Containing the earthquake risk in Istanbul's city planning: perspectives from scientists

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Abstract. Earthquake risk is a vast issue triggering the urbanization of Istanbul. Plans and laws, conceived as sociotechnical tools that play a key role in this process, combine scientific facts and recommendations for the city. This article discusses the production of scientific facts and their inclusion into planning tools to define earthquake risk in Istanbul. Grounded on the Actor-Network Theory (ANT), our methodology follows the statements of scientists in journal articles, supplemented with semi-directed interviews with geologists and geophysicists. On this basis, the article shows the circulation of statements and scientific facts until they get selected to be included in sociotechnical tools with which the city is performed.

1 Introduction

This study investigates the role of translation in managing earthquake risk. As an important theme in Sciences and Technologies Studies (STS), "translation" aims to identify courses of action that enable actors from different fields to cooperate with each other while also defending their own interests and values. [1] My own study will show that the assessment of risk in the scientific field is a translation's process of some of its components. This process aims at formulating a certain definition of the risk that planning tools will manage. "Containing the risk" encompasses the risk assessment and its mitigation. My findings are based on the way scientists define the earthquake risk for Istanbul. The assessment seems to contain risk in a narrow perspective. Nevertheless, it is not due to issues coming from the outside of the laboratory. I will then discuss the mechanisms through which constructed scientific facts are contained into urban planning tools.

1.1 An analysis based on all the actants of earthquake risk mitigation: human and non-human in action

I don't aim to look at the "earthquake risk" on a hazard-based perspective. According to the theoretical framework I follow, there is no reason to make any distinctions between "nature" and "culture" and risk does not belong completely to either of those categories. [2, 3, 4, 5, 6] Earthquake risk illustrates this: there is no *a priori* reason to separate physical from cultural factors in analysing a risk within a particular territory. [7] ANT emphasizes the heterogeneity of our society, which is composed of both human and non-human actors, as well as of the networks that connect one another. [6] Following this logic, Bruno Latour proposes a particular conception of "agency", which he calls the "capacity of doing". In his terminology, both humans and non-humans can be "actants". [3] He considers non-humans as actants insofar as they participate in defining humans' identity within a network. By means of their interactions, all actants participate in a definition of a risk. [8] Valérie November has already used ANT to understand the relationship between a risk and a given territory. She follows all the actants in the way they identify, evaluate, and mitigate the risk and considers the total risk level to be the product of translations and reconfigurations occurring in the communication between different actants. [9]

How to analyse the relationships of actants to earthquake risk mitigation and urban production? We propose to use Michel Callon's notion of "*interessement*", which denotes "all the actions of an entity […] that endeavour to impose and to stabilize the identity of the other actants that it defines by its problematisation". [5] Regarding the two above-mentioned issues, we could thus focus on the following human actants: a) scientists aiming to model earthquake waves according to geological and geophysical data; b) engineers aiming at ensuring the solidity of buildings; c) planners attempting to "cure the urban crisis" [10]; d) urban inhabitants concerned about their safety; and so on. We could also identify some non-humans involved in negotiations with those human groups, such as seismic waves, geologic layers, seismic faults, and buildings. For example, a seismic wave needs to spread into the ground, while buildings can create obstacles for the implementation of an urban project. One common problem that arises from all those actants is the following: is it possible to live with the risk of an earthquake? My study focuses on scientists and follows Latour's work in evaluating the modes of enunciation that make it possible to detect "all the absent elements, the presence of which is nevertheless presupposed by speech thanks to marks that help the competent speaker to bring them together in order to give meaning to the utterance". [11] My methodology assumes that "the laboratory is part of a network and takes care of fact, not theory". [12] How is a scientific fact produced? I will address this question by analysing the statements found in articles written by scientists and by following their circulation in other articles.

