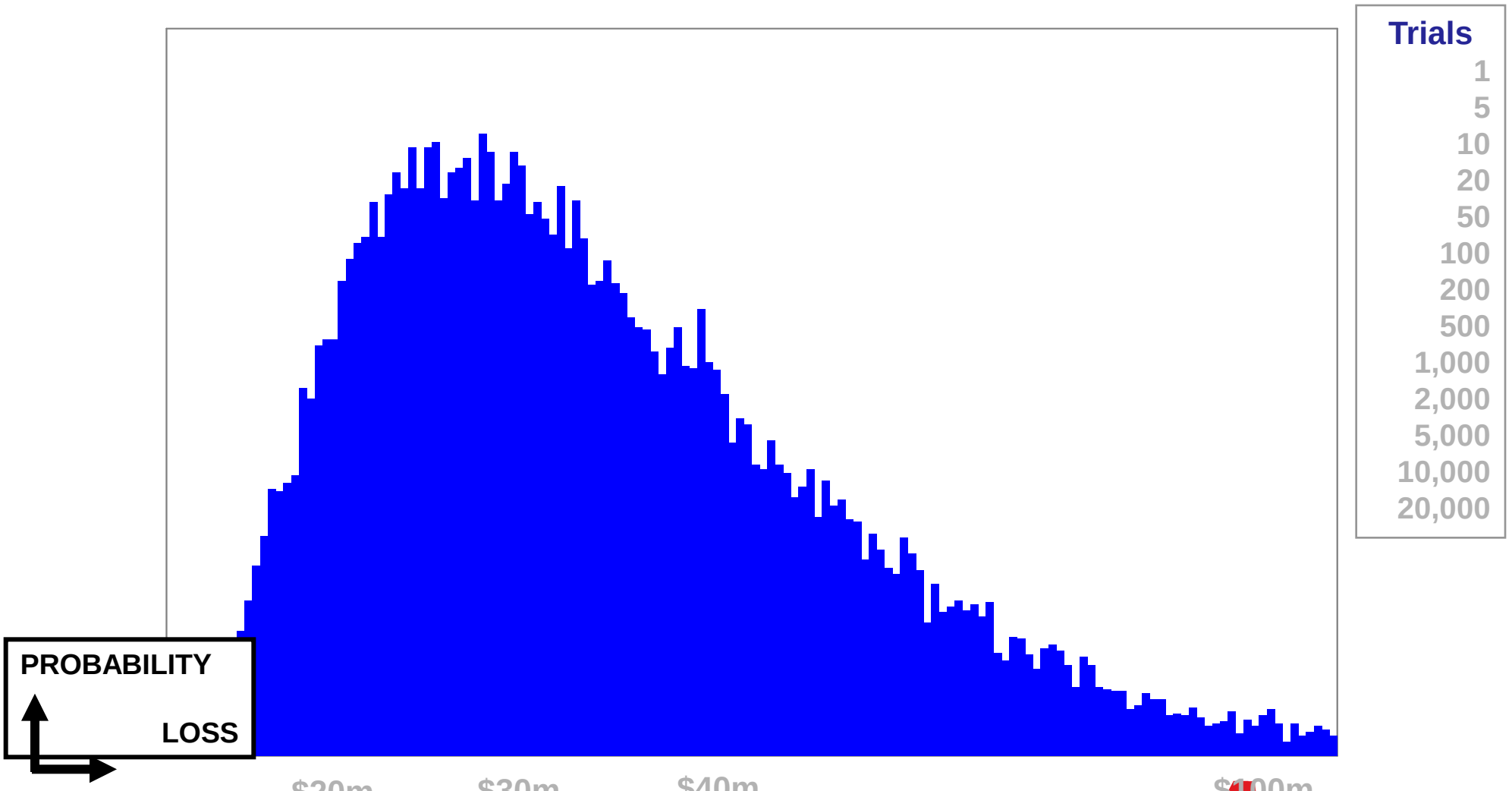
Stochastic modeling when we are not able to calculate the distribution function

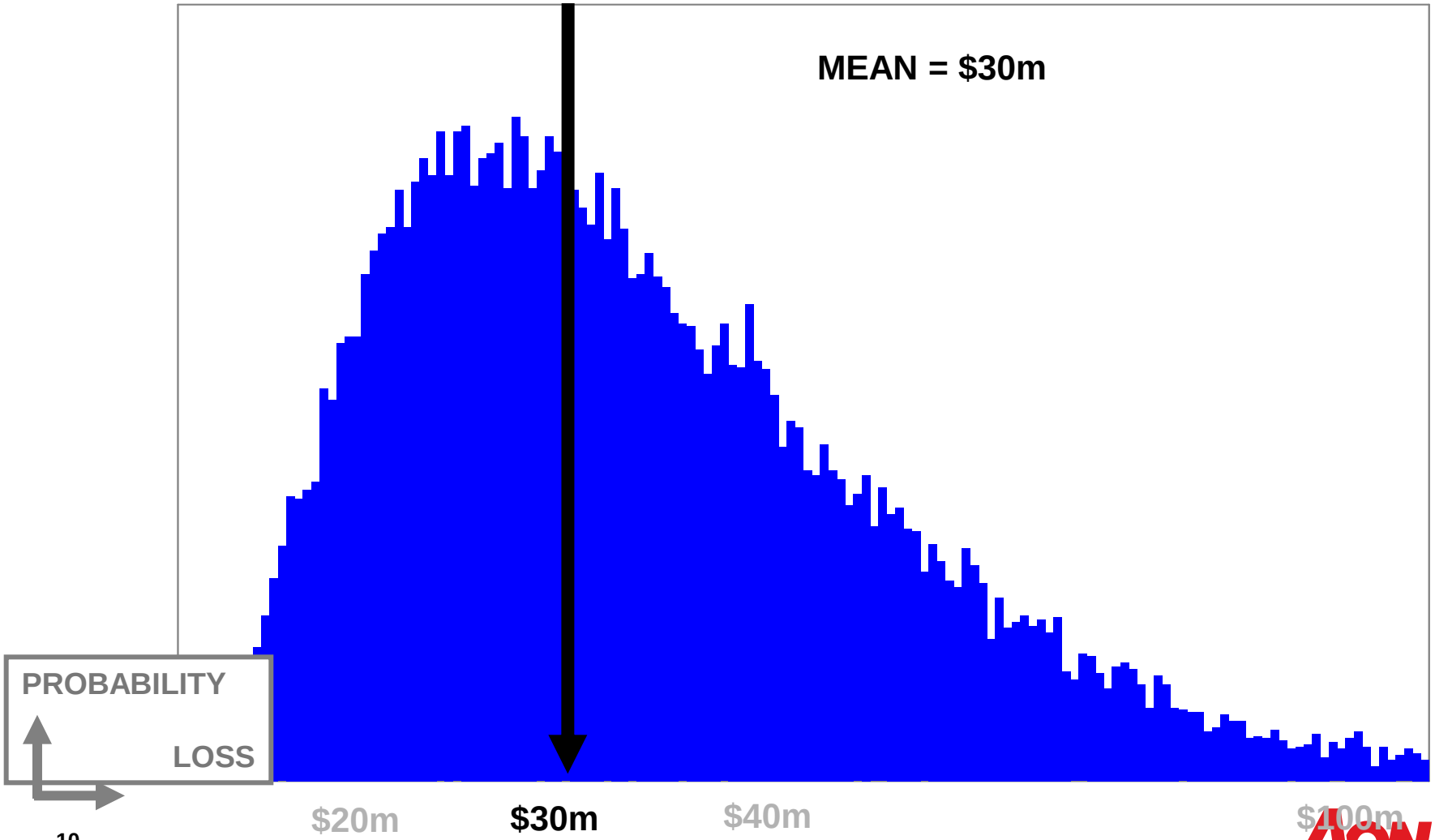
- Estimate the distribution functions of some components in isolation
- Simulate for these components a high number of scenarios
- Combine the results on all these components for each scenario together taking into account the correlations, inflation indexes, aggregation, heterogenic business lines, non-proportional reinsurance, ...
- Create the distribution functions of the variables we want to follow
- Interpretation of the results

