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Earthquake risk communication as dialogue – insights from a workshop in Istanbul's urban renewal neighbourhoods

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Abstract. An important paradox of hazard communication is that the more effectively a potential physical threat is made public by the scientist, the more readily the scientific message becomes normalized into the daily discourses of ordinary life. As a result, a heightened risk awareness does not necessarily motivate personal or collective preparedness. If geoscientists are to help at-risk communities adopt meaningful measures to protect themselves, new strategies are needed for public communication and community engagement. This paper outlines an attempt to develop a novel approach to train geoscientists, using doctoral and post-doctoral researchers in an EU integrated training network studying tectonic processes and geohazards in Turkey. An urban field visit to seismically vulnerable neighbourhoods in Istanbul allowed the researchers to meet with local residents facing the seismic threat. Those meetings exposed the complex social, political and cultural concerns among Istanbul's at-risk urban communities. These concerns were used to provoke subsequent focus group discussions among the group of geoscientists about roles, responsibilities and methods of communicating hazard information to the public. Through the direct testimony of local residents and geoscientists, we explore the form that new strategies for public communication and community engagement might take.

1 Introduction

Hazard scientists rarely meet the people that are actually at risk – those in communities prone to natural threats. When they do, scientists generally find that those living in the shadow of disaster view an impending threat in ways very different to that envisaged by the specialist, whose outlook is steeped in probabilistic or deterministic thinking about the chances or impacts of an extreme event. Unfettered by the technical prognosis for a particular hazard scenario, ordinary citizens instead embed scientific concerns about the likelihood of a natural calamity into the broader social, economic and political stress field that shapes their day-to-day lives. The projected earthquake, volcanic eruption or flood event feeds into community conversations about topics such as ongoing social transformations, local arguments over economic development plans and political debates about corporate corruption and civic trust.

Such a situation confronts the issue of risk communication in Istanbul. The geoscientific consensus is that the city of 13.5 million inhabitants will face a major earthquake threat in the coming decades (Parsons, 2000; Bohnhoff et al., 2013). The destructive earthquakes of August and November 1999 to the east of the city highlighted that lethal potential of the seismic threat (Özerdem, 1999) and the intervening years has built up a considerable body of science concerning future disaster scenarios (e.g. Barka, 1999; Okay et al., 2000; Le Pichon et al., 2001; Armijo et al., 1999; Ansal et al., 2009; Erdik et al., 2011). A loss-estimation study carried out for Istanbul after the 1999 Kocaeli earthquake (JICA and IMU, 2002) revealed that, under a scenario earthquake of magnitude 7.5 along the Marmara Sea segment of the North Anatolian Fault, over 50 000 buildings could expect to be heavily damaged or collapse. In response, extended public education and awareness programmes on structural and non-structural mitigation measures took place, and geologists and engineers have been involved in city-wide earthquake preparedness measures, mainly focused on improving the resilience of the city's largely vulnerable building stock. Despite a recognition that "seismic risk in the buildings in Istanbul is mostly

dominated by building vulnerability, not hazard" (Yakut et al., 2012; Lall and Deichmann, 2011), there is widespread distrust of Istanbul's retrofitting and reconstruction measures even among residents of some of the city's most at-risk quarters (Green, 2008; İslam, 2010; Karaman, 2013; Kuyucu, 2014; Özkan Eren and Özcevik, 2015).

The roots of this distrust go deep into the Turkish psyche. An intercomparison of populations living in seismic earthquake-prone areas in Japan, USA and Turkey revealed that especially strong and varied emotions permeate Turkish earthquake perceptions and attitudes (Joffe et al., 2013). The direct experiences with the 1999 earthquakes provoked heightened feelings of worry, fear and anxiety, but in addition there were strong expressions of corruption and incompetence of politicians, civil servants, planning regulators and the construction industry. According to the study, discussion of corruption accompanied expressions of lowered self-esteem, and two-thirds of Turkish respondents lamented a "demise of identity", with responses to earthquake risk permeated by the widespread belief that the character and moral fibre of the country was weak and ineffective. For many participants, it was this endemic corruption, greed and selfishness that was seen to produce vulnerable cities and buildings, and which produced a heightened fatalism and weakened sense of control and self-efficacy. The result was that despite a substantial awareness of the earthquake risk, the Turkish respondents were far less likely than their US or Japanese counterparts to adopt seismic adjustment measures (Joffe et al., 2013), a phenomenon also described by other scholars (Özerdem, 1999; Eraybar et al., 2010; Erdik, 2014; Taylan, 2015).

The contested nature of Istanbul's seismic preparedness exemplifies a general view emerging from disaster risk reduction research. For more than a decade, social science studies indicate that there is little or no correlation between the provision of scientific information about risks and the adaptive changes in individual or community behaviour that would reduce risk (Slovic, 2000; Kasperson, 2014; Palm and Hodgson, 1992; Solberg et al., 2010; Fischoff, 2012; Lichtenstein and Slovic, 2006; Lupia, 2013; Morgan et al., 2001). As reflected in the concept of "shifting baselines", an important paradox of hazard communication is that even if a potential physical threat is made public by the scientist, the scientific message can become normalized into the complex, chaotic and contested discourses of daily life (Rost, 2014). Wachinger et al. (2013) describe a "risk perception paradox" in which it is widely assumed by hazard practitioners that high risk perception will lead to personal preparedness; yet, the authors provide evidence that also the opposite can occur if individuals with high risk perception still choose not to personally prepare themselves in the face of a natural hazard. They describe a multitude of different factors that influence the relationship between risk perception and preparedness for actions, with personal experience of a natural hazard and trust – or lack of trust – in authorities and experts having a particularly significant impact (Wachinger et al., 2013). The need for hazard practitioners to pay more attention to the different factors shaping risk behaviour, and to analyse how, and if, adaptation and mitigation measures integrate local concerns is also outlined by other scholars (Moser, 2014; Krüger et al., 2015; Egner et al., 2014; Bankoff, 2015; Irwin et al., 1996; Samaddar et al., 2014; Taylan, 2015).

Despite various examples for a recent change of scientific and government risk communication practices towards inter- and transdisciplinary approaches (Bostrom, 2014; Drake et al., 2014), for the geoscientist charged with a responsibility to communicate the earthquake hazard, addressing the social and cultural dimensions of seismic risk is problematic. Most hazard scientists are trained in the physics of natural processes and practised in intricate risk assessment procedures, but not in the nuances of political science or cultural theory, nor the sociology and psychology of human relations. For that reason, most geoscientists would regard it as beyond their realm and remit to confront the messy reality of how natural threats are translated and perceived by an at-risk community (The Royal Society, 2006; Jensen et al., 2008; Bentley and Kyvik, 2010). Despite the risk of being ineffectual, the majority of risk communication is still taking place in the form of a "deficit model" (Frewer, 2004), as a one-way transmission of risk information from experts to lay people.

