Using hazard information for establishing a rationale decision-making

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Outline

- Introducing the problem: the separation of roles in the decision making process
- Hazard/risk separation principle
- The principles of a rationale decision making; when it is important to make a distinction of roles.
- Some real cases, where this distinction is not applied

Introducing the problem

- **Risk reduction process requires different expertise** (scientific and non-scientific), and the **boundaries between these expertise are often fuzzy**. Often scientists **act unconsciously as decision makers.**

- **Separating and clarifying roles is important!** It is not only matter of culpability. This clear separation
  - allows each partner **to protect the integrity of their specific assessment**;
  - **clarifies the competences** required at each step of the risk reduction process;
  - facilitates the establishment **of transparent and clear decision making protocols**

- **Hazard/risk separation principle** is important to make this separation

Introducing the problem

Recommendations on the Immediate Use of Nuclear Weapons, June 16, 1945

Recommendations on the Immediate Use of Nuclear Weapons, by the Scientific Panel of the Interim Committee on Nuclear Power, June 16, 1945.

Source: U. S. National Archives, Record Group 77, Records of the Office of the Chief of Engineers, Manhattan Engineer District, Harrison-Bundy File, Folder #76.

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RECOMMENDATIONS ON THE IMMEDIATE USE OF NUCLEAR WEAPONS

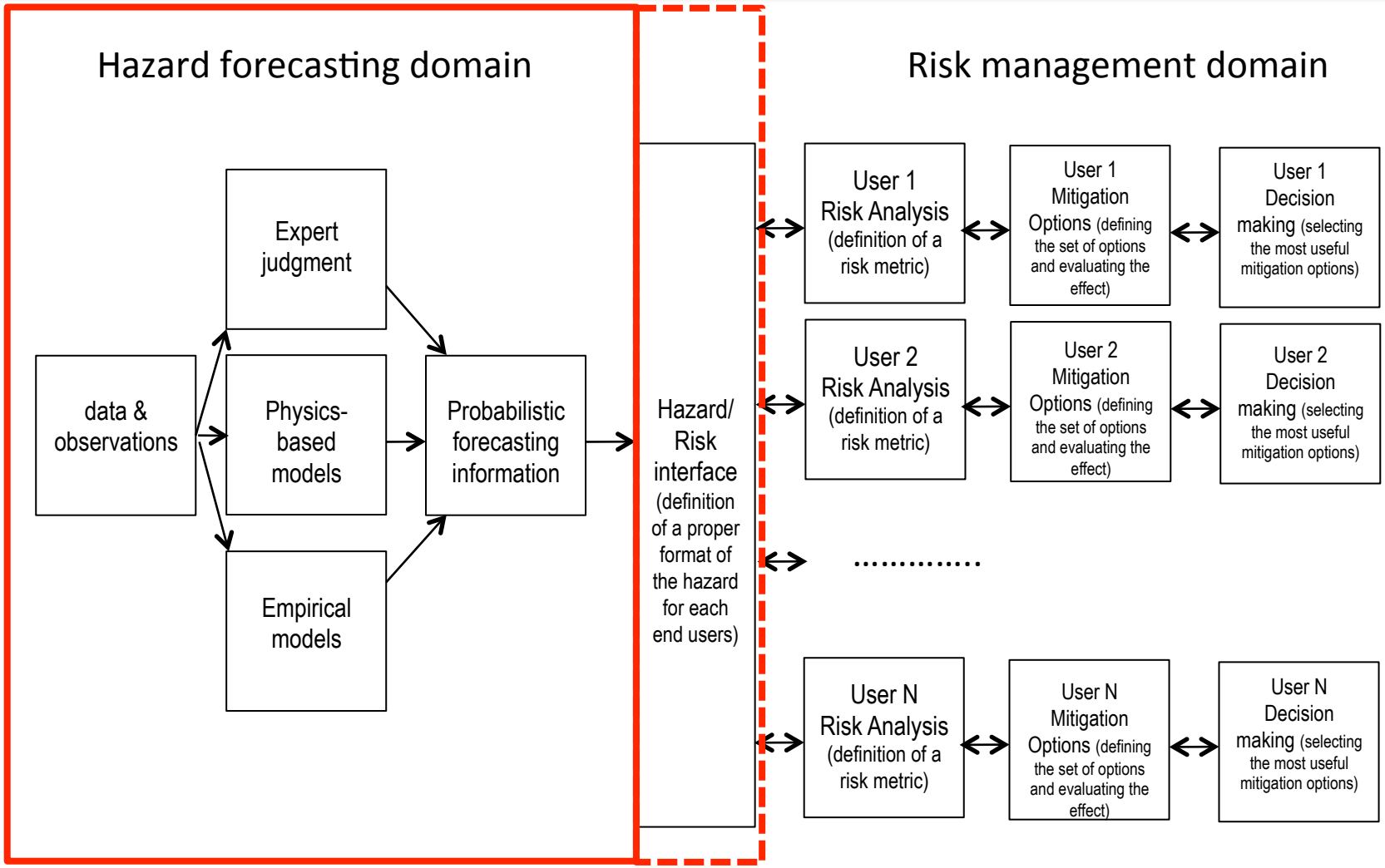
A. H. Compton
E. O. Lawrence
J. R. Oppenheimer
E. Fermi

[signature]
J. R. Oppenheimer
For the Panel

(3) With regard to these general aspects of the use of atomic energy, it is clear that we, as scientific men, have no proprietary rights. It is true that we are among the few citizens who have had occasion to give thoughtful consideration to these problems during the past few years. We have, however, no claim to special competence in solving the political, social, and military problems which are presented by the advent of atomic power.

The Hazard/Risk separation principle

Hazard/Risk separation principle



Hazard analysis is purely driven by Science. Risk analysis and mitigation is more heterogeneous and Science is not enough (different levels of decision-making)

❑ Hazard/Risk separation principle

Notwithstanding any scientist knows very well the distinction of hazard and risk, we note that the hazard/risk separation principle is not often properly acknowledged by many scientists working in hazard analysis (that sometimes tend to be overconfident on their capability to reduce the risks for society)

Some examples…

- Scientists that define which **event probability (hazard) is negligible** or not (Operational Earthquake Forecasting)
- Scientists that **advocate the (worst) scenario** to be used in risk mitigation
- Scientists that **define alert levels** in volcanic systems
- Scientists that **define a traffic light** for induced seismicity

