Installing Seismic Risk of Istanbul

Calculated surprise and torn-down slabs. An introduction to the art-science project *Installing Seismic Risk of Istanbul.* Supported by the German Research Centre of Geoscience GFZ Potsdam and presented at the Forecast Forum, HKW 2015.

I want to start by introducing a pervasive image, whose complexity, composition, and emotional impact will assist in the understanding of my art-science experiment called *Installing Seismic Risk of Istanbul*. The author of this photograph is Idris Bedirhanoglu,[1] a structural engineer who is researching at Dicle University in Diyarbakır, Turkey. The photograph shows a breathtaking scene shot in the aftermath of a catastrophic earthquake that occurred 2011 in the city of Van in eastern Turkey.

It depicts the ruins of an apartment building. In the background, part of the building has moved into complete instability, held only by the arm of the crane (in the right-hand corner). However, the front of the building has pancaked completely, which means that all the floors have piled tightly one on top of another, and the walls have fallen away completely. What comes to the fore in this image is a broad concrete slab, the top of the building, burying everything underneath it. This scenario may produce feelings of shock and powerlessness. It is heart-wrenching when one realizes that between those tons of floors lay the bodies of the occupants, crushed to death.[2] It is far beyond the everyday experience of being at home and looking up at neatly plastered ceilings, that these ceilings could become weaponized. But here in this photograph, against this background of normal perception, these violent slabs come to the front, very dominant and visible. However, the deep transformation of the form and aesthetics of the building into something that is no longer recognizable, into bare concrete fragments leaving sparse remains and signs of everyday life, may produce a feeling of the uncanny. This building that was constructed to protect and to shelter has finally turned into a violent object, acting almost as if it were alive and producing complete disorder. In the face of this disorder, helpless against the tightly piled concrete, the small group of emergency rescue

[1] See <http://www.dicle.edu.tr/a/idrisb/webeng/index.htm>.

[2] Cf. Randolph Langenbach, “Preventing Pancake Collapses: Lessons from earthquake-resistant traditional construction for modern buildings of reinforced concrete.” Paper presented at the International Disaster Reduction Conference (IDRC), Davos, 2006, p. 3; also online <http://www.conservationtech.com/RL's%20resume&%20pub's/RL-publications/Eq-pubs/2006-IDRC-ICCROM/Langenbach(ICCROM)3_0.pdf>.

staff in their shiny red workwear signals a danger and a warning that comes too late.

Photograph taken by Idris Bedirhanoglu, Dicle University, Diyarbakır, Turkey, 2011.

However, if Istanbul, a megacity of 18 billion people, were to be hit by a major earthquake, the scenario of collapsing buildings as seen in the photograph would be multiplied by an incredible number. The city is a candidate for an urban earthquake in the near future, a direct hit right underneath this large and often poorly constructed city, with catastrophic consequences. Due to Istanbul's recent history of reinforced concrete construction, which has facilitated the city's rapid growth, large parts of the so-called *Gecekondu* settlements have little or no earthquake resistance.[3] Despite its beauty and presence, Istanbul is located on one of the most seismically active plate boundaries of the planet—the NAF or North Anatolian Fault system—which is ready to rupture and shake the city.

[3] Claire Berlinski, "The Politics of Earthquakes," *Los Angeles Times* (posted July 24, 2011), online <http://articles.latimes.com/2011/jul/24/opinion/la-oe-berlinski-earthquakes-20110724/2>.

But what do we really know about the future we face? Accurate prediction is a cornerstone of scientific knowledge, but earthquakes cannot be predicted in a deterministic way. Despite this evidence, earthquakes are forecast over the long term and seismic risk is assessed. But what is seismic risk?

Risk is a very complex and paradoxical concept with no final definition. It can be said that risk is not real; it is not the disaster. It is the anticipation and imagining of a possible future disaster. Therefore, risk only exists in a permanent state of possibility and virtuality.[4]

In the scientific language of risk, the possible future disaster is anticipated in a certain way. It is quantified and calculated in terms of probabilities. For seismic risk, the probabilities assessed are very low, but they result in very significant consequences. Seismic risk is characterized by calculating two main elements: first, the recurrence and strength of future earthquakes on fault lines (as ground motion accelerations); and second, the building's response to a seismic event and its vulnerability to collapse or damage—two dynamics whose interface is frequently abysmal.[5]

So, the disaster is not only attributed to an external natural agent, the earthquake, but also to human decisions. Humans are constructing buildings of variable earthquake resistance. And the way in which they are constructed depends, for example, on knowledge or ignorance, economics, building codes, and the builder's integrity. Corruption is a very big problem: the most corrupt sector worldwide is the construction industry.[6]

The risk of an urban earthquake has increased worldwide due to the rapid growth of poorly constructed megacities near active fault zones. In the 1999 earthquakes in Turkey, for example, which resulted in approximately 30,000 deaths, "it was the newest buildings in the

---

[4] Cf. Ulrich Beck, "Living in the World Risk Society," *Economy and Society*, vol. 35, no. 3 (2006): pp. 329–45; also online <http://www.skidmore.edu/~rscarce/Soc-Th-Env/Env%20Theory%20PDFs/Beck--WorldRisk.pdf> (p. 4 of PDF).