In this paper, we attempt to address this "deficit gap" between what geoscientists want to tell at-risk communities and what those communities want to hear from the scientific experts. We do so by reporting on a communication workshop that directly provoked a group of doctoral and post-doctoral geoscientists with the sharp focus of the local politicized nature of seismic preparedness in Istanbul. The aim was to challenge the geoscientists about their role as "communicators", to reflect on what the essential geoscience messages that need to be publicly conveyed are and to critically evaluate methodological frameworks for a more integrated seismic risk communication. With that objective, in the following sections we first introduce the geoscientists, and then outline the political and social context in which Istanbul's seismic risk controversy is embedded. The paper then documents the responses of the geoscientists to the communication problem they have been confronted with, and follow that up with recommendations that emerged from the group about establishing new strategies for geoscience communication in general and community-centred earthquake education initiatives in particular.

2 The participants

The geoscientists in question were a group of doctoral and postdoctoral researchers engaged in a Marie Curie Integrated Training Network on "Anatolian pLateau climatE and Tectonic hazards" (ALErT). This network is engaged in top-level research on the complex interaction between tectonic and cli-

matic processes which influence the morphologic evolution of the Central Anatolian Plateau (CAP) in Turkey and associated natural hazards. ALErT's emphasis on natural hazards – principally earthquakes, landslides and flooding – means that in addition to receiving training in advanced methods of geoscience data acquisition and field investigation, the young researchers are expected to develop expertise in effective risk communication. The severe consequences of the 2011 Tohoku earthquake or the L'Aquila earthquake have clearly shown how important it is for risk communicators to respond to the close connection between natural and human-induced hazards and to be aware how scientific paradigms shape risk communication. To communicate with different audiences via multiple channels in ways that are not only scientifically sound but also socially robust is competence that scientists need to develop from early on. The ALErT proposal states the following:

> Delivering basic information on hazards to those who are most at risk is recognized as a fundamental and persistent weakness in disaster risk reduction programs worldwide. Addressing this deficiency requires not only a combination of "top-down" technocratic approaches, in which scientific expertise is communicated down formal decision-making chains of command, but also "bottom-up" community-based approaches, in which that expertise feeds into local educational initiatives to build resilience among those at risk.

To put these attempts into practice raises the question how a group of doctoral and post-doctoral researchers, such as in the case of ALErT (2012), can realize such bottom-up community-based approaches. Merging various viewpoints into a common communication strategy faces major difficulties; the scientific backgrounds of the ALErT group are drawn from seismology and geophysics, tectonics, geology and geography, hydrology and palaeoclimate and spatial analysis and geostatistics. Such diverse geoscience specialisms present difficulties for overcoming technical jargon and methodological barriers emerging from a disparate suite of analytical techniques and research approaches. To compound the difficulty, many of the researchers are concerned with very different time frames, some tracking processes that operate over several millions of years, other studying phenomena encountered in recent human memory. Thus, in a project that juxtaposes a researcher collecting microfossil samples from 10 million year-old sediment deposits in montane basins with one that is acquiring offshore seismic reflection data from marine survey vessels and another that is creating a regional database of modern hydrological flood events, it is easy to perceive that the individuals involved have little scientific overlap. Such a mixed expertise and such a fragmented knowledge base means that the researchers have to spend a considerable amount of time trying to understand each other before attempting to communicate their findings to lay audiences (Scherer and Renn, 2015).

Another challenge for this international group of early researchers emerges from their own social and cultural diversity. Around half of the 12 researchers in the ALErT team come from Turkey, with the remainder from Germany, Netherlands, Spain, Sweden and USA; only the US participant has English as a first language, and across the group the level of proficiency and confidence in written and spoken English was variable. The individual researchers are now almost all based at institutions or organizations outside their home country, in academic settings that are sometimes very different to those in which they undertook their initial studies. Some are products of traditional, overtly prescriptive approaches to formal geoscience training, now transplanted into more student-centred or outward-facing learning environments. For others, the reverse is true. The result is that the group is an amalgam of academic cultures in which the exposure to generic communication skills varies markedly from individual to individual and the impetus to engage with external publics is inconsistent. A common element, however, was that none had received any formal academic training in science communication.

As a group, the potential geocommunicators within the ALErT consortium constitute a highly specialized and academically disparate collective of researchers, attempting to share their technical expertise with at-risk communities, a context that most of the participants are unfamiliar with. Regarding the various cultural and academic barriers as well as the complexities of a bottom-up communication approach, standard graduate training in generic science communication principles and practices was considered unlikely to be effectual.

Therefore, a methodological framework (Sect. 4) was devised to create a "level playing field" for the heterogenous workshop participants. It is widely emphasized that involving communities and decision-makers in knowledge exchanges can lead to a more effective communication outcomes beyond disciplinary boundaries (Lindenfeld et al., 2013; Wachinger et al., 2013; Scholz and Steiner, 2015). Recent research on effective risk communication has paid increased attention to the role of participation-oriented approaches, often also labelled as integrated, deliberative or transdisciplinary (Werlen, 2015; Árvai and Rivers, 2014; Kasperson, 2014; Dietz, 2013; Popa et al., 2014; Hagemeier-Klose et al., 2014; Bunders et al., 2010; Nowotny et al., 2001). Despite various interpretations of the term, Pohl and Hirsch-Hadorn (2007) have identified four features for transdisciplinary research, which are the transcendence and integration of disciplinary paradigms, participatory research, the focus on real-world problems and the search for unity of knowledge beyond disciplines. According to Árvai, major advantages of communication approaches in such formats are that they not only "improve the capabilities of non-experts", but also "provide much-needed insight to risk

assessments and their subsequent application to risk management" (Árvai, 2014). On the other hand, as outlined by Wachinger et al. (2013) "they are probably the most effective means to create awareness of potential disasters, enhance trust in public authorities and encourage citizens to take more personal responsibility" (Wachinger et al., 2013). Engagement and transparency policies in the USA and the EU, as applied in the Horizon 2020 Framework Programme for Research and Innovation or the National Research Council (NRC, 1996), indicate this shift towards more pluralistic sets of participants and upgrades in deliberation processes (Bostrom, 2014). In Turkey, as outlined in the next paragraph, more integrated approaches in risk communication in Turkey have not been yet translated into practice. This becomes particularly visible in the case of Istanbul, where scientific "matters of fact" are inextricably linked with societal "matters of concern" (Latour, 2004).