The Principles of rationale decision making

The principles of a rationale decision-making

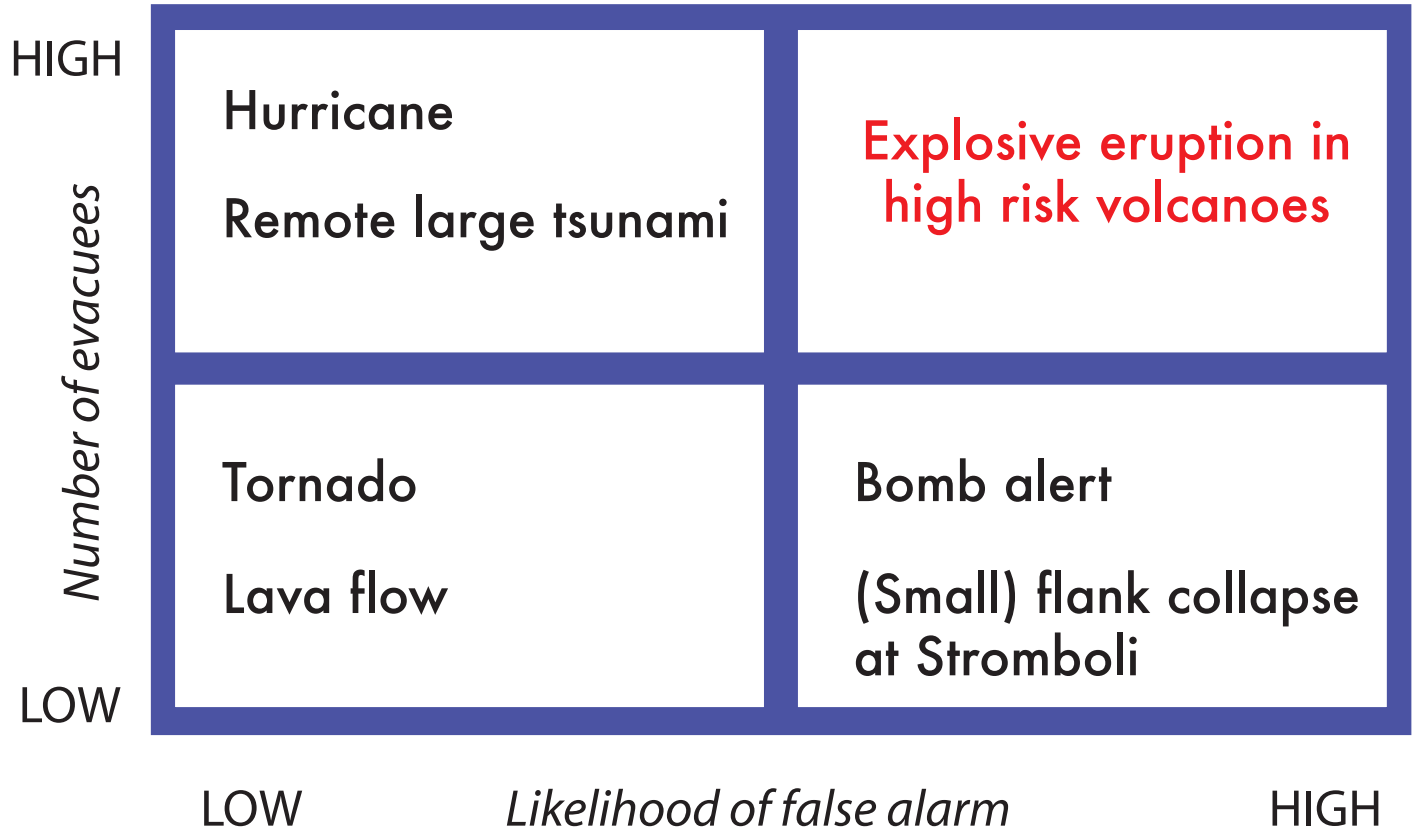
Traditional deterministic **precautionary approach** for Civil Protection

If there is a potential public danger, a precautionary evacuation would prioritize safety above any other considerations.

No risk assessment is needed for most evacuation decisions

The principles of a rationale decision-making

Quantitative Risk assessment is particularly important in some situations



The principles of a rationale decision-making

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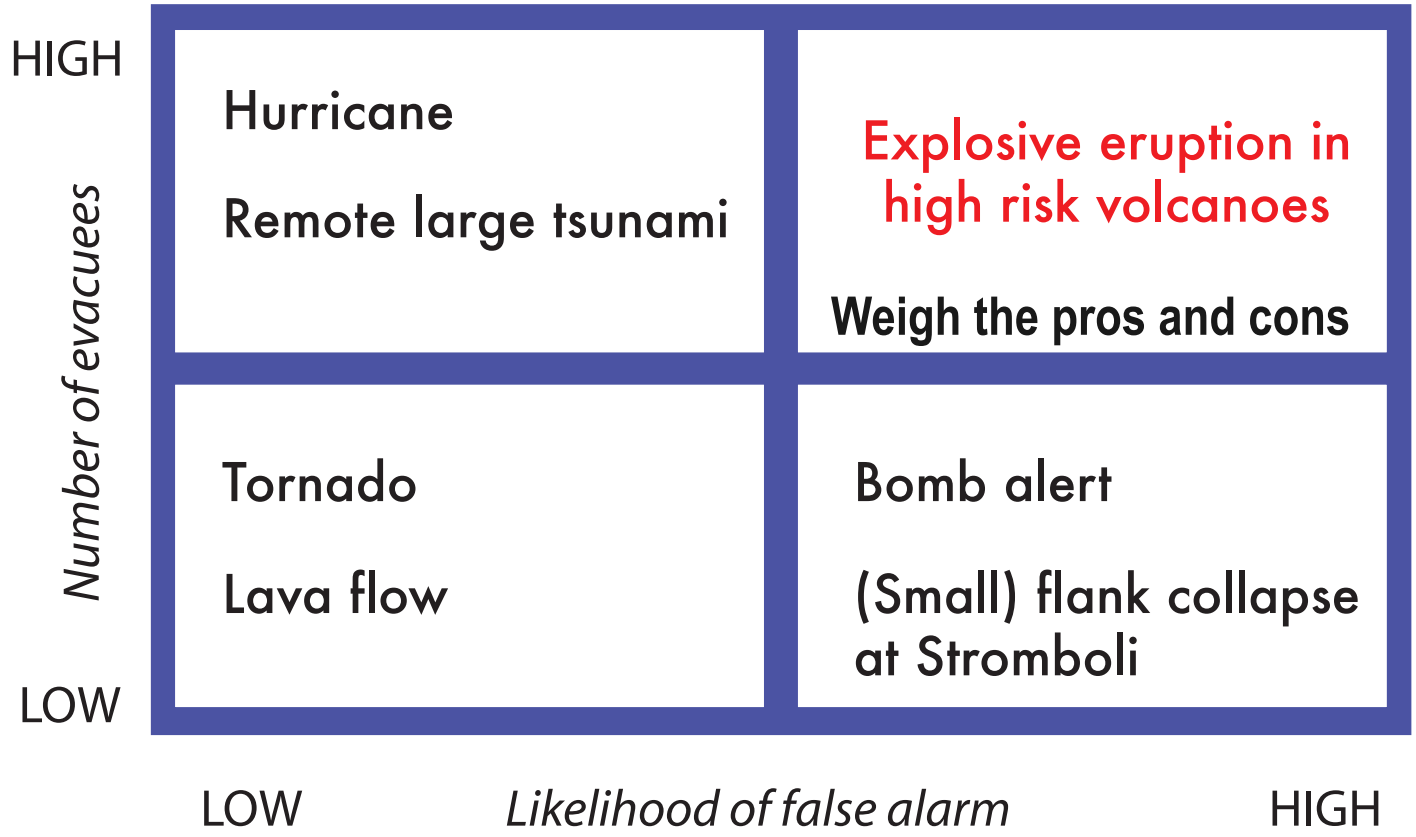
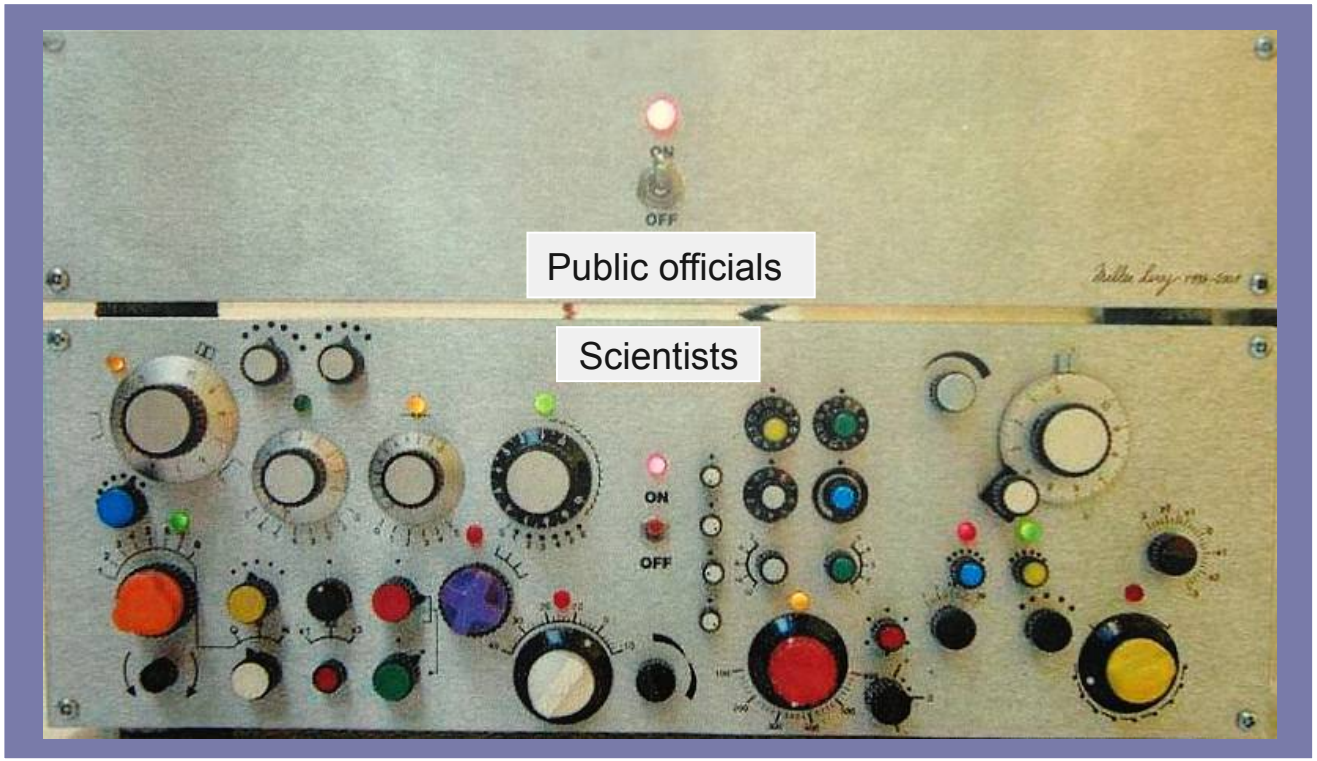


