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Visual Anthropological Methods in Earthquake Risk Communication: A Transdisciplinary Approach

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Visual Anthropological Methods in Earthquake Risk Communication: A Transdisciplinary Approach

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Author's declaration

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Presentations at Conferences

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Abstract

Johanna Ickert. Visual Anthropological Methods in Earthquake Risk Communication: A Transdisciplinary Approach

Increases in disaster losses, in combination with emerging cascading crises, are provoking a fundamental rethinking of prevailing disaster risk reduction measures, including risk communication principles and practices. The resulting paradigm shift towards participation, action, and prevention is firmly outlined in the Sendai Framework's call for (1) more people-centred approaches and (2) the broader use of innovative information and communication technology (ICT). However, this call raises many epistemological and methodological challenges and open questions about how hazard scientists will translate these novel requirements into their daily research practice.

This thesis presents a practice-led enquiry dedicated to exploring the potential of audiovisual methods for novel approaches in the field of seismic risk communication. It confronts the shortcoming that disaster risk communication research and practice are still widely rooted in earlier outdated models of risk communication. Theoretically underpinned by research in the field of applied visual anthropology and transdisciplinary science, two video-based case studies were undertaken, as well as the development of four audiovisual prototypes. Ethnographic fieldwork in Istanbul was conducted in close collaboration with a multidisciplinary group of hazard scientists and inhabitants of at-risk communities, producing rich in-depth data on their perceptions. My research thus provides new insights into how audiovisual methods might help to facilitate novel approaches in risk communication. In particular, audiovisual techniques are used in three ways: (1) as a research tool in the context of an ethnographic field study; (2) as a collaborative editing tool; and (3) as a risk communication training tool. The interlinking aim is to critically conceptualise, apply, and also partly evaluate audiovisual methods and generate insights on how risk communication might be re-thought and re-practised.

This thesis presents the first critical analysis of the current use of audiovisual methods in the field of disaster risk communication. Moreover, it provides an innovative methodology, grounded in applied visual anthropology and transdisciplinary research, in which theory and practice inform each other through processes of knowledge co-production, co-design, iterations, and feedback loops. The resulting case studies and audiovisual prototypes break new ground in transformative science, specifically in setting out the template for a new critical interface between hazard science and society, namely the emergent field of 'transformative risk communication'.

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Commonly Used Abbreviations

AI	Artificial Intelligence
AV Media and Methods	Audiovisual Media and Methods
DRM	Disaster Risk Management
DRR	Disaster Risk Reduction
ICTs	Information and Communication Technologies
OCKD	'Okmeydanı Cevre koruma ve Güzellestirme Dernegi' (Neighbourhood Association in Okmeydanı, Istanbul)
Prototype 1	The ArcGIS StoryMap From Matters of Fact to Matters of Concern
Prototype 2	The motion graphics film The North Anatolian Fault
Prototype 3	The collaborative AI assisted editing tool Directors' Room
Prototype 4	Training framework for Audiovisual Risk Communication
SDGs	Sustainable Development Goals
SFDRR	Sendai Framework for Disaster Risk Reduction 2015-2030
SİTEDER	'Cumhuriyet Mahallesi Sakinleri' (Neighbourhood Association in Sultangazi, Istanbul)
SRM	Seismic Risk Management
TMMOB	Union of Chambers of Turkish Architects and Engineers

‘It is more likely that the planet we inhabit
will go up in smoke as a consequence of theories
that are entirely unrelated to the world of the senses,
and defy all description in human language,
than that even a hurricane will cause theories
to burst like a bubble.’
(Hannah Arendt, 1963, p. 533)

Introduction

This chapter introduces my doctoral thesis and situates it within the broader academic context. In Section 1, I provide important background information and elaborate on the research problem of this thesis. I start with highlighting an increasing disaster vulnerability despite better disaster risk management, and address disaster losses with regard to earthquakes, a type of disaster that my thesis is specifically concerned with. Following this, I outline the role of risk communication in contributing to disaster preparedness and resilience, and give key information about the recent changes in risk communication in light of the Sendai Framework for Disaster Risk Reduction 2015–2030 (SFDRR) with its call for more *people-centred* risk communication approaches and more substantial use of *innovations in information and communication technology* (ICT). On the basis of these findings, I describe the research problem this thesis seeks to address, namely the challenges for hazard scientists to translate and integrate the priorities of the Sendai Framework into risk communication. Section 2 outlines the focus of this thesis and the research gaps it addresses, followed by Section 3, in which I present the selected research approach, the research context of my study, and my motivation for this thesis. In Section 4, I will provide conceptual considerations and elaborate on the scientific and technical value of my research, highlighting the specific potential of case studies and audiovisual prototype development for novel approaches in risk communication. In Section 5, I summarise the key aims and objectives of my research and Section 6 provides an overview of the thesis structure.

Background and Research Problem

Our world is currently confronted with a number of complex and interlinked global challenges — be they economic and social inequality, the loss of biodiversity, the rise of populism, the effects of digitisation, pandemics, or the tremendous impact of climate change and natural hazards (WEF, 2020). Worldwide, people are faced with old and new risks to their survival and wellbeing. Rapid demographic changes, urbanisation in hazardous areas, poor governance, and socioeconomic inequality lead to increased risk exposure, vulnerability, and persisting disaster losses despite better knowledge of risk (Aitsi-Selmi et al., 2016). This is why — despite the fact that societies have become increasingly efficient at managing disaster risks over the last 30 years — disaster vulnerability has dramatically increased (Lauta et al., 2018). According to the WHO (2020), more than half of all deaths in the period between 1998 and 2017 were related to natural disasters. This problem cannot be tackled individually, as recently demonstrated by COVID-19. Rarely has a collaborative approach that is driven by a wide variety of actors and that takes a multi-hazard, multi-sectoral, inclusive, and accessible approach (UNISDR, 2015a) been so urgently needed to reduce global vulnerability, avert catastrophes, and promote resilient societies.

This thesis focuses in particular on seismic risk. Between 1994 and 2013, earthquakes and the tsunamis they often trigger have caused around 750,000 deaths, and more than 125 million people have been affected, either through injury, loss of homes, displacement, or evacuation (UNIDSR, 2015b). At the same time, the impacts of earthquakes are unequally distributed: Since 1980, 92% of all fatalities from earthquakes have been in developing countries and the poorer emerging nations (low-income and lower-middle-income groups). Around 61% of all earthquakes worldwide have occurred in these countries (Munich Re, n.d.a). In addition, earthquakes can cause enormous economic damage. For example, the 2010 earthquakes in New Zealand and Chile caused damages in excess of 20% of the countries' national GDPs (OECD, 2016). The 2011 nuclear disaster in Fukushima, triggered by a tsunami in the wake of the Tōhoku earthquake, was the most expensive natural disaster of all time, with costs of around 210 billion US dollars (Munich Re, n.d.b).

This thesis argues that hazard scientists hold a particular responsibility in promoting risk-resilient societies, as they are the ones that produce knowledge on disaster risk and risk-related research fields. Moreover, their ability to share their knowledge with different target groups is a crucial factor in the success of disaster risk reduction measures (DRR) and disaster risk management (DRM). Communicating seismic risk is crucial to limiting earthquake impacts and contributing to seismic preparedness. There is broad agreement that risk communication plays a vital role during all four stages of the disaster cycle: mitigation and prevention, preparedness, response, and recovery (e.g., Boersma et al., 2017). Numerous authors outline that risk communication should seek to prevent and mitigate harm from hazards by informing people about potential threats and enabling them to adopt protective measures (e.g., Höppner et al., 2010; Kar & Cochran, 2019; Lundgren & McMakin, 2018; Twigg, 2015). Research has demonstrated that seismic preparedness can be furthered through education that seeks to increase knowledge about earthquake risk as well as hazard exposure and possible precautionary actions (e.g., Hoffmann & Muttarak, 2017). However, it is not sufficient to merely provide risk information, and over recent years, there has been a paradigm shift from a reliance on top-down, expert-led production of risk information to a more integrated and polycentric knowledge generation scheme (Liu et al., 2018). Already in 1989, the US National Research Council (NRC) pointed out that:

> Risk Communication is an *interactive* process of exchange of information and opinion among individuals, groups and institutions. It involves multiple messages about the nature of risk and other messages, *not strictly about risk*, that express concerns, opinions and reaction to risk messages or to legal or institutional arrangements for risk management. (NRC, 1989, p. 21)

In addition, the US Environmental Protection Agency (EPA) highlights that risk communication

> should put a particular risk *in context*, possibly add comparisons with other risks, include advice about risk reduction behavior, and encourage a *dialogue* between the sender and receiver of the message. Ideally, risk communication is a *two-way conversation* in which an agency or organization informs, and is informed by, affected community members. (EPA, 2018)

As will be outlined below, a shift towards more dialogue-based, prevention-oriented, integrated, and polycentric approaches has also been highlighted by three landmark UN agreements.

The New Lens of the Sendai Framework: A Call for More People-Centred Approaches and the Use of Innovations in Information and Communication Technology (ICT)

The year 2015 marked a historic moment with the publication of the Sendai Framework for Disaster Risk Reduction 2015–2030 (SFDRR), the Sustainable Development Goals (SDGs), and the Paris Agreement on Climate Change

(COP21 Agreement). These agreements hold the potential to significantly contribute to an improvement of people's health, the preservation of their environment, and disaster risk reduction (Aitsi-Selmi et al., 2016; de la Poterie & Baudoin, 2015; Kelman, 2017). The agreements also have significant implications for risk communicators. The Sendai Framework provides both occasion and orientation for this research. However, this thesis follows a comprehensive approach, meaning that I regard the Sendai Framework's translation into practical risk communication actions in accordance with the two other landmark agreements as well as the New Urban Agenda and UN-Habitat. As such, the strong interconnections between, for example, disaster risk reduction and climate change adaptation or the development towards urban resilience are always an implicit part of my reflections.

The Sendai Framework is largely seen as the global instrument for disaster risk reduction. It is based on the overarching goal

> to prevent new and reduce existing disaster risk through the implementation of integrated and inclusive economic, structural, legal, social, health, cultural, educational, environmental, technological, political and institutional measures that prevent and reduce hazard exposure and vulnerability to disaster, increase preparedness for response and recovery, and thus strengthen resilience. (UNIDSR, 2015a, p. 12)

The four priorities of the Framework are 1. Understanding disaster risk; 2. Strengthening disaster risk governance to manage disaster risk; 3. Investing in DRR for resilience; and 4. Enhancing disaster preparedness for effective response and to 'Build Back Better' in recovery, rehabilitation, and reconstruction. The Science and Technology Road Map (UNIDSR, 2016) provides a list of expected outcomes, actions, and deliverables in the four priority areas of the SFDRR.

Most important for this thesis is the fact that the Sendai Framework outlines the necessity for a more *people-centred* and preventive approach to disaster risk reduction measures as well as the use of *innovative information and communication technologies* (ICTs). In comparison to its predecessor (the Hyogo Framework for Action), it calls for a shift of focus from managing 'disasters' to managing 'risks' in current DRR practices, outlining the role of participation, action, and prevention for more effective outcomes of disaster risk management. Several scholars argue that this implies, among other things, that hazard scientists have a greater societal responsibility in the realm of disaster prevention, that they must engage much more than before in processes of *transdisciplinary* knowledge co-creation with people from policy, civil society, and the private sector, and that they must translate and share their research more effectively, for example, by using information and communication technology (e.g., Aitsi-Selmi et al., 2016; Bai et al., 2016; Briceño, 2015; Collins, 2018; de la Poterie & Baudoin, 2015; Ismael-Zadeh et al., 2017; Okada et al., 2018). According to Scolobig et al. (2015a), the publication of the Sendai Framework reflects the transformation of DRR policies towards more proactive investments in prevention and preparedness and towards more inclusive approaches with 'stakeholder participation, responsibility shifts from the authorities to the public, greater transparency in risk/uncertainty communication and social/institutional capacity building' (p. 203). Furthermore, the authors clarify that 'in people-centred approaches the power and responsibility for risk-related decision-making is shared among a broad variety of stakeholders, including citizens, because these approaches acknowledge and value different inputs, information and knowledge' (Scolobig et al., 2015, p. 205). The following quotes are taken from the SFDRR text and were selected based on their presumed impact on how risk communication is carried out and conceptualised:

Requirement 1: **A preventive, people-centred approach to DRR**	**Requirement 2:** **Use of innovative information and communication technologies (ICTs)**
'There has to be a broader and a more people-centred preventive approach to disaster risk. Disaster risk reduction practices need to be multi-hazard and multi-sectoral, inclusive and accessible in order to be efficient and effective' (p. 10).	'... it is important [...] to promote real-time access to reliable data, make use of space and in situ information, including geographic information systems (GIS), and use information and communications technology innovations to enhance measurement tools and the collection, analysis and dissemination of data' (p. 15).
'... it is important [...] to invest in, develop, maintain and strengthen people-centred multi-hazard, multi-sectoral [...] disaster risk and emergency communications mechanisms, social technologies and hazard-monitoring telecommunications systems; develop such systems through a participatory process; tailor them to the needs of users, including social and cultural requirements, in particular, gender' (p. 21).	'... it is important [...] to develop, periodically update and disseminate, as appropriate, location-based disaster risk information' (p. 15).
'... There is a need for the public and private sectors and civil society organisations, as well as academia and scientific and research institutions, to work more closely together and to create opportunities for collaboration' (p. 10).	'... it is important [...] to strengthen the utilisation of media, including social media, traditional media, big data and mobile phone networks, to support national measures for successful disaster risk communication' (p. 16).
'Disaster risk reduction requires a multi-hazard approach and inclusive risk-informed decision-making based on the open exchange and dissemination of disaggregated data, including by sex, age and disability, as well as on easily accessible, up-to-date, comprehensible, science-based, non-sensitive risk information, complemented by traditional knowledge' (p. 13).	[Media should be used in a] 'simple, transparent, easy-to-understand and accessible manner [...] support [...] protective measures; and stimulate a culture of prevention and strong community involvement in sustained public education campaigns and public consultations' (p. 24).

Fig. 0.1: *Key requirements outlined by the SFDRR (UNIDSR, 2015a)*

All four priority areas of the SFDRR impact how risk communication should be conceptualised and carried out. Two claims in particular — the call for more people-centred and preventive approaches in DRR and the use of ICT innovations — have significant implications on the different rationales of risk communication and the tools and methods used. A shift towards novel, 'Sendai-conforming' approaches to risk communication obviously encompasses modifications in current communication patterns, a claim that is supported by the wider DRR community, sustainability science community, and the Sendai Framework itself (e.g., Ismael-Zadeh et al., 2017; König, 2015). Or, as Aitsi-Selmi et al. (2016a) memorably express, hazard science (and risk communication) 'needs to be more useful, usable and used' (p. 3). However, although the Sendai Framework 'captures the developments in science and policy thinking of the last 10–20 years' (Aitsi-Selmi et al., 2016a, p. 2), neither the Framework nor the Road Map provide sufficiently detailed guidance for how the Framework could be translated into risk communication practice. However, we need to know much more about how risk communicators can translate these two requirements of the Sendai Framework into practice: How do hazard scientists need to design their communication efforts in order to effectively contribute to the resilience of at-risk communities, with their specific communication and information needs? What methods and tools are required? What technological opportunities need to be fully exploited in order to enhance such approaches?

Challenges of Translating the Sendai Requirements into Risk Communication Practice

The last decade has seen an exponential growth of innovations in digital online communication and technologies that — technically — allow for more interactive user- and dialogue-oriented risk communication. A broad range of risk communication formats can be accessed via social media networks, websites, or other forms of communication. They often deploy innovative technologies, for example, in the context of serious games, risk simulations, early warning SMS, GIS applications, smartphone apps, or online databases. Audiovisual media have become a ubiquitous source of information, with online educational videos emerging as a communication means highly appreciated by scientists. However, while these developments demonstrate that the bandwidth exists for a more engaging, low-threshold, and interactive risk communication via ICTs, they are not necessarily designed to meet the Sendai priorities. Several factors still seem to hamper a translation of the Sendai requirements.

For example, the rapid technological developments in the ICT sector pose new challenges, as their translation into sustainable DRR practices requires, among other things, an increased degree of digital literacy. According to Suarez (2015), new technologies to 'obtain, process, communicate, and use relevant information' are expanding rapidly, and 'efforts to embrace and deploy such geoinformation tools seem to be outpaced by the changing threats and opportunities' (p. 1730). In contrast to these opportunities, hazard scientists mostly use one-way media channels such as publications in scientific journals or conference contributions. Such channels are, however, not easily accessible for non-experts (Lee & Yamori, 2020). Similarly, web-based social-media content such as tweets, posts, images, or online videos are mostly deployed to *represent* risk-related information rather than taking these as a starting point for an *interaction*. One reason for this communication mode certainly lies in constraints relating to time and resources. However, scholars also repeatedly outline that one of the critical challenges lies in the fact that most risk communication efforts are still underpinned by the belief that a transfer of scientific knowledge from experts to non-experts can change public opinion and ultimately heighten the resilience of communities. This way of communicating science has been widely debated as a *knowledge deficit model* (e.g., Demeritt & Norbert, 2014; Frewer, 2004; Simis et al., 2016; see also Chapter 1). The persistence of the deficit model is astonishing, especially against the background that for more than two decades, social science research has indicated that there is little or no correlation between the provision of scientific information about geohazards and risks and adaptive changes in individual or community behaviour that would reduce risk (e.g., Fischhoff, 2012; Kasperson, 2014; Lichtenstein & Slovic, 2006; Palm & Hodgson, 1992; Slovic, 2000; Solberg et al., 2010).

Further, although current research projects dealing with disaster risk are often conducted under the premise of integrating transdisciplinary approaches and ascribe a high priority to more reflexive, user- and action-oriented communication and outreach activities in line with the Sendai Framework, a critical conceptualisation and evaluation of the methodological frameworks for successfully implementing these premises is often missing (Scolobig et al., 2015a). Most hazard scientists only seldomly collaborate with those affected by risk, include their views, or co-design risk communication with those affected (e.g., Jin, 2020). Currently, there is a lack of transdisciplinary formats and teaching spaces for involving at-risk communities in the design of people-centred risk communication (e.g., Hoinle et al., 2021), a lack of training for more dialogue-based or transdisciplinary approaches (e.g., Besley et al., 2015; Schneidewind et al., 2016), and most scientists still shy away from processes of knowledge co-creation (e.g., Bai et al., 2016). One can provocatively state that most hazard scientists are trained in the physics of natural processes and practised in intricate risk assessment procedures, but not necessarily in responding to the requirements of risk communication in line with the Sendai Framework.

As a consequence, scientists are confronted with various practical, methodological, and epistemological challenges. This raises questions relating to how they see their current and future roles and responsibilities within the communication process, what skills, methods, and formats they can make use of to better respond to the novel requirements of the Sendai Framework, and how these approaches can be implemented, evaluated, and institutionally embedded.

Research Focus and Research Gaps

This thesis explores the question of how *post-Sendai risk communication* can be supported, facilitated, and enacted with and through audiovisual methods. As will be further elaborated in the literature review (Chapter 1), a post-Sendai risk communication seeks to translate the two above-mentioned Sendai requirements into action. Most significantly, it fosters transdisciplinary, collaborative and dialogue-based approaches to communication and is based on an assessment of user needs and/or co-creative development. It is context-specific, actionable, reflexive, and science-based. Wherever possible, it deploys innovative and interactive information and communication technologies.

This thesis is based on the assumption that audiovisual methods are powerful tools to stimulate risk dialogue and transdisciplinary collaboration in different risk communication contexts. A vast interdisciplinary body of research has examined the narrative, multi-modal, and multi-vocal potential of film and video (e.g., Allgaier, 2019; Pauwels, 2015; Pink, 2011; Sakellari, 2015). Scholars have highlighted their ability to generate knowledge that goes beyond a better understanding of the technical aspects of risk (e.g., Hicks et al., 2017; Hurtado-de-Mendoza et al., 2019; Tuong et al., 2014). A particular strength of audiovisual media is seen in their potential to reach audiences on a more personal, context-specific level that is usually not part of standard risk communication or the public image of hazard science (Finkler & Léon, 2019). Moreover, scholars describe the potential of audiovisual methods to allow for experiential learning, social learning and empowerment (e.g., Hicks et al., 2017; Reavey, 2020; Saladino et al., 2020). However, current risk communication research lacks critical reflection, application, and evaluation of how audiovisual methods could be used for a post-Sendai risk communication.

This thesis will address three fundamental gaps in existing research:

1. Insufficient guidance for risk communicators on how to incorporate the Sendai priorities

Although the Sendai Framework provides a useful guideline to critically reflect and approach current scientific engagements for more disaster resilience, it does not explicitly refer to risk communication and does not specify a clear set of recommendations and actions for this field. This is surprising, as risk communication is an integral part of the entire disaster risk reduction process. Therefore, it is necessary to a) translate the implications of the Sendai Framework for the field of risk communication, and b) reflect on the potential of audiovisual methods for risk communication in line with the Sendai priorities.

2. Lack of critical reflection on the ways in which audiovisual methods and media are currently deployed for purposes of risk communication

Current disaster risk communication studies mainly focus on the role of audiovisual media as an outreach or publication vehicle that holds the potential to engage audiences more effectively for risk-related themes. In this respect, most risk communication scholars regard audiovisual media as a transfer tool that, due to certain features, can more effectively contribute to cognitive or behavioural changes of target audiences. At the same time, there is a lack of disaster risk communication studies that critically examine the deficit-orientation of audiovisual media, explore audiovisual risk communication with its underlying rationales and actors, or address the lack of user evaluation. Furthermore, very few risk communication studies build on findings from visual social sciences, such as visual anthropology, visual psychology, or visual sociology.

3. Limited focus on audiovisual media as communication products

There are also very few intervention studies that explore alternative ways of using audiovisual media and methods for risk communication beyond film production, such as how the actual *process* of generating and disseminating audiovisual media can be made productive in transdisciplinary settings of disaster risk communication or facilitate it. There are, to my knowledge, no case studies that explore the potential of audiovisual methods to facilitate a co-design of novel risk communication formats.

Research Approach, Research Context, and Motivation

The aim of my thesis is to address the three above-mentioned research gaps through a qualitative, practice-led approach of exploring audiovisual methods in their potential to facilitate post-Sendai approaches in the field of seismic risk communication. I use a case study approach and develop four audiovisual prototypes to provide in-depth insights into different modes of conceptualising, applying, and partly also evaluating audiovisual methods in specific risk communication contexts. Methodologically, my work is anchored in applied visual anthropology and transdisciplinary research. All case studies and prototype developments follow a transformative agenda and explicitly aim to demonstrate, discuss, and shape post-Sendai risk communication processes in collaborative or participatory ways. Although the methods used in the case studies and prototype development mainly stem from the field of visual anthropology, they are not limited to this discipline. Furthermore, this research adopts an *interdisciplinary* approach that blends research in risk communication, visual social science, and insights from the field of seismic risk management.

After a detailed literature review on current risk communication rationales in light of the Sendai Framework and the outline of my methodology, my first case study (Case Study 1) used audiovisual methods as a research tool in the context of ethnographic fieldwork in Istanbul, a megacity that faces one of the highest seismic vulnerabilities in the world. The goal of that exploratory study was to gain insights into the specific risk communication context in four at-risk neighbourhoods. Case Study 1 provided the foundation for the follow-up studies this thesis presents. By using a combination of visual and verbal research methods in the context of ethnographic fieldwork as well as a transdisciplinary workshop and focus group discussions, this exploratory study generated rich data concerning current issues related to seismic risk communication and risk mitigation in Istanbul. All follow-up studies were inspired by the research findings obtained in Case Study 1 and seek to address the shortcomings of risk communication identified here. The follow-up prototype developments seek to explore the potential of audiovisual methods for a more nuanced, multi-vocal representation of seismic risk and for facilitating transdisciplinary collaboration in the realm of collaborative film editing. Case Study 2 uses audiovisual methods as a training tool, researching how the developed prototype for a video-based risk communication training framework contributes to the development of 'sustainability skills' necessary for a post-Sendai risk communication.

The case studies and prototype developments presented in this thesis were conducted in iterative ways, and involved the integration of multiple feedback loops and adjustments in my methodological approach. For example, in order to address methodological weaknesses in Prototypes 1 and 2, the development of Prototypes 3 and 4 took place through the application of a Design Thinking framework, as proposed by the Stanford d.school (Plattner, 2012).

It is also important to clarify that this doctoral project is concerned with risk communication that takes place *before* a disaster occurs and therefore has a clear focus on risk communication for disaster prevention, risk reduction, and preparedness. In line with Höppner et al. (2010), this thesis regards risk communication as a 'preventive activity that prepares communicating actors for hazard events, that enables them to better cope with hazard events and which helps to reduce adverse impacts on people and social systems' (p. 7). This approach is distinguished from disaster, crisis, and emergency communication, which tend to focus on communication activities during and in the immediate aftermath of hazard events. In addition, despite the fact that my focus lies on seismic risk communication, the overall rationale of this thesis is in line with the Sendai Framework, which promotes multi-hazard, multi-sectoral, and multidisciplinary approaches to disaster risk reduction. I expect that the insights gained in the case studies are thus also applicable to other domains of risk communication.

Regarding the implementation of the case studies, this project was embedded in a very supportive and inspiring research environment. The work presented here was part of a Marie Curie Integrated Training Network on 'Anatolian pLateau climatE and Tectonic hazards' (ALErT). Within this network, a multidisciplinary team of Earth scientists studied the complex interactions between tectonic and climatic processes that influence the morphologic evolution of Turkey's Central Anatolian Plateau (CAP) and associated natural hazards (such as the Istanbul earthquake risk) from 2014 to 2017. This network has represented a promising framework: ALErT's emphasis on natural hazards — principally earthquakes, landslides, and flooding — meant that in addition to receiving training in advanced methods of geoscience data acquisition and field investigation, the researchers were expected to develop expertise in risk communication and transdisciplinary collaboration in line with the requirements of the Sendai Framework.

The thematic focus of this thesis overlapped to a larger degree with my background as a professional filmmaker and editor, which enabled several synergies. Due to my training in the field of cultural anthropology and documentary filmmaking, I have collaborated with different research institutes and universities over the last 10 years and have produced several films that aim to support the communication of transdisciplinary research projects dealing with the societal implications of environmental change (https://librafilm.de/, http://filmasmethod.com/). Through this work at the interface between audiovisual media and science, I could gain first insights into film's potential as a communication tool in transdisciplinary research contexts. This background productively fed into my collaboration with colleagues from the ALErT group, many of whom participated in the case studies presented in this thesis. The insights gained in the process of this collaboration also helped me to gradually develop the central aim and objectives of this thesis and to understand the scientific and technical value of using audiovisual methods in the field of risk communication.

Conceptual Considerations

The knowledge of disaster risk and resulting adaptation and mitigation measures are generated, to a large degree, by geoscientists such as those from the ALErT group. It is therefore crucial that this technical knowledge is shared in a way that goes beyond conventional scientific channels and formats and reaches at-risk communities based on an assessment of their communication and information needs (Bendito & Barrios, 2016). The significance of this approach is well-described by Oreskes (2015), who states that:

> We know well where earthquakes occur, but we seem to know less well how to persuade governments and individuals to prepare adequately for them. [...] In short, our well-being will depend on our ability to consider the physical and the social as parts of integrated and interacting systems. (p. 264)

Consequently, using audiovisual methods in 'post-Sendai ways' would ideally help to facilitate and enhance risk dialogue and collaboration between different academic and non-academic stakeholder groups; produce and co-create more context-specific, actionable, and user-oriented risk communication content; use innovative ICTs; and also improve skills to better handle methodological hurdles associated with risk communication. The resulting integrated strategy might support scientists to do a better job in creating such dialogues, discussions, and individual contributions, and could potentially ensure that their views and communication efforts are also a trusted part of public debates.

Specifically, this thesis will provide three discrete perspectives on the potential of using audiovisual media and methods for a post-Sendai risk communication:

Film as Research Method: An Exploratory Case Study in Istanbul with Follow-Up Prototype Development

In Case Study 1, I used film as a research tool (in combination with other verbal research methods) to gain a more nuanced understanding of the themes connected to seismic risk communication in four at-risk neighbourhoods in Istanbul. Through ethnographic fieldwork — including methods such as filmed interviews, filmed participant observations, reflexive photography exercises, photo-elicitation interviews, and other participatory video techniques — different perspectives and perceptions of risk held by hazard scientists and inhabitants became apparent. These views were further complemented by a transdisciplinary workshop and focus group discussions.

My fieldwork revealed that seismic risk communication in Istanbul is marked by a deep political controversy on current risk-mitigation processes. I outline how the use of audiovisual methods helped me to demonstrate that the very act of trying to represent earthquake-related themes in more nuanced and collaborative ways can gain a theoretical, socio-political, and practical relevance. For example, as I used methods such as 'photo-elicitation' (Collier & Collier, 1986; Harper, 2002), which facilitates a conversation on the basis of photographs, different 'ways of seeing' seismic risk were supported. As research participants freely commented on their own and other stakeholders' representations regarding the current seismic risk communication and mitigation, epistemological and ontological assumptions related to seismic risk were explored. Further, I present how — due to the participatory and multi-sensory potential of this method (Pink, 2009) — multi-layered processes of translation and mediation were facilitated. Moreover, the process of sharing, watching, and discussing different versions of edited film sequences raised the empathy, sensitivity, and creativity of the different research participants involved in the case study.

As both — the use of audiovisual methods, but also the transdisciplinary workshop and the focus groups — revealed major shortcomings of risk communication, I wanted to actively confront these through the joint conceptualisation of two prototypes with participants from the ALErT group: the ArcGIS StoryMap 'From Matters of Fact to Matters of Concern' (Prototype 1), and the animation film 'The North Anatolian Fault' (Prototype 2).

Using Film for Transdisciplinary Collaboration: Prototype-Development of a Collaborative, AI-Assisted Editing Tool

In this chapter, I outline how I conceptualised Prototype 3: the collaborative AI-assisted editing tool 'Directors' Room'. Based on a critical reflection of the preceding prototypes, the methodology of Case Study 1 and a review of further literature, I ask how the transdisciplinary co-design of risk communication can be facilitated through collaborative editing. In the following, I reflect on how film can be used not only as a *representational* visual instrument but how the *process* of collaborative editing can be used for dialogue-oriented, experiential, and reflexive approaches. I argue that a major benefit of collaborative editing is the strengthening of 'social learning' that transdisciplinary communication formats seek to promote (Hagemeier-Klose et al., 2014; see also Árvai & Rivers, 2013; Buchecker et al., 2013; Kasperson, 2014; Lindenfeld et al., 2013; Werlen, 2015). From that, I conceptualise the prototype for collaborative, AI-assisted editing and provide an example of how audiovisual methods could be used to foster integration and creative exchange on different forms of knowledge and epistemologies. In order to complement this prototype development, I present a draft for a follow-up user test and outline possible fields of application, e.g., in the context of Vulnerability and Capacity Assessment (VCA), Participatory Rural Appraisal (PRA), or Participatory Action Research (PAR).

Film as Educational Tool: A Case Study on Audiovisual Risk Communication Training

Case Study 2 explores in what sense the use of audiovisual methods can enable early-career researchers to more fully understand and critically engage with the Sendai rationale of risk communication. It conceptualises an audiovisual risk communication training framework (Prototype 4) with the goal to address the shortcomings identified in Case Study 1 through training the 'sustainability skills' of scientists (Wiek et al., 2011). These skills encompass five key competencies: systems-thinking competence, anticipatory competence, normative competence, strategic competence, and interpersonal competence. The assumption is that scientists, who are armed with these skills, can more critically question current conceptions of 'effective' communication. These skills might enable hazard scientists to pursue more multi-layered and multi-vocal risk communication strategies that foster long-term processes of negotiation and knowledge co-creation beyond the deficit model.

Altogether, the use of audiovisual techniques might encourage the emergence of new practices, methods, and paradigms in the field of seismic risk communication. This can contribute to long-term impacts on the development of risk communication practices in line with the Sendai Framework.

Aim and Objectives

Given these conceptual considerations, the primary aim of my study is to critically explore different approaches of using audiovisual methods for post-Sendai risk communication. I will do so by conceptualising, applying and partly also evaluating them

1. as a research method for a more nuanced representation of seismic risk in the context of an ethnographic field study,
2. as a collaborative editing tool to facilitate transdisciplinary collaboration, and
3. as a risk communication training tool to strengthen sustainability competencies

Thus, this research seeks to provide insights on how to expand current deficit-oriented risk communication strategies and extend their scope, methods, and perspectives, thereby contributing to a critical re-appraisal of disciplinary tools and concerns. In doing so, I seek to advance the use of audiovisual methods and to provide a basis for further (empirical) research, e.g., in the field of intervention studies. Furthermore, through the development of audiovisual prototypes, I seek to provide hazard scientists with practical examples and tools for how to approach risk communication in 'post-Sendai ways'.
As such, the interlinked, sequential objectives of my research will be to:

1a. Identify current approaches and 'modes' of seismic risk communication in the realm of audiovisual media and analyse if and how they respond to the requirements raised by the Sendai Framework for more people-centred approaches and the use of information and communications technology innovations.
1b. Provide a critical reflection on the current research literature of audiovisual media in risk and seismic communication.

2. Critically collect different perceptions held by geoscientists and inhabitants of urban areas with seismic risk in Istanbul regarding seismic risk communication by using audiovisual methods as a research tool and setting up a film-based transdisciplinary workshop. Explore if and how using audiovisual methods as

a research tool can help to better describe and reflect on seismic risk mitigation and its communication. Critically conceptualise prototypes that are informed by this transdisciplinary research and co-designed with inhabitants and hazard scientists.

3. Conceptualise a prototype for collaborative, AI-assisted editing tool that facilitates dialogue, knowledge co-creation, and joint creativity between hazard scientists and inhabitants of at-risk neighbourhoods. Outline how the use of this editing tool might support hazard scientists to better understand and respond to complex sociocultural and sociopolitical contexts and differing risk perceptions in the context of transdisciplinary collaboration.

4. Design and undertake a theoretically informed, film-based risk communication workshop. Through evaluation interviews with workshop participants, explore if and how using audiovisual methods as a risk communication training tool can contribute to the development of sustainability competencies necessary for a post-Sendai risk communication.

Objectives 2, 3 and 4 will be provided along with visualisations and moving image works integrated as links into the respective chapters. Parts of the audiovisual work will also be presented in the ArcGIS StoryMap 'From Matters of Fact to Matters of Concern'. As these audiovisual materials are ethnographies in their own right, the corresponding case studies will not merely present their ethnographic findings. Rather, they will take these materials as points of departure for a theoretical exploration of the medium's potential to communicate in more reflexive, user- and action-oriented, as well as transdisciplinary ways.

Thesis Structure

The following Chapter 1 presents a detailed critical review of pertinent interdisciplinary literature focusing on the Sendai Framework in the field of risk communication and the use of audiovisual media and methods in risk and seismic risk communication. Based on this review, I raise a series of emerging research questions that this thesis addresses.

Chapter 2 provides a detailed exposition of the research design. This is positioned in relation to current and past discussions regarding the use of film as a research method. I will also outline the rationale for the choice of methods and the (ethnographic) case study approach.

Chapters 3, 4, and 5 discuss the background and context of the two case studies and prototype developments. The first case study explores the use of film as a research method for a more nuanced representation of seismic risk in the context of an ethnographic field study. The following prototype development explores audiovisual methods as a facilitation device for transdisciplinary collaboration and the second case study investigates the use of film as a risk communication training tool.

Chapter 6 discusses my research findings. Here, I outline the novel contributions that this thesis makes to the field and examine possible implications. Furthermore, I critically reflect on the strengths and weaknesses of the case studies and prototype developments and give recommendations for future research.

The last chapter provides the conclusion of this thesis.

Chapter 1 – Literature Review

In this chapter, I review interdisciplinary literature that provides a theoretical framework for the research on audiovisual methods in (seismic) risk communication. In light of the new requirements for disaster risk reduction raised by the Sendai Framework for Disaster Risk Reduction 2015–2030, I critically explore the literature on its implications for (seismic) risk communicators. Specifically, I examine the literature on current limitations, challenges, and opportunities of using audiovisual media and methods to translate two essential requirements raised by the SFDRR: a) more people-centred approaches in DRR and b) more substantial use of innovations in information and communication technology.

After a short introduction on the interdisciplinary nature of this review, Section 2 briefly introduces the Sendai Framework and examines literature in the field of disaster risk and risk communication to theorise these requirements. In Section 3, I outline how audiovisual methods are currently being used by hazard scientists and evaluate key research on the role of AV technologies in disaster risk communication. Section 4 addresses the shortcomings of the current use and research of audiovisual media in risk communication through the lens of literature from the (visual) social sciences. Based on these findings, Section 5 raises a series of emerging research questions that my thesis will address.

1.1 Why an Interdisciplinary Literature Review on (Audiovisual) Risk Communication?

In this chapter, I will review literature from two extensive and distinctly interdisciplinary research fields — risk communication research and the visual social sciences — to theorise the potential of audiovisual media and methods to translate the above-mentioned Sendai requirements into action. Although my thesis focuses specifically on the role of audiovisual media and methods in the field of seismic risk communication, I thus acknowledge the rich research findings from other fields of risk communication research, e.g., in the areas of health risk (e.g., Glik, 2007), environmental risk (e.g., Mabon, 2020), climate risk (e.g., Nkoana et al., 2018), flood risk (e.g., Rollason et al., 2018), and volcanic risk (e.g., Barclay et al., 2008). I also acknowledge the profound body of research from sub-disciplines like visual sociology (e.g., Harper, 2012), visual anthropology (e.g., MacDougall, 2005; Hockings, 2009), and visual psychology (e.g., Reavey, 2020). Astonishingly, despite significant overlaps, most risk communication and visual research fields are disconnected from each other, although an interdisciplinary perspective, as attempted in this chapter, could provide mutual insights, e.g., on common trends or best practices. For example, seismic risk communication research is concerned with findings from the field of seismology and earthquake engineering. However, similar to other sub-disciplines of risk communication, it uses methods from the social sciences, natural science, and media and communication studies, and involves issues around risk perception and the public understanding of science and risk management (Hunka et al., 2015). Similarly, common themes in the field of visual research include questions of representation, the use of video for more inclusive, reflexive, and participatory forms of collaboration — often within inter- and transdisciplinary formats — or the exploration of the phenomenological and artistic qualities of film (Harris, 2016). Without disputing the richness of disciplinary perspectives, each of which has its own ontological and epistemological stance towards risk and the visual, I hope that this review provides insights for both scholars of risk communication and visual social scientists, regardless of their disciplinary focus.

Despite the intricacies of disaster risk communication that I will outline in the following sections, researchers broadly agree that risk communication plays a key role in the development of more resilient societies. However, risk communication is, in many cases, a highly complex endeavour. Risk communicators need to deal with challenges raised by risk characteristics that result from a lack of knowledge and/or competing knowledge claims about the risk problem. Besides the inherent challenges of risk communication, which include the communication of complexity (Boholm, 2008) and scientific uncertainty (Boholm, 2008; Fischhoff & Davis, 2014; Funtowicz & Ravetz, 1992), risk communication is often challenged by sociopolitical ambiguity resulting from the fact that heterogeneous actors are involved in risk communication management and have diverse expectations about design, procedures, and overall goals (Beck, 2009; Höppner et al., 2010; Renn et al., 2018). As such, risk communication takes place ‘within an increasingly multilayered and diversified sociopolitical landscape in which a multitude of actors, each individual with their own perceptions and evaluations, draw on a diversity of knowledge and evidence claims, value commitments, and political interests in order to influence processes of risk analysis, decision making, and risk management’ (Jasanoff, 2004, as cited in Renn et al., 2018, p. 434). Further, risks are often related to globally intertwined social-ecological systems, complex cross-scale interactions, and anthropogenic changes in the Earth system’s key functions. This has led authors such as Keys et al. (2019) to refer to new 'Anthropocene risks'[1]. Scholars from science and technology studies (STS) and adherents of post-critical theory also frequently interrogate the modern distinctions between nature and culture, subjects and objects, humans and non-humans, and experts and non-experts (e.g., Haraway, 2013; Klingan et al., 2015; Latour, 2004).

In order to exemplify these views, I refer to two particular seismic events that illustrate why a better understanding of (audiovisual) risk communication processes requires a more holistic perspective:

Simultaneous natural and human-made disasters such as the nuclear disaster in Fukushima following the 2011 Tōhoku earthquake tragically illustrate the increasingly destructive potential of earthquakes and show their knock-on effects, which often hit complex societies in particularly hard ways (Lauta et al., 2018). They also offer profound insights into the complexities and limitations of seismic risk communication, questioning 'modern barricades between technical and public 'spheres' of argumentation' (Goodnight, 2012, as cited in Olman & DeVasto, 2020). Lacassin and Lavelle (2016) describe how risk communication was deeply intertwined with a crisis of a scientific paradigm: Japanese seismologists had based their hazard evaluation on the concept of the repetition of characteristic earthquakes; a dominant, however, in this case, faulty paradigm of seismology. Although there were scientific controversies and uncertainties, with critics of this paradigm outlining the possibility of a complete breakage of the fault up to the seafloor and thus predicting a larger earthquake, this scientific dissensus was not communicated to political decision-makers. In light of globally intertwined social-ecological systems and complex cross-scale interactions, this ultimately led to one of the most costly and devastating nuclear disasters in the recent past. Authors such as Funabashi (2012), Shirabe et al. (2015), and Ng and Lean (2012) argue that the Fukushima nuclear disaster was to a significant degree a human-made calamity because of ineffective (preventive) risk communication that lacked critical discourse and public participation.

The 2009 L'Aquila earthquake in Italy, which resulted in over 300 deaths and 1,500 injuries, is another earthquake that triggered a paradigm shift in how

1 The concept of the 'Anthropocene', originally developed by Crutzen and Stoermer (2000), suggests that 'boundary conditions' that have defined the last twelve millennia of our planet's surface history have been compromised as we have entered an age in which humans have become a major geological force (Crutzen & Stoermer, 2000; Steffen et al., 2007). However, the concept of the Anthropocene not only deals with evidence for these distortions on a stratigraphical level. It is also understood in a much more 'fluid and broader sense' (Maslin & Lewis, 2015, p. 114) that affects how knowledge is produced and communicated. The close entanglement of social and environmental, material and immaterial processes challenges dominant disciplinary paradigms and Cartesian world-views, placing a novel responsibility on scientist' shoulders regarding the sustainability of their scientific enterprises (Klingan et al., 2015; Latour, 2004; Popa et al., 2015).

seismic risk communication is viewed within the scientific community. In 2012, six scientists and one civil servant were sentenced to manslaughter for failing to adequately warn L'Aquila's inhabitants of an impending earthquake. Just days before, this group had taken part in an official meeting with local politicians called to assess risks in view of recent seismic tremors in the region. However, this meeting led to a false message of calm and reassurance immediately prior to the earthquake. From the beginning, the case became the subject of broad scientific controversy (e.g., Alexander, 2014; De Vasto et al., 2016; Stucchi et al., 2016; Yeo, 2014). The historian of science Naomi Oreskes poignantly describes that

> the case centered not on the matter of whether or not earthquakes can be predicted, but on political questions about the social obligations of scientists speaking in official advisory capacities, and epistemic questions about the appropriate manner in which risk assessments should be performed. The questions at stake were what information scientists should have offered the public and how that information should have been communicated. They were not so much matters of scientific facts, but matters of how those facts were rendered and communicated. (Oreskes, 2015, p. 254)

An influx of similar cases, most recently the COVID-19 pandemic, has made it clear that the L'Aquila and Fukushima disasters are, despite their tragic consequences, no exceptions, but a new 'Anthropocene norm' (Olman & DeVasto, 2020).

My literature review thus acknowledges that (audiovisual) risk communication needs to consider a complex interrelationship between knowledge, safety, and society from different perspectives. Beyond the physical threat of natural disasters, ethical, social, cultural, and economic facets of risk are inseparably present in decisions made under uncertainty and affect how risk is researched, conceptualised, and communicated (Scolobig, 2015a). Given the complex and multifaceted nature of risk research, many authors call for a more inter- and transdisciplinary 'whole-of-science' approach (e.g., Bai et al., 2015; Barnosky et al., 2014; Bendito & Barrios, 2016; Donovan et al., 2019; Ismail-Zadeh et al., 2017). The lively and controversial discourse that followed the two cases mentioned above demonstrates the difficult and changing role of risk communication research and practice. Risk management goes beyond rectifying gaps in knowledge or potentially incorrect risk assessments and is increasingly concerned with the resolution of broader risk conflicts and questions related to public engagement (Scolobig, 2015b). This shift in how risk communication is conceptualised and carried out goes hand in hand with the emergence of new 'hybrid' disciplines like geoethics (Wyss & Peppoloni, 2014), which investigates the implications of an 'Earth science as a Social Science' (Oreskes, 2015; Stewart & Gill, 2017) at a time in which 'matters of fact' are also 'matters of concern' (Latour, 2004).

The Sendai Framework attempts to incorporate these lessons by highlighting more integrated, preventive, and people-centred approaches to communication and the role of communication technology. However, as already discussed in the introduction, there is a lack of detailed guidance regarding how the Framework could be translated into risk communication practice. There is only a brief overview document, the 'Words into Action Guideline' (UNIDSR, 2017), which gives government officials and other professionals generic recommendations on how to communicate with general audiences to reduce the risk of disasters. Therefore, I will provide a more in-depth analysis of the two requirements through the lens of risk communication literature in order to better confront the question of how practitioners are actually translating them within research and practice. Through this deepened perspective, I will consider the degree to which risk communication scholars use and reflect current AV methodologies and tools to translate Sendai's requirements into practice.

1.2 The Sendai Framework for Disaster Risk Reduction 2015–2030: A Paradigm Shift for Risk Communication?

1.2.1 What Does the Requirement for a 'People-Centred Approach to DRR' Encompass for Risk Communication?

Unsurprisingly, Sendai's calls are broadly in line with and based on current recommendations of recent risk communication research. Regarding the need for a more people-centred and preventive approach to DRR, it first has to be taken into account that disaster risk communication has long been oriented along a sender-receiver scheme, with a one-way, top-down transfer of information from scientists and disaster management authorities to the general public (Lundgren & McMakin, 2018). The risk communication models based on this rationale (e.g., Crisis Communication (Coombs, 2007), Hazard/Outrage (Sandman, 1993), Social Amplification of Risk (Kasperson et al., 1988) largely draw on this one-way communication process approach such as described by Shannon & Weaver (1949). The current academic discourse on risk communication is marked by increased attention to social constructivist models (Wadell, 1995) that move beyond the 'one-way' communication mode, with its often narrow focus on information transfer and/or behavioural change. Here risk communication is regarded as a coproduction among various actors, with risk communication based on interactive, cyclical, and dialogue-centred exchanges (also referred to as 'two-way flows of information' or 'two-way communication', see Fig. 1.1).

Knowledge coproduction at the research level ranges from the participation of civil society organisations in research projects to citizen science, science shops, and many more formats (Schneidewind et al., 2016). It is broadly assumed that such approaches promote social learning as they allow for an integration and exchange of different forms of knowledge and epistemologies, for example, by building upon both the cognitive and affective responses to previous experiences with disasters (e.g., Árvai and Rivers, 2013; Boersma et al., 2017; Buchecker et al., 2013; Dietz, 2013; Fischhoff, 2014; Hagemeier-Klose et al., 2014; Kasperson, 2014; Lindenfeld et al., 2013; National Academies of Sciences and Medicine, 2017; Popa et al., 2015; Wachinger et al., 2018; Werlen, 2015). Besides ensuring a shared understanding of risks as outlined in Sendai priority 1, core benefits of dialogue-based risk communication are seen in the potential generation of mutual trust by taking different stakeholders' concerns seriously and including different perspectives into a risk discourse (e.g., Renn & Levine, 1991; Wachinger et al., 2013). Facilitating a shared consideration of alternative risk adaptation strategies can, for example, improve the capabilities of non-experts and promote stakeholders' risk maturity so that they understand the basis of risk decision-making (Árvai, 2014; Renn et al., 2018). Authors such as Treurniet et al. (2015) also outline such improved decision-making capabilities, clearly stating that dialogue-based risk communication approaches are more 'effective' than top-down communication. According to Árvai (2014), they also provide 'much-needed insight to risk assessments and their subsequent application to risk management' (p. 1248). Or, as summarised by Wachinger et al. (2013), dialogue-based formats are 'the most effective means to create awareness of potential disasters, to enhance trust in public authorities, and to encourage citizens to take more personal responsibility for protection and disaster preparedness' (Wachinger et al., 2013, p. 1063). According to Boersma et al. (2017), the non-linear, multi-directional approach to risk communication 'is consistent with a political landscape where legitimation is gained through negotiation and deliberation' (p. 390), which corresponds to Sendai priority 2 (Strengthening disaster risk governance to manage disaster risk). Dialogue-based communication among multiple stakeholders is a fundamental part of transdisciplinary collaboration, which is seen as increasingly important for the coproduction of risk communication. For example, Ismail-Zadeh et al. (2017) propose

> a fundamental change in scientific approaches to disaster risk reduction by shifting the emphasis from an individual hazard and risk assessment dominant in the geoscientific community today to a more comprehensive systems approach involving multiple hazards, action-oriented research on disaster risk reduction co-produced with other stakeholders including policymakers, and methods that facilitate the ability of diverse stakeholders to provide complementary perspectives. (p. 971)

The chances for transdisciplinary approaches in risk communication research increase with new opportunities that are opening up. Science policies that seek to strengthen participation of civil society organisations in research and innovation can be observed at the national level as well as at the European level with programmes such as 'Science in and for Society' in the seventh and eighth research framework programmes (FP7 and FP8) (e.g., Owen et al., 2020). However, while the literature outlines the efficacy of such dialogue-based or transdisciplinary formats, research into current risk communication practices indicates that a series of EU-funded research projects engaged in seismic risk communication (e.g., through audiovisual means) still rely on one-way forms of communication (Musacchio & Solarino, 2019), an aspect that I will further elaborate in Section 1.4.

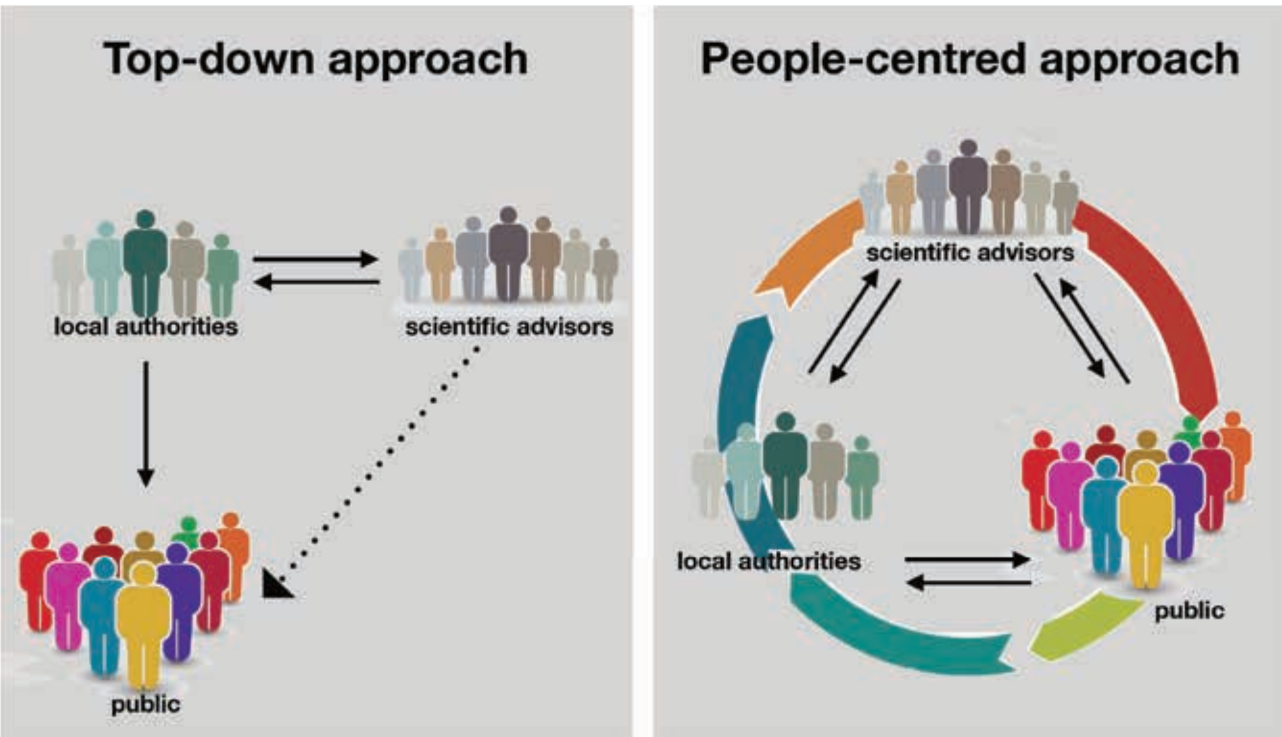


Fig. 1.1: A simplified comparison between a top-down, expert-led risk management approach and a people-centred risk management approach, as suggested by the Sendai Framework (adapted from Scolobig et al., 2015a)

1.2.2 What Does the Requirement for an Innovative use of Information and Communication Technologies (ICTs) Encompass for Risk Communication?