3 The context: Istanbul's political earthquake

The destructive Kocaeli and Duzce earthquakes of August and November 1999, although located east of the city, brought home to many Istanbul residents the likelihood of a future direct seismic strike on the metropolitan area (Özerdem, 1999). The two earthquakes led to a region-wide disaster that caused close to 20 000 deaths and over 54 000 damaged buildings (Erdik, 1999). Geological investigations have revealed that the principal seismic threat comes from an "earthquake gap" in the North Anatolian Fault immediately south of the city (Stein et al., 1997; Parsons et al., 2000; Armijo et al., 1999; Bohnhoff et al., 2013), but the lethality of any large ($M>7$) earthquake triggered beneath the waters of the Marmara Sea largely arises within the city itself. When the earthquakes struck in 1999, the majority of housing in Istanbul did not even meet minimum building standards specified in the earthquake design codes introduced in 1944, and updated in 1953, 1968, 1975 and 1998 (Soyluk and Harmankaya, 2012). Based on statistics from the 1999 events, it is estimated that the multistorey reinforced concrete buildings that dominate modern Turkey are 10 times more vulnerable to earthquakes than similar buildings in California exposed to the same level of hazard (Erdik et al., 2003). Accordingly, 30–40 % of Istanbul's building stock is considered to be at risk (Erdik and Durukal, 2007; Bugra, 1998).

The acute seismic vulnerability of Istanbul's built environment is a direct product of its rapid unauthorized urban growth from 1930, when this capital of the Ottoman Empire housed 800 000 residents, to 2000 when its population surpassed 10 million people (Green, 2008). Facilitating this rampant unplanned industrialization and urbanization was the proliferation of Istanbul's informal housing districts, locally called "gecekondu" neighbourhoods. These squatter districts emerged during the onset of massive rural–urban migration that started in the 1940s (Bugra, 1998; Green, 2008). The districts are dominated by low-quality, sub-standard buildings, erected within a short time (the term gecekondu is Turkish for "built over night") and typically without any professional consultation of planners or architects (Bugra, 1998; Green, 2008). The casual nature of the construction means that this self-built housing is especially vulnerable to earthquakes, and its intrinsic vulnerability was heightened further in the 1980s when a series of amnesty laws legalized a large percentage of the informal building stock. As a result, many existing one- to two-storey gecekondus were extended into "post-gecekondu" settlements with three or more storeys (Esen and Lanz, 2005).

In an attempt to strengthen the seismic safety of the city, in the mid-2000s, Istanbul's civic authorities introduced an ambitious programme of "urban transformation" projects, also known as "urban renewal" programmes, during which many gecekondu districts underwent large-scale retrofitting and reconstruction. Istanbul's urban transformation projects have been accompanied by major public protests, especially within gecekondu districts. Despite broad societal support for the necessity of risk reduction efforts, the main popular objections relate to socioeconomic trade-offs, negative environmental impacts, triggered gentrification processes and democratic deficits, especially in the lack of citizen participation (İslam, 2010; Adalanı, 2013; Turam, 2015; Balamir, 2013; European Commission, 2013, 2014; Angell, 2014; Özkan Eren and Özcevik, 2015; Alkışer et al., 2009; Alpay, 2012; Karaman, 2012; Sakizlioglu and Uitermark, 2014). Prevailing divides and entrenchments between the local communities and civic authorities in charge of the mitigation measures were intensified by the perception of a strongly hierarchical disaster management structure in Turkey. This organizational structure lacks formal mechanisms to facilitate interchange between academic scientists and the general public, and more critically is devoid of participatory decision-making with at-risk local communities by shared platforms, consensual implementation of projects, devolved forms of governance and the involvement of resident groups in the identification of local vulnerabilities (Balamir, 2013).

As shown in the next section, the criticism about the way risk mitigation measures are being implemented also affects the public perception of scientific pronouncements about serious hazard threats. It is against a contested and highly political backdrop that geologists and engineers are compelled to communicate, and the question is raised as to how to methodologically respond to this situation.

4 The workshop methodology: gaining insights from Istanbul's seismic suburbs

In order to gain a more nuanced understanding of the sociocultural dimension of risk in Istanbul, a combination of two qualitative social science research methods was applied within the context of the communication workshop. Firstly,

to help enhance the group participants' awareness of local perspectives that are generally not integrated into seismic risk communication, they were asked to do field-based interviews with residents and to take detailed field notes. In addition, a series of moderated focus group discussions was organized to voice more in-depth different topics and concerns related to seismic risk and its communication and to support a process of knowledge co-creation. In order to document the process for further analysis, both the field visits as well as the focus group discussions were recorded on camera by the lead author.

4.1 Field-based narrative interviews with local stakeholders

In late May 2015, under the guidance of local urban historian Orhan Esen, the 14 geoscience researchers undertook a half-day field visit to the urban renewal districts of Zeytinburnu and Okmeydanı. At important spots of the neighbourhoods visited, Orhan Esen gave short kick-off lectures about the historical development and the implementation of seismic risk mitigation measures in the gecekondu districts. In addition to this local information, the visit gave the participants a first-hand picture of the building stock of both neighbourhoods and provided the opportunity to meet several inhabitants and community representatives. During the first stop in Zeytinburnu, the participants initiated two extended interviews with inhabitants of the urban renewal area "Sumer Mahallesi". The interview partners also guided the group to the old gecekondu part of the neighbourhood, that had not yet been transformed within the urban renewal process. The second field stop was the neighbourhood of Okmeydani. In a 2 h round-table set-up, the participants had the opportunity to interview a representative of the Okmeydanı-based neighbourhood association "OkmeydanıÇevre Koruma ve Güzelleştirme Derneği", on his and the association's perception of seismic risk mitigation, given their specific locale. In addition to his detailed statements, he provided a broad array of visual materials, such as maps, newspaper articles and public announcements. The emerging discussion was moderated by Orhan Esen. He also translated all verbal contributions during the day from Turkish into English and vice versa.

4.2 Focus groups

On the back of the field visit designed to take the geoscience researchers to the edge of their academic "comfort zone", the authors facilitated two 90 min focus group sessions to explore the perceptions and attitudes of the ALErT investigators to the prospect of communicating their science more broadly. The initial focus group discussion took place on the afternoon of the field visit and aimed to provide the participants a framework to reflect the field experiences and to voice their own individual views and concerns about their potential roles and responsibilities as communicators. There then followed a 5-day technical field course along the North Anatolian Fault during which the participants were encouraged to have informal discussions among themselves about the broader issue of geoscience communication. At the end of the field school, a second focus group was organized to elucidate the group's reflections on more effective approaches of communicating hazard science to at-risk communities. Both groups were structured around a set of preconceptualized questions, but the discussion itself was free-flowing. To ensure that the variety of different ideas and opinions from as many group participants as possible could be voiced, both focus groups were moderated by Prof. Iain Stewart. He also facilitated an inventory of the discussion positions of the group, which were later structured on a flip chart.

The following paragraphs of Sect. 4 will outline the key topics and concerns that emerged through the interviews and round-table conversations among workshop participants and inhabitants of the urban renewal neighbourhoods. Based to a large degree on the quotes of the interview partners in order to provide direct insights, we will summarize local perspectives on the mitigation process relevant to consider when developing communication strategies for (and with) at-risk communities. Section 5 will synthesize – also based on and conversation extracts – the major aspects of the two follow-up focus group discussions and summarize the recommendations that were elaborated by the participants.