The principles of a rationale decision-making

Recently one decision maker told me:
"***If you want to make a separation of roles you have to give me probabilities: otherwise, please let me know also what I have to do… but forget any distinction in roles***"
(and responsibilities)

The principles of a rationale decision-making

The Challenge is for scientists to **articulate uncertainty** without losing credibility and to **give public officials the information they need for decision-making**



this requires **to bridge the gap** between scientific output (**probability**) and the boolean logic (**YES-NO**) of decision-makers

Cost-benefit analysis of precautionary mitigation action (1)

ACTION	Adverse Hazard State	Not Adverse Hazard State
[a] Take action	C	C
[b] do NOT take action	L	0

Loss-Cost Matrix

Cost-benefit analysis of precautionary mitigation action (2)

C is the cost if a mitigation action is **taken**.
P * L is the cost if a mitigation action is **not taken**.

If **P * L > C**, the cost for society "probably" lost exceeds the cost of the mitigation action. Therefore, the mitigation action should be taken when

$$P > C / L$$

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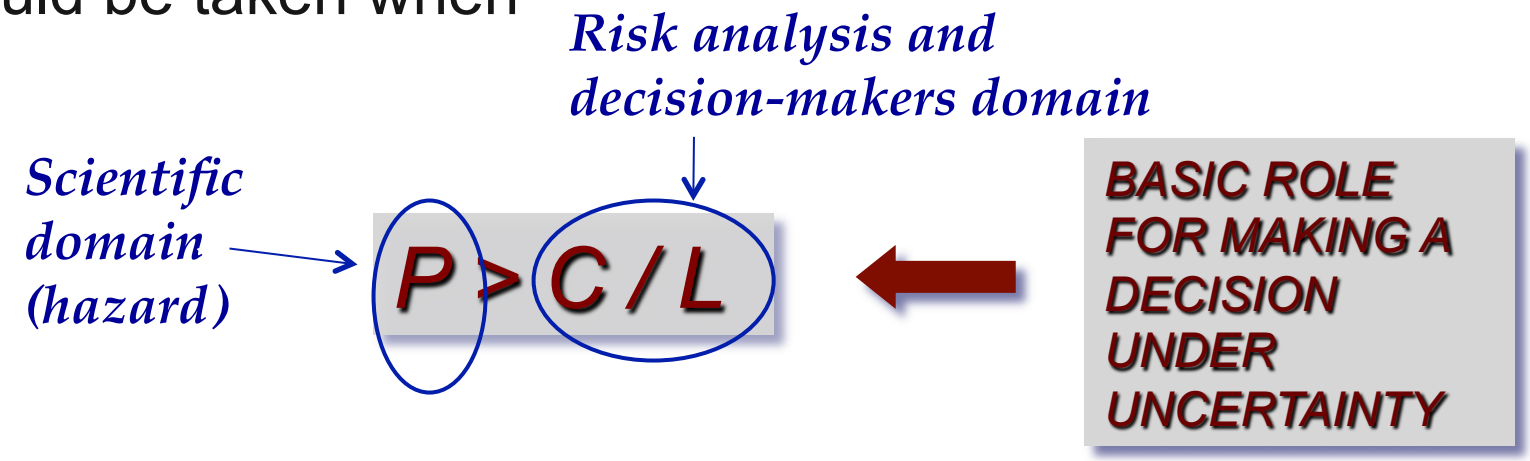
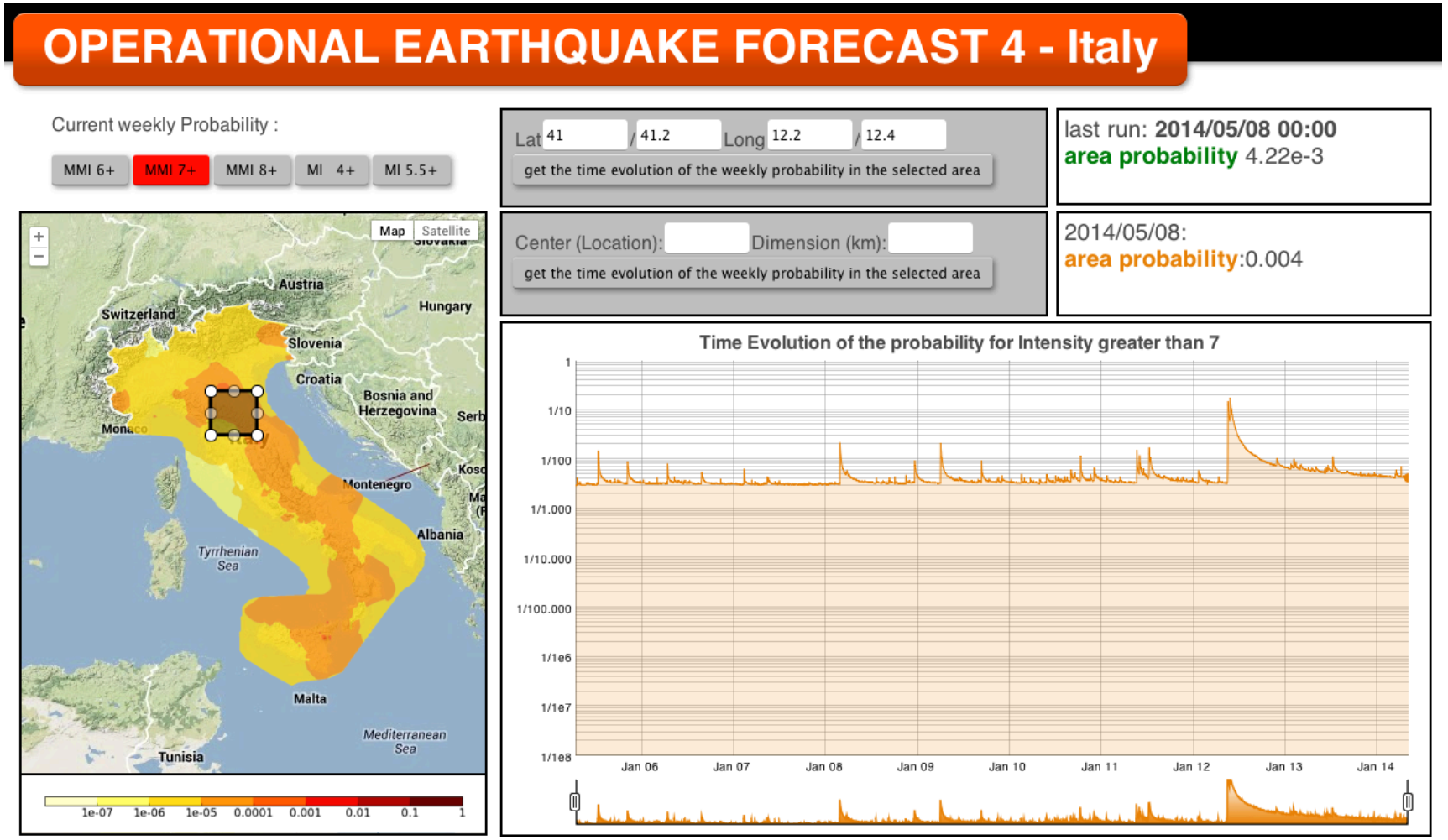


Some cases where hazard/risk separation principle is not acknowledged

Saying that the probability of an earthquake is negligible



Evolution of the **weekly probability** with time for the selected area: updated every **day** or after a M3.5+

The Science of OEF

- Seismic (and risk) hazard **varies with time** (in particular in the short-term)
- During a seismic sequence the weekly probability of a destructive earthquake can **increase 100-1000 times** with respect to the reference level (derived from the long-term hazard), but this **probability rarely reaches 1%**. *(NOTE: OEF does not necessarily imply 'small' probabilities)*
- Some models based on **earthquake clustering** provide **accurate estimations of such probabilities** (continuously under test through **CSEP** experiments)
- Despite the usual belief, such models are verified empirically **much better** than long-term hazard models.