Disaster risk communication takes place not only through different modes (e.g., one-way or two-way communication, as mentioned above) but also through different direct or mediated channels and communication tools that largely depend on or are shaped by technological developments. Besides face-to-face conversations and 'old media' such as radio, television, and print, nowadays internet-based knowledge platforms and networks, smartphone apps, databases, GIS applications, and various social media channels are increasingly decisive for risk communication. Information and communication technologies (ICTs), also referred to as information networks (Castells, 2000), are of significant importance in today's network society, and they form the basis of many social and organisational structures in the field of DRR. Furthermore, scientists increasingly outline the relevance of machine learning techniques for AI-supported risk management and communication (for a review, see Ogie et al., 2018). Ideally, the choice of communication modes, channels, and tools is guided by the purposes and functions of communication, with technical and social resources for risk communication optimally used for the sensible design and application of ICTs (Boersma et al., 2017; Höppner et al., 2010).

A more people-centred, preventive risk communication depends to a large extent on the quality of the channels and media that practitioners use, with web-based ICTs offering opportunities to reach, aggregate, and include many people who would otherwise have limited access to relevant risk information (Stal, 2013; Zaman et al., 2020). ICTs hold the potential to disseminate 'more targeted and actionable risk information to diverse audiences across multi-cultural, multi-disciplinary and multi-jurisdictional boundaries' (Boersma et al., 2017, p. 392). Social networks have become increasingly important for the co-design and co-production of risk communication. Beyond this, multi-hazard knowledge centres, multi-sectoral platforms, and other web-based knowledge services offer the possibility to work with content from scientists as well as various other actors, for example, information resulting from citizen science (e.g., Jennings et al., 2017; Kar, 2016).

How technological innovations in risk communication are developed depends strongly on user preferences and user feedback (e.g., Ogink & Dong, 2019). For example, social networks often allow users to shape technological innovations by taking on the different roles of audience, synthesiser, modifier, player, and producer (Becker et al., 2017). In addition, it is helpful to describe the roles of the actors involved in risk communication through different scenarios of contemporary communication. Jenkins et al. (2013) propose three models – the

first describes communication from one sender to multiple receivers ('broadcast model'); the second describes online communication in which users themselves actively search for content that meets their expectations ('stickiness model'); and the third describes how content reaches users through their involvement with interactive digital tools ('spreadable model').
After having introduced these general findings, what developments can be observed in the realm of AV technologies for disaster risk communication?

1.3 Novel Audiovisual Formats and the Rise of Online Video

The substantial changes in the realm of AV technologies over the last two decades had a significant impact on science and risk communication practice and research (e.g., Allgaier, 2019; Bennett & LaForce, 2019; Drake et al., 2014; Finkler & Leon, 2019; Sutton & Veil, 2017). In addition to traditional broadcast media such as television and cinema, there is now potential to use a wide variety of video-based applications on social media platforms, smartphone apps, and virtual or augmented reality. Furthermore, new film formats such as urban screens, 360-degree films, ten-second snaps, or live-streaming offer fresh opportunities for risk communicators. Novel technologies are increasingly blurring the line between consumers and producers of media content. This not only leads to new challenges in risk communication but also holds enormous potential for its development (Ciastellardi & Di Rosario, 2015; Finquelievich et al., 2014). Undoubtedly, the democratisation of audiovisual media and the multitude of interactive applications are changing many of the technological and procedural assumptions that guide (risk) communication (Allgaier, 2019; Erviti et al., 2020; Varghese et al., 2020). They also enable new pathways for more people-centred risk communication and ICT innovations.

Obviously, this also means one has to take into account the changed behaviour of media usage in the field of video consumption, which has significantly increased over the past decade. Online video is currently the fastest growing means of communication (León & Bourk, 2018). According to an online survey of video viewers across selected countries in August 2020, 27.2% of viewers watched more than 10 hours of online video weekly (Statista, 2020). According to Cisco (2020), online video will make up 82% of all IP traffic by 2022. However, risk communicators using video have to compete with strong players in the field. For example, only 1% of popular Facebook videos represent 83% of total watch time (Tang et al., 2017). Besides platforms allowing and promoting the use of video, such as Facebook, Instagram, TikTok, Snapchat, LinkedIn, Xing, and Twitter, surveys have demonstrated that YouTube (as one of the world's most popular websites and the second most accessed search engine after Google) is a favoured source for people seeking scientific information (Welbourne & Grant, 2015). According to its self-description, YouTube has 2.3 billion users worldwide and 79% of internet users have their own YouTube account (Statista, 2021). In Germany, 58% of people under 30 use YouTube as a source of information about science, technology, and medicine (Forum Wissenschaftskommunikation, 2020). Therefore, authors such as Erviti and Stengler (2016) have asserted the 'immense potential of online video [...] especially regarding the possibility of establishing a dialogue with the audience and of experimenting with different formats' (p. 1). If audiovisual media representations have such great potential regarding their public impact, how has the use of audiovisual media and methods evolved in the communication of natural hazards, particularly in the field of seismic risk communication?

1.3.1 The Current Use of AV Technologies for Risk and Seismic Communication

Risk visualisations have always served as a valuable source for hazard education, risk communication, and scholarship in disaster risk research. Various visual methods such as drawings, charts, slides, maps, and photographs were, from early onwards, integral to the production and dissemination of geoscientific knowledge on natural hazards and risks (e.g., Charrière et al., 2012; Frodeman, 1995; Kastens et al., 2009; Landecker, 2006). With the improvement of computer processing power and sophisticated visualisation software, the last three decades have been marked by an impressive and rapid development of dynamic image generating technologies and related research. These include various forms of geo-referencing, 3D WebGIS (e.g., Thomas, 2018), real-time techniques (e.g., Stempel et al., 2018), and 3D virtual reality (VR) environments (e.g., Havenith et al., 2019). Particularly web-based visualisation technologies are frequently used for risk communication purposes. For example, GIS-related applications are used to generate and collect user data (e.g., through mobile technology, such as early warning apps) or to help make geoscientific data, such as hazard-related information, more accessible to users who might benefit. Such approaches seem to conform to a large degree with the Sendai requirements for more user participation and user orientation. Interesting examples in the field of disaster risk include projects by the Humanitarian OpenStreetMap Team (Herfort et al., 2021) or the Global Earthquake Model (Pagani et al., 2014).

However, compared to 'static' visualisations, the use of *moving* images has so far played a rather subordinate role in risk communication. Scientists have engaged with this medium in different ways, which can be broken down into five categories (proposed by Garrett, 2010): 1. Writing about films (analysis), 2. Production for an audience, 3. Footage as record (data collection), 4. Reflexive filmmaking (experiential filmmaking), 5. Participatory video (collaborative filmmaking). I would add two more categories, namely 6. Filmmaking for dissemination of inner-scientific research (for example, in the form of video abstracts for seminar announcements or publications) (e.g., Bredbenner & Simon, 2019), and 7. The use of film and AV methods as an academic teaching tool (e.g., Laursen & Brickley, 2011; McKnight et al., 2016; Wade & Courtney, 2014; Wiese & McConnell, 2014). As there are to my knowledge no publications about the proportionate usage of different AV formats, I can only base on my literature review that types 2, 3, and 7 seem to be most prevalent:

Regarding type 3, several authors have outlined the value of using film and video as a research tool for the description of 'objective' scientific reality. For example, Kastens et al. (1996) state that 'a moving image can convey fundamental information about how the earth has changed through time', i.e. through tectonic plate movements (p. 534). Since approximately the 1930s, film recordings have served as an archival device to capture scientific observations (e.g., during fieldwork) or as a tool for time-lapse film and photography. Such recordings represented a useful resource for educational illustrations, for example, of the importance of time in geologic processes (Fahnestock, 1966; Reams, 1981; see also the section 'A Brief Overview of the Past and Current Role of Audiovisual Media in Geology' in the Appendix).

Regarding type 7, I would state that film and video are broadly regarded as inherently educational because of the technological features of these mediums, especially their ability to archive, analyse, and screen events (Gaycken, 2011). In addition, several authors have highlighted the general effectiveness of audiovisual media in the area of geoscience education (Dohaney, 2015; Johnson, 1961; Laursen & Brickley, 2011; McKnight et al., 2016; Mühlberger, 1962; Taylor, 1958; Wade & Courtney, 2014; Wiese & McConnell, 2014). Already in 1958, Taylor highlighted that

> one movie shot with sound effects of, let us say, a marsh buggy rolling across trackless swamps and carrying a seismic shooting crew, gives a more vivid and lasting impression of this subject than could hundreds of the best-chosen words, or even a sequence of text pictures. (Taylor, 1958, p. 25)

Regarding type 2, which is presumably the most common category, it can be specified that television formats have frequently been deployed since the 1950s to disseminate hazard knowledge and that television has been seen as a powerful tool to communicate geoscience-related content, e.g., about disaster risk (e.g., Hut et al., 2016; Lighthart, 2000; Liverman & Sherman, 1985; Liverman & Sherman, 2015). Nowadays, however, hazard scientists don't just appear on screen as experts; they produce films on their own.

With new technologies, it is easier to access, create, and distribute video as a means of risk communication, and hazard scientists are increasingly encouraged to produce or coproduce their own audiovisual content (e.g., Adams, 2011; Allen et al., 2012; Barrett et al., 2014). For example, the European Geoscience Union (EGU) and the American Geoscience Union (AGU) host video workshops and screenings, and discuss video as a tool for science and risk communication (Botton & Stürmer, 2019; Harned, 2012). Courses on audiovisual storytelling are still rare but sometimes become an element of science and risk communication training (e.g., Wade et al., 2016). Several science-based institutions such as TEDx, the German Research Centre for Geosciences (GFZ), the Global Facility for Disaster Reduction and Recovery (GFDRR), and seismological surveys produce video content related to disaster risk, and individual hazard scientists acknowledge videos as part of their efforts to educate at-risk communities. The chosen formats are usually web-based educational videos that explain general information about geohazards or provide background information on different risk-related research projects, including fieldwork experiences (e.g., in the form of fieldwork diaries or documentation). Additionally, platforms such as PreventionWeb and other major risk reduction knowledge services provide video data stemming from different sources (e.g., Wang et al., 2020).

The fact that research funding is largely connected to effective communication measures might also be a reason why audiovisual risk communication efforts come into play. Major research frameworks and agencies, for example, the International Federation of Red Cross and Red Crescent (IFCR), NASA's Science Mission Directorate, the National Science Foundation, or the Federal Emergency Management Agency (FEMA), encourage the use of (audio-)visual media to communicate science 'more effectively' to the public. The Horizon 2020 Grant Agreement also points out that beneficiaries must have a comprehensive communication plan and provide 'targeted information to multiple audiences (including the media and the public), in a strategic and effective manner and possibly engaging in a two-way exchange' (European Commission, 2019, p. 281).

However, the use of audiovisual media and methods for two-way exchange (or even one-way communication) still seems to confront hazard scientists with several limitations (see Section 1.4). As several authors have outlined, it is impacted by technological, financial, and methodological barriers (e.g., Léon & Bourk, 2018; Musacchio & Solarino, 2019). Therefore, the use of film, video, and other audiovisual methods appears, at best, to play a role at the very beginning or end of hazard science: At the beginning as a means of collecting data (type 3) and at the end for illustrating theories in the classroom (type 7) or for generic outreach (type 2). Although hazard science has always dealt with dynamic Earth processes, research publications generally prefer static images. In disseminating research for the public, only few hazard scientists produce their own audiovisual risk communication. Most scientists instead leave this task to media professionals who are provided with their expert scientific knowledge (Koivumäki & Wilkinson, 2020). Furthermore, many (hazard) scientists still shy away from the perceived 'lack of objectivity' within AV content (Daston & Galison, 2021; see also Dahlstrom, 2014). For this reason, and in light of short attention spans (Reinecke et al., 2016), increased distrust towards experts (Hendriks et al., 2016; Laybats & Tredinnick, 2016), and time/resource constraints or publication pressure (Benes, 2017), the primacy of the 'written word' remains.

After having briefly summarised the current use of AV technologies, I would now like to outline the main trends in current research on audiovisual media in disaster risk communication.

1.3.2 The Current Research on AV Technologies for Risk and Seismic Communication

A frequent theme in science and risk communication research is that message creators should use *visuals* to improve their communication attempts. Numerous scholars have discussed the potential of the visual in risk communication. These scholars include not only hazard scientists but also authors in the fields of environmental communication (e.g., Hansen & Machin, 2015; Scharl et al., 2015), visual climate communication (Altinay, 2017; O'Neill & Nicholson-Cole, 2009; O'Neill & Smith, 2014; Schroth et al., 2014; Sheppard, 2012; Stephens et al., 2014; Wang et al., 2018), and visual health risk communication (e.g., Downs, 2013; Garg et al. 2012; Hernandez et al., 2016; Kehoe, 2018; Sutton & Fischer, 2021). Research interests encompass evaluation schemes and criteria for successful visual risk communication (e.g., Percival et al., 2020), specific visualisation technologies (e.g., Liu et al., 2019), or a questioning of power imbalances in visualisation techniques (e.g., Heesen et al., 2014; Liu et al., 2018). A major research interest relates to how images can impact the viewer's reception of messages (King, 2015). For example, Bostrom et al. (2008), researching how earthquake risk maps impact risk perception, have outlined that the translation and representation of technical information about risk and uncertainty is critical to the effectiveness of risk communication. In addition, Zillmann et al. (2001) demonstrated that photos draw viewers' attention to the content of articles and stories, while Gibson and Zillmann (2000) showed that recipients associate the integration of images in press releases with the relevance of the issues presented in the texts.

My major motivation for this thesis lies in the fact that disaster risk research has only to a minimal degree investigated audiovisual media and methods as a risk communication tool, despite the ubiquity of video described above. The dominant interest of the sparse existing research is how video can make risk communication more 'effective'.
For example, in the small field of seismic risk communication research drawing on audiovisual methods, most studies are concerned with how educational videos influence risk behaviour based on knowledge. For example, Solarino et al. (2020) have analysed what knowledge needs to be conveyed in risk communication, mentioning video as a major tool to convey 'actionable' information on preventive action. Musacchio et al. (2016a) have focused on effective dissemination strategies and have produced a series of videos. However, they did not evaluate the specific impacts of these videos or their exact design features. Musacchio et al. (2016b) have used several video formats (such as video games and a series of educational films) to establish a bottom-up earthquake education project in different countries, linking the design of the videos to the social, historical, and cultural backgrounds of their study areas. They concluded that audiovisual products were found to 'represent the best way, at the lowest cost, to promote the risk awareness and education of the general public' (p. 2084). Finally, a Master's thesis by Massolino (2016) has explored how seismological institutions use video within their social media networks, outlining the potential and some of the constraints of scientists using online video.
I would like to highlight three projects that take a participatory approach to seismic risk communication, as their approach has inspired this thesis: Sanquini et al. (2016) carried out an interdisciplinary research project in Nepal examining how video can be used to motivate people to take precautionary action to protect their homes and schools against earthquakes. Although the authors decided upon the editing, the video was produced on the basis of inter- and transdisciplinary insights, incorporating local knowledge with the social sciences and geoscience. The authors worked with a film team from the immediate area to facilitate the recordings and bring local expertise into play. Thus, the film *Naya Suruwaat* follows a multi-vocal approach in the sense that diverse local people affected by natural hazards represent their views within their social context. Further, Piangiamore et al. (2020) conducted an experiment of public engagement in seismic risk communication and asked students within

a cooperative learning framework to develop and produce risk communication tools in close cooperation with hazard scientists. However, although the students produced several videos and the promising ‘people-centred’ methodology was comparable to Sanquini’s approach, the use of audiovisual methods throughout the filmmaking process itself was not the primary interest of this study. Finally, Miño Puga (2018) used participatory video methods in the aftermath of an earthquake in Ecuador, arguing in line with a theoretical framework proposed by Margolin (2010) that participatory video can be effective in supporting agency, creating shared narratives and fostering a deeper sense of community for those affected by earthquakes.

In other domains of disaster risk communication, only few studies follow a similar interventionist and participatory approach to the use of audiovisual media. Examples are Hicks et al. (2017) in the field of volcanic risk communication or Ryvola and Suarez (2013), Walker and Arrighi (2013), and Haynes and Tanner (2015) in the field of climate risk communication. Similarly, Rollason et al. (2018) state that ‘participatory practices have not been applied to flood risk communications’ (p. 1670). Much like seismic risk communication, many scholars see video-based communication as an effective educational tool to improve hazard awareness for various target groups (e.g., Dengler, 2005; Liverman & Sherman, 2015), with some scholars referring specifically to the potential of (audiovisual) images to educate children or other groups that are less ‘able’ to understand text-based information (e.g., Midtbust et al., 2018; Towers et al., 2014). Similarly, with a focus on behavioural change and information transfer, but concentrating on audiovisual formats other than (online) video, scholars have researched the impact of visual media technologies such as 360° video (e.g., Fraustino et al., 2018) or video-based games (Fox et al., 2020; Gampell & Gaillard, 2020; Lee & Yamori, 2020; Solinska-Nowak et al., 2018; Tanes, 2011). These authors attribute high potential to these more interactive formats, for example, through the impact of more immersive environments or player-game interactions and their influence on the viewing experience and risk perceptions.

Important for my research is also the fact that, according to several authors, science and environmental communication on YouTube is — despite its popularity — still a very under-researched theme (e.g., Allgaier, 2019; León & Bourk, 2018; Welbourne & Grant, 2015). For example, Pearce et al. (2019), in their review on climate risk communication in social media, have found that research in the field has strongly focused on Twitter and large-scale quantitative textual approaches (and not on the use of video). To my knowledge, despite a few exceptions in the field of climate science (De Lara et al., 2017; Erviti et al., 2018;

Shapiro & Park, 2018), there seem to be no studies evaluating audiovisual seismic risk communication in different social media environments, e.g., assessing the influence of different interest groups, user preferences, chosen styles, or the deliberation potential of post-video discussions. This stands in sharp contrast to the ubiquitous use of social media platforms.

1.3.3 A Major Research Interest: The Affordances of Audiovisual Media for Risk Communication

The research literature on audiovisual risk communication frequently mentions the general affordances of audiovisual media. According to my review, most attention lies in the realm of video as a 'product' (type 2), with rather little attention drawn to the other six types mentioned above.

Various authors see a great potential in video. This is due, first of all, to its multi-modal technical properties. Video allows the use of visual and audio channels in isolation or combined to transmit text, images, animations, films, subtitles, multiple languages, and many other innovative and creative means of communication (Allgaier & Svalastog, 2015). Video's recognised benefits include its potential to engage the public and raise awareness, to convey information or processes that are perhaps hard to envision or understand, to influence (risk) perceptions, to motivate behaviour change, to increase trust, and to maintain the social memory of particular events (e.g., Hicks et al., 2017; Körkel & Hoppenhaus, 2016; Suarez et al., 2005).

According to Goldberg et al. (2019), video helps practitioners to communicate 'in ways that more closely resemble how people navigate the social world, namely through language, experience, and basic metaphors and analogies' (p. 670). The authors provide results that indicate the effectiveness of conveying the 'experience' of scientific consensus on climate change through the use of narrative and vivid imagery. By the same token, other authors outline that the skilled use of video can foster public interest and convey scientific insights to viewers, as it more effectively appeals to an intuitive, cultural, and experiential understanding of the world (e.g., Finkler & Léon, 2019; Hurtado-de-Mendoza et al., 2019).

Researchers have argued that exhibiting personal experiences through film is linked to a greater belief in the risks associated with anthropogenic climate change and can lead to greater support for environmental issues (e.g., McDonald et al., 2015). Similarly, Van der Linden et al. (2015) note that personal experiences are often a stronger motivator for risk adaptation and mitigation than fact-based knowledge, as they can promote feelings of self-efficacy. In the field of health risk communication, researchers have found that videos with protagonists drawing on personal experiences are more effective than generic educational resources (whether writing or video) in aiding decision-making for patients (Downs et al., 2018; Kehoe, 2018).

User engagement is another important theme for audiovisual communication (Moser, 2016; Stephens et al., 2014; Van der Linden et al., 2015). Van der Linden et al. (2015) highlight that stimulating people's personal, intrinsic motivations can improve communication outcomes and user engagement. In particular, interactive media such as games and VR environments involve media users in communication and action, often in highly immersive ways that engage their senses. They are thus often perceived as motivating (e.g., Ahn, 2015; Fox et al., 2020; Law & Weyers, 2016; Liu & Shrum, 2002). In science and risk communication, online videos are usually associated with passive media consumption, but they also allow for intensive interaction between users through the development of social networks around specific media content (Erviti & Stengler, 2016).

While the role of sound seems very much neglected in the research literature, two elements are responsible for the positive effects attributed to AV technologies: The use of visuals, such as (moving) images and metaphors, and the use of narrative elements, such as dramaturgical choices and storytelling.

According to Fox et al. (2020), images are often remembered because they provide vivid and emotionally engaging appeals. For this reason, they also have the potential to reduce psychological distance (Millarhouse et al., 2020). In addition, people with cognitive or language impairments can often communicate better through the use of images (O'Neill & Smith, 2014). In the field of climate risk communication, working with visual media is presented as effective because hazard scientists can influence the interpretations of larger publics by changing the frames, images, icons, and emotions deployed for their communication efforts (Leiserowitz & Smith, 2017). According to Lakoff and Johnson (1980), the abstract notions we use in everyday life are usually metaphorical and permit us 'to understand and experience one kind of thing in terms of another' (p. 5). Metaphors and analogies are also widely discussed by scholars in the field of climate risk communication (e.g., Nerlich, 2010; Thibodeau et al., 2017), especially regarding their use for risk communication strategies focused on persuasion (e.g., Rossi et al., 2012; Sopory & Dillard, 2002).

Another relevant theme for risk communication scholars relates to the requirement of tailoring messages and making them more relevant to at-risk communities (Fischhoff et al., 2013; Moser, 2016; Van der Linden et al., 2015). Dahlstrom (2014) outlines that narratives or narrative frames can potentially increase comprehension, interest, and engagement, and that they are intrinsically persuasive, giving communicators tactics (however questionable) for persuading otherwise resistant audiences. According to Bandura (2004), narrative media 'gain influence because people's social constructions of reality rely heavily on what they see, hear and read rather than on what they experience directly' (p. 78). Neurobiology also provides evidence that protagonist-based stories trigger the release of oxytocin, a neuro-chemical that promotes cooperation and empathy (Green & Fitzgerald, 2017; von Stackelberg & Jones, 2014). Developing character tension holds the audiences' attention, promotes recall of the story, and can potentially broadcast the feelings and behaviours of the scientists (e.g., O'Connell, 2016). Finally, authors outline the potential of framing risk messages as narratives to 'democratise' risk communication, since multiple user groups can be reached (Lejano et al., 2020).

These affordances help us understand the growing role of visual culture. Disasters have become the subject of an enormous amount of representations within visual communication and the mass media — powerful depictions that influence public debate and perceptions of risk. The ways in which hazard scientists, as one category of actors in the risk communication process, design their communication efforts thus plays a crucial role in affecting how people experience and learn about risk-related themes (e.g., Drake et al., 2014; Goldberg et al., 2019; Nagy, 2018). However, as I will outline in the next section, the impact on behavioural change is unclear. Furthermore, in light of the high level of responsibility hazard scientists hold, it is important to critically assess current attempts at risk communication. There are several reasons to argue that both the current use of audiovisual media and the current research focus in audiovisual disaster risk communication studies do not necessarily incorporate Sendai's call for a more people-centred approach and the use of innovative information and communication technologies.

1.4 A Critical Approach Towards the Current Use of Audiovisual Media for Risk Communication

In the following section, I will provide a critical analysis of the current use and research of audiovisual media for disaster risk communication, thereby deriving the research questions for this thesis. My critique will be informed by recurring concerns and key concepts from (visual) social science that can potentially inform and inspire a post-Sendai risk communication with audiovisual means.

1.4.1 Insufficient Evidence for the 'Effectiveness' of Using Audiovisual Media in Risk Communication

As presented in Section 1.3, a wide range of risk communication researchers and practitioners see audiovisual media as an effective tool for risk communication and outline its potential to provide the public with expert knowledge, increase risk awareness, and stimulate behavioural responses of at-risk communities, thus contributing to more community resilience. However, the often-proclaimed 'effectiveness' of audiovisual communication is more complicated, as this notion masks a much broader array of normative assumptions and conceptual frameworks (Árvai, 2014; Demeritt & Norbert, 2014). In the following, I would like to highlight several aspects of this debate.

According to an exhaustive literature review of disaster risk communication intervention studies by Bradley et al. (2014), there are not enough systematic studies to conclude what makes risk communication effective. Further, the review reveals that there are currently no intervention studies that demonstrate the impact of video-based disaster risk communication on *long-term* behavioural change (Bradley et al., 2014). Decades of research in the decision sciences have shown that in many contexts, better information and more education are largely disconnected from improved decision-making (Fischhoff, 2012; Kasperson, 2014; Slovic, 2000), with seismic risk communication scholars providing further evidence that there is little or no correlation between heightened scientific literacy or risk awareness and risk adaptation measures (e.g., Solberg et al., 2010). In the area of health risk communication, literature indicates that people actively search for online educational videos on the websites of hospitals or health care services, but there is little knowledge about how these videos are helpful for the respective users (Diviani et al., 2016). Similarly, many scholars in the climate sciences see awareness, information, and understanding as insufficient for climate change adaptation (Moser, 2014) and point out the need to develop more inclusive communication strategies based on the evidence that dialogic, two-way forms of positive communication and collaboration can more effectively stimulate change (Carlton & Jacobson, 2015; Hagemeier-Klose et al., 2014; Jarreau et al., 2015; Lassen et al., 2011; Moser, 2014). By the same token, Goldberg et al. (2019) conclude that, to date, the relationship between audiovisual risk communication and a long-term increase in risk awareness or behavioural change is not clear.

One reason for these findings is seen in methodological weaknesses. In studies about the effectiveness of audiovisual technology (or AV technology), impact is usually measured by surveying people before and after watching a film, and it is defined as an increase in parameters such as scientific literacy or motivation. For example, in comparisons of pre- and post-assessment responses, Laursen and Brickley (2011) or Finkler and Léon (2019) have shown that audiences can better retain certain scientific information after having watched a documentary. However, it is uncertain how meaningful such findings are in terms of long-term scientific literacy. Similarly, using pre- and post-evaluative processes, Visschers et al. (2008) investigated how sound, footage, and text in videos can influence processes of risk perception in the field of nanotechnology. For the authors, the primary evaluative process is an associative and experiential process that leads to a 'gut feeling' and forms an instantaneous reaction to risk. They describe the second process as analytic and elaborative, regarding it as a deliberate evaluative process. Unsurprisingly, the authors found that people not only rely on cognitive processes when interpreting risk but also on their feelings. However, the authors outlined that they were not sure if they measured risk perception or general affect. Several authors therefore argue that such forms of evaluation are limited in understanding behaviour if they do not account for such things as beliefs, emotions, habits/past behaviours, and motivation, or if they are too strictly focused on the cognitive aspects of the individual (Goldberg et al., 2019; Kehoe, 2018; Van der Linden et al., 2017). It is also problematic that the 'success' of web-based AV risk communication is often interpreted by the number of hits and likes they receive (e.g., Kehoe, 2018). Various analytical tools (such as YouTube Analytics) remain unused, although they might provide a more nuanced view on user behaviour and could also be used to inform film aesthetics and dramaturgical choices (Surakitbanharn & Ebert, 2017).

If effectiveness could indeed be measured by the degree of behavioural change, then much more actionable risk communication approaches would be necessary for AV-based risk communication. Wood et al. (2012) criticise the emphasis that risk communication interventions place on the provision of technical information, rather than providing 'actionable' information about what recipients can 'do' about the risk. Another theme is a lack of message identification, which is outlined by Carlton and Jacobson (2015) with regard to the field of climate change communication. The authors highlight that people tend to ignore threats that are distant, general, or not caused by specific and identifiable actions, as is also often the case for audiovisual seismic risk communication. They suggest that effective climate outreach and communication should focus on compatible parts of mental models of experts and non-experts and should incorporate local concerns to discuss climate-related hazards. Kahan et al. (2011)

have shown how linking climate change effects and adaptation strategies to more relevant, local issues detected through these processes can also be effective in overcoming possible cultural biases against action on climate change. Similarly, authors such as Van der Linden et al. (2015) highlight five 'best practices' for the field of climate risk communication rooted in psychological research. They suggest that in order to improve public engagement with the issue (e.g., through online videos), policymakers should emphasise climate change as an 'experiential, local and present risk; define and leverage relevant social group norms; highlight the tangible gains associated with immediate action; and last, but certainly not least, appeal to long-term motivators of pro-environmental behavior and decision making' (p. 761).
It must be emphasised that these reflections also go much further than the SFDRR, with its rather limited call to use media that are 'simple, transparent, easy-to-understand and accessible' (UNIDSR, 2015a, p. 24). For example, the perception of what counts as easy-to-understand information often differs greatly. A study by Stofer (2016) revealed that scientific visualisations that represent numerical data, often in the form of graphics, are generally used to convey scientific concepts to lay audiences, but the understanding of these visual devices is mostly limited to experts. This study provides evidence for the significant differences in what scientific experts and lay audiences understand when they encounter visuals produced by scientists (for example, when complex presentation slides are integrated into videos).

Another essential aspect in this regard is that fear-based, threatening representations are often used in AV risk communication to motivate specific proactive audience reactions (Witte & Allen, 2000). In contrast, O'Neill and Nicholson-Cole (2009) conclude that visual and iconic representations depicting a strongly negative or frightening message do not have long-term effects in motivating proactive behaviour change; instead, they can even nourish fatalism or apathy, or leave the audience desensitised with a sense of 'issue fatigue'. Studies of the public impact of Hollywood blockbusters such as *The Day After Tomorrow* (Leiserowitz, 2004; Nisbet, 2004), *An Inconvenient Truth* (Sakellari, 2015), or *The Age of Stupid* (Howell, 2011) show a raised awareness about the impacts of climate change, but highlight that the iconographies of many of these films do not motivate environmental behaviour. Similarly, O'Neill and Smith (2014) examined engagement with climate change imagery drawn from mass media sources and showed that current imagery of climate impacts promotes risk awareness but undermines self-efficacy. A more recent study by Ettinger et al. (2021) has differentiated the perspective on fear-based approaches, highlighting that impacts of a single hope or fear appeal can be overstated and outlining the need to be cautious against claims that either hopeful or fear-driven climate change communication strategies are optimal.

Further, most studies discuss *if* film can be used as an 'effective' educational tool and not *how*. The problem here is that the scope of a film's 'impact' includes many more factors, which are always context-dependent. Currently, research on audiovisual media and methods as a risk communication tool seems to entirely neglect evaluating a video's style, audiovisual language, or the impact of different formats. For example, in studies highlighting video's effectiveness, scholars have failed to describe which facets of video most strongly drive its effects on beliefs and attitudes. Video design emerges through complex audiovisual and narrative approaches based on the choice of specific images, motions, colour schemes, music, sound design, voice-over, motion graphics, and many more elements. Excluding multiple video styles misses a nuanced understanding of the effectiveness and user preference for a video style. Furthermore, studies often falsely assume that the style presented is the chosen or preferred style (Kehoe, 2018). However, without evaluation, it is unknown how videos affect or influence the intentions and behaviours of individuals, or whether individuals even prefer videos. Conversely, in a study based on open-ended survey responses, Ettinger et al. (2021) outline that certain video production elements, such as music, editing, and pacing, may even be associated with ideological views about climate change. Because of the findings mentioned above, authors such as Goldberg et al. (2019) recommend that future research projects should

> measure potential mediators of measured, video-induced effects that could distinguish key processes and mechanisms that may differentiate the effects of the video from those of the transcript, such as affect, engagement, memory recall, thought-listing, and perceived credibility and persuasiveness of the message. (p. 669)

However, I would expand this metric-driven approach and state that the relationship between audience, medium, and messages is even more complex. In line with Reavey (2020), I would argue that we experience audiovisual (risk) communication in unique and highly individual ways: our perceptions and choices depend on complex configurations influenced and shaped by locations, different points of view, personal or collective lived and embodied histories, and different socio-cultural and psychological dispositions. Referring to Michel Serres's famous work *The Five Senses* (2008), Reavey states that 'the act of looking is always subject to our sensorial engagement in the world, our physical entanglements, affective and embodied engagement with others or the igniting of other senses and forms of knowledge. Seeing is thus enmeshed in a plurality of

ways of being and meaning-making practice' (Reavey 2020, p. 1).
When this complexity is not taken into account through other complementary methodological approaches, the effectiveness of audiovisual media in terms of risk resilience remains a celebratory and descriptive attribution that does not pay sufficient attention to the many parameters that affect the relationship between the filmmaker, collaborators, the audience, the medium, and the contexts of production, reception, and distribution.

1.4.2 The Persistence of the 'Deficit-Model' in the Realm of Audiovisual Risk Communication

Despite the use of disaster risk communication videos in the context of social media networks, several authors argue that such videos are still deployed for a 'one-way' communication (e.g., Jones et al., 2019; Musacchio & Solarino, 2019). Of course, not all risk communication is or can be dialogue-based, and undoubtedly the crucial provision that (audiovisual) media naturally offers, is, first of all, a form of 'one-way' communication. The critique relates more to what can be discussed through the concept of the 'knowledge deficit model' (Demeritt, 2014; Simis et al., 2016; Sturgis & Allum, 2004). As already briefly indicated in the introduction, the main intention behind deficit-oriented communication efforts is to take advantage of audiovisual media's ability to convey 'scientific facts' in a more captivating way than text-based media, thus motivating certain cognitive/behavioural responses in different target audiences and an increase of 'disaster literacy' (e.g., Brown et al., 2014). Understandably, most of the scientific attention lies in the design of the message, the production of compelling images, or the latest technological trends in the realm of audiovisual media, as these seem to determine the 'effectiveness' of information transfer. Because of the perceived limits of the public, scientists argue that scientific information needs to be easy to understand and that it must be visual and entertaining (Cook et al., 2004: Davies, 2008; De Boer et al., 2005, as cited in Besley & Nisbet, 2013). In the context of audiovisual formats, scientists still see their role as producers and conveyors of expert knowledge to a non-expert audience. Arguing against this deficit-orientation, authors such as Árvai (2014) highlight that risk is a concept that needs to be understood – by laypeople and experts alike – and not corrected. Further, this kind of risk communication, for example, in the form of expensively produced 'science image films', has only to a limited extent been able to reach society in all its facets (Forum Wissenschaftskommunikation, 2017). People who do not come into contact with science, or do so very rarely, are largely left out. Authors such as Musacchio and Solarino (2019) also outline that many researchers who state that they use video for ‘two-way interaction’ often do not have dialogues with envisaged audiences, as they are addressing an audience that is already interested in their topic. In line with authors such as Kamlage and Nanz (2017), I would argue that there are also cases of ‘deficit-oriented’ two-way communication, in instances where dialogue-based risk communication is practised with the goal of creating acceptance for decisions that are already made.

An aspect that seems neglected in risk communication research is the fact that the production of film and video is no longer the well-defined domain of professionals who have specialised technology and knowledge, speak in a language that is incomprehensible to laypeople, and — if necessary — sometimes also make participatory video projects. As described in Section 1.3, our media age is determined by the fact that recipients and consumers are often also producers and have highly individual media use interests — a phenomenon that does not seem to fit the frequently formulated target group category of the ‘general public’. Therefore, while technological opportunities for interaction have developed tremendously, it still seems true that ‘often twentieth-century communication styles are merely superimposed on twenty-first-century channels’ (Moloney & Unger, 2014, p. 110). For example, videos are frequently uploaded onto a private or institutional YouTube channel without further dissemination or user interaction. One could provocatively state that videos are frequently produced and uploaded in order to fulfil the outreach requirements of major funding bodies or for intra-science communication. Because of a lack of interaction, for example, through *transmedia storytelling* (Jenkins, 2006), Moloney and Unger argue that ‘the new media landscape’ demands that scientists take ‘a new approach to media’, for example, by narrating, disseminating, and discussing their video content via multiple channels and audiences (Moloney and Unger, 2014, p. 110). However, authors such as O’Connell (2016), Musacchio and Solarino (2019), or the WHO (2017) outline that also the lack of an undefined and sustained budget for risk communication (via social media) often limits successful two-way communication with different target groups.

1.4.3 ‘Real’ Participatory Approaches in Audiovisual Risk Communication?

As most films made by hazard scientists are narrated from a scientific perspective, participatory approaches are usually not applied in current risk communication (Hicks et al., 2017; Rollason et al., 2018). Although I do not claim that all film productions need to involve participatory practices, it is important to state that those affected by risk are often excluded from processes of (co-) creating risk communications, although they could significantly inform the generated content. Further, they could help to ensure that innovations in DRR are implemented more quickly and successfully transferred into society. In contrast, people in risk situations are often portrayed as helpless, uninformed, or dependent on expert opinions that dictate which risk information is important and relevant for their decision-making (Willis et al., 2011). There is little evidence in the research literature regarding insights from the actual application of participatory approaches in risk communication and how such approaches could productively feed into the conceptualisation of a risk storytelling based on 'story-listening'. Examples such as Hicks et al. (2017), Miño Puga (2018), Piangiamore et al. (2020), Sanquini et al. (2016), and Ryvola and Suarez (2013) are still rare exceptions. And even these approaches can be criticised, as participation could also be understood in a neoliberal context of 'post-politics' (e.g., Cooke & Kothari, 2001; Miessen, 2017; Tsouvalis & Waterton, 2012), where the burden of risk assessment and mitigation is placed on the individual and the market, and less on public institutions. Further, the strong focus on people-centred approaches allocates responsibility for risk adaptation at the level of 'the people at risk' or 'at-risk communities', although risk (in light of reflexive modernity (Beck, 2009)) should be regarded as a collective endeavour as many sources of risk adaptation and mitigation exist outside of the operating range of individuals or communities (Scolobig et al., 2015b). Also, films that follow a participatory approach are not automatically free from raising fundamental ethical and representational concerns that require increased awareness and critical reflection in order to avoid a 'tick-the-box' filmmaking, stereotypes, a 'colonising' view, or ignorance towards minorities or the groups that these communications actually want to address (see also Chapter 4).

Today, consciously facing and addressing the pitfalls of representation and participation is an integral concern of visual research, perhaps most critically exercised by sub-disciplines such as 'film geography' (e.g., Aitken & Dixon, 2006; Aitken & Zonn, 1994; Cresswell & Dixon, 2002; Hawkins, 2013; Kennedy & Lukinbeal, 1997; Lukinbeal & Zimmermann, 2008), 'visual anthropology' (e.g., Ballhaus & Engelbrecht, 1995; Banks & Ruby, 2011; Banks & Zeitlyn, 2015; Pink, 2013), or 'visual sociology' (e.g., Grady, 2007; Harper, 2012). In disciplines like anthropology—where scientific representations of 'the Other' are inextricably linked with the colonial heritage of the discipline — discussions about the 'appropriate' filmic form have led to slow but significant transformations, a finding that will be further elaborated in a short excursus in Chapter 2.

1.4.4 Lack of Risk Communication Training for the Development of 'Audiovisual Literacy'

The SFDRR's paradigm shifts towards participation, action, prevention, and stronger use of ICT innovations have led to open questions of how scientists can translate these novel requirements into risk communication practice. Despite various cases that exemplify a recent shift of scientific and government risk communication towards inter- and transdisciplinary practices (Bostrom, 2014), the geoscientist's task of addressing the social and cultural dimensions of disaster risk is complex. Using audiovisual methods for transdisciplinary risk communication approaches seems even more complicated. Most hazard scientists focus on the physics of natural processes and risk assessment procedures, not on the nuances of audiovisual media and issues around representation, political science, cultural theory, sociology, and the psychology of human relations. For this reason, most geoscientists would regard it as beyond their realm and remit to confront the messy reality of how natural threats are perceived by an at-risk community and translated into (audiovisual) language (Bentley & Kyvik, 2010; Jensen et al., 2008; The Royal Society, 2006). Certainly, many challenges arise with the possibilities of audiovisual media. These include various questions, last but not least how to navigate the sheer number of seemingly unlimited opportunities for film production and dissemination.

Because conveying scientific information to an audience is usually declared as one of the major goals of science filmmakers (as outlined in the previous paragraph), the potential of multi-modal filmic language — for example, the sensory or experiential dimensions of communicating risk — is often unexploited. For instance, when risk communication videos are detached from their production methods, they are often less transparent and reflexive, although such insights could benefit risk dialogues, as authors such as Irwin (2014) have outlined. Similarly, Köhn (2016) highlights that a scientific text is often illustrated through images that are barely 'allowed' to 'speak' for themselves. In addition, subjectivity is often kept to a minimum in order to maintain scientific integrity, with 'context [...] not thought of as being produced by the arrangement of images, but by the accompanying text' (p. 20). Similarly, 'visuals' are often viewed as a more naïve or simplistic form of communication, although the act of reading images is a highly complex, often tacit endeavour (Boden et al., 2019; Wakefield & Underwager, 1998; as cited in Reavey, 2020). Therefore, although much scientific attention and effort is normally invested in the scientific 'text' and its visuals, filmic language (the dramaturgy, narrative perspective, rhythm, role of sound, etc.) emerges through a rather intuitive process. One could argue that films are created on the basis of individual assumptions and provocatively state that although such media represent a scientific perspective, the conceptualisation of AV risk communication is usually not based on scientific insights. Despite these critical points, in line with Köhn (2016), I do not want to claim that audiovisual media in risk communication should be purely regulated by scientific insights — by 'logos' and 'ratio', or by codes of ethics — as the richness of cinematographic language would risk being restricted in favour of claims of scientific validity (Köhn, 2016). Dahlstrom (2014) compares and contrasts the narrative vs logical-scientific approaches to communication and highlights the important potential of a hybrid interplay between both. I would, on the other hand, argue for a more conscious and discursive use of AV media and methods and the establishment of training frameworks that strengthen a variety of competencies.

Current communication training initiatives focus primarily on rhetorical or presentation skills for academic/technical conferences or journalistic interviews (Besley et al., 2015). This is astonishing, as beyond these key competencies, scientists/filmmakers need to understand the significant impact that different disciplinary practices and paradigms have on the way they elaborate their filmic language. They also need to grasp the distinct social, political, and cultural meanings that emerge when framing content through different audiovisual representations (Bucchi & Saracino, 2016). Further, knowledge about new forms of digital (audiovisual) online communication is also crucial in order to harvest the potential that innovative ICTs offer for risk communication. Besides 'audiovisual literacy', the ability to find, evaluate, and compose information through various digital platforms ('digital literacy') also seems to be a key competence that has been neglected in risk communication training (see also Chapter 5).

1.4.5 A Narrow Focus on Film as 'Product'

As already indicated in Section 1.3, another problem becomes apparent regarding the question of audiovisual media's potential within risk communication *beyond* the informational and representational purposes that characterise its current use. In disaster risk communication, AV methods and media remain under-utilised when compared to other types of filmmaking referred to by Garrett (2010). My last point of criticism thus relates to the lack of scientific and practical interest given to a) other fields of application of audiovisual media and methods (particularly in science communication training, participatory filmmaking, or reflexive filmmaking) and b) other approaches of designing audiovisual media to allow for a post-Sendai risk communication beyond the 'deficit model'.

Therefore, in line with Harris (2016), I would argue that risk communicators would benefit greatly from expanding their toolset to include the consistent use of audiovisual media and methods in realms other than mere video production and by using the potential of novel communication channels and technological innovations in the digital sphere.

1.5 Emerging Research Questions

My literature review has provided evidence that despite the 'celebratory approach' (Pauwels, 2015) many scholars have towards the use of video as a tool for risk education and risk communication, its full potential for post-Sendai risk communication still needs to be examined and developed. This is particularly important in light of the fundamental shift brought about by the changing media landscape in the age of the prosumer, in which increased audiovisual/ digital literacy is of crucial importance for hazard scientists to interact with heterogeneous audiences (Ciastellardi & Di Rosario, 2015; Varghese et al., 2020). For this reason, in order to be in line with the Sendai requirements for a more people-centred and technologically innovative DRR, the application of AV media and methods needs to better address the emergent challenges and opportunities of a transforming media landscape and the complexities of transdisciplinary research communication.

In the previous sections, I have outlined the need to deal more critically with questions around representation and participation, to train audiovisual and digital literacy, and to expand the current focus on audiovisual methods for video production. Further, I have criticised the current, relatively narrow notion of the 'effectiveness' of audiovisual risk communication in light of the lack of scholarly research in this domain, its dominant focus on behaviour change and 'better' information transfer, as well as the persistence of a deficit-oriented use of AV technology. Accordingly, I argue that despite the affordances of audiovisual media and methods for risk communication, their current use is rather ineffective in strengthening community resilience. The complex, often contested, and highly personal nature of the link between audiovisual communication and the adoption of protective behaviours reveals the likely limitations of its current restricted use. Therefore, although I strongly acknowledge the need for more empirical investigation of the mechanisms driving the risk perception and behaviours of users of audiovisual content, my research interest lies in another domain.

Through an examination of case studies and the development of audiovisual prototypes, this thesis sets out to conceptualise, apply, and also partly evaluate different forms and formats of audiovisual risk communication that understand effectiveness as the realisation of the dialogic potential of the medium. Therefore, I seek to explore how AV risk communication needs to be designed to bring together and methodologically equip and support heterogeneous groups that seek to manage complex risks in a more interactive and *transdisciplinary* way. In doing so, I ask how specific information and communication technologies can support this process. More boldly formulated, this thesis follows a progressive and process-oriented understanding of risk communication as I move from the current focus on simplification, storytelling, and attention generation towards a more critical approach that harvests the deliberative potential of audiovisual media and methods. As such, my thesis seeks not only to contribute to risk communication theory and practice, but to actively improve the conditions *for* risk communication.

In the following two case studies and prototype developments, I explore how a critical and more expanded use of audiovisual media and methods can support hazard scientists in better using the potential of the medium for post-Sendai risk communication. As already outlined in the introduction, a post-Sendai risk communication encompasses features of communication that help to translate the two above-mentioned Sendai requirements into action. Based on my literature review, I would argue that such approaches are transdisciplinary, collaborative, dialogue-based, and established on an assessment of user needs and/or co-creative developments of risk communication. Furthermore, they use actionable, user-oriented, and (ideally) interactive information and communication technologies in addition to being reflexive and science-based. In order to explore the potential of audiovisual methods for a post-Sendai risk communication, the following questions will guide my research:

What is the potential of audiovisual methods in facilitating post-Sendai risk communication
1. when used as a research tool in the context of an ethnographic field study?
2. when used as a collaborative editing tool?
3. when used as a risk communication training tool?

Through my approach based on case studies and prototype developments, I hope to find practical evidence of how insights from the visual social sciences can help reassess the relationship hazard scientists have with audiovisual media in the field of risk communication. In doing so, my aim is to find potential new research avenues and practical applications that could help further drawing the contours of a post-Sendai risk communication. Beyond this, I hope that researching how theories and practices from the visual social sciences can be used to approach, critically conceptualise, and practice risk communication also holds the potential to produce new modes of knowledge that can foster innovations in both fields. This literature review provides evidence that the methods of the visual social sciences have not yet been used or researched with regard to their contribution to novel approaches in (seismic) risk communication. Thus, the next chapter will outline the methodology with which I will proceed to address the above-mentioned research questions.

Chapter 2 – Methodology

This chapter presents the methodological approach to answering my research questions. Section 1 contextualises my research project within the visual social sciences and positions my research in relation to current and past discussions on the use of film as a research method. I begin with a brief introduction to the visual social sciences, before specifically addressing visual anthropology and some of its core themes in the form of a short excursus. I then present the research fields that have most significantly informed my methodological approach: applied visual anthropology and transdisciplinary research. In Section 2, I elaborate on my chosen research design. In a first step, I outline the qualitative, practice-led approach of this thesis and how it informed the research design. In a second step, I present the case study approach in combination with prototype developments, refer to the chosen research strategy of triangulation, and the methods for data collection and data analysis. Thereafter, I refer to the following topics: 1. my research participants and collaboration partners, 2. how I gained access to the field, and 3. the representation of my research data, including generated prototypes and further moving image works. In Section 3, I focus on issues of access, ethics and informed consent and address specific methodological problems and challenges that arose in the course of the research.

2.1 Research Context

This research project draws largely on methods from the field of visual social sciences, particularly visual anthropology. Speaking and writing are nowadays key modalities for social scientists interested in the 'experiential, relational, embodied, socially situated, discursively constituted and culturally meaningful ways in which people encounter others, live out their daily lives and engage with their everyday worlds' (Henwood et al., 2020, p. 555). Over the last two decades, there has been an expansion in research methodologies that use different technologies for the recording and analysis of visual data, where the experience, the representation and the communication of meaning are realised in a visual mode. Working with various textual, auditory, visual or audiovisual media has become an accepted standard in the social sciences. One central reason for the increase of visual research — and for the decision of using audiovisual methods and media in this thesis — is that multi-modal methods allow access to different forms of knowledge and modes of meaning (e.g., Pauwels, 2015; Reavey, 2020).

A decisive motivation for the methodological approach of my research was the fact that the individual and collaborative process of conceptualising, applying, and evaluating (audio-)visual material provides not only heterogeneous perspectives, but also different forms of knowledge and expressive capacities about risk and risk communication that could not be generated through other, non-visual methods. The expressive capacities of audiovisual methods hold the potential to enhance the representation and exploration of experiences and create a sensual proximity, for example to the theme of seismic risk (e.g., Miño Puga, 2018; Reavey & Johnson, 2008). Moreover, visual culture and cultural practices are increasingly important in making sense of human experience related to disaster risk (Oliver-Smith & Hoffmann, 2002; see also MacDougall and Taylor, 1998; Pink, 2006). (Audio-)visual representations of climate and disaster risk are now integral to our daily lives and contemporary culture. Moreover, digital information technologies for the creation, collection and display of static and moving visual images are omnipresent, and more and more people have relevant skills and competencies in the use of visual media they could — in principle — deploy for risk communication. Therefore, my methodological approach is informed by insights and modes of reflection from the visual social sciences, and seeks to translate these in fruitful ways into the case studies and prototype developments this thesis presents. In doing so, I seek to contribute to the current disaster risk communication discourse, in which other ways of using audiovisual methods for risk communication beyond film production and teaching are rarely discussed (see Chapter 1).

In particular, this research largely draws on methodological and conceptual frameworks from the field of (applied) visual anthropology. The discipline of visual anthropology emerged in the 1970s in the Western European world and, as a sub-field of cultural anthropology, developed out of the research on and production of ethnographic photography and film. Although there are numerous definitions of visual anthropology (e.g., Ginsburg, 1998; MacDougall, 2005; Morphy & Banks, 1997; Ruby, 2000) one can observe that, in general, visual anthropologists are preoccupied with analysing or producing visual cultural representations from an ethnological perspective. According to Pauwels (2015), the activities of visual social scientists such as visual anthropologists go beyond 'scrutinizing the visually observable aspects of society as a gateway to the deeper immaterial traits of culture, but also about using visual means to visualize the material, immaterial and conceptual for improved understanding' (p. 3). As such, film and video technology, photography, visual artefacts, but also television, new media, performance, museums and visual arts, and other visual media are used in the following ways:

- as cultural documents and source of scientific analysis,
- as an instrument for documentation (as part of field research in the form of (audio)visual field notes),
- as a method in research and teaching,
- as a form of presentation of research results, and
- for researching visual representation and perception.

The use of film and photography in visual anthropology has always been accompanied by intense debates and has challenged researchers in their basic assumptions about the medium. The methods and research foci of visual anthropology have been shaped by a variety of paradigmatic shifts in the past. A wealth of literature provides information on different 'turns' such as the pictorial, performative, sensory, cultural or experiential turn (e.g., Howes, 1991; Mitchell, 1992; Jameson 1998; Thrift, 2008; von Hantelmann, 2014). Whilst the details of these turns are beyond the scope of this study, ongoing discourses in visual anthropology are of interest for my research. They relate to issues of representation, the use of video for inclusive, reflexive, and participatory forms of collaboration, often within inter-and transdisciplinary formats, or the exploration of the phenomenological, artistic qualities of film (for an overview, see Harris, 2016; Hockings, 2009; Köhn 2016; Margolis & Pauwels, 2011). The following excursus on productive 'controversies' in the history of visual anthropology is by no means exhaustive and is not obligatory to take into account for the deeper comprehension of my methodological framework. Rather, it serves to lay out some of the impulses and lines of thought from the field of visual anthropology that stimulated the development of the methodological framework underpinning this research.

2.1.1 Excursus

2.1.1.1 From 'Mimesis' to the Crisis of Representation

Much like geoscience, film was valued early on in anthropology for its 'mimetic quality' but soon led to significant debates about questions of 'ethnographic realism' (e.g., Banks & Morphy, 1997). This potential of film and photography as a means of documentation made it an important research tool in the period around 1900, especially in the course of colonisation and voyages of discovery and exploration, to observe, 'capture' and analyse visual data for specific research purposes, usually supplemented by written works. The main interest was in gaining biological-anthropological knowledge about members of other cultures, especially by recording and analysing movements during manual activities or ritual acts on film material or to 'rescue something 'authentic' out of destructive historical changes' in the sense of a 'salvage anthropology' (Clifford, 1989, p. 73). Likewise, film served as a teaching or demonstration tool where '...students could gain a sense of what it would be like to experience [...] places first hand, just as if they were in the field' (Aitken & Dixon, 2006, p. 327). However, in comparison to the communication of geoscientific or hazard knowledge, the ascribed 'realism' of the audiovisual media also triggered intense debates. Early ethnographic films such as *Nanook of the North* (1922) by Robert Flaherty or the works of Margaret Mead and Gregory Bateson soon led to the insight that the (anthropological) knowledge of films cannot be separated from their film-aesthetic or methodological approach. Discussions about the 'appropriate' cinematic form, particularly in anthropology, led to gradual but significant transformations and culminated in the 'crisis of representation' (Grimshaw, 2001).