4.2.1 Side effects of urban transformation on disaster preparedness

The dramatic transformation of the gecekondu districts was noted by all of our interview partners, who acknowledged the seismic threat as the main official argument for the urban renewal projects:

> We have been living here for 30 years. This used to be a football field, then there was an urban transformation process, so people were being taken to these new buildings that are safer for earthquakes. It was an empty area; it was just a sport area before. (Sedat, Zeytinburnu)

Although living conditions in the new Zeytinburnu apartment blocks were regarded as now being "comparable to European standards", the construction of large multistorey apartment blocks attracting additional tenants marked a worrying increase of population density in the high-risk district:

> By this kind of market-driven risk mitigation, you have to raise the density. Because the financing goes through the market, not through public funding. [...] The increasing of the density is in clear contradiction to the requirements of earthquake building codes. (Orhan Esen, Okmeydanı)

Moreover, the construction of new high-rise apartment blocks, shopping malls, private car parks etc. was criticized

for taking over previous open spaces that would be needed in the post-disaster phase for evacuation:

> For the rescue just after an earthquake we would need free spaces. So obviously the government doesn't take the risk seriously. (Neighbourhood representative, Okmeydanı)

Perhaps more significantly, Zeytinburnu residents lamented the increased anonymity brought by the large influx of "new people that moved into the project", a product of the engineered gentrification processes. Despite an agreement on the necessity of physical risk mitigation measures and an appreciation of modernized, earthquake-proof apartments, residents reported unintended social side effects of a risk reduction strategy focused mostly on physical measures:

> The residents are supposed to stay within this compound, this gated community. So you have your social club inside, you have your swimming pool inside, your sports facilities, a kindergarten and so on. Which you obviously didn't have in the former "mahalle", in the former quarter, which is now being pulled down piece-by-piece. But interesting is that our interview partner said that although they are living in the compound, they prefer to go to the old café which will now also be pulled down. He plays cards there with his companions. [...] Obviously the new compound that has been built lacks some quality. (Orhan Esen, Zeytinburnu)

In Okmeydanı, a loss of cultural heritage was described, with an impact on the cultural identity of the neighbourhood:

> They destroyed all of what was here. This is a former pastoral bath house, it is built into the foundations of the new building. [...] They just pulled it down to build a minaret, which has nothing to do with the old one. There was an open air prayer space; it has also been pulled down and reassembled. It has nothing to do with the old one. These are just Disneyland fakes of the originals. (Neighbourhood representative, Okmeydanı)

The modernization of the district also goes along with a fear of the inhabitants to be displaced. According to Orhan Esen, only a few of the former inhabitants can afford to live in the new projects:

> It is a working class area. Most of the people cannot afford such standards. They never paid rent, but they cannot easily get well paid jobs either. They still work as unqualified labourers. They still work as unqualified labourers. Whenever they move in the new compound, they cannot afford the new lifestyle there, they cannot keep up the payments. Here in Zeytinburnu, which is quite a well-off middle class community of Istanbul, it is like one third that could make it into the new project. In no case you can expect more than 30–40 % of the former inhabitants to live in the new projects. (Orhan Esen, Zeytinburnu)

The fragmentation and dissolution of community cohesion that are described in these interview statements are themes already apparent in previous attitudinal surveys, with Joffe et al. (2013) noting the heightened feelings of isolation, despair and sadness encountered among Turkish respondents when it comes to seismic risk adjustment. Similarly, an ethnographic fieldwork study undertaken by Angell (2014) describes the societal dynamic that is triggered by the mitigation processes, in which "fragile buildings become personal concern and political matter [...] and the measurement and mitigation of risk provides the grounds for planning and contesting the city's transformation."

4.2.2 Lack of co-determination, cooperation and transparency

A persistent complaint among interviewees related to a lack of citizen participation in the risk mitigation process, highlighting few, if any, established forums for science–public exchange, and an absence of contributions of local communities in the planning process and in regeneration activities:

> We found out about the [urban renewal] process only through their [the municipalities] marketing campaigns and the actual demolitions. And first hand experience. They never ask the public, they just construct a situation where it's all about them and their gains. There weren't any plans made in cooperation with the public. (Neighbourhood representative, Okmeydani)

Inhabitants mentioned few information campaigns that were initiated by the municipality, but described these as showcases aiming at the creation of public acceptance for mitigation measures rather than as opportunities for open, critical discussion. The Okmeydani neighbourhood association criticized a one-sided orientation and a social pressure that emerged from these events, where the panel guests "talked the entire time" and wouldn't enable citizens "to ask critical questions". These experiences contributed to a growing distrust in the authorities responsible for the mitigation process, who were criticized for "mostly building for themselves and their profit", and not for the safety of the residents. Informal comments expressed on the ground in Zeytinburnu and Okmeydanı endorse the findings of Green (2008) and Joffe et al. (2010). These document widespread complaints of corruption in the political sphere and in the construction sector, the commercialization of urban development and a marginalization of the inhabitants exposed by the seismic risk. These perceptions feed a growing distrust in the quality of seismic safety of the newly built apartments and nourish feelings of fatalism.

Such a strong relationship between distrust and the perception of seismic safety can also be studied in this exchange:

> Neighbourhood representative: They pulled down 37 houses and said "We are going to make you a park." [...] Three years after, they demolished the park, they built (...) an exclusive club for archery. (...) But even this is just make-up. Because their real concern is converting that whole area into a shopping mall. They have already built four elevator shafts. It is prepared for building up.
>
> Researcher 4: Do you feel prepared for an earthquake?
>
> Neighbourhood representative: There is no preparation, that is for sure. But do you think that there is any preparation in any other districts other than Okmeydanı? (...) We don't believe this government, because if they just built this exclusive archery club and declare this as a kind of a measure vis-a-vis the earthquake risk, what does this have to do with earthquake mitigation? They just built things for themselves. Within their whole ideological context they built an exclusive club. It doesn't have anything to do with an earthquake. So what gives us the reason to believe in anything they do about the earthquake?

The severe lack of trust stated in this conversation corroborates with the findings of Wachinger et al. (2013), describing how due to the fundamental affective dimension of trust, individuals may feel more at risk if their trust in experts is lacking or damaged (Wachinger et al., 2013). The statement that there is "no preparation at all" also indicates that inhabitants clearly understand the risk, but assign the main responsibility for structural risk mitigation to public institutions. In the context of this anger at a perceived "irresponsibility", the focus on individual preparedness actions seems to fall behind.