1.2 Method

The methodology for this study is divided into two parts. First, three articles have been chosen for their recurrence in research about the North Anatolian Fault in the Marmara Sea in Turkey: Şengör et al's "The geometry of the North Anatolian transform fault in the Sea of Marmara and its temporal evolution: implications for the development of intracontinental transform faults" [13], Yaltırak's "Tectonic evolution of the Marmara Sea and its surroundings" [14] and Armijo et al's "Submarine fault scarps in the Sea of Marmara pull-apart (North Anatolian Fault): Implications for seismic hazard in Istanbul". [15] Those articles have been analysed according to the type of statements made by Bruno Latour and Steve Woolgar in their study *Laboratory life: the construction of scientific facts*. [12] Considering ourselves as "ignorant", it is therefore by an ANT analysis of scientific articles that we will be able to identify recurrences or exceptions, agreements or disagreements about the same topics.

Secondly, for each of those three articles, I have selected five articles (fifteen in total) quoting them in order to follow statements and see how they are quoted. I have analysed how each of the five articles citing the original three articles quoted and discussed their statements in order to legitimize their own thesis. In some cases, articles transformed the source's meaning.

Finally, I complete my analysis with fifteen semi-directed interviews with geologists and geophysics engineers and civil societies in Istanbul.

1.3 Analysing statements

The analysis of statements shows how they appeared with an organized structure in the first three articles mentioned above.

A first part of the statements includes general facts at a continental scale that are taken for granted by the scientific community: general organisation of the tectonic plates, their direction, and their displacement: "The 1500-km-long North Anatolian Fault Zone (NAFZ) bifurcates into three branches to the east of the Marmara Sea" [14]. Most of the time researchers rely on other researchers to support a fact: the more the references cited, the more consistency the fact acquires. We can also find speculation disguised as hypothesis: "A uniform right-lateral strike-slip motion parallel to the Anatolia/Eurasia plate boundary may have facilitated the westward progression of earthquake ruptures along most of the eastern and central NAF." [15]

A second part explains the methods and tools used. These are justified on the fact they have been already used by peers. While the methods are the same in the three articles (analysis by bathymetry), they distinguish each other by the site analysed in the Marmara Sea and the volume of data collected.

A third part explain and analyse the data by presenting them as facts or by relying on other statements with their modalities to support an analysis: "In detail, Sorlien et al. (2012) age model taken as face value does suggest some slowing down of the subsidence over the last 130–330 ka once compaction is taken into account". [13] We can observe the use of conditional tense to qualify the analysis. This part shows that data are interpreted and need either to be validated by others, or to be considered as hypothesis. Therefore, all the articles contain a discussion part (fourth part) to refute or validate other scientists' assumptions, or to create new hypotheses.

A fourth part as a conclusion provides conjectures and speculations: "The normal faults bounding the Marmara shelves, which started their activities in the early neotectonic period and are also known as the northern and southern boundary faults, can be still active as normal faults due to existing rotational extensions (1 - 2 km) between the blocks." [14]

A last part consists in acknowledgments that include institutions providing research funds, universities, laboratories, colleagues, administrative staff etc. All those human actants contributed to the production of scientific facts too.

This first analysis shows that the production of scientific facts is included in a large network of human and non-human actants. While the structure of each article is very stable, I observed that statements are not: they rely on other statements, and they contain assumptions.

2 The circulation of statements

Based on a corpus of fifteen articles I observed how the statements of the first three articles circulated. My analysis shows that statements circulated outside the laboratory and in other networks including researchers who did not belong to the same research field or who were from other countries. Often, the original statements were transformed while circulating. They could either be taken for granted (Yaltırak's "The basins in the Marmara Sea, up to about 1200 m deep, are the products of a superimposed evolutionary history controlled by two different in age fault systems: the early Miocene-early Pliocene Thrace-Eskişehir Fault Zone and its branches, and the late Pliocene-Recent, dextral strike-slip North Anatolian Fault (NAF) and its branches" [15]), or remain hypothetical (Şengör et al's "however, based on geomorphologic expression, slip rates on these secondary faults are expected to be much smaller than on the main fault"). [16] Actually, the more a statement circulated, the more it acquired consistency and legitimacy.