Saying that the probability of an earthquake is negligible

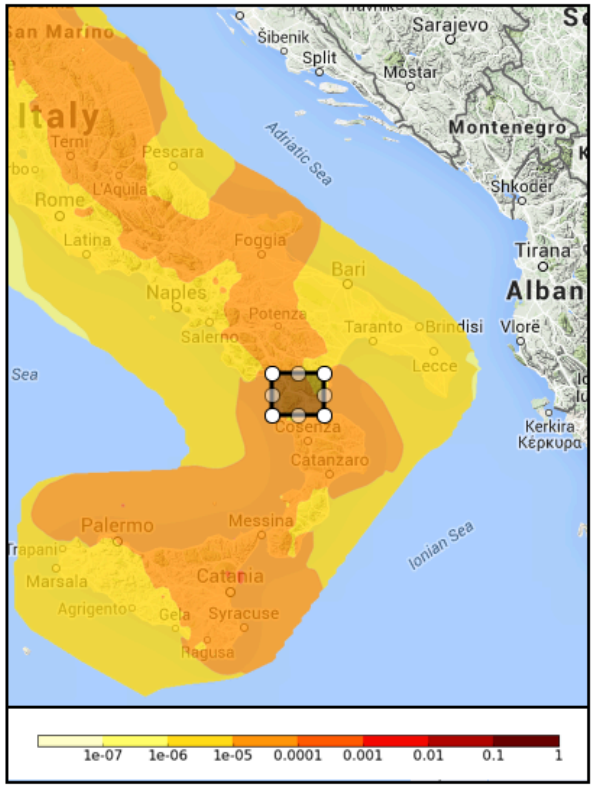
… you can't issue any **alert/warning** with such probabilities; such probabilities (up to 5%) are not useful for **saving lives** *[Wang & Rogers, 2014]*

Saying that the probability of an earthquake is negligible

OPERATIONAL EARTHQUAKE FORECAST 4 - Italy

Current weekly Probability :

MMI 6+ | MMI 7+ | MMI 8+ | Ml 4+ | Ml 5.5+



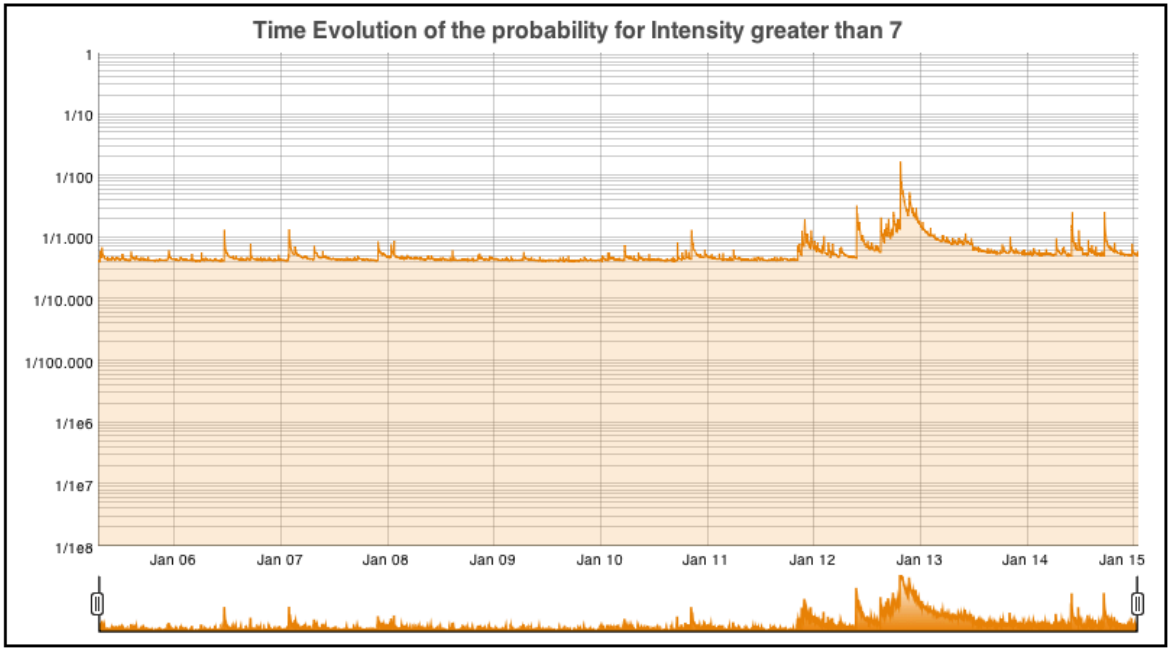
Lat 39.61 / 40.09 Long 15.7 / 16.5

get the time evolution of the weekly probability in the selected area

Center (Location): Dimension (km):

get the time evolution of the weekly probability in the selected area

last run: **2015/01/19 00:00**
area probability 5.13e-4



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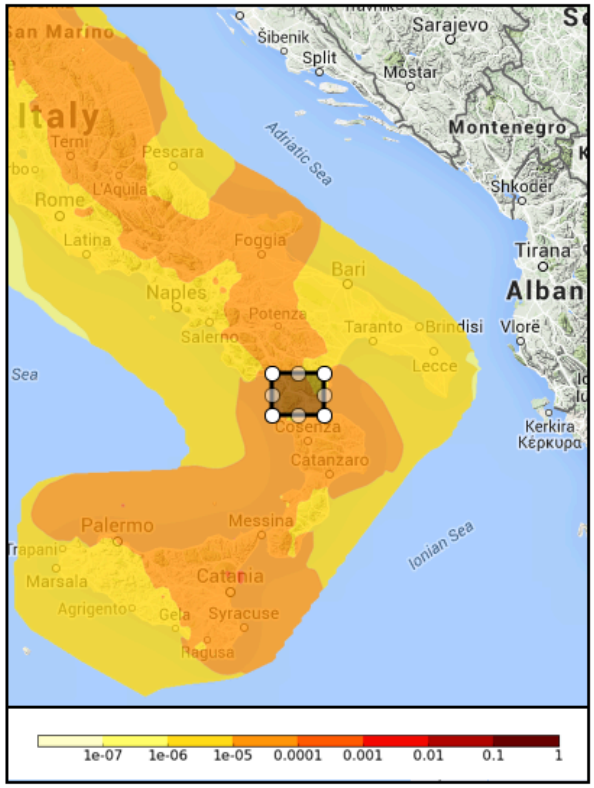
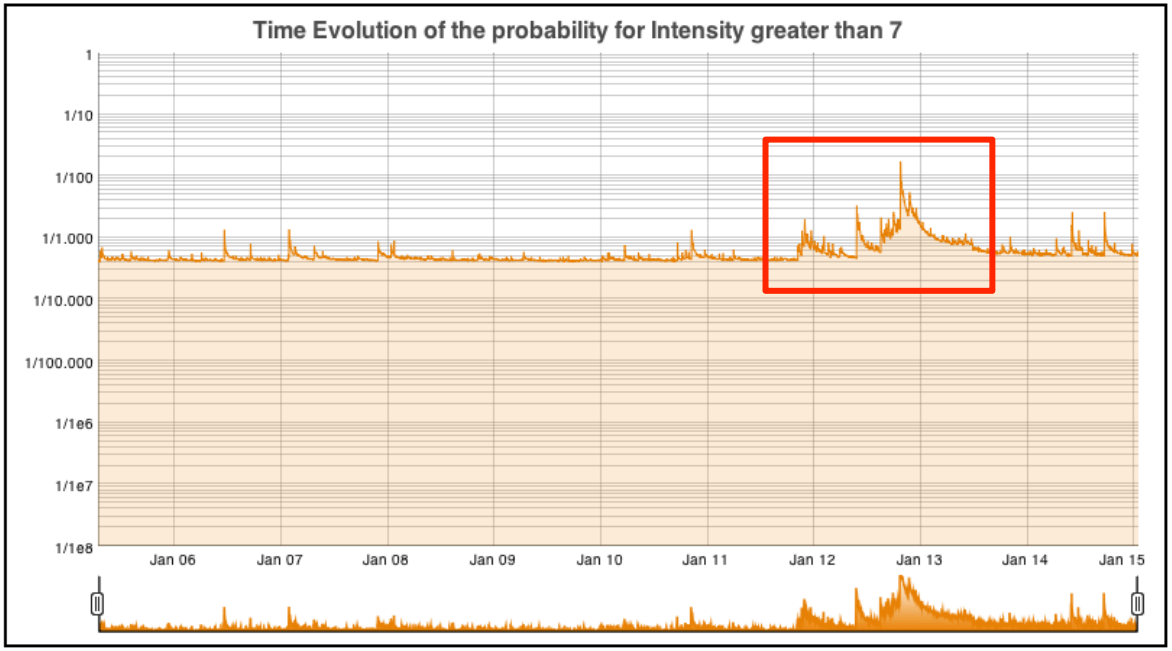