The rather sparse theoretical engagement in disaster studies with the (audio-) visual representation of human and non-human subjects or with questions related to the often proclaimed 'objectivity' of films must be contrasted with the fact that as early as in the 1950s and 1960s, ethnographic filmmakers and theorists such as Jean Rouch, Sol Worth and Timothy Asch were questioning the realism of film and promoting innovative ideas about reflexivity, authority and representation (Grimshaw, 2001). They also reflected critically on the impact of rapidly developing imaging technologies on the application and theorisation of audiovisual media. For pioneers such as Rouch, technological development went hand in hand with novel forms of representation and their critical reflection, as can be read in his reflections on the 'cinéma verité' that developed in the context of the emergence of portable, mobile cameras that allowed for much greater freedom of expression (Loizos, 1993; Rouch, 1995). I claim that a similar engagement would be valuable for disaster risk communication research and practice, where critical questions about authorship, representation, and the narrow notion of effectiveness of risk communication are rarely discussed.

It is important to emphasise that Rouch did not understand 'verité' as a claim to truth, but rather as the process of searching for 'truthful' forms of representation. As can be seen in *Chronique d'un été* (1962), an 'ethno-film' directed by Jean Rouch and Edgar Morin, the explicitly displayed presence and agency of the actors involved in the film process made clear how cinematic reality was created. In this respect, Loizos (1993) states, 'Rather than treating the world as processes that a recording instrument could 'passively' record, the Rouch-Morin team treated the making of the film as an investigative process or a 'provocation' that fed directly into the filming without any attempt at concealment' (p. 60). The reflexivity evident throughout the film, with the actors acknowledging that their subjectivity is at the centre of the filmic research process, is of interest for my research as it inspires, among other things, reflection on the meaning of reflexivity and subjectivity in the process of co-designing audiovisual risk communication.

Another critical approach to ethnographic realism in film has been repeatedly undertaken by filmmaker and anthropologist Timothy Asch and his wife, who state that 'so far we have emphasised the value of using film as an observational tool, but it is naïve and misleading to assume that ethnographic data — be it films, tape recordings or field notes — is a reflection of reality rather than the creation of a unique individual from a particular culture who collected data at a particular time and usually collected it to share with members of his or her own culture' (Asch and Asch, 1995, p. 338). In *The Ax Fight* (1975), an ethnographic film dealing with a conflict in the indigenous community of the 'Yanomami', Asch operates on several analytical levels, allowing the viewer to experience the process of visual anthropology in action and showing how filmmaking can be part of the interpretive process.

While such approaches are very common today, these progressive forces driven by visual researchers went largely unnoticed by mainstream anthropology, which only discovered these issues two decades later, in its postmodern reorientation during the famous 'crisis of representation' that was widely felt in the 1980s. As outlined by Köhn (2016), the experience of decolonisation triggered intense debates about the legitimacy of anthropological research, and the publication of Malinowski's field diaries seriously affected the credibility of the ethnographer as an objective observer. In his diaries, the ethnographer Malinowski describes his experience during this fieldwork on the Trobriand Islands. His diaries from the years 1914-1915 and 1917-1918 show less the development of a theoretical processing of the fieldwork than the difficulties of participating in the life of another society (Malinowski, 1986).

In other disciplines such as human geography, vivid discourses on post-structuralism and feminism also had a significant impact, challenging the interpretive sovereignty of science or the scientific 'gaze' as perpetuating global power inequalities (e.g., Foucault, 1973; Lacan, 1978; Said, 1978; Sartre, 2001). This uncertainty about adequate means of representation led to a shift in focus, away from the 'realism of films' towards the question of how meaning is produced (Aitken & Dixon, 2006, p. 326)

2.1.1.2 Participatory Video

As mentioned in Chapter 1, there is very little research activity on participatory audiovisual methods in disaster studies, although collaborative approaches are fundamental to knowledge co-production processes in the sense of the Sendai Framework. The process of audiovisual research, whether formulating, conducting, or disseminating research, is usually seen as at least triangular rather than dual process of social negotiation (between 'sender' and 'recipient'). At the very minimum, those involved in this process are the filmmaker/researcher, the film subjects/informants, and the audience. But other 'agents' such as production companies or representatives of the institutions in which the research is embedded are also part of this social negotiation process and influence how moving images are created and experienced (Battaglia, 2014).

The use of 'participatory video' is one approach to critically engage with this relationship (e.g., Kindon et al., 2007; Parr, 2007; Yang, 2016). As early as the 1960s, Sol Worth, John Adair and Richard Chalfen attempted to cinematically challenge the 'hegemony of the anthropological gaze' through participatory video. In their project *Through Navajo Eyes* (1966), they taught young Navajo students how to make films without the conventions of Western production and editing, wondering if this would reflect 'a distinctive Navajo film worldview' (Ginsburg, 1995). This approach has been criticised for assuming that unbiased 'Navajo worldviews' existed, and thus seen as an extension of a 'salvage anthropology' (e.g., Dubin, 1998). However, it also marked the beginning of participatory video and collaborative filmmaking, which critically questions power relations in the filmmaking process.

There is usually a great awareness in the visual social sciences, including visual anthropology, that participatory projects are challenging to realise in their theoretical and methodological intent (Battaglia, 2014). Authors such as Milne (2016), Mistry et al. (2015) and Shaw (2015) highlight the ethical and methodological challenges of using participatory video in a variety of different ways. As a result, they call for a rigorous analysis of methodological approaches, as there can often be 'hidden politics' in participatory projects that disaster risk communicators should also be aware of (see also Chapter 4). The concept of a *shared anthropology* (Rouch, 2003) between filmmaker and protagonist, which Rouch considers to be 'the only morally and scientifically feasible anthropological attitude today' (p. 44), has not lost its relevance today and is certainly not only applicable to visual anthropology. Common elements of this concept are transparency and reflexivity, the inclusion of protagonists in the film production process, their feedback on the edited footage, and the sharing of knowledge about filmmaking (see also Section 2.3.1).

2.1.1.3 Artistic and Phenomenological Qualities of Using Film

Another strand of interest for the development of my research design relates to the phenomenological and artistic qualities of film as a medium of knowledge. Of course, using audiovisual risk communication in creative ways always has elements of artistic expression and the actors involved in film production can be labelled as 'artists'. In the last decade, there has been an increased engagement of the Geosciences with the Creative Arts and vice versa (Tooth et al., 2019; see also Poissant et al., 2016). On the one hand, filmmakers and artists are often inspired by geoscientific knowledge, adopt or experiment with geoscientific methods in the context of their artistic practice, or themselves practice artistic research; activities that were initially described as an 'ethnographic turn' in current art productions (Foster, 1996). On the other hand, scientists regularly engage with the Arts to develop novel ways of communicating their findings and to reach different audiences.[1] Besides 'using' the Arts for a more inspiring research communication, authors such as Pink (2009, 2011, 2014) outline how an engagement with the sensory and material practices of art can offer scholars new ways of seeing and working with visual material, describing this engagement as a 'sensory turn' (Pink, 2011).

1 Art-science collaborations can unfold synergetic potentials that go far beyond a conception of the arts as a mere 'eye-catcher' for a more effective scientific outreach, or the sciences as just a 'source of inspiration' for artists. For example, several exhibitions on Earth-science-related themes gripping our societies showed the potential for these 'convergence zones' very well. Examples are the Anthropocene Project 2013–14 at the Haus der Kulturen der Welt in Berlin, the experiment Make it work by the Institut d'études politiques de Paris (Sciences Po), the 14th Istanbul Biennale Saltwater, or the exhibition Alien Matter as part of the Transmediale Berlin 2017 on the topic of media geology. In these projects, both artists and scientists critically engaged with sensory and material art practices, and at the same time demonstrated new ways of seeing and approaching scientific research. Furthermore, they demonstrated the potential to cross linguistic, socioeconomic, and ethnic boundaries, and bring together participants who would ordinarily not interact. Furthermore, in documentary cinema, there are inspiring examples of a co-development of joint narratives and shared perspectives, as can be seen in the film Into the Inferno (2016), a film on active volcanoes co-directed by volcanologist Clive Oppenheimer and director Werner Herzog.

> Similarly, there is a deep theoretical engagement in anthropology with artists' explorations of human perception, such as how learning occurs through direct, responsive engagement with (physical) materials, e.g., in the context of film editing (Ingold, 2013; Marcus, 1995; Schneider and Wright, 2010). In the context of audiovisual media, scholarly attention is focused on the experiential qualities of film. As early as the 1980s, Tyler (1987) used the term 'evocation' instead of 'representation', 'since evocation is non-representational, it is not to be understood as a sign function, for it is neither a "symbol of" nor does it "symbolise" what it evokes' (p. 206). Similarly, adherents of 'non-representational theory' (Thrift, 2008) shift the focus to the practice of (film-) *making* itself, rather than examining and representing social relations (through audiovisual media). They thus look at 'embodied practices' — how human and non-human relationships are enacted or performed — rather than simply what is produced. Although my research is not guided by a phenomenological perspective, such reflections are of interest for my study, as they allow deepened reflections on the potential of audiovisual methods, for example in the domain of experiential learning, or regarding the process-inherent qualities of film.

Two seemingly disconnected research fields—applied visual anthropology and transdisciplinary research—are of major interest for my research, as they have informed my approach to answering my research questions to a significant degree. In both research fields, intense dialogue between scientific and societal participants takes place, spanning from the joint definition of problems, the development of implementation-oriented knowledge to the realisation of 'products' or 'prototypes' that feed back into societal and scientific practice.

2.1.2 Applied Visual Anthropology

To inform my research interventions for more people-centred approaches in risk communication, methodological reflections and practices from *applied visual anthropology* provide valuable insights. Researchers such as Pink (2006a, 2011) and Chalfen and Rich (2007) have extensively progressed this subfield of visual anthropology, with Pink (2006a) defining it as follows:

> Broadly, applied visual anthropology involves the use of visual anthropological theory, methodology and practice to achieve applied non-academic goals. It usually involves an element of problem-solving, is concerned with "cultural mediation" (Chalfen & Rich, 2004) —

> representing the experience of one group of people (or "culture") to another — and is interdisciplinary. (p. 87)

Applied visual anthropological research is usually highly solution-orientated and seeks to intervene in the themes it addresses, rather than merely comment on them (Pink, 2013). Projects are commonly created through and/or informed by collaborative and participatory practices such as researching, photographing or video recording, and participants in applied visual anthropological research projects can 'gain new forms of self-awareness and understandings of their situations' (Pink 2014, p. 415). Audiovisual strategies are usually developed through a joint assessment of participants' needs and act in a user-driven manner rather than being merely inspired 'by theoretical, content-related or methodological issues that stem from academic practice' (Pink, 2006a, p. 87). Frequently, applied visual anthropology also draws on interdisciplinary collaboration and evolves alongside contributions from several academic disciplines. Research projects are often done not only for but with a specific target group, and the results are used in ways that might influence the public, policymakers, business leaders, and others. Visual anthropologists, therefore, often point out that it is not only the final (audiovisual) product that helps to facilitate an intercultural understanding and transformative developments but the research process itself. Furthermore, Pink (2014) points out that the design of visual anthropology is often focused on the production of film as artistic or research intervention, rather than on services that are intended to effect change in the everyday environments and practices of a target user group. She outlines the limitation that 'projects do not necessarily become part of intervention for change, especially when the project ends at the point that its outputs — a report, a film, multimedia or online dissemination — is delivered or published' (Pink, 2014, p. 416). Visual research projects such as those conducted by Pink and Leder Mackley (2012, 2014) demonstrate vividly how films can be designed based on collaboration, and how interdisciplinary and historically embedded research perspectives inform the application of audiovisual methods.

The core principles of applied visual anthropology — such as user orientation, the generation of action knowledge, and transformative effects through social interventions — means that the goals of applied visual anthropology strongly align with the goals of more people-centred approaches proclaimed by the Sendai Framework. Furthermore, they are in line with social constructivist approaches to risk communication that emphasise the relevance of collaboration and dialogical, co-creative forms of communication to stimulate change more effectively (Carlton & Jacobson, 2015; Hagemeier-Klose et al., 2014; Jarreau et al., 2015; Lassen et al., 2011; Moser, 2014).

2.1.3 Transdisciplinary Research

In line with the rationale of applied visual anthropology, my research represents a problem- and solution-oriented endeavour that follows a transformative agenda. It aims to generate 'actionable knowledge' (Wood et al., 2012) for collective transformation processes and to address, potentially mitigate, or resolve earthquake risk communication problems using audiovisual methods. Given the highly contested theme of risk communication in Istanbul, I realised in the context of my initial ethnographic fieldwork that a *transdisciplinary* research framework is most appropriate, as several scholars have outlined its potential for contributing to problem-solving and societal transformation, especially in light of complex, contested, or 'wicked' problems (e.g., Pohl et al., 2017). According to Lang et al. (2012)

> Transdisciplinarity is a reflexive, integrative, method-driven scientific principle aiming at the solution or transition of societal problems and concurrently of related scientific problems by differentiating and integrating knowledge from various scientific and societal bodies of knowledge. (pp. 2-3)

The scientific principle of transdisciplinarity is not new. Already in the 1990s scholars described a need for a new mode of research, introducing the term *mode-2 science* to refer to a way of scientific knowledge production 'which was socially distributed, application-oriented, trans-disciplinary, and subject to multiple accountabilities' (Nowotny et al., 2003, p. 179). Instead of the *mode -1 science*, which is 'characterised by the hegemony of theoretical or, at any rate, experimental science; by an internally-driven taxonomy of disciplines; and by the autonomy of scientists and their host institutions, the universities', this mode-2 science stands for a pluralisation of the places where relevant knowledge is produced and of agents involved in the production of knowledge. To acquire *socially robust knowledge* (Gibbons & Nowotny, 2001) that can be applied under diverse, uncertain and unforeseeable conditions, a transdisciplinary research process needs to be based on close interaction with societal participants. In addition, it must have a ''double-bind' character so that both practice and science can benefit' (Scholz et al., 2015, p. 522). Buser (2016) describes that this interaction necessitates that stakeholders are included in the research process from the beginning (co-design), that deliberation on normative target questions takes place, and that the process enables a co-production of knowledge about how to reach these targets. According to Lang et al. (2012), this requires an integration of different kinds of knowledge, interests and activities, and different languages and forms of expression to arrive at a shared understanding.

Regarding an overview of the requirements of transdisciplinary research, I draw on the principles proposed by Lang et al. (2012). However, it is important to note that my research project only contains elements of transdisciplinary research. Since I was responsible for executing this PhD project, the shared project ownership, normally characteristic of transdisciplinary research projects, was not possible (also see Section 2.3.2.5). Below I list the criteria outlined by Lang et al. (2012). Each criterion is followed by an explanation of how it has informed my own research approach:

(a) Focusing on societally relevant problems.

In my research, I explore (often in collaborative ways) the potential of audiovisual methods for post-Sendai risk communication to productively address the practical and theoretical problems of audiovisual risk communication, as outlined in my literature review and the exploratory case study in Istanbul (see Chapter 3a). In doing so, I seek to contribute to people-centred risk communication that supports disaster prevention.

(b) Enabling of mutual learning processes among researchers from different disciplines (from within academia and from other research institutions), as well as actors from outside academia.

The combination of different audiovisual and verbal qualitative research methods (see Section 2.2.4), most significantly the participative ones, triggered in-depth mutual learning, mainly between me as an anthropologist/filmmaker, geoscience researchers, and inhabitants of at-risk neighbourhoods. My research questions and the chosen research design and methods largely came out of that learning process. Furthermore, new knowledge about important aspects of seismic risk communication was produced (co-production), and (normative) target questions were negotiated (e.g., 'What is the role and responsibility of hazard scientists regarding risk communication?' 'How does risk communication need to be designed to be more user-oriented?'). Most significantly, research participants were involved in conceptualising, applying, and evaluating prototypes to address commonly identified problems of risk communication (co-design). In addition, the research results were regularly shared and discussed with all project participants (see also Wickson et al., 2006).

(c) Aiming at creating knowledge that is solution-oriented, 'socially robust', and transferable to both the scientific and societal practice.

Through case studies and audiovisual prototypes, I attempted to contribute to the genesis of solution-oriented, socially robust knowledge, by differentiating and integrating knowledge from different scientific and social bodies of knowledge. This also involved a 're-evaluation' of audiovisual methods and thus a critical reflection on disciplinary tools of risk communication research. This can be understood in line with Blassnigg and Punt (2012), who state that at the very minimum,

> transdisciplinarity extends the scope, methods and perspectives of existing disciplines whilst at the same time respecting and using the existing disciplinary frameworks. Ideally, emerging new practices, methods, paradigms consequently lead to a re-evaluation of disciplinary tools and concerns through interactive reflection and knowledge exchange, which can lead to a transformative long-term impact on the development of disciplinary practice. (p. 3)

2.2 Research Design

2.2.1 A Practice-led, Qualitative Research Design

The research design of this thesis is guided by my aim to critically explore different approaches of using audiovisual methods for post-Sendai approaches in (seismic) risk communication by conceptualising, applying and also partly evaluating them in different risk communication contexts. As this research seeks to primarily lead to new understandings about the practice of using audiovisual methods, it can be termed 'practice-led' (Candy & Edmonds, 2018). It is important to outline that my research does not depend on the *creation* of audiovisual artefacts. Instead, it is founded in practice as it is interested in the process of using audiovisual methods in different risk communication contexts. The outcome is shared in the form of prototypes and principles for the use of audiovisual methods for a post-Sendai risk communication.

Throughout this thesis, I consider my research participants as active subjects embedded in specific, ever-changing, contingent contexts (e.g., socio-cultural, socio-political, historical). To gain deep insights into such ever-changing risk communication contexts that are limited in time, place and situation, it was clear that a qualitative research approach is most suitable. In Case Study 1, I pursued an *inductive* research approach, as I wanted to 'develop concepts, insights, and understandings from patterns in the data rather than collecting data to assess preconceived models, hypotheses, or theories' (Taylor et al., 2015, p. 8). Instead of starting from theories and testing them, I found *sensitising concepts* (Charmaz,

2003) of crucial importance to approach my research questions. According to Charmaz (2003):

> Sensitizing concepts offer ways of seeing, organizing, and understanding experience; they are embedded in our disciplinary emphases and perspectival proclivities. Although sensitizing concepts may deepen perception, they provide starting points for building analysis, not ending points for evading it. We may use sensitizing concepts only as points of departure from which to study the data. (p. 259)

Case Study 2 is characterised by deductive thinking, as I was testing the concept of 'sustainability skills' (Wiek et al., 2011) against the data generated within the film-based risk communication training (see also Flick, 2009).

2.2.2 Case Study Approach and Development of Prototypes

In order to collect in-depth data on specific risk communication settings through the use of multiple data collection methods in multiple study sites, a case study approach seemed to me to be most suitable for this research. Case studies allow for a 'holistic description and analysis of a single, bounded unit situated in a specific context to provide insight into real-life situations', and allow the study of problems and processes 'to engender understanding that can improve practice' (Ponelis, 2015, pp. 535-536). Yin (2009) defines a case study as

> an empirical investigation that examines a contemporary phenomenon in its real-world context, where the boundaries between phenomenon and context are not clearly evident, and where multiple sources of evidence are used. (p. 18)

However, I here highlight that the data I obtained through the case studies does not allow for generalisation. My data collection took place with few participants and in small, locally specific settings and I decided on a case study approach to provide in-depth insights into different risk communication contexts.

The structural set-up of my research was as follows:

Case Study 1 (Chapter 3a) was a *single-case exploratory case study*, as my fieldwork and data collection in Istanbul at-risk neighbourhoods was undertaken prior to my definition of the research questions and was a form of 'prelude' to my research (Yin, 2009). At the beginning of this exploratory study, I did not want to narrow my research focus too much as I wanted to be open to emerging topics and insights. For that first case study, I chose to use an *ethnographic* approach, as my aim was to better understand the attitudes, beliefs, and behaviours of my research participants over an extended period of time, using fieldwork methodologies that allow for a situated, nuanced exploration and 'thick description' (Geertz, 1973). As I wanted to address the challenges and intricacies of seismic risk communication in places where the risk of a major seismic threat is acute and where my work could potentially create positive impact, my study took place in four at-risk neighbourhoods: Okmeydanı, Sultangazi, Zeytinburnu and Fikirtepe (see also Chapter 3 for more detailed information).

In total, I spent 4.5 months in these neighbourhoods in the context of several research visits (in December 2014 (2 weeks), in May 2015 (1 month) and from August-October 2015 (3 months)). After my first fieldwork phase, I decided to work with geoscientists and inhabitants of at-risk neighbourhoods in more integrated ways, and chose to initiate a transdisciplinary workshop and focus group discussions. The insights gained in Case Study 1 served to inform a culturally sensitive, practically applicable yet scientifically sound research framework for the development of four audiovisual prototypes for post-Sendai risk communication interventions. These interventions address both scientific and societal problems identified in the course of Case Study 1. The follow-up studies thus engage with the problems of risk communication identified in the exploratory study on different levels.

Chapter 3b presents and reflects upon the collaborative process of developing Prototype 1 (the ArcGIS StoryMap 'From Matters of Fact to Matters of Concern') and Prototype 2 (the animation film 'The North Anatolian Fault'). Both prototypes offer ways to translate the findings from Case Study 1 into novel, post-Sendai risk communication formats.
Chapter 4 focuses on the development of Prototype 3 (the collaborative editing tool 'Directors' Room).

Case Study 2 (Chapter 5) was a *single-case explanatory case study*, as I was seeking to provide preliminary evidence for how sustainability skills could be being trained through the proposed audiovisual training methodology. The audiovisual training framework for this case study represents Prototype 4.

The prototype development took place in close cooperation with research participants from the ALErT group and included the feedback of research participants from Istanbul (mostly inhabitants of the at-risk neighbourhoods). The prototypes are in different stages of development: some are only developed but not yet publicly available (Prototype 1 and 3), others are already published (Prototype 2). Prototype 4 was already tested by research participants.

It is important to emphasise the iterative, adaptive character of how the two case studies and the prototypes were developed. For example, the conceptualisation and the design of the prototypes did not always lead directly to 'solutions', but at times to the recognition of new limitations. For this reason, in many respects, the case studies and prototype development strongly inform one another and are based on an intense process of mutual learning. The figure below is adapted from Lang et al. (2012) and represents the structure of my research.

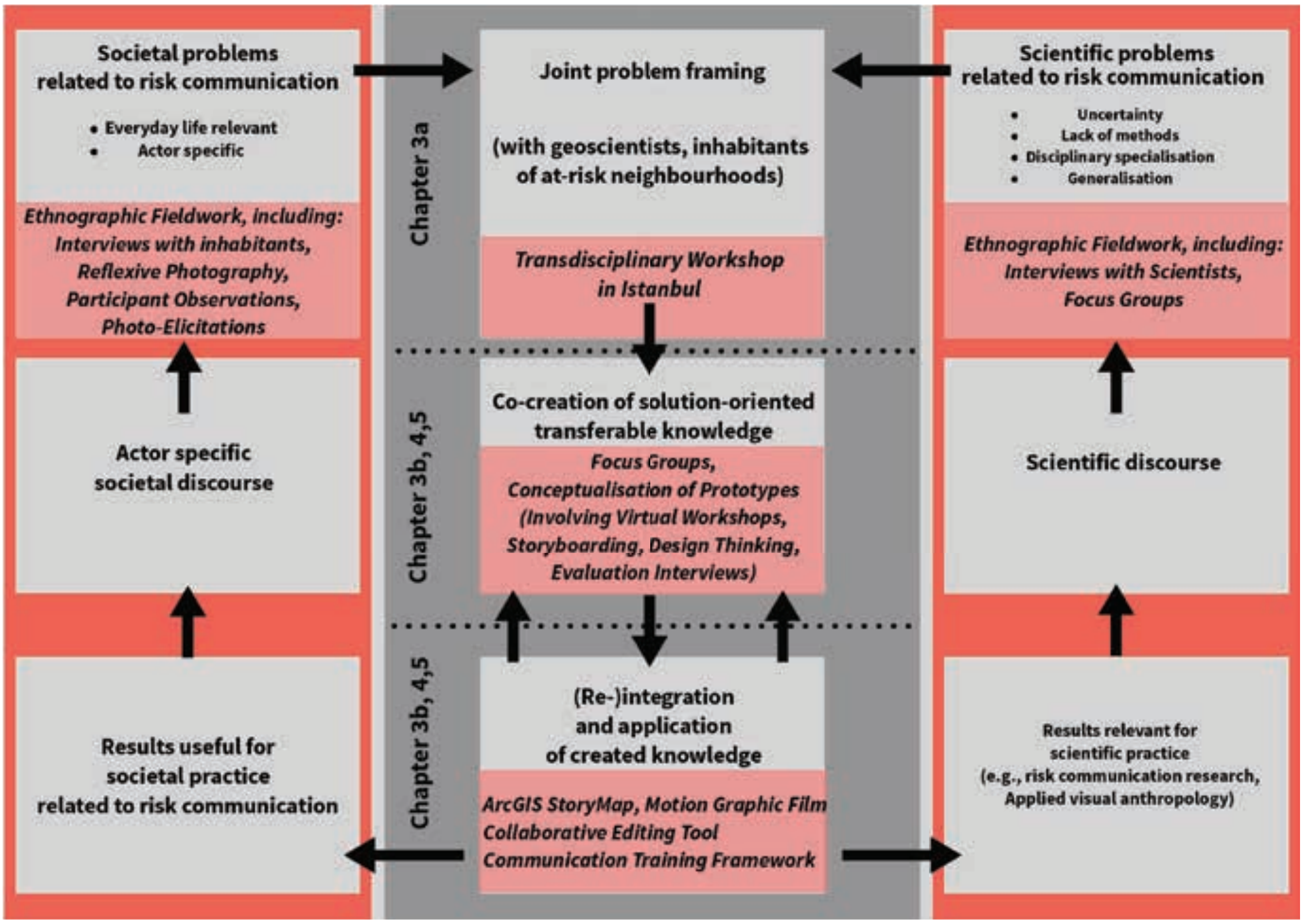


Fig. 2.1: Simplified structure of my research approach (based on Lang et al. (2012)

2.2.3 Triangulation

For Case Study 1 and 2, I decided to use the methodological approach of triangulation because 'looking across different kinds of data (interviews, observations, documents) and diverse interpretive frameworks (previous research findings, alternative theories, competing conceptual frameworks) can help to get a clearer picture what interpretation best fits the data' (Rossman

& Rallis, 2016, p. 23). Similarly, Taylor et al. (2015) argue that by drawing on different types and sources of data, this approach allows for 'a deeper and clearer understanding of the setting and people being studied' (p. 94). Triangulation means a consideration of the research object from at least two perspectives in order to increase the reliability of the data and thus the validity. This method allows for the weaknesses in some approaches to be compensated for by the strengths of others.

Hussein (2009) distinguishes between different forms of triangulation: *Methodological triangulation* is the use of more than two methods in studying the same phenomenon under investigation (Mitchell, 1986 cited in Hussein, 2009). *Analysis triangulation* describes the use of more than two methods of analysing the same set of data for validation purposes (Kimchi, Polivka, & Stevenson, 1991, cited in Hussein, 2009). *Investigator triangulation* can be defined as the use of more than two researchers in any of the research stages in the same study. *Data triangulation* depicts the use of multiple data sources in the same study for validation purposes. *Theoretical triangulation* is defined as the use of multiple theories in the same study for the purpose of supporting or refuting findings (Hussein, 2009, pp. 3-4).

Three of the above triangulation approaches are used in my research:

Methodological triangulation comes into play as I have used different qualitative and complementary visual and verbal methods within my data collection and analysis to enhance the internal credibility of the research findings.

It can also be argued that analysis triangulation was applied in the exploratory case study of this thesis, as the same data was analysed using different methods (e.g., analysis of film sequences, inductive coding, and focus groups).

Finally, data triangulation played a role, as I combined data from multiple sources to achieve a deeper and more grounded understanding of the research question and more detailed insights. Here, the timing of data collection, the people involved, and the locations where the data was collected varied.

2.2.4 A Brief Remark on Methods of Data Collection and Data Analysis

I used a broad array of different social science-based visual and verbal research methods to gradually deepen, broaden and complement my understanding of the research field and to enable different perspectives on it (see Fig. 3.1). Since

I will discuss the methods of data collection and data analysis in detail in the respective chapters, here I briefly list the methods I used in the case studies and prototype developments:

Chapter 3a (Case Study 1):
In the exploratory case study in Istanbul, I collected my data through a combination of filmed participant observations, filmed narrative interviews, image elicitation techniques (photo-elicitation), the analysis of online visual communication, and a transdisciplinary workshop with field-based narrative interviews and follow-up focus group discussions.

Chapter 3b (Prototype Development):
For the development of Prototype 1 (The ArcGIS StoryMap) and Prototype 2 (the motion graphics film), used practices encompassed storyboard development, creation of moodboards, and different brainstorming techniques.

Chapter 4 (Prototype Development):
For the development of the AI-assisted, collaborative editing tool 'Directors' Room', I used a methodology for structured prototyping and chose Hasso Plattner's five-step Design Thinking process (Plattner, 2012). However, as this study does not have a typical case study design and lacks more in-depth user tests, evaluations, and revisions of the prototype, only the conceptualised prototype is presented here. This includes first visualisations that explain the key functions, as well as a first draft for a user survey.

Chapter 5 (Prototype Development and Case Study 2):
In this chapter, I again used a Design Thinking approach to conceptualise a video-based risk communication training that includes modules such as photo-elicitation exercises, interview role-plays, joint film analysis, or reflexive interview exercises. The testing procedure was carried out with the help of qualitative, semi-structured evaluation interviews.

2.2.5 Research Participants and Collaboration Partners

In the course of my research, I have worked with two groups of actors in particular:
The first group mainly includes geoscientists who are actively engaged in risk communication or have an interest in it. Besides local geoscientists from Istanbul and from other international research institutes (IPGP Paris, University of Bergen), I have collaborated with a group of geoscience researchers from the

STRATEGy group (STRATEGy is an acronym for 'Surface processes, Tectonics and Georesources: The Andean foreland basin of Argentina'). However, my main collaboration took place with my colleagues from the ALErT group (ALERrT is an acronym for 'Anatolian pLateau climatE and Tectonic hazards').

The ALErT group is a Marie Curie Integrated Training Network engaged in research on the complex interaction between tectonic and climatic 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. As the ALErT proposal (2013) states:

> 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. (p.6)

As a group, the potential geocommunicators within the ALErT consortium represented a highly specialised yet academically disparate collective of researchers from a wide range of disciplines seeking to share their technical expertise with vulnerable communities — a context with which most of the participants were unfamiliar. Given the various cultural and academic barriers and the complexity of a bottom-up communication approach, it was deemed unlikely that formal graduate training in general principles and practices of science communication would be effective. Therefore, the above-mentioned transdisciplinary research framework seemed a useful means of presenting researchers with the perspectives of residents from at-risk neighbourhoods in a personal way, and encouraging collaboration.

In addition, I worked with a number of 'real-world actors' in Istanbul who have their own experience, expertise, and other relevant 'stakes' in the research project. Some of them were directly affected by current urban transformation measures. Others had a personal interest in the topic of earthquake risk mitigation and its communication or were involved in the topic professionally. I worked with a number of individuals such as city planners, architects and lawyers, NGO representatives, and inhabitants of the neighbourhood of Sultangazi, Fikirtepe and Okmeydanı. In addition, I worked with representatives of two Istanbul neighbourhood initiatives: The Neighbourhood Association 'Okmeydanı Cevre koruma ve Güzellestirme Dernegi' (OCKD) and 'Cumhuriyet Mahallesi Sakinleri' (SİTEDER).

In the framework of the case studies this thesis presents, I was supported by a cameraman, local translators, and a science communication trainer. During the development of Prototype 3, I worked closely with a graphic designer to create a series of illustrations that visualise the prototype of the collaborative editing tool. Furthermore, I engaged in discussions with an AI-specialists and an IT-specialist that helped me to productively confront my knowledge gaps regarding the use of artificial intelligence and film annotation for collaborative editing.

2.2.6 Field Access

During the first joint field schools and network-wide meetings in Greece and Turkey, I was able to enter into a lively and exciting exchange with geoscientists from the ALErT group and developed a relationship of mutual trust with many group members. In the framework of the field schools, I also created first visual field notes to gain more understanding of the principles and methods of geological reasoning. These resulted in short video sequences that helped me to reflect on my field experiences.

Fig. 2.2: Impressions from ALErT field schools

ALErT Fieldschool - Video Diary 1: https://youtu.be/PDLuJodUyao
ALErT Fieldschool - Video Diary 2: https://youtu.be/ThcH-4WPNEo
ALErT Fieldschool - Video Diary 3: https://youtu.be/6oBOFw8PoYk

In Istanbul, my field access took place in the framework of a longer engagement with inhabitants of the three neighbourhoods under study and active participation in events and situations in which risk communication played a role (see Chapter 3a).

A vital prerequisite for my field access was my collaboration with translators. It was important to me that all research participants who were not proficient English speakers could speak in their mother tongue. In Case Study 1, many interviews were conducted in Turkish and translated by an interpreter. Furthermore, a professional translator transcribed all Turkish interviews for translation. For Case Study 2, some of the evaluation interviews took place in Spanish or French, which did not lead to any comprehension problems as I speak these languages. Thus, in this case study, only the passages included in the final text of the chapter were professionally translated into English. This was a decision also based on achieving the most sustainable use of the project's financial and time resources.

In order to counteract potential biases in the research data and to allow for a fair representation of my research participants' verbal and written contributions, I collected not only confidentiality and neutrality declarations of the translators, but also consciously decided to work with a variety of them (five in total). In the case of the transdisciplinary workshop, I also had an external Turkish-speaking person proofread all the quotes that appeared in the text and checked the translations against the source material (in the form of video material from the workshop). In addition, I asked the translators to conform to specific translation styles, so as to make aspects such as pauses or intonations/accentuations/emphases of the speakers visible in the text (Sperber et al., 1994).

2.2.7 Presentation of Audiovisual Research Data

Most of the moving image works created in this thesis are part of Prototype 1 (The ArcGIS StoryMap 'From Matters of Fact to Matters of Concern'). Further, the films that were created in the framework of the video-based risk communication training, as well as work-in-progress sequences I used for specifying my research questions and for getting familiar with the subject of risk communication, are unlisted YouTube videos that go along with embedded links in the respective chapters.

The audiovisual works this thesis comprises can be read in several ways. They are, on the one hand, *data collections* that helped me to reflect upon the process of using film and photography as research method (Chapter 3a) and as a risk communication training method (Chapter 5). In that regard, they have offered me access to different perspectives and modes of engagement with the cognitive, material, and embodied dimensions of risk communication. On the other hand, the moving image works are *prototypes* that attempt to conceptualise and develop (as in Chapter 4), and also evaluate (as in Chapter 5) concrete tools for post-Sendai risk communication. In addition, the films presented in this thesis are also a form of *research communication*, as in the case of the motion graphics film *The North Anatolian Fault*, the photo-elicitation films or the trailer for the transdisciplinary workshops in Istanbul. All the moving image works of this thesis have in common that they attempt to explore people-centred communication in the use of audiovisual methods in risk communication, in some cases using innovative communication technologies.

2.3 Ethical Considerations, Reflections on the Research Process, and Challenges Encountered

2.3.1 Ethical Considerations

This research has a strong ethical dimension in that it aims to initiate dialogical and collaborative processes and to actively involve people who are otherwise excluded from risk communication and the design of it. Nevertheless, there are significant implications for ethical requirements in research activities such as mine, in which a great deal of visual material is collected, processed and in some cases published. For me, therefore, in addition to examining some major frameworks, such as the American Anthropologist Association's Code of Ethics (AAA, 1998), the active application of some guiding principles was essential. Helpful in reflecting on ethical questions was the aforementioned concept of a 'shared anthropology' established by the ethnographic filmmaker Jean Rouch (2003).

This concept informed the overarching principles of my research: to enable the best possible representation of my research participants and their viewpoints and to promote collaboration of mutual trust and integrity. This encompassed involving participants in a reflexive process, in which the methods were to a larger extent discussed and developed together with them. Wherever possible, participants were offered feedback on the audiovisual findings at different editing stages. This meant also that participants were able to see the raw visual data created by/of them, had access to the transcripts of their interviews and had the opportunity to reflect upon it. Furthermore, they could withdraw their statements and video material at any time, provide additional information, or add glosses on interpretations. In addition, they were provided with the right to anonymity.

Beyond the obvious matter that the filming was always announced beforehand and only took place when participants gave explicit consent, I also gave them declarations in which I assured them confidentiality, openness, honesty, and protection from harm. I gave all research participants a detailed briefing about the research project, explaining to them that their images may appear in the research and the implications of film production and research publications. Obtaining written informed consent was the first step before beginning recordings and conducting interviews. However, following Ruby (1991), I was also aware that *full* informed consent is difficult to achieve. For example, it is questionable how objective people can be towards their own image in situations of direct pressure on their livelihoods through urban transformation projects. This was an insight that motivated me to seek even more collaborative audiovisual methods. Over the course of Case Study 1, I found it increasingly productive and insightful to use film as a collaborative, experiential, and reflexive method and not as a representational instrument.

2.3.2 Methodological Challenges

For reasons of transparency I want to address a number of methodological challenges in the following section, as they posed limitations to this research project and also shaped the direction of my research. A detailed evaluation of my methodological approach is provided in Chapter 6.

2.3.2.1 Political Tensions in Turkey

First, it is important to highlight that the political tensions in Turkey impacted my research to a significant degree, as they directly affected cooperation with my research participants. Already during my fieldwork in 2014/2015, some of my research participants reported experiences of state repression in different forms. This was due to the fact that they either openly opposed the government, were members of civil society organisations, or worked for media outlets critical of the regime. Furthermore, many of them were involved in the Gezi protests 2012-2013. After the military coup against the Turkish government on 15 July 2016, Recep Tayyip Erdoğan's state apparatus imposed a state of emergency for two years and used this framework to reshape the country according to its political ideas. The wave of purges that followed the coup, with the introduction of a presidential system, has transformed Turkey into an autocracy in which many fundamental rights have been suspended (e.g., Jongerden, 2019; Selçuk, 2016). Citing national security and terrorism, thousands of academics and media professionals were dismissed or banned from their professions across Turkey (Baser et al., 2017). During this phase, two of my research participants were charged under anti-terror laws, one of them imprisoned for several years. However, it is important to clarify that these juridical interventions were not associated with this research project.

My fieldwork ended in October 2015. After the military coup, I decided to cancel my plan to go back to Istanbul for the joint development of the audiovisual prototypes and to continue my research in the UK and Germany. However, the prototypes developed in the framework of this thesis still are targeted at research participants from the Istanbul neighbourhoods under study as well as hazard scientists. However, it was challenging to maintain the same level of cooperation with all research participants after my return. Although an active exchange and feedback was possible with most participants, in conversations in the aftermath of the coup, some of them made clear that they did not want to comment publicly on the policies of the Istanbul Municipality or — as in the case of Okmeydanı and Fikirtepe — ceased responding to my contact attempts. Therefore, the prototype development is based more on collaboration with the researchers from the ALErT group. This is regrettable, as the close collaboration, knowledge co-creation, and co-design with residents did not continue as vigorously as during my fieldwork.

My approach to disclosing names was also influenced by the political situation. Due to the tense situation in Turkey, but also because other respondents of this research project wished to stay unnamed, I decided to anonymise some of my research participants. Other participants, who explicitly consented to be named, are people who are often in the public eye, such as Mustafa Erdik, Celâl Şengör, or Mücella Yapici. Although I have obtained consent forms and image rights declarations from all research participants, I have not yet published any video material, so as not to put my research participants at risk. All links contained in this thesis are 'unlisted' and thus not publicly viewable. However, as soon as the situation in Turkey eases, I would like to comprehensively evaluate all projects in terms of sustainability, and further disseminate my results.

2.3.2.2 *Language Barriers*

As data was generated in several languages during my research (mainly Turkish and English, but also French, German, and Spanish), intensive translation processes were necessary. However, working with translators led to some epistemological and ontological issues being raised. Even before the research project began, I was aware that translation is not only about a 'correct' transmission of meaning but also about the role interpreters/translators take on. A broad array of literature provides an in-depth reflection on whether translators should be neutral, advisory, or advocates, and the nuances of cross-cultural translation (e.g., Thomson et al., 1999; Venuti & Venuti, 1994). However, many decisions regarding translations in the research project were also subject to practical and logistical constraints. For example, during the above-mentioned transdisciplinary workshop, a translator and professional facilitator, who also acted in the role of an urban planner/architect, translated all statements made by workshop participants and interview partners about Istanbul's urban redevelopment.

On the one hand, this 'double role' was beneficial for the implementation of the workshop, but on the other hand, it gave this person an enormous responsibility in the research process, which must be critically examined. Furthermore, it can be assumed that important information was omitted during the complex and demanding translation process that lasted several hours (during which time short inputs from the participants were translated immediately). It can also be assumed that value judgements influenced the translation. For example, there are several passages in the following Chapter 3a in which the political stance of the translator is clearly expressed. Other Turkish translators I worked with similarly articulated their critical views towards the Istanbul municipality's risk mitigation policy. Even though I do not find this advocacy stance problematic—primarily since my research decidedly advocates for the interests of certain groups as suggested by scholars in applied visual anthropology — this factor must be made transparent since it influences the representation of research data. Although all of the translators committed themselves to neutrality and confidentiality in written declarations (see Appendix), they naturally have put their personal 'stamp' on the research. This is relevant to the research process as it raises questions of representation, or, as Temple & Young (2004) argue, 'language constitutes our sense of self as well as enabling us to communicate the ways in which we are similar to and different from others' (p. 174). The authors also state that the assumptions translators make about meaning equivalence is what makes them not only translators but also analysts and cultural brokers (p. 171).

2.3.2.3 Sampling of Research Participants

Due to limited resources and methodological reasons, it was only possible to work with a relatively small number of research participants. However, to sustainably contribute to 'problem-solving' in the field of risk communication, other relevant actors and their expertise should have been included (see Chapter 6). For example, the transdisciplinary workshop with geoscientists and representatives of the association in Okmeydanı would have benefitted from participants who could also implement the developed audiovisual prototypes in the neighbourhoods of Okmeydanı, Sultangazi and Fikirtepe. Here, for example, 'Muhtars' (elected heads of the village or neighbourhood) or critically-minded actors from the local government, committed to strengthening collaborative, integrated planning and communication processes, could have contributed to the testing, evaluation, or implementation of the prototypes.

One can also critically question the fact that I worked with many, in some cases prominent, representatives of citizens' initiatives and activists who probably belong to a group that is naturally open-minded towards participatory and civic involvement processes. However, these groups' perspectives only represent a small section of the population in the respective neighbourhoods, although they have raised important issues for understanding risk communication and mitigation.

Furthermore, practical challenges influenced the sampling of participants (e.g., Scholz et al., 2015), since participants in the interviews and transdisciplinary workshop needed to have sufficient time and means to take part (e.g., for the feedback on the prototypes, which involved time-consuming evaluation processes).

2.3.2.4 Challenges During the Film Production

Although I have years of experience in film production due to my professional background, it was challenging for me to film on my own and to be responsible for the administration of the entire technical project. Although I was supported by a professional cameraman during the transdisciplinary workshop in Istanbul and during the risk communication training workshop (Chapter 5), I depended on my own resources during several recording situations. As my skills in handling camera and sound equipment are limited, I found these situations demanding, as in some cases they reduced the depth of my engagement with my research participants. For example, the transdisciplinary workshop was an attempt to bring together a group of various participants (including myself) to discuss problems of earthquake risk communication and mitigation across disciplinary boundaries. However, I was largely preoccupied with the technical facilitation of the recording. A similar issue arose from the fact that large amounts of film material needed to be translated. For the preparation of the editing, intense subtitling was required, which was a major (rather administrative) effort. In retrospect, it would have been preferable to have collaborated more continuously with a film professional to be able to better handle such technical-organisational hurdles.

2.3.2.5 Unbalanced Problem- and Project Responsibility

It is important to emphasise that this research project was initiated by me and not by my research participants themselves. Even though the research project addressed problems of risk communication that affect all research participants in different ways, the project and problem responsibility nevertheless lay primarily with me. Thus, the development of the prototypes to move from joint knowledge production to the implementation of 'solutions' was mainly progressed by me, even though a significant amount of feedback was sought and researchers from the ALErT group actively collaborated with me. 'Real' transdisciplinary 'collaboration', however, would not locate large parts of project ownership with one person (see Chapter 6). Rather, shared rights and responsibilities would be established, and shared problem ownership would be sought (e.g., Lang et al., 2012; Rosendahl et al., 2015). However, as briefly outlined above, this problem of project ownership is rooted in the fact that, in the context of this thesis, it was important that I be responsible for implementing the many stages of the research. In addition, the distribution of resources naturally plays a significant role in this context, as not all participants were able to invest the same level of energy and time in the project.

Chapter 3a – Using Film as an Ethnographic Research Tool for a More Nuanced Representation of Seismic Risk

This chapter presents the findings from my ethnographic research in Istanbul that sought to actively confront the persisting deficit-mode of risk communication, as outlined in Chapter 1. It is important to highlight that due to the exploratory nature of this case study, a large part of it consists of reflecting — through audiovisual and verbal research methods, a transdisciplinary workshop, and focus groups — the findings related to risk communication and its mitigation in Istanbul, and to determine the scope of my doctoral project. While Chapter 3a presents important background knowledge, my methodological approach, and the initial findings from my ethnographic research, Chapter 3b outlines how the generated findings were reflected in focus groups and later deployed for the conceptualisation of two audiovisual prototypes for post-Sendai risk communication.

Chapter 3a consists of the following sections:

Section 1 introduces why this case study follows the approach of designing post-Sendai risk communication prototypes on the basis of audiovisual ethnographic research. I will argue that a combination of visual research methods along with other qualitative research methods can play an important role in gaining a more grounded understanding of the sociocultural and sociopolitical complexities of risk communication.
Section 2 provides social-scientific as well as geoscientific background knowledge on the earthquake risk of Istanbul and gives insights into the controversial debate around the municipalities large-scale seismic adaptation and mitigation measures.
Section 3 outlines the research methodology of this case study. Firstly, this section elaborates on the undertaken ethnographic fieldwork and the methods applied. Furthermore, it highlights how the findings from the ethnographic fieldwork fed into the conceptualisation of two risk communication prototypes.
Section 4 analyses the results of the ethnographic fieldwork regarding local risk perceptions.

Chapter 3b is structured as follows:

Section 1 analyses the results of the ethnographic fieldwork regarding geoscientists' views on post-Sendai risk communication. It presents the results of the interviews with local geoscientists and of focus groups 1 and 2 that sought to reflect on the findings from the transdisciplinary workshop. Major themes here were methodological frameworks for a more integrated seismic risk communication and a reflection on geoscientists' roles as 'communicators'. Section 2 outlines how the recommendations that emerged from the ethnographic fieldwork were used for the conceptualisation of prototypes. This conceptualisation took place in collaboration with geoscientists from the ALErT group, inhabitants from at-risk neighbourhoods, and a motion graphic designer.

3a.1 Contextual Understanding as a Prerequisite for 'Sendai-proof' Risk Communication

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 & Hand, 2006), it is crucial to approach risk communication as 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 in the last decade. For example, scholars are engaging in comparative approaches towards different risk perceptions in different cultural contexts (e.g., Solberg et al., 2013), asking how specific epistemological orientations and or scientific paradigms shape activities and decisions of stakeholders involved in risk communication (e.g., Lacassin & Lavelle, 2015), or researching how risk communication artefacts in the form of specific visualisations, rhetorics, or communication formats are being formed by various cultural orientations, assumptions, and paradigms (e.g., Medin & Bang, 2014).

As already outlined in Chapter 1, a large body of research literature highlights that risk communication ideally takes place in the form a dialogue conducted to help facilitate a more accurate understanding of risks among people and, relatedly, the decisions they may make to manage them. Yet, what counts as 'good' or 'effective' risk communication depends very much on aspects such as the standpoint from which it is judged, on cultural perceptions, on 'taken for granted' assumptions and rules, or on underlying theoretical models for risk communication (Demeritt & Norbert, 2014). This requires, among other things, increased reflexivity from the side of the communicating scientist as well as a deeper understanding of the different sociocultural and sociopolitical realities of recipients that influence their risk perceptions. As Deville et al. (2014) state, disasters make the 'political constitution of reality' more visible (p. 185). The authors refer to a complex assemblage of natural and cultural, material and social, and human and non-human concerns that must be subjectively recognised and used for a more nuanced discourse on disaster preparedness. By the same token, the anthropologists Oliver-Smith and Hoffmann (2002) note:

> When hazards threaten [...], they both reveal and become an expression of the complex interactions of physical, biological, and sociocultural systems. [...] Disasters expose the way in which people construct or "frame" their peril [...], the way they perceive their environment and their subsistence, the ways they invent explanation, constitute their morality and project their continuity and promise into the future. (pp. 5-6)

Consequently, how risk communication is understood and practised reveals much about the complex network of different actors and forces coping with disasters. Strategies to better respond to sociopolitical and sociocultural complexity thus require, first of all, a closer understanding of the context of risk communication (e.g., Egner et al., 2012). However, video-based approaches informed by social theory that carry out user surveys as a preparation for a science-based, locally adjusted conceptualisation of risk communication are almost non-existent in seismic risk communication, apart from the example of Sanquini et al. (2016) described in Chapter 1.
This is very surprising, as authors such as Storm-Mathisen (2010), Pink (2013), and Alfonso et al. (2004) outline that using visual methods (for example in ethnographic fieldwork) holds the potential create 'thick descriptions' of the aforementioned actors and forces and can help analyse the microstructures of (risk) communication processes. This can lead to the production of more relevant research data, which can be useful to develop (audiovisual) communication strategies. Such studies can of course not be carried out by single hazard scientists, but depend on inter- and transdisciplinary collaboration between geoscientists, (visual) social scientists, and users in which communication is an on-going, contingent and sequential accomplishment between actors (e.g., Tinti & Armigliato, 2016). Such collaborations with their actual unfolding of communicative situations seems even more urgent against the background that hazard scientists rarely meet or collaborate with the people that are actually 'at risk' — those in communities prone to natural threats. When they do — as will be presented in this case study — scientists can also 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, many 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 (e.g., Bempah & Øyhus, 2017; Paton, 2003; Simpson, 2013). Furthermore, the projected earthquake, volcanic eruption or flood event is one aspect of public debates about topics such as ongoing social transformations, local arguments over economic development plans, or political debates about corporate corruption and civic trust. As will be outlined in the next sections, a public conflict about the nature of the current Istanbul earthquake mitigation programme seems to influence citizens' perception of risk communication. In the following Section 3a.2, I will provide background knowledge on the physical earthquake risk of Istanbul and outline the public reactions on the municipalities undertaken adaptation and mitigation measures.

3a.2 The Seismic Risk of Istanbul

In Istanbul, a sprawling metropolis home to over 15 million residents, earthquakes are part of the collective historical experience of the city due to its proximity to the North Anatolian Fault. Thirty-four devastating earthquakes with a magnitude of more than 7.0 have struck Istanbul in its nearly 2000 years of recorded history, with more recent ones in 1509, 1894 and 1999 (Ambraseys, 2002). Now, the geoscientific consensus is that Istanbul is again facing a major earthquake threat in the coming decades (Bohnhoff et al., 2013; Parsons, 2000). The destructive earthquakes of August and November 1999 east of the city highlighted the lethal potential of the seismic threat (Özerdem, 1999), and the intervening years have built up a considerable body of science concerning future disaster scenarios (e.g., Ansal et al. 2009; Armijo et al., 2005; Barka, 1999; Erdik et al., 2011; Okay et al., 2000; Pichon et al., 2001). 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 (Armijo, 2005; Bohnhoff et al. 2013; Parsons et al., 2000; Stein et al., 1997), 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 & Harmankaya, 2012). Based on statistics from the 1999 events, it is estimated that the multi-storey reinforced concrete buildings that dominate modern Turkey are ten 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 & Durukal, 2008; Bugra, 1998). A loss-estimation study carried out for Istanbul after the 1999 Kocaeli earthquake (JICA & 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.

3a.2.1 The Seismic Vulnerability of Istanbul's Built Environment

The acute seismic vulnerability of Istanbul's built environment is a direct product of its rapid unauthorised 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 industrialisation and urbanisation 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 overnight') and typically without any professional consultation of planners or architects (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 legalised a large percentage of the informal building stock. As a result, many existing 1-2 storey gecekondus were extended into 'post-gecekondu' settlements with 3 or more storeys (Esen et al., 2005). However, it must be outlined that according to a leading geomorphologist from Istanbul Technical University, more recently constructed buildings by the Housing Development Administration of Turkey (TOKİ) are also frequently not meeting seismic building code regulations because of insufficient ground studies, corruption, and/or a lack of control mechanisms.