[5] See the shake table simulation at <https://www.youtube.com/watch?v=3z4YLUqOysI>.

[6] Cf. "Seismologist Roger Bilham: 'In recent earthquakes buildings have acted as weapons of mass destruction,'" Democracy Now (posted March 1, 2010), online <http://www.democracynow.org/2010/3/1/seismologist_roger_bilham_in_recent_earthquakes>; cf. Nicholas Ambraseys and Roger Bilham, "Corruption Kills," *Nature*, vol. 469 (2011): pp. 153–55; also online <http://ethicalsystems.org/sites/default/files/uploads/Nature_CorruptionConstruction.pdf>.

damage district that suffered the most damage."[7] A new term has emerged in recent years to describe the problem, not with old buildings but with new reinforced concrete buildings: "pancake collapse."[8] While concrete

> has the appearance of an advanced technology, based upon theoretical understanding of stresses and chemistry of cements and knowledge held by trained experts, reinforced concrete is also at the same time a simple process that can be, and in many parts of the world is, executed by people with no theoretical knowledge what so ever.[9] […] It is the ease with which concrete lends itself to [nontransparent] self-building that makes it hard to sustain the notion that we are dealing with an advanced material.[10]

Instead, concrete buildings rely heavily on their internal structure being hidden, on the physical distribution of forces remaining invisible, and on their ability to mask weak spots resulting from weak choices. This poses the very old and highly explosive question of who or what is responsible for earthquake disasters. That is the second paradox—to a large extent, seismic risk is produced by humans themselves.

Another paradox related to risk is that risk starts where certain knowledge ends. This means that uncertainty is always on the other side of all scientific knowledge about the future. To complicate the problem, earthquake science faces different levels and characteristics of uncertainty. In the physical world, the probabilities assessed remain uncertain, imprecise, or completely unknown, hard or impossible to calculate or decrease—unlike in a casino, where one deals mostly with known and calculable probabilities.

With the help of "constant advances in technologies of data collection, analysis and interpretation,"[11] scientists expect that some uncertainties can be reduced with more research and data. When facing a lack of data—and this is normal, because large earthquakes are very rare or hidden in the Earth's history—then an interesting scientific approach could be applied: the so-called subjective probability judgment. This reveals another paradox related to risk. In the philosophy of statistics, probability can be divided into either a physical property, like

---

[7] Langenbach, "Preventing Pancake Collapses," p. 3.

[8] Langenbach, "Preventing Pancake Collapses," p. 3.

[9] Adrian Forty, *Concrete and Culture: A material history*. London: Reaktion Books, p. 28.

[10] Forty, *Concrete and Culture*, pp. 28–9.

[11] Godofredo Pereira, "The Underground Frontier," Continent, issue 4.4 (2015): p. 2; online <http://continentcontinent.cc/index.php/continent/article/view/210>.

mass or distance, or just a degree of belief. So, parts of earthquake science are very close to science fiction; this is referred to as intersubjectivity.[12]

In other words, earthquake science is operating at the limits of knowledge and at the limits of calculation, because the deep uncertainty of all involved represents a complete absence of knowledge. It cannot be measured or reduced. What could happen in the future is beyond imagination and experience, a surprise—we don't even know what we don't know. Which means that everything is now possible. Maybe Fukushima was an example of this uncertainty, or maybe it was just pure ignorance. So can we peer into the darkness and approach the unknowable risk? Ulrich Beck, the well-known German sociologist and risk scientist, said in this regard: "[T]o knowledge, therefore, drawn from experience and science there now also has to be added imagination, suspicion, fiction and fear"[13] in order to cope with the future.

Installing Seismic Risk of Istanbul therefore deals with the installation of a paradox, the installation of a calculated virtuality and possibility. It means to create an imagination of the future disaster and enable the possibility of violence to occur through uncertain calculations. How is this being realized?

Here, I want to return to the photograph showing the collapse of a building during the Van earthquake and the uncanny concrete slabs that tear into the foreground. To anticipate and visualize the future violence, this background, the concrete fragments are now shifted to the front and layered under the ceiling of the building. The concrete slabs exhibit not only the aesthetics of violence, but also its force. A real force that could harm. Now, in order also to provide a possibility of violence occurring due to uncertain calculations, every slab is coupled with and animated by the "uncertain" probabilities of earthquakes and building collapse calculated by the sciences. This means that the uncertain knowledge of scientific calculations is brought into a real-time performance. This simulation is carried out by calculating engines (random number generators) that perform aleatoric uncertainty (Latin: *alea* = dice) every second or every tenth (this is the type of uncertainty that occurs when throwing a dice). In the simulation, time is not modeled by accelerating the timeline; instead, the simulation and performing probabilities operate in durations of real time.