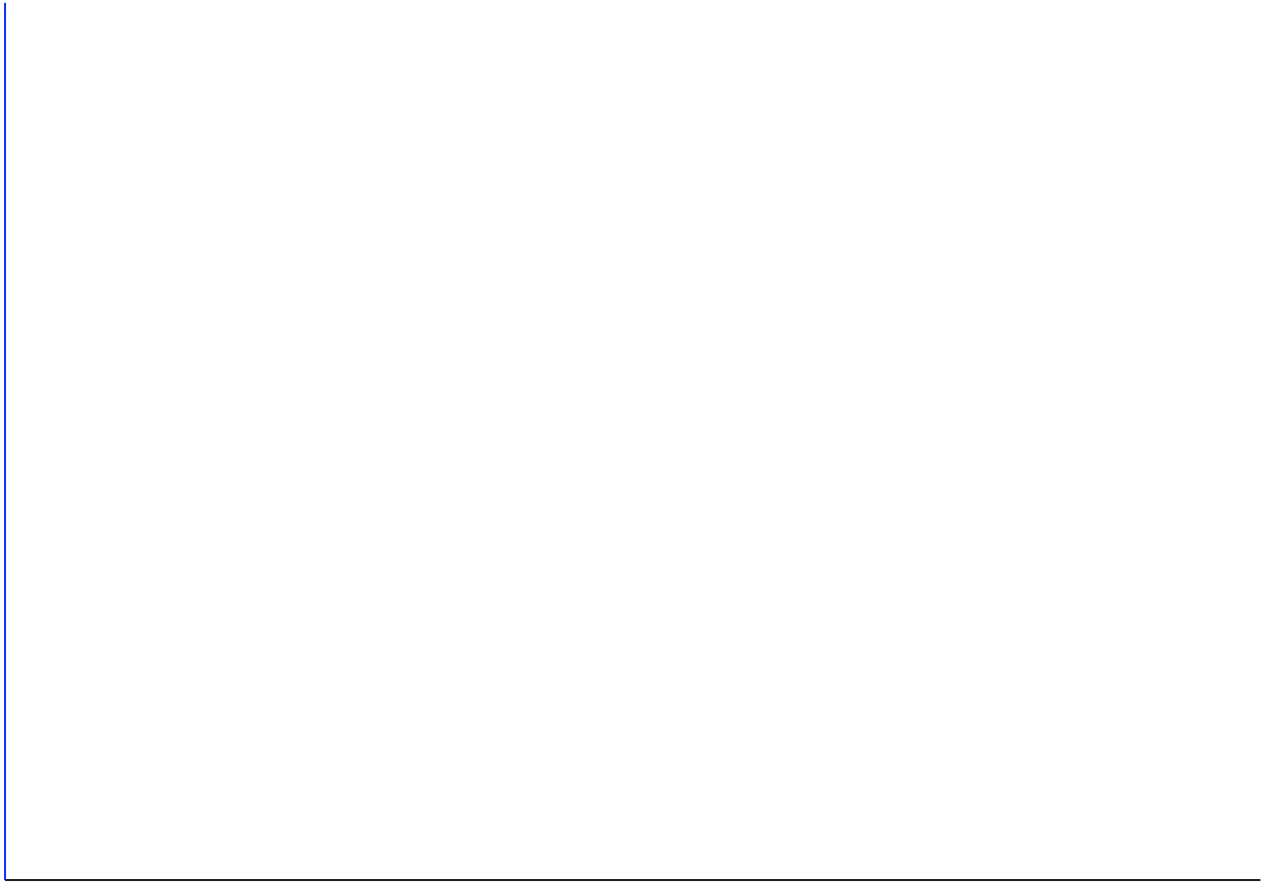


Saying that the probability of an earthquake is negligible

Weekly Individual risk of death

less than 10 km from seismic sequence

(in parenthesis annual risk)



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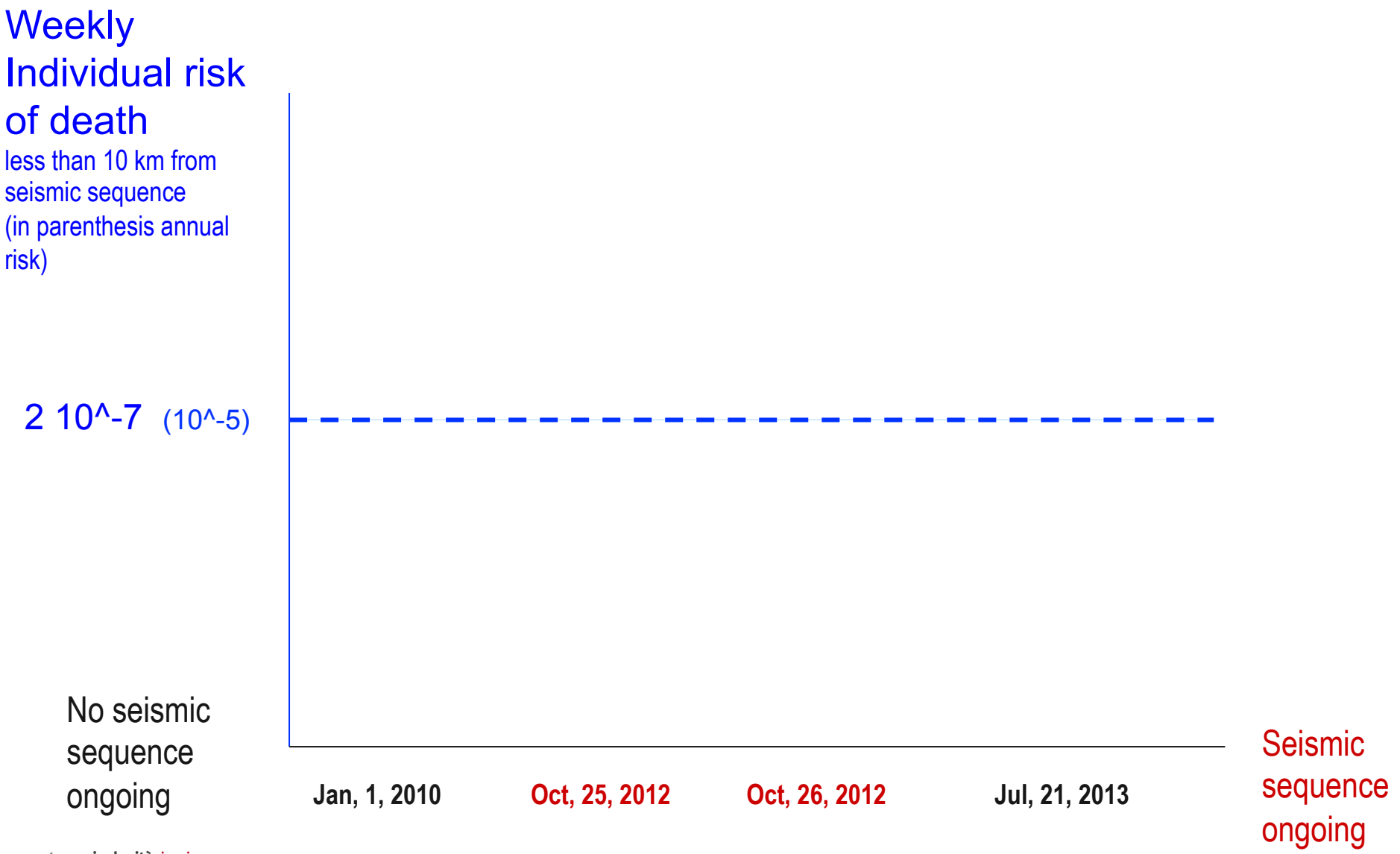