☝ **To make the stochastic model, we need to make actuarial choices**

ReMetrica DFA Simulation



ReMetrica DFA Simulation



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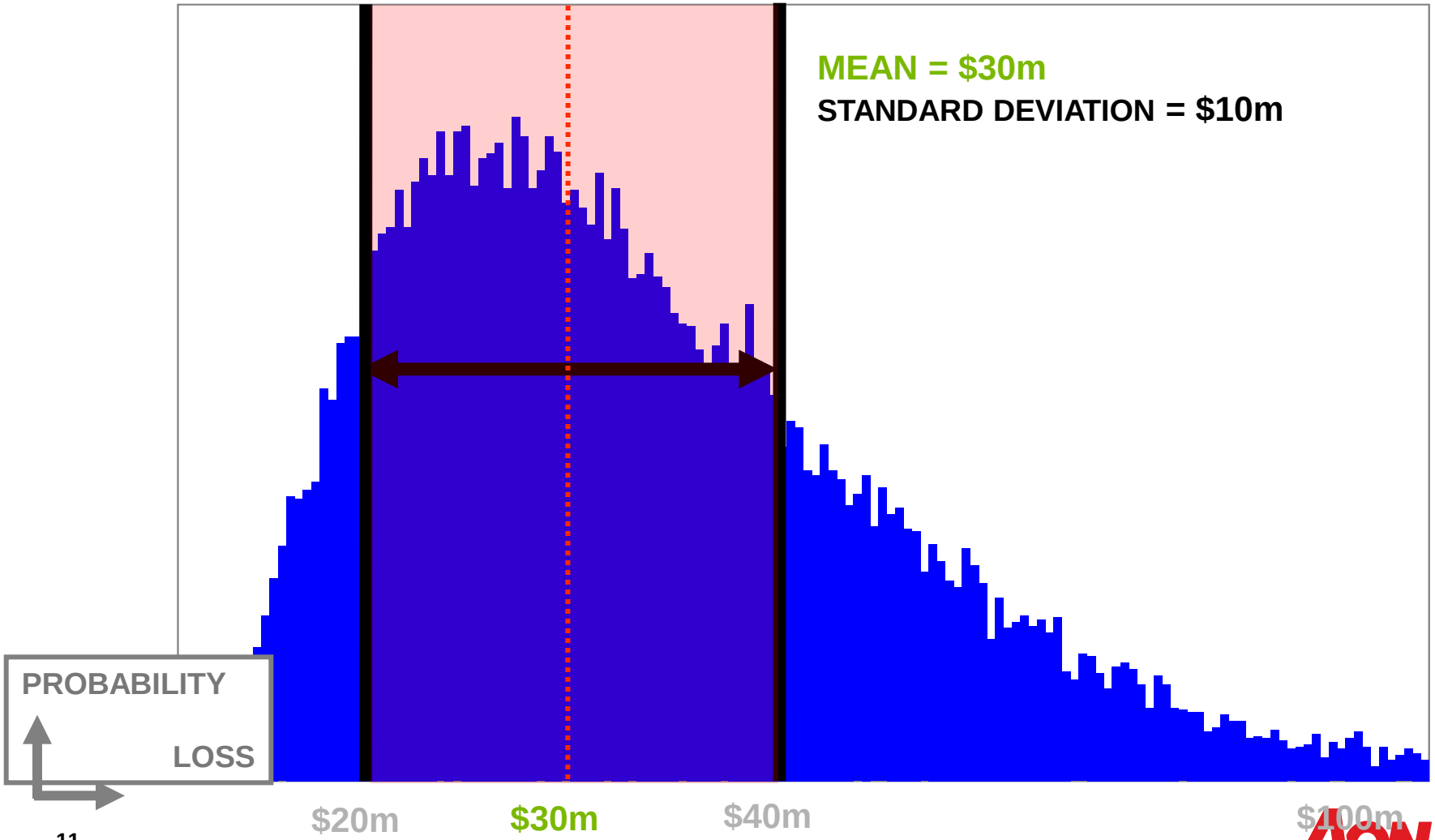
ReMetrica DFA Simulation



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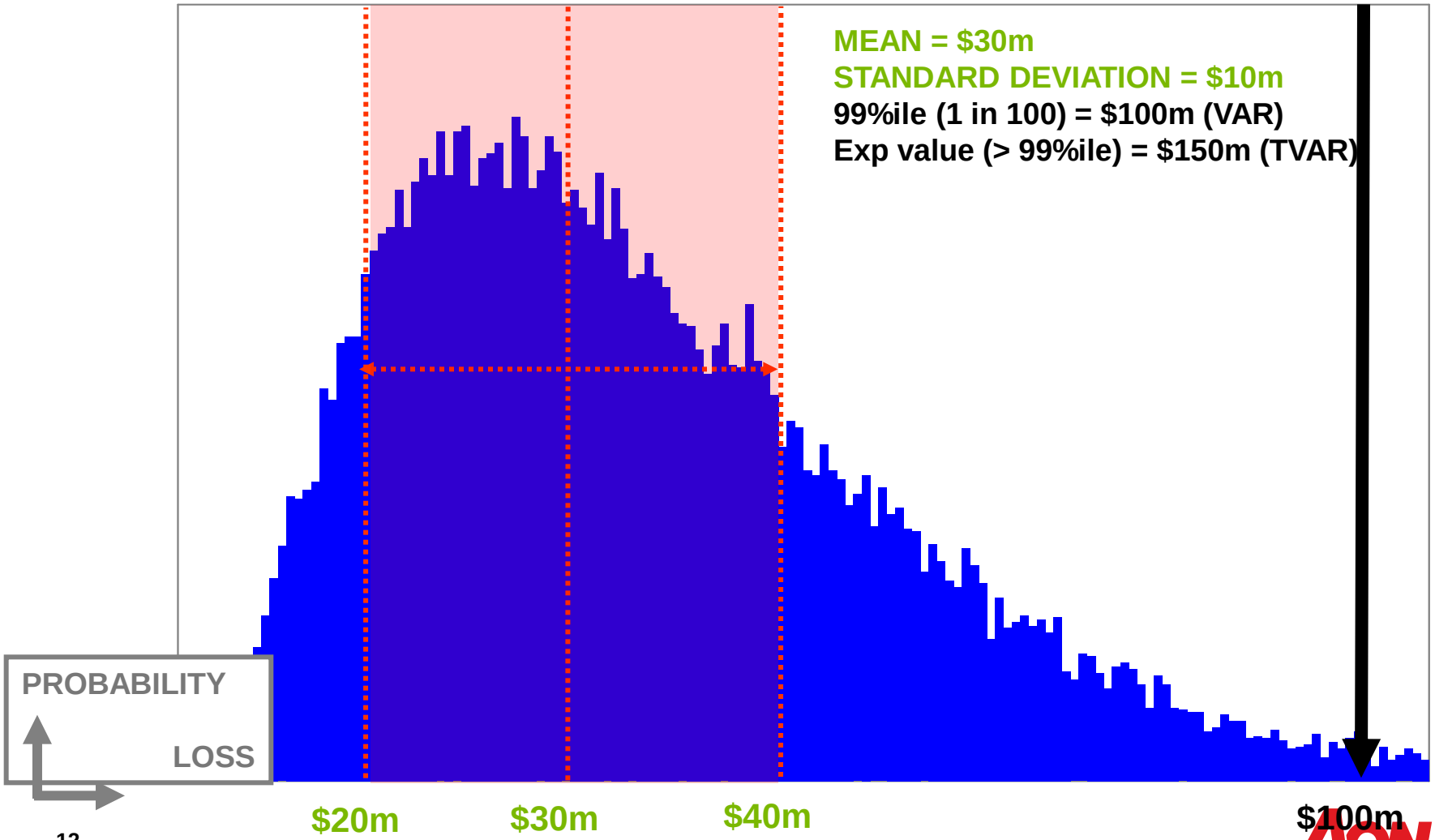
ReMetrica DFA Simulation



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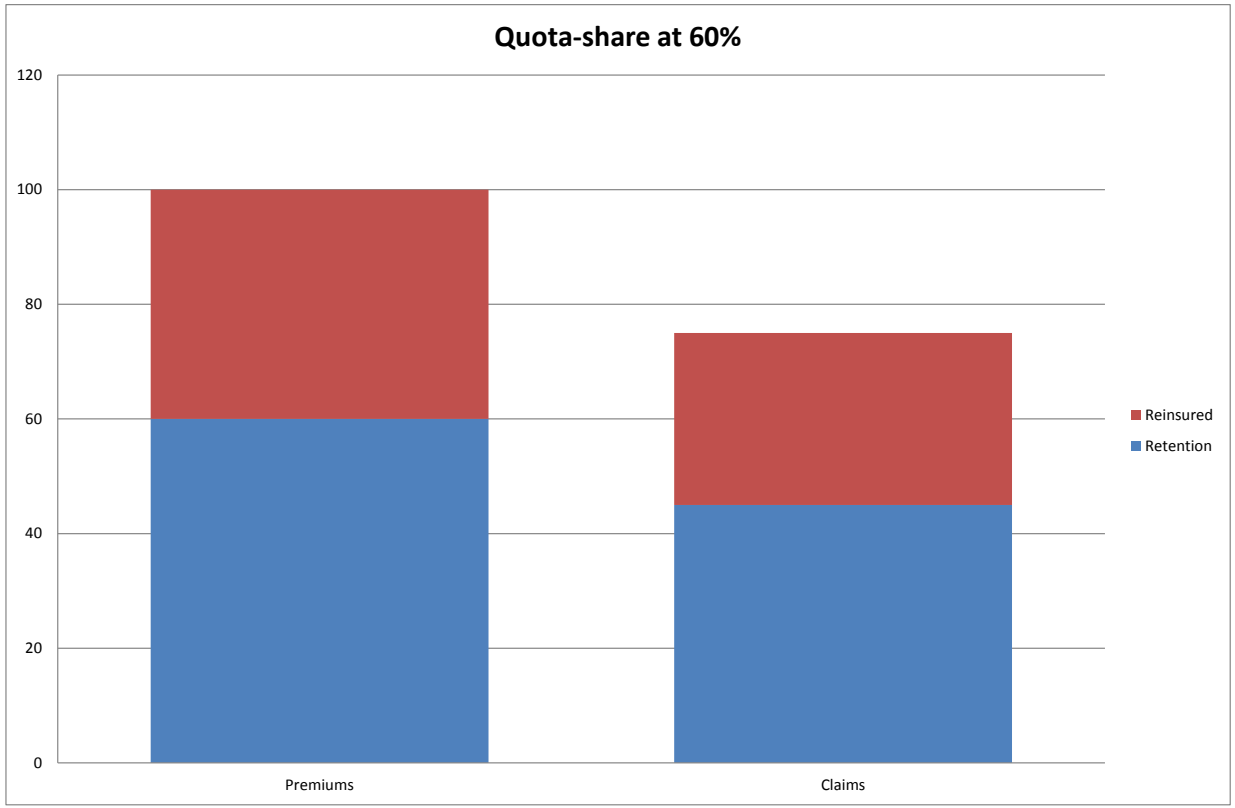
Our Example to be modelled

- Portfolio in property protecting:
  - Fire business: protection of property in case of fire
  - Engineering: protection for buildings that are in the construction
  - Burglary

- Actual reinsurance structure:
  - Fire Line of Business: Surplus
  - Engineering Line of Business: Surplus + Quota-share
  - Burglary Line of Business: Quota-share
  - For Fire and Engineering: Excess of Loss (XL) for catastrophic events