4.2.3 Deficiencies of seismic risk communication

Following on from this perceived lack of trust in the authorities, residents also expressed a lack of trust in most mediated risk communication. This sentiment was based on the perception of a media reporting that is driven by interests of the private sector and does not provide sufficient information on preparedness measures:

> We are not informed at all. What we believe is that the earthquake is just used as alibi, as an excuse, as a pretext. The term earthquake doesn't point to the real thing. The real thing is that they want to acquire this very precious land here. (Neighbourhood representative, Okmeydanı)

Another argument was that scientific research results and conclusions were viewed to be frequently and widely misrepresented in the media coverage, usually by heightening the consequences and not sufficiently providing information on what to do about the risk. Other complaints related to the poor accessibility and usability of scientific information given out by public institutions, which were often deemed incomprehensible, not targeted at or written for ordinary citizens. Furthermore, inhabitants expressed a confusion about the role and responsibilities of the institutions in charge of risk mitigation. In Okmeydanı there were specific complaints about a lack of transparency and scientific evidence for the municipalities' high-risk designation of the neighbourhood, a finding that is also described by Angell (2014) and Eren and Özerdem (2015) who stress that the municipalities' designation of high-risk areas does to a large extent not match with the areas identified by the JICA report study (JICA and IMM, 2002).

> Researcher 3: Are these houses safer than others?
>
> Orhan: Supposedly, officially. By the very official discourse they are.
>
> Researcher 5: Is there also more safety during earthquakes?
>
> Orhan: I cannot say. The official justification for this project is that this mitigates the risk. [...]
>
> Researcher 10: Concerning the kind of data for the red areas, [designating the seismic high-risk areas] – what kind of data is it?
>
> Orhan: There is no data! It is not data, it is something else. [...] All red areas that are designated as urban transformation areas for the sake of risk mitigation are areas where some private developers showed interest for whatever reason. There is no scientific criteria, nothing. If there is a group of developers that show an interest in transforming that particular informal housing area, that area is transformed into a disaster risk area.

Although residents expressed their concerns about the quality of seismic risk information given out by the media, the municipality and their contractors, they expressed their trust in geoscientists, a view that is also shown by literature, claiming that the public trusts universities and independent institutions far more then they trust the government, the media and business (Bunders et al., 2015).

> Researcher 3: It seems as if you don't have a lot of faith in the government, but do you have a lot of faith in scientists?
>
> Neighbourhood representative: Of course, why shouldn't we trust scientists? A major reason why we don't trust the government is that they already founded a development company to market our

> neighbourhood. This is already part of the official newspapers around Turkey. It is not that we don't trust the government out of ideology, but just by the very facts we see.
>
> Researcher 10: But science comes mainly from the universities, and the universities are mainly driven by the government. So it is a paradox. [...]
>
> Neighbourhood representative: Of course there are differences between universities and universities, scientists and scientists. Of course we are aware of that, but there is also something that we can call "common sense". And maybe we are not geologists, but we also have our education in different fields. We are experts in our field. That allows us to judge in a proper way. Of course we also have our interests. As citizens, we can kind of measure our interests and our expertise in our field. And the common sense will help us to differentiate between scientists and scientists.

Referring to the importance of a "common sense" and "education in different fields", The neighbourhood representative described how the Okmeydanı neighbourhood organization consulted geoscientists from universities in order to obtain scientifically valid information; yet, the exchanges were described as problematic. Factors named were problems to understand the scientific terminology and difficulties to extract relevant knowledge for their specific locale. In addition, the independence of the consulted geoscientists was seen as limited, as they "didn't want to give out written reports" and "didn't want their names to be publicly mentioned". Possibly, it was these unsatisfying attempts to gain valid information that led Okmeydanı residents to also rely on their own observations and investigations, for example, the absence of observed damage during the Kocaeli earthquake in August 1999, when "no single house, not even a garden fence had any single crack or damage", was interpreted as an indicator for a low seismic risk of the neighbourhood:

> So what we know from experience is that we are not a risk area. Our experience with past earthquakes proves us this. But you are all experts in that, please make your own investigations and tell us. We are happy to cooperate with you. (Neighbourhood representative, Okmeydanı)

The Okmeydanı-based neighbourhood association expressed their wish for a close science–public collaboration, and outlined their goal of preparing and promoting a planning process that "incorporates the idea of risk mitigation". Significantly, as is demonstrated in the final exchange between researchers and the Okmeydanı Neighbourhood representative, the direct involvement of geoscientists in addressing the "seismic problem" was encouraged, alongside the desire among residents for a more "actionable" communication as described by Wood et al. (2011).

> Researcher 8: What would change if we [as independent scientists] would say that this is indeed a high-risk area?
>
> Neighbourhood representative: First of all we would thank you that we have the chance to finally learn about the threat. Then we would of course cooperate with you, and would like to hear from you what you would suggest. We would like to hear that, because of course for all of us human life is the most important thing. Please come to us with your suggestions and let's think together what can be done.

Through conversations with local inhabitants, the ALErT geoscience researchers were exposed to a social framing of Istanbul's seismic-hazard preparedness dilemma that was very different from their own geological and geophysical perspective. Main issues that emerged as alternative dimensions of the seismic-risk problem – and that were not visible to the researchers before the field encounters – encompassed social and cultural impacts of risk mitigation, the importance of co-determination and transparency, the role of trust in authorities in charge of mitigation measures and the relevance attributed to an actionable and socially robust risk communication.

5 The evaluation workshop: lessons from Istanbul's seismic suburbs

In the following paragraphs, we report, through the direct comments of the ALErT researchers, on the areas of concern that emerged in the two focus group discussions following the urban field visit. These will summarize how participants reflected on the experiences gained through the field visits, their role and responsibility in communicating to at-risk communities and how they approached the question of potential methods and approaches towards a more integrated seismic risk communication.

5.1 Impact of seismic risk communication on individual preparedness

The fact that a high risk awareness of the inhabitants of at-risk neighbourhoods is not necessarily translated into preparedness actions was mostly familiar to the workshop members; yet, the multitude of factors influencing how inhabitants ultimately perceive and act upon a seismic threat was much more apparent to the participants in the context of the field excursion and led to discussions about the basic nature of geoscience communication:

> Researcher 8: If you would have asked me before the workshop, I would have said geocommunication is contributions, papers, conferences...But now it is gaining much more body with the public.

> Researcher 3: I am not even sure if geoscientists' answers are necessarily involved. I think that politicians' and the public's communication about geoscience issues is also geocommunication in a way.

Turkish geoscientists within the group corroborated and substantiated resident's statements about the deficiencies in seismic risk communication. They similarly observed that media coverage on seismic risk often gives misleading, partly contradictory information, including a severe lack of actionable communication. Particularly information on prevention measures and geoscientific background information were described as not easily accessible and not sufficiently user-friendly for at-risk communities. In addition, Turkish participants perceived a general weakening of prevention messages after a "window of opportunity" for communication following the Kocaeli and the Duzce earthquake, mentioning a diminishing media coverage on preparedness actions and a decreasing visibility of public education campaigns, such as earthquake simulation buses and the promotion of family action plans.

