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Improved financial management of Mexico's Natural Disasters Fund using advanced risk-estimation tools

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Mexico

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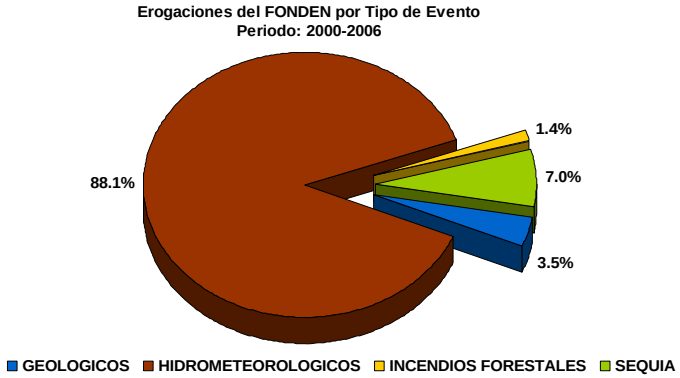
- In order to face the economical impact of frequent as well as catastrophic events on the **Federal property**, Mexico's Federal Government established in 1996 the Natural Disasters Fund (Fondo de Desastres Naturales, FONDEN)



Fuente: Secretaría de Gobernación

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Average annual loss in the last 15 years (Federal property): about 2000 million USD

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- At the beginning, FONDEN operation was more an aid scheme than a risk management instrument
- Losses were covered using only fiscal money, which caused frequent cash-flow troubles. (Average annual losses in the last 15 years: about 2,000 million USD)
- But the possibility existed of the occurrence of an event that demanded far more resources than those arbitrarily assigned to the Fund
- Lack of knowledge of the risk made it impossible to have technical criteria to determine the right size of the Fund and to design risk-transfer instruments

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- So the Ministry of Finance launched a project aimed to construct databases and develop tools to correctly estimate the risk to Federal property due to the combined effect of several natural hazards
- Here, we will present these tools and some results

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Main objective

To develop a system to estimate economical losses to houses and infrastructure, as well as population potentially affected by natural events

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Expected results

R-FONDEN should compute risk measures due to the combined effect of several hazards, by each hazard alone, by sector, and by all sectors combined.

Requested economical risk measures:

- Expected annual loss
- Loss exceedance curves
- Probable maximum losses (PML)

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What is interesting?

- Results for the Government are not only databases and loss curves, but a stand-alone computer system (R-FONDEN)
- R-FONDEN can be operated by the Government independently of the developers (II-UNAM and the firm ERN Consulting Engineers)
- Within the Public Administration a new process has started in which rational risk management is (finally!) someone's job

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What is interesting?

- The system is designed with an integrated approach able to perform multi-hazard risk analysis.
- In fact, the computing engine is peril-blind, in the sense that it does not know which peril is being evaluated
- Hazard, vulnerability and risk representations are conceptually and operationally equal for all perils

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What is interesting?

- The system includes a set of tools and post-processing applications designed to facilitate risk-transfer computations