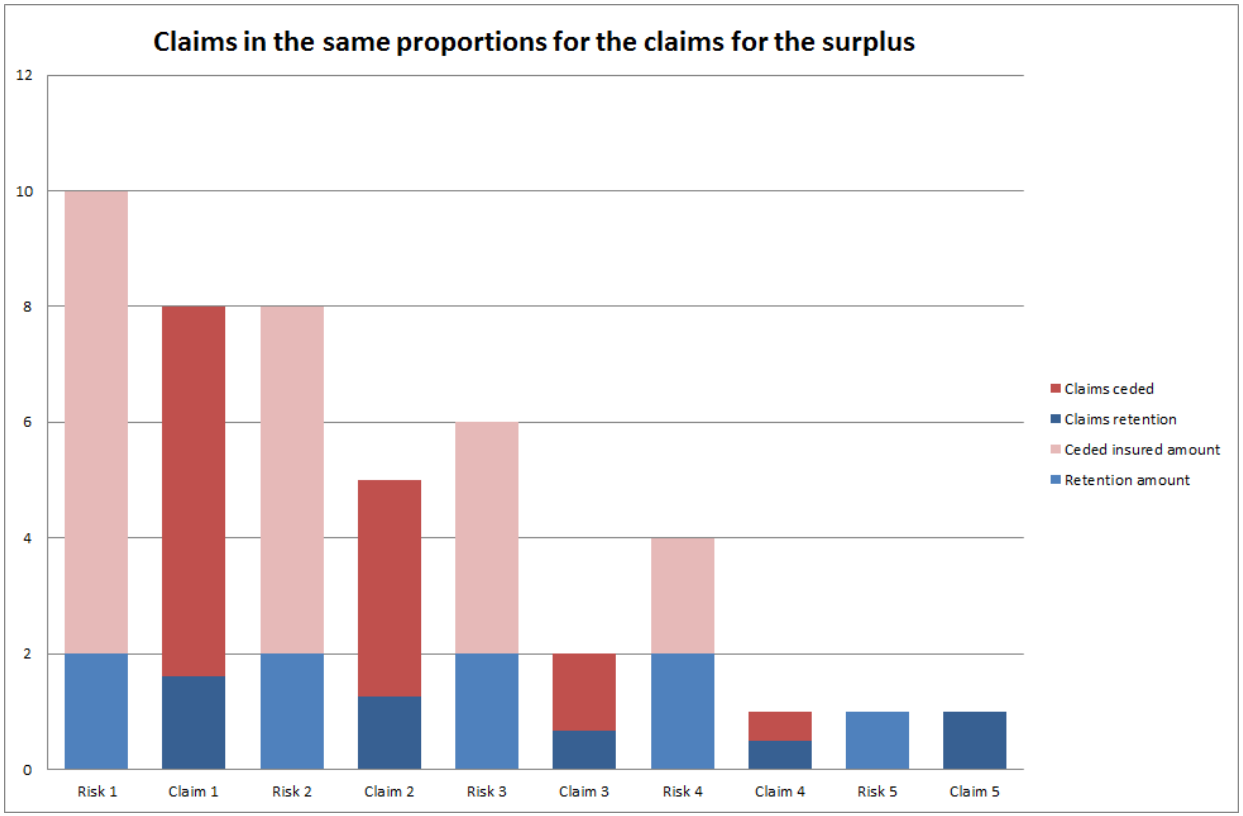
- See if it is interesting to propose an better reinsurance cover: we try for all lines only a XL for large losses and a XL for Natural Catastrophe events

What is a quota-share



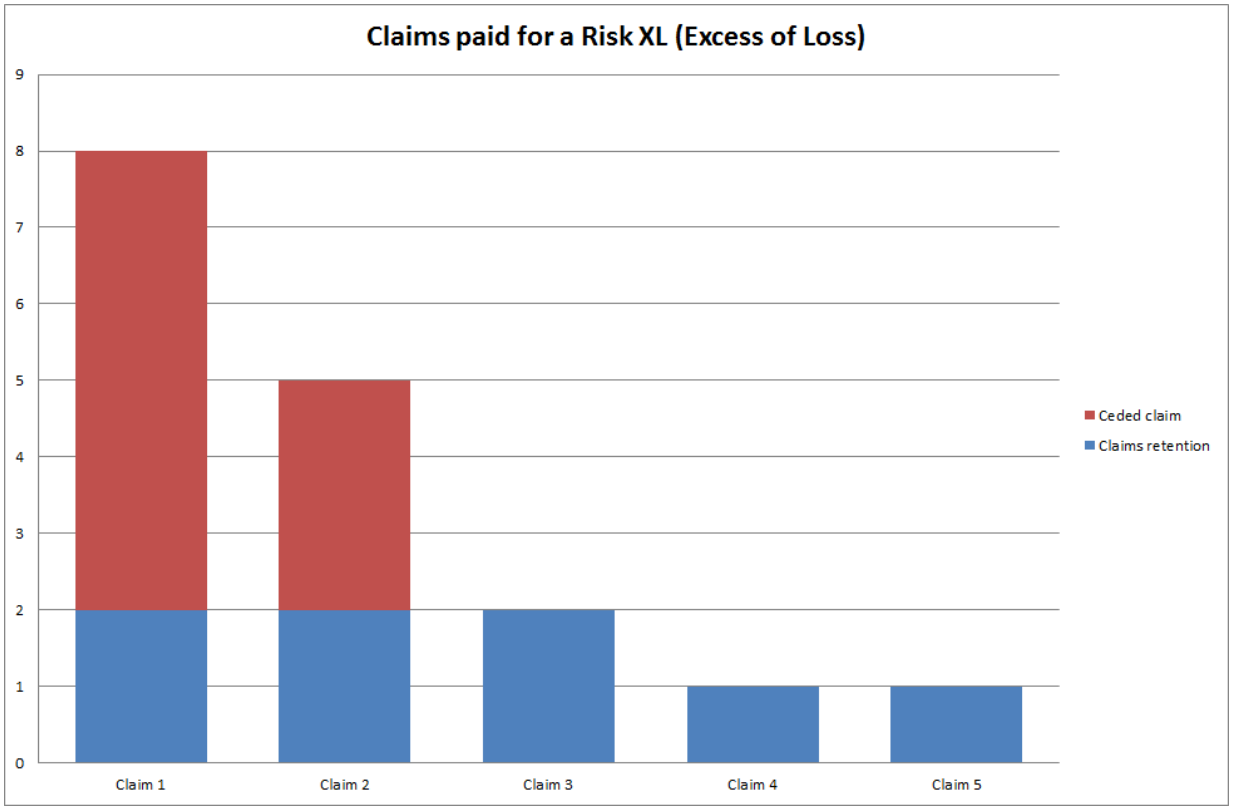
- Same proportion of premiums ceded and claims ceded on the whole portfolio
- Usually the reinsurer pays a reinsurance commission to the insurer

What is a surplus



- The proportion of the premiums ceded and the proportion of claims paid is the same for each insured good
- The proportion is defined compared to a retention and a number of lines
- The amount of claim is usually lower than the amount insured

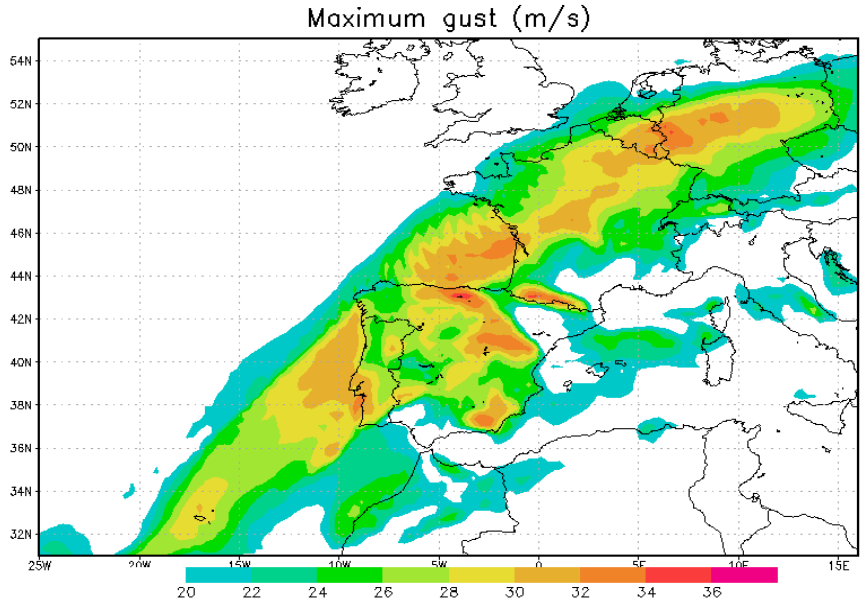
What is a Excess of loss



- The premium is calculated globally.
- Each claim above the retention is paid by the reinsurer till the limit defined in the contract
- In a CAT XL, we consider a claim the total of the payments made linked to one event