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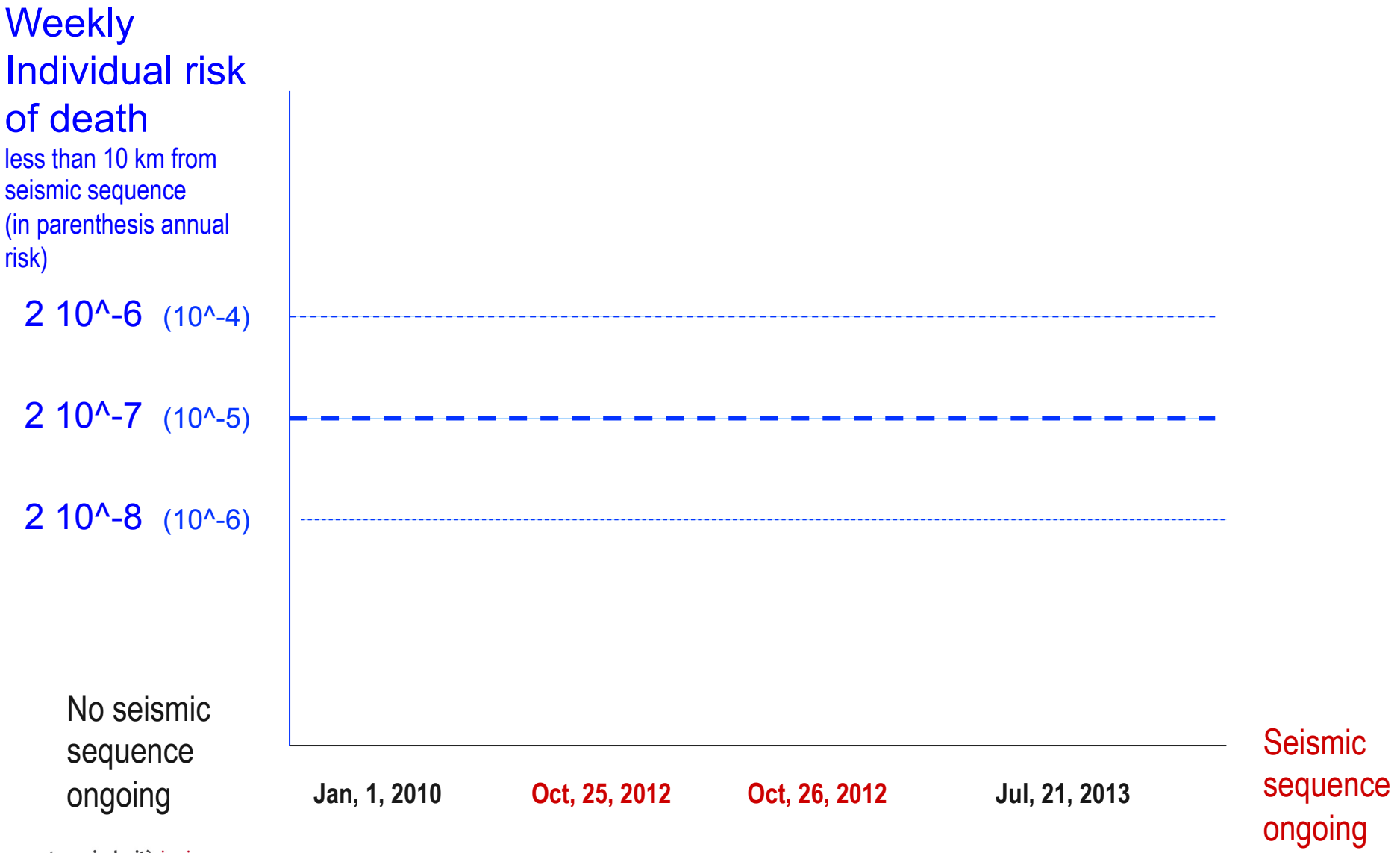

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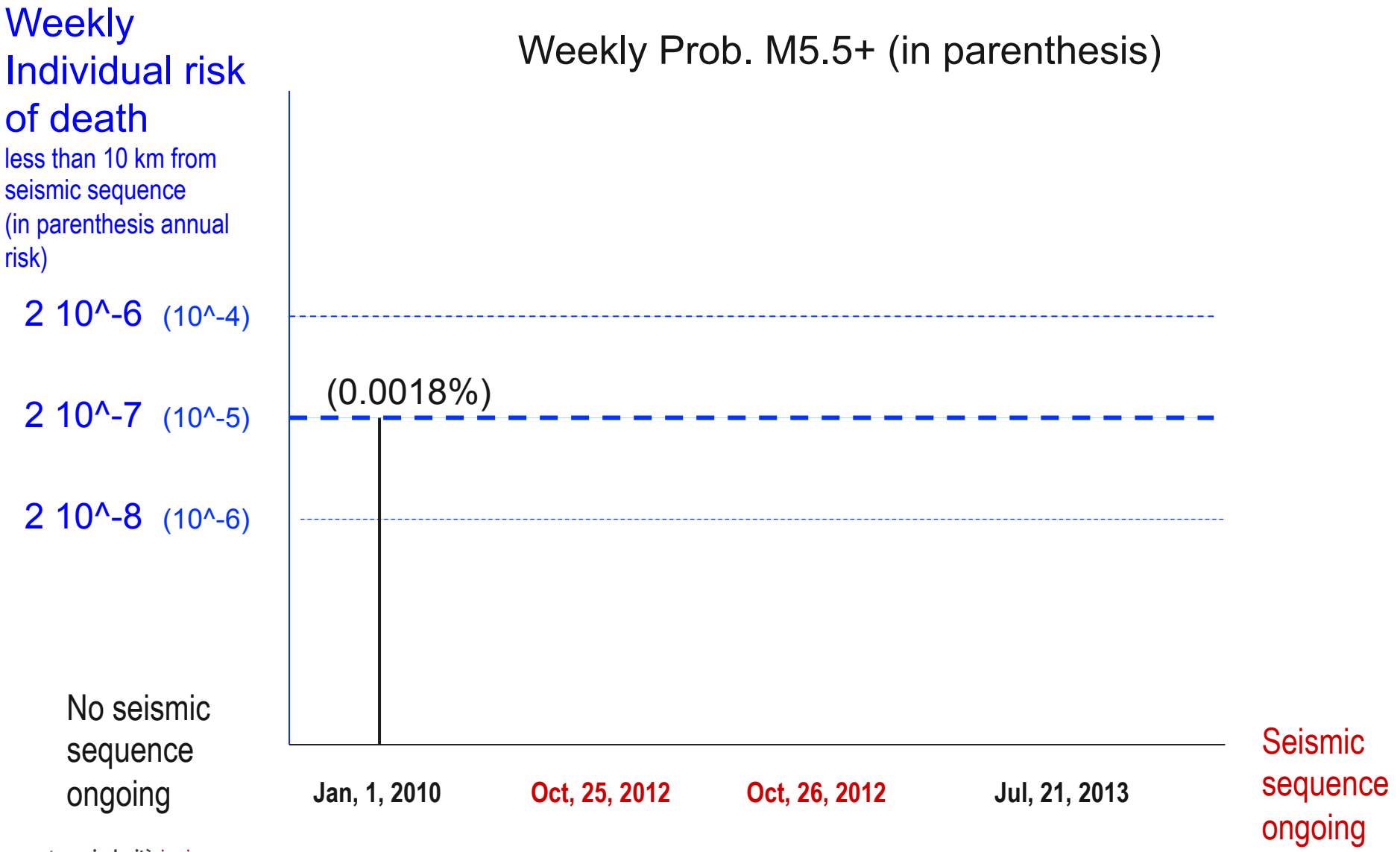