> Researcher 5: I remember that just after the big earthquake in Duzce they had films, advertisements. They had some commercials. Some information what we can put in our backpacks, how to make emergency plans [...] but now there is nothing. Everybody forgot about it.
>
> Researcher 2: After 16 years, of course everything changes.

Turkish participants also criticized insufficient public prevention measures in the field of non-structural risk mitigation. The existence of "nice looking reports" from institutions such as the Turkish Disaster and Emergency Management Authority (AFAD) were seen in clear contradiction to the actual implementations on the ground.

> Researcher 5: There is no application. They [the governmental authorities] say: "Yes, we have to do that." [...] Yes, good plan, good application. And when a natural hazard or an earthquake is coming, there is no application. It is written, but there is no application.
>
> Researcher 6: There is no continuity.

While the group expressed their comprehension for inhabitants who cannot identify with current forms of seismic risk communication, they also criticized a lack of motivation to take individual adjustment measures. Aspects named were a reluctance to go online and actively search for prevention measures in their everyday life, but also a tendency to "listen and forget" about information or to rely on "fatalistic arguments". Turkish participants argued that this risk behaviour is also culture-specific, as emerges in this exchange with the facilitator:

> Researcher 5: I do not think that ordinary people like Sedat will go to the Internet and type in "What can I do in the case of an earthquake? What is the emergency plan?" I don't think so. For Turkey it is a little bit hard to get the attention of the people about these serious things.
>
> Facilitator: Why? Is it a cultural thing in Turkey?
>
> Researcher 5: For example if you want to give them some important information, if you want to inform them, they easily forget about it. They don't want to do any action about it. They just listen and then forget. There is no prevention, there is no application. So it is a little bit about the culture.
>
> Facilitator: Do the others accept that? Before we judge the culture in Turkey...is it maybe different to the USA or Japan?
>
> Researcher 6: One aspect is that culture is also affected by religion. When you say "There will be an earthquake", they say: "Oh, if it is going to happen, it will come from God." It is a faith and they tend not to do anything to avoid the bad circumstances of these events.

Interestingly, the Turkish workshop participants openly stated that they attributed a certain risk behaviour to a specific prevention culture in Turkey. While essentialist views on culture, especially when certain behavioural schemes are attributed to certain groups or even parts of the population, can easily promote stereotypes or a process of "othering" (Brons, 2015), this exchange reveals the importance of understanding the impact of cultural interpretations as a prerequisite for effective risk communication, a fact which has also been recognized by a broad array of research done in this field (for example Krüger et al, 2015; Hoffman and Oliver-Smith, 2002; Renn and Rohrmann, 2000; Stoppa und Berti, 2013). Given that culture is not static, but emerges through contingent configurations of multiple practices, values, and beliefs that individuals use to engage and make sense of the world (Nasir and Hand, 2006), it seems promising also to approach risk communication as being embedded in contingent cultural contexts, and not to reduce it to mere scientific knowledge exchanges. This more dynamic view on risk communication and/as culture has led to a growing body of hybrid research projects, with scholars that engage, for example, in comparative approaches towards different risk perceptions in different cultural contexts (Joffe et al., 2013), look at the scientific actors themselves who are engaged in risk communication, ask how specific epistemological orientations and or scientific paradigms shape their research activities and their decisions (Lacassin and Lavelle, 2016), or focus their research on

science communication artefacts in the form of specific visualizations, rhetorics, communication formats etc. and how they are being formed by various cultural orientations, assumptions and paradigms (Medin and Bang, 2014).

5.2 The role and responsibility of geoscience communicators

Despite broad agreement within the group on the relevance and importance of reaching at-risk communities, there was an intense discussion about the appropriate way and level of engaging with the public. Much of the debate therefore centred on the participants' individual understandings of the role and responsibility of geocommunicators, and what implication this has on their professional life.

> Researcher 1: If you know that something will happen [...] that many people could die [...] you will have to communicate that. You have to communicate that in order to prepare people.

Despite an awareness of the modern push for the democratization of knowledge, some participants found it crucial not to blur the borders between scientists and non-scientists and to retain their role as "objective experts".

> Researcher 11: I think you should do your best to improve your analyses and get proper results and publish and explain these results to proper people. For example, the government or the administration. And these people should know what to do with this. You can give them suggestions what you think is the best idea to use the results and how to protect the people, but the decision belongs to them.

Some participants considered geocommunication as a rather "one-way", linear transfer of "geoscientific expert knowledge", restricting geocommunication to "the provision of correct data" and "recommendations" to decision makers (government, civic administration, selected media representatives) who then "should decide what to do with the information".

> Researcher 4: In my humble opinion, science has something to do with knowledge. Policies, hazard mitigation, those are things related to judgement, to decision-making. Those are two completely different things.

For these participants, a direct engagement with residents, particularly in politicized contexts, was considered as negatively affecting this role, and potentially risking a loss of reputation, trust and scientific credibility due to actual or perceived advocacy positions. Others, however, whilst acknowledging these fears, stressed instead the "moral and professional duty" to directly provide their expertise to communities, especially in situations where inhabitants face an acute risk and openly request closer collaborations with scientists. For them, there was a "risk of losing public trust" when not reacting on shortcomings of communication, as this exchange reveals:

> Researcher 8: A hypothetical case, let's imagine the scientific community has a very clear view that the Marmara earthquake is going to happen in five years time, and it is going to be magnitude 8. Then what is your responsibility, when people are not reached by standard geoscience communication? This is how I face this problem. Then you really have two push the boundaries and tell the people that they should move away from the boundary [...] but I am already in the activist part.
>
> Researcher 2: You're looking at the human aspect, not at the scientific aspect. As a human being, when you see that something bad will happen very soon, then of course you will push people and try to fix the problem [...]. As a scientist you just have to do the research, get the information and share it.
>
> Researcher 8: But I absolutely don't feel like this – this is my scientific part and this is my human part [...] I don't understand why geoscience should be communicated in a very specific, narrow way, for example centred on geohazards. Then people might know something about the physics happening, but they don't really do anything in their daily lives. And this is the challenge.
>
> Researcher 7: You could make sure that you inform the public better, so that they can find a way around this corrupt system so that people are informed to really make decisions.
>
> Researcher 10: But this is really complicated.

These last exchanges, clearly outlining the very different perceptions about roles and responsibilities of geoscientists in the risk communication process, show that a multitude of factors influence not only how risk communication is perceived, interpreted and translated by inhabitants of at-risk communities, but also how this is equally valid for scientists.