Windstorm

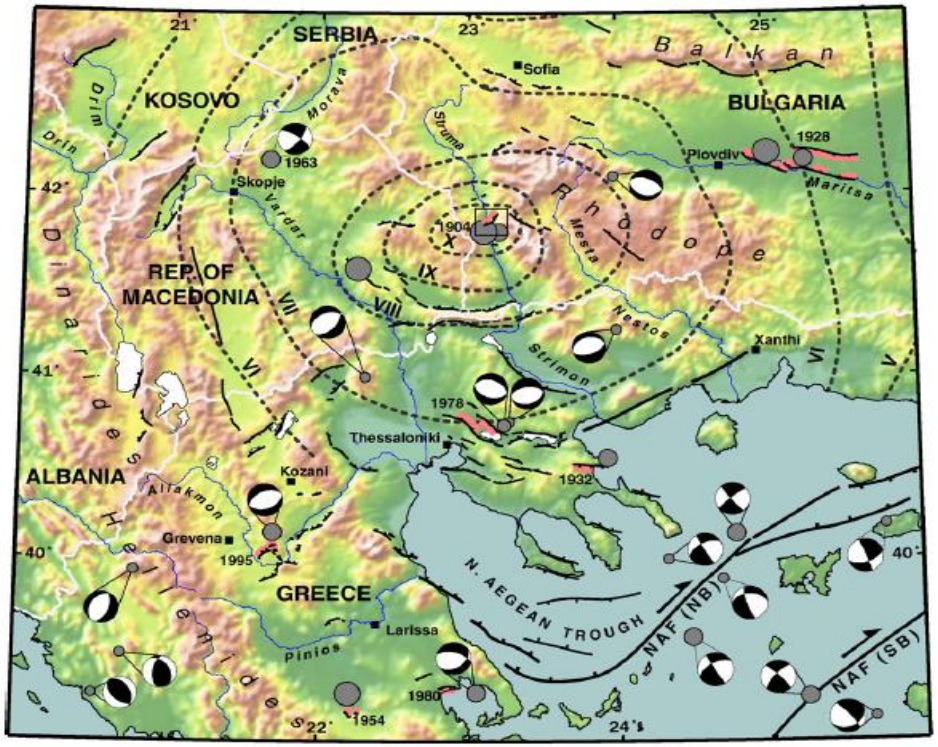
- **Typical features:**
  - Large territories affected
  - Low damage ratios, serious structural damage is rare (destruction of walls, failure of buildings)
  - Low number of casualties
  - Multi-country losses in Europe
- **Main windstorm territories** (RI point of view): Western European winter storms, US hurricanes.
- **US Hurricane season:** June – October
- **Western European Windstorm season:** October – March



Xynthia windstorm, February 2010

Earthquake

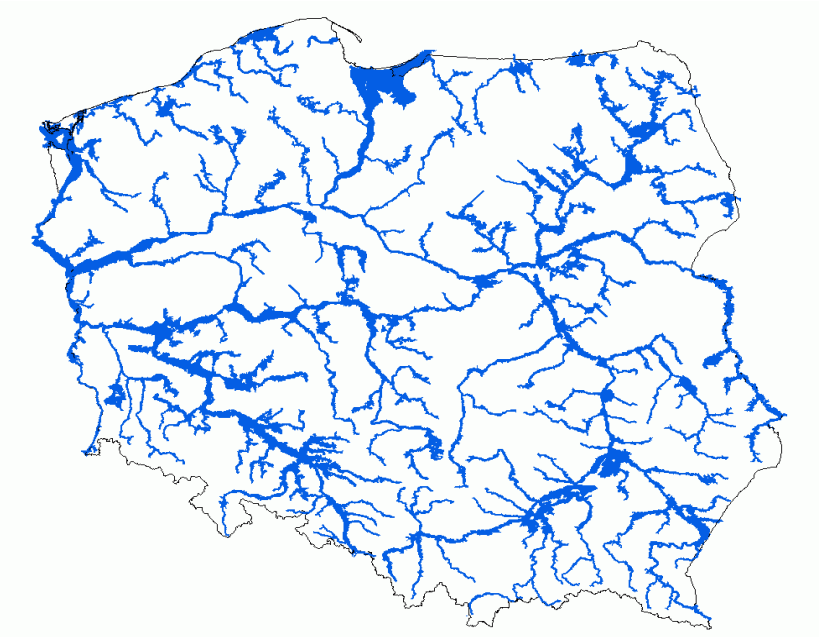
- **Typical features:**
  - Smaller territories affected
  - Usually only single country losses
  - Damaging earthquakes are less frequent than floods and windstorms. Typical – low frequency and high severity.
  - High damage ratios, serious structural damage (failure of walls, collapse of buildings)
  - Usually high number of casualties
- **Main earthquake territories** (RI point of view): **Japan, California**



4 April, 1904, SW Bulgaria. Shallow event, magnitude M = 7.8

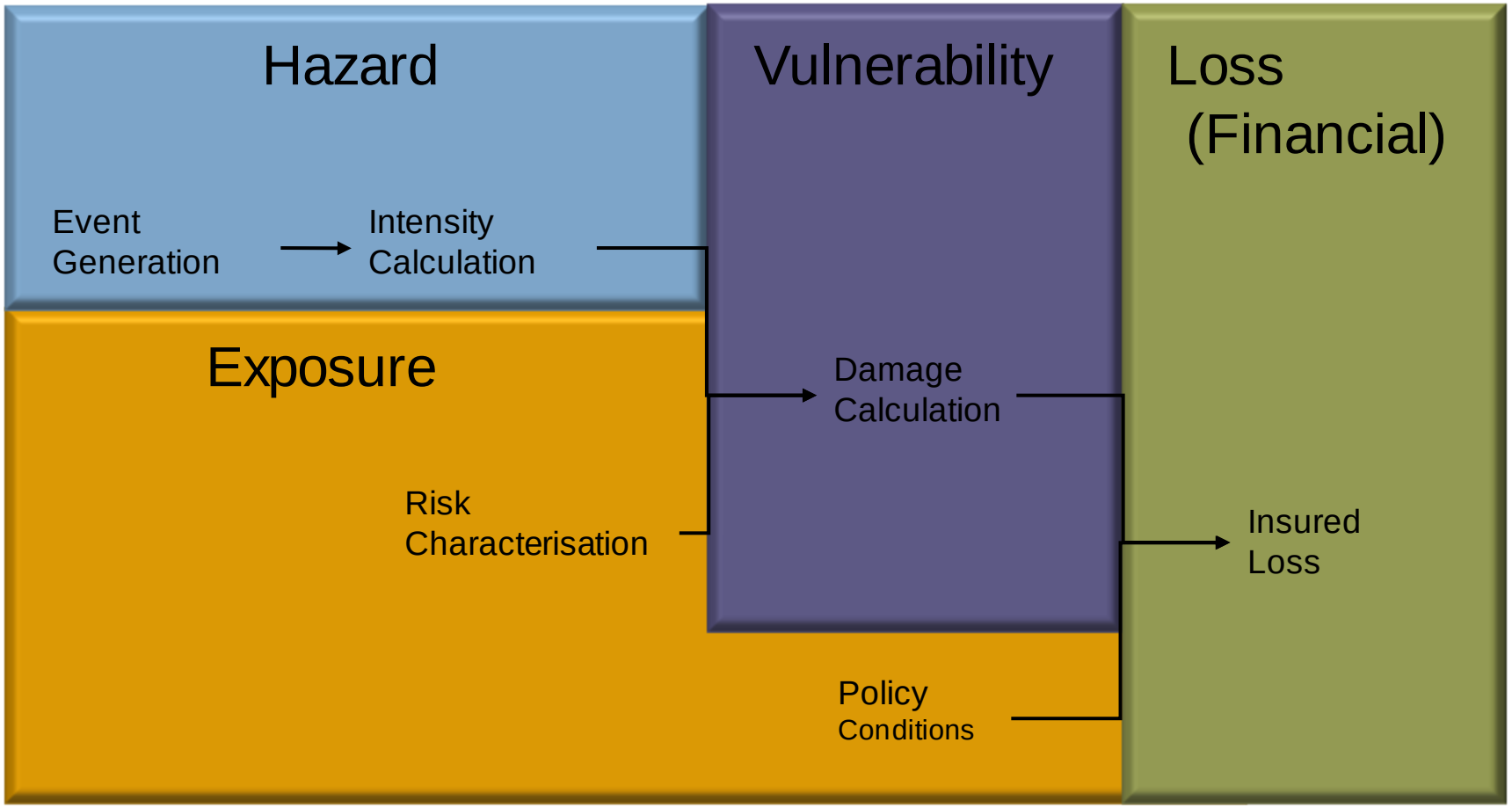
Flood

- **Typical feature**
  - Flood propagates along river streams and cannot affect large areas continuously, like wind or earthquake
  - Lower damage ratios, serious structural damage is not common
  - Low number of casualties
  - Typical - multi-country losses in Europe
  - Loss prevention can be very effective – flood defences, early warning



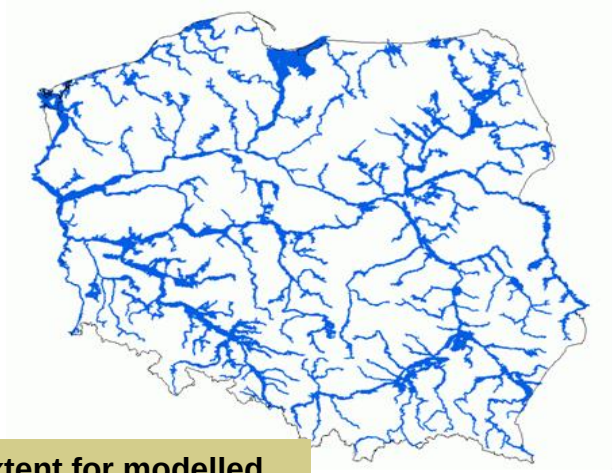
Floodable zones in Poland

IF Cat Model Structure



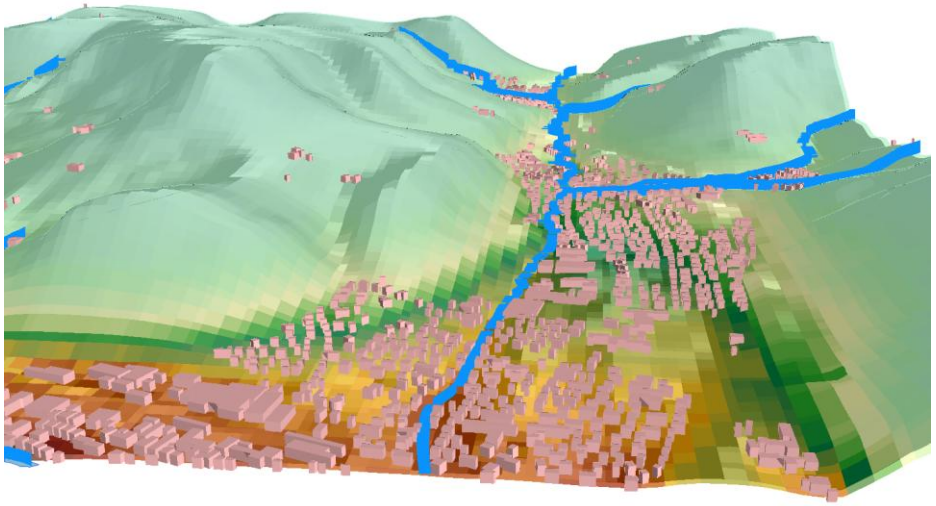
Hazard Example

Modelled rivers (14,595 km)