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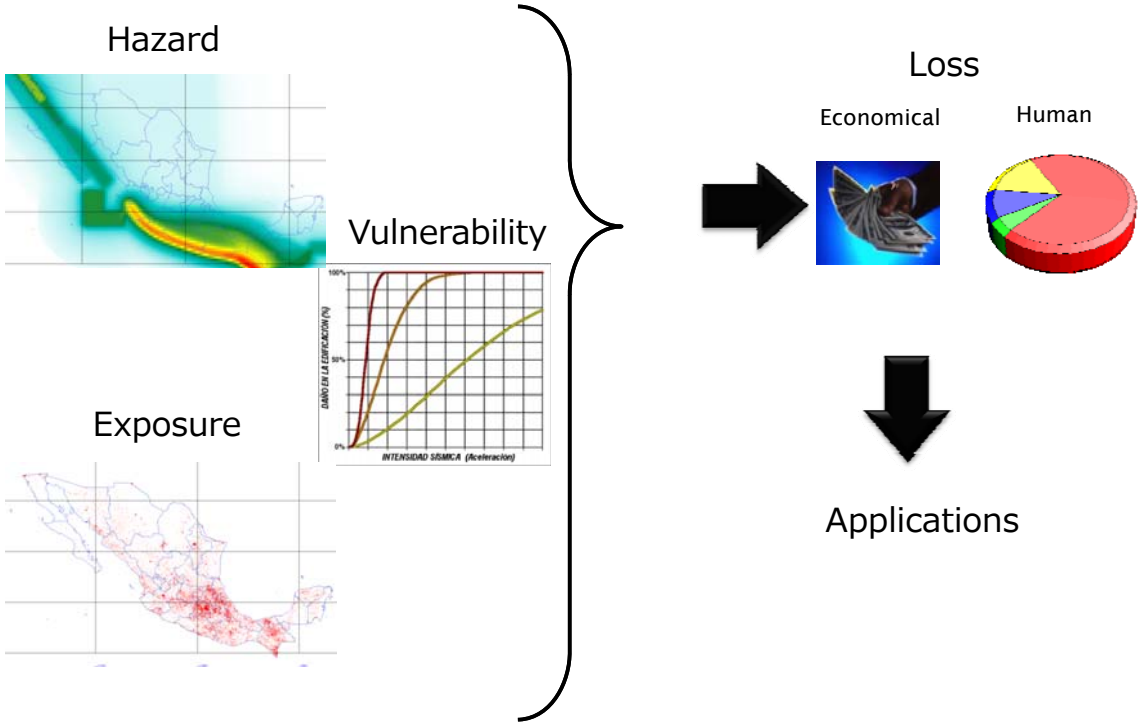
Classic risk-computation approach



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Hazards included in R-FONDEN

- Earthquake
- Tropical cyclone (flood, wind, storm surge)
- Non-cyclone flood
- Landslides
- Hail
- Tsunami
- Volcanic eruption
- Wild fires

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Hazard

We use an event-based approach, common to all hazards:

- Determine all the ways in which a damaging event can occur
- Assign occurrence frequency to each of these events
- Determine the spatial distribution of intensities for each event (including site effects)

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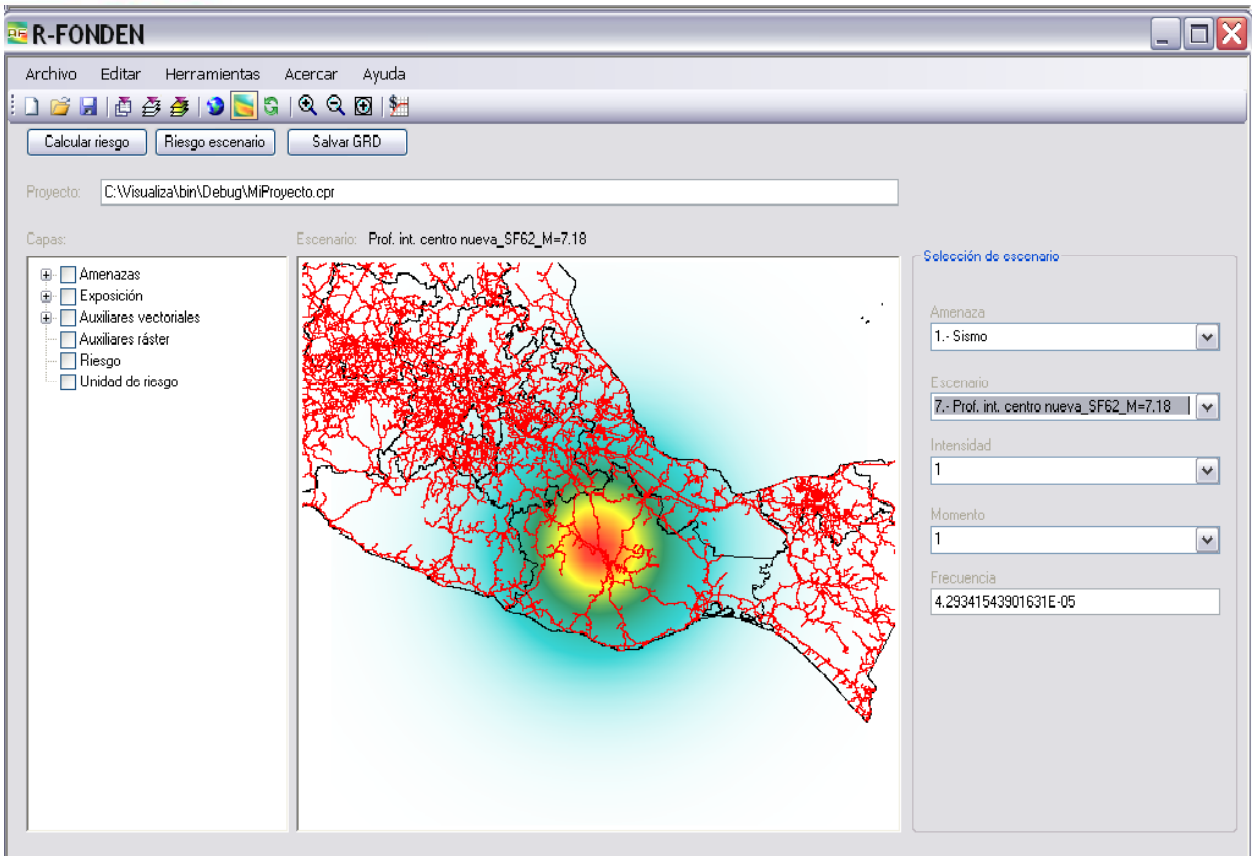
Earthquake