3a.2.2 Current Earthquake Mitigation and Adaptation Measures

Experiences of past earthquakes and the threat of future ones give both occasion and rationales for (scientific) efforts subsumed under the umbrella terms 'adaptation and mitigation measures' or 'risk communication'. After the Kocaeli earthquake in 1999, extended public education and awareness programmes on structural and non-structural mitigation measures took place[1], and geologists and engineers have since been involved in city-wide earthquake preparedness measures, mainly focused on improving the resilience of the city's largely vulnerable building stock. 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 the 'Urban Renewal'-Programme, during which many gecekondu districts underwent large-scale retrofitting and reconstruction. In 2005, the 'Law on the Protection of Deteriorated Historic and Cultural Heritage through Renewal and Re-use' (Act 5366) was enacted, more popularly referred to as the 'Urban Renewal Act'. The law enables the municipality and TOKİ, which reports directly to the office of the Prime Minister, to declare any site previously designated as a historic preservation sites a renewal area in order to take precautions through retrofitting and reconstruction. This also gives the municipality expropriation powers to implement a renewal project in a region where the consent of property owners is not given (Dinçer et al., 2008). To further facilitate retrofitting and construction projects, in light of complex ownership structures, the 'Law for the Regeneration of Areas Under Disaster Risk (6306)', also called 'disaster law', was implemented in 2012 and is applicable all over Turkey. This law empowers the Ministry of Environment and Urbanisation to conduct urban transformation projects in the name of disaster risk mitigation at an unprecedented rate. The law enables the declaration of risk zones (or 'riskli alan'), which are seen to pose a threat to lives and properties, and similarly 'risky buildings' inside or outside the above-mentioned areas, as 'reserve development areas' where new residential buildings will be constructed (Adanalı, 2013).

Istanbul's urban transformation projects have been accompanied by major public protests, especially within gecekondu districts. Despite broad societal

1 The complex interrelationship between natural hazards and man-made vulnerabilities, as outlined by Oliver-Smith and Hoffmann (2020), became particularly apparent in the aftermath of the Kocaeli and Duzce earthquakes of August and November 1999. What transformed the 1999 earthquakes from a natural hazard into a 'disaster' was not only the high amount of casualties (20,000 dead) and economic losses (6.2 billion USD) (Erdik, 1999) but also the significant shortcomings of disaster management in Turkey (Balamir, 2013). One important origin of these shortcomings, according to my interview with Prof. Şengör, was the 'ineffectiveness' of risk communication: Although the geologists Aykut Barka and his colleague Ross Stein reported significant evidence for an increased earthquake risk of Izmit and the wider region, and also published this risk in both an academic journal ('Geophysical Journal International') and the newspaper 'Cumhuriyet', relevant decision-makers and the public didn't react on this announcement of a potential catastrophe (A.M.C. Şengör, interview, 17th of December, 2014; see also Barka et al., 1999). Despite descriptions that geoscientists had not sufficiently rung the 'alarm bell' (R. Armijo, interview, 8th of May, 2015), the post-1999 period was marked by adaptation and mitigation measures becoming matters of public debate and private concern all over Turkey, with a particular focus on Istanbul and its vulnerable building stock.

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 (Adanalı, 2013; Angell, 2014; Aşar, 2020; Balamir, 2013; Eren & Özcevik, 2015; European Commission, 2014/2020; Islam, 2010; Turam, 2013; Vatan & Güney, 2018; Yasar, 2019). 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 organisational 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 via shared 'platforms', consensual implementation of projects, devolved forms of governance, or the involvement of resident groups in the identification of local vulnerabilities (Ay & Ozkul, 2021; Balamir, 2013).

Despite a recognition that 'seismic risk in the buildings in Istanbul is mostly dominated by building vulnerability, not hazard' (Yakut et al., 2012, p. 1545), there is widespread distrust of Istanbul's retrofitting and reconstruction measures even among residents of some of the city's most at-risk quarters (Eren & Özcevik, 2015; Green, 2008; Islam, 2010; Karaman, 2013; Kuyucu, 2014). The roots of this distrust go deep into the Turkish psyche. An inter-comparison 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 concern about political corruption, and the 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 informed 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). This phenomenon is also described by other scholars, who outline that seismic risk communications shows low levels of information penetration and personal preparedness, with only few people living in at-risk areas appreciate their risk or have a plan for necessary preparedness actions (Eraybar et al., 2010; Erdik, 2013; Özerdem, 1999).

In Istanbul, as will be outlined in Section 3a.4, this distrust strongly 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.

Fig. 3a.1: *Risk mitigation through urban redevelopment: construction site near Taksim Square (photograph taken during initial field work phase)*

3a.3 Case Study Design

3a.3.1 Combining Visual and Verbal Research Methods in an Ethnographic Case Study

This case study combines social scientifically grounded visual and verbal research methods to provide geoscientists with important local insights. I argue that such a 'local knowledge base' holds the potential to facilitate a 'people-centred' risk communication and the design of innovative information and communication formats based on an assessment of the needs of those affected by seismic risk.

This case study combines different qualitative (visual) methods and uses data-triangulation to gradually deepen, extend, and complement my understanding of the research field and to provide different perspectives on it. The different methods of participant observations, qualitative interviews, reflexive photography exercises and photo-elicitation interviews as well as focus groups and field excursions will be more precisely explained in the following sections. The mix of methods was chosen to generate rich data with high levels of internal validity, to authenticate my interpretations and also to be able to provide several sources to justify the findings (Flick, 2000). The methods were largely generated in the context of video-based ethnographic fieldwork in at-risk neighbourhoods of Istanbul and took place in the context of shorter field visits and one extended fieldwork phase in Istanbul (in December 2014 (2 weeks), in May 2015 (1 month) and from August-October 2015 (3 months) (see also Chapter 2).

The case study was divided into three major phases. The first phase was largely concerned with data acquisition to gain a deeper understanding of the subject matter. The second phase served to evaluate the generated findings, and the third phase focused on the development of risk communication formats based on the fieldwork results (see Chapter 3b). However, the phases were not strictly separated, and some of the evaluation work took place during phase 1 and informed the further research process. Aside from my research interest in using audiovisual methods, key questions during my initial fieldwork were:

(1) What attitudes do inhabitants of at-risk neighbourhoods have towards current seismic risk management (including risk communication)?
(2) How do these attitudes affect the motivation of inhabitants to take seismic preparedness actions?
(3) What different understandings and criteria do inhabitants of at-risk neighbourhoods and geoscientists have in terms of 'effective' seismic risk communication'?
(4) How can the answers to question 1-3 be used for the development of post-Sendai risk communication formats?

Ethnographic Fieldwork	Evaluation	Conceptualisation of Risk Communication Prototypes
• Review of Contextual Literature • Exploratory Participant Observations • Qualitative Interviews • Reflexive Photography and Photo-Elicitation Interviews • Transdisciplinary Workshop (Including Field Excursions and Participant-Led Interviews) • Focus Groups	• Analysis of Audiovisual Research Data • Editing of Thematic Sequences and more substantial edited films • Thematic Analysis (Transcription, Coding, Categorisation)	• Virtual Workshops, including Brainstorming Methods, Generation of Storyboards, Moodboards
Phase 1	**Phase 2**	**Phase 3**

Fig. 3a.2: *The three project phases of Case Study 1*

The mixing of visual and oral methods led to profound insights into the topic. Most significantly, I gained a better comprehension of sociocultural and sociopolitical specificities in the four at-risk neighbourhoods and learned about particularities regarding my research participants' perception of (audiovisual) risk communication and their concrete wishes for novel risk communication strategies.

3a.3.2 Phase 1: Ethnographic Fieldwork

The following methods were applied in the framework of my ethnographic fieldwork:

3a.3.2.1 Exploratory Participant Observations

A large proportion of the ethnographic data was gathered through filmed participant observations and through informal, sometimes audio-recorded conversations, which were later reflected in field diaries. First explorative visits took place in the neighbourhood of Kadiköy (Fikirtepe). More extended fieldwork took place in Beyoglu (Okmeydanı), Sultangazi (Cumhuriyet) and Zeytinburnu (Sumer). At the time of the fieldwork, these neighbourhoods had in common that they were all centrally located, working-class, low-income neighbourhoods with a high degree of major structural retrofitting and reconstruction measures that were either being planned or currently implemented under the rationale of reducing the seismic vulnerability of the building stock.
Several initial field visits helped me to develop a sense of these transformation processes and how they are being perceived by affected inhabitants. During this 'ethnographic sampling', I tried to distil common features of social situations important for my research field, determined the situations to focus on, and started to collect video data in places such as construction fields, information

offices of urban transformation projects, public places such as cafés or markets, as well as in homes of inhabitants affected by urban transformation projects. In addition, I filmed in an earthquake education and preparedness education unit as well as during two earthquake information events. In parallel with the participant observations, a detailed literature review on the studied neighbourhoods and on risk communication was undertaken, drawing from scholarly books, journals, articles, blogs, and news outlets. I also analysed numerous examples of public relations material provided by the Istanbul municipality, such as plans, plan reports, and brochures of their institutions.

Fig. 3a.3: *Participant observations in the Disaster Preparedness Education Unit (DPEU) at Bogazici University's Kandilli Observatory and Earthquake Research Institute (KOERI)*

3a.3.2.2 Qualitative Interviews

Having the deepest possible knowledge of their local context, the inhabitants of at-risk communities and people involved in neighbourhood-based risk management are the most qualified to explain and address their risk perceptions. For this reason, the method of qualitative interviews with local participants seemed highly appropriate for this case study. To increase my understanding of the above-mentioned questions, I conducted a series of 12 filmed and 15 audio-recorded in-depth interviews (a full list of interview partners is available in the Appendix). These included semi-structured interviews with scientific and local experts, among them mainly inhabitants of at-risk neighbourhoods and geoscientists, but also Istanbul-based earthquake engineers, lawyers, architects, planners, and NGO representatives. In addition, eight interviews took place in the form of photo elicitation interviews (see Section 3a.3.2.3).

First interview partners were recruited through the exploratory participant observations via face-to-face recruitment. Furthermore, two of the geoscientists I interviewed were recommended as leading experts in the field of seismic risk management in Istanbul. The main method used for the recruitment of the interview partners was exponential discriminative snowball sampling, as the first interview partners I talked to provided several referrals. From these referrals I made selections based on criteria such as their willingness to participate in a filmed interview and/or a transdisciplinary workshop, or their experience with urban renewal processes.
Participant information sheets as well as consent forms were developed in English and translated and localised to Turkish by a native speaker who also translated during the interviews. With authorisation from each research participant, the interviews were video-recorded, transcribed and translated into English by two local translators.

As can be seen in the interview question guides in the Appendix, semi-structured interviews with open-ended questions were employed to elicit my respondents' thoughts on topics such as: their risk awareness; motivations and attitudes towards risk mitigation; their perception of how earthquake risk information is being presented; risk information sought by them; their information needs and wishes regarding risk communication.

During the interviews, which usually lasted between 1 and 2.5 hours, it was particularly important for me to allow my interview partners to freely reflect on the topic of seismic risk communication, avoiding a strict question response-schema. Although I prepared a list of questions that needed to be covered during the conversation, I allowed related or peripheral trajectories that the participants felt were relevant were considered, as well as narratives that followed a self-generating scheme (Schütze, 1987).

Despite these open situations and efforts to establish mutual trust, I found that some interviews were biased by social desirability (Grimm, 2010) as some respondents seemed to prefer giving answers that they believed were more likely to be met with social approval (for example, when attributing a high relevance to their own seismic preparedness). This was presumably further intensified or even provoked by the presence of the camera. Furthermore, although the visual recordings served to capture the feelings and attitudes of the interview partners through visualisation facial expressions, gestures, and intonation, they still focused very much on cognitive aspects of risk communication. Therefore, I felt it important to complement this method with less directed approaches that were more participative and that elicit more of the embodied and socio-material aspects of the everyday life situations of my informants. I chose the method of reflexive photography and photo-elicitation interviews to give research participants more creativity and agency in the research process.

Below is a link to a first rough montage sequence used to structure and analyse some of the first interviews made in the field (see also Section 2.2.7 for clarification of my use of audiovisual research data).

Challenges of Seismic Risk Mitigation and its Communication:
https://youtu.be/bEkSHpttlh4 (46 mins.)

Fig. 3a.4: *Some of my interview partners*

3a.3.2.3 Reflexive Photography and Photo-Elicitation Interviews

The method of *photo-elicitation* is a non-directive method that favours collaboration between researcher and respondent through the use of photographs during the interview process. It was first scientifically described by the anthropologist John Collier in 1957, who proposed a method called 'photo interviewing' in order to help a group of researchers to articulate previously taken-for-granted categories. According to Collier (1957), initiating a conversation through photographs fosters a collaborative understanding of perception. Furthermore, the author suggests that it leads to an improved quality of interviews. He observed that the 'material obtained with photographs was precise and at times even encyclopaedic; the control interviews were less structured, rambling, and freer in association [and] seemed to be governed by the mood of the informants' (Collier, 1957, p. 856).

Photo-elicitation interviews represent a means of synchronising interviewers and interviewees because 'two people standing side by side, looking at identical objects, see different things. When a photo is made of that shared view, the differences in perception can be defined, compared and eventually understood to be socially constructed by both parties' (Harper, 2002, p. 20). Pink describes the method of photo-elicitation interviews as intrinsically collaborative (Pink, 2006). Moreover, Lapenta (2011) highlights the value of image-based conversations as they can prompt subjects to explore 'the content and communicative potential of images and the subjectively and linguistically negotiated interpretations, descriptions, and meanings they invoke' (p. 202). Usually, the photographs used in photo-elicitations are made or selected by the researcher, with or without suggestions from informants on the motifs. The selection of the photographs is generally based on the researcher's assumption of what might be meaningful to the interviewee (Church & Quilter, 2021). Yet, there are alternative approaches in which the interviewees themselves take pictures or select them for the specific aims of the interview, an approach that has been referred to as *reflexive photography* (Harper, 1987). In line with Schulze (2010), I would argue that this method allows participants to better define the scope of analysis by identifying the issues themselves, encouraging a careful and self-aware image-capturing. In this regard, the approach is more suitable to meet the goal of designing a more 'people-centred' risk communication based on an assessment of user needs.

In this case study, I combined the method of reflexive photography with photo-elicitation interviews. Research participants were members from the neighbourhood initiative 'Cumhuriyet Mahallesi Sakinleri (SİTEDER)' in Sultangazi (Cumhuriyet), three members of the neighbourhood initiative 'Okmeydanı Çevre Koruma ve Güzelleştirme Derneği (OCKD)' in Beyoglu (Okmeydanı) and a father and his son in Kadiköy (Fikirtepe). It is important to outline that the photo-elicitation interviews were conducted in a group context, as the participants I worked with wished to participate collectively. In preparation for the project, a short re-description of the research project and an introduction to the methods took place, in which I shared previous photo-elicitation projects I had facilitated. Furthermore, I stimulated a conversation about the ethics of photography and gave a short explanation of the DSLR camera. As all participants had basic photography and video recording skills, they could use the camera without hindrances. Finally, all participants were instructed to take photographs (and optionally short video clips) that represented visual explorations of the following three questions:

1. What does seismic risk in this neighbourhood mean to you and your family?
2. What is your experience with seismic risk?
3. What do you think about seismic risk communication, where is it visible for you?

After the preparatory steps, a tour through the neighbourhood took place with the individual participants taking photographs or short video clips of places that were meaningful for them in response to the above-mentioned questions. Back at the location for the photo-elicitation interview, participants were asked to also research images or videos related to the theme of risk communication and risk mitigation online that they wanted to use as a basis for further reflecting on their perceptions. After these steps, the materials were watched together on a laptop in order to stimulate a recorded conversation.
During the elicitation-interviews, using the images and video clips inspired lively comments and verbal exchanges on the topic of seismic risk and facilitated a verbalisation of the often burdensome and complex themes connected to the images. In line with Schulz (2010), I would argue that this method allowed participants to express themselves more effectively, as the photographs, researched images and video files were perceived as an interpersonal and socially acceptable communication medium. In particular, the process of reflecting upon the images significantly contributed to reducing distance in the relationship with my research participants, as it created a space for a more open communication. As a result, the recordings complemented the qualitative interviews I conducted with the inhabitants in the previous interview sessions. However, although the capturing of material and the conversation about it were very informative, respondents often quickly entered into a conversation with the translator, exchanging their concerns about risk mitigation without necessarily using the photographs, images and videos. Therefore, the images often served as a facilitator for the subsequent conversation and were at times not explored in detail. However, wanting the conversation to unfold freely, I did not interfere in the engaged exchanges.

3a.3.2.4 A Transdisciplinary Workshop

After having studied the different individual perspectives of inhabitants, people involved in risk management and geoscientists, one of the ALErT field schools that took place in Istanbul was a welcome opportunity to add a further transdisciplinary perspective to my fieldwork. As part of the programme of the ITN project, members of the ALErT group received regular training, with science communication training being one course module. However, instead of offering regular technical science communication training, in collaboration with Prof. Iain Stewart I decided to set up a workshop that confronted the 12 geoscience researchers from the ALErT group with the local perspectives of Istanbul residents, with the intention of creating a space for interaction and dialogue. Based on the findings from my literature review and my research questions, the key goal of the workshop was to gain mutual awareness and knowledge of local perspectives that are generally not integrated into seismic risk communication. My role was to design a methodological framework for the workshop, to invite the interdisciplinary group of ALErT researchers and local contributors (mainly inhabitants of at-risk neighbourhoods and representatives of a neighbourhood association) and to organise the workshop (including finding an urban historian who supported the workshop), to develop different exercise modules, and to audio-visually capture and document the workshop for further analysis. In addition, I organised a series of moderated focus group discussions that took place after the workshop to more in-depth voice different topics and concerns related to seismic risk and its communication and to support a process of knowledge co-creation. The workshop included of three major elements: field visits to at-risk neighbourhoods, participant-led interviews with local stakeholders, and a roundtable debate.

In late May 2015, under the guidance of the local urban historian Orhan Esen, the ALErT group — which encompassed several members from Turkey and some who actually live in Istanbul — undertook a half-day field visit to the Urban

Renewal districts of Zeytinburnu[2] and Okmeydanı[3]. All participants were asked to do field-based interviews in the respective neighbourhoods with residents and to take detailed field notes. At important locales in the visited neighbourhoods, Orhan Esen also 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 Okmeydanı. In a 2-hour roundtable set-up, the participants had the opportunity to enter into a dialogue with Ali Çetkin, chairman of the Okmeydanı-based neighbourhood association 'Okmeydanı Çevre Koruma ve Güzelleştirme Derneği', on themes such as his and the associations' 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. During the workshop and the proceeding focus group discussions, I focused on the filming process, assisted by a local cameraman.

2 The neighbourhood of Sumer Mahallesi in the district of Zeytinburnu was described in the report of the Japanese International Cooperation Agency (JICA) as one of the risky districts in Istanbul (JICA, 2003). The Sumer neighbourhood is the oldest quarter in Zeytinburnu and the most deteriorated residential area. The seismic microzonation report highlights areas with a high risk of liquefaction and amplification of seismic shaking. The dominant form of development in Zeytinburnu is unauthorised blocks of flats on informally subdivided land. Although all technical and engineering services were avoided at their inception, a minor part of this stock experienced legal registration after 1984, with the consequence that these already risky buildings were extended. Zeytinburnu was a pilot district for urban renewal, led by the Istanbul Metropolitan Municipality in cooperation with the Istanbul Public Housing Corporation (KİPTAŞ) and contractors (Alpay, 2012; Balamir, 2005). For the contractors to finance the construction of the new allotment and generate a profit, the density in the Urban Renewal area was increased. Former residents of the reconstructed buildings were offered apartments 30% smaller than their old homes as a share. These smaller but modernised apartments were given to the former residents for free, but they have to pay a fixed fee for amenities comparable to rent, which 60% of the former residents cannot afford (Ozcevik et al., 2007).

3 In 2012, Beyoglu city council members declared Okmeydani as a 'first-degree high-risk area'. The decision was made under Law No. 6306 on the restructuring of areas at risk of natural disasters. Following the declaration as a high-risk area, a $400bn project was announced together with the plan to demolish and retrofit all buildings that were not prone to earthquakes. Okmeydani is in a central position and has one of the highest land prices in Istanbul. As a district near the city's Golden Horn estuary, Okmeydani is affected by large scale transformations since 2005. Under law 5366, with the formal name 'Preservation by Renovation and Utilisation by Revitalising of Deteriorated Immovable Historical and Cultural Properties', the transformation project was initiated to protect Okmeydani's historic archery steels from seismic risk. In this context, larger residential areas were demolished to generate space for the historic steels. Major civil protests accompanied these processes (Ökten et al., 2021). Okmeydani is a working-class district, and the neighbourhood consists mainly of informal housing. It has many socio-economically weak inhabitants and is home to a Kurdish community (Arslan, 2014).

Fig. 3a.5: Pictures of the field trip (from top left to bottom right) 1) Orhan Esen answers interview question in the demolition area of Zeytinburnu 2) Participant-led interview with resident 3) Newly constructed buildings in Zeytinburnu 4) Demolition area in Zeytinburnu 5) Participant takes field notes 6) Roundtable-conversation in the neighbourhood centre in Okmeydanı

3a.3.2.5 Focus Groups

On the back of the field visit designed to take the geoscience researchers to the edge of their academic 'comfort zone', I organised two 90-minute focus group sessions to explore the perceptions and attitudes of the ALErT investigators to the prospect of communicating their science in more 'people-centred' ways as suggested by SFDRR. Through the support of the local cameraman, I was also able not only to record both focus group discussions but to also create an inventory of the discussion positions of the group, which were later structured on a flip-chart. 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. The initial focus group discussion took place on the afternoon of the field visit and aimed to provide the 12 participants of the ALErT group 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 and georisk communication. At the end of the field school, a second focus group was organised to elucidate the groups' reflections on more effective approaches of communicating hazard science to at-risk communities. Both groups were structured around a set of pre-conceptualised questions, but the discussion itself was free-flowing.

The insights generated in the context of the two focus group discussions as well as the voiced concern of ALErT participants regarding a lack of training motivated me to collaborate with the group in the context of the prototype developments (see Chapter 3b).

Fig. 3a.6: *Focus groups*

3a.3.3 Phase 2: Evaluation of Fieldwork Data

The evaluation of the comprehensive fieldwork data took place through a lively interplay of two methods that I will outline below: A) an analysis of the audiovisual research data and the generation of edited sequences and videos, and B) a thematic analysis in which I analysed all verbal contributions of my research participants. The combination of thematic and timeline-based analysis helped me to determine patterns and allowed me to conduct an insightful evaluation of inhabitants' and geoscientists' views on the risk communication situation in Istanbul as presented in Section 3a.4 and 3b.1.

3a.3.3.1 Analysis of Audiovisual Research Data

In total, 90 hours of (audio-)visual recordings were generated, encompassing 13 hours of workshop recordings and 77 hours of ethnographic field recordings. Furthermore, around 300 photographs were generated in the framework of the reflexive photography exercises. For the viewing, analysis and editing process, I used the editing programme Final Cut Pro X. The comprehension, structuring, and interpretation of the (audio-)visual material and the photographs was facilitated through an ongoing interplay between thematic analysis (see below) and the exploration of the many dimensions of meaning incorporated in the audiovisual footage. This led to an intense editing process, including a detailed structuring and categorisation of the findings (Knoblauch & Schnettler, 2012), in which the different subcategories of the thematic analysis were also used to generate thematic timelines in the editing programme. Creating edited sequences also involved creative experimentation with the film material in which my subjective position and my own creativity played a significant role in generating more open-ended, polysemic observations of seismic risk. The evaluation process took place throughout the entire fieldwork phase, as the fieldwork was not divided into a strict 'data collection' and 'data analysis' phase (Pink, 2009).

Analysing the film material beyond the verbal contributions of my research participants allowed me to reflect on other important sources of meaning that complemented the thematic analysis. For example, the footage generated during participant observations served for the creation of more 'place-based', locally embedded imagery and helped me to understand the multi-sensory experiences gained in the respective locations. Furthermore, I focused to a large degree on how the urban renewal areas were visually captured by my research participants during the reflexive photography exercise and elicited in the interviews, my research participants' contributions in the form of their image selections regarding risk communication, and the emotional and gestural expressions during the qualitative interviews. In addition, I analysed the modalities in which the participant-led interviews by the ALErT researchers were being conducted, what places they chose for the interviews, or the level of engagement, feelings, and the atmosphere of the focus group discussions. Additionally, the analysis of film material provoked a critical reflection on my own involvement and presence as a visual anthropologist in the research process (see Chapter 2.3.2.5).
Below is a selection of thematic sequences as well as more substantial edited films that were created both during and after my fieldwork. These links are also inserted in Section 3.4 to further illustrate and expand my findings.

3a.3.3.2 Overview of Edited Sequences

Thematic Work-in-Progress Sequences

Interview sequence with longer statements of individual informants that summarise the different views on the conflict around risk mitigation and contain some of the major thematic threads that I derived from the analysis of the interviews:

Challenges of Seismic Risk Mitigation and its Communication *(46 mins.): https://youtu.be/bEkSHpttlh4*

Combined interview sequences on distinct topics and concerns that already create a form of 'dialogue' between the separate statements of my research participants:

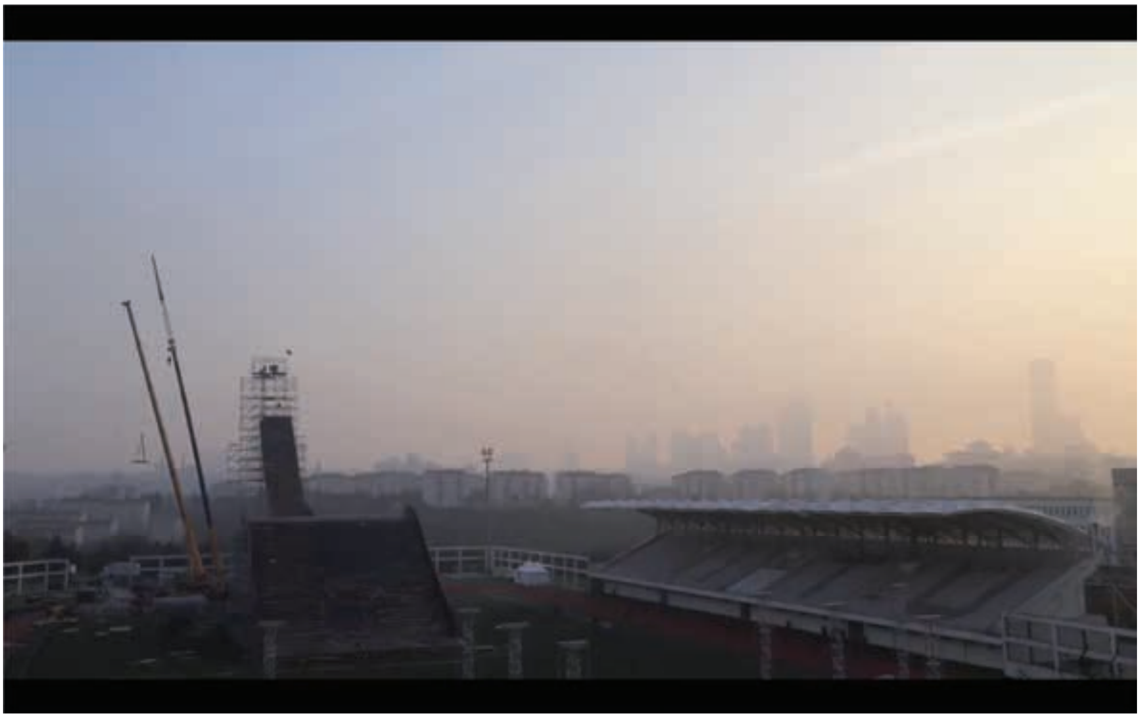
***The Communication of Contested Geoscience—The Example of Seismic Risk Communication in Istanbul** (8.20 mins.): https://youtu.be/2JhcsEE6wGA*

More substantial edited films

A trailer and two short video essays, in which I playfully combined audiovisual footage from the participant observations, participant-generated footage as well as off commentaries and interview extracts:

"From Matters of Fact to Matters of Concern". *Project trailer about the transdisciplinary workshop (for the communication of the research project) (3.20 mins.): https://youtu.be/_nzD5o6OEnM*

The Seismic Vulnerability of Istanbul *(2 mins.): https://youtu.be/97a3b9Lom_0*



Short essay that summarises first participant observations in the neighbourhood and that already contains images that my research participants contributed:

Istanbul Impressions *(4.36 mins.):*
https://www.youtube.com/watch?v=StWWSA7ydfM

The process of editing the photo-elicitation videos took place during fieldwork and led to an intense exploration of the generated data, deepening my understanding of the questions listed in Section 3a.3.2.3 from a more holistic perspective. In total, I edited three photo-elicitation videos of 4–9 minutes length in which I used the material from the elicitation-interviews and participant-generated visual materials. In the case of Okmeydanı, I added further images from the workshop (see below) after having discussed this step with research participants. Furthermore, I added atmospheric sounds in these videos that I recorded in the respective neighbourhoods.

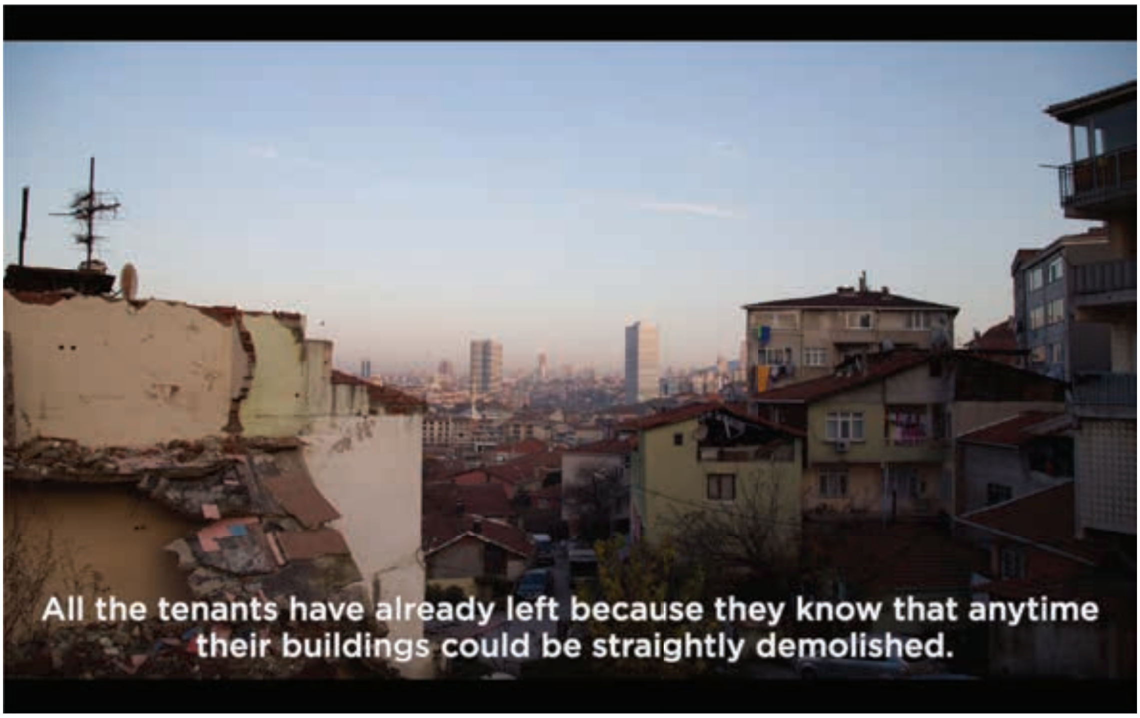


Photo-Elicitations with Inhabitants of Fikirtepe (Kadiköy) *(4.09 mins):*
https://www.youtube.com/watch?v=t-Yf4LHXgek

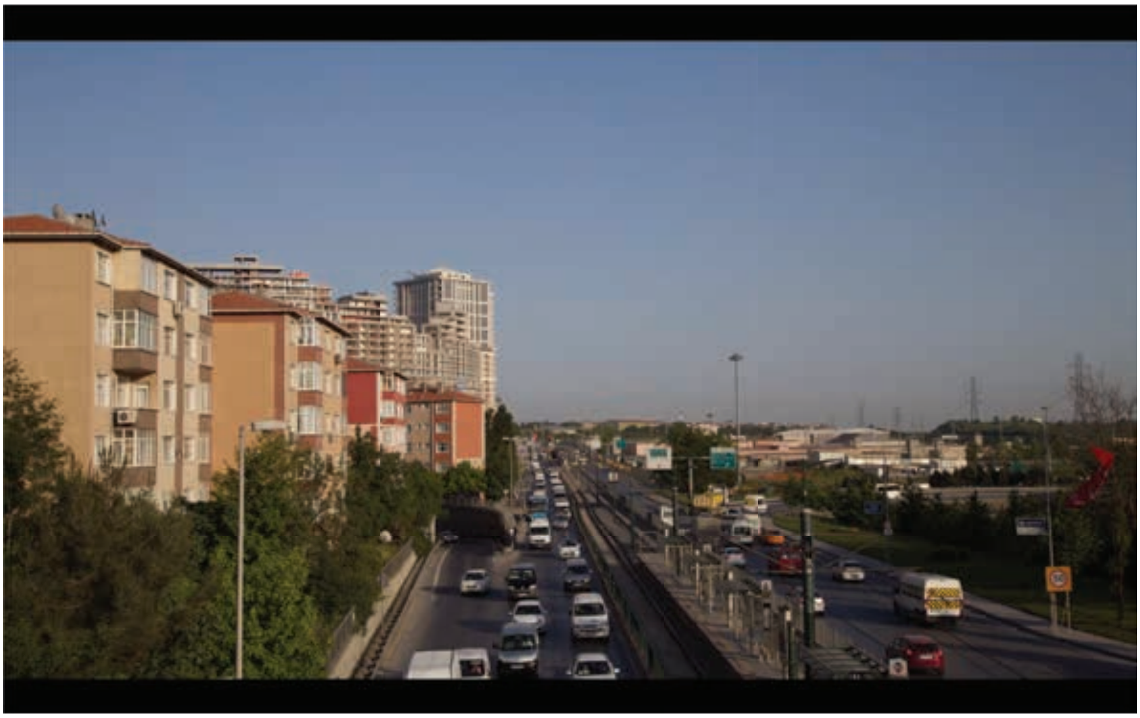


Photo-Elicitations with Inhabitants of Cumhuriyet Mahalesi (Sultangazi) *(6.24 mins): https://www.youtube.com/watch?v=KTeZt3OgCLc*

Photo-Elicitations with Inhabitants of Okmeydanı (Beyoglu) *(7.48 mins):*
https://www.youtube.com/watch?v=KPb62UkSNhE

As outlined in detail in Chapter 2, I shared and discussed sequences and videos with my research participants, asking for their feedback on the final versions and securing their consent to use them. However, a major shortcoming was that the process of knowledge co-creation and the degree of participation of my research participants was restricted, as the editing process was not sufficiently co-creative. This methodological weakness I will address and critically discuss in Chapter 4.

3a.3.3.3 Thematic Analysis

Parallel to the analysis of video- and photography footage, all filmed interviews and workshop conversations were transcribed. Based on the transcribed data, a thematic analysis was carried out, as the primary intention was not to test a theory but to descriptively form a picture of how the themes of risk mitigation and risk communication were reflected by research participants. Their responses were coded manually based on recurring and common themes from sub-categories (Boyatzis, 1998). For the contributions of inhabitants of at-risk neighbourhoods and local stakeholders involved in risk management, these categories were the perception of seismic risk mitigation in Istanbul, the perception of seismic risk communication (including their user-needs and wishes towards risk communication), their own degree of seismic preparedness, and their views on the role of hazard scientists. For the local geoscientists from

Istanbul and the geoscientists from the ALErT group, these sub-categories were their definitions and their views about seismic risk communication (in light of the workshop), their perceived role and responsibility as risk communicators, and their suggestions about methods for a more 'people-centred' approach in line with the Sendai Framework.

3a.3.4 Phase 3: Conceptualisation and Production of Risk Communication Prototypes

As one of the objectives of this case study was to conceptualise (and if possible, produce and distribute) audiovisual post-Sendai risk communication prototypes based on an analysis of the visual and verbal ethnographic findings, and as the transdisciplinary workshop and the focus group discussions were well received by the ALErT group, the work on this project phase started shortly after the Istanbul workshop and was inspired by it.

Given that the members of the Okmeydanı neighbourhood initiative and inhabitants from Zeytinburnu had generously shared their knowledge with us, and given that in the case of Okmeydanı the request for geoscientific support and collaboration was clearly formulated, the question arose as to how seismic risk communication could contribute to improving the situation. As already outlined in Chapter 2.3.2.1, it was difficult to maintain the same level of cooperation with residents from at-risk neighbourhoods after I left Istanbul. Therefore, I decided on an approach of co-producing the prototypes with interested participants of the ALErT group as well as a motion graphic designer, while integrating the feedback from my research participants from Istanbul. In total, two male and two female participants from the ALErT group participated, among them two Turkish geoscientists. A series of project meetings took place, in which the findings from the transdisciplinary workshop, the results of the focus group discussions, and also my own fieldwork results were recapped and fed into the discussion. All participants shared an interest in further exploring and creating more actionable and 'people-centred' storytelling formats based on the voiced requirements of inhabitants of at-risk communities. As we created the prototypes remotely, the collaboration took place mainly through online collaboration tools, such as google docs, Slack, and Skype.

During the initial meeting, we created a list of 'guiding principles' with important aspects to consider for the joint prototype development. Further, I contributed a simplified visualisation of my preliminary research findings in the form of a table that contained, among others, central quotes from my ethnographic fieldwork, inviting the ALErT participants to discuss these and to add their comments and views. In the framework of several virtual meetings, idea sketches for two prototypes were elaborated: The ArcGIS StoryMap 'From Matters of Fact to Matters of Concern' (Prototype 1), and the motion graphic animation 'The North Anatolian Fault' (Prototype 2) (see Chapter 3b for a more detailed presentation of the results).

The most intense collaboration took place during the joint idea generation, which involved several brainstorming techniques (Wilson, 2013), as well as the development of moodboards, storyboards, and — for Prototype 2—character development (Mou et al., 2013). While the ALErT researchers were giving advice for the correct wording and depiction of the geoscientific parts of the film and provided scientific visualisations for a motion graphic designer, the final implementation of the production was, however, to a large degree realised by me, writing the voice-over script based on my research findings, creating the final storyboard, providing a detailed briefing for the motion graphic designer, and coordinating the speaker and the sound-designer. Furthermore, I shared the different stages of the film with both ALErT participants as well as with research participants from Istanbul to gather and incorporate feedback. Finally, I was also responsible for the translation and the distribution of the film.

Regarding the ArcGIS StoryMap, a collaboration with a female ALErT researcher from the area of hydrogeology took place. Although being specialised on flood risk, the seismic risk of Istanbul was of strong interest to her as she was familiar with the tense conflict around the seismic risk mitigation processes in Turkey. After joint conversations on how to translate the findings of the workshop into a Story Map and after setting up a first project outline, she focused on the acquisition of GIS data and consulted me regarding geoscientific questions, while I prepared the video content and the first texts for the portal. Complications arose, however, as we faced significant difficulties in obtaining the respective GIS data from Bogazici University and the Istanbul Municipality. We received some GIS data sets, however not the ones concerning the seismic risk of the respective areas. A project poster as well as a detailed draft for the Story Map exists, however so far without the necessary risk maps.

3a.4 Empirical Findings from the Ethnographic Fieldwork

The following section will outline the key topics and concerns that emerged through the combination of visual and verbal methods during my ethnographic fieldwork. In order to provide direct insights into local perspectives relevant to consider when developing AV strategies for and with at-risk communities, I will provide video links and images, as well as key research participant quotes from the interviews, the transdisciplinary workshop and focus groups, and the photo-elicitation interviews. Section 3b.1 will then synthesise — based on conversation extracts from the focus groups with the ALErT group and further interviews with geoscientists — the major aspects and recommendations regarded as relevant to consider when approaching a post-Sendai risk communication.

3a.4.1 Side-Effects of Urban Transformation on Disaster Preparedness

The dramatic transformation of the gecekondu districts was noted by all research participants from the at-risk neighbourhoods and other local interview partners, who acknowledged the seismic threat as the main official argument for the Urban Renewal projects and the laws that enabled them, as illustrated by the following responses:

> I can say that the City Planning Law no. 5366 was the first step to use the pretext of earthquake safety to render urban space and the natural landscape with its diverse habitats to market objects. The law for the renovation and revitalisation of degraded historical and cultural property. [...] Law No. 5366 is a typical neoliberal law. In which the neoliberal state makes legal irregularity and arbitrariness the rule [...] this law is mainly justified by the earthquake risk. (Can Atalay, Lawyer for the Union of Chambers of Turkish Architects and Engineers (TMMOB))

> 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 sports area before. (Sedat, Inhabitant Zeytinburnu)

In the case of Zeytinburnu, although living conditions in the new apartment blocks were regarded as now being ‘comparable to European standards’, the construction of large multi-storey 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)

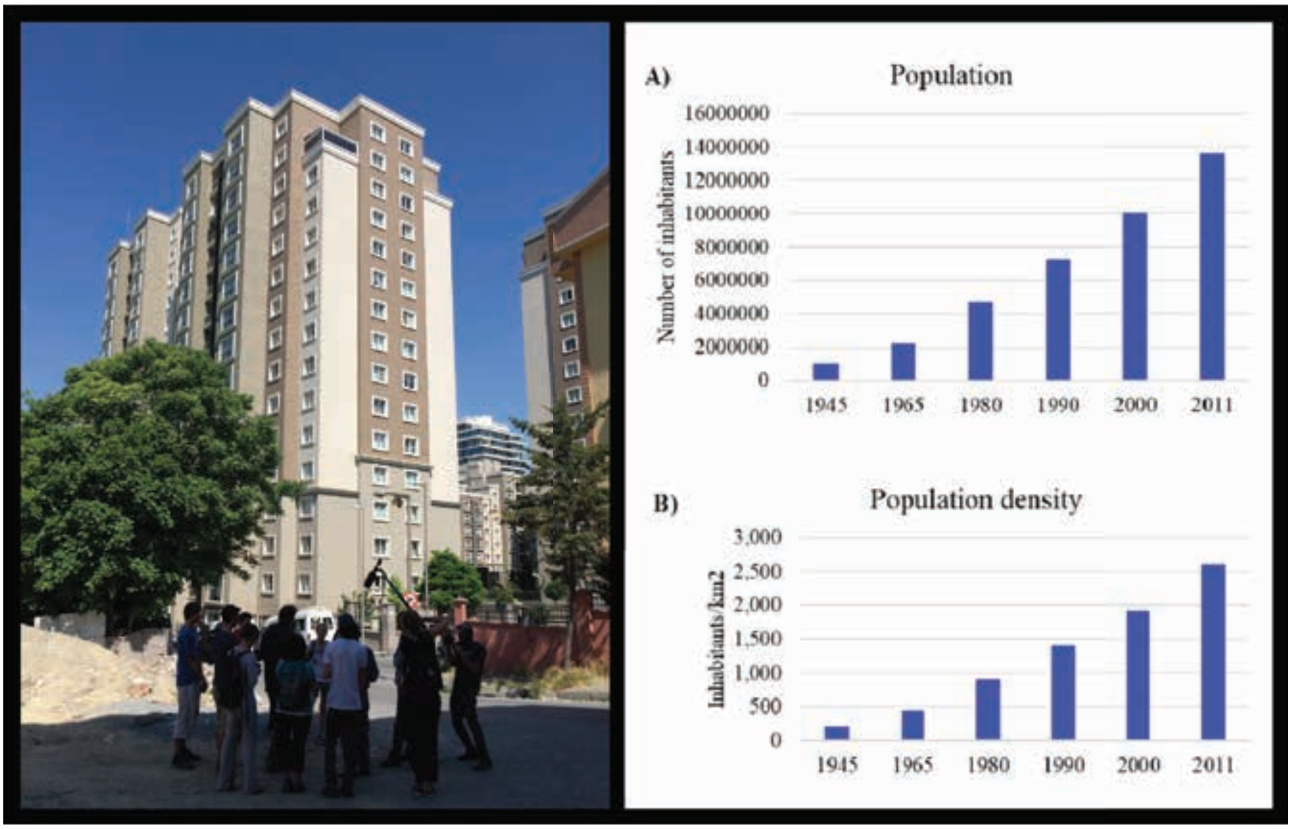


Fig. 3a.7 (left): New constructions in Zeytinburnu, (right): A) growth of population and (B) increase of population density of Istanbul. Data analysed from 1945 to 2011 (adapted from Calò et al., 2015)

Moreover, the urban renewal measures were regarded by interview partners as dramatically changing the atmosphere of the neighbourhood. Images generated during the reflexive photography exercises were interpreted in the photo-elicitation interviews with terms such as 'destructive', 'bewildering' or 'lonesome'. However, interview partners from Fikirtepe district described what was depicted also as a 'relief', as for them it was a 'necessary modernisation' and 'cleaning'. However, one of the two Fikirtepe interview partners described his disorientation, as follows:

> Once the construction work started, I had difficulties in finding our house again. Everything looked different as streets and houses were missing. (Ahmed, Inhabitant Fikirtepe)

Fig. 3a.8: Photographs taken during reflexive photography exercise in Fikirtepe

Furthermore, the construction of new high-rise apartment blocks, shopping malls, or private car parks was criticised 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. (Ali Cetkin, OCKD)

> There are designated evacuation areas, but they are used for other purposes despite their designation. (Güzel, Okmeydanı)

In addition, the disregard of ecological conditions was regarded as a significant shortcoming:

> They say that it is development, but later we found out that it is just destroying our nature. (Suleyman Sahin, Inhabitant Gaziosmanpaşa)

In addition, several interview partners 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 modernised, earthquake-proof apartments, residents reported unintended social side-effects of a risk reduction strategy focused mostly on physical measures:

> The social dimension has been neglected continuously and persistently in the discussion on earthquake safety and the design of the mitigation measures. (Can Atalay, TMMOB)

> 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)

> You and your neighbour have been living in a house for tens of years, and suddenly he or she disappears. This changes the social life of the neighbourhood. And this changes the solidarity, but during the disaster, the most necessary thing is solidarity. (Cengiz Yildirim, geoscientist)

> Peoples' needs should be consulted to prevent unfair outcomes or a destruction of social networks. (Abdul, Okmeydanı)

In the case of Fikirtepe, where Urban Renewal projects take place on an area which extends 1.3 million square metres, my respondents described an increased social pressure within neighbourhoods, as some owners sold their buildings for higher prices than others, or as some refused to sell their property and therefore were criticised for slowing down the transformation process.

This change of atmosphere in the neighbourhood can be understood through the following photo-elicitation video with inhabitants of Fikirtepe (Kadiköy), who made photographs and short video stills of their former 'mahalle' (Turkish for neighbourhood) as well as provided video footage from their internet research.

Link to Photo-Elicitation: https://youtu.be/t-Yf4LHXgek

The fragmentation and dissolution of community cohesion being described in these interview statements are themes already apparent in previous attitudinal surveys, with Joffe et al. (2010) 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.' (p.676)

In Okmeydanı, a loss of cultural heritage, a disappearance of the original character of the Mahalle and of the collective memory of the local population was observed, with an impact on the cultural identity of the neighbourhood:

> They destroyed all of what was here. This is a former pastoral bathhouse; 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. (Ali Cetkin, Neighbourhood Association Okmeydanı Cevre koruma ve Güzellestirme Dernegi (OCKD))

Another major issue in the context of the districts' modernisation is the constant fear of the inhabitants being displaced. According to Orhan Esen, only 30-40% 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 are not qualified for the job market either. 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)

This fear of displacement becomes particularly apparent in the following reflexive photography exercise and photo-elicitation interview conducted in the neighbourhood of Cumhuriyet in the district of Sultangazi. The Turkish Council of Ministers declared the sites where nearly 6 thousand people live as a risky area. However, according to the JICA report (2010) and to AFAD (Turkish Disaster and Emergency Management Authority), the neighbourhood was not in a 1st-degree earthquake zone due to its solid ground. In addition, after the Kocaeli earthquake, none of the buildings showed any harms. The inhabitants of Cumhuriyet made available important documents, such as consent forms given to them by the municipality for immediate expropriation or the 'risk maps' they were provided with, that — according to researchers form the ALErT group — significantly lacked scientific accuracy as they were not referring to preexisting research let alone peer-reviewed publication. The following video is based on the findings from the reflexive photography exercise and the elicitation interview with research participants from the neighbourhood association SİTEDER:

Link to photo-elicitation video of Cumhuriyet Mahallesi (Sultangazi):
https://youtu.be/KTeZt3OgCLc

3a.4.2 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 from local communities in the planning process and in regeneration activities. This became particularly apparent in the neighbourhood of Okmeydanı:

> 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. (Ali Cetkin, OCKD)

The following photo-elicitation video with Inhabitants of Okmeydanı highlights this persistent lack of consultation:

Link to photo-elicitation video of Okmeydanı (Beyoglu):
https://youtu.be/KPb62UkSNhE

In the elicitation interviews, my respondents from the Okmeydanı neighbourhood association were drawing on information campaigns initiated by the municipality and presented corresponding leaflets. They described those leaflets as illustrating the goal of these campaigns to create public acceptance for mitigation measures rather than creating opportunities for open, critical discussion. Further, they criticised a one-sided orientation and a social pressure that emerged from these events, where the panel guests 'talked the entire time' and would not enable citizens 'to ask critical questions'. These experiences contributed to a growing distrust in the authorities responsible for the mitigation process, who were criticised 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), who document widespread complaints of corruption in the political sphere and in the construction sector, the commercialisation of urban development and a marginalisation 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.

Fig. 3a.9: *Images of marketing campaign for the urban transformation project in Okmeydanı*

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

> Ali Cetkin: 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 makeup. 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?
>
> Ali Cetkin: 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 measurement 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 to do anything 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), suggesting that, due to the fundamental affective dimension of trust, individuals may feel more at risk if their trust in experts is lacking or damaged. 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. This can be read in line with Lee and Yamori (2020), who outline that the fact that local residents tend to define disaster prevention and recovery work as the responsibility of experts and the government are a result of the traditional framing of disaster education as a one-way communication process.

3a.4.3 Perceptions On the (Audio)Visual Language of Seismic Risk Communication

Following on from perceived lack of trust in the authorities outlined above, residents also expressed a lack of trust in most risk communication published by public institutions and in media reporting. Most of the risk communication that was actively noticed by my respondents was from urban renewal marketing, television, insurance companies and sometimes from public campaigns. As one of my respondents pointed out:

> The theme of risk mitigation through urban transformation was mainly] popularised [...] with the help of the media. Nowadays, for a TV channel to exist, it all depends on how much it earns from ads. When you are watching TV, the only ads you are seeing are housings and transformation ads. (Mücella Yapici, TMMOB)

Insightful were the findings that were generated through the use of visual methods. In order to learn more about my respondents' perception of risk communication, I asked them in the framework of the individual interviews to provide me with examples of risk communication that they notice in their everyday life. Most participants chose to use images to document their perceptions. An aspect many respondents were concerned with was the visual design of current risk communication. Widely claimed was that usually fear-based appeals and highly stylised images are being used that are detached from the domain of lived experience, as these quotes illustrate:

> In a way, these are pictures that we know too well, but that have little to do with our everyday life. But many of us have this "earthquake ticking" in our backhead as we witnessed the Kocaeli earthquake, so it immediately triggers emotions. (Olcay Bingöl, Inhabitant of Beyoglu)

> It is wrong to focus only on the stability of the buildings. If we want to save the lives of people, we should look at other aspects as well. (Hatice Kursuncu, Social Innovation Platform 'IMECE')

> Mostly, we see those pancaked-houses and rubble, but for example during the Kocaeli earthquakes, 50% of the people died because of non-structural things, like falling wardrobes, mirrors and so on. (Gülüm Tanircan, Kandilli Observatory and Earthquake Research Institute (KOERI))

***Fig. 3a.10:** Image selection of respondents for photo-elicitation interviews*

The quote above exemplifies that rather than showcasing the habitual, mostly unreflected, everyday life patterns (such as not attaching shelves, not knowing ones neighbours etc.) the current risk communication sets the focus on fear-based approaches focusing on the vulnerability of the built environment. This is problematic in a dual sense: Firstly, it neglects the fact that non-structural mitigation measures in the realm of household preparedness can have a significant impact on increasing household resilience (Becker et al., 2012). Secondly, as outlined by Solberg et al. (2010), fear-based images are problematic, as they do not contribute to increased risk perception and interfere with the communication and adoption of disaster preparedness recommendations if not being combined with efficacy messages. By the same token, it can be argued that such efficacy messages are widely lacking in risk communication as messages are usually not accompanied by location data, further links, authorship, or actionable approaches as suggested by Wood et al. (2012). Moreover, according to one of my interview partners, current risk communication does not show ‘people you feel close to’ or people who act as positive role-models. As such, current risk communication lacks transparency, legibility and also usability. In addition, although the images associated with risk communication were described by some of my respondents as ‘compelling’, they did not seem to motivate precautionary actions, as this quote illustrates:

> Of course you look at it these pictures because they are so catastrophic. And then you just pray that this won’t happen to you. (Suleyman Sahin, Inhabitant Gaziosmanpaşa)

On the one hand, such catastrophic images can be perceived as an aesthetic stimulus, as they render images of seismic catastrophes into artistically pleasing depictions. On the other hand, these images, as shown in the quote above, also leave audiences with feelings of fatalism and in the position of ‘passive’ or neutral victims. Furthermore, they obscure the accountability and responsibility behind these catastrophic depictions and tend to create a ‘we-mode’ in which the viewer often can only perceive a collective fate rather than the real sources of the disaster or his or her agency (Demos, 2017). For example, interview partners from Fikirtepe stated that after an unplanned period, a ‘necessary modernisation’ takes place, without critically interrogating the processes behind it. The project was regarded as an improvement despite the many side effects outlined in the photo-elicitation interview. The advertisement clip shown in the photo-elicitation video was regarded as a positive example of such a modernisation. On the other hand, other respondents stated the following about images associated with risk communication:

> You look at it as if it is Hollywood, but it is real. (Hatice Kursuncu, Social Innovation Platform ‘IMECE’)

This quote also illustrates that in their ‘monumentality’, the images evoke feelings of disinterest, anxiety or simply neutrality because nothing new is being presented. For example, one respondent described the two poles of 'destroyed houses' or 'Ottoman empires', which gives hints for these stereotype depictions. In some cases, such images potentially trigger the idea that those people showcasing these images have indeed the same 'strength' to master the solution to this catastrophe. As overloaded as the images of destruction appear the images of the 'solution' in the form of assimilated, gentrified neighbourhoods cleaned from any natural forces. These images create a closed system of a city that is no longer a public space governed by negotiation, city planning and jurisdiction, but a system subject to a constant threat and emergency situation because of which means have to be undertaken to manage and 'improve' the whole of the city along one logic.