Flood extent for modelled 2m water height

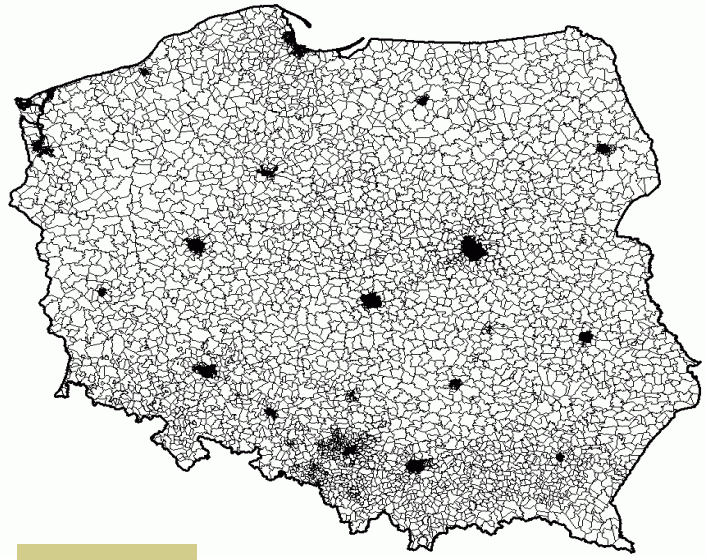
Digital terrain model



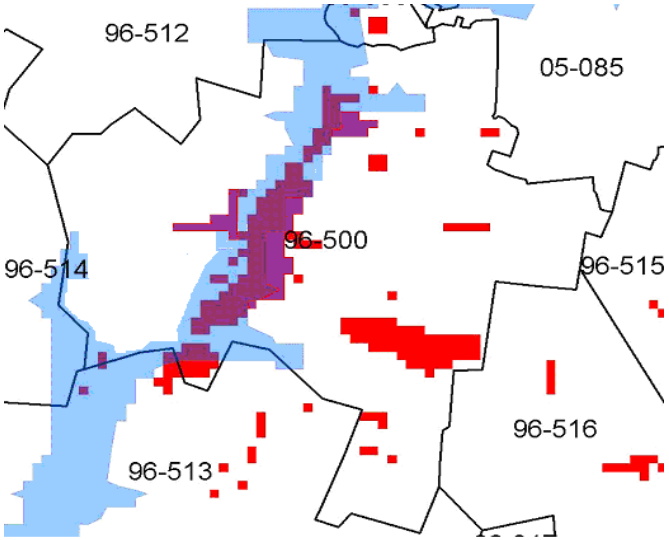
- **Stochastic event set** – all floods that can potentially happen over a period of 10,000 years
- **Simulation of a flood event:**
  - Always based on historical hydrological data
  - Food extents are simulated and 3D digital terrain model is “flooded”
  - Different risks are affected by different flood height

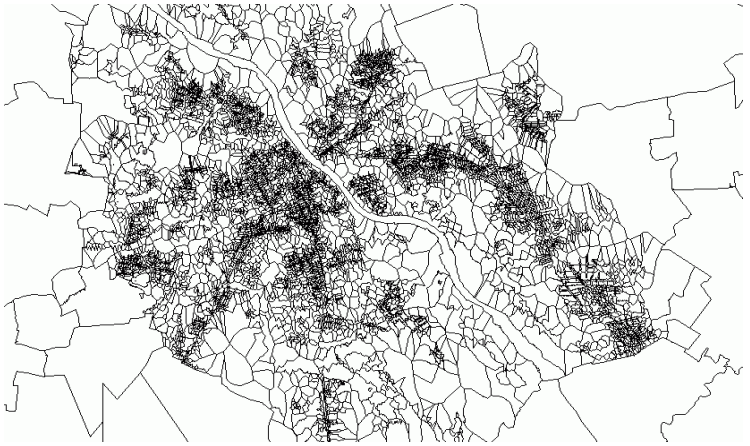
Exposure Example

- High resolution exposure data is **essential**
- Polish postcode system sufficient
  - 24,000 Postcodes
  - High resolution in main cities
  - Exposure imported on postcode level and redistributed into urban areas based on satellite images



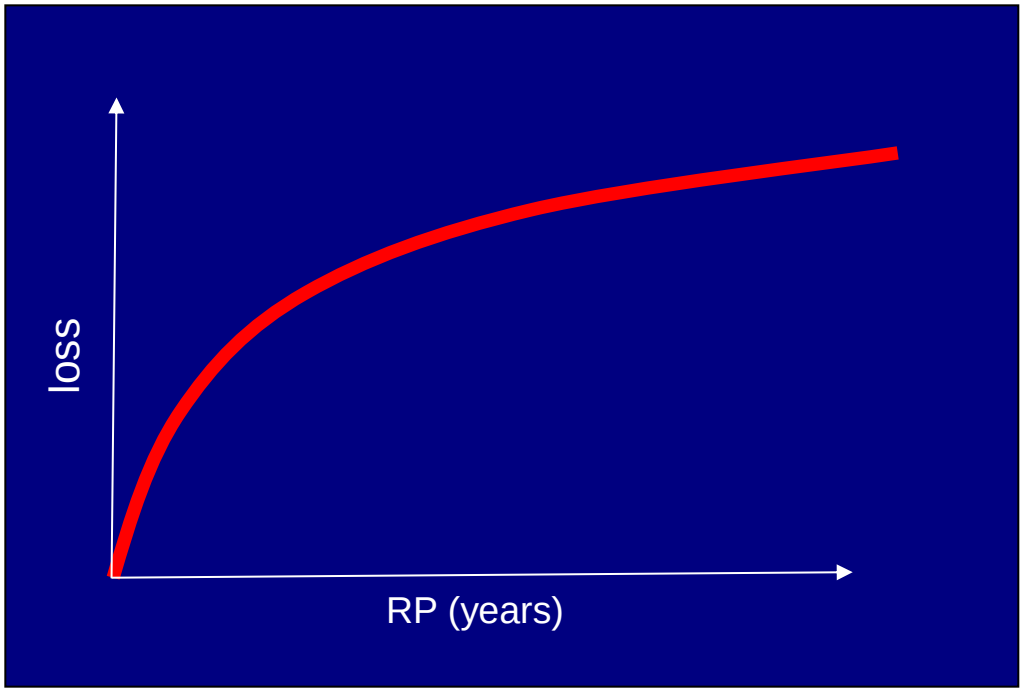
Warsaw



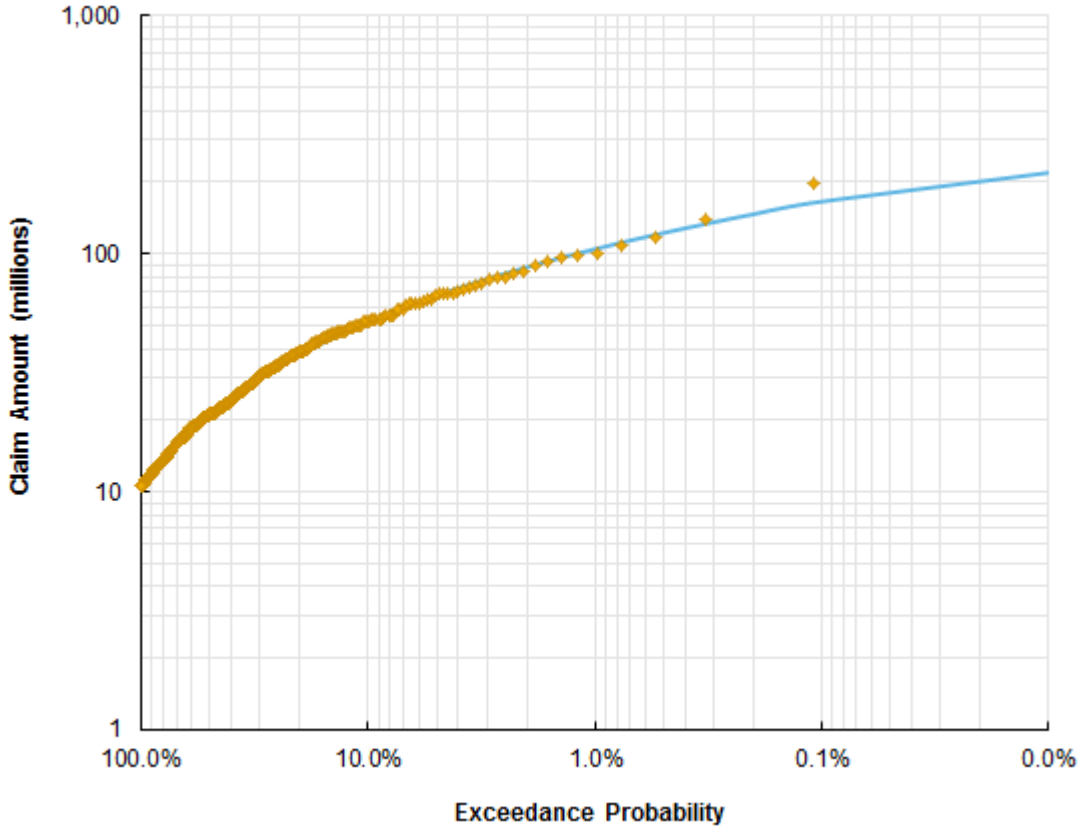


Output from Natural Catastrophe models

- **Modelling results**
  - Most often in a form of a certain loss amount related to a return period (**RP**)
  - Loss of amount X (1bn) could be expected to happen in average once in Y years (250).
- **250 years loss** is often used as a standard
- Expressed in a form of Exceedance probability (**EP**) curve