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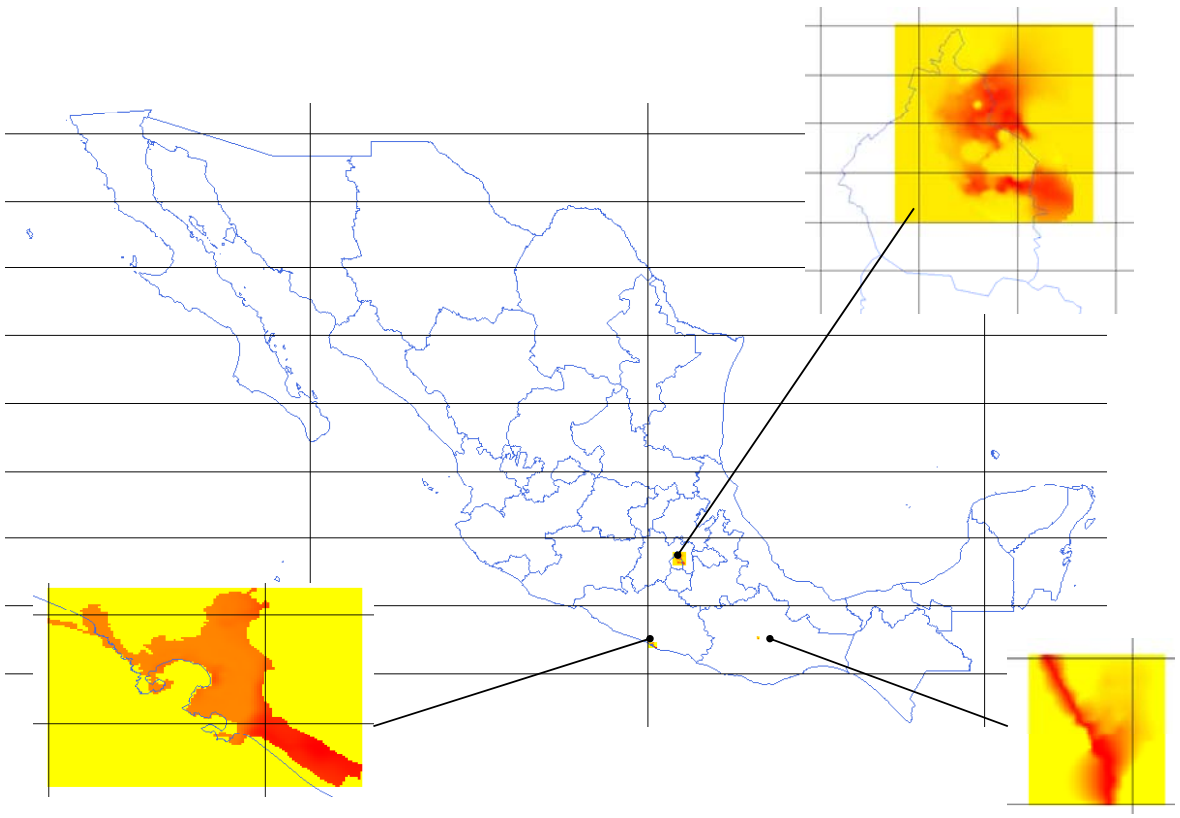
Site effects (earthquake)