Science communication literature stresses how different norms, values, sociopolitical contexts etc. influence how scientists communicate, for example by institutional norms that value research productivity over other types of contributions (De Rond, 2005), or by pressure arising from expectations of peers, who consider colleagues who popularize or make science too accessible as suspect (Jensen et al., 2008). More recently, the lively discourse on risk communication in the "Anthropocene" has stressed scientists' role and responsibility to help overcome disciplinary silos and to rethink current dualisms such as theory/practice, objectivity/subjectivity, or

nature/culture to better address climate change, loss of biodiversity or an increased vulnerability to geohazards and risks (Klingan et al., 2015). New interdisciplinary and transdisciplinary research programmes, such as the Politiques de la Terre network in Paris or projects of the IASS Potsdam (e.g. "One hectare", "Paradise Reloaded") are attempts to put this (novel) responsibility of scientists into practice and to initiate, support and scientifically accompany transformative processes.

5.3 Lack of intermediaries and interdisciplinary collaborations

Despite different perceptions of roles and responsibilities, the group agreed on the necessity to more effectively communicate with at-risk communities in order to reduce the seismic vulnerability. The round-table discussions brought to the fore a concern among the participants of not having sufficient communication skills to successfully connect with lay audiences. For example, they expressed an insufficient knowledge on how to methodologically approach such exchanges, given the complexity of audiences and their cultural settings, and given a lack of experience outside the "geoscience world". Only a few participants could give firsthand examples of science–public interactions beyond casual conversations with friends and family members; some mentioned occasional encounters with local residents in the course of their field work, incidents in which they "had to get information from local people", and were asked to "explain" what "they are doing". Beyond these exchanges, interaction with different audiences were viewed as a "rather unknown territory". Debates emerged about whether to "pinpoint the communication talents" within the geoscience community or to engage in interdisciplinary research collaborations. It was suggested to broaden collaboration networks with social scientists, but also with media representatives, artists or NGOs, who were seen as promising intermediaries or translators to more effectively share knowledge with people on the ground.

> Researcher 10: Our responsibility is to produce science and use other scientists who can talk to people, like anthropologists, sociologists or people who have studied philosophy, psychology, this kind of stuff... My point is that we need a bridge to communicate with the people. We cannot communicate directly. We need a translator.

The proposal "to use" external interlocutors to help facilitate geoscience communication was countered by some individuals, worried that working with other groups might negatively affect the quality of messages. For example, collaborations with journalists "to reach people", were deemed important, albeit limited by the constraints of media agenda-setting and "loss of information" from the perceived insufficient "accuracy" of journalistic writing. This scepticism towards the scientific quality of journalistic writing was also assigned to social media representations. Despite this, group members accepted that only a small minority of people read scientific journals or news reports from research institutes – outlets to which the participants assigned the greatest trust in terms of properly conveying scientific messages.

> Researcher 6: The translator should be capable enough to translate the geoscientific language correctly. So maybe it can be better [...] if we could be able to directly tell the public rather than using an agent in between.
>
> Researcher 10: If we want to bring the education to the people possibly the best point to start is to use the universities which have a Facebook page. And specifically when talking about earthquakes they should choose simple words.
>
> Researcher 6: I am not using Facebook. That kind of network wouldn't be able to reach people like me. Ok, we are a minority for sure. [...] I prefer an earthquake observation centre. But I am educated on this and my options are different.
>
> Researcher 8: But what if you were Sedat?
>
> Researcher 6: If I would be Sedat I would prefer... daily newspapers.
>
> Researcher 8: All types of media! You have to reach the TV, the newspaper, Facebook, Twitter...everything. That's the difficulty.

In addition to discussing the multiplicity of media communication networks, debate over the need to collaborate to achieve more effective geoscientific outreach led to strong exchanges within the group, with some of the participants finding it unsatisfactory to depend on "agents" to share their knowledge with the public. Instead, some argued for a better appreciation of participatory processes that allow for the combination and integration of different forms of knowledge, and hereby stressing the role of creativity, applied learning and social networks.

> Researcher 6: Why do you think that only the geoscientists give the information? Maybe there are things that you don't know, and that only an ordinary person knows. For example when you go to the field, [...] to a little village, if you are working on a recent event of that region, you go to the manager of the village, and you talk to him, for example "Have you ever had any floods in this area?" It is a communication situation and you learn from a person that is not a geoscientist.
>
> Researcher 11: If you find a way how to communicate with the people, the agent is not always necessary.

> Researcher 1: It makes much more sense to bring people into the topic. The problem is not that they don't know that an earthquake might happen. That is not the problem. The problem is that they have to deal with that problem. And usually the best way to motivate people is a playful way. That the people can be active together and learn at the same time. It is like language learning. If you don't apply it together with others, then you forget it.

5.4 Constraints and the appreciation for transdisciplinary approaches

A final strong sentiment that emerged from the workshop discussions was the expectation that geoscientists ought to engage in communication and outreach activities together with other disciplines and with at-risk communities, and to jointly address the seismic risk problem; yet, all participants expressed their concern that the implementation of such transdisciplinary activities is not sufficiently supported by institutional frameworks of universities or research institutes. Contrary to the fact that scientific outreach and the active involvement of the public into the research process is increasingly often obligatory in research frameworks (for example in Horizon 2020 projects), the majority of participants perceived an individual engagement still as an optional, private decision. For example, writing about geohazards and risks using social media channels was perceived as something associated with "leisure" or "sacrificing leisure time"; answering scientific questions within social networks is something that "you simply do" because of social expectations. Despite a perceived "moral obligation" to communicate, not least because scientists are mostly "being financed by taxpayers", participants underlined that putting this personal responsibility into practice is hindered by major factors, and mentioned multiple hurdles for their individual engagement. Besides a "lack of reward", factors commonplace in science communication surveys were named, such as "maintaining a career", "time pressure", "specialization", "publications mostly for academic journals" (Stewart and Nield, 2012).

> Researcher 8: (...) It is our responsibility. But the problem is: We are not paid for that. We have to maintain a career as well. And this is only one of the little aspects that are very relevant. We have to do it for the sake of it. We do a lot of things for science which are for free. And we also have a hard time to maintain a pace...and to do publications, to find the next position and so on. So it is a very difficult balance.

> Researcher 7: There is no real reward.

> Researcher 8: Well, it depends on how you interpret reward.

It was also described that outreach training usually focuses on the development of communicative skills, such as a user-friendly language, storytelling strategies or visualization techniques. These abilities were regarded as fundamentally important, but they were also considered as not being sufficient for connecting with and learning from different audiences. One participant mentioned that "ideally we should have 48 hours a day", "to educate in schools, to educate the media, to educate the politicians" and "to learn what is relevant for them". Opportunities for mutual learning, whether by involving local practitioners or other disciplines within university frameworks, were still seen as an uncommon institutional praxis. For the ALErT researchers, the idea of a transdisciplinary communication training framework represented a distant "ideal", and in that regard, even the workshop itself was considered an "unfamiliar event".