Find the severity of the losses



– Thanks to the format of the curve, we can have an estimate of the very large losses that can happen on the porfolio

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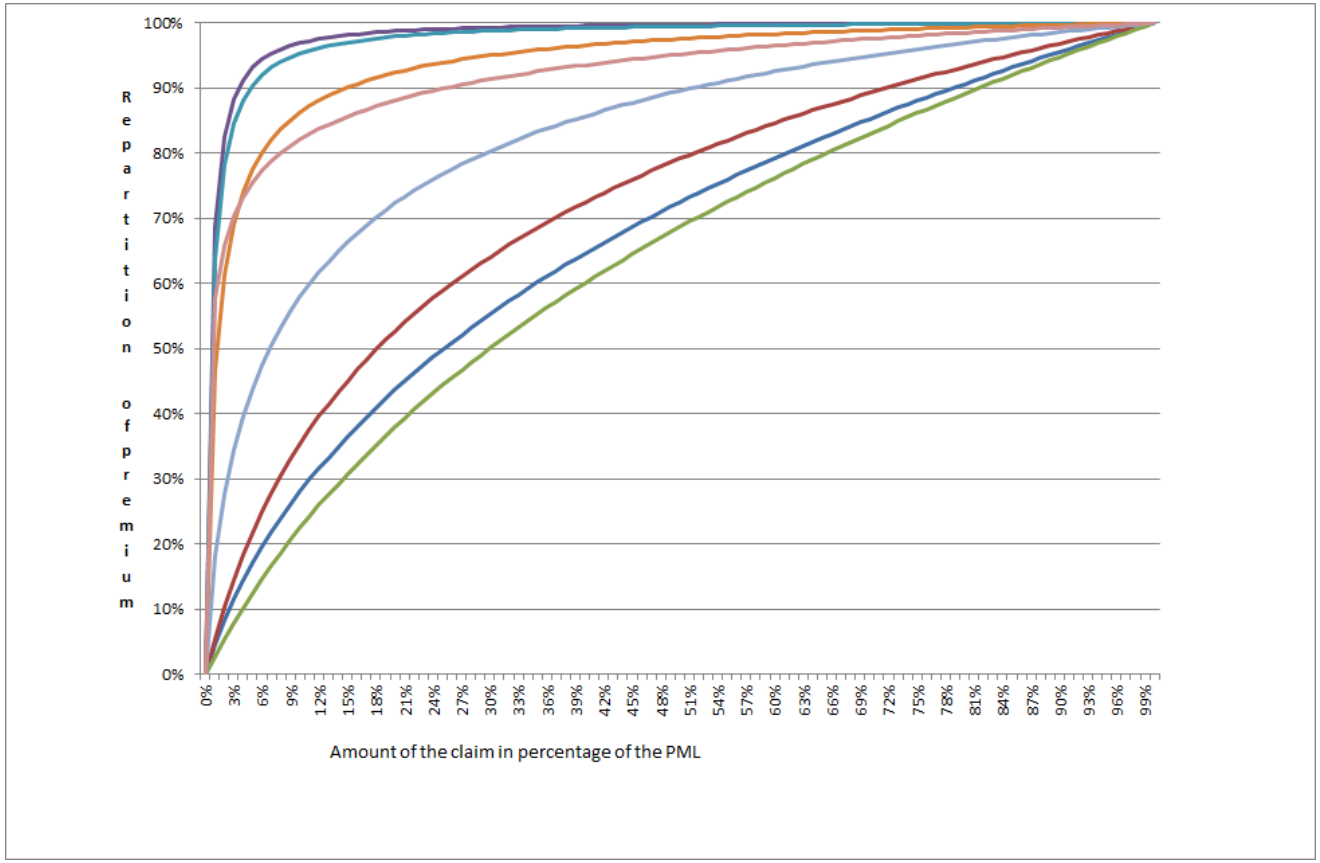
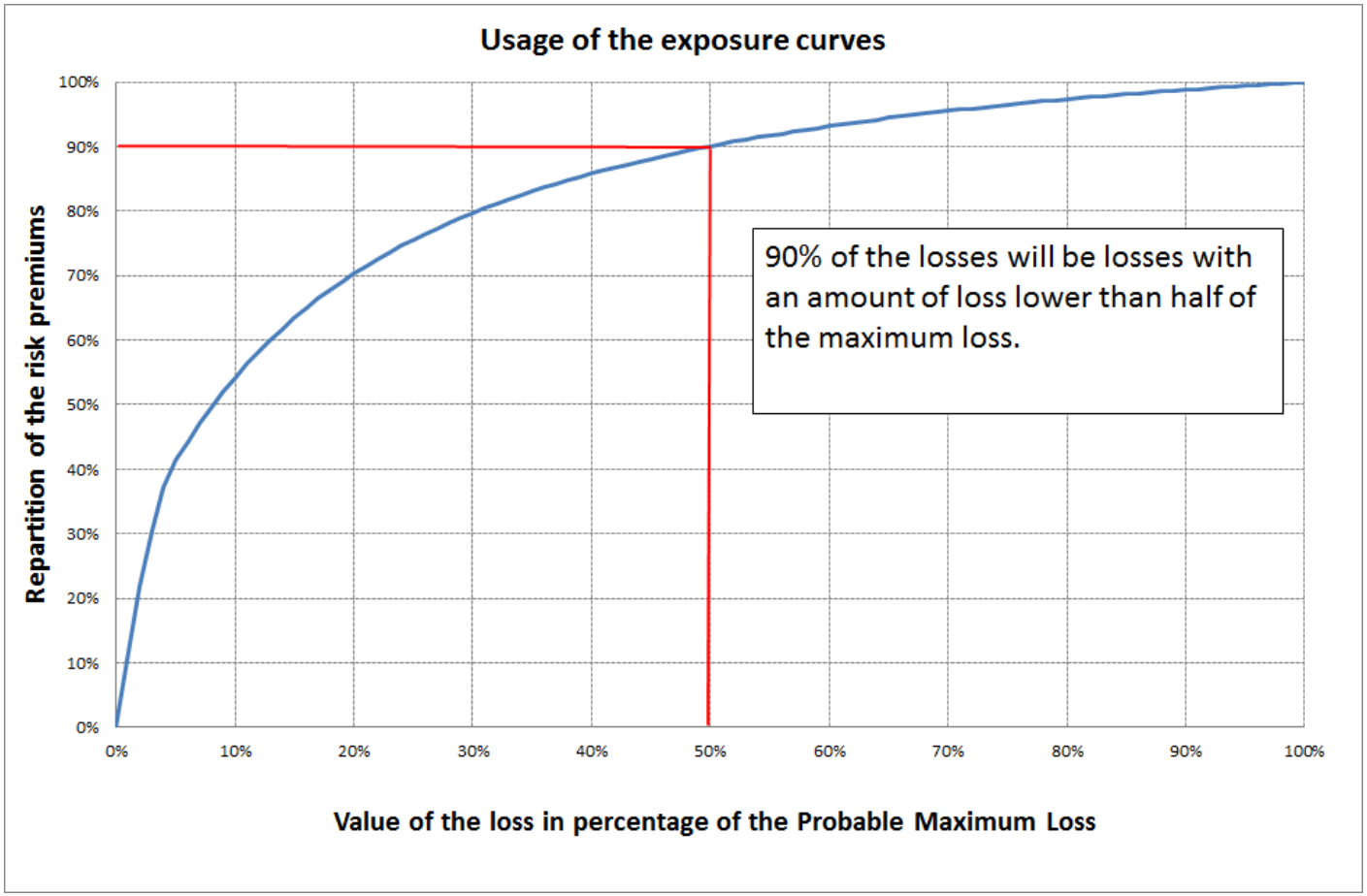
Other method: Exposure rating that we used in this case



– Very often used for Property risk, especially when there is a surplus

Data Requirements



– There needs to be added the Loss ratio and the risk profile for this activity

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Using the software ReMetrica, used by over 170 companies worldwide

Admiral
ADNIC
Africa Re
AFSC
AGEAS
AG Insurance
Al Koot
Alfa
Alterra
Aioi Nissay Dowa
American Homes
Ampega
Anadolu
ANPAC
Aon Group
Aras
Argo
Ariel Re
Ark Underwriting
Ascot Lloyds
ASR
Assurant
Atradius
Atrium Lloyd's
Axis Capital
Banesco
Barbican
BCAA
Beaufort
Beazley
Bermuda Monetary Authority
Best Re
BRIT

Canopius
Catlin
CASS
Catalina Re
Centriq
Chartis
China Pacific
China P&C
China Re
Chubb Europe
Cigna Europe
Deloitte
Dexia Insurance
Endurance
ENI
EQC
Ernst & Young
E+S Re
Etana
Eureko
European Reliance
Farm Bureau
Farmers Ins Group
Finity
Flagstone Re
First Central
Fuji Fire and Marine
GARD
GCEA
Generali
Hannover Re
Hanover Group
Harel

Helvetia
Heritage
Hiscox
Hollard
Horace Mann
IAG Re
ICAT
If P&C
IGI
Inter Hannover
Ironshore
Island Heritage
Itau Seguros
Jubilee
Juniperus
KGM
Kiln Lloyd's
Kooperativa
KPMG
Kuwait Re
Lancashire
Lane Clark & Peacock
Lexington
Liberty
Lombard
Lloyd's Corporation
Mannheimer
Marketform
Mapfre Re
Maxum
Menorah
Microsoft
Milli Re