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Hazard representation

- Geographical distribution of intensities (multi-scale) for each event (*scenario*, *intensity footprint*)
- Several intensity measures per peril
- Probabilistic: two statistical moments of the intensity are stored
- All information compressed in an AME object (ancestor of the more streamlined WB's CAPRA AME object)

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Vulnerability/Exposure

- Locate in space the exposed items
- Assign them value
- Classify them from the point of view of their vulnerability (one classification per hazard)
- The "golden rule" of the Ministry of Finance

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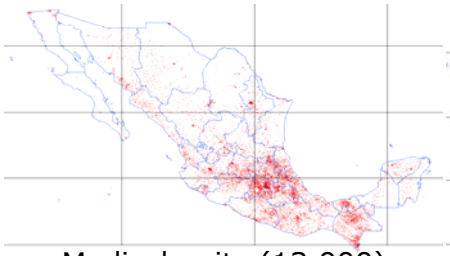
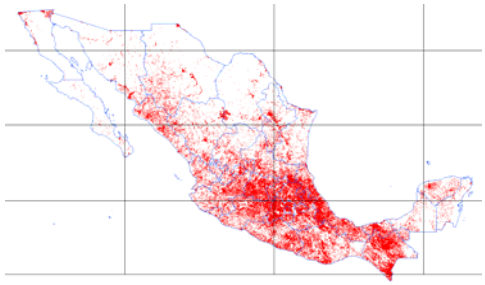
Exposure examples



Medical units (13,000)

Bridges (7000)

Highways (136,000 Km)



Schools (190,000)

Public buildings

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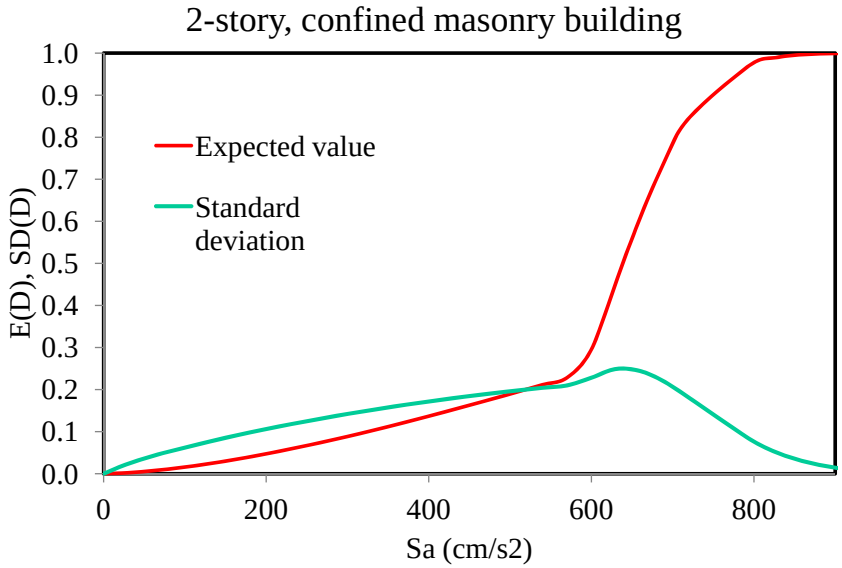
Vulnerability

Probabilistic intensity-damage relations for all classes of buildings (and each hazard)



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Risk computation

Risk is measured with the exceedance rate of loss values, p:

$$\nu(p) = \sum_{All\ events} {}_i \Pr(P_i > p \mid \text{event i}) F_i$$

P_i is the loss during event i, resulting, in general, of the addition of numerous individual losses, probably correlated;