3 Uncertainties about defining the earthquake risk

According to interviews conducted with geologists and geophysics engineers, three main parameters are necessary to evaluate the earthquake risk at a given location: a) the wave source, b) the geological structure of the ground, and c) the geological structure on the built site. I decided, based on the analysis in the preceding section, to focus on the wave source. On that point, it turned out that researchers disagreed on the position and the character of the NAF below the Marmara Sea. Yaltırak defended a type of pull-apart fault (stubborn fault giving rise to an elongated sedimentary basin). [14] Armijo, a type *in step* [15]. Şengör, a fault in a single segment. [13] While investigations aimed to produce a more precise topography map of the Marmara Sea from bathymetrical data, all could be imprecise and sensitive to any perturbation adding noises into the triangulation map. Therefore, I can point out at least two uncertainties that conditioned the ability of geophysical engineers to determine the real shape and location of the fault. On the one hand, many of the assumption analysis are issued from interpretations of the data. On the other hand, it is also difficult to precisely determine the physical processes of the rupture not just because the stress submitted by the displacement of the plates is not precisely quantifiable, but also because this stress is different according to the localization and impossible to apprehend as a whole considering scale reports.

Furthermore, it must be pointed out that parameters outside of the laboratory play substantial role in the risk assessment. As underlined by one of the interviewees, it is a matter of funds and budget for scientists: “I don’t know every square centimetre, individual density, porosity, velocity and the rigidity model and so on. […] It requires supercomputers which we don’t have in Turkey. […] I’m talking about a 100 million euros computer […]. So that’s why it’s all a matter of how rich you are” (interview conducted in November 2019 with T., geophysicist). That also shows the competition between laboratories regarding the budget allocated to their research and explain the creation of scientist collaborations with other laboratory outside of Turkey to manage new research.

4 Then, how to qualify the earthquake risk?

In the end, for scientists, the earthquake risk constitutes a probability based on the quantification of the seismic wave including magnitude and approximative date of the next earthquake with a percentage of uncertainty. This percentage contains all the previous uncertainties analyzed above. We can take as an example this statement: “We find a 62 +/- 15% probability (one standard deviation) of strong shaking during the next 30 years and 32 +/- 12% during the next decade.” [17] At this point of the demonstration I observed then that a scientific fact taken as given hid many uncertainties while used to produce tools for decision such as an urbanization master plan. These uncertainties are indicative of the instability of the actants in the networks in which they are involved: by reducing these uncertainties, the actants seek to stabilize. I aim now to observe how those scientific facts are included into socio-technical tools in urban planning. A sociotechnical tool makes it possible, following the definition of Michel Callon, to stabilise actants. [5] According to Madeleine Akrich, its role is to “constitute organizing elements of relations between humans and non-humans among themselves and with their environment”. [18] It is also interesting to consider the performative dimension pointed out by Valérie November. [9]

5 Including scientific statement into performative sociotechnical tools

The analysis of two sociotechnical tools for urban planning – the *Earthquake Master Plan for Istanbul* (EMPI) of 2003 and the Disaster Law n. 6302 of 2012 – reveals how they have been shaped by scientific statements and how they have transformed statements in return. Those tools are performative in the way that they have an impact on new actors.

After the earthquake of 1999 in the Marmara region, an *Earthquake Master Plan for Istanbul* was elaborated to propose solutions for earthquake risk mitigation in urban planning. Four Turkish universities were involved to produce analyses spelling (Orta Doğu Teknik Üniversitesi, Istanbul Teknik Üniversitesi, Yıldız Teknik Üniversitesi and Boğaziçi Üniversitesi), as well as other international institutions such as the JICA (Japan International Cooperation Agency) or the ARC (American Red Cross). It appears that one of the main statements about the earthquake risk was the following:

> "The similarity between Figure 2.1.2 and Figure 2.1.3 demonstrates that the occurrence of the M=7.5 scenario earthquake used in the assessment of the seismic risk Istanbul is highly probable in the next 70 years. Actually, based on the stress transfer theory, Parson et al. (2000) estimate a 60% probability of having a destructive earthquake in the next 30 years (corresponding to a return period of 50 years)". [19]

This statement shows that the selection carried out among all the analyses of the earthquake to produce a tool was not neutral.