---

[12] Cf. John Rundle, "Forecasting Natural Disasters in the Chaotic and Complex Earth," lecture at Santa Fe Institute, November 15, 2006, min. 30:50, online <https://www.youtube.com/watch?v=z2E0SZmOUNA>.

[13] Beck, "Living in the World Risk Society."

The slab fragments that are at risk remain in a permanent state of possible collapse. A real possibility exists that slabs could come crashing down in the venue. A falling 200 kg slab could produce 2 tons of dynamic force, which means that a proper risk is created in the venue. But the probability of a slab falling down is very low. One example of the long-term probability of a major earthquake in Istanbul would be 60 percent over thirty years.[14] A mathematical conversion of this thirty-year forecast into the probability over one year results in a probability of 2 percent, and per second results in a probability with the number 10 to the minus 8**.** This probability occurring seems negligible, but not over a longer time span.

For testing purposes and in order to establish an emotional relationship, the famous experimental animal—a flock of live cockatoos—will linger under the slabs, protagonists of the canonical experiment on a bird in an air pump and of the construction of facts through technical instruments and scientific observations.

The project considers the historical and cultural role of concrete in the installation of risk in Istanbul, owing to the city's construction qualities and practices, and to the material characteristics of reinforced concrete constructions themselves. Concrete is appearing as the material of the architecture of modernity. But it is also emerging as a very vulnerable and uncertain substance in cases where seismic activity impacts the surface of widespread un-engineered (*Gecekondu*) or corrupt concrete constructions. The project will illustrate these ambiguities of reinforced concrete. The distinct building practices and material strength are used to calculate the probabilities of seismic building collapse in Istanbul, represented by the hanging concrete slabs. Each slab represents a different level of concrete building resistance and type of construction practice in Istanbul.

To complicate things even more, the performance also embeds higher-level uncertainties of seismic risk, such as the elicitation of expert judgments, part of the so-called epistemic uncertainty. The performance will use and visualize the various model approaches, argued beliefs, and narrations of experts (with distinct reputation, experience, etc.). This provides an evaluation of confidence in these experts.

I will now summarize some characteristics of the installation. In this experiment, the risk of a future disaster is produced not only by reality or a "natural environment" but by artifacts and human calculations of reality, with a calculated future and a calculated surprise. It somehow

[14] Ian Traynor, "A Disaster Waiting to Happen: Why a huge earthquake near Istanbul seems inevitable," *The Guardian*, December 9, 2006; also online <https://www.theguardian.com/world/2006/dec/09/turkey.naturaldisasters>.

reflects the contemporary technological condition and the perversion that risk is mainly produced by humans themselves and by their calculations and technologies. As the basis and the result of our decisions.

The animated slabs could be seen as three-dimensional maps, tracing back the causes and relations responsible and participating in the collapse or resistance of buildings, from the earth underground to the construction practices and decisions made by scientists, politicians, or building companies, among others.

Maybe the installation is also a metaphor, a Damoclean sword, which is not connected to reality but to the calculation of reality, emphasizing that construction always comes with responsibility.

The installation also represents a time experiment, interfacing geological time with human time. For seismic risk, that means facing low probabilities with great consequences.

And finally, it is not about the falling here, but about the possibility of falling.

The past is the scientific basis for looking into the future. It might give a clue to what lies ahead for Istanbul. A guaranteed seismically active Turkey. In the venue, the installed risk has to be managed. The falling of a slab is a real seismic event for the building. Under the conditions of the city, Istanbul's settlements and citizens have to be protected, and society and politics have to be involved in risk reduction, resilience, and decision making. The scientific risk assessments and anticipations serve here as knowledge bases for these decisions.

As an unanticipated and surprising consequence, the scientific anticipation of future earthquakes in Istanbul's built environment has mobilized a state-directed urban renewal of vulnerable communities in the city. It established stricter building codes, but also a new law that allowed the government to survey, demolish, and rebuild homes at risk of damage and allowed the involuntary displacement of residents, with no legal possibility of protesting, leading to an increase in real-estate speculation and the destruction of social communities.[15] This process is an example of the way in which knowledge produced by science—once it is captured by quantification procedures and algorithms that model the Earth's future—could

[15] Paul Short, "Istanbul: A city transformed," Pulitzer Center on Crisis Reporting (posted August 27, 2014), online <http://pulitzercenter.org/reporting/eurasia-turkey-istanbul-development-housing-gekekondu>.

become a basis and a motor for ambiguous new forms of decisions and disputes, measured through capitalist modes of valorization.[16]

Svenja Schüffler's 3-D video sketch of the installation *Installing Seismic Risk of Istanbul* can be seen at <https://www.youtube.com/watch?v=4lVo8Bt7wc4>.

[16] Pereira, "The Underground Frontier," p. 2.