F_i is the annual frequency of occurrence of event i

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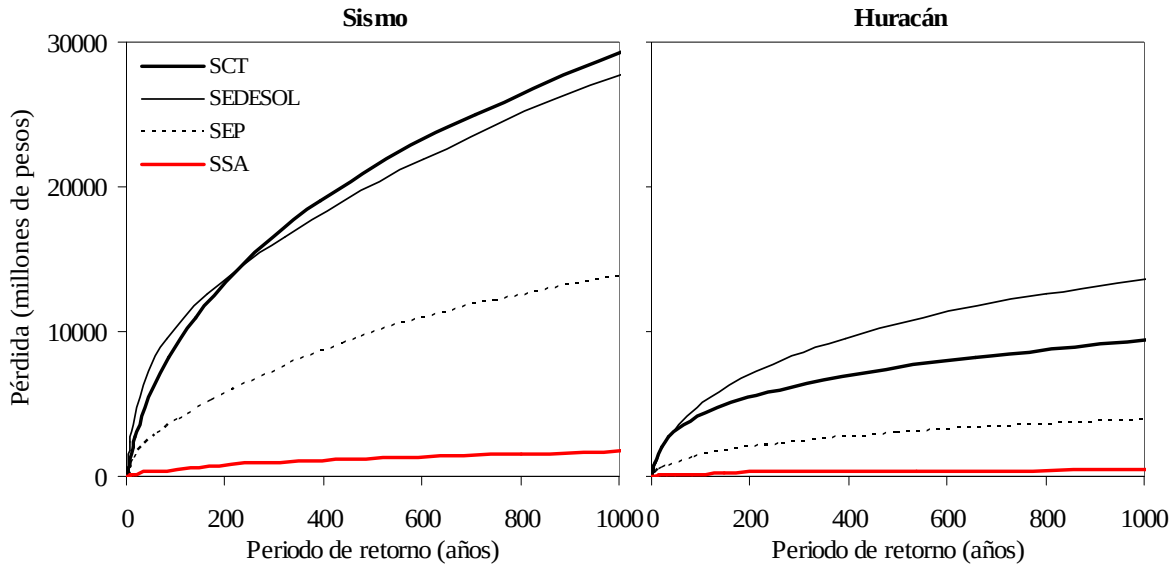
R-FONDEN



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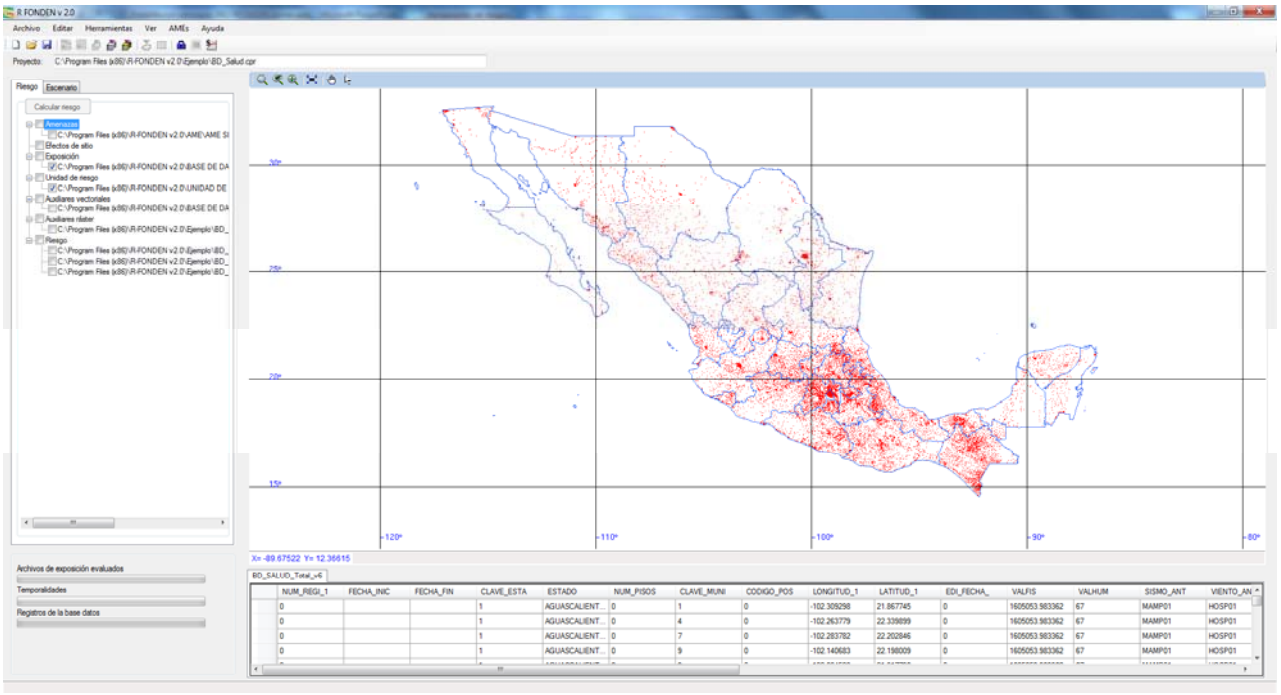
R-FONDEN