MSIG Asia
Munich Re
Mutual & Federal
Natixis
Navigators
Nestle
New Re
Nipponkoa
Nisshin
NKSJ Holdings
North of England
Oberöesterreich
Omega
P&V
Peace Hills
Philadelphia Insurance
PricewaterhouseCoopers
Q-Re
QBE
Quest
Quindiem
Rheinland
RITC
RLI Corp
RMB
Rockhill
SA Meacock
Sagicor
Saikyosairen
Samsung
Santam
SCOR
Securis

Sentry Insurance
Sirius
Sogessur
Solvency Fabrik
Sompo Japan
Standard Bank Insurance
State Auto
Sunshine
Swiss Life
Swiss National
Taiping Re
Telesure
Thai Re
Thelem
Thomas Miller
Toa Re
Tokio Marine Group
Topdanmark
Tower Hill
Tranquilidade
Transatlantic Re
UNPMF Mutex
Uniqa
Univé
Vienna Insurance Group
Wesfarmers
Westfield
Winterthur AXA
White Mountains Re
Whittington
XL Group Worldwide
Zenkyoren
Zurich Financial Services

KEY

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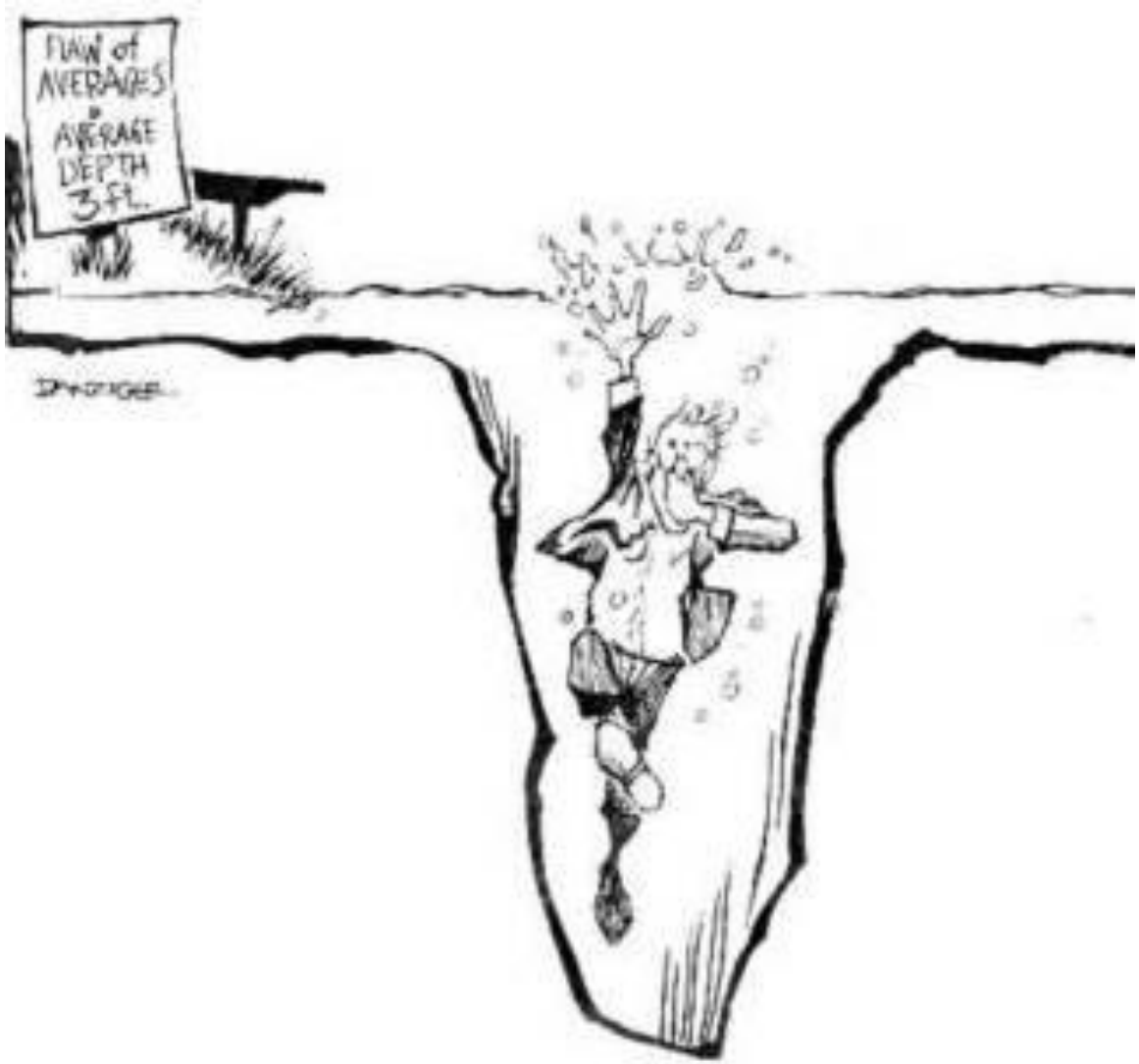
Measure for profitability

- Average for **Reinsurance premium – Reinsurance recoveries – Reinsurance commission**

- This figure is usually positive, meaning that usually the insurer is losing money on average on the reinsurance contract.

- Reduction of average income in exchange of protection against bad and very bad results

A measure of the risk: need more than averages



What is a good risk measure

- A risk measure is said to be coherent when it has the following properties:

- Sub-Additivity
  - Risk(A+B) ≤ Risk (A) + Risk (B)

- Monotonicity
  - Risk(A) ≤ Risk (B) if A ≥ B

- Positive homogeneity
  - Risk(kA) = k Risk(A) for any constant k

- Translation invariance
  - Risk(A+k) = Risk(A) + k for any constant k

Standard deviation is not a good risk measure

- Very different portfolios with the same standard deviation could have a very different distribution and large potential losses depending a lot on the skewness of the distribution

- Not coherent risk measure as it fails the monotonicity criteria

- Example: we have two portfolios
    - A: Equal likelihood of a loss or a profit of 100 (mean 0, st dev = 141)
    - B: Always a loss of 100 (mean -100, standard deviation = 0)
    - ➢ Risk(A)>Risk(B) when A>B

- But:
    - Takes into account a big part of the distribution function
    - It can be used to see the volatility of the profit income

VAR Value At Risk

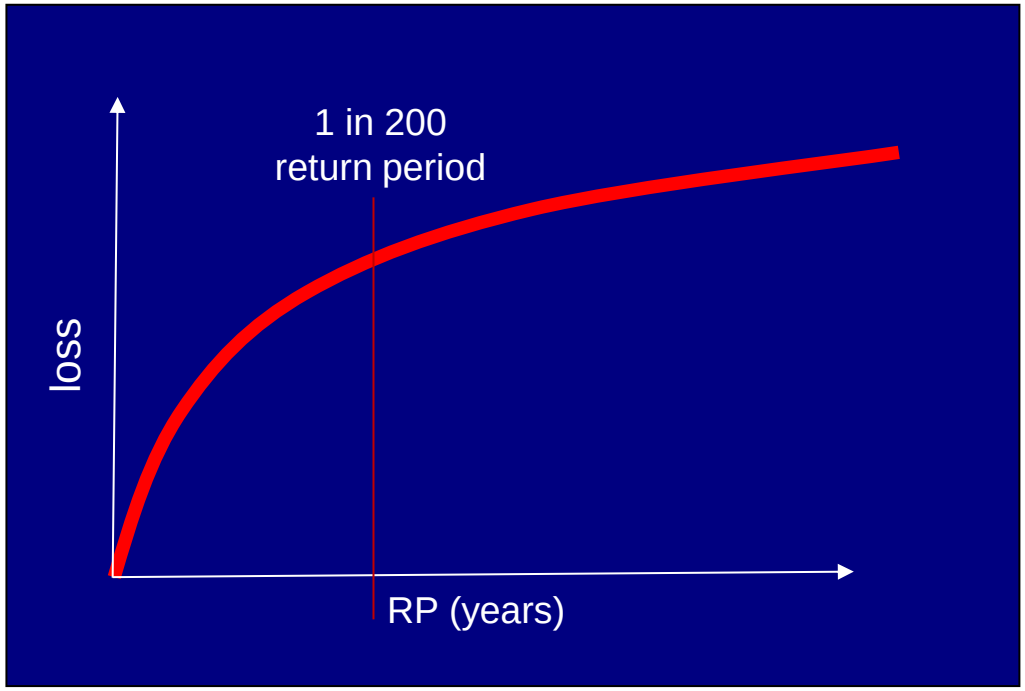
- Only uses one point in the distribution function
- Not a coherent measure as it fails sub-additivity
- Example: we have two portfolios
  - A: 99,1% chance to earn 10 and 0.9% chance to lose 100, so VAR 1 in 100 = profit of 10
  - B: Same as A
  - Combination of A and B will give a loss of 90 in the VAR 1 in 100
  - ➢ Risk(A+B) > Risk(A) + Risk (B)
- Example of Bond portfolio:
  - We have 100 bonds to chose from with each a cost of 100, an income after one year of 105 and a probability of default of 2%
  - Portfolio A : fully concentrated with 100 in bond 1
  - Portfolio B: 1 bond of each bond to chose from
  - VAR95%(A)=profit of 500, VAR95%(B)= a loss of 25: VAR will tell that Portfolio A is less risky even if B is more diversified
  - TailVAR will give the portfolio B
- TailVAR is a coherent risk measure and it is easier to decompose the result of the TailVAR.

Why is then the VAR mainly used?