Fig. 3a.11: *Image used during photo-elicitation interview—Tarlabasi before and after the urban renewal project*

Finally, in line with Ferreira (2004), I would argue that these risk visualisations co-structure the larger contexts within which notions of risk and trust unfold and play an active role in how the risk mitigation process is perceived. The currently used imagery in Istanbul does not contain images of everyday responsible behaviour, but rather ideological images with a pretence of controllability through hard infrastructural measures, often using fear-based approaches and obscuring the sociocultural and ecological side of risk mitigation. It avoids the visualisation of local realities, of bottom-up prevention strategies, or the provision of meta-data.

3a.4.4 Perceptions On the Content of Risk Communication

The perceptions of the content of risk communication are similar to those of the visual language of risk communication. For example, one interview partner from Okmeydanı stated that risk communication through the municipality is driven by interests of the private sector and does not provide sufficient information on preparedness measures:

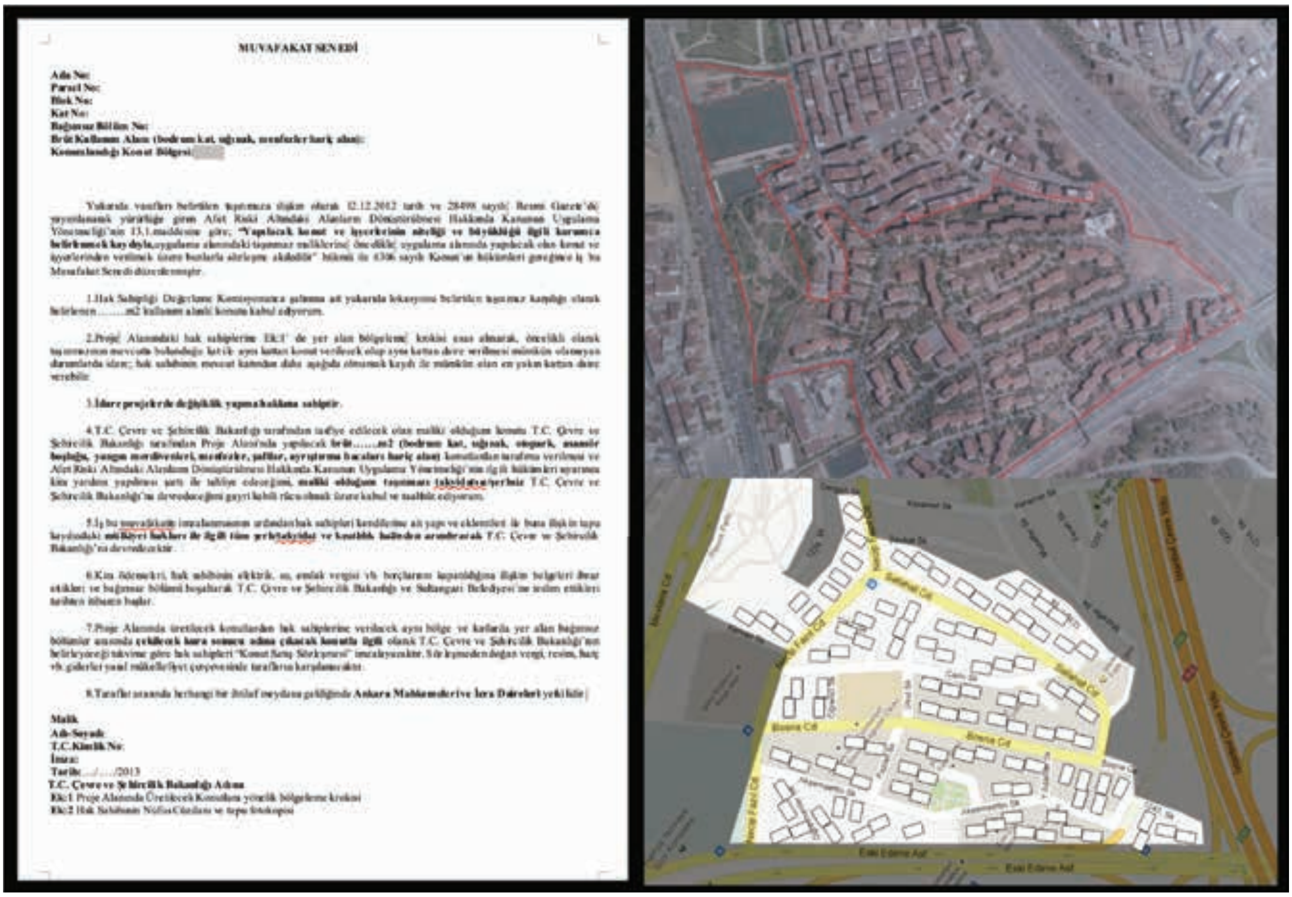
> We are not informed at all. What we believe is that the earthquake is just used as an alibi, as an excuse, as a pretext. The term earthquake doesn't point to the real thing. The real thing is that they want to acquire this very precious land here. (Ali Cetkin, OCKD)

Another argument was that scientific research and conclusions were viewed to be frequently and widely misrepresented in media coverage, usually by heightening the consequences and not providing sufficient information on what to do about the risk. Other complaints, as already noted above, 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. Interview partners who were experts in the field of seismology outlined this shortcoming:

> I know that this early warning program was developed. Whether that is operational, I do not know. [...] As a citizen of this city, no one has told me anything about that. But I should know this! I have no idea where I should go when the earthquake happens. For example, where will be the mobile hospitals? I have no idea! In my area, where should I go? There are earthquake assembly places. What do they mean? I have no idea! Where will I get my bread? I have no idea! It is said that these informations are online. If I search for it online, I cannot find anything! (Ali Mehmet Celâl Şengör, geologist)

Furthermore, inhabitants expressed confusion about the role and responsibilities of the institutions in charge of risk mitigation. In Okmeydanı as well as in Cumhuriyet, there were specific complaints about a lack of transparency and scientific evidence for the municipalities high-risk designation of the neighbourhood. This is reinforced by the findings of Angell (2014) and Eren & 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), a finding that is also supported by inhabitants of Sultangazi and Okmeydanı:

We were shocked to find out that our neighbourhood has been labelled as a risk zone. [...] According to the JICA report, our area was one of the most durable in Turkey. (Lütfü Durmaz, member of the neighbourhood organisation SİTEDER)


MUVAFAKAT SENEDİ

Ada No:
Parsel No:
Blok No:
Kat No:
Bağımsız Bölüm No:
Konumlandığı Konut Bölgesi:

3.İdare projelerde değişiklik yapma hakkına sahiptir.

8.Taraflar arasında herhangi bir ihtilaf meydana geldiğinde Ankara Mahkemeleri ve İcra Daireleri yetkilidir.

Malik
Adı-Soyadı:
T.C.Kimlik No:
İmza:
Tarih: ..../..../2013
T.C. Çevre ve Şehircilik Bakanlığı Adına
Ek:1 Proje Alanında Üretilecek Konutlara yönelik bölgeleme krokisi
Ek:2 Hak Sahibinin Nüfus Cüzdanı ve tapu fotokopisi

***Fig. 3a.12:** Documents of the neighbourhood association SİTEDER: Letters of consent (including expropriation threats if not signed) (left), the municipalities' risk designation of the neighbourhood (right)*

The following exchange from the field excursion to Okmeydanı provides similar insights:

Participant 3: These houses are safer than others?
Orhan: Supposedly, officially. By the very official discourse they are.
Participant 5: Is there also more safety during earthquakes?
Orhan: I cannot say. The official justification for this project is that this mitigates the risk. [...]
Participant 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)

Participant 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?
Ali: 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.
Participant 10: But science comes mainly from universities, and the universities are mainly driven by the government. So it is a paradox. [...]
Ali Cetkin: 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.

Unsatisfying attempts to gain valid information about the risk designation 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. (Ali Cetkin, OCKD)

The Okmeydanı-based neighbourhood association expressed their wish for a closer science-public-collaboration, and outlined their goal of preparing and promoting a planning process that 'incorporates the idea of risk mitigation'. Similarly, an interview partner from Gaziosmanpaşa outlined that citizens would not oppose a reconstruction or retrofitting of their houses to increase seismic safety, but would oppose their exclusion from the mitigation process:

> Of course, we, the local people, want to live in good and safe conditions. But we want to be in the plans, not out of the plans. (Suleyman Sahin, Inhabitant Gaziosmanpaşa)

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. (2012).

> Participant 8: What would change if we [as independent scientists] would say that this is indeed a high-risk area?
> Ali Cetkin: 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 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.

However, several respondents outlined obstacles to this science-public collaboration, highlighting that more collaborative efforts are needed to confront the current situation:

> Unfortunately, right now, in decision-making, the separation of different professions and individuals has distorted the moral relationship between them. Therefore, me – as a person responsible for urban planning and architecture, would like to say to you — the geologists — the following: If we really don't want the earthquake, which is a natural phenomenon, to turn into a disaster, then we must unite our efforts. (Mücella Yapici, TMMOB)

Ali Cetkin described how the Okmeydanı neighbourhood organisation already consulted geoscientists from universities to obtain scientifically valid information. Yet, the exchanges were described as problematic. Factors identified were problems to understand the scientific terminology and difficulties to extract relevant knowledge for their specific locale. Additionally, the independence of some of the geoscientists that were contacted was seen as limited, as the members of the neighbourhood organisation 'never heard back from them', and as scientists they contacted 'didn't want their names to be publicly mentioned'. In the photo-elicitation video for the case of Okmeydanı, the point was also raised that scientists in Turkey 'cannot communicate freely'. This was also outlined by one of the partners from the ALErT group, who claimed that 'If you want to maintain a career and have a family, you are careful about what you say' (Interview, 27th of May, 2015).

Chapter 3b – Evaluation of Focus Groups and Prototype Development

In this chapter, I present different perspectives from geoscience participants on risk communication and outline the process of developing two risk communication prototypes.

In the following Section 1, I consider areas of concern for translating post-Sendai risk communication into practice, providing evidence in the form of interview quotes from geoscientists as well as the ALErT researchers. I will summarise how research participants think about risk communications' impact on seismic preparedness, how they reflect their role and responsibility in communicating with at-risk communities, how they would approach more integrated seismic risk communication and, for those researchers that participated in the workshop, how they experienced the personal conversations with local research participants.
In Section 2, I outline the process of conceptualising of two risk communication prototypes that took place in collaboration with members of the ALErT group, involving several feedback loops and iterations.

3b.1 Implications for Risk Communication – Views from Geoscientists

3b.1.1 Impact of Seismic Risk Communication on Individual Preparedness

The ALErT scientists who participated in the workshop were mostly familiar with the fact that a high level of risk awareness of the inhabitants of at-risk neighbourhoods is not necessarily translated into preparedness actions. Yet, the multitude of factors influencing how inhabitants ultimately perceive and act upon a seismic threat was much more apparent to the participants after the field excursion and led to discussions about the basic nature of communicating geoscience.

> Participant 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.

> Participant 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.

In addition, geoscientists I interviewed as well as ALErT researchers 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.

Moreover, Turkish geoscientists highlighted a general weakening of prevention messages after the 'window of opportunity' following the Kocaeli and the Duzce earthquake, mentioning a diminishing media coverage on preparedness actions and decreasing visibility of public education campaigns, such as earthquake simulation buses, the promotion of family action plans, or the provision of first aid containers with information leaflets in the different neighbourhoods.

> Participant 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.
>
> They have prepared emergency boxes with everything a neighbourhood would need in case of a crisis. And where are they now? [...] Vanished! [...] They were in every corner of Istanbul, and not a single one is left! (Ali Mehmet Celâl Şengör, geologist)

Turkish participants also criticised 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.

> Participant 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.

While my interview partners widely expressed their comprehension for inhabitants who cannot identify with current forms of seismic risk communication, they also criticised a lack of motivation for taking 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 of some citizens to 'listen and forget'. Turkish workshop participants also openly stated that they attributed a certain risk behaviour to a specific prevention culture in Turkey and highlighted the topic of fatalism, as this quote illustrates:

> Participant 6: When you say "There will be an earthquake", they say: "Oh, if it is going to happen, it will come from God." It is faith, and they tend not to do anything to avoid the bad circumstances of these events.

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 recognised by a broad array of research done in this field (e.g., Krüger et al., 2015; Oliver-Smith & Hoffmann, 2002; Rohrmann & Renn, 2000; Stoppa & Berti, 2013).

3b.1.2 The Role and Responsibility of Science and Risk Communicators

Despite broad agreement among geoscientists on the relevance and importance of reaching at-risk communities, there was an intense discussion about the appropriate methods and level of engagement with the public. Much of the debate, therefore, centred on the participants' individual understandings of the role and responsibility of 'geo-communicators', and the implications this has for their professional life.

> Participant 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'. The following quotes exemplify this conception of risk communication.

> Participant 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.
> Participant 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.
>
> When something occurs in the Earth or in Turkey, we don't have any responsibility. Responsibility belongs to decision-makers. Our role is to provide correct data. (Cengiz Yildirim, geomorphologist)

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'.

One of my interview partners stated the following:

> There has to be a hierarchy in the transfer of knowledge. It starts with the geoscientists who pass this on to engineers and then to social scientists who know how to communicate with the public. It has to follow that trend. If a geoscientist talks directly to the public, it doesn't mean anything. (Mustafa Erdik, KOERI)

Although people campaigned to preserve the park and the square in order to have a place of escape after an earthquake, Ali Mehmet Celâl Şengör stated that he would not cooperate with people resisting against the urban renewal processes, referring to the Gezi protests:

> If there is a demonstration [...] to save the environment, to save the trees, I don't understand what these communist or socialists flags are doing? I don't want to get identified with such people. [...] they are brainless people for me! I can't afford to appear with these people. (Ali Mehmet Celâl Şengör, geologist)

These quotations make clear that some of my research participants saw their role rather in policy advice but not in cooperation with affected citizens. For some of them, a direct engagement with residents, particularly in politicised contexts, was considered as negatively affecting their role as experts, 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 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:

> Participant 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.
>
> Participant 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.
>
> Participant 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.
>
> Participant 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.
>
> Participant 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 range of factors influence not only how risk communication is perceived, interpreted and translated by inhabitants of at-risk communities, but also by scientists. Science communication literature stresses how factors such as different norms, values, or sociopolitical contexts influence how scientists communicate, for example, institutional norms that value research productivity over other types of contributions (De Rond & Miller, 2005), or 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 further 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 (e.g., Jahn et al., 2016; Klingan et al., 2015; McDonald et al., 2019). Interdisciplinary and transdisciplinary research programmes, such as the 'Politiques de la Terre'-network in Paris, Future Earth or projects of the 'IASS Potsdam' (e.g., 'One hectare', 'Paradise Reloaded') are attempts to translate this (novel) responsibility of scientists into practice and to initiate, support and scientifically accompany shifts towards transformative science (König, 2015).

3b.1.3 Lack of Intermediaries and Interdisciplinary Collaborations

Despite different perceptions of roles and responsibilities, my interview partners agreed on the necessity of more effectively communicating with at-risk communities to reduce seismic vulnerability. Debates emerged about whether to 'pinpoint the communication talents' within the geoscience community or to engage in interdisciplinary research collaborations. One suggestion was 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'.

> Participant 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 people. We cannot communicate directly. We need a translator.

The proposal 'to use' external interlocutors to help facilitate risk 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 reporting, as this quote illustrates:

> They invited people on their programmes who are all professors, but who have never done any research on earthquakes, who have no good scientific position at all, nothing! And they presented them to the people as experts. And they said absurd things. Then the people can rightly have no confidence at all in science. (Ali Mehmet Celâl Şengör, geologist)

This scepticism towards the scientific quality of journalistic reporting 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.

The debate over the need to collaborate to achieve a more effective risk communication led to strong debates 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, thereby stressing the role of local knowledge. In particular, the role of 'Muhtars' (elected heads of the village or neighbourhood) was highlighted, citing their contribution of local knowledge and communication via their social networks.

> Participant 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, by asking 'Have you ever had any floods in this area?' It is a communication situation and you learn a lot from a person that is not a geoscientist.

> Participant 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.

Regarding the involvement of local representatives into risk communication and the attempt to jointly elaborate preparedness measures, particularly the role of creativity and experiential learning was outlined:

> Participant 1: Usually the best way to motivate people is in a playful way. It is like language learning. If you don't use the language, you forget about it.

3b.1.4 Constraints to engage in risk communication and the appreciation for transdisciplinary approaches

Contrary to the fact that scientific outreach and the active involvement of the public into the research process is increasingly obligatory in research frameworks (for example in Horizon 2020-projects), the majority of participants still perceived individual engagement as an optional, 'private' decision. For example, writing about geohazards and risks using social media channels was perceived as something associated with 'sacrificing leisure time'; answering scientific questions within social networks something that 'you simply do' because of social expectations. One participant observed that

> ideally, we should have 48 hours a day [...] to educate in schools, to educate the media, to educate politicians [...] and to learn what is relevant for them. (Participant 8)

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. For example, some of them highlighted that despite the fact of them principally wanting to engage in post-Sendai risk communication approaches, this was also associated with time and resource constraints and not being sufficiently valued by their peers, academic institutions, or funding bodies. Moreover, factors commonplace in science communication surveys were named, such as 'maintaining a career', 'time pressure', 'specialisation', 'publications mostly for academic journals' (Stewart & Nield, 2013). These findings can be interpreted in line with Bernard (2017), who describes the lack of time and space of scientists who need to respond to highly demanding and often standardised communication requirements, and that are subject to pressures from performance measurement regimens such as citation indices, impact factors, or h-index (acatech, 2017).

The above indicates a conflict between post-Sendai risk communication approaches and the demands of an ever more competitive science market on early career scientists. This helps to explain why, paradoxically, scientists place high societal value on science and risk communication whilst lacking motivation to become active communicators themselves. This discrepancy is also being described in the field of science communication training by Besley et al. (2015). The authors have undertaken an empirical study on the motivation of scientists to take part in communication workshops and found 'high ratings for the usefulness to engage the public with science, but moderate to relatively low individual and collective willingness to do so by scientists, based on moderate to low perceptions on whether outreach and engagement would be valued and appreciated' (Besley et al., 2015, p. 212).

> Participant 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.
>
> Participant 7: There is no real reward.
>
> Participant 8: Well, it depends on how you interpret reward.

It was also observed that outreach training usually focuses on the development of technical communication skills, such as a user-friendly language, storytelling strategies or visualisation techniques. These abilities were regarded as fundamentally important, but they were also considered as not sufficient for connecting with and learning from different audiences. A more user-oriented and actionable communication was seen as overly demanding because of a lack of training of how to assess different audiences' needs, how to connect with them and how to craft messages and formats that are suitable for specific audiences.

A final strong sentiment that emerged, particularly 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, to jointly address the seismic risk problem. Yet, all participants expressed their concern that the implementation of such transdisciplinary activities would not be sufficiently supported by institutional frameworks of universities or research institutes. Opportunities for mutual learning, whether by involving local practitioners or other disciplines within university frameworks, were still seen as an uncommon institutional praxis. In addition, outlined constraints regarding dialogue-based risk communication included, among others, insecurities about how to create partnerships for such exchanges, how to manage and facilitate discussions, or how to engage at-risk communities and other stakeholders for this exchange. Furthermore, most of my respondents stated that they were rarely confronted with people outside their academic realm who are affected by the impacts of natural hazards.

The focus group discussions in the context of the workshop brought to the fore a concern among the participants about 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 first-hand 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 fieldwork, 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 was viewed as a 'rather unknown territory'.

For the ALErT researchers, a transdisciplinary communication training framework as presented here was described as a 'distant ideal', and in that regard, the workshop itself was considered an 'unfamiliar event'.
It can be concluded that 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. Key issues that emerged as alternative dimensions of the seismic-risk problem — which 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 a less fear-based, more actionable and user-centred (visual) risk communication.

There was agreement among the majority of participants on the relevance of actively involving at-risk communities to achieve more 'people-centred' communication outcomes, taking into account that 'every scientist has a different level of capacity', 'ability' or 'willingness' to reach the public. Furthermore, given the variety of institutional research frameworks and different research cultures, it 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 in how risk communication is approached and designed.

3b.2 Development of Two Risk Communication Prototypes

3b.2.1 Collaboration in the Framework of a Virtual Workshop Series

The findings from the focus group discussions outlined in the preceding section demonstrate that the majority of the ALErT participants was — despite the above-mentioned points of criticism — open to further explore post-Sendai risk communication approaches. This matched to a large degree with one of my research objectives to design risk communication prototypes on the basis of my ethnographic research findings. Given the rationale of this thesis to contribute to post-Sendai risk communication not only as an individual researcher but also through dialogue and exchange with my research participants, and given the readiness of ALErT researchers to continue their reflection on novel forms of risk communication, I devised a framework for collaboration to conceptualise two risk communication prototypes (see Section 3a.3.4 for the methodology of the prototype development). As a reminder, in the framework of an initial meeting that took place shortly after the Istanbul workshop, we discussed and developed some 'guiding principles' to consider when conceptualising the prototypes (see Fig. 3b.1). In the following virtual meetings, geoscientists from the ALErT group participated actively in the development of the prototypes by contributing their geoscientific expert knowledge, but also by discussing and recapitalising their views in light of the preceding workshop and focus groups. The prototypes were created through an intensive dialogue and contained several feedback loops. At different working stages, the prototypes were shared with my research participants from Istanbul and the ALErT group.

- If hazard scientists are to engage in effective risk communication, it is vital to learn about user-needs, to take into account local information as a foundation of communication efforts, to gather feedback from at-risk communities and to evaluate the impact of communication efforts
- Scientifically accurate risk maps need to be made available and understandable to at-risk neighbourhoods
- Risk communication should be user-oriented, provide actionable risk information, and take into account the controversial nature of risk mitigation by contributing knowledge for an evidence-based dialogue
- Currently, risk mitigation currently has a too narrow perspective on technical and engineering aspects. This is why also non-structural risk mitigation should be addressed (ideally be representing someone who already successfully implemented measures)
- Fear-based approaches and stereotype imagery should be neglected
- Use of storytelling, development of personal, experience-based views on the topic and strengthening of lifeworld-approaches
- Strengthening of a female perspective on the issue of risk mitigation
- Inhabitants of at-risk neighbourhoods should be targeted directly by embedding social context knowledge and integrating local representatives familiar to audiences
- Give opportunity for more information

Fig. 3b.1: *Guiding Principles*

An important document for the workshop was a simplified visualisation of my findings from my ethnographic fieldwork. This visualisation was used to support the idea generation and the conceptualisation of the prototypes. It contained different conversation extracts that were clustered along three overarching problem categories identified during my fieldwork (including the transdisciplinary workshop and the focus groups).

Exemplary Quotes from Fieldwork Data	**Problem-Definition**
'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.' 'It is written, but there is no application.' 'For the rescue just after an earthquake we would need free spaces. So obviously the government doesn't take the risk seriously.' Panel guests (during an earthquake information event) "talked the entire time" and wouldn't allow citizens "to ask critical questions". 'We were 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.'	Current risk communication in Istanbul is seen as not sufficiently accessible, user- and action-oriented For example, seismic risk communication in Istanbul • focuses mainly on the conveyance of 'geo-facts' along the deficit-model, although it has only little or no effect on individual earthquake preparedness, especially regarding inhabitants who oppose current mitigation measures. • operates often with fear-provoking images • strongly focus on technical and engineering aspects of hard infrastructure development(Urban Renewal) and not on household preparedness • is not sufficiently user-oriented and actionable lacks of depictions of real-world settings and role models
'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.' '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.'	There is a lack of deliberative formats for knowledge co-creation and co-designing risk communication
'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 [...] but I am already in the activist part.' 'I absolutely don't feel like this – this is my scientific part and this is my human part.' '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' 'We need a bridge to communicate with the people. We need a translator.'	There is a lack of training for geoscientists to develop necessary skills for post-Sendai risk communication

Fig. 3b.2 Simplified overview of my findings from the ethnographic fieldwork

In the following paragraphs, I will outline the process of conceptualising the two prototypes, and discuss some of the limitations and shortcomings encountered.

3b.2.2 Prototype 1: The ArcGIS StoryMap 'From Matters of Fact to Matters of Concern'

Prototype 1 was intended to address two major shortcomings identified during my ethnographic fieldwork.
Firstly, a recurring concern of inhabitants of the studied neighbourhoods was the lack of scientific data, particularly regarding the contested risk classification of the neighbourhoods in Okmeydanı and Sultangazi. As more recent risk maps were not publicly available following the JICA report (JICA & IMM, 2002), the idea arose to fill this void by integrating risk maps and corresponding explanations into an audiovisual narrative context. This is why I started to research technologies for a more advanced interactive visualisation of research data and for making the consensus views of a geoscientific expert community more accessible, understandable, and actionable.
Secondly, research participants voiced a lack of communicative interfaces for a risk dialogue. Therefore, in order to apply hazard knowledge of ALErT participants and Istanbul-based geoscientist to the concerns of residents, a new communication format seemed appropriate to place scientific knowledge in relation to societal actors' local and contextual perspectives and to generate information that is 'useful, useable and used' (Aitsi-Selmi et al., 2016a, p.3).
Furthermore, one of my concerns was related to the question of how to use the generated video sequences and films of my research in line with the rationale of post-Sendai risk communcation. Although my research films attempted to communicate seismic risk in an actionable and user-centred way, and although I used participatory practices (as in the case of the reflexive photography exercises and the photo-elicitation interviews), my moving image work still conformed to a rather conventional 'one-way' form of author-driven storytelling. Moreover, as single video files, I found my work too fragmented.

In order to address the aforementioned shortcomings, I decided to develop a pilot for an ArcGIS StoryMap in collaboration with a Turkish geoscientist. This tool seemed promising, as it allowed me to combine current risk maps for the four neighbourhoods in which I undertook fieldwork with the films and materials produced over the course of my research, such as photos, links, or online materials.
ArcGIS StoryMap is particularly useful for research in risk communication because it is frequently deployed by geoscientists as a platform for visualising

geospatial information through the use of 'geographic information systems' (GIS) and enables users to capture, store, manipulate, analyse, manage and present different types of geographical data. This geo-data can be augmented by other multimedia (digital elevation models or 3D representations and remote sensing products such as satellite imagery or air photos) and combined with storytelling to make data more accessible and engaging. Importantly, the data can be continually improved, enables mutual access, and has transparent data sources, all of which can strengthen the trust of different user groups and provide the basis for the kind of multi-stakeholder knowledge exchange advocated by the Sendai Framework. GIS data is increasingly being used in scientific studies that deal with contemporary environmental trends and their future implications, including addressing themes of vulnerability and risk management (Mychajliw et al., 2015; Zolnai, 2014). Studies also outline the potential of GIS data for more participatory approaches in risk communication and for providing an effective link between coordinating and implementing local disaster risk reduction and resilience building (Heesen et al., 2014; Liu et al., 2018).
To date, there has been no research on, nor practical examples of how *video-based* StoryMaps could be applied in the context post-Sendai risk communication approaches, nor on their potential to represent findings of transdisciplinary collaboration. However, there are few studies on how interactive maps allow for more user participation and novel forms of storytelling (e.g.,Mychajliw et al., 2015; Zolnai, 2014).

Under the following link, the work-in-progress website of the ArcGIS StoryMap "From Matters of Fact to Matters of Concern" can be accessed:

Link: ***https://storymaps.arcgis.com/***

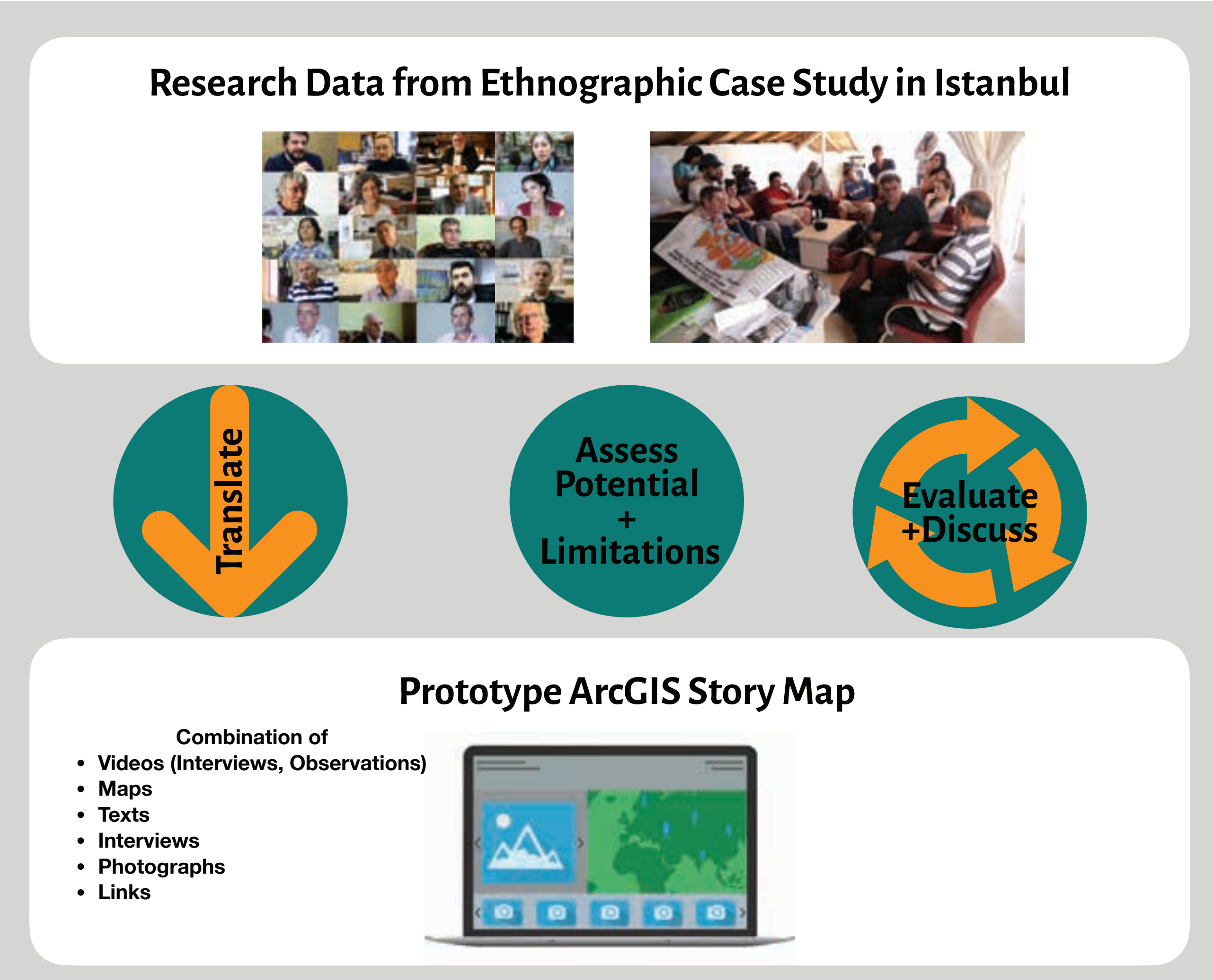


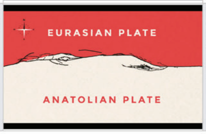
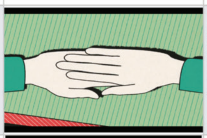
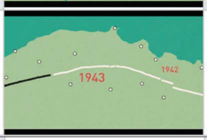
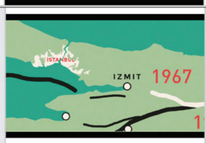
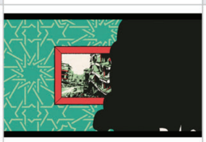
Fig. 3b.3: Illustration of Conceptual Approach for the ArcGIS StoryMap

3b.2.3 Prototype 2: The Motion Graphics Film 'The North Anatolian Fault'

A further developed prototype was the motion graphic film 'The North Anatolian Fault'. In this film, Olcay, a female geoscientist, tells us about her motivation and interest in studying the seismic risk of Istanbul and about her thoughts on seismic preparedness. The idea emerged through a brainstorming session with the participants of the ALErT group, motivated by the question of how to incorporate some of the developed guiding principles into a communication product. Most important for the generation of this film was the wish for a locally-based, personal, reflexive, and actionable communication of seismic risk as well as the wish to have an engaged and critically-minded female geoscientist as the key protagonist. Below are the links to the English and Turkish version of the film. The following storyboard demonstrates the aesthetic and narrative choices made during the production of the film.

Link to motion graphics gilm "The North Anatolian Fault" (3.57 mins):
https://www.youtube.com/watch?v=y6IxyLeoPKw&feature=youtu.be

Link to the Turkish Version:
https://www.youtube.com/watch?v=Dg4MkWV83V4&feature=youtu.be

No.	Voice-Over Text	Video Stills	Images	Comments on Voice-Over	Comments on Visual Layer and Sound Design
1	When I was a kid, I tried not to think about earthquakes. I knew they were violent and deadly.		Cansu, our protagonist, is lying on the sofa. She is looking at the ceiling lamp. Starting from her face, slowly zoom out until the whole room becomes visible.	Subjective perspective of Cansu, describing a fear that many inhabitants are familiar with and that is, however, often repressed. Allow for the interpretation that it is "immature" to suppress the topic of seismic risk out of anxiety. However, make clear that it is a fear that is absolutely understandable and legitimate.	Establish our protagonist in her everyday local surrounding; Integrate elements that create a local reference, for example local furniture. Sound of a ticking clock and a rumbling earth shifts, cracking glass
2	Many of us had experienced them in the past, yet no one really talked about it.		We now see the ceiling lamp from her point of view. The lamp starts to swing around back and forth due to seismic tremors.	Again, refer to the "seismic memory" and the theme of trauma and repression. Show understanding for the these psychological predispositions that affect many Turkish citizens.	Visualise the earthquake risk as an "active" part in the imagination of many people.
3	Istanbul, our home, is one of the most vulnerable cities in the world. There is a two out of three chance of an earthquake hitting us in the next 15 years, so we all live with this ticking in the back of our heads.		Cansu is sitting on a public bus that drives through Istanbul. We see a diverse group of people sitting on the bus (e.g. young and elderly people, woman with and without scarf etc.). In the bus windows the the cityscape is being mirrored.	Create further proximity to other inhabitants (e.g. by referring to "our home") Provide first, easy-to-understand information about the probability of a larger earthquake in Istanbul. Make use of some of the images described by protagonists ("the ticking in the back of the heads" was a quote from one of the fieldwork interviews)	Depiction of day-to-day activities. Visualise that the seismic risk in not an individual problem but a collective one. Create a direct link to the local environment. Sound of a muezzin, further city sounds (traffic, birds, people).
3	As I grew older, I started to wonder: What actually causes earthquakes? Why do they happen so often here in Turkey? That was when I started to discover the world under our feet...		Close-up of on Cansu's face. Slow movement of the camera downwards.	Embed the topic of seismic risk in the everyday life of our protagonist. Establish how direct experiences triggered a rational approach to the topic of seismic risk through scientific questioning. Show that scientific curiosity can lead to new insights and discoveries.	Visualise the connection between everyday life and the "underground". Use transitions to connect these apparently disconnected "two worlds". City sounds (traffic, birds, people) fade out and we here the sound of a something digging through the soil
5	Tectonic plates inspired me to study geology. They are ancient pieces of moving earth, millions of years old. They created Istanbul's topography and its beautiful coastline, including the Marmara Sea. You could even say that Istanbul developed as a city because of plate tectonics.		As the camera moves downwards, a visualisation of tectonic plates becomes visible : We see the Eurasian Plate and Anatolian Plate and the Faultline between them. Visualise slow movement of these plates. Transition into a further "map-layer", showing the Marmara Sea. Highlight the area of Istanbul.	Give information that might inspire the audience to learn more about tectonics. Show that particularly Istanbul citizens have a close relationship to the topic.	Establish tectonic plates not as something "instrinsically evil" as being suggested by current media depictions, but as a part of nature. Also showcase positive impacts (such as the creation of Istanbuls topography). Light drone sounds
6	But they also cause earthquakes. The most destructive quakes occur along the edges of moving tectonic plates. And in Istanbul, a dangerous fault line, the North Anatolian Fault, lies under the sea, only 20 km away. Why do earthquakes occur here?		Zoom onto Istanbul in direct proximity to the North Anatolian Fault. Visualise slow movement of the plates through red dots along the faultline.	Highlight that the spatial proximity of the faultline. Show how our protagonist reacts on this with scientific questions rather than with fear.	Visualise where the North Anatolian Fault is located in order to counter the stereotype of an abstract, non-localisable threat. Light drone sounds
7	Along this fault line, the slow and constant plate motion sometimes gets stuck and pressure builds up. Under enough stress, the fault ruptures and both plates slip, releasing their stored energy as shock waves. During earthquakes, faults shift many meters in only a few seconds, creating violent tremors on the surface of the Earth.		We see how Cansu uses her hands to illustrate how the pressure is building up between two plates, how it ruptures and one plate slips. After this, we see the movement of plates during an earthquake. A pan upwards visualises the impacts of an earthquake on the built environment – the Hagia Sophia is shaken by the earthquake and severely damaged.	Provide answers to Cansu's question that are illustrative and easy to understand.	Create a connection between our protagonist and plate movements (through the illustration with our protagonists' hands). Provide simple, memorable information on the basic concept of plate motion. Light drone sounds, Room sounds, increasing earthquake sounds
8	Over the centuries, Istanbul has been shaken by many large earthquakes. They have become part of our history and our culture.		Slow Zoom on Hagia Sophia being shaken by the earthquake.	Make clear that Istanbul has a long "earthquake history" that has formed the cities appearance, identity and culture.	Use depictions of Istanbul's cultural heritage such as the Hagia Sophia as metaphors for the "seismic history" of Istanbul. earthquake sounds
9	But the North Anatolian Fault not only cuts through Istanbul, but across our entire country. And countless villages, towns and cities – home to millions of people – all lie along its path.		Zoom to a map of Turkey with NAF. Movement along the North Anatolian Fault eastwards, thereby showing places where major earthquakes occurred.	Highlight that Istanbul is not "alone" with this earthquake risk, but that much more citizens have to deal with it. Create a sense of solidarity between cities.	Use simple visual explanations how the seismic risk of Istanbul relates to previous earthquakes. Establish a connection to the earthquake history of other parts of Turkey through the faultline that cuts through the country. Light drone sounds
10	In recent decades, seven major earthquakes occurred in succession along the North Anatolian Fault. Starting in the East, the released stress moved along the fault line like a series of falling dominos, increasing the probability of a quake further west.		Illustration that exemplifies stress transfer: Visualisation of westward propagation, showing the year and places of 7 major earthquakes.	Introduce the basic "behaviour" of the North Anatolian Fault as something easy to understand.	Visualise the seismic threat for Istanbul due to the released seismic stress being propagated westwards. Light drone sounds, sounds of stress transfer
11	In the 1990s, scientists expected an earthquake close to Izmit. But they didn't know exactly when it would strike.		Slow zoom on the city of Izmit.	Outline the communication of uncertainty as one of the major challenges of risk communication.	Illustrate the example of the 1999 Kocaeli earthquake in Izmit as an example that everyone can connect to. Reappearance of the ticking clock, earthquake sounds
12	It was the 17th of August 1999. I remember the deep sadness and frustration of my parents, who went to help survivors. The death of almost 18.000 people could have been prevented through safer construction, more prevention and also through better science communication.		Close-up of Cansu, looking at family photos. Show severely damages houses (using original photographs as template). The image attached to the wall starts shaking. The Ottoman patterns on the wallpaper symbolically break up and fall apart.	Highlight through the narrative about Cansu's parents the collective memory of all the Istanbul residents that witnessed the Izmit earthquake in close proximity (e.g. through media images, by directly experiencing the tremors in Istanbul, or by helping to find victims). Refer to the anger, sadness and incomprehension for the shortcomings that rendered this earthquake a disaster. Allude to the fact that the catastrophe was partly caused through a failure of science communication	Find images to visualise the tremendous impact of the earthquake and the paradigmatic changes it has provoked. Find metaphors that illustrate that the earthquake has affected the lifes of many Turkish citizens. Loud earthquake sounds, merging into sounds of cracking and falling glass.
13	As geoscientists, we feel certain that in the coming decades, the result of a 16-year long chain reaction will reach Istanbul. This serves as both a warning and an opportunity.		Cansu sitting at the desk in her apartment. She is looking at articles about the seismic risk of Istanbul (use original papers).	Outline that the situation in Istanbul is very similar to the one in Izmit: Again, scientists are repeatedly warning that there is a high probability for a major earthquake hitting the city. This warning can be used to create more seismic resilience.	Create a visual link between the role of science, embodied through our protagonist Cansu, and the „real-word" context of Istanbul. Light spheric sounds

14	We know how to build an earthquake-proof city. But we also need to adapt to multiple disasters in ways that are more sustainable, socially responsible and transparent than what we are doing now. Earthquakes are not just a matter of scientific facts and better engineering. They raise questions about how the city we all want to live in should be designed.		Cansu (in close-up) is looking out of the window again. Slow zoom from her point of view to the skyline of Istanbul. We see a multitude of construction sites with cranes as well as newly built skyscrapers next to older, smaller buildings.	Highlight without further polarising that current risk mitigation has a too narrow focus on infrastructure development and engineering and disregards important ecological, social and political aspects. Cansu has gained a lot of personal experience and knowledge on this topic, and therefore outlines the importance of democratic decision-making, a people-centred approach to risk management and a multi-hazard approach.	Try to see the city of Istanbul through our protagonist's eyes by showing her point of view. Light spheric sounds
15	I remember that my father said: 'Earthquakes don't kill people, collapsing buildings do.' We now know that it's not only buildings, but a lack of preparation from each of us.		Close-up of Cansu standing at the window, looking at the construction work taking place.	Confront common stereotype perceptions that seismic vulnerability lies only the shortcomings of the built environment.	Personalise the engagement for a more critical perspective on risk mitigation. Light spheric sounds
16	Even though it's so easy to take action: Get an earthquake backpack ready, learn how to make your home more resilient, find out what to do during and after an earthquake. Curious how this works?		Visualisation of different activities for more seismic preparedness: (1) Items that go into an earthquake backpack (2) Attachment of furniture. (3) Drop, cover, and hold exercise.	Encourage people to take immediate action by addressing them directly.	Illustrate several simple measures to enhance seismic preparedness. Light spheric sounds merge into motivating music
17	GO TO www.anatolianfault.com (for Turkish version) and www.ready.gov/earthquakes (for English version) and share your knowledge with the ones you love.		Provide link with further information.	Provide recommendations for further actionable information.	

Fig. 3b.4: Storyboard for the motion graphics film "The North Anatolian Fault"

3b.2.4 Methodological Shortcomings of the Two Prototypes

After having conceptualised the two prototypes, I acknowledge that despite the promising attempt to incorporate some of the aforementioned guiding principles, there still remain some shortcomings, weaknesses, and aspects relevant to consider (see also Chapter 4 and 6).

Although the motion graphic film can be shared via a broad range of social networks and interactively discussed, the format is still is a form of traditional 'one-way' communication.
Furthermore, the film could have been designed to be more context-specific, targeting for example the neighbourhood of Okmeydanı and playing with local imagery. Given the importance of people-centred approaches, another possibility for a more integrated approach would be to combine film screenings with local offline events to strengthen a more neighbourhood-centred, discursive focus. For example, community-based organisations and NGOs could use the film for further knowledge-sharing. This could also support important resilience factors, such as the creation of trust and social cohesion in the neighbourhood, the support of community engagement for preparedness, or volunteers' integration into preparedness activities. It would have also been useful to give more space to the communication of actionable risk, showing, for example, a protagonist such as Olcay who undertakes preparedness measures herself.

Moreover, the collaboration of multiple authors on user-defined StoryMaps in which their own datasets can be published is not free but requires specific licenses to be bought. Therefore, although users can in principle access and share

data openly and can give feedback, the relatively high license fees often mean that there is usually only one project manager who can make executive decisions about what content is to be made visible and how it informs the direction the story takes.
For the display of film content in the StoryMap, there is the problem that the free, not user-defined StoryMaps have predetermined design templates, which inhibit actions such as the creation of links between the different media sources. For example, it is not possible to create key points within a narration that allows the user to choose if he or she wants to receive further information on a specific topic. This hinders the potential of non-linear storytelling and the integration of metadata at specific points in the timeline.

Another major constraint was the lack of access to GIS data needed for the visualisation of the risk and vulnerability of the neighbourhoods. The lack of quality and availability of this geo-risk data limits the impact of this project, as scientifically valid knowledge and decision support are lacking. As briefly outlined in Section 3a.3.4, the reason for this 'missing data' relates to the restricted access of key Turkish institutions, principally the Istanbul municipality and Bogazici University. Although much research data is nowadays publicly accessible, the Turkish government does not allow public access to comprehensive datasets on seismic risk, and so, despite several requests, only very restricted data access was provided. Therefore, for the continuation of this project, supplementary datasets from international researchers who conducted studies in Istanbul (such as from Japan, Germany, Norway) need to be acquired.

Together, these outlined deficits are the reason why the video-based ArcGIS StoryMap and the motion graphics film can only partly facilitate and support post-Sendai risk communication approaches. Furthermore, as will be outlined in the next chapter, a more structured process for the generation of the prototypes, such as the method of Design Thinking, would have been supportive for the development of the prototypes presented here.

3b.2.5 Concluding Remarks

This chapter has presented the findings I generated in the context of ethnographic fieldwork, using audiovisual methods along with other qualitative methods as a research tool to explore seismic risk communication in Istanbul, and to conceptualise prototypes for a post-Sendai risk communication. Although large parts of this case study reflect my attempt to gain a nuanced understanding of local risk perceptions and to determine the scope of this thesis, I could provide initial evidence that using audiovisual methods as research tool had methodological, analytical and theoretical value for this research (a finding that will be further expanded and discussed in Chapter 6). Through filmed participant observations and reflexive photography exercises, I could gain insights into embodied and non-linguistic dimensions of seismic risk and produce rich visual data that has — together with data generated through verbal or text-based research methods — *theoretical* value for conceptualising post-Sendai risk communication. Further, a *methodological* value was that the reflexive photography exercise and the joint conceptualisation of prototypes motivated participants to reflect their perceptions and views with the help of audiovisual means. The use of audiovisual methods such as the storyboard development or the creation of photos and videos with subsequent elicitation interviews also facilitated and enriched the dialogue between me and my research participants. The fact that there were common points of reference in the (audio)visual material allowed for a much more concrete and lively communication and more *analytical* depth. In addition, the participatory process reduced power imbalances in the relationship between me and my research participants.

However, this study has only to a limited degree used film in the framework of *transdisciplinary* collaboration. As will be further outlined in the next chapter, it was a shortcoming not to use audiovisual methods in the context of the Istanbul workshop. I suspect that the use of visual methods such as a joint analysis of (my research) films and images related to seismic risk could have supported processes of social learning between geoscientists and inhabitants of at-risk neighbourhoods, for example, by facilitating an exchange and integration of different forms of knowledge. Furthermore, although some participatory video practices have been deployed in the ethnographic fieldwork, the potential of participatory video is larger than presented here. These critical considerations will be discussed further in the framework of Chapter 4, which explores the potential of a more collaborative approach to using audiovisual media for post-Sendai approaches in risk communication.

Another finding is that geoscientists from the ALErT group that were confronted more directly with views of inhabitants through the workshop recognised important community-centred topics and concerns that had previously lain outside their geoscientific perspective. Particularly important was the combination of the insights from the transdisciplinary workshop and the application of audiovisual methods in a collaborative set-up that motivated some of the ALErT members to engage in a co-development of audiovisual risk communication prototypes as presented here. However, ALErT participants also pointed out their doubts about engaging as risk communicators in such politicised conflicts, being insecure about their roles and responsibilities and their wish for further training in that domain. Here, it became clear that maintaining the value and integrity of the disciplinary knowledge (sound science) whilst at the same time adjusting to specific socio-cultural contexts requires a novel mode of communication training, as will be discussed in Chapter 5.

Chapter 4 – Using Film for Transdisciplinary Collaboration: Prototyping the Potential of Collaborative, AI-Assisted Editing

Based on the insights of Case Study 1, this chapter presents how I conceptualised a prototype for collaborative, AI-assisted video editing to support post-Sendai risk communication. The prototype uses technological innovations in the realm of editing to promote in particular transdisciplinary processes for the co-design of risk communication. The collaborative editing of audiovisual material, so the assumption of this study, strengthens the assessment and integration of user perspectives and user needs through creative means and stimulates risk dialogue and processes of knowledge co-creation.

Section 1 of this study elaborates on how specific challenges related to my participatory research approach in Case Study 1 motivated the prototype development. These shortcomings are contextualised within the broader academic discourse on participatory video (PV). In addition, I link these findings to the research literature on technological advancements in the fields of interactive filmmaking and collaborative editing, film annotation, and artificial intelligence (AI). These fields, as I will argue, hold significant potential for developing participatory video. Altogether, these findings lead to the central aims and objectives addressed in this chapter.
Section 2 outlines the methodology of this study. It provides a brief introduction to design thinking (as outlined by Stanford d.school) as a way to generate socially robust prototypes and presents how I applied the five steps of the design thinking process for this study. As the development of the first conceptual drafts of the prototype also required further experience from the field of AI and programming, I also describe how I obtained feedback and consultation in these fields.
Section 3 provides an in-depth description of the prototype and illustrates its key functions, such as collaboration on shared timelines, integration of user-generated data, annotation/tagging of video footage, rearrangement of timelines based on tags, annotations or AI-detectable properties, and the creation of nonlinear timelines. Moreover, in the form of short exercise descriptions, it gives

examples of how the different functions can be applied.
Section 4 outlines how the prototype can be made operational and presents a strategy for follow-up research. This includes a reflection on possible limitations important to consider and recommendations for how a future pilot software could be made accessible and scaled up to more fully facilitate and support post-Sendai approaches to risk communication.

4.1 Confronting Methodological Shortcomings of Case Study 1

As broadly described in the introduction, the Sendai Framework advocates for a more people-centred approach to disaster risk reduction and the use of innovative ICTs. It calls on risk practitioners to co-create and collaborate with at-risk communities and to promote continuous dialogue between researchers, policy-makers, and civil society (UNISDR, 2015a). However, its suggestions — for example broader stakeholder participation, a shift in responsibility from authorities to the public, and greater transparency in risk/uncertainty communication — have yet to be implemented. Therefore, new tools and platforms, such as multi-hazard knowledge centres, multi-sectoral platforms, and other knowledge services, are needed to translate Sendai's priorities into action.

Thus far in this research, I have primarily deployed audiovisual methods as a tool to gain a more nuanced understanding of the sociocultural and sociopolitical complexity of risk communication. In using this approach, I tried to embrace participatory practices. As outlined in Chapter 1, participatory video's potential for feedback, peer-to-peer learning, and advocacy is not sufficiently used and researched in the field of disaster risk communication, apart from few examples in the field of climate risk communication (e.g., Haynes & Tanner, 2015; Padgham et al., 2013; Ryvola & Suarez, 2013; Suarez et al., 2009; Walker & Arrighi, 2013). To confront this knowledge gap, I have deployed participatory video in the area of seismic risk communication, initially through ethnographic fieldwork that encompassed participatory methods (such as reflexive photography exercises and photo-elicitation interviews), and then by using video production as a participatory tool for the development of Prototype 1 and 2. Further, as will be presented in Chapter 5, I shared film production tools with early-career scientists to evaluate a novel risk communication training framework.