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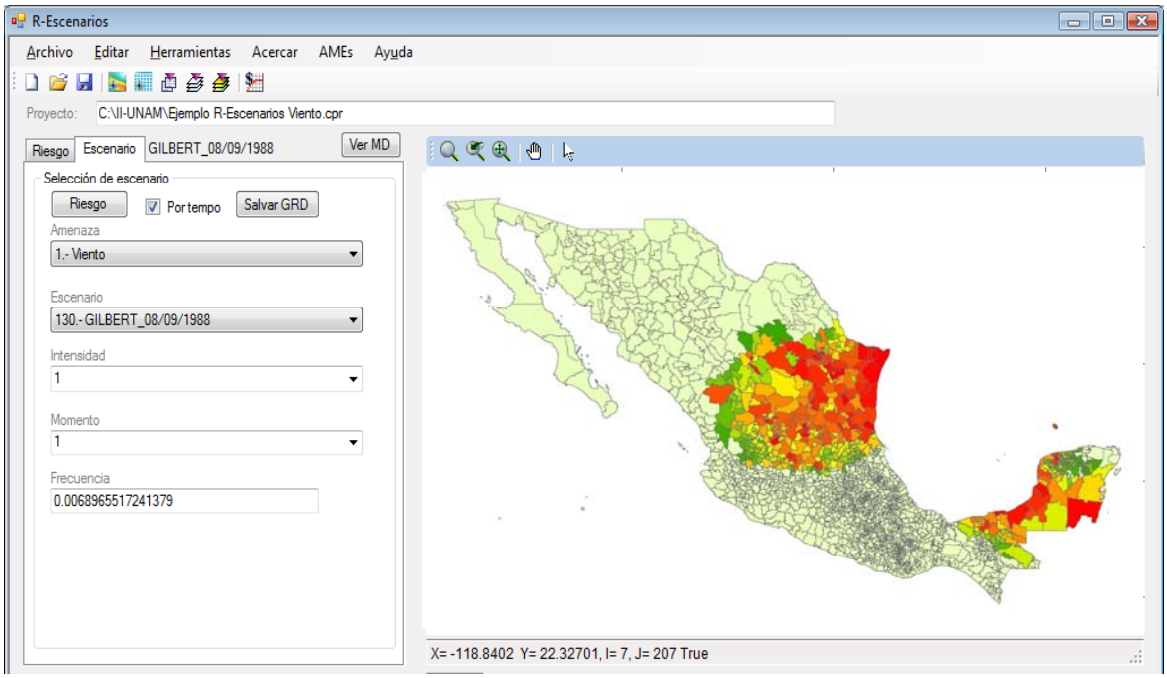
R-FONDEN