6 Discussion: emerging principles and practices

There was general agreement among the participants on the relevance of actively involving at-risk communities to achieve socially robust communication outcomes, taking into account that "every scientist has a different level of capacity", "ability" or "willingness" to reach the public. Additionally, given the variety of institutional research frameworks and different research cultures, is was seen as difficult to derive a "standard formula" for more integrated communication approaches. Yet, all participants expressed their wish for a serious reappraisal of some core principles.

6.1 Principle 1: a more holistic perspective on geocommunication

Geoscientists need to evolve a greater awareness for the various audiences and the messages that confront them. The generation and provision of technical expertise remain a primary responsibility of geoscientists, but more integrated approaches are needed for risk communicators to better respond to the social and cultural dimensions of risk. It is broadly shown in social science research literature that the relationships between risk awareness and preparedness actions are highly complex and influenced by multiple factors, such as trust in relevant experts, direct experience of a natural hazard, sense of ownership over mitigation measures etc. (Fischoff, 2012; Wood, 2011; Joffe et al., 2013; Wachinger et al., 2013; Kettle et al., 2014; Weichselgartner and Kasperson, 2010; Árvai and Rivers, 2013). If geoscientists are to help at-risk communities adopt meaningful measures to protect themselves, then arguably they need to pay attention to these intervening factors, and appreciate local knowledge bases as important source for the development of risk communication strategies. Given the interdependences of hazards and societal concerns, geoscientists – as specialists in complex interacting systems – were seen as being entirely capable of

raising people's interest for these challenges of the dynamics of the Earth and of the places where people live.

6.2 Principle 2: the need for inter- and transdisciplinary collaboration

Collaborations that forge exchanges with citizens, scientists from different disciplines, planners, politicians etc., and which help to address risks collectively were seen as highly relevant, and were not seen in contradiction to the high importance of disciplinary expertise. Yet, according to the workshop participants, "more practical experience" in integrated risk communication approaches are needed.

Firstly, many participants encouraged actively involving lay people in the development of communication strategies in the framework of transdisciplinary approaches. In the context of the field excursion to Zeytinburnu and Okmeydani, local citizens made clear that excluding local groups from technical assessments and participation can create resentments, limit valuable information sources and undermine the legitimacy and outcomes of communication and mitigation efforts. Paying more attention to these important, but often invisible concerns relevant for inhabitants and integrating their feedback (e.g. whose interests are served or threatened by various natural hazards, and to what degree information have an applicable utility for inhabitants) can avoid stereotypical depictions of target groups or even worse "the public". Similarly, collaborations with artists, journalists and NGOs were described as promising, as such groups often have a longer and more deep-seated experience or skills in approaching various publics and as they can bring important insights and perspectives into the design of risk communication.

Secondly, the role of interdisciplinary linkages was perceived as significant. In the context of collaborative projects, synergies can be elaborated, for example by critically reflecting methods, terminologies and concepts that are often not questioned within monodisciplinary frameworks. Specifically highlighted was the integration of insights from empirical social sciences that can help to give geocommunication strategies a more theoretical foundation to effectively target audiences, develop clearer messages and adopt the most appropriate channels and platforms of communication.

6.3 Principle 3: institutionalization and assessment of inter- and transdisciplinary communication approaches

Despite the fact that interdisciplinary and transdisciplinary collaborations are terms frequently used in public outreach descriptions and funding applications, there was broad agreement among the ALErT researchers that in reality, critical practice and evaluation of such collaborations are often weak, and that especially transdisciplinarity risks become a buzzword. A view that emerged from the workshop was that the university should be a central player in the critical development of more integrated risk communication approaches. Three major aspects were seen as particularly relevant. Firstly, the communication workshop clearly showed that network-based processes can be challenging, undirected and time- and resource-consuming. In order to facilitate inter- and transdisciplinary learning, geoscience communication training was seen as requiring curricular changes. Such training ought not only to inculcate skills for an effective transfer of knowledge, but also develop researchers' ability for "story-listening" and their sensitivity to the complex societal dimensions of communication. Integrating relevant actors outside academia was seen as equally important as a regular training in using social media such as blogs, and social networks such as Facebook and Twitter for actual interaction with lay people.

Secondly, there was consensus among participants that joint research projects within a university framework could be ideal places for communication training. These research projects should not only bring together scientists of different disciplines, but also create forums to link scientific expertise with community concerns. Some group members argued that universities should "have the courage" to provide knowledge dedicated to communities at-risk, for example "by more frequently using their web and Facebook pages".

Thirdly, novel methodological approaches in science–public collaborations need an in-depth evaluation so that they can be scaled up. One participant critically noted that, while many outreach activities are being done and labelled as innovative, no one knows "if they really create an impact". This view is also reflected in current social science literature on transdisciplinarity, which demonstrates a lack of a commonly shared research framework to ensure valid and reproducible results, and the often generalized and unreconstructed use of the term "transdisciplinarity" is criticized for provoking a devaluation of this important concept (Werlen, 2015; Brandt et al., 2013; Blassnigg and Punt, 2012; Scholz and Steiner, 2015).

On a European level, a series of joint MSc programmes have already responded to the need of integrated disaster risk research to link sound transdisciplinary collaborations with communication training based on empirical social science research. Examples are the MSc programm Risk Prevention and Disaster Management at the University of Vienna, or Disaster Risk Management and Climate Change Adaptation at Lund University. Both programmes are based on a more in-depth evaluation of best practices and methodologies and foster a close collaboration with practitioners from governmental and non-governmental institutions. The joint masters of "Disaster Management and Risk Management" (University of Bonn/Federal Office for Citizen Protection and Disaster Support, BBK) or "Geography of Environmental Risks and Human Security" (The United Nations University/the University of Bonn) are other examples of education initiatives that focus on practising and evaluating inter- and transdisciplinary approaches.

7 Conclusions

Conventional seismic risk communication tends to be focused on the conveyance of "geofacts" (Stewart and Nield, 2012), but, as the ALErT geocommunication workshop demonstrates, geoscientific matters of fact are generally strongly intertwined with societal matters of concern. This results in knowledge configurations that strongly influence the efficiency of geoscientific information transfer. A way to counter this tendency is to integrate local perspectives into the design of communication approaches. Through critical conversations with urban residents, the participants of the ALErT workshop recognized important community-centred issues and concerns that had previously lain outside their geoscientific perspective. Maintaining the value and integrity of the disciplinary knowledge (sound science) whilst at the same time adjusting to specific sociocultural contexts requires a transdisciplinary mode of communication training. Field-provoked communication workshops, community-centred participatory knowledge exchanges and self-reflection on disciplinary practices and paradigms are elements that can readily be incorporated into geoscience communication training more widely. By fostering a more nuanced understanding and awareness of the complexities of science–public collaborations, the next generation of geoscientists can start to develop more fruitful ways to build genuine resilience among those most at risk.

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