Although the findings from my fieldwork in Istanbul provide encouragement that audiovisual methods can be an important complementary element of post-Sendai risk communication, there are a number of shortcomings related to the participatory approach of Case Study 1 that limit its usefulness as a basis for truly people-centred approaches. Case Study 1 was based on SFDRRs emphasis that if hazard scientists engage in DRR measures such as risk communication, it is vital to learn about user needs, take into account local information as a foundation of communication efforts, and gather feedback from at-risk communities. Furthermore, for a truly people-centred post-Sendai approach, communication ought not to be regarded as the *result* of collaboration but as the *process* of collaboration. In other words, rather than producing final videos, the video production with inhabitants and geoscientists ought to be jointly reflective. By the same token, Lundgren and McMakin (2018) contend that 'having the audience or stakeholders interact *directly* with those who are communicating, assessing, and/or managing the risk … can be an extremely effective way to communicate risk' (p. 285). Without this ongoing interaction of knowledge, hazard scientists lack a powerful tool on which to design their risk communication efforts. Given these findings, user-generated audiovisual content can be more rigorously used as a dialogic tool than in Case Study 1, where, for example, the transdisciplinary workshop was simply recorded, and the medium of film was not used as a tool for the co-creation of knowledge. Equally, the film editing was not truly co-creative due to language barriers, logistical challenges, the constraints of linear timelines, and a lack of collaborative tools. A further shortcoming reflects the view that the promise of participatory video is overrated and not examined critically enough (e.g., Mistry et al., 2015; Plush, 2015; Shaw, 2015; Walsh, 2014; Yang, 2016). For example, most of the people I worked with in Istanbul did not have access to technology in order to initiate participatory video projects themselves (in other words, the filming largely took place with university film equipment). Moreover, one could argue in line with Mistry et al. (2015) that there is little evidence that the users themselves (in my case, inhabitants of at-risk neighbourhoods) demand and make use of participatory approaches. My research — a European-funded project with expected deliverables requiring successful implementation — started with a preconceived idea that, in light of high seismic vulnerability, seismic risk reduction would be of interest (or even a priority) for research participants. However, it became evident that for most respondents, the issue was not earthquake resilience per se but rather the lack of citizen participation in current formal risk management efforts. A common criticism of participatory processes is that they cannot be inclusive if they do not also explicitly address unequal power dynamics, in this context between risk authorities and risk publics (Shaw, 2015; Tsouvalis & Waterton, 2012). Authors such as Scolobig et al. (2015a) thus argue that 'prematurely placing greater responsibility on private shoulders is likely to be ineffective unless deeper changes at the institutional and cultural level that truly foster transformative participation are forthcoming' (p. 210).

Collectively, these points of criticism demonstrate that a deeper interrogation of my approach to participatory video in line with applied visual anthropology is crucial. To circumvent some of the limitations of participation, Mistry et al. (2015) propose

- strong involvement of participants in the design of the projects from the very beginning and a discussion of different motivations for and perspectives on the participatory project throughout the work
- the regular recording of changing motivations and perceptions of the project to ensure that better results are made possible for those involved, while at the same time providing as detailed as possible a picture of the course of the project
- a focus on the integration of the projects into the everyday world of participants
- a simple, preferably self-explanatory handling of the technology, appropriate training users (if necessary), availability of equipment, and sufficient internet connectivity

In the wider context of the Sendai Framework, two additional points seem appropriate:

1) the use of participatory video to support longer-term governance processes, involving not only marginalised groups but also more diverse groups in order to contribute to wider social transformation. Shaw (2015), for example, highlights that scholars who frame participatory video predominately as a means for participatory *representation* may actually help curtail transformative social possibilities. Therefore, it also seems important to use the generated findings for activism or policy advice.
2) making the video material accessible and visible to all users as a means to create greater transparency in the risk communication processes, which is a key ingredient to relationships of trust and a precondition for group creativity.

4.1.1 Technological Facilitation of Participatory Video

To enable more deliberative and transparent forms of participatory video, it seems promising to move to a virtual setting and make use of online platforms and web-based collaborative tools. As already outlined in Chapter 1, many user groups are now familiar with new technological opportunities for online communication and collaboration. Digital and media literacy have improved.

Smartphones have become ubiquitous, opening access to a wide variety of collaborative tools, often free of charge. With the development of the World Wide Web, cloud storage, cloud computing, and broadband communication, online tools and social media have improved the accessibility and usability of online collaboration. So far, collaborative tools that support creative teamwork are primarily text-based (Al-Samarraie & Saeed, 2018). In terms of collaborative video editing tools, web-based solutions for more efficient feedback loops, media review, and approval have recently been developed to make the collaborative process of cloud-based film production more efficient. A large proportion of users (not only film professionals) are familiar with creating images and videos, in some cases editing them with professional software and sharing them via social networks. As outlined in Chapter 1, this has led to an increase not only in the provision of user-generated visual data but also in citizen science, whereby citizens supply images and videos next to geographic information such as maps, geotagged images, or personal stories (e.g., Kar, 2016; Mychajliw et al., 2015; Olman & DeVasto, 2020). Alongside this, there has been a proliferation of new formats that allow for the interactive use of audiovisual material.

Over the last two decades, new formats such as web docs, transmedia documentaries, serious games, cross-platform docs, locative docs, docu-games, and pervasive media have enabled a more multi-vocal, interactive, and discursive sharing/arrangement of knowledge between filmmakers and diverse groups of stakeholders. These formats can be summarised under the umbrella term 'interactive documentary' or 'i-Doc'. An i-Doc can be defined as a 'documentary which uses interactivity as a core part of its delivery mechanism' (Galloway et al., 2007, p. 330) and is usually characterised by a nonlinear spatiotemporal organisation and interactive capacities that allow multiple pathways through the material (Harris, 2017, p. 25). Therefore, i-Docs are a medium typified by modularity and variability (Gaudenzi, 2013), complexity and choice (Nash, 2012).
Through multiple web-based design possibilities, i-Docs allow for narrative diversity, thereby challenging the standard linear mode of storytelling and its dramaturgical conventions. As Harris writes, 'i-Docs can enhance understanding of the politics of nonlinear imaginaries by focusing attention on the varied and localised ways that nonlinear spatiotemporal logics are crafted into politically significant ways of seeing' (Harris, 2017, p. 2). The user can, for example, decide how to navigate through a collection of multimedia, although specific 'routes' can still be programmed by the director.

The multiple-narrative format of an i-Doc allows for a multiplicity of open-ended options for exploration, which can stimulate the process of forming opinions.

Favero (2017) differentiates between active, participatory, and immersive i-Docs. For example, active i-Docs merely provide the audience with a variety of angles from which to explore the materials that make up a documentary, for example, by choosing specific routes through the story. This is a form of nonlinear storytelling that is also designated as a ‘branching narrative’ (Riedl & Young, 2006). Immersive i-Docs seek to close the gap between the platform and the everyday life of users (e.g., VR documentaries or 360° documentaries). Most interesting for this study are participatory i-Docs, which give users possibilities to actively engage with the film, for example, by adding their own footage or edited sequences, engaging in discussion forums, contributing comments or material, or saving their own view paths or favourites. There are also hybrid forms of these ‘participatory’ documentaries where a facilitator (e.g., the director) guides a group in an analogue setting to choose the continuation of the film that is screened. I would suggest labelling such formats as ‘performative’ i-Docs.

The use of participatory i-Docs for a more ‘deliberative’ risk communication is still exploratory and has not yet been researched. Thus, it remains questionable if i-Docs — despite the promise of their advanced communication technology — incorporate key requirements for credible transdisciplinary risk communication (Green et al., 2017). For example, do i-Docs consider and integrate the specific needs of end-users into the development of their design? Do platform operators or users practice ‘research’ or ‘knowledge co-creation’ with the activities they carry out? Do the platform operators engage in processes of upscaling and/or do they create further linkages to other actors or institutions dealing with their themes? Moreover, there is a question of accessibility, as i-Docs are usually cost-intensive, whilst alternative low-cost software programmes (e.g., klynt.net or korsakow.com) only allow limited functionality and little or no opportunities for user participation.
In some ways, the majority of i-Docs seem to focus more on enabling a different user experience than on facilitating new forms of collaboration or even transdisciplinary research. Therefore, the question persists as to what degree these emergent audiovisual methods might enhance transdisciplinary collaboration. The following Section 4.1.2 examines a potential transdisciplinary audiovisual tool that may satisfy the aforementioned demands of Lundgren and McMakin (2018) of ‘having the audience or stakeholders interact directly with those who are communicating, assessing, and/or managing the risk’ (p. 285). It also has the potential to critically confront the often hierarchical relationship between audiences/stakeholders and producers of risk communication. This tool is ‘collaborative editing’.

4.1.2 Collaborative Editing

Nowadays, many forms of editing software do not require users to have significant technical skills. Software packages such as OpenShot, VideoPad, iMovie, or Movie Maker are free to use and have a variety of functions. More recently, DaVinci Resolve or Frame.io have launched software that allows for simultaneous, collaborative work on timelines, though it is targeted at more experienced filmmakers and postproduction teams. Nevertheless, it marks an important transition in the democratisation of the editing process. Further technological developments for collaborative editing have taken place in the realm of film annotation. In their detailed reviews of current software solutions for collaborative film analysis, Estrada et al. (2017) and Pustu-Iren et al. (2020) have examined different visual annotation tools for film studies that allow users to directly interact with the video material, for example by adding different feature dimensions to the different modalities of the film (the video footage, the audio or text, as well as the transition effects). Tags or text in the form of comments, thoughts, or clarifications about the material can be added to the timeline and to other (meta-)data, such as additional clips or photographs. The annotations can also be sorted in user-specific ways through the use of multiple layers.

Alongside software to manually or automatically annotate film material, there is now also software that uses algorithms to analyse data related to the film footage (for an overview, see Podlesnyy, 2019). Despite some overblown expectations and hype, artificial intelligence is becoming a fundamental technology for film production. Quantitative data can be analysed and used to automatically segment scenes, detect faces, shot length, camera motions, and edits, or analyse colours and patterns in the image. With the advance of deep convolutional neural networks, it is also becoming possible to analyse qualitative data. By means of emotional artificial intelligence, a semantic analysis is, to a certain degree, also possible, such as the recognition of different tones of voice or facial expressions (Zhao et al., 2020). Pustu-Iren et al. (2020) highlight how machine annotations are already of similar quality to those of humans for some basic tasks, like object classification, facial recognition, or geolocation estimation. With the rapid development of artificial intelligence systems over the last decade, we are now seeing the emergence of algorithms for the automated generation of visual storylines (e.g., Choi et al., 2016; Liu et al., 2020a; Liu et al., 2020b; Sigurdsson et al., 2016; Xu et al., 2019; Zhong et al., 2018). Although artificial intelligence has certainly not reached human abilities in most editing tasks, it is impacting creative workflows in film production and changing the role of the author (McCormack et al., 2019). Currently, these algorithms are mainly used in the commercial sphere. Their role in the academic or artistic realm needs to be further explored, particularly in light of fundamental ethical questions and issues related to data security.

4.1.3 How can hazard scientists benefit from innovations in the realm of interactive filmmaking?

Current technological opportunities for collaborative editing, film annotation, and artificial intelligence offer promises for novel approaches to post-Sendai risk communication that require critical reflection. Already there are examples of participatory approaches to risk communication that deploy innovative technologies, such as serious games (e.g., Suarez, 2015), data visualisation or semantic tagging (e.g., Bharwani et al., 2015), or participatory mapping (e.g., Liu et al., 2018). However, the DRR community seems less responsive to broader changes in the landscape of AV technology. While individual hazard scientists or working alliances of scientists and film professionals invest considerable time and resources to create audiovisual risk communication, filming, streaming, and sharing movie clips have become a preferred and ubiquitous form of expression for many inhabitants of 'at-risk neighbourhoods'. In light of these changes, participatory video in DRR has the potential to be technologically 'updated'. In the age of the 'prosumer' — a time in which participants are increasingly used to accessing and gaining control over visual methods — participatory video in DRR could harvest novel forms of online collaboration.

This study seeks to bridge the gap between what is technologically possible in the realm of participatory AV technology and the way in which it is currently used. It envisages to reimagine and to redesign the editing process as a social activity and, in doing so, offer audiovisual material for a richer risk dialogue. Using a web-based, AI-assisted editing tool, my assumption is that collaboration on joint timelines can leverage a transdisciplinary co-design of risk communication because it can:

a) help to structure, facilitate, and inspire risk-related dialogues between stakeholders;
b) bring more transparency into the risk communication process;
c) give agency to those threatened by risk by enabling them to contribute their own video content;
d) enable new forms of remote collaboration;
e) promote creativity, bridging visual and verbal methods; and
f) challenge the chronology and linearity of the film production and editing

process, thereby rebalancing power relations in the way that risk is depicted.

Motivated by the contention that such a tool might address some of the present pitfalls of participation, in the following section, I will conceptualise the prototype *Directors' Room* for an open-source, collaborative, AI-assisted editing tool. This tool foregrounds the social dynamism of the editing process, facilitating dialogue between the people involved. Along this rationale, it is important to emphasise that video production *can* result from this collaboration, but is not the primary interest. The following prototype development is undertaken as a 'provocation' for thought. Follow-up research needs to be conducted for the refinement of the prototype, including user surveys and integration of test results (see Section 4.4).

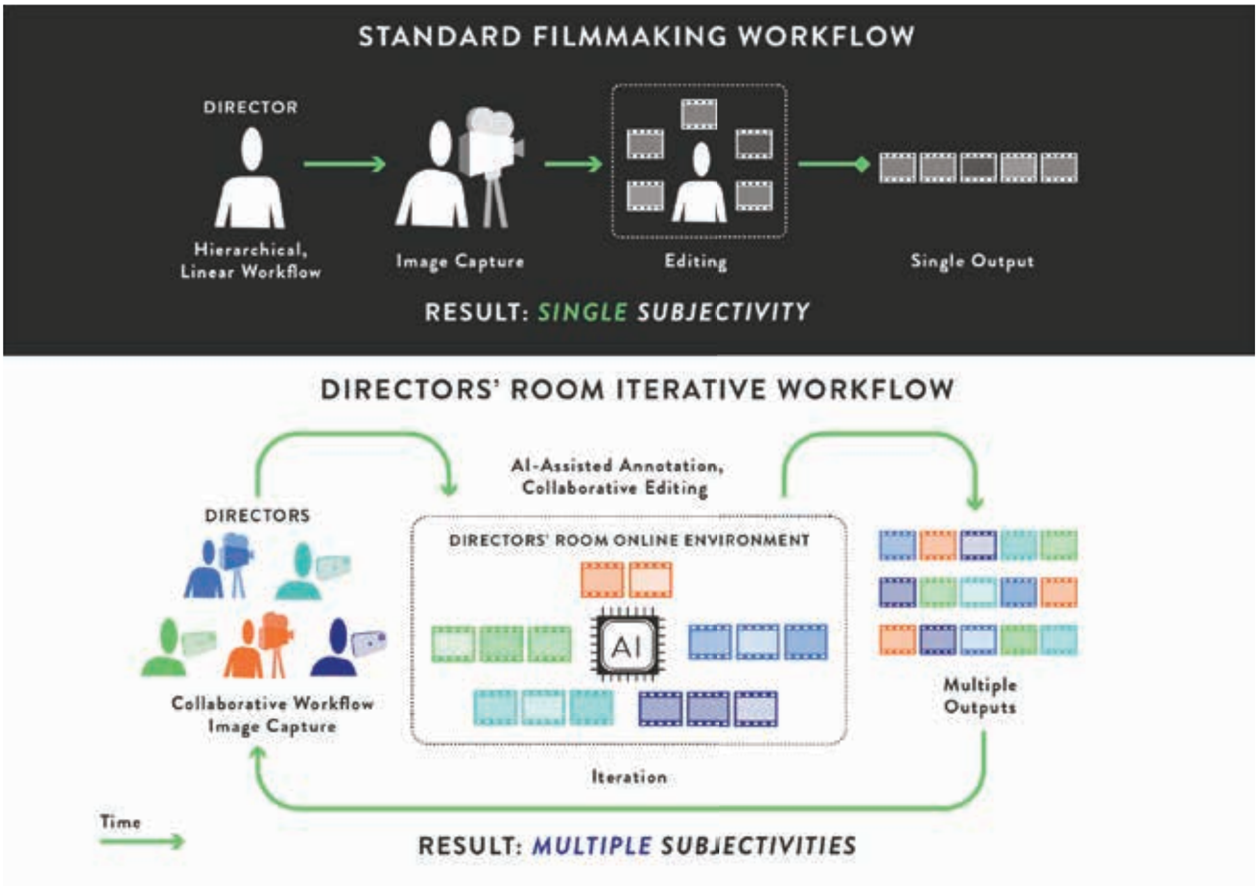


Fig. 4.1: Visualisation reflecting the core goals of the prototype

4.2 Methodological Approach for the Prototype Development

The design of this study is based on the overarching goal to further develop co-creative approaches for the design of risk communication. To allow for a more structured approach of prototyping than presented in Chapter 3b, I use a modified form of the method of Design Thinking for the development of *Directors' Room*, that offers a helpful approach for the development of conceptual prototypes. Design Thinking uses co-design and intuitive problem-solving techniques to match people's needs with what is technologically feasible and organisationally viable. According to the Hasso Plattner School of Design Thinking (HPI), 'we-intelligence' and collaboration are the foundations for new learning and working models. This inclusive, human-centred method is typically applied to work on difficult, multi-dimensional problems. It is widely used in business and design contexts and, in the last years, also in sustainability science and health science (Fabri, 2015).

Design Thinking is 'a tool to foster creative thinking, while at the same time providing for a structure in order to systematize the ideas' (Fischer, 2015, p. 2). Key aspects that are critical to the process are:

a) diverse teams with people from different backgrounds (Paulus, 2000);
b) a physical setting supporting creativity and the production of knowledge (Vithayathawornwong et al., 2003), and
c) a structured process of applying techniques for idea creation (Dorst & Cross, 2001).

Although Design Thinking processes can be structured in different ways, they all share the common feature of building an iterative process (Fischer, 2015). In the following section, I will draw specifically on the Design Thinking process as outlined by the Stanford d-school (Plattner, 2012), which provides five defined steps:

Empathise — gain an understanding of beliefs, values, topics, and concerns of research participants to learn about the human underpinnings of problems.
Define — establish a framing of the problem. The goal here is to craft, from the findings of Step 1, a meaningful and actionable problem statement or 'point-of-view' (POV). The POV is the explicit expression of the problems the research seeks to address based on insights from the data collection. POVs can be seen as guiding statements that focus on the needs of a particular user group.
Ideate — the transition from the definition of the problem to the generation of ideas for possible solutions. This stage provides important elements for building prototypes and getting innovative solutions into the hands of the selected user group. Crucially, this mode requires an openness towards fresh ideas, the ability to look beyond obvious phenomena, and creativity.
Prototyping — the design method in which prioritised ideas are put into practice

in the form of one or several prototypes, such as an object, service, or system. *Testing* — provides the researcher with feedback from participants about the prototypes and serves as another opportunity to gain empathy for intended users. Through this evaluation, the positive and negative sides of the prototype can be appreciated and modified, for example, by changing prototypes or creating additional prototypes for comparison.

According to Plattner (2012), the whole Design Thinking process is a loop that should be repeated multiple times, even within the individual steps, in order to narrow the scope and refine the concept and its implementation.

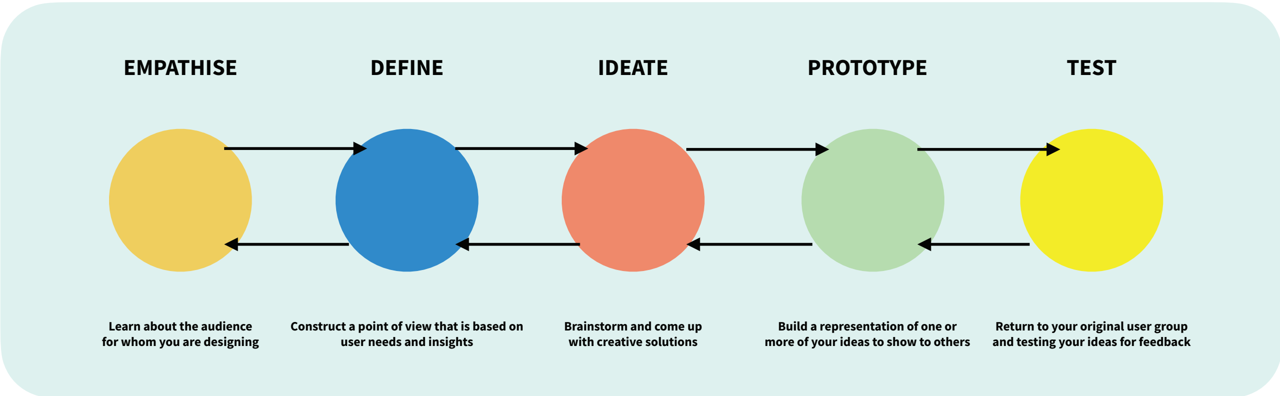


Fig. 4.2: *The five-step Design Thinking model as suggested by Stanford d.school*

For the development of the prototype 'Directors' Room', I use Plattner's Design Thinking approach only as a 'lens' to structure and reflect on the (audiovisual) ethnographic findings from Case Study 1. I apply the three steps of emphasising, defining, and ideation to these findings and use the generated insights to develop a visualisation and conceptual elaboration for the prototype presented here. This conceptual prototype can be used for further user tests with selected audiences and, ultimately, for a refinement of the prototype.

There are two major differences in the approach suggested by Plattner (2012): Firstly, this prototype development uses the structure of Design Thinking in a manner that is largely *retrospective*. This is because the prototype was conceptualised after my fieldwork had ended. Nevertheless, the structure of my ethnographic fieldwork and the transdisciplinary workshop, as well as the development of Prototype 1 and 2, largely followed the steps proposed by Plattner. As illustrated in the table below, there are strong overlaps with the approach suggested by Plattner.
Secondly, the 'Directors' Room' prototype is not only based on verbal and written contributions generated in the 'empathise-define-ideate' phase but also builds on the findings generated through audiovisual research.

EMPATHISE	DEFINE	IDEATE	PROTOTYPE	TEST
Exemplary quotes, such as: ‘There weren’t any plans made in cooperation with the public.’ ‘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.’	There is a lack of deliberative formats for knowledge co-creation and co-designing risk communication	Create tools that ... take into account the media literacy and technology literacy of the population -create space for user-generated content -allow for peer-to peer learning -allow for transparency -Combine different perspectives, achieving multi-vocality, increasing knowledge -leave enough space for the inclusion of other related topics	Collaborative Editing Tool ‘Directors’ Room’	To be conducted (only conceptual outline for further testing)

Fig. 4.3: *Applying a Design Thinking framework as a retrospective lens to the findings of Case Study 1 (simplified illustration)*

Below, I describe how I used the five steps proposed by Plattner (2012).

4.2.1 Using Design Thinking as a Retrospective Lens

1) Empathise Mode: The entire data acquisition phase in Case Study 1 was consistent with the ‘empathise’ step. To better understand how geoscientists and inhabitants of high-risk areas think, feel, and act upon seismic risk communication in Istanbul, I conducted (visual) ethnographic fieldwork. This research approach elucidated the complexities of risk communication in Istanbul and provided a more nuanced perspective on the needs and priorities of my research participants. This step helped me to develop empathy for the current situation and behaviour of possible users of alternative forms of risk communication and to use the insights I gained as a springboard for the next step.

2) Define Mode: The acquired data revealed tacit insights that helped identify, structure, and analyse specific problems related to risk communication. Besides audiovisual data and qualitative interviews, insights from the transdisciplinary workshop/focus groups in Istanbul enabled an understanding of the different perspectives of both geoscientists and inhabitants. Recorded discussions helped to structure my findings, augmented by an evaluation of both the analysed transcriptions of the fieldwork data and the edited sequences. These activities

were in line with Fischer's objective to 'get close to the situations and ask about the reasons that make a problem hard to solve' (Fischer, 2015, p. 2). The findings shed light on problems associated with current risk communication as well as concerns related to seismic preparedness, both of which are crucial to developing specific points of views (POVs) for the 'ideate' step.

3) Ideate Mode: Case Study 1 incorporated several ideation phases. Firstly, research participants were invited to freely express ideas relating to their POVs/ problem statements, for example, by suggesting how they would improve seismic risk communication. Both inhabitants and geoscientists outlined a series of concrete ideas about how to approach current problems associated with risk communication. The ideas generated in the ideate mode were used as a reference for further elaboration, which resulted in the prototype development.

4) Prototype Mode: The ArcGIS StoryMap (Prototype 1) and the motion graphics film 'The North Anatolian Fault' (Prototype 2) were already intended to provide solutions to the findings generated in the three preceding modes. Here, I develop a third prototype that also builds on the three preceding modes, but that also seeks to learn from the identified shortcomings of Prototype 1 and 2. However, in contrast to Prototype 1 and 2, in which the ideation phase was conducted together with the ALErT group, all the work related to the ideation mode of this prototype was done by me, providing my expertise and experience as a filmmaker and editor. Bearing in mind that I lacked proficiency in the fields of programming and artificial intelligence, I consulted two experts in these areas in order to take important feasibility criteria into account when developing the prototype concept and its visualisation (as presented in Section 4.2).

5) Testing Mode: As can be seen in Fig. 4.3, the development of Prototype 1 and 2 involved user feedback, but lacked a concise testing strategy and evaluation. Therefore, I propose next steps for the evaluation of the prototype presented here (see Section 4.4).

It is important to outline that this prototype concept and the visualisations are intended as a 'provocation' for thought and provide a basis for further research and testing. A detailed user analysis via further user questionnaires and an investigation of user journeys and types will bring additional insight and allow for an iterative process of improving the proposed collaborative editing tool.

4.3 Initial Results: Sketching the Prototype of the Collaborative AI-Assisted Editing Tool 'Directors' Room'

This section will outline the core idea of 'Directors' Room' as well as its specific functions that address the findings from the definition and ideation phases of the Design Thinking process. Complementary figures serve to further illustrate the presented functions. Furthermore, I give examples of how these functions could be operationalised in the context of a transdisciplinary online workshop on risk communication.

The name 'Directors' Room' alludes to the fact that this collaborative editing software confronts the weaknesses of my approach to participatory video in Case Study 1 by enabling several authors to be involved in a risk dialogue and the co-production of risk communication products. While the editing process is usually a task exercised by a single person, here, the prototype acts on behalf of several authors and serves as a tool for social negotiation. Furthermore, input from multiple users challenges the chronological order of film production, as the conceptualisation, the generation of material, and the editing process can happen at the same time. The software also lowers skill barriers associated with different roles of the filmmaking process, as this tool makes it easy to 'prosume' (produce and consume) video content.

To this end, the prototype provides a cloud-based environment for video editing that enables heterogeneous groups of participants to shoot and upload individual clips, create and edit multiple timelines and branching narratives, and assemble multiple final cuts assisted by specific algorithms.

Currently, I envision four core features of the prototype:

1. A modern web-based user interface that allows multiple remote users to participate and simultaneously upload, edit, arrange, and annotate film clips.
2. A cloud-based back end that manages multiple versions of footage and metadata, organising clips, timelines, and branches.
3. Intelligent annotation and organisation of the collected raw film material based on methods of computer vision and pattern recognition that identify high-level features, such as shot size, lighting, camera motion estimation, image and sound quality, location/person/action/scene recognition, as well as speech/audio recognition.
4. Identification of semantic connections between shots of different users, cameras, or modalities and automated suggestion of clip sequences based on editing patterns (e.g., shot-reverse-shot dialogue) through a combination of machine learning features and knowledge-based approaches.

Regarding the use of artificial intelligence, I would like to emphasise that this is just a possible 'facilitator' of the software and provides an attempt to incorporate Sendai's call for the use of innovative ICTs. Given the many constraints associated with AI in the realm of data protection and ethics, it is important to highlight that the core idea of the software would also work *without* AI (artificial intelligence) if serious barriers are seen in its application. In this prototype, AI-based methods are suggested to support and improve the editing process for users who are not familiar with editing, thus freeing up time for creativity and collaboration. The audio/video analysis algorithms being integrated are using open-source software from scientific publications. The AI functionality can comprise intelligent support and guidance/assistance throughout the process, using the methods of computer vision and pattern recognition named in function 3 of the prototype (see Section 4.3.1.5). It is also important to state that basic editing functionality is integrated via free and open-source web services of the editing software Openshot (http://openshot.org) and ffmpeg.

The following prototype is designed for a small group of participants, similar to the 15 participants of the transdisciplinary risk communication workshop in Istanbul. For reasons of clarity, the complementary visualisations only depict four participants, as they only serve to exemplify the functions. Although the prototype is designed as an easy-to-use, open-source tool, it will require a technical introduction and a briefing on ethics and data protection. Furthermore, in order to bring the diverse input together in a structured way and feed it back into the discussion, it is useful to have facilitators who are experienced in conducting workshops with heterogeneous participants. As a 'creative intervention' in risk communication, working with the online environment of 'Directors' Room' could already fill an entire workshop. However, it is also possible to use only some of the four exercises mentioned below and to combine these with other virtual workshop methods, such as focus group discussions, breakout room meetings, and the use of other collaborative tools, such as Mural or Miro. This ultimately depends on user needs identified and articulated prior to or within the workshop.

The workshop also necessitates some preparatory work. At the beginning, participants should develop and agree upon a series of tags to allocate to the video footage. For example, if the theme is non-structural risk mitigation, possible tags could include 'actionable information', 'sensitive issue', 'key message', 'local knowledge', 'inspiration', and 'unnecessary information'. Such tags will help to classify video footage at a later stage of the workshop. Throughout the process of using the prototype, additional tags can be developed as new categories emerge during the analysis of video footage. In addition, it is crucial to perform a technical check of participants' video cameras, microphones, and internet connections.

4.3.1 The Central Functions of the Prototype

4.3.1.1 Function 1: From Individual Use of Private Timelines to Multi-User Collaboration on Shared Timelines

Function 1 allows different users to work on timelines simultaneously and remotely. It allows single users to work on private timelines and several users to work together on shared timelines. Likewise, timelines can be watched in shared as well as private spaces. The project file with the different private and public spaces can be accessed through the cloud, and all the functions that normal editing programs have can be used in real-time. These functions include editing audiovisual footage, arranging clips, or inserting transitions, titles, and effects. Furthermore, every user can upload (self-generated) content. In addition, they can create changes in the project file without interrupting the workflow of other participants. A further feature of this function is the comparison of different users' timelines. All users of 'Directors' Room' are encouraged to present their private timelines in a shared space.

The function of working on shared timelines incorporates many of the findings voiced in the definition and ideation mode. Firstly, it promotes co-authorship, as several users can upload their own footage, represent their individual position, and take ownership over their editing choices, which can then be negotiated in a larger forum for knowledge co-creation. As such, it addresses current power imbalances and the lack of an inclusion of local knowledge, thereby helping to better understand the specific vulnerabilities and capacities of communities. This function also allows users to express their own creativity and to decide not only on content but also on aesthetic and dramaturgical style. It takes into account that different participants will prefer to upload different film footage, such as videos shot on their mobile phones, contextual video footage found online, data visualisations, interviews, sketches, animations, or tagged maps. Whilst some participants will feel more comfortable with verbal contributions, others might want to solely use images or images to which they add written comments. This function thus promotes multi-vocality and more nuanced forms of representation, allowing for fresh perspectives on risk discourse.
The comparison of timelines and collaboration on shared timelines allows users to collect, organise, interpret, and work on diverse video content. This process is intended to provide important local and scientific knowledge for the

joint interpretation of disaster risks and the development of possible solutions. It helps establish visual comparative tools to identify and discuss overlaps, similarities, or differences, e.g., between locally-identified topics and concerns and the perspectives of hazard scientists and risk managers.

4.3.1.2 Sample Exercise

A facilitator invites participants to create short video clips of a maximum duration with their smartphones, laptop cameras, or camcorders, or to search for web-based footage (e.g., on Creative Commons platforms). For example, several questions could be answered in ways that best suit the participants, such as: 'Why does the topic of seismic risk matter to you?', 'What are situations in your everyday life where you are confronted with seismic risk?', or 'What purpose should risk communication ideally fulfil?'

After the footage of all participants has been uploaded and inserted into a timeline, each participant adds tags to their material and selects messages of crucial personal value/interest.
Once the tagging and selection are finished, a timeline comparison allows participants to see the different editorial choices and tags and to discuss them. These selections within the editorial process are highly valuable for understanding the participants' perspectives. Questions could relate to aspects such as why selections were made, why other aspects were left out, or how the participants experienced selecting material from their own contributions. In doing so, initial ideas are generated regarding elements of a potential group narrative.

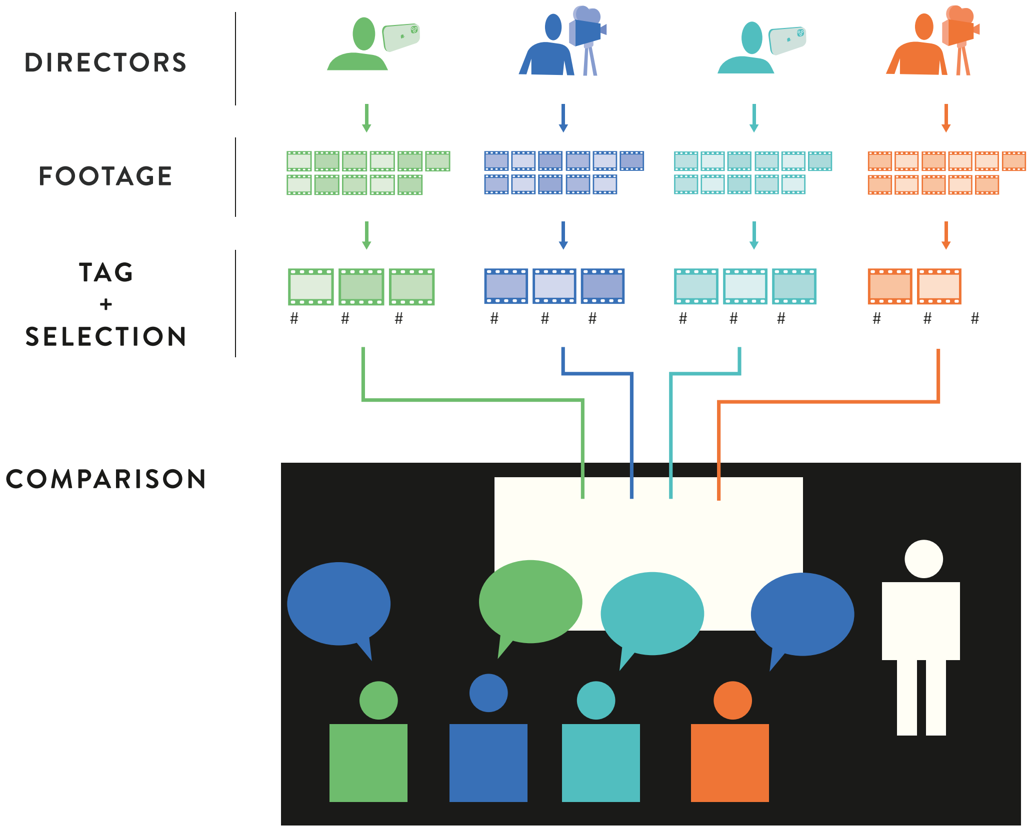


Fig. 4.4: Comparison of user-generated timelines in a shared space

5.3.1.3 Function 2: Annotation

This function allows the creation of different types of annotations on individual clips, sequences, or the entire timeline. Annotations can be made in added 'windows' in which elements like text, images, or further video clips (e.g., alternative shots) can be inserted. It is also possible to add private annotations that only the user can see and that help him/her search, structure, and label personal thoughts on the film footage.

This process allows users to further complement video footage with other data. By adding text, images, or other sources, they can share their thoughts and knowledge regarding the film material, comment on the material, or further develop new ideas for editing. The annotation complements function 1 by allowing users to decode or expand the content of the film footage. It can also make the different semantic layers of film material more visible/transparent to the audience, thus allowing for a richer viewing experience.

5.3.1.4 Sample Exercise

This exercise takes place in three rounds that build upon each other and enrich the video footage. In this exercise, users are asked to exchange their timelines and thus to react to footage that is not their own.

In the first round, a facilitator asks participants to insert text-based annotations onto clips in a timeline that is not their own. The text could consist of questions that participants ask themselves about the clip ('You talk about the seismic threat in my neighbourhood. Are there also risk maps that you could provide?'), reactions ('Beautiful depiction of seismic risk – inspired me a lot'), or comments on the depicted footage ('I couldn't understand that illustration, can you explain it, please?').
In the second round, the facilitator asks participants to provide a visual response to different clips. For example, participants could add photographs, videos, or other found footage to further complement a statement or provide a filmed response.
In the third round, participants are asked to detect 'decision points'. These are certain moments in the timeline where they think that a new story could emerge — one that better suits their needs.
Finally, the sequences are watched in full-screen mode together with the metadata, and a debriefing takes place. The goal of this exercise is not only to promote social learning through someone else's depictions but to have a kind of shared 'stream of consciousness' that reveals the different layers of visual material.

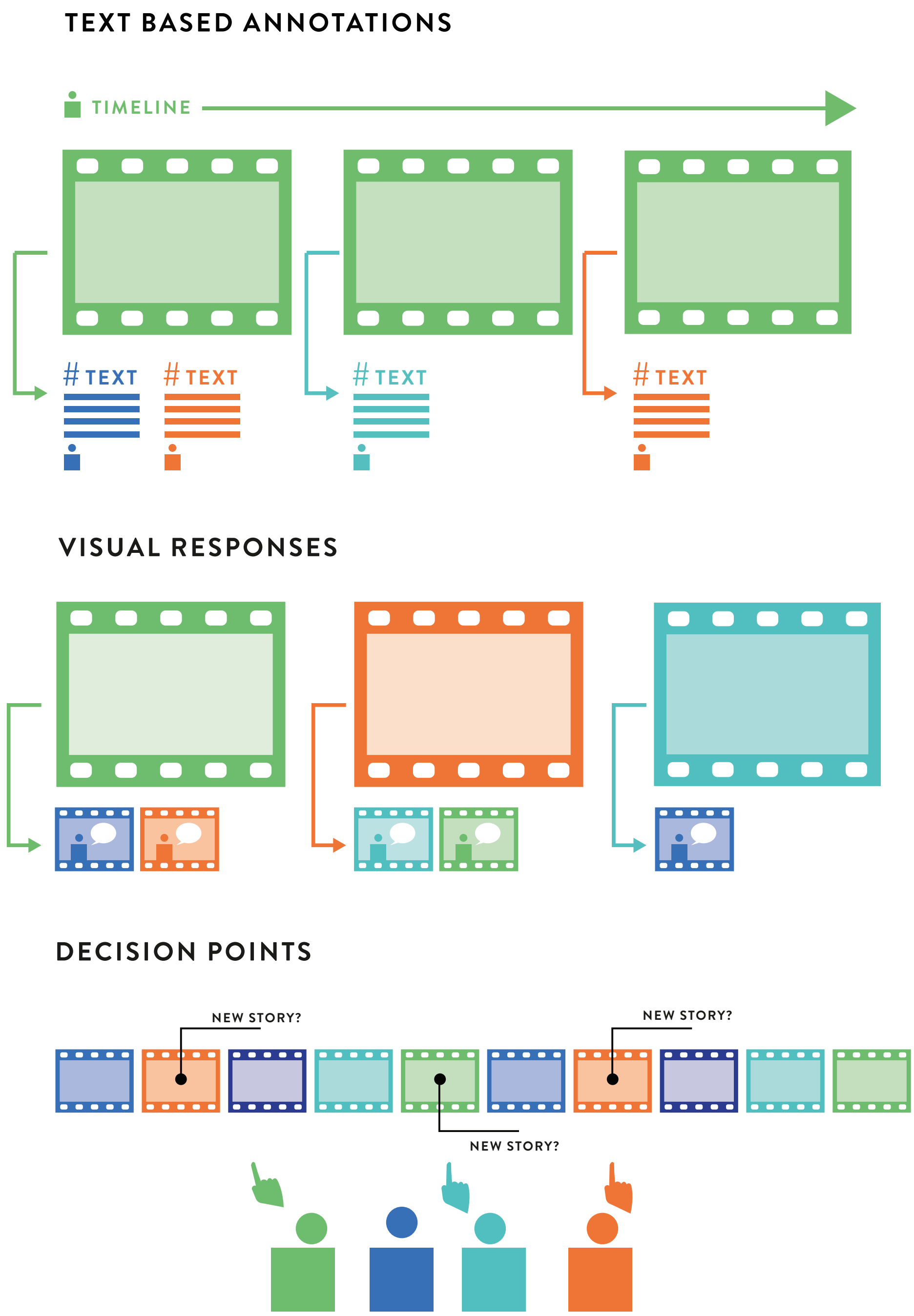


Fig. 4.5: Timelines with integrated annotations, visual responses and decision points

4.3.1.5 Function 3: Rearrangement of Timelines based on Tags, Annotations, or AI-Detectable Features

This function allows users to rearrange timelines or generate new timelines based on specific annotation criteria, tags, or 'AI-detectable' features. Depending on their search requests, users can determine which kinds of tags, annotations, or AI-detectable features they want to draw into a new timeline. With the development of neural networks, the prototype is able to locate images and sounds in the video footage and assign them to known categories. For example, object recognition allows footage to be systematised and analysed. It can thus search for specific images, for example, compiling all video material featuring a specific person. Moreover, built-in speech recognition can create a highly accurate transcript of the sounds in the video or allow for an automatic translation if multi-lingual users are involved. Users can then search this transcript to find the appropriate location in the video or search video content using keywords. Through this function, it is possible to support new forms of analysing video footage, as clips are reconfigured on timelines depending on criteria set up by a group.

As well as allowing quick searches and a more effective handling of complex video material, this function provides new perspectives on the film footage and can potentially inspire users to discover novel relationships within the material. A different arrangement of film footage in the timeline could also promote empathy with the people appearing in the footage, add humour, or challenge dramaturgical conventions.

4.3.1.6 Sample Exercise

In this exercise, a facilitator develops a rough sketch for a film structure together with the participants. For example, the users may decide to make a film on seismic preparedness in Zeytinburnu.

In the next step, the participants discuss possible titles for sequences they want to include and arrange these titles. For instance, they could decide to start with short impressions of Zeytinburnu ('impressions Zeytinburnu') and quotes of inhabitants who describe their neighbourhood ('quotes inhabitants'), continue with outlining the relevance of seismic preparedness in Zeytinburnu ('relevance of seismic preparedness'), followed by a sequence with key questions related to the subject of seismic preparedness ('key questions'), a possible approach to motivate citizens to invest in preparedness measures ('approach to seismic preparedness'), possible challenges ('challenges'), and the results they are expecting ('results').

Next, users can 'tag' or annotate the existing video footage in relation to these titles, search for existing tags/annotations or AI-detectable features, search online for appropriate footage, or create new content on their own.

Once this selection phase is completed, the software is able to create a new timeline in which all the footage containing the user selections appears in the order determined by the group.

In the next step, the group can decide which clips to delete (for example, because of redundancy) or to rearrange in order to create a more coherent storyline.

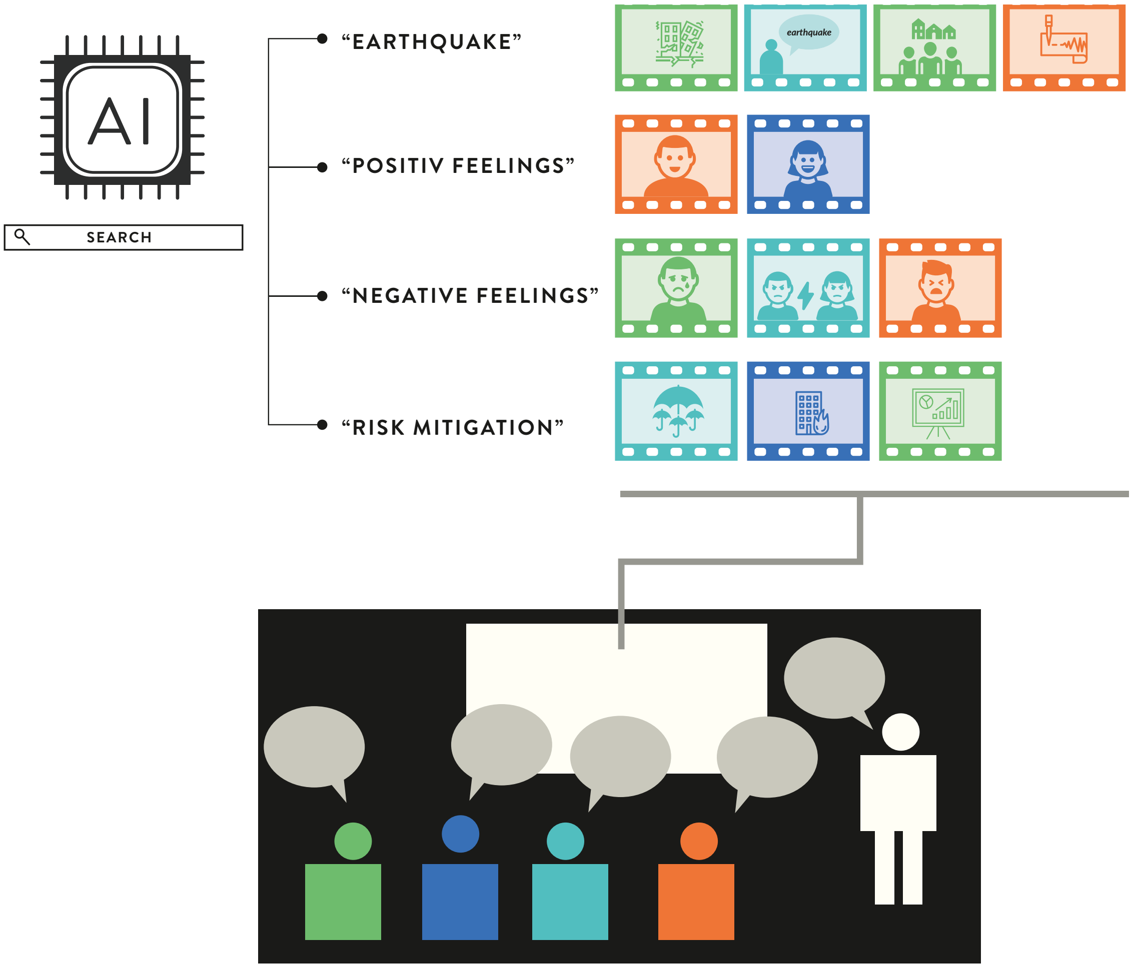


Fig. 4.6: Theme-specific timeline with integrated annotations

4.3.1.7 Function 4: Nonlinear, ‘Branched’ Timelines

Function 4 allows linear modes of storytelling to be broken up through the creation of ‘branched’ narratives. Decision points can be included in the timeline, allowing users to select options to progress the story in their own way (for example, by adding new sequences or alternatives to existing sequences). This nonlinearity allows the film to be developed progressively as new footage is included. In this way, sequences can be ‘updated’ or improved if more relevant footage is available.

Often, a linear way of editing ‘one film’ clashes with the desire to capture multiple narratives of different participants in one timeline. The possibility of representing different interpretations — visualising different interconnections within the film footage/data or deriving sequences with contrary ‘sub-themes’ — could be a powerful alternative to a linear representation. This function could transform the rich data inherent in film footage into different narratives and timelines. As such, this function addresses the problems outlined by respondents with regard to integrating their own ‘version of the story’ into risk scenarios.

4.3.1.8 Sample Exercise

A facilitator has already asked the group to determine possible 'decision points' where other versions or continuations of the story could emerge. Now users are encouraged to create such alternative sequences, for example, by inserting a pre-existing film or sequence into a timeline.

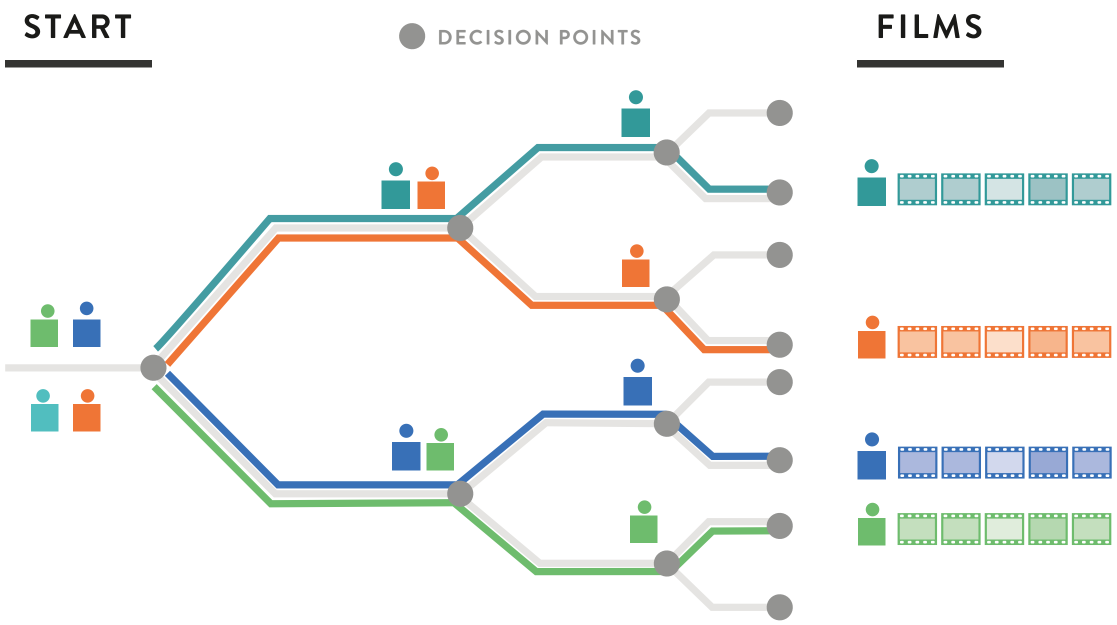


Fig. 4.7: *'Branched' timelines*

4.3.1.9 Further Functions: Built-in Chat and Video Communication Function

A chat and video communication function allows users to elaborate on the process collectively. Here, they can analyse the material together, share thoughts and ideas, or comment without leaving the software. The discussions could also be filmed and used as further documentary footage. Additional functions include a shared storage space, the comparison of timelines and sequences, as well as an auto-save of all the different working steps.

4.4 Next Steps

4.4.1 User-Tests, Feedback-Integration, Refining the Prototype

The prototype outlined here seeks to facilitate a novel form of people-centred risk communication, enabling diverse users to produce and consume relevant local risk information on a level playing field. Through the process of collaborative editing, some of the complexities of multi-stakeholder risk communication can be made surfaced, negotiated, and navigated. However, this assumption is still only theoretical and needs to be tested. I envisage the following steps: After obtaining ethical approval, a user survey needs to be conducted to gain a deeper understanding of the topics and concerns of potential users (see Appendix for a first draft of a user questionnaire). After integration of the survey results, a prototype/mock-up focused on user experience has to be built. Once the prototype is realised, test workshops need to be conducted with different groups of participants, where participants upload film material to a mock-up version of the user interface, test its different functions, and discuss the process and the prototype. Although those steps have not yet been implemented, I had numerous conversations with research participants from Istanbul, colleagues, and interested users to discuss the prototype draft and was invited to workshops to present the prototype.

Albeit the evaluation of the prototype has not taken place so far, the following limitations need to be considered when continuing the prototype development:

4.4.2 Possible Limitations

4.4.2.1 Addressing Varying Competencies and Engagement of Users

One limitation is that rather than bridging the gap between expert and user, the use of AV technologies such as those presented here can risk perpetuating an already existing digital divide. As Ramsetty and Adams (2020) point out, the Corona pandemic has made it apparent that people with higher education make better use of digital technologies. Although digital literacy in Turkey is high, especially among younger citizens (Hamutoglu et al., 2020), there are certainly groups for whom the prototype might be challenging. It requires critical thinking, creativity, and skills related to video production and online communication within larger groups. In addition, despite the tool's potential to confront communication more creatively and strategically, it adds further technical complexity to already complex themes and thus could lead to 'information overload'. For users who are not familiar with AV technology and do not like creative group work, the prototype could be disappointing. There is also the risk that power imbalances could persist due to the dominant behaviour, higher engagement, or greater audiovisual expertise of users who add more content than others or impose their versions of sequences. As recognised by Köhn (2016), the project risks reinforcing existing power imbalances as more technically experienced, rhetorically talented, or assertive participants with enhanced social capital tend to dominate the setting, content, and film language. To narrow these gaps, strong facilitators are required to level the playing field and instil motivation for collaboration.

4.4.2.2 Data Protection and Ethics

Facilitators of this tool must consider several issues of data protection and ethics due to the fact that private/sensitive footage might be used and exposed to a larger group. The group needs to determine if they want to publish the results of their collaboration and can only do so after receiving the explicit consent of all users that appear in the video footage. As Varghese et al. (2020) note, the prototype's 'claimed qualities of authenticity and directness, and the medium itself (video), can pose a very real risk to the very members of communities it seeks to 'empower'' (p. 5). This topic is particularly relevant given the tense political situation in Turkey. Finally, facilitators need to be aware of the fact that scientific sources need to be checked regarding their integrity and veracity, and they need to make sure that the tool is not misused, e.g., for the distribution of fake news or propaganda. In addition, all users must critically question where and with which access rights and usage agreements data is stored or even resold.

4.4.2.3 Lack of Upscaling

Another risk can be seen in line with Suarez (2015), who provocatively states that 'dialogue processes currently used in geoinformation for disaster risk management fail to yield adequate results in part because they create islands of knowledge in a sea of ignorance' (p. 1734). In order to create stronger linkages to disaster risk management and further upscaling, some recommendations can be given for the testing of the prototype in environments where it could have a stronger impact (see next section).