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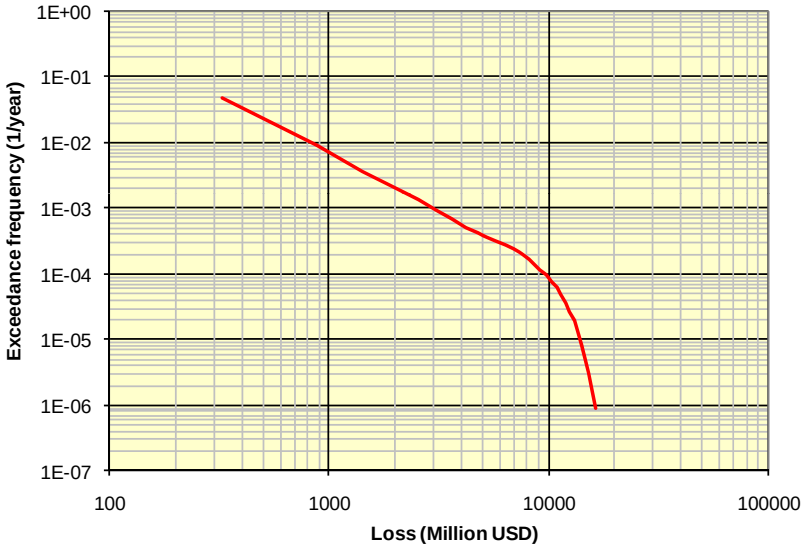
Risk management



This curve describes, in probabilistic terms, the (contingent) liability of FONDEN. It is impossible to do rational risk transfer without this information

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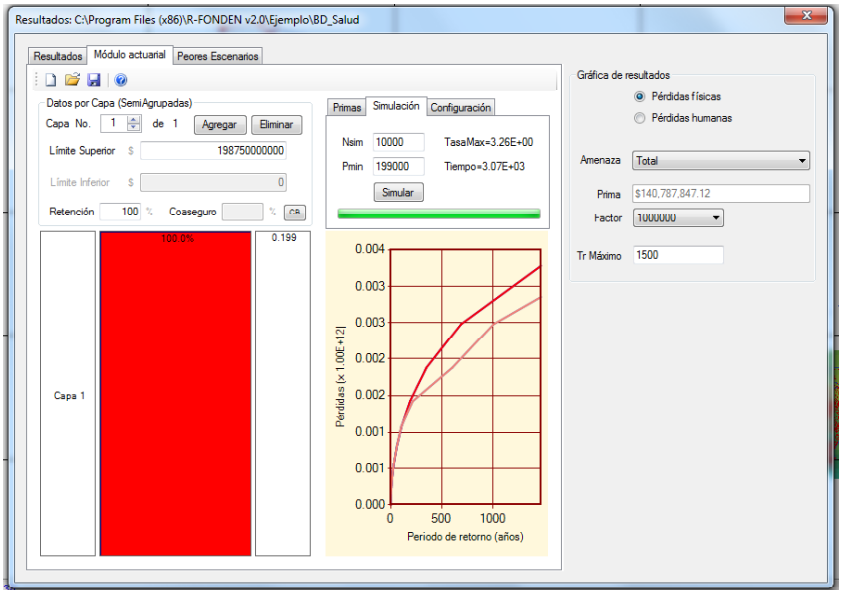
Risk-transfer tools



Different risk transfer strategies can be evaluated in search of optimization, given the current budget and market restrictions

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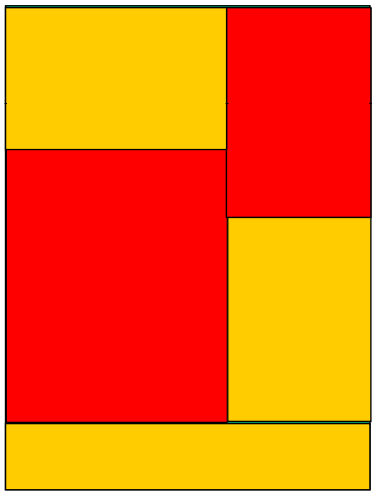
Risk-transfer tools