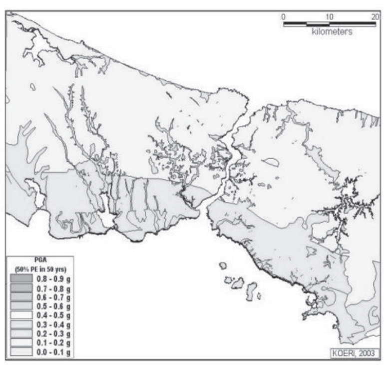

Fig. 1: Figure 2.1.2 in the *Earthquake Master Plan for Istanbul*, 2003. Source: *Earthquake Master Plan for Istanbul*, 2003.

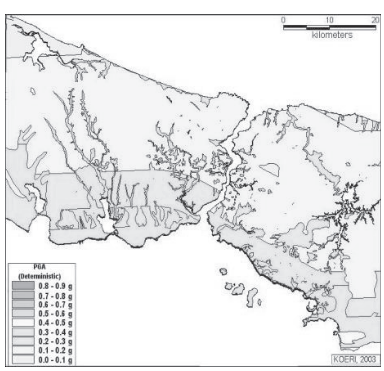

Fig. 2: Figure 2.1.3 in the *Earthquake Master Plan for Istanbul*, 2003. Source: *Earthquake Master Plan for Istanbul*, 2003.

Secondly, the purpose of the law n°6306 on the transformation of areas under a risk of disaster (*Afet Riski Altındaki Alanların Dönüştürülmesi Hakkında Kanun*) implemented in 2012 was to provide solutions to reduce the risk of seismic disasters and to create a better environment and better housing. It appears that assessments of risk zones were not directly coming from scientists, neither from the Master plan, but from other institutions such as the Ministry of Construction and Urban Planning (TOKI) or private persons. Thus, this law allowed people who were not scientists to "speak" on their behalf. Indeed, by facilitating expropriations and changes in the plan on the risk's behalf, many critics emerge from civil societies. For them, it appears that this law contributes to serve economical and speculative interests in the construction rather than risk mitigation.

Members of civil societies are far from being passive. Since the earthquake of 1999 in the Marmara region and the authoritarian shift [21] of the Turkish government, associations (*dernekler*) contribute to produce and disseminate scientific statements. For instance, in Avcılar, a vulnerable district to the earthquake, some associations argue for a better protection and prevention. To manage risk in their own way, those associations involve scientists and other types of experts as one of them told me: "there is the Chamber of Geophysical Engineers, we ask for their support. There are engineers in our Community Center, we ask for their support. Apart from that, we ask for support from psychologist friends. We first receive training ourselves, and after the training we receive, we try to explain it to people." (Interview conducted in November 2020 with A., member of Avcılar Halkevi). As this other type and non-institutional dialogue exists, it questions in return the use of scientific facts to manage earthquake risk.

6 Conclusion

The analysis of the circulation and implementation of scientific facts has shown that those facts, after being selected, could be qualified as readymade science [20] and were subject to new translations in the development of devices federating and stabilizing the identities of actants. Such devices were performative insofar as each of them used the same information but had different scopes and carried different challenges and criticisms. The Actor-Network Theory has shown us that questioning the matters of risk containment requires to follow the practice of each actant playing a role in the negotiations toward the production of sociotechnical devices and to follow the way in which they define a risk. This requires having a look at more complex knowledges of the value of a socio-technical device. In Istanbul and widely in Turkey, the task is not easy as actor's interests confront themselves with capacity of action that remain unbalanced. Other types of dialogue inside civil societies assumes however that containing risk is a common concern including detour from the institutional framework.

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