4.4.3 Possible Fields for Testing the Prototype

4.4.3.1 Use of the Prototype in Vulnerability and Capacity Assessment

Vulnerability and Capacity Assessment (VCA) is a current tool for disaster risk assessment largely built on the participation of at-risk communities (e.g., Guragain et al., 2008; Van Aalst et al., 2008). Expanding on the methodology of Participatory Rural Appraisal (PRA) or Participatory Action Research (PAR), this approach integrates local knowledge and risk perceptions for better risk management and risk communication (e.g., McCall & Peters-Guarin, 2012; see also Chapter 2). In the framework of such methodologies, local stakeholders 'share and analyze their local and traditional knowledge on both livelihoods and disaster risk, to plan and to act for enhancing their capacities and reducing vulnerabilities to natural hazards' (Liu et al., 2018). A variety of participatory tools already come into play in the context of VCA, such as participatory mapping or participatory GIS. Testing this prototype in a VCA setting for the analysis of local vulnerabilities and capacities could thus be the next step to take into consideration.

4.4.3.2 Use of the Prototype in Risk Communication Training

A collaborative editing process holds the potential to be a powerful risk communication training tool. This would allow (early-career) geoscientists who are mainly trained in empirical, quantitative methods to approach hazard phenomena from a qualitative perspective, e.g., responding to how communities perceive a hazard, exploring how they could best be supported to prepare for potential threats, or providing more locally targeted, user-centred scientific information. Another potential advantage is the opportunity for collaboration among different groups of researchers, independent of their location. This would also be beneficial in the context of the debate around lower-emission forms of cooperation, so as not to contribute even more to the climate crisis through risk communication workshops. Unfortunately, this prototype was developed after the audiovisual risk communication training workshop presented in Case Study 2, which is why it was not tested there.

4.4.3.3 Use of the Prototype in Analogue Workshops

Of course, it would also be interesting to test the use of the prototype in an analogue workshop setting. The prototype could have an interesting impact in the context of at-risk neighbourhoods. Together with film exercises (e.g., for filming in the neighbourhoods/homes of participants), this could be an inspiring activity for diverse participants who seek deliberative, creative interventions in their local area. It could also further support important resilience factors, such as building trust and social cohesion among different local actors in the neighbourhood, institutionalising community engagement for preparedness, response, and recovery, and empowering community-based organisations and

NGOs to share knowledge.
Apart from such uses in the field of DRR, the prototype would certainly also be of interest in other fields, for example, as a tool for professional filmmakers to communicate with their clients, as a playful intervention in the framework of virtual conferences, or as a 'plug-in' feature in collaborative software such as Mural, Miro, or ArcGIS StoryMaps.

4.5 Concluding Remarks

The prototype presented here is an attempt to explore, discuss, and creatively approach risk communication as a collective design exercise through the process of collaborative editing. So far, this study has only sketched a theoretical outline for a tool that responds to the current mismatch between technological opportunities for interactive filmmaking in light of AI, digital annotation, and open-source editing software and hazard scientist's lack of adopting these technological opportunities. Using this option to practice post-Sendai risk communication requires further development and testing of the prototype presented here. However, it is vital to stress that the primary goal of the prototype — in contrast to the sometimes simplistic rhetoric of Design Thinking — is not only to 'solve problems'. It can also be seen as a resonant space that seeks to reflect and unveil the problems, tensions, and complexities of risk communication in order to create a more inclusive and productive arena for negotiation. As such, the prototype represents a 'provocation' for further thought and research, a proposal for a novel risk communication tool that can generate both a richer risk dialogue and possibly also more user-centred risk communication products. The resulting films could be products of an intense collaborative effort. They could reflect feedback from a diverse community of stakeholders and go beyond the specific expertise of hazard practitioners and the key challenges that only they have identified.

Chapter 5 – Using Film as an Educational Tool for Post-Sendai Risk Communication Training

This chapter examines the potential of video production as a training tool to enhance key competencies for a post-Sendai risk communication. It presents the findings from two video-based risk communication workshops for early-career geoscientists that were initiated for this research purpose.

In Section 1, I outline the motivation for this case study, namely to address concerns of geo- and hazard scientists from the ALErT group voiced in the focus group discussions in Chapter 3b, using an audiovisual risk communication training framework. These focus group discussions revealed that many researchers of the ALErT group feel insufficiently prepared and supported regarding post-Sendai risk communication and see a need for further communication training. My response is structured around the concept of 'sustainability competencies' proposed by Wiek et al. (2011), which provides a helpful theoretical framework to reflect on the competencies necessary for a post-Sendai risk communication training.
In Section 2, I present the specific course design that aims to provide an alternative to current deficit-oriented communication training by using more reflexive, collaborative, actionable, as well as dialogue-oriented training modules. In particular, I outline how I conceptualised the use of audiovisual methods in such a way that they allow for experiential learning of course participants. Moreover, I outline how I conducted qualitative, semi-structured evaluation interviews to retrospectively analyse the individual learning experiences of the workshop participants. The self-reported learning experiences provided the main data source to identify hints for a development or strengthening of the aforementioned sustainability competencies through the audiovisual training approach.
The findings from the evaluation interviews are presented in Section 3, where I explore possible gains in each of the five competencies through selected interview quotes and further literature analysis. The evaluation also considers limitations and methodological challenges faced by respondents in relation to the workshop design.
Section 4 provides concluding remarks and outlines the necessity for further discussion.

5.1 Challenges of Adapting a Post-Sendai Risk Communication Approach

The exploratory case study in Istanbul demonstrated that enabling students to adapt their current risk communication approaches to a 'post-Sendai' mode is a complex endeavour that requires further practical and theoretical research. As a reminder, participants highlighted a lack of training of for a transdisciplinary, more "people-centred" risk communication, e.g., how to co-design messages and formats based on an assessment of different audiences' needs. Furthermore, they outlined their wish for stronger institutional support to gain more experience and competencies in such novel approaches to risk communication. For some, time pressure and a lack of motivation were other factors that limited their engagement.

The findings this case study make clear that incorporating a post-Sendai risk communication approach (as outlined in the Introduction and Chapter 1) requires a student-centred design framework that promotes, develops, and strengthens a variety of new or unfamiliar scientific competencies.

5.1.1 The Role of Sustainability Competencies in Higher Education for Sustainable Development

The challenges connected to transdisciplinary approaches in research and its communication have been faced in the field of education for sustainable development (ESD). Against the background of the UN Decade of Education for Sustainable Development, an academic debate about how to integrate ESD into global educational systems (e.g., Laurie et al., 2016; Wu & Shen, 2016) has focused attention on different sets of knowledge, skills, attitudes, and values that play an important role both in confronting the complexity and uncertainty of sustainability issues and also in promoting sustainable development with and through science (e.g., Biasutti & Surian, 2012; Cebrián & Junyent, 2015; Lambrechts & Petegem, 2015; Rieckmann, 2012). In a systemic review of different integrated 'sustainability science' competence models, Wiek et al. (2011) isolate five overarching *sustainability competencies* related to 'plan, conduct, and engage in sustainability research and problem-solving based on the interplay of systems-thinking, anticipatory, normative, strategic, and interpersonal competencies' (Wiek et al., 2011, p. 207). These competencies, which are listed in Fig. 5.1, will theoretically underpin this chapter.

Key Competence	Definition
Normative competence	'...the ability to collectively map, specify, apply, reconcile, and negotiate sustainability values, principles, goals, and targets' (p. 209)
Anticipatory competence	'...the ability to collectively analyse, evaluate, and craft rich "pictures" of the future related to sustainability issues and sustainability problem-solving frameworks' (pp. 207-208)
Interpersonal Competence	'...the ability to motivate, enable, and facilitate collaborative and participatory sustainability research and problem solving' (p. 211)
Systems-thinking competence	'...the ability to collectively analyse complex systems across different domains (society, environment, economy, etc.) and across different scales (local to global), thereby considering cascading effects, inertia, feedback loops and other systemic features related to sustainability issues and sustainability problem-solving frameworks' (p. 207)
Strategic competence	'...the ability to collectively design and implement interventions, transitions, and transformative governance strategies towards sustainability' (p. 210)

***Fig. 5.1:** Definition of five sustainability competencies proposed by Wiek et al. (2011)*

Although Wiek et al. (2011) derive these competencies from the perspective of sustainability research, their categorisation provides a coherent and useful conceptual base for addressing learning goals in the related transdisciplinary inquiry of risk communication. My basic premise, therefore, is that the effectiveness of risk communication also depends on the anticipatory, strategic, normative, or inter-personal competencies of communicators that Wiek et al. (2011) refer to, as well as on their ability to reflect their communication approaches within a broader 'systemic' context. Conversely, effective post-Sendai risk communication training can enable hazard scientists to contribute to sustainable development issues through a shared understanding of challenges marked by complexity and uncertainty together with other societal actors, as it is the case with other such science-public collaborations (e.g., Barnosky et al., 2014; Dietz, 2013; Kamlage et al., 2018; Moser, 2014; Rice & Robinson, 2013).

It is unclear from Wiek et al. (2011) how this classification scheme might be transferred into practical educational settings. Moreover, although the need for sustainability competencies has been broadly discussed within the literature, its integration into science education and training remains limited. According to Cebrián and Junyent (2015), an analysis of the perceptions and views of student teachers in relation to education for sustainable development competencies indicated that 'despite the declaration of good intentions and policy developments at the national, regional and international level, little has been achieved in terms of embedding education for sustainable development holistically' (p. 2768). As briefly indicated in Chapter 1, a similar finding applies to science and risk communication training, in which the training of sustainability competencies has so far not been embedded.

5.1.2 Shortcomings of Current Risk Communication Training

There are few comprehensive studies on risk communication training, with the majority of these being in the field of health risk communication (e.g., Beerens & Tehler, 2016; Jose & Dufrene, 2014; Miller et al., 2017; Williams et al., 2008). Most focus on crisis communication training, which is not in the purview of this thesis as it requires very different communication approaches as disaster risk communication for prevention and preparedness. As a result of this dearth of critical inquiry, risk communication training shares the lack of a conceptual framework of clear learning goals, a problem that has been levelled at science communication training more generally (Baram-Tsabari & Lewenstein, 2017). Here, critics complain that methodological frameworks often lack scientific rigour, because methods used for evaluation are heterogeneous and not well described (Miller et al., 2017).

Importantly, science communication (and, by implication, risk communication) training courses are still largely based on the *knowledge deficit-model* (Besley et al., 2016; Simis et al., 2016), wherein the key goal of science communication is to 'rectify' a 'knowledge gap' (Frewer, 2004, p. 392). As Besley et al. (2015) elaborate, 'training efforts continue to focus on skills development related to being more effective in explaining scientific phenomena [...] and not to meaningfully engage with members of the public through dialogue-based approaches' (p. 201). Instead, most risk communication training focuses on the development of specific technical communication skills rather than on the broader scientific competencies outlined by Wiek et al. (2011). This prevailing deficit-orientation of communication training risks strengthening participants' beliefs that communication with the 'general public' — if it takes place after all — 'needs to be simple, carefully worded [...] visual [...] and entertaining' (Cook, 2004; Davies, 2008, De Boer et al, 2005, as cited in Besley & Nisbet, 2011, p. 647). These attributes are important, but the underlying 'edutainment' communication paradigm leaves little space for a broader approach consistent with the requirements raised by the SFDRR, and risks reducing science and risk communication training to a mere soft-skill acquisition for intra-scientific communication or generic outreach activities.

With the persistence of its deficit-oriented underpinnings, the current design of science and risk communication training pays little attention to the active integration of social science perspectives, and therefore remains an under-conceptualised field. For example, theory and practice of science and risk communication beyond the deficit-model have been intensively discussed among social scientists and could inform a more evolved and sophisticated approach to communication training. As outlined in Chapter 1, communication scholars have demonstrated the potential of dialogue-oriented risk communication (e.g., Árvai, 2014; Frewer, 2004; National Academies of Sciences and Medicine, 2017; Renn, 1998), highlighting exchanges that foster 'third-order thinking' through reflexivity (Irwin et al., 2014), take into account the ethical dimension of science and risk communication (Stewart et al., 2018; Wyss & Peppoloni, 2014), or target risk communication efforts on actionable decision-making on the ground (Wood et al., 2012; see also Sanquini et al., 2016).

Finally, another key deficiency in current science and risk communication training is the lack of critical appraisal on the use of audiovisual methods. Climate scientists have used the production of public service announcements as an educational tool (Rooney-Varga et al., 2014), have examined interactive role-play for volcanic crisis communication (Dohaney et al., 2015), or analysed the potential of serious games for crisis communication training (Haferkamp et al., 2010), but in general there is a surprising lack of evaluative interest in the potential of emerging AV technologies to advance risk communication. As outlined in Chapter 1, ubiquitous smartphones, free editing software and increasing bandwidth allow creators to express themselves and to produce, publish, and stream scientific video content worldwide from platforms such as YouTube, TikTok, and Twitch. And yet, despite this digital media revolution, academic training programmes have been slow to leverage the potential of film production as an educational tool (Ickert, 2017; Rooney-Varga, 2014). This is surprising, also because several studies have demonstrated that an involvement in the process of generating audiovisual media production can support and strengthen various skills, such as media literacy, creativity, social learning, analytic, and affective processing or reflexivity (e.g., Haynes & Tanner, 2015; Richter, 2016; Saladino et al., 2020; Weilenmann et al., 2013).

To date, no studies have examined how risk communication training with audiovisual methods might help to develop a broader set of competencies in line with the requirements for a post-Sendai risk communication. For that reason, I explore how such a film-based approach could stimulate those competencies and confront some of the recurring concerns that students such as from the ALErT or STRATEGy group face in dealing with post-Sendai risk communication approaches.

5.2 Case Study Design

In order to confront the shortcomings named above, it was clear that it is not sufficient to simply train early-career scientists 'on "new tools" with "old methods"' (Suarez, 2015, p. 1730). For this study, I conceptualised a prototype for a teaching methodology that went beyond formal science communication training, and focused on competence development with student film production as a 'means to an end'. As in Chapter 4, I used the method of Design Thinking as a structural and procedural lens for the conceptualisation of the training prototype (see. Fig. 5.2). Here, I used mainly the findings from the focus group discussions for the problem definition ('define mode'). Similar to the development of Prototype 3, I also conducted the ideation phase on my own, which represents a modification of the Design Thinking approach proposed by Plattner (2012).

EMPATHISE	DEFINE	IDEATE	PROTOTYPE	TEST
Exemplary quotes, such as: 'I absolutely don't feel like this – this is my scientific part and this is my human part.' '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'	There is a lack of training for geoscientists to develop necessary skills for post-Sendai risk communication	Create a training framework that helps to develop or strengthen sustainability skills	Conceptual Framework for an Audiovisual Risk Communication Training	Evaluation Interviews with Workshop Participants

Fig. 5.2: Using a Design Thinking scheme as a structural and procedural lens for prototyping the training framework (simplified illustration)

In the framework of a 3-day science and risk communication workshop, participants had the opportunity to use the production of short online videos as a process-oriented and playful learning device to explore post-Sendai risk communication approaches. During the workshop, the participants went through all the steps of the filmmaking process, from the initial idea to the presentation of results, thereby being free to choose the format, content, and target audience of their video. At the same time, they were encouraged to not only convey scientific information with audiovisual means but to also to actively reflect and communicate often neglected aspects of their research – for example, its socio-ecological, ethical or cultural dimensions. In addition, they were invited to explore how audiovisual media and methods can be used for a more user- and action-oriented risk communication. As I wanted to pay particular attention to participants' individual learning experiences and perceptions regarding the film production process, I chose to work with two small groups in order to acquire more fine-grained insights.

The first course took place in November 2016 at Potsdam University with 6 doctoral students from the international training network 'ALErT' (Anatolian pLateau climatE and Tectonic hazards). Based on the experience from this pilot course, I gave a second workshop a month later, again at Potsdam University, to 10 participants of the international research training group 'STRATEGy'(Surface processes, Tectonics and Georesources: The Andean foreland basin of Argentina). The interdisciplinary character of both projects meant that the participating researchers came from numerous sub-disciplines, such as paleo-climatology, mineralogy, petrology, seismology, geophysics, and geochemistry, representing a diverse range of age groups, nationalities and origins, with one-third of the course participants being female. Given the research interests of most of the participants, I gave special attention to the communication of geo- and climate risk and its geoethical and sociocultural implications. However, as risk communication was not a subject relevant to all participants, I addressed also more general issues related to science communication in the workshop. During the facilitation of the workshops, I was supported by a professional cameraman and, in the second workshop, also by a science communication trainer, who contributed special vocal training and feedback for the developed storyboards. I divided the course into three major sections represented in the figure below.

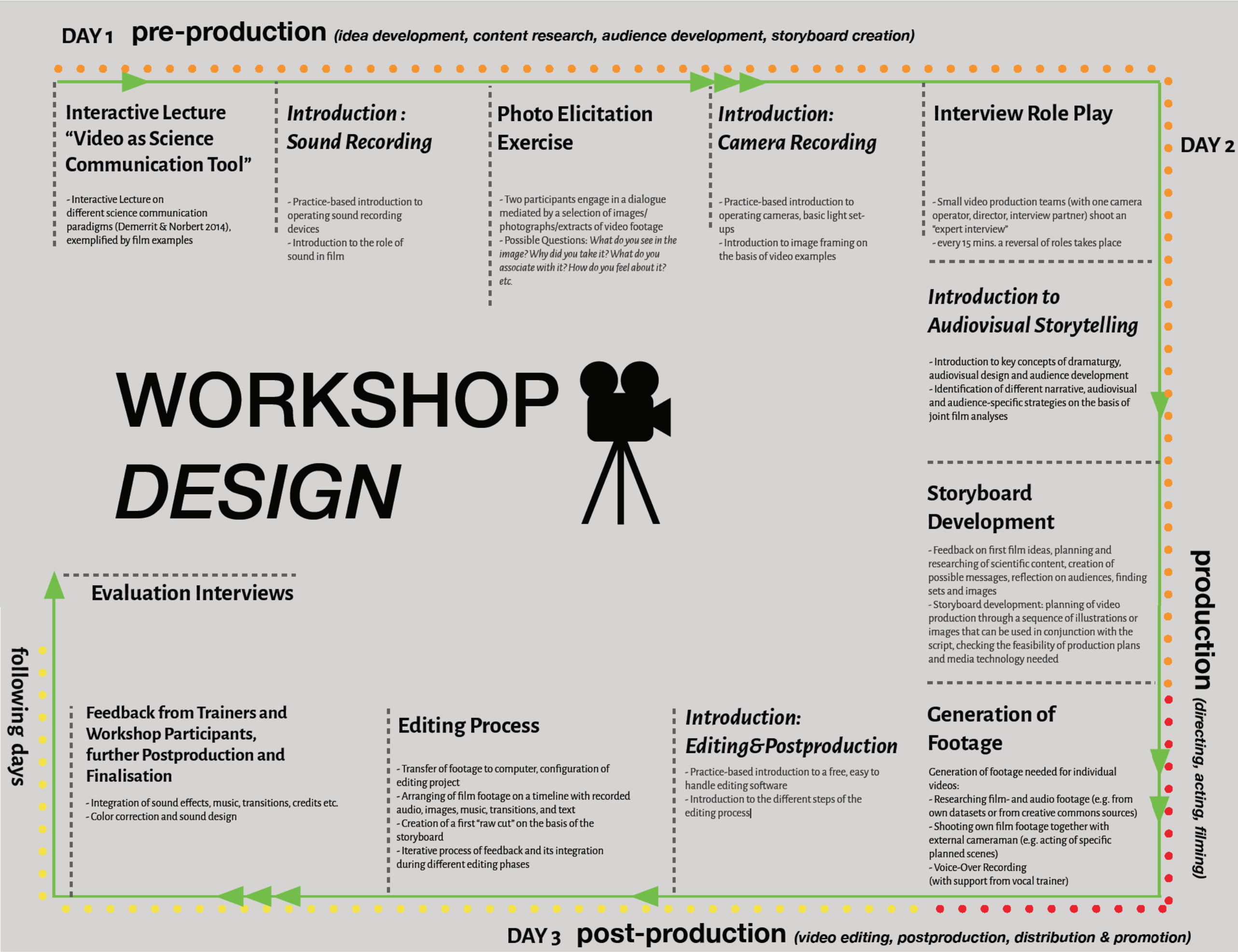


Fig. 5.3: Flow chart

In the pre-production phase, students had to plan and research their film projects, which involved intense preparatory exercises, as well as receiving an introduction to sound- and video recording, dramaturgy and audience development, and the creation of storyboards. The technical equipment was provided through the media centre of Potsdam University and the cameraman. In the production phase, the students generated the actual audiovisual material for their films, which involved acting, directing, filming, voice-over recording, researching film and audio footage online, as well as creating simple sketches and animations.
In the post-production phase, after my introduction to editing and necessary post-production steps, the film material was digitised onto the participants' computers and integrated into an open-source editing program. The students then assembled their material such as recorded voice-overs, film footage, music, and text on a timeline. This was the most labour-intensive phase of the workshop, and the period in which much experimentation took place, as students continued to reflect upon, criticise, and change their projects.

Despite the progression through successive film production stages, I designed the workshop deliberately not as a risk communication training in audiovisual media production. There were to two reasons: Firstly, in line with the concept of 'imperfect cinema' (Gall, 2016), I wanted a highly process-oriented workshop design and wanted to focus on playful experimentation with the medium film rather than on meeting specific dramaturgical or aesthetic standards. I and the cameraman gave technical introductions, but those were reduced to a minimum, as the focus instead lay in the creative and conscious use of audiovisual methods to explore issues related to post-Sendai risk communication. Consequently, I stressed to participants at the beginning of the course that films can emerge, but that they do not need to be finished in the limited time frame of the workshop. Secondly, I also used different visual research methods such as photo-elicitation exercises and reflexivity exercises to the pre-production phase to stimulate reflection on the intricacies of the participants' personal approaches to communicating their science. The following four training modules I specifically designed to foster an understanding of film as a process of social negotiation and to stimulate reflexivity, creativity, and curiosity.

5.2.1 Audiovisual Training Modules

5.2.1.1 Interactive Lecture - 'Video as a Risk Communication Tool'

This introductory lecture aimed to explore four different risk communication case studies through different video material together with the workshop participants: Building on the risk communication modes proposed by Demeritt & Norbert (2014), the film examples illustrated risk communication in the form of a one-way information transfer along the deficit-model, in the form of 'instrumental' approaches to stimulate cognitive respectively behavioural change, or as dialogue-oriented approaches of participatory deliberation. These examples helped students to discuss different risk communication approaches, strategies, and goals and to reflect on possible underlying paradigms with their specific benefits and risks.

Model	Direction	Role of communicators	Role of receivers	Purpose of communication	Film Example
Risk message	One	Educator	Passive	To inform	Disaster Risk Reduction in the European Union https:// www.youtube.com/ watch? v=j3KlaRhEbVE
Risk instrument	One	Educator	Passive	Behavioural alteration	Last minute https:// www.youtube.com/ watch?v=LpvzVstU5RU
Risk dialogue	Two	Active Participant	Active Participant	Knowledge exchange to inform Behavioural alteration	Energieland Climate Cultures https:// youtu.be/ 33ftvqVd9Yw
Risk governance	Integrated	Active Participant	Active Participant	Encourage participation & knowledge co-creation, creation of new knowledge/ viewpoints	Demoenergie https:// www.youtube.com/ watch?v=ASb2jbh2nSY

Fig. 5.4: *Risk communication model proposed by Demeritt and Norbert (2014), with corresponding film examples*

5.2.1.2 Photo-Elicitation Exercise

Before the start of the workshop, I asked all participants to create or to select a series of individual photographs, images or field recordings, they found meaningful for themselves and that they would like to use to start a dialogue with a person not familiar with their science. This step was a preparation for a 'photo-elicitation' exercise, which, as outlined in Chapter 3a, is a non-directive social scientific method that can facilitate dialogue by the use of images (e.g., Collier & Collier, 1986; Harper, 2002; Matteucci, 2013; Wang et al., 2016). During the workshop, I asked students to split up into pairs and to start a conversation based on their image selections, thereby revealing the symbolic qualities of the images such as the denotative or connotative dimension of the selected images (Barthes, 1977). Being encouraged to carefully and creatively consider their image selection and to comment upon them, the participants detected aspects such as feelings, memories, or experiences connected to the images. These conversations were recorded and later analysed to inspire initial ideas for audiovisual storytelling.

5.2.1.3 Reflexive Interview Role Play

In this exercise, I asked groups of participants to create short interview videos about their research, inspired by video-based role plays used in therapeutic filmmaking (Saladino et al., 2020). Each team had a person responsible for operating the camera, light- and sound equipment, an interviewer/director, and an interviewee. After a 15-minutes interview shooting, the team changed the roles to ensure that every participant could experience a different perspectives of the recording situation.

5.2.1.4 Introduction to Audiovisual Storytelling

This exercise I conceptualised to explore and discuss basic concepts of dramaturgy (e.g., Hero's Journey, 3-act-structure, 5-act-structure), audiovisual design, and audience development. I prompted participants to analyse key audiovisual and narrative strategies, using various film examples, including formats such as independent art-house documentaries, presenter-driven TV documentaries, web-based, interactive documentaries, short educational videos, or animated films. Parameters I asked them to identify and discuss included the dramaturgical structure of the films, key messages being conveyed via visual and verbal language, the set design, representational strategies, and/or possible stereotypes, or intended audiences. I also chose those film examples, as I wanted to familiarise participants with the films' online and offline dissemination strategies.

Although the production of final videos was not the primary aim of the workshop, the following films were produced by participants (see Fig.5.5).

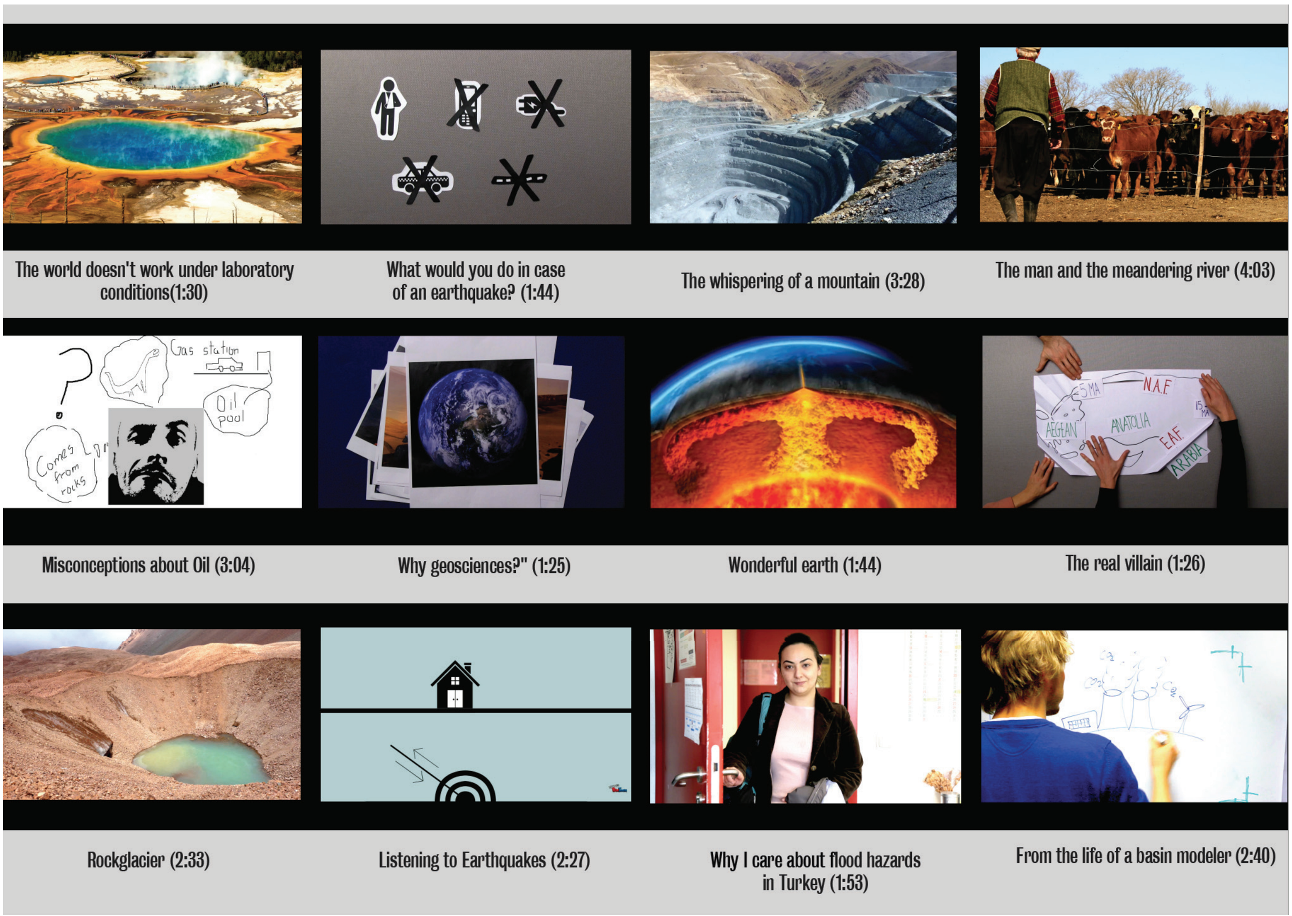


Fig. 5.5: Overview of produced films

5.2.2 Evaluation Interviews

After the course, I undertook 12 qualitative evaluation interviews with the participants in order to gain information about the possible development of sustainability competencies and the impact of the film-based methodology. To assure the generation of insightful and robust data, I elaborated a qualitative semi-structured interview guide in line with the 5-step-framework for the development of interview guides proposed by Kallio et al. (2016). In the first step, the data collection method was chosen. I decided on semi-structured qualitative interviews, as this method can facilitate an in-depth exploration of the experiences and opinions of respondents. As most participants were not familiar with the Sendai Framework and its integration into risk communication practice, and as most of them were not used to an intense reflection on their individual communication experiences, the qualitative interview provided the necessary space for exploring these themes. In addition, this interview method helped me to voice the insights that were relevant and meaningful for the participants (sensu Kallio et al., 2016), and to reveal individual perspectives on the exploration of alternative science and risk communication approaches through moving image methodologies. After a second step in the form of further interdisciplinary literature review of issues relevant for this case study and the interview situation, the third step was dedicated to formulating major questions for a preliminary semi-structured interview guide. The fourth step was to pilot test this guide with one interviewee. Based on this test, I reformulated some of the questions to make them more understandable and concise, which then led to the final interview guide.

A) Previous Experience in the Field of Science and Risk Communication	1	Please describe your previous experience in science and risk communication prior to this workshop.
	2	Which media or formats did you use so far for your science / risk communication?
	3	What science / risk communication knowledge did you acquire in a university context prior to this workshop?
B) Audio-Visual Media in Science and Risk Communication	4	What is for you the potential of audiovisual media in communicating your research or geo-related themes? What is for you the potential of audiovisual media in risk communication
	5	Apart from audiovisual media as "outreach tool", can you imagine any other helpful features of using audiovisual media in science and risk communication contexts?
C) The workshop: Science and risk communication through audiovisual methods and media	6	What societal impact of your individual research did you want to communicate in your video?
	7	What were the key learning outcomes of the workshop for you?
	8	Did the process of video-making help you to think/act differently regarding your individual science / risk communication? If so, why? If not, why not?
	9	a) What modules of the workshop were helpful/not helpful for you in learning about the aspects you mentioned in 8? Please describe the different learning impacts of the different course elements (Interactive lecture, photo elicitation exercise, interview role play, introduction to audiovisual storytelling, production, post-production).
	10	What were retrospectively the biggest challenges in the process of video-production?
	11	Have you already shown your video? Where? What kind of feedback/ conversation has emerged from you showing the video?
D) Recommendations for future science communication training	12	What are the aspects you criticise most about the workshop?
	13	What would be your recommendations/wishes/ideas for future science video courses in a university context?

***Fig.: 5.6:** Interview Guide*

During the interview, I gave special attention to providing my interview partners with enough space to freely express their impressions and experiences based on the open-ended questions, while ensuring that the theme of competence development through moving image methodologies remained in the focus of each interview. In addition, the interviews took place in such a way that dialogue and changes to the order of the questions were possible at all times (Bernard, 2017). As I suspected a potential bias in the fact that I was at the same time the person facilitating the workshop and conducting the evaluation interviews, I explained to the respondents in detail that I was particularly grateful for constructive criticism and not personally offended by negative feedback. I conducted almost all interviews one-to-one at the participants' workplaces. Due to increased project-related travelling, however, I conducted four interviews via online video calls. All interviews were audio-recorded and fully transcribed. One interview was held in Spanish, one in French, and three in German to avoid any limitations in the expression of my interview partners. The interviews lasted 40-90 minutes, depending on the time that could be allocated by researchers and as contributions from interview partners varied in scope and complexity.

Based on the transcribed interviews, I carried out a thematic analysis, as the primary intention was not to test a theory but to descriptively form a picture of how the aforementioned dimensions were reflected by participants. Their responses were coded manually based on recurring and common themes from the four sub-categories (Boyatzis, 1998). These categories were 1. the previous experience participants had with (audiovisual) science and risk communication and communication training, 2. their views about the potential of audiovisual media in risk communication, 3. their views on the film making process within the workshop and the competencies acquired through the different workshop modules, and 4. their recommendation for future film-based science and risk communication training, based on their views about the strengths and weaknesses of the workshop methodology. As my major research interest was related to category 3, the interview statements that related the participants' views on the film making process within the workshop and the different modules provided the most extensive findings for this study.

The following thematic analysis is mainly carried out with supporting quotes that are assigned to the themes of the four categories. Although robust empirical evidence cannot be provided with this pilot study, the thematic analysis has helped me to determine patterns and allowed an in-depth evaluation of how the process of filmmaking supported participants in developing sustainability competencies. I want to stress that this study does not intend to establish a novel framework for assessing sustainability competencies, but rather aims to provoke discourse about the potential of audiovisual methods as an educational tool for post-Sendai risk communication training.

5.3 Analysis of Evaluation Interviews

The analysis of the qualitative semi-structured interviews revealed major recurring themes, the dominant ones being:

- the multi-faceted potential that participants see in using audiovisual media and methods for their science and risk communication, together with the learning outcomes, and the inspiration the participants gained from the workshop,

- the general lack of communication training in different university contexts, and
- their uncertainties about their roles and responsibilities as communicators, including the possible loss of trust and credibility when using audiovisual media to creatively express subjective attitudes, opinions or feelings.

In the following sections, I provide an analysis of these themes, linking them to the question of how they relate to the possible development of different sustainability competencies outlined by Wiek et al. (2011). Indicative quotes from the respondents are used to illustrate the different learning pathways and critical reflections that were triggered through the filmmaking process along with the exercises.

5.3.1 Normative Competences

> Normative competence is the ability to collectively map, specify, apply, reconcile, and negotiate sustainability values, principles, goals, and targets. This capacity enables, first, to collectively assess the (un-)sustainability of current and/or future states of social-ecological systems and, second, to collectively create and craft sustainability visions for these systems. This capacity is based on acquired normative knowledge including concepts of justice, equity, social-ecological integrity, and ethics. (Wiek et al., 2011, p. 209)

At the time the workshop took place, the majority of participants were involved in research areas that have strong implications for sustainability, such as research about past climate change and climate change adaptation and mitigation, renewable energies, the generation and extraction of minerals or rare earth, or natural hazards and risks. In the framework of the workshop, all participants developed individual stories about their research on the basis of intense research and reflection about possible audiences, communication goals and messages. As their stories were in different ways addressing the societal dimension of their research, most participants necessarily voiced important normative aspects through the filmic language. Many of them not only actively assessed key issues of (un)sustainability throughout the filmmaking process but also developed visions and strategies of how to actively approach them — including their own engagement in making a film.

Firstly, regarding the assessment of (un)sustainability as the first component of normative competence that Wiek et al. (2011) refer to, it can be stated that the process of filmmaking usually involves an active negotiation of norms and values that usually require complex decision-making processes and a positioning of the author. Therefore, voicing ethical and normative concerns about (un) sustainable practices of geoscientific research was part of such decision-making and positioning processes. Against this background, it is helpful to draw on the concept of *reflection* and *reflexivity* proposed by Bolton (2010). 'Reflection' is described by the author as an

> in-depth consideration of events or situations, the people involved, what they experienced, and how they felt about it. This involves reviewing and reliving the experience to bring it into focus, and replaying it from diverse points of view. (Bolton, 2010, p.13)

Reflexivity (or being reflexive) is described as

> a way of standing outside the self to examine, for example, how seemingly unwittingly we are involved in creating social or professional structures counter to our espoused values. It enables us becoming aware of the limits of our knowledge, of how our own behaviour is complicit in forming organisational practices which, for example, marginalise groups or exclude individuals. Reflexivity uses such strategies such as internal dialogue to make aspects of the self strange. (Bolton, 2010, pp. 13-14)

5.3.1.1 Examples for Reflection Triggered by the Exercises

The analysis of the interviews provides evidence that both reflection and reflexivity were fostered through some of the workshop modules. Several respondents actively reflected and assessed their own intentions, practices and their sustainability, and raised critical questions around justice, equity, socioecological integrity, and geoethics. For example, during the photo-elicitation exercise, one respondent actively contemplated his fieldwork experience in a mining area, where he witnessed several conflicts of interest about the mine's impact on factors such as the environment, employment opportunities, land rights, or ethical questions. He expressed that:

It's thanks to the photo-elicitation exercise that I really could crystallise these ideas and realise by looking at myself differently through these sort of external eyes that there was a really deep link between what I do and what happens there. (Respondent 10, mineralogist)

Film example 'The whispering of a mountain' *(2.54 mins.):*
https://youtu.be/8wy8Zd_91Aw

Similarly, a respondent who created a film about river erosion explained:

We build cities around rivers, and if it's eroding, then we need to know where that is in order to determine where we're going to build things [...] I think making the video helped me to think about these implications of my research in a more tangible way and to expose them. (Respondent 11, geomorphologist)

Another respondent active in the field of flood hazards and its mitigation in Turkey appreciated the film process for a reflection of the difficulty to implement the Sendai Framework at the local level in Turkey, stating:

I think my film can create an awareness of this lack of implementation. (Respondent 02, hydrologist)

Fig. 5.7: *Stills and voice-over-sequences taken from a participant-generated video*

An insightful example is also the following storyboard that depicts the normative dimensions related to the study area of the participant:

Scene No.	Voice-Over	Images and Sound
1	In my daily life I see people using their mobile phones in their cars and in their trains. I also see them with their computers in their offices and at their homes.	Series of pictures of people with phones in a car, trains, computers at work and at home
2	What most of them don't realise is that their technology is related to my work as a mineralogist.	Picture of me in the lab
3	Mobile phones are made of 40 different elements, only 5 of them are rare earth elements. Elements that are not easy to find but we use them in all of our daily life technology. For example, in wind turbines, only 3 rare earth elements are used but tonnes of them are needed.	Picture of a mobile phone, a computer and wind turbines and the names of REE incorporated in them
4	Rare earth elements can be mined only in a few countries in the world, like China, Australia or the U.S.	Picture of a world map showing the big REE mines
	The tricky thing is that we only have a few known reserves but rare earth elements are highly needed. To avoid conflicts and major environmental damage, we need to better understand how and where they are formed.	
5	Here my work comes into play. Me as a mineralogist has the task to study the formation processes of rare earth elements with the help of modern technologies.	Picture of me in the lab

***Fig. 5.8:** A first storyboard draft*

5.3.1.2 Examples for Reflexivity Triggered by the Exercises

Regarding reflexivity, the interview evaluation provided several indications that participants actively made attempts to stand outside the self to examine social or professional structures. For example, the above-mentioned respondent who made a film about his fieldwork in a mining area pointed out that he deliberately decided not to communicate a 'conclusion' or a 'certainty', but to make his inner conflicts transparent. He described that the experimentation during the editing process helped him a lot to have an internal dialogue, as he could

> openly and creatively explore his ambivalences working in the field of extractive industries. (Respondent 10, mineralogist)

He used the construction of the dramaturgy of his film to reflexively narrate this tension and stated:

> If I had an answer I think I would not have raised all these questions [in the film]. I do not know if I will continue in the field of mineral resources [...]. As a scientist, I see that the consequences are there. But what do I choose

> for me to respond to these consequences?' (Respondent 10, mineralogist)

The reflection of this respondent's own societal role and the responsibilities as well as related insecurities can be seen in line with Bolton (2010), who describes that reflexivity 'requires being able to stay with personal uncertainty, critically informed curiosity, and flexibility to find ways of changing deeply held ways of being: a complex, highly responsible, social, and political activity' (Bolton, 2010, p. 19). This example makes clear that the process of filmmaking can trigger very personal questions on normative views and can help to explore their implications with creative means.
Another respondent highlighted the importance of individual communication requirements. Here, he emphasised in particular raised the notion of authenticity, describing openly that he was struggling with different competing roles during the interview exercise. On the one hand, he wanted to give 'perfect statements as a scientific expert' in his interview, but at the same time, he didn't find himself authentic in this role, explaining:

> When you see yourself in the interview, you see that you are not really attached to the feeling or pose that you try to express. Just by using this recipe of being the knowing expert. (Respondent 09, palaeoclimatologist)

5.3.1.3 Role Conflicts and Uncertainties of Self-Representation

The aforementioned respondent criticised certain 'objectivity standards', stating:

> When you are showing something to other people and you want them to really get that message, I think it's good to leave them also with a feeling, not only with facts. And I think film is a way to combine both worlds. (Respondent 09, palaeoclimatologist)

This statement can be reflected in line with Friedemann Schulz von Thun (1981) who outlines that information transfer can become a living, animated process if the communicated is recognisably rooted in the personal, and if the separation of thing and person, of the factual level and relationship level are abolished. The author states that most recipients are more willing to learn when the person behind the lecturer shines through what has been said. The two examples described above illustrate that with the shift away from the paradigm of an 'objective science' where researchers look from a seemingly neutral perspective on their subject matter, many questions arise about the researcher as the acting [and communicating] subject (Daston & Galison, 2021). Also the second component of normative competence, the creation and the crafting of sustainability visions that Wiek et al. (2011) refer to, is strongly entangled with this question of how participants reflect their roles as communicators. For example, one participant outlined his wish for more ‘actionable’ communication, while also acknowledging:

> Risk mitigation in Turkey is a far more complex and controversial theme than what I can express with my story about the broken arm [...] but maybe it triggers curiosity. (Respondent 04, geophysicist)

Fig. 5.9: *Stills and voice-over-sequence taken from a participant-generated video*

5.3.1.4 Uncertainties about Responsibilities as Communicators

The creation and crafting of sustainability visions seem to correspond to what Schneidewind et al. (2016) describe as innovation and actionable approaches ‘to increase the scope of societal action and open up previously unthought-of solution spaces’ (Schneidewind et al., 2016, p. 6). However, the idea of providing ‘actionable’ information (sensu Wood et al., 2012) through their films in order to increase the adaptive capacities of their target groups was seen critically by some participants. This observation overlaps with the findings from the transdisciplinary workshop in Case Study 1, in which some participants expressed their doubts about any form of (political) advocacy. For example, one respondent expressed uncertainties about using film as a communication tool to help with ‘solving’ problems, highlighting:

> We [as scientists] just like to grow our knowledge and share it, not necessarily because there is a human risk involved, or because we’re trying to prevent a risk. But just for learning more about the risk. (Respondent 05, petrologist)

This conflict was also perceived by two other respondents who described the potential impacts of an 'actionable communication' on message framing. Typical was the statement of one respondent who expressed her doubts that explicit recommendations in the field of risk communication might be seen as manipulative rather than informative and objective. She outlined the potential of the medium film to reach audiences and 'impress them on an emotional level' (Respondent 04, glaciologist), something she depicted as potentially risky for scientists' credibility.

On the other hand, several respondents also appreciated an actionable communication and to move from being data providers to being 'translators and messengers of our own data' (Respondent 06, palaeoclimatologist). Through the process of assessing the topic of societal implications and sustainable development in their specific research areas, most of them felt inspired to use the film production process as an opportunity for a different approach to communicating their science:

> I find it really important to realise precisely this important aspect of communication, that I am not just a scientist that remains inside the office and only publishes his data. (Respondent 10, mineralogist)

Some participants went even further and reflected on the disconnection between science and risk communication and real-world application, criticising that certain communication approaches do not help to 'connect' to non-expert audiences and do not provide them with actionable information. For example, one respondent expressed his view, that simply offering 'personal stories' of them 'as successful researchers' was not a 'sufficient' response to societal problems. Instead, he outlined:

> It has to be useful this knowledge [...] to react to possible changes in the climate [...] to more frequent droughts or more frequent floods. (Respondent 09, palaeoclimatologist)

Finally, it can be stated that the majority of respondents reported that working with audiovisual media provided them with a space to reflect on normative questions reflectively and reflexively, something they usually do not encounter in their everyday research routines, 'because there isn't really a time where you sit down and think about that' (Respondent 05, geomorphologist), or because 'the focus is usually on presentations and publications' (Respondent 08, tectonophysicist). Questions such as which narrative perspective to take, which message to convey, and how to frame it were not only seen from a purely scientific or storytelling-specific angle but also thought of through the lens of normative knowledge. For some of them, this process triggered a reflection about fundamental themes, such as their identity, their position in society, or future career paths.

Fig. 5.10: *Workshop impressions*

5.3.2 Anticipatory Competence

> Anticipatory competence is the ability to collectively analyse, evaluate, and craft rich ''pictures'' of the future related to sustainability issues and sustainability problem-solving frameworks. (Wiek et al., 2011, pp. 207&209)

For Wiek et al. (2011), anticipatory competence consists of several components: The ability to 'analyse' pictures of the future[1] is according to the authors equivalent with 'being able to comprehend and articulate their structure, key components, and dynamics';
the ability to 'evaluate' them is constituted through 'comparative skills that relate to the ''state of the art'''; and the ability to 'craft' them is associated with 'creative and constructive skills'.
'Pictures', similar to 'stories' or 'images', Wiek et al. describe as 'an open notion to include qualitative information, quantitative information, narratives, imagery, etc.' (Wiek et al., 2011).

The thematic analysis of the evaluation interviews shows signs of respondents' learning outcomes that appear to match with the above-mentioned description of anticipatory competence. Here, however, Wiek et al.'s (2011) 'ability to collectively analyse, evaluate, and craft rich pictures' (Wiek et al., 2011) is described as 'audiovisual literacy' and 'storytelling skills', because these terms seem to better apply to the competencies developed in the workshop, without contradicting the original definition. Audiovisual literacy can be understood as a sub-category of the broader term 'media literacy', which is defined as the ability

1 Although Wiek et al. explicitly refer to 'pictures of the future', I will also include 'pictures of the present' in my analysis, as those are relevant to consider in post-Sendai risk communication.

‘to access, analyse, evaluate, and create messages across a variety of contexts’ (Christ & Potter, 1998, p. 7). A more elaborated definition is provided by Pauwels (2006), who defines (audio)visual literacy as

> a reflexive attitude (throughout the production process), a specific body of knowledge, and even a certain level of proficiency or skill in assessing and applying specific characteristics (strengths and limitations) of a particular medium, and awareness of cultural practices (codified uses, expectations), and the actual context of use (including the cultural repertoire of the intended audience). In other words, a visually literate scholar should be aware of the impact of the social, cultural, and technological aspects involved in the production and handling of representations, as well as the different normative systems that may be at work and how they exert a determining influence on the eventual appearance and the usefulness of representations. (Pauwels, 2006, p. 22)

I would suggest expanding this definition and to also include the ability to coproduce (audio)visual content together with other media professionals. A focus on the development of ‘audiovisual literacy’ seems worthwhile, especially because moving images have a growing influence on the public perception of science (e.g., Erviti & Stengler, 2016), which makes the ability to analyse, evaluate, and craft audiovisual media increasingly important.

The competence of ‘crafting’ or creating rich (audiovisual) ‘pictures’ that Wiek et al. (2011) refer to, however, involves not only audiovisual literacy but is also closely tied to the competence of using ‘storytelling’ or ‘narrative methods’ to assemble and make meaning out of different sources of information. As already briefly indicated in Chapter 1, cognitive psychology and educational science have been providing empirical evidence since the 1980s that learning processes can be effectively supported through the use of narrative methods (e.g., Kirsch, 2016; Morgan & Rinvolucri, 1983). Narrative competencies have become a central feature of Education for Sustainable Development (Franck & Osbeck, 2018) as well as for science communication more generally (e.g., Dahlstrom, 2014; Olson, 2018).
Here, the thematic analysis will focus on the two previously mentioned dimensions — audiovisual literacy and storytelling skills — as central parts of an anticipatory competence.

5.3.2.1 Anticipatory Competence as Audiovisual Literacy

All respondents indicated that the introduction to audiovisual storytelling as well as the conversations triggered by it provided them with important knowledge of how to to access media, such as online platforms, tutorials, science video channels, open-source footage platforms or image archives. As most of the participants frequently watched and commented on science-related videos and seemed to have a relatively high digital literacy, they could also actively contribute their knowledge to the course. During the exercises, participants used a variety of sources for their own video productions and to provided themselves with 'helpful research tools for the video production' (Respondent 2, hazard scientist).

In terms of how it influenced the participants' ability to analyse audiovisual media, the joint film analysis was described as insightful. The different examples helped participants to distinguish a variety of different formats and channels, to decode narrative or audiovisual strategies, or to reflect upon target groups being addressed. A typical comment, outlining the appreciation for this exercise, was:

> We were inspired to see certain things [...] to develop the eye of experts [...] to adapt a way of seeing that we would not have had before. (Respondent 10, mineralogist)

The interview role play was described as valuable for analysing media. As participants could adopt the perspective of different media professionals, they increased their awareness for the different parameters that influence the film production process, as outlined by this respondent:

> How should we formulate the question [...] should we film outside or inside? This angle or that? How does that change the message? I would say that was also the purpose of the workshop for me: To let us know these kinds of things exist and have an impact. (Respondent 05, petrologist)

Another respondent stated that this exercise was useful 'to see yourself from outside and prepare for being recorded' as well as for understanding the 'needs of the different parties involved in a recording situation. (Respondent 10, mineralogist).

Altogether, several respondents expressed having obtained an improved understanding of the particularities of audiovisual media production and audiovisual language. This is consistent with authors such as Parr (2007), Mondada (2009), and McKnight et al. (2016) who outline the unique ways in which the use of audiovisual methods in diverse training contexts can enhance participants understanding of the mediums' capacity to communicate the bodily, spatial, and temporal dimensions of reality and to compare it with other media, such as text or static images. The importance of being able to analyse and understand the characteristics of the medium film was summarised by a respondent, who stated:

> We have just started to explore how to read films. (Respondent 2, hazard scientist)

Regarding the creation of audiovisual media, the technical introductions, as well as the entire production and postproduction process, were seen as valuable, as participants acquired skills in using film equipment and software. Several respondents stated that they gained 'confidence' (Respondent 7, seismologist) in using this technology, outlining that being able to

> find the best place, the right light, the good sound [...] to have precisely these technical skills, it is extremely important (Respondent 10, mineralogist).

However, some of them were also struggling with the unfamiliar technical requirements and were partly frustrated by the amount of time they needed to invest in order to understand the editing software, stating that in future communication projects, 'you are not going to do everything because you don't have time to do it' (Respondent 1, geochemist).

Besides accessing, analysing, and creating audiovisual content, respondents also described several skills that relate to what Jenkins (2006) describes as *transmedia literacy*, a series of advanced competencies related to digital interactive media production and consumption. For example, participants were drawing on their everyday experiences with different social media platforms and linked their experiences and inspirations regarding online videos to work out how to practically produce such viewable content in the framework of the workshop. In addition, respondents were not only motivated to cite different sources but also to contextualise video within an increasingly multimodal communication (Kress & Selander, 2012), in which video co-exists within many other media formats. In that sense, an active examination and use of innovative information as well as communication technologies took place throughout the workshop. For example, knowing more about the specific strengths and weaknesses of videos for online communication was outlined as a learning outcome by respondents, as this quote from one respondent illustrates:

> For example, I can provide more detailed background information with a blog article, in which I can integrate my video to illustrate or inspire and to make sure that I trigger peoples curiosity about the topic. And this blog I can then promote via Facebook and many other channels. (Respondent 2, hazard scientists)

This quote also exemplifies that awareness for 'transmedia storytelling' across online platforms, which 'uses multiple media simultaneously in an expansive way to better tell a single, complex story' (Moloney & Unger, 2014, p. 110) was potentially heightened in the framework of the workshop, as this respondent regarded the dissemination of her video as part of a broader transmedia communication strategy.

In addition, the workshop seems to have also triggered the reflection of some respondents about the democratization of media creation. A typical quote came from a respondent who referred to his observation that formerly passive (non-academic) 'consumers' can become 'prosumers' active in the production of media content (e.g., Ciastellardi & Di Rosario, 2015). He stated that those prosumers can strongly contribute to the creation of (scientific) knowledge as they
'are passionate, not necessarily experts, but people who will produce and share content in a much more open and free way than, for example, the television does nowadays' (Respondent 10, mineralogist).

5.3.2.2 Anticipatory Competence as Storytelling Skills

The exercises and the video production involved course participants in a process that went beyond familiar procedures of them communicating their science. While participants were used to conveying unbiased research results as objectively and concisely as possible, e.g., through scientific papers or conference presentations, the course challenged them to translate their research into more reflexive, user- and action-oriented stories in line with requirements for post-Sendai risk communication. Creating a captivating storyline as an interplay of images, sound, and text for a specific audience required them to engage in a multi-layered process:
They needed to find their potential audiences by researching their audiences' life-worlds and preferences in as much detail as possible, while bearing in mind

that this audience is expecting a captivating and understandable storyline adapted to individual preferences and contexts. In addition, they had to make selections about their film subject and the key messages they want to convey. Developing a narrative and enacting it through combinations of image, text, and sound was another step, which required them to elaborate and shape the messages they want to convey and to explore the potential of audiovisual methods and technologies.

