



Humboldtians in Focus

A Risky Business

By Georg Scholl

When can we expect the next tsunami or perhaps a gigantic earthquake? People living on the coast of Japan or in cities like Los Angeles have no idea, and live with the risk. Seismologist Seth Stein elaborates strategies for dealing with incalculable risk.

The wall is ten metres high and stretches along the coast for kilometres. But when the wave hits, it dwindles away to nothing. Masses of dirt-laden water surge over the seawall and crash down on the other side, sweeping away everything in their path: traffic lights, cars, entire ships. Seth Stein stops the video and lets the images speak for themselves. When the devastating tsunami hit the east coast of Japan in 2011 and caused the nuclear disaster at Fukushima, no one could have foreseen the scale of the catastrophe. The earthquake that triggered the tsunami was 20 times more powerful than seismologists had expected, and the size of the tidal wave outstripped the boldest predictions. Seth Stein is an earthquake researcher at Northwestern University in Evanston, USA. Trained at MIT and Caltech, the Humboldt Research Award Winner is one of the thought leaders in his discipline. For more than 30 years, Stein has been investigating the causes and impact of earthquakes. His experience has taught him to be modest: "We overestimate what we know and underestimate what we don't know."



Disastrous tsunami in Japan, 11 March 2011: triggered by an earthquake measuring 9, huge waves crash down on the coast road in the north-eastern town of Miyako.

Photo: picture alliance / dpa / AFLO

Earthquake researchers like Stein record every quake that registers on their instruments, but because the requisite equipment has only been available for the last 100 years or so, in the great geological scheme of things, seismologists' earthquake maps chart only a tiny segment. The concomitant spatial and temporal patterns, which are usually complex, are often impossible to trace. So drawing inferences from the past and applying them to the future can be misleading, according to Stein. "Our predictions on how earthquakes will behave are like the classic arcade game Whac-A-Mole, where you try to hit a plastic mole over the head with a mallet when it pokes its head out of its hole. You think it's going to pop out of a particular hole – but then its head pops up somewhere completely different instead."

So what message do researchers have for the inhabitants of cities like Istanbul, Tokyo, Teheran, Mexico City or Los



Quakes with explosive force

Source: Seth Stein, Jerome Stein: Playing against Nature, Wiley & Sons, 2014



Professor Dr Seth Stein

Photo: private

Humboldt Research Award Winner Professor Dr **Seth Stein** is currently cooperating with colleagues in Göttingen and Munich, searching for patterns in historical records of past earthquakes in Europe. In the recently published book, "Playing Against Nature", which he wrote with his late father, Jerome, he describes his research for a broad-based readership.

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Angeles, who all live under the threat of the next Big One? “What we can tell them is that they live in an endangered area. No more than that. The Earth is much too chaotic, and we don’t know enough to be able to develop a reliable risk prediction model for natural disasters,” says Stein. Thus for him as a scientist the most important priority is to understand the processes better and make predictions more reliable.

“Tectonic plates move very slowly, at about the same speed as our fingernails take to grow. We have to find out more about how they build up pressure over a long period of time, and when this is suddenly going to be released in a quake,” Stein notes. Most earthquakes happen where the plates rub up against each other and collide, which is a plausible explanation for the frequent quakes. But some earthquakes occur at the centre of the plates, a long way from the edges. This type is particularly difficult to predict and is a hard nut for Stein and his colleagues to crack.

It could take a long time to acquire a better understanding of the geological principles. In the meantime, the inhabitants of the regions affected continue to live in uncertainty. This prompted Stein to study how society deals with risk and how economic cost-benefit analysis could help to make sensible decisions. There is a lot of money at stake because natural disasters are increasingly expensive. In 1980, the impact of flooding, storms, major fires, droughts, volcanic eruptions and earthquakes worldwide cost some 75 billion dollars. By 2012, according to Stein, this sum had exceeded 400 billion. So it is clearly worth investing in the avoidance and reduction of risk. But what constitutes a reasonable level of risk? And how much risk are we prepared to accept?

False alarm: not lava, snow

The costs generated by wrong predictions, even when no disaster actually occurs, are illustrated by the events at Mammoth Lakes, a winter sport resort in California’s Sierra Nevada. The resort is located on the slopes of a volcano and was a prime skiing area until 1982, when government geologists warned that a volcanic eruption was imminent. The disaster failed to materialise, as did the tourists, although instead of lava, pristine powder snow continued to grace the slopes. House prices plummeted, shops closed, people moved away. It took a decade for the economy to recover and the skiers to return.

Should the scientists have kept their warnings to themselves? How big would the damage have been if a volcanic eruption had hit the people unprepared? What is the ethical and economic value of human loss?

Looking to Japan: Is it more expensive to build new, even higher flood barriers or to relocate a coastal town?

Immediately after a disaster is not necessarily the right time to discuss this kind of question dispassionately. It is the hour of political action and announcing consequences. Measures



Otsuchi, Japan, 14 March 2011: the sea wave that hit the town three days previously, leaves massive devastation in its wake.

Photo: picture alliance / dpa / epa / Asahi Shimbun



World earthquake map

Source: Seth Stein, Jerome Stein: *Playing against Nature*, Wiley & Sons, 2014

implemented in the wake of disasters do not always achieve a healthy balance in relation to their impact, as illustrated by the campaign to make Californian hospitals earthquake-proof. The relevant resolution was passed after an earthquake in the San Fernando Valley in 1971, which destroyed a number of hospitals and killed more than 50 people. The California state government subsequently ruled that hospitals should be encased in a steel frame to make them more stable. This work is still in progress and the costs continue to grow. It will not be completed before 2030. “What we spend on one thing, we can’t spend on another,” says Stein.

“Could we save more lives by investing at least part of the money in human resources or medical equipment? This example shows that we need to conduct a sober, transparent analysis of costs and benefits, especially when dealing with public goods.”

When jobs are more important than risks

Stein has developed a mathematical model setting the costs of mitigation against projected losses and the probability that a certain hazard event will occur. The result is a cost curve on which the optimal balance between mitigation and willingness to take risk is located at the lowest point. More mitigation would be unreasonable; resources would be better invested elsewhere.

The model allows scientists to take a systematic look at the pros and cons when dealing with hazards. But, as Stein knows, the calculations are subjective, especially when considering risk from the perspective of a human lifetime. “For the people living in a place economically dependent on a crumbling nuclear power plant, the short-term risk of losing their jobs if the plant is closed down may weigh more heavily than the threat of a possible nuclear accident or the long-term problems of radioactive waste in decades to come.” What is important, according to Stein, is to assess the risk in the first place and consider the costs and benefits thoroughly before making a decision. “We need to do more to integrate scientific, economic and political considerations,” says Stein, who always gives his students a thinking test to illustrate the point: If a bus ticket costs 2 EUR and the fine for fare-dodging is 40 EUR, at what point is it rational to buy a ticket? The students think about this for a while until eventually one plucks up courage and asks how often someone comes round to check the tickets. And this, in Stein’s opinion, is precisely the point. The students have to make a decision based on their own, limited experience. When it comes to natural hazards, says Stein, the situation is no different. “We have to live with uncertainty and



The Veterans Affairs Medical Center in San Diego was later encased in a 60 million dollar steel construction designed to stabilise the building during earthquakes.

Photo: VA San Diego Healthcare System



Northern Sumatra, Indonesia, January 2014: ash clouds and thunder erupting from Mount Sinabung. Who would still dare to attend that church?

Photo: picture alliance / AP Photo / dpa / Binsar Bakkara

make the best possible decisions on the basis of very limited information.”

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