- Some official reasons:
  - Because others are using the VAR (ex: solvency II)
  - Simpler to communicate and to understand
  - The TailVAR requires to model the tail of the distribution where information is scarce and assumptions are needed
- A less official reason:
  - For shareholders, the relevant measure is the VAR, since once the company is bankrupted their money is gone anyway and the company has no responsibility for losses beyond this threshold. The insureds and the regulator care more about these losses beyond this threshold.
- In Aon Benfield, we are mainly using the VAR except for cases such as the split of the reinsurance premium between different lines of business

Do not think that the choice of the risk measure is just technical

- Example for Natural catastrophe losses



- If the insurer takes reinsurer takes a reinsurance cover till 1 in 200 return period, the $VAR_{0.5\%}$ will be equal to the deductible of the reinsurance cat XL cover.

- If the insurer increases the reinsurer cover, the capital will not be further reduced when using the VAR. It would still be reduced if the risk measure were the TailVar.

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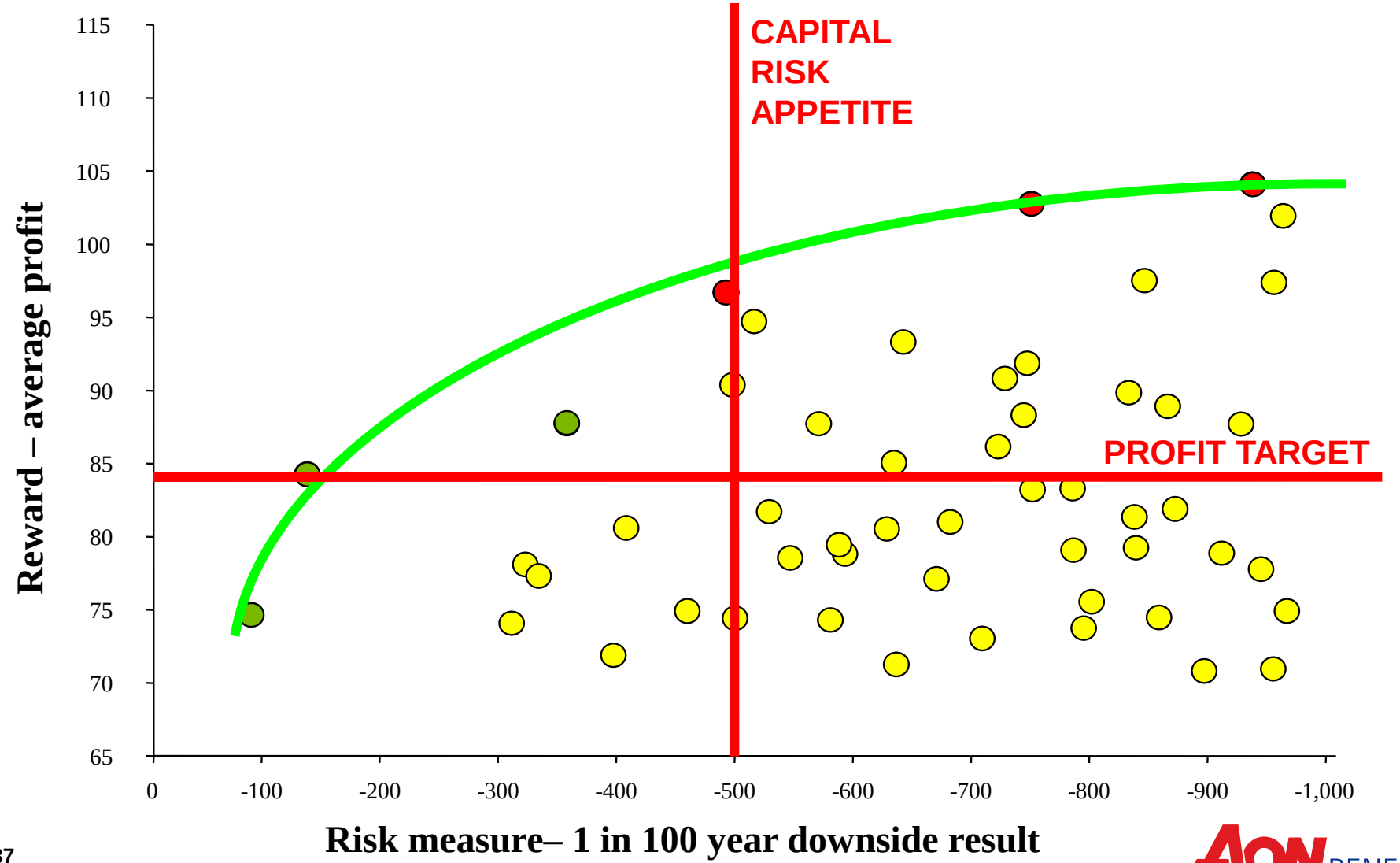
Risk - Reward



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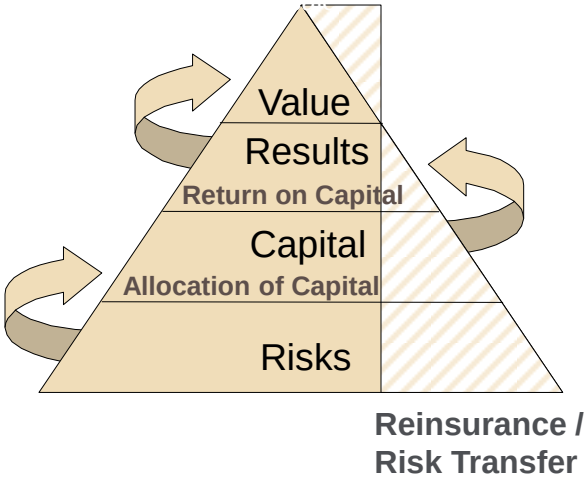
RORAC : Return On Risk Adjusted Capital

- There are different definitions of capital:
  - Capital required by the Regulator to be able to pursue an insurance activity
  - Capital required by the rating agencies to obtain a certain rating
  - **Capital based on the risk taken by the insurer**, the Risk based Capital.
- We will use this Risk based capital to advice on the most optimal reinsurance structure
- Example: Risk based capital = VAR at 0.5% probability
- RORAC = Average result / Risk based capital needed
- Remark: with Solvency II, risk based capital and capital required by the regulator are getting closer

Introducing the concept of Ceded ROE (Return On Equity)

Risk transfer at a cost below the internal CoC creates value



4. How much value created?

3. Cost of ceded RoE?

2. How much capital released?

1. How much volatility transferred?

- Ceded ROE = $$\frac{\text{Mean cost of reinsurance net of tax}}{(\text{Decrease of capital due to reinsurance})}$$

Where:

- Mean cost of reinsurance net of tax = (Reinsurance premium + Mean reinstatement premiums – mean of commissions – mean recoveries) × (1- tax on corporate dividends)
- Capital in this case is defined as the risk based capital

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Introducing the concept of Ceded ROE (2)

- The ceded ROE represents the profitability that the insurer would have on the business it is ceding to a reinsurer. The lower this rate is the better it is to reinsure.

- The ceded ROE should be compared to the cost of capital of the insurer. If it is lower than the cost of capital, it creates value for the insurer. The insurer can use the saved capital to develop in activities that will have a higher profitability.

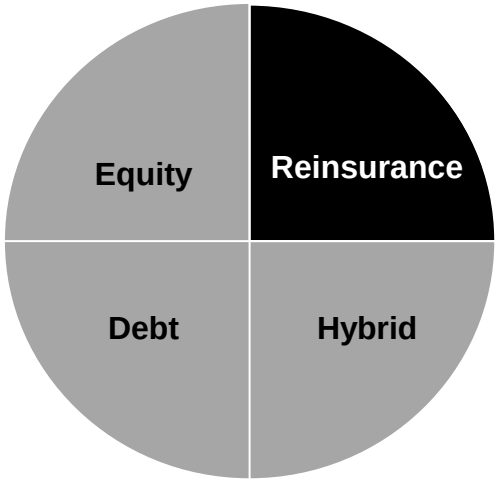
- The advantage of the Ceded ROE is that we just need to look the impact of the reinsurance and not the return on the global activity

- Attention: the capital allocated to a business line will be lower than the capital necessary if the business line is considered on its own due to the diversification effect (sub-additivity of the risk measure)

Creation of value

- Shareholders value is created when insurers:
  - **Earn returns greater than the cost of capital**
  - Grow revenues and earnings at rates that beat inflation
  - Produce consistent earnings with minimal volatility

Alternative sources of capital for insurance company



Reinsurance can help insurers create value by:

- Lowering the weighted average cost of capital
- Reducing earnings volatility
- Supporting new or expand products to help drive new revenue and earnings
- Expanding to meet rising revenues with incrementally less equity capital
- Providing sustainable competitive advantage through structure and underwriting performance improvement

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Creation of Value (2)

$$\text{Value Creation} = \text{Cost of capital} * \underbrace{(\text{Gross Required Capital} - \text{Net Required Capital})}_{\text{Capital Savings}} - \underbrace{\text{Reinsurance Margin}}_{\text{Cost of Reinsurance}}$$

- In our example, we take a cost of capital of 10%
- Again, the capital allocated to the property business line should be lower

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Conclusion

Stochastic modeling is a help in the decision making

- ❑ Allows to estimate the extreme cases
- ❑ Even more interesting when we compare two results from a stochastic model

Know the limitations of your model

- ❑ Lack of correlation between the different business lines, no copulas
- ❑ Lack of volatility of attritional losses
- ❑ ...

Make backtesting comparing to your past results

- ❑ See what is the return period of the last years compared to the model

There are other criteria used to chose the reinsurance cover

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Some criteria in the choice of a reinsurance cover :

Capital : treats with extreme events

- ❑ Capital required by the regulator
- ❑ Risk based capital
- ❑ Other definitions of capital

Cost of reinsurance

- ❑ It is the average value of the reinsurance premiums minus the average amounts paid by the reinsurer (recoveries or commission)

Earnings volatility

- ❑ Reinsurance can make the earnings of an insurer less volatile

Other

- ❑ Lack of knowledge of the risk
- ❑ Lack of confidence of the risk
- ❑ Protect the results of a profit center
- ❑ Other……..

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