Large rare losses



Small frequent losses

Risk retained by the Federal Government

Risk ceded to insurance, reinsurance and capital markets

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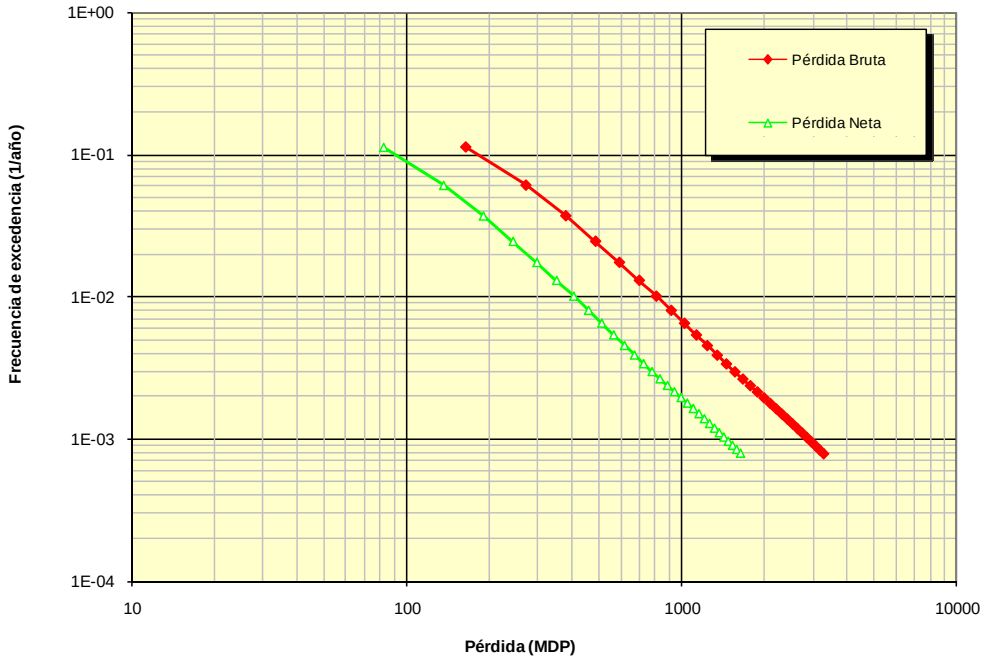
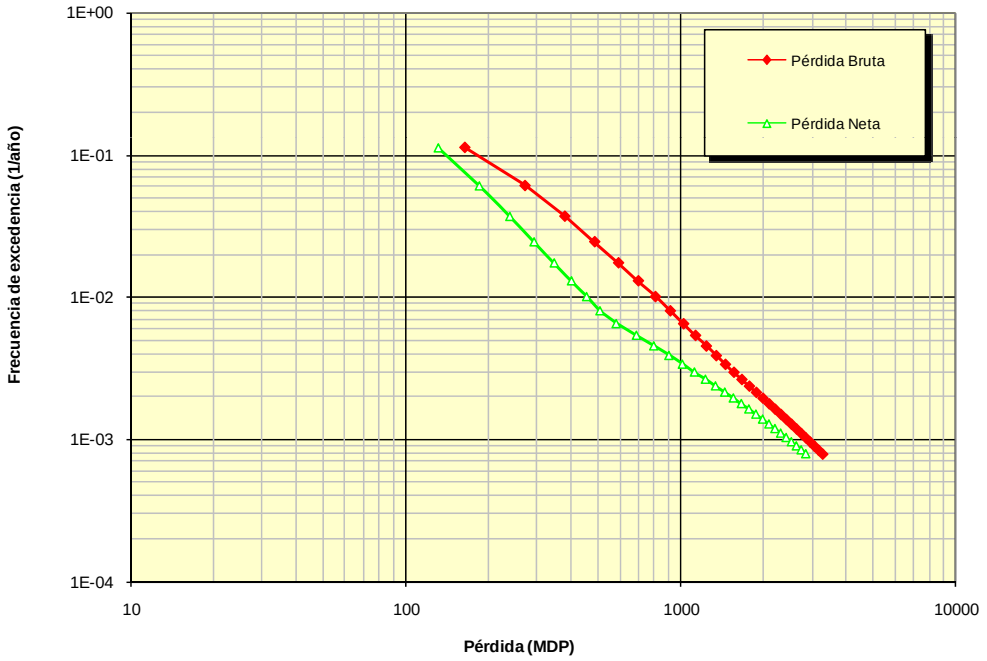
Effects of risk-transfer instruments

Proportional risk-transfer



Effects of risk-transfer instruments

Non-proportional risk-transfer



Conclusions

- R-FONDEN has improved the risk management obligations of the Ministry of Finance regarding Federal infrastructure in Mexico

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Conclusions

- Other interesting applications have come out: real-time expected loss calculations for hurricanes, earthquakes and tsunamis
- Scenario selection to test the strength of the Civil Protection System at various levels
- Application to State and Municipal property is being studied