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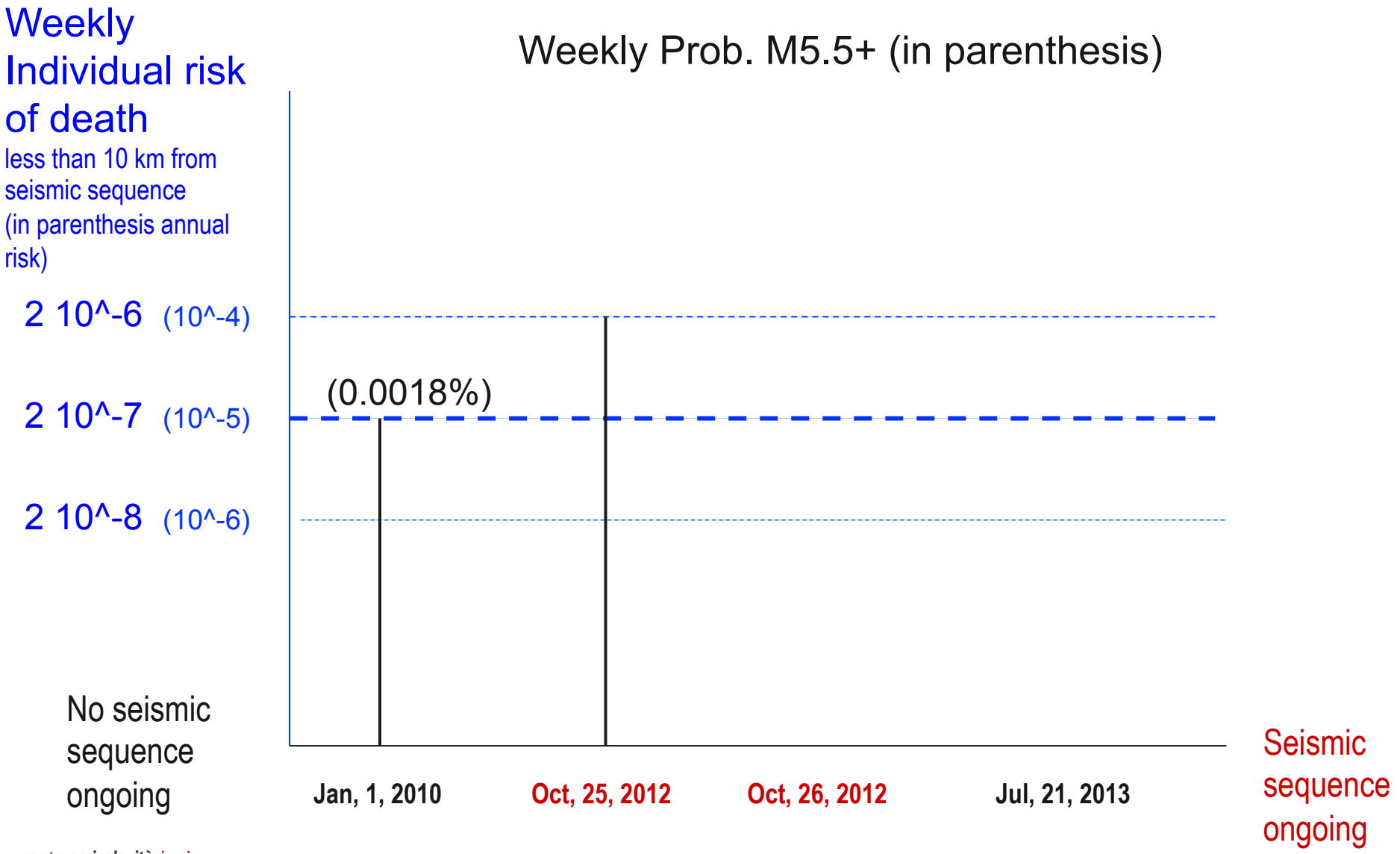

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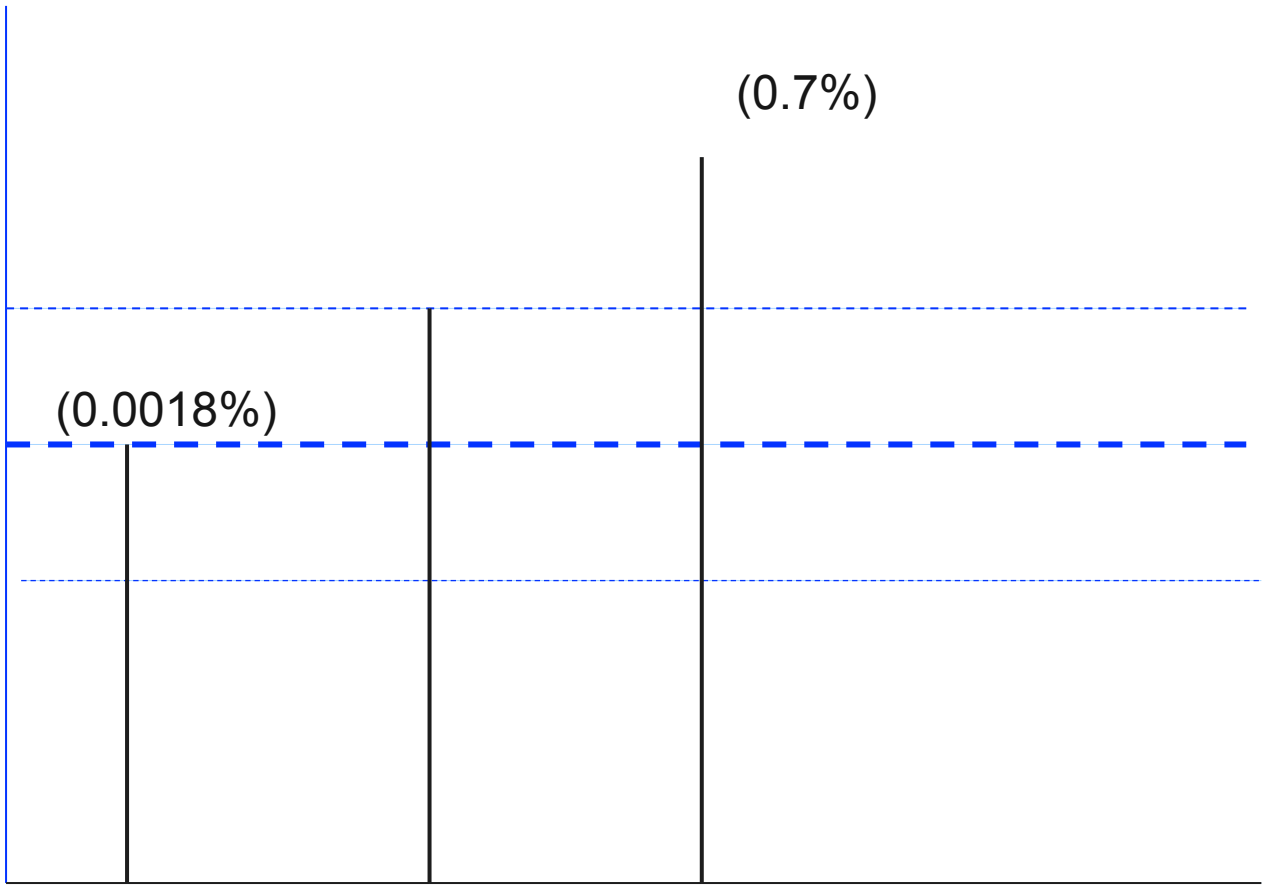

No seismic sequence ongoing

Seismic sequence ongoing

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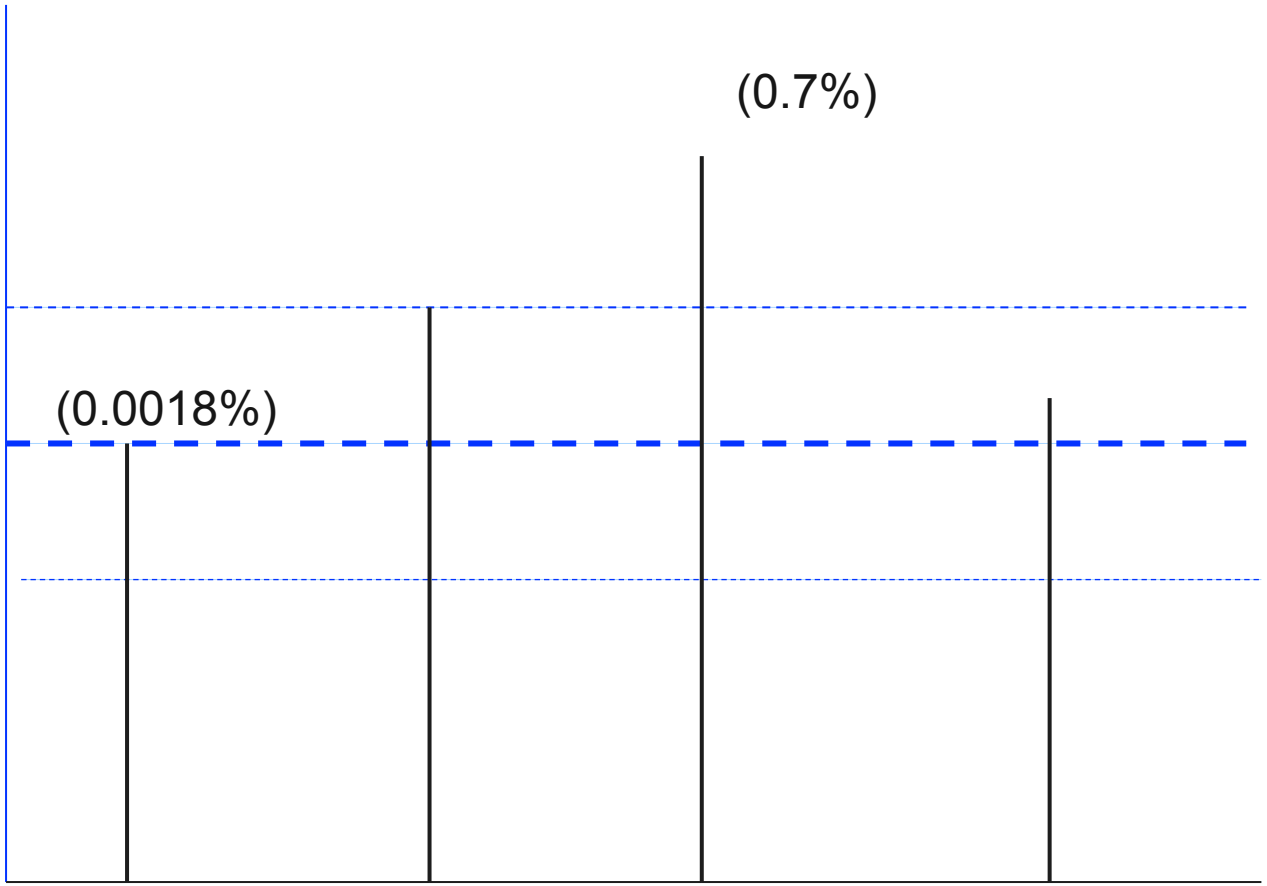

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Choosing the (worst) scenario

Some scientists advocate the need **to protect society from the worst scenario**. This sounds very appealing (assuming it is possible to define the 'worst'), but **it does not lead to ethical and rationale decision-making**.

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Example: Should we protect Naples from the worst scenario of Campi Flegrei? The products of the last Campi Flegrei eruption arrived close to Rome. Should we plan an evacuation of more than 10 millions of people? Or should we take into account that the most likely eruption is of much smaller magnitude?

Defining the alert systems

ALERT LEVELS	STATE OF THE VOLCANO	ERUPTION PROBABILITY	TIME OF THE ERUPTION
Base	No significantvariation of monitored parameters	Very low	Undefined, not less than several months
Attentio n	Significant variation of monitored parameters	Low	Undefined, not less than some months
Warning	Further variation inmonitored parameters	Medium	Undefined, not less than some weeks
Alarm	Appearance of phenomena and/or evolution of parameters suggesting a pre-eruption dynamic	High	From weeks to days

ALERT LEVELS
The alert system described in the emergency plan includes the following main levels:

Attention:
when monitored variables exceed their established thresholds; monitoring processes are further enforced and the local population and civil authorities are promptly alerted.

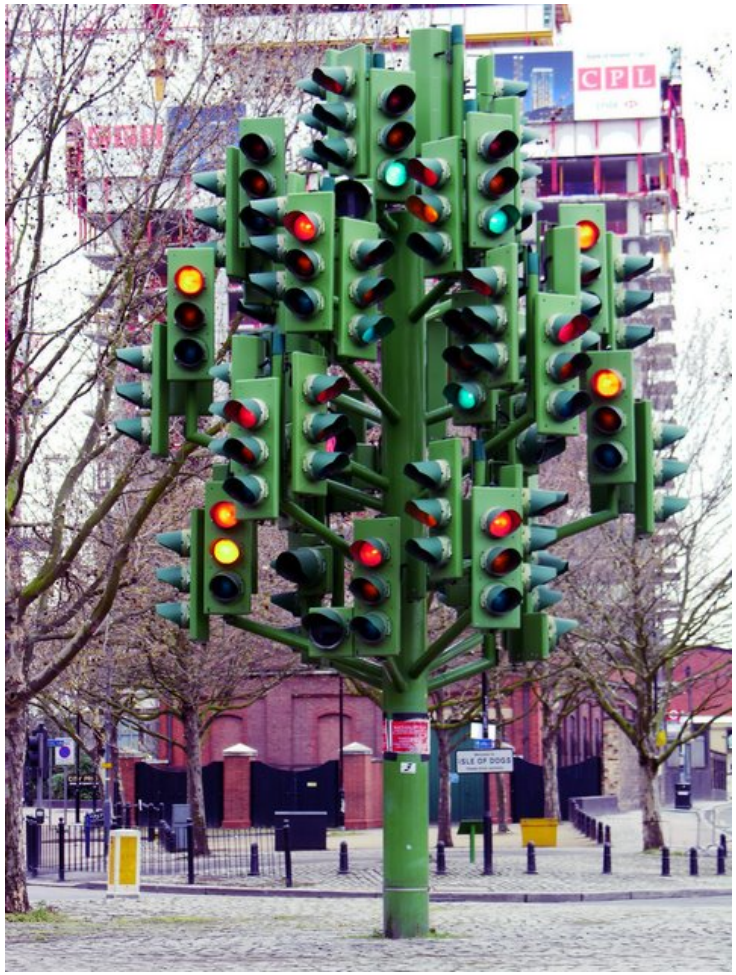
Pre-alarm:
when the probability of an eruption increases all bodies in volved in the emergency plan must enter a state of alertness and be dispatched on the area to be evacuated (red zone).

Alarm:
when the eruption is imminent and people are evacuated from the red zone.

Each color corresponds to a set of specific actions that have to be made by Civil Protection. **Moving from one color to another means a lot of things in terms of impact on society.**

So, how can volcanologists **define 'low', 'medium' or 'high' probability**? These thresholds **do not have any scientific meaning**, but they have a lot to do with the costs and benefits of any set of mitigation actions.

Defining the traffic light



Usually, the traffic lights are defined according to the magnitude of the event. So, it is implicitly assumed that the higher the magnitude, the higher the risk for the future; but there is no any quantitative estimation.

In practice, the threshold magnitudes are not defined according to pure scientific thoughts, but looking at the costs to keep the traffic light amber (or red) too often.

Few final remarks

- The hazard/separation principle is essential to **separate and clarify roles and responsibilities** in the risk reduction process.

- Such a distinction facilitates the interaction of different experts in planning **transparent risk reduction protocols**.

- This principle is very important for **governmental institution** to define their mission.

- A single scientist can wear **different hats** simultaneously. S/he just need to be aware that **each hat requires (very) different competences**, and that a good, even an excellent scientist, is not necessarily a good decision-maker

Thank you