The motivation, interest, and excitement to engage with this process were continuously high, most probably due to the highly positive views respondents held about audiovisual storytelling. A joint theme that respondents addressed was, for example, the immersive potential of audiovisual storytelling and its ability to captivate audiences' attention, as this quote expresses:

> It's alive! [...] people do not have to force themselves to be attentive. From the moment it is well done, the film takes them directly. (Respondent 10, mineralogist)

Additionally, the possibility to engage the senses was highlighted by respondents:

> We can use sounds, we can use our voice, we can integrate our pictures [...] it moves [...] it's the rhythm, the possibility to tell a story that pleases [...] that we manage to grasp. (Respondent 09, palaeoclimatologist)

The following quote particularly highlights the potential of audiovisual storytelling to achieve a more personal and integrated approach through the playful combination of different elements:

> Film allows movement, immersion, and retreat in the image as well as behind the camera. Even your own voice blurs into a concept of movement [...] unlike an interview, where the focus is usually only on what is said. It's more holistic. (Respondent 12, sedimentologist)

The statement of one respondent that 'the brain is naturally captured' (Respondent 09, palaeoclimatologist) through audiovisual media can be linked to what Moloney & Unger (2014) address when stating that 'we paint deeper and more memorable mental images when information is delivered as narrative' (Moloney & Unger, 2014, p. 110). Furthermore, their contention that 'narrative stories appeal to the imagination' as they 'provide more opportunity for the story-based value judgments we apply to any information we receive' (Moloney & Unger, 2014) is consistent with respondent 9's remarks.

While there was celebratory and positive appreciation of audiovisual storytelling, developing distinctive narrative strategies was perceived as far more complex and challenging for the participants. In line with Baram-Tsabari & Lewenstein (2017), respondents outlined how specific communication practices are being used in different contexts, depending on audiences' needs and communicators' objectives. For example, one participant reported that he 'appreciated the joint video analysis', as the 'clarification' of distinct audiovisual and dramaturgical strategies helped them 'to more critically assess' authors' possible 'intentions' or preferences (Respondent 3, mineralogist). Decoding the audiovisual languages of different authors was considered as inspiring for the participants as well as supporting them in the development of their own audiovisual and narrative approaches. In the framework of the storyboard development, participants had to translate their ideas (possibly inspired though the exercises) into a coherent filmic text. For many participants, this step was an entirely novel approach of communicating their science, as this response indicates:

> I would say the most important thing for me was to try to explain things in a different way [...] thinking of other possibilities and to try to communicate in different ways while having your audience in mind. (Respondent 05, petrologist)

Secondly, the photo-elicitation exercise helped to raise awareness of the different semantic layers of communication. This training step aimed to support participants to deeper explore their chosen images through a conversation and to develop first ideas for their film. According to Respondent 3 (mineralogist) this exercise allowed for a 'work of introspection' and to access feelings triggered by the process of analysing the images, as this quote indicates:

> It wasn't a purely rational process [...] something inspired me in a way to chose that picture, and I just wanted to talk about my thoughts and feelings. (Respondent 05, petrologist)

Through the conversation upon the selected images, participants were also inspired to see their selection 'through the eyes' of their 'counterpart', and to critically interrogate themselves how 'this image can be of any interest for somebody apart from me' (Respondent 08, tectonophysicist). Furthermore, the process of talking about the images stimulated some participants to detect 'hidden stories'. One respondent described how this exercise helped him to look at his fieldwork recordings in the role of him being a filmmaker:

> I took a lot of videos on the road [...] and during our conversation I suddenly thought they express this very well: We change! We move! We go elsewhere! We have the impression that the story is moving forward. (Respondent 10, mineralogist)

During the actual video shoot, respondents were describing the value of experimenting with different steps of the film production. For example, the voice-over recording was perceived as a possibility to express individual perspectives through the specific intonation of the texts the participants wrote. One respondent outlined the relevance of 'the feeling that you can transmit with what are you doing with your voice' (Respondent 04, glaciologist).
This described value of finding other means of expression beyond text can be seen in accordance with Lorimer, who outlines that film can 'escape text- and talk-based approaches' (Lorimer, 2010, p. 242). Furthermore, several participants stated that getting involved with audiovisual storytelling allowed them to find a more flexible and playful approach to communicating their themes, as these responses illustrate:

> I see film as a way to act more freely and to express myself, and not to be confronted with myself in such a hard way, as in a photograph or interview. (Respondent 12, sedimentologist)

> Working on the storyboard really helped me to communicate my thoughts. (Respondent 11, geomorphologist)

Here the respondents outlined that they appreciated particularly the 'imperfect cinema'- mode (Gall, 2016) of the workshop, as the low expectations towards technical standards and the adaptation of different roles (e.g., cameraperson, editor, authors, protagonist), as well the focus on experimentation with the medium, provided space for improvisation and creativity. For example, respondents expressed their appreciation of learning how to

> create communication in a very simple but not simplistic way without having to go very far technically' (Respondent 09, palaeoclimatologist), and 'to [...] unlock something that was maybe sleeping in me. (Respondent 06, palaeoclimatologist)

Taking the pressure from participants to create a 'perfect movie' led many participants to enjoy the process of filmmaking:

> Playfulness and imperfection are not necessarily a bad thing in education, on the contrary. I think we can [...] learn, think, and educate, while having good times! (Respondent 10, mineralogist)

These quotes can also be read in line with Suarez (2015) who highlights that standard disaster risk communication tools only seldomly engage participants in a 'desire to learn, collaborate, and improvise' (p. 1730), while tools that allow for playful experimentation usually foster the motivation of participants. Additionally, most course participants were made aware of their individual 'pre-conditions' for creativity. For example, one respondent preferred to use the editing process for openly playing with different filmic fragments and rejected the option to develop a storyboard beforehand, stating that too much planning 'puts you in some range' (Respondent 10, mineralogist). Others expressed the view that they needed a 'precise storyboard' as a shooting plan they could properly follow.

However, some of them also outlined not only a liberating or inspiring character of the workshop, but also that time pressure played a role because of self-set goals to produce a final video by the end of the workshop. A typical comment was:

> It would have been better if the workshop had lasted a week. We rushed through the workshop quite a bit. (Respondent 04, glaciologist)

Finally, when being asked to outline a major learning impact, one respondents stated as a key finding that filmmaking is 'time consuming' (Respondent 04, glaciologist). Others stated that after the workshop they felt more aware regarding audiovisual media, being motivated to apply their first insights to other video projects. One respondent stated that she 'was inspired' to make a video right after the workshop as she was so 'enthusiastic' about 'having acquired these new skills' (Respondent 04, glaciologist).

Another typical comment was:

> It was really important to have this experience because it opened your eyes to things you wouldn't usually see. Most importantly, how storytelling can make your study more valuable to people. (Respondent 01, seismologist)

5.3.3 Interpersonal Competences

> Interpersonal competence is the ability to motivate, enable, and facilitate collaborative and participatory sustainability research and problem solving. (Wiek et al., 2011, p. 211).

Closely entangled with the normative dimension is the question of how the filmmaking process encouraged participants to think about how to engage in a more people-centred communication, and the interpersonal competences this requires. Interpersonal competence, according to the authors, includes skills related to communicating, deliberating and negotiating, collaborating, leadership, pluralistic and trans-cultural thinking, and empathy. Moreover, 'the capacity to understand, embrace, and facilitate diversity across cultures, social groups, communities, and individuals is recognized as a key component of this competence' (Wiek et al., 2011, p. 211).

5.3.3.1 Video Production as a Collaborative Process

Video production is an inherently collaborative process that cannot be reduced to the mere production of a technical communication 'product'. Complex social negotiation processes take place during all the steps of media creation and dissemination, which is also one of the reasons why 'Video recordings are used more and more within social sciences for the study of social interaction' (Mondada, 2009, p.68). The negotiation processes that are taking place in the context of the video-making process can be understood in line with Engström et al. (2012), who introduce the term *mediated looking*. The authors argue that 'video technologies support a type of collaborative gaze' and define three different forms of the latter: a) 'looking editorially', respectively making decisions on what to select for display in a storyboard or a video timeline, b) 'looking together as a team', e.g., in creating several complimentary camera perspectives together as a team, and c) 'looking on behalf of others', e.g., potential groups of audiences or viewers. The latter category involves not just looking at a presumed audience but can also include the cameraperson looking on behalf of the editor or director (Engström et al. 2012, p.2).

For example, during the storyboard development, participants had to decide upon a story to narrate ('type A – gaze'). This decision was largely taken based on a reflection how this idea for a story could be of interest for a specific audience ('type C – gaze'). Matching this personal idea with audience requirements was actively practised by all participants, as this quote illustrates:

> Part of the video, in fact, is a form of self-reflection for myself. Secondly, I thought about my sister to see it. Or people who are interested in those questions. (Respondent 10, mineralogist)

As a consequence of this chosen audience, participants had to ask themselves a series of questions, such as how their science might relate to audiences' life-worlds, how it might impact them, or how it might become relevant and interesting for them. For this step, the participants had to explore diverse perspectives and non-traditional data sources, for example through active online research or market research on their target audience, or through initiating a dialogue with the audience they had in mind in order to test or adjust their film ideas. Developing this audience-aware approach that emphasises how spectators co-experience events was perceived as valuable, as this quote shows:

> To ask from someone else's perspective: What is the message? [...] What is the purpose of this guys research? What are the consequences? [...] But also: What elements do I want to put? [...] That was a good lesson for me. (Respondent 05, petrologist)

A further result of this 'mediated looking' was for some also the development of a more empathetic gaze. For example, a respondent reflected that the photo-elicitation exercise in particular activated his social memory, recalling that

> the picture [used in the photo-elicitation exercise of his fieldwork in Argentina] of this woman carrying all the stuff in her bag, it is was making me remember what I felt at that moment. And maybe showing this picture in the video could make the people feel that empathy I had. (Respondent 09, palaeoclimatologist)

***Fig. 5.11:** Photograph used by respondent during photo-elicitation exercise*

5.3.3.2 An Example of Message Framing and Social Learning

A 'type-C' gaze was also triggered by the exercises in the pre-production phase of the workshop and appear to have helped the participants to frame or shape their messages to better resonate with audiences' values or predispositions. In science communication literature, this inclusion of a message framing in order to place arguments in contexts that matter to audiences while maintaining the scientific accuracy of findings is closely examined (e.g., Druckman & Bolsen, 2011; Nisbet, 2009; Nisbet & Scheufele, 2009). For example, Folke (2006) states that framing and shaping of communication based on social learning holds the potential to improve adaptive capacity with regard to unpredictable and uncertain social and environmental change. How the process of social learning can be facilitated through the use of context-specific images can be understood through a statement of the above-mentioned respondent, who outlined how a specific image of a lake in Argentina that was used in the photo-elicitation stimulated his reflection about the role of framing and social learning through images. Referring to a fieldwork collaboration with local project partners, he stated:

> After my first presentation, I realised that they [the local project partners] were not so interested in the question if there were maybe wet episodes

like 1,000 years ago. Therefore we started to talk about how the lake works today [...] what the lake would probably do when it is one week raining. Or what happens when the lake might dry out in the future because of climate change. And as they were interested in this, we thought that we could also use these images of the lake today and discuss local impacts of past and present climate change in schools together. (Respondent 09, palaeoclimatologist)

Fig. 5.12: *Photograph used by respondent during photo-elicitation exercise*

This statement can be read as a form of social learning, as this respondent found a way to discuss local impacts of climate change by adapting his approach of communicating, as he used photographs he took in order to stimulate a conversation. Hagemeier-Klose et al. describe this form of learning as a process that 'occurs when emergent, contextualised knowledge is coupled with social interactions. In these instances, individuals and the resources at stake are brought into new relationships with each other' (Hagemeier-Klose et al., 2014, p. 23). The authors further suggest that social learning can also happen when the individuals involved undergo a change in their understanding — for example, in terms of their attitudes or epistemological beliefs — a process that can only occur through social interactions between actors (Hagemeier-Klose et al., 2014). This change of understanding is reflected in the above statement, as the respondent realised that effective communication can be facilitated through the use of context-specific images that can foster an interactive, two-way communication approach. Furthermore, it can lead to an adjustment to specific audience requirements. In the case of this respondent, it was the photo-elicitation exercise that appears to have stimulated this realisation and helped him to articulate it.

5.3.3.3 Who is the 'General Public'?

Furthermore, several respondents pointed out that the storyboard development was for them an opportunity to think about how to include different forms of knowledge and multiple perspectives ('type-A' gaze). Criticising a lack of specificity and appreciation for how target groups are usually chosen, one respondent referred to the term 'general public', outlining:

> Maybe you as audience don't feel comfortable when hearing "general public". I'm not implying those people are less or more [intelligent] than me. I just try to imply that people are without this kind of training. But they can [...] explain things to me that I don't know. (Respondent 05, petrologist)

This respondent also stated that he deliberatively chose a non-academic protagonist for his film to show the protagonist's scientific curiosity is not an attribute peculiar to scientists. He also pledged for more occasions of transdisciplinary collaboration that could better inform science and risk communication, stating:

> I don't know the way people think. That's why having different tools and formats at hand, [...] and to evaluate them together contextually is needed. (Respondent 05, petrologist)

5.3.3.4 Inter- and Transdisciplinary Collaboration

Obviously, the workshop would have benefitted significantly from a collaboration with more diverse participants, including people who would benefit from more target-oriented risk communication (see also Chapter 6). However, it should be noted that the interdisciplinary composition of the group also stimulated mutual learning and a 'type B'-gaze. Elaborating in a team of colleagues with different geoscientific backgrounds or with media professionals/anthropologists about how to best approach the video production was described as 'mutually beneficial' (Respondent 08, geomorphologist), 'refreshing' (Respondent 10, mineralogist) or ‘exciting’ (Respondent 11, geomorphologist). One respondent even pointed out that she perceived the different perspectives and opinions on the shown film examples or regarding the film production process as ‘the most helpful element’ of the course (Respondent 03, mineralogist). Another respondent described ‘having the technical support from filmmakers to be able to express my creativity’ as positive, especially as scientists like him sometimes ‘have ideas [for film concepts], but it is the implementation that is missing’ (Respondent 10, mineralogist).

5.3.3.5 Overcoming Language Barriers and the Role of Finding an Appropriate Language

In total, 6 respondents reported that the collaboration within the workshop, as well as the storyboard development, made them aware that social learning requires an effort from all participants to overcome language barriers and found film to be suitable to do so. Regarding his voice-over text, one respondent pledged for

> avoiding words that sound technical and where people feel afraid and maybe lose their interest because it [the film] has not developed their confidence. (Respondent 04, geophysicist)

In line with Obrist et al. (2015), who outlines the potential of social media ‘for new services for viewer participation and engagement’ (pp. 35–36), a respondent stated that an appropriate, ‘diplomatic’ and comprehensible language in personal video messages could be a way to react on fake news:

> When I see the number of debates that exists on the internet, on Facebook generally, I often have the feeling that I have to intervene [...] And I think that, for example, a clearly stated, personal video message can be extremely powerful in these cases. (Respondent 10, mineralogist)

Furthermore, the respondent here explicitly outlined that it was ‘not only the content of my message or the tone’ in that regard but the fact of me showing my face.’ (Respondent 10, mineralogist)

Finally, through the workshop, participants appear to have acquired a deeper understanding of the nuances of audiovisual language and the complex social aspects it involves. Moreover, for some, their identity as communicators seemed to gain more depth through a critical reflection of their roles as information providers, advocates or even persuaders. Before the workshop, most participants were familiar with important criteria used to judge videos, such as scientific accuracy, technical quality, and — in case of online videos — click rates of videos. However, after the workshop, they also referred to other important aspects that play a vital role in science and risk communication, such as the societal context in which their video is produced or shown, questions around what a 'fair' representation is, their role as authors, and the integration of audience-specific perceptions and requirements.

5.3.4 System-Thinking

Hints for the development of the two remaining types of competences that Wiek et al. (2011) refer to can also be seen in the findings from the interview evaluation, although the more applicable of the two to this case study is system-thinking competence.

Wiek et al. (2011) define systems-thinking competence as

> the ability to collectively analyse complex systems across different domains (society, environment, economy, etc.) and across different scales (local to global). (Wiek et al., 2011, p. 207)

This competence I would compare with the competence to understand and integrate different knowledge bases, voices, and forms of representation into a film, while considering 'effects, inertia, feedback loops and other systemic features related to sustainability issues and sustainability problem-solving frameworks' that the authors refer to (Wiek et al., 2011, p. 207). Most respondents highlighted their experience of having dealt with considerable complexity throughout the workshop because a wide variety of parameters had to be evaluated in their individual film projects. A typical statement was that filmmaking was perceived as a 'playful but at the same time very demanding process', given the 'many aspects to consider' (Respondent 03, mineralogist), such as scientific integrity, the quality of the production, context evaluation, anticipation of user-experiences, technical feasibility, production costs, or dissemination strategies. However, one respondent stated that 'using images and metaphors also helps to deal with complexity' (Respondent 02, hazard scientist). Also 'the role of humour' was outlined by one respondent as a strategy to 'build bridges' (Respondent 06, hazard scientist).

The fact that the topics of the participants' films were almost all located at the dynamic interface between natural processes and human action, or within a 'nexus' (Howarth & Monasterolo, 2016) makes this competence particularly important. I would also argue that this competence is actually part of the geoscientific curricula. Due to the fact that geology's scientific scope encompasses some of the most crucial Earth-related topics, it sits at the interface between science and society (Stewart & Gill, 2017). For example, Gill (2017) relates the 17 agreed SDGs to 11 key aspects of geology. Therefore, I would state that even if it is not visible at the first glance, geology is a genuinely interdisciplinary, process-oriented, experiential, and holistic discipline (Frodeman, 1995; Kastens et al., 2009; Rudwick, M.J., 1976; Simon & Zarzoso, 2013). It also holds the potential to push forward novel representational strategies in the realm of audiovisual media, that can better address the synergistic and interdisciplinary nature of problems. Having the competence for systems thinking is especially noteworthy as many of the participants will probably be confronted with socio-politically controversial debates in their future careers, e.g., in the field of geoengineering, mineral extraction or risk mitigation. In that regard, the workshop was an endeavour for a 'holistic' approach, as it was an attempt to foster the capacity to handle complexity, adopt multiple perspectives, and justify choices. Through the film production process, participants could explore ways to integrate and represent a variety of aspects, e.g., affective and cognitive, personal and political, scientific and poetical, personal and political, or rational and sensory dimensions of their research.

5.3.5 Strategic Competence

According to Wiek et al. (2011), strategic competence is the

> ability to collectively design and implement interventions, transitions, and transformative governance strategies toward sustainability. This capacity requires an intimate understanding of strategic concepts such as intentionality, systemic inertia, path dependencies, barriers, carriers, alliances etc.; knowledge about viability, feasibility, effectiveness, efficiency of systemic interventions as well as potential of unintended consequences. (p. 210)

It is difficult to apply the lens of this competence to the respondents' answers and also seems to be further away from the learning goals pursued in this workshop. To a degree, strategic competence partly appears to be a learning outcome of the workshop. Similar to what Wiek et al. (2011) outline, participants used ‘a language that non-academics are comfortable with’, and also developed a ‘political understanding’ of their subject and a familiarity with ‘real-world situations and relationships’ as they were confronted with many, before partly unknown dimensions of their research field. Furthermore, some of them ‘were working with deadlines’, and were ‘able to solve logistical problems’. Despite the explicit openness of the workshop regarding the actual production of films, they were motivated to produce a final film by the end of the workshop and therefore took into account time and task pressure and the need to coordinate the film project with many other tasks. However, most of these aspects have already been discussed exhaustively in the previous sections.

5.4 Concluding Remarks

This pilot study has provided practical evidence that conducting a video-based post-Sendai risk communication training means to critically reflect conceptions of major science and risk communication training goals and to challenge taken-for-granted ways in which science and risk communication videos are being conceptualised, created, and disseminated. The analysis of the evaluation interviews with participants provides hints that video production and film-based exercises can be valuable training tools to foster important sustainability competencies. The study particularly shows the relevance of using audiovisual media and methods as dialogic, reflexive, and process-oriented training tools. Some of the workshop modules stimulated a deeper reflection about the nuances of audiovisual communication and its dialogue-supporting potential, but also gave participants novel forms of expression to give form and meaning to their scientific work and critically interrogate their role as communicators. Furthermore, the study highlighted the potential of using innovative communication technologies for a two-way interaction with audiences. However, also the lack of co-design with other stakeholders and audiences and the lack of technological means for knowledge co-creation became evident in the workshop. In principal, tools for a co-creative conceptualisation of risk communication could have been applied such as presented in Chapter 4. However, as Prototype 3 is not operational so far, this step was not undertaken. Furthermore, to successfully apply the presented training methodology to future (research) projects, a series of critical aspects need to be acknowledged and discussed (see Chapter 6).

Chapter 6 – Discussion

6.1 From Post-Sendai Risk Communication to Transformative Risk Communication

My exploration of audiovisual methods in risk communication has been set up in terms of the Sendai Framework and its advocacy for a people-centred approach to disaster risk reduction. However, as I outline in this chapter, I see this as part of a wider call for broadening science/society interaction.
To facilitate that interaction, I have drawn from applied visual anthropology to examine how audiovisual methods can contribute to productively shaping and supporting the complex processes of co-designing a post-Sendai risk communication. Here, audiovisual methods are also the 'product' of this process, in the form of new prototypes for risk communication formats. But how do we judge the efficacy of these products? While most research on the use of film in risk communication measures the effectiveness of films in terms of information gain and behaviour change, my work instead considers effectiveness in terms of the 'facilitation' of transdisciplinary processes, aided by technological innovations. In order to propose meaningful criteria for the domains in which audiovisual methods can contribute to this 'new' mode of communication, I have used the collective term 'post-Sendai risk communication'. However, this term lacks an important component, which is the *transformative* potential of risk communication. And that transformative component lies at the heart of the emergent realm of transdisciplinary research.

Transdisciplinary research necessitates processes of inquiry that are designed in such a way that the interests and expectations of social and political agents are not only taken into account, but systematically integrated into the research process. Jahn (2008) emphasises that 'knowledge and strategies won through the process of transdisciplinary research can appropriately *influence* the discourses found in both everyday praxis and in the sciences' (p. 11). Inspired by that thinking, I will apply two conceptual lenses to the discussion of my findings: *Transformative science* and *Transformative literacy*. Both concepts help elaborate the theoretical framework for the current shift towards transdisciplinarity and the co-design and co-production of (audiovisual) risk communication.

The discourse around the first conceptual lens, transformative science, originated from the field of sustainability studies at the beginning of the millennium, with scholars arguing for a combination of analyses of processes of environmental change and active support of a transition towards more sustainability (Bernstein, 2015; for a review see Brandt et al., 2013). According to the German Advisory Council on Global Change (WBGU), transformative science analyses 'transformation processes with regard to their causes, conditions and development' and actively contributes to 'transformation processes through specific innovations in the relevant sectors' (WBGU, 2011, p. 373 as cited in Schneidewind et al., 2016). According to Schneidewind et al. (2016), the concept of a transformative science is based on the conviction that the science system itself has to change to counter the dysfunctional effects of increasing differentiation and dis-embedding in the age of reflexive modernity and provide answers to accelerate socio-ecological transformation to respond to challenges of the Anthropocene. The authors define transformative science as:

> a specific type of science that does not only observe and describe societal transformation processes, but rather initiates and catalyzes them. It aims to improve our understanding of transformation processes and to simultaneously increase societal capacity to reflect on them. (Schneidewind et al., 2016, p. 6)

To achieve that aim, Schneidewind et al. argue that four inherent societal functions of the science system need to be activated: (1) increasing reflexivity in societal processes, (2) broadening the solution space and scope for action through social and technological innovations, (3) facilitating processes of balancing societal power structures through the legitimising force of evidence-based arguments, and (4) strengthening participation and self-organisation in modern societies through transdisciplinary processes of knowledge co-creation and a stronger user orientation. Activating those societal functions has implications for the area of research and knowledge production, education and teaching; and also on institutional change of the science system.

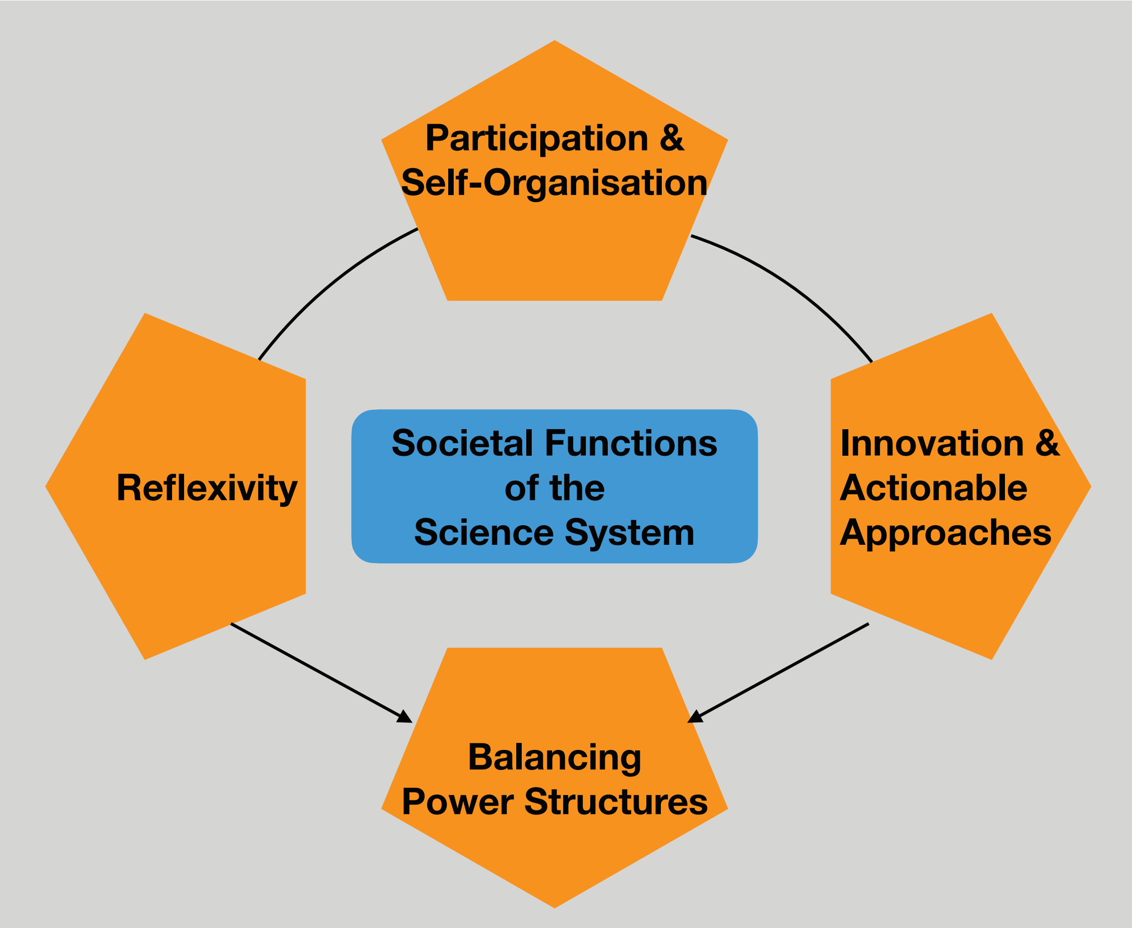


Fig. 6.1: Four inherent societal functions of the science system within a 'transformative science' framework (adapted from Schneidewind et al., 2016)

Drawing on the concept of 'transformative science' described by Scheidewind et al. (2016), I will develop the concept of 'transformative risk communication'. More theoretically grounded than the collective term 'post-Sendai risk communication' it is based on five distinct pillars that allow me to critique my research findings of how audiovisual methods have facilitated such a transformative risk communication and helps in identifying further research avenues. A transformative risk communication still incorporates the two requirements raised by the Sendai Framework, but helps to approach them more critically. Building on the four inherent societal functions of the science system proposed by Schneidewind et al., I add an additional element of 'literacy' to establish a transformative risk communication framework:

1. Strengthening participation and self-organisation through transdisciplinary, 'people-centred' processes of knowledge co-creation and interdisciplinary collaboration.
2. Increasing reflexivity in risk communication processes.
3. Broadening the solution space and scope for (preventive) action through user-oriented and actionable risk communication along with social and

technological innovations (such as ICTs), and

4. Facilitating processes of balancing societal power structures through the legitimising force of evidence-based arguments.
5. Contributing to the development of a 'transformative risk literacy'.

The added fifth element highlights that transformative science seeks to contribute not only to 'scientific literacy' but to 'transformative literacy' (Ober, 2015). I borrow this term from Ober to expand the concept of risk literacy that — in deficit-oriented communication models — is one of the major risk communication goals (see Chapter 1). Derived from this concept, I would argue that risk communication should not only increase risk literacy, but also contribute to a 'transformative risk literacy', which 'enables people to adequately understand scientific information as well as societal change processes and to contribute own actions to these processes' (Ober, 2015, p. 2). From this perspective, the goal of risk communication should not only be a question of providing (risk) information, but also of establishing communication in such a way that it resonates, and 'allows contradictions, disputes, and opens up creative spaces' (p. 2).

In the following sections, I critically reflect on the findings and limitations from my case studies and prototype developments through the lens of those five pillars and link them back to the major research literature introduced in this thesis.

For reasons of clarity, as in the previous chapters, I refer to the ArcGIS StoryMap 'From Matters of Fact to Matters of Concern' as 'Prototype 1', to the prototype of the Motion Graphics Video 'The North Anatolian Fault' as 'Prototype 2', to the collaborative editing tool 'Directors Room' as 'Prototype 3' and to the Transformative Training Framework as 'Prototype 4'. Further, I will refer to the Istanbul-based case study as 'Case Study 1' and to the post-Sendai risk communication training as 'Case Study 2'.

6.2 The Five Pillars of a Transformative Risk Communication

6.2.1 Pillar 1: Participation and Self-organisation

As shown in Chapter 1, a broad body of research literature on risk communication outlines that a transdisciplinary, people-centred development of risk communication requires new forms of collaboration that help to reorganise, re-evaluate and also (re)visualise different sources of knowledge about disaster risk. Scientific and non-scientific participants have diverse expertise and experience, but often also different values, interests and perspectives on how ‘effective’ risk communication should be designed (see also Demeritt and Norbert, 2014). Therefore, stimulating and open spaces for collaboration between hazard researchers, at-risk communities and other participants (e.g., visual social scientists, decision-makers etc.) are needed to set in motion processes that are commonly referred to as ‘knowledge co-production’, ‘co-design’, ‘participation’ or ‘social learning’, which I consider the most important components of a post-Sendai risk communication.

In Case Study 1, I demonstrated that residents of earthquake-prone neighbourhoods and hazard researchers can provide essential knowledge for the design of conventional risk communication. However, I argue that in a transdisciplinary mode, this knowledge generation can become more effective, especially for the case of risk communication, which sits at the interface between science and society (e.g., Beck, 2009; Höppner et al., 2010; Renn et al., 2018). Therefore, after my first research phase in which I used audiovisual methods from a disciplinary perspective to gain a broader understanding of risk communication, I decided for a transdisciplinary mode of research to support this more direct form of engagement and collaboration. What followed were a transdisciplinary workshop and focus groups, the co-design and co-production of four prototypes, as well as continuous dialogue/solicitation of feedback throughout all stages of the research.

Through my film-based fieldwork and also in the subsequent transdisciplinary orientation of my research, I was able to act as a ‘knowledge broker’ respectively as a ‘mediator’, and through this activity generated some valuable insights in terms of facilitating transdisciplinary collaboration that would not have been possible without my audiovisual approach. Here, I would like to highlight several findings, but also some instructive weaknesses of my approach.

First and foremost, I would argue that the use of audiovisual methods has supported what Jahn (2008) describes as cognitive-epistemic, social and organisational, as well as communicative knowledge integration that successful transdisciplinary projects can achieve (see also Chapter 2).
Jahn (2008) states that through cognitive-epistemic integration, ‘knowledge components from different disciplines are both distinguished from one another and also linked, while, at the same time, scientific knowledge is differentiated and linked to everyday knowledge’ (p. 9). The use of audiovisual methods in the development of Prototype 1 and 2, the present Prototypes 1 and 3, as well as the interdisciplinary collaboration between myself and hazard researchers in the context of Case Study 1 and 2, have in my view promoted such *cognitive-epistemic*

integration, as different forms of local and expert knowledge could be identified and related to each other.

This form of integration of scientific and everyday knowledge is particularly evident in the conceptual considerations of Prototype 3, where heterogeneous participants discuss self-generated film footage and images, explore its meanings, and enter into a discourse on different approaches to the topic of earthquake risk communication. Here, the audiovisual data is seen as containing different forms of knowledge and meaning that the users can informally relate to each other. Furthermore, they can differentiate and facilitate their debate using tags, annotations and visual response mechanisms. Whereas in Prototype 1 different forms of knowledge are on an equal footing and epistemic integration takes place via the StoryMap as a medium, the collaborative editing tool helps to progress epistemic integration through the co-creation of the users. Moreover, the *process* of prototyping facilitated by different brainstorming methodologies (see Chapter 3b) and Design Thinking (Chapter 4 and 5), helped to link scientific knowledge to the contextual findings elaborated in the Istanbul workshop and focus group discussions.

It is important to acknowledge, however, that the audiovisual methods and the generated audiovisual footage were not used throughout as a *transdisciplinary* tool. Firstly, both Prototype 1 and 2 emerged rather out of *interdisciplinary* and not transdisciplinary collaboration, although inhabitants provided valuable feedback on the prototypes at different stages. In a transdisciplinary, *integrative mode of access*, research participants from the respective neighbourhoods would have been part of the prototyping process from the beginning (Jahn, 2008). Secondly, the transdisciplinary workshop was simply recorded, and the medium (film) was not sufficiently used as a tool for creative interaction; a deeper transdisciplinary inquiry would have benefitted from the opportunity to discuss some of the sequences I edited during my ethnographic fieldwork to allow for a form of *ciné-débat*, a method where screenings of films are used to create more lively interactions with the viewers/participants (Richter, 2016). Thirdly, the editing of the films during my ethnographic fieldwork were not wholly co-creative. Edited versions of the material were shared with the participants at a later stage of my research, asking research participants for feedback, validation and approval of the final edits, but the process of knowledge co-creation was restricted. This was partly due to language barriers and logistical challenges but also due to technical barriers and a lack of collaborative tools. In addition, it turned out that the linearity of the editing process with its dramaturgical constraints limited the space to elaborate freely on the complexity of voices and themes, a problem actively addressed in Prototype 3. In line with Pink et al.

(2014), I can therefore conclude that my *initial* research design allowed for the production of films as research interventions rather than the generation of long-term 'infrastructures and tools' for transdisciplinary collaboration.

Despite these methodological constraints, my visual ethnographic fieldwork has provided important *disciplinary* insights for the conceptualisation of transformative risk communication. Both the knowledge from my review of (empirical) social science literature and the visual fieldwork data can be deployed to improve risk communication, e.g. for more effectively targeting audiences, developing better framed messages and choosing the most appropriate communication channels and platforms. Incorporating these insights can be helpful for a more informed understanding of risk communication, enrich future processes of co-design and, in that regard, lead to further cognitive-epistemic integration. Another valuable finding is that — in contrast to the very limited use of film for scientific outreach criticised in Chapter 1 — I understand film as an insight-generating, scientifically accepted research tool and not merely an 'added value' in risk communication. In that, I demonstrated the high value for (hazard) scientists to work with visual researchers, a finding also repeatedly outlined by authors such as Harris (2016), Pauwels (2015) or Reavey (2020).

My ethnographic fieldwork provides insights into how film as a research method helps gain a more socially robust, culturally sensitive, and socially-anchored understanding of important preconditions of risk communication. The chosen methodological framework—including reflexive photography exercises, photo elicitation interviews, filmed qualitative interviews, and filmed participant observations — helped to reflect socio-cultural, socio-political, ecological or economic dimensions of risk in the respective neighbourhoods. Moreover, this methodology was able to support people-centred approaches, as my empathy-guided approach in line with the concept of a 'shared anthropology' (Rouch, 2003) was particularly suited to voice, deepen and make tangible individual perspectives of my research participants and to allow for relationships of mutual trust. The approach captured not only cognitive but also sensory, embodied and experiential knowledge, allowing rich forms of epistemic integration to take place. Moreover, the process of montage allowed me to detect, interpret and communicate interdependencies between residents' perceptions of urban mitigation measures and their willingness to take precautionary measures themselves. The sometimes strongly conflicting concerns and priorities of geoscientists and citizens with regard to seismic risk communication could also be presented in a condensed form.

S*ocial and organisational integration* took place through the process of developing the prototypes, as people with different cultural and professional backgrounds, preferences, and interests collaborated through audiovisual means. Especially during the development of Prototypes 1 and 2 as well as in Case Study 2, it became apparent that the creation of storyboards, mood boards and character development, as well as the joint editing process or the reflexive interview exercise, can be helpful in bridging discrepancies between different working cultures. The integrative power of audiovisual methods clearly lay in the utilisation of film as a collaborative, experimental process in which, through visualisation and storytelling, thoughts can be projected and given new form. This projection potential facilitates a joint discussion on communicative goals, stylistic and dramaturgical choices as well as joint organisational and temporal procedures. However, the success of such processes highly depends on effective moderation, supportive institutional frameworks, as well as the willingness and motivation of course participants. Further, carefully developed (course) methodologies are key success criteria for social and organisational integration. Luckily, these criteria were largely met during my research.

However, the development of Prototype 1 and 2 has methodological weaknesses. The decision to use a Design Thinking approach in Prototype 3 was based on the fact that my previous procedure was not sufficiently systematic, partly because transdisciplinary research literature did not give detailed information on methodologies for prototype development, a shortcoming also voiced by Plattner (2012). Furthermore, it is important to outline that social and organisational integration are not 'guaranteed' through the application of inclusive, visual methodologies. Even the opposite may be true if the use of audiovisual methods instead leads to an increase of complexity, technical challenges, or if the participatory approach is just perceived as a stepping stone on the way to quicker outcomes. If the above-mentioned criteria are met, I would argue that audiovisual methods can improve that form of integration and thus facilitate inter-and transdisciplinary collaboration. In turn, inter-and transdisciplinary collaboration can significantly enrich the generated audiovisual content, improve social learning, and also feed back into research by provoking new research questions.

The process of developing Prototypes 1, 2, and 3, as well as the prototypes themselves also represent a form of *communicative integration*, as my research participants and I had to find a common language, for example, when debating on the selection and arrangement of film material in Prototype 1 and 2. In this process, different forms of meanings and communicative practices had to be identified, and similarities, differences, and other relationships had to be discussed. In addition, the function of Prototype 3 to add detailed visual and text-based annotations, comments and alternative narratives is particularly noteworthy in this context, as differentiated framings of risk communication are highly dependent on productive methods of co-creation with future target groups, a finding repeatedly outlined by authors such as Hagemeier-Klose et al. (2014) or Boersma et al. (2017) (see also Carlton & Jacobson, 2015; Jarreau et al., 2015; Lassen et al., 2011; Moser, 2014). Furthermore, communicative integration also takes place when possible linguistic differences are balanced by the possibility of audiovisual expression. Even participants with different rhetorical strengths are thus provided with a level playing field. Similar to the ArcGIS StoryMap, a vital element in Prototype 3 is that all participants using 'Directors' Room' are thrown back on the same medium of expression with which they are not necessarily familiar. The fact that all of them have to acquire the necessary technical literacy has the potential to break down hierarchies as participants with different levels of expertise use the same tools. However, also here the reverse might be true if technically skilled participants with a higher motivation for cinematic forms of expression dominate the setting. Here again, excellent moderation is necessary to bridge and not to widen the digital divide (e.g., Ramsetty & Adams, 2020).

Finally, all forms of integration depend upon *mutual trust* (e.g., Renn & Levine, 1991; Wachinger et al., 2013). The concept of a 'shared anthropology' (Rouch, 2003) was an important methodological prerequisite and orientation to create trust between myself and research participants. The ongoing dialogue, the joint prototyping as well as the feedback loops and the integration of feedback were all trust-building activities. Hazard researchers working with filmmakers to co-design risk communication can benefit from these trust-building methods. However, trustful relationships do not simply emerge through a skilled use of methodological frameworks, but require many, more far-reaching conditions (e.g., Renn & Levine, 1991).

It is important to recognise that audiovisual methods cannot remedy many, often structural, problems of transdisciplinary collaboration (Blassnigg & Punt, 2012) or may even be counterproductive in situations of *distrust*. In Case Study 1, for example, it became clear that my research participants from the respective neighbourhoods felt not sufficiently involved in the overall process of earthquake risk management, but also did not want to collaborate with the municipality under the given political circumstances. In addition, there was a clear consensus among the residents that the main responsibility for risk mitigation rested primarily with the municipality, which from their point of view was not acting responsibly. In the context of such a crisis of trust, it is questionable whether a transdisciplinary process *with representatives of the municipality* would be possible. In such a case, the use of audiovisual methods might even be counterproductive, as it could instead be seen as an instrument for the forced creation of acceptance, as discussed in Chapter 1 and 4 (e.g., Mistry et al., 2015; Shaw, 2015; Tsouvalis & Waterton, 2012). Therefore, although important insights were generated in the exchanges in Case Study 1, questions about my project's long-term legacy arise if the generated knowledge does not flow back into the political sphere (see Section 6.2.4).

Against this background, the joint prototype development was not desired by all participants to the same degree. From feedback given on the prototypes, residents who had more traditional assumptions about the distribution of responsibility tended to question the meaning of their involvement in the development of the prototypes. The very tense political situation in Turkey made things even more difficult. I would argue that my methodological approach offered a critical alternative to the status quo risk communication, but that unless links to the political sphere are created, the proposed framework simply 'preaches to the converted'.

6.2.2 Pillar 2: Reflexivity

According to Scolobig (2015a), the complexity of a 'risk society' requires more adaptive, iterative and flexible approaches to risk and disaster management (and risk communication) that are typically not associated with traditional top-down approaches. Reflexivity is a central component of developing such adaptive and 'transformative' approaches of DRM and risk communication. Reflexivity, according to Göpel (2016) 'is a uniquely human capacity that enables people to become aware of biases and the effects of socialization, and to identify the ways that habits, path dependencies and guiding stories drive societies along development routes that are not (any longer) in line with broader goals and aspirations' (p. 168). Therefore, in order to go beyond a no longer sufficient use of a deficit-oriented, technocratic approach to risk communication, I sought to ensure a continuous reflexive engagement for transdisciplinary approaches through my methodological approach. The transdisciplinary workshop and the Design Thinking format, alongside my iterative approach and the continuous integration of feedback from my research participants, was a deliberate attempt to ensure reflexivity and adaptability, recognising that 'in order to increase reflexivity in dealing with great societal challenges and to re-integrate societal sub-systems, science needs to transcend its descriptive analytical functions and cooperate with non-academic agents to achieve shared, normative goals' (Schneidewind et al., 2016, p. 4). The engagement between hazard researchers from the ALErT group, myself, and the inhabitants of the at-risk neighbourhoods can be seen as a starting point for collaborations with increased reflexivity, where a reflection on problem definitions, values, and possible solutions took place. How audiovisual methods within this chosen methodological framework have stimulated reflexivity is demonstrated throughout Case Study 2.

Although the video-based risk communication training has been conducted with only a small number of participants and is therefore not representative, it is promising that the majority of participants reported a strengthening or awareness for certain sustainability competencies that Wiek et al. (2011) refer to, with increased reflexivity being one major component. Although the learning outcomes were only provided in the form of qualitative interviews with the participants, the audiovisual approach of the workshop design was strongly tied to the self-reported acquisition of sustainability competencies.

Based on the evaluation interviews, I would argue that both the film analysis and the process of film production can help early-career scientists to more reflexively approach important dimensions of their interactions with the public, and to work out 'a properly integrated perspective with clarity and transparency about one's own assumptions and value judgments' (Göpel, 2016, p. 168).

Most significantly, the joint film analysis, the reflexive interview exercise and the photo-elicitation exercise were described by the workshop participants as 'incubators' for self-reflection on disciplinary practices and paradigms, a necessity highlighted by Demeritt and Norbert (2014). For example, jointly analysing film examples turned out to be highly inspiring for participants, helping them to reflect on aspects such as underlying scientific paradigms and scientific reasoning incorporated in these films. Listening to their own recorded narration from the elicitation exercise and seeing themselves on camera further stimulated self-reflection. Moreover, the reflexive interview exercise and the collaboration with myself and the cameraman helped participants to develop a greater awareness of the work of media professionals. It also helped them to gain deeper understanding of how narrative strategies or aesthetic choices influence the impact of their messages (Miller, 2001).

Furthermore, the film production, from initial idea to post-production, despite being technically challenging and time-consuming, can highlight the relational processes that underlie 'making' science and risk communication videos and also make participants aware of the tacit, experiential knowledge that can be conveyed through audiovisual media. Conceptualising films through storyboards and moodboards and the development of protagonists supported participants in reflecting and elaborating on their own key messages and in finding their potential audiences and storytelling techniques. Moreover, it helped them to explore, structure, and centre their thoughts and communication goals, but also to consider the societal and ethical dimension of their research. Participants described how, through the filmmaking process, they have analysed risk communication processes with greater reflexivity, gained insights into actively collaborating with other disciplines and societal agents in an interdisciplinary way, learned about the relevance of transdisciplinary collaboration, and contributed with their films to more audience-aware, or even 'actionable' media.

The evaluation of the risk communication training also gave hints for limitations and methodological challenges posed by the film-based approach that fail to exploit the full reflexive potential of my proposed risk communication training framework. The most important discussion thread relates — again — to the lack of transdisciplinary encounters *within* the course. Although the workshop was conceptualised on the basis of insights gained in the transdisciplinary workshop in Istanbul, the workshop itself gave participants only few opportunities to develop sustainability competencies within a 'real-world' setting. The transdisciplinary workshop design could have provided more options for reflexivity, for example by embedding a video-based communication training into a transdisciplinary research project. It would have been instructive if the training course had taken place before or during the Istanbul workshop to find out how the competencies could be applied in practice.
Furthermore, given the few institutionalised structures for a systematic exchange between science and different (civil society) stakeholder groups (Hoinle et al., 2021), such a training course could be a suitable tool to address this shortcoming. Here, using tools such as 'Directors' Room' could potentially be beneficial for the process of co-designing risk communication. Moreover, representatives from different stakeholder groups could jointly work on timelines, exchange perspectives, productively address expectations or misconceptions, and finally find out which forms and formats could generate knowledge for different stakeholders(e.g. which topics and findings would be relevant for different groups and how they could be well communicated to elicit interest and provide useful applications). Visual training methods (as outlined in Case Study 2) have translational potential beyond use in a course specifically for individuals in Earth Sciences, and support a more expanded use of film as proposed by Garrett (2010).

With this statement that a transdisciplinary orientation of the course would have created an added value, I do not want to fundamentally question discipline-oriented training models, as these offer the possibility of analysing complex issues from *one* perspective in a differentiated way. However, I do want to emphasise in line with Kurz et al. (2014) that more exchange with researchers from other disciplines allows recognising specific possibilities and limits of one's own subject. Furthermore, entering into exchange with other societal participants (from politics and civil society) promotes a learning process that takes up important societal problems. Scholz (2011) poignantly describes this form of knowledge generation as 'disciplined interdisciplinarity in transdisciplinary processes' (p. 394).

In my work, I have shown that collaborations with filmmakers and visual social scientists in particular can support such 'disciplined interdisciplinarity in transdisciplinary processes' and should be further promoted in order to enable a theoretically and practically sound application of the methods proposed in this thesis.

6.2.3 Pillar 3: Broadening the Solution Space

One of the central research achievements of this thesis was to provide hazard scientists with in-depth insights into the complex problem of earthquake risk communication — which is specific from neighbourhood to neighbourhood — and to derive practice-relevant actions/prototypes and solution strategies from it. This is in line with Schneidewind et al. (2016), who outline that 'by producing knowledge and innovations, science can generate new options, increase the scope of societal action and open up previously unthought of solution spaces' (p. 6). Here, the authors explicitly refer not only to technological innovations, but also to social and institutional innovations.

Those three innovation dimensions in my research can be critically discussed, though my focus here lies in the discussion of technological innovation, as this is also one of the Sendai requirements whose translation I wanted to explore through my chosen research approach. To the aspect of institutional innovation, I will refer to in the next section. Social innovations are 'new ideas that resolve existing social, cultural, economic and environmental challenges for the benefit of people and planet. A true social innovation is system changing — it permanently alters the perceptions, behaviours and structures that previously gave rise to these challenges' (Centre for Social Innovation, 2008, as cited in Pol & Ville, 2009, p. 880). In that regard, both the risk communication workshop in Istanbul (which combined field excursions, focus groups and a transdisciplinary workshop) as well as Prototype 3 contained at least elements of social innovation, because both created forums for *hybrid collectivity*. I borrow this term from Olman & DeVasto (2020) who state that hybrid collectivity is the ability of environmental risk communication 'to build robust and equitable networks across modern divides imposed between scientific/public, expert/non-expert, and human/non-human communities' (p. 5). I argue that this hybrid collectivity can — in the long-term — lead to system-changing effects and break up disciplinary silo-thinking in risk communication, a finding also outlined by authors such as Donovan et al. (2019) and Ismail-Zadeh et al. (2017). Such approaches of building 'hybrid collectivity' are not new, especially as the use of creative methodologies and the Arts in the context of transdisciplinary research projects addressing 'Anthropocene risks' has become increasingly popular (see also Chapter 3). Furthermore, I would argue in line with van Baalen et al. (2021) that projects such as *Paradise Reloaded* by the IASS (Rivera, 2015), *The Soil Cinema* at EGU (Toland, 2017), the *Anthropocene Project* and *S.O.S. - Schools of Sustainability* at Haus der Kulturen der Welt (HKW)— all interesting transdisciplinary Art-Science collaborations — only have the potential to become social innovations if they also create groundwork for the establishment of long-term structures.

There is a strong emphasis in research and practice on the development of technological innovations. According to Scolobig et al. (2015), behind this imperative is the assumption that risk problems can be solved by technological or technical innovations in combination with effective economic management, because decision-making and the capacity to improve public behaviour are improved. In Chapter 1, I argued that the relationships between risk awareness, risk perception, and risk adaptation measures are not as simple and straightforward as this 'innovation paradigm' suggests (Fischhoff, 2012; Kasperson, 2014; Slovic, 2000). Furthermore, as Ober (2018) highlights, innovation inevitably stands for economic competition and growth dynamics, which can lead to unsustainable developments. The fact that the solution of fundamental problems connected to risk communication (e.g., loss of trust, lack of participation, lack of a systemic perspective) is often an institutional, socio-political, or cultural rather than a technical transformation challenge is often not sufficiently taken into account in research. These findings make a critical evaluation beyond the 'technical innovation' of the developed prototypes even more pressing (see Section 6.3.1).

Although my use of audiovisual methods can be termed 'technologically innovative', only Prototype 3 holds the potential to become a true 'innovation', in the strict sense that it comprises 'significant technological changes of products and processes' (OECD, 2001). The development of the 'Directors' Room' clearly represents a new, albeit still conceptual, prototype for AI-assisted virtual collaboration in the realm of video editing that has not been used in DRR practice so far, and so is a promising contribution to new knowledge.

Prototype 1, on the other hand, does not fulfil this criterion, because the ArcGIS StoryMap represents no significant technological change and because it only has limited functionality, e.g. regarding the use of video and the limited amount of users that can collaborate, as well as the high associated costs. Instead, as outlined in Chapter 3b, it is a platform to represent multiple sources of knowledge in a more engaging way, but still along a 'sender-receiver' scheme. However, the combination of risk maps and video content is certainly still an important feature of a more people-centred risk communication. Hazard scientist could produce 'solutions' in the form of risk maps and short videos based on their expert knowledge while taking into account at-risk communities wants and needs.

Furthermore, beyond the often overstrained call for technological innovation, my research has sought to contribute to a more actionable communication, as proposed by Wood et al. (2012). In contrast to audiovisual formats in which people are portrayed as predominantly passive and as victims of earthquakes, or which are functionally disempowering for non-experts through their synoptic 'Gods-Eye' perspective (Olman & DeVasto, 2021), in the course of my work I explored how people can be portrayed as acting and having an 'agency', or how they can co-create risk communication content in line with the rationale of an applied visual anthropology (Pink, 2006a). My work thus aimed to demonstrate the complexity, multi-vocality and contextuality of risk communication and to provide an 'empowering perspective'. For example, Prototype 2 showed concrete possibilities for action and intervention, while Prototype 3 serves to enable participants themselves to develop a more actionable risk communication.

Although Prototype 1 and 2 demonstrate options for action and were developed co-creatively, from a product- and not process-oriented perspective, they are still a form of one-way communication. I would argue that such one-way approaches do not need to be 'outdated' in the context of a people-centred risk communication, and agree with Scolobig (2015a) that they can still be appropriate, practical and successful in their own way, depending on the threat, cultural contexts or institutional settings.
Nonetheless, a potential criticism of Prototype 1 and 2 is that they are not yet sufficiently linked to concerns and possibilities for action in the respective neighbourhoods. It would be desirable that the 'local' earthquake risk be negotiated at the neighbourhood level, at which groups such as neighbourhood associations, schools, or the local councils can take action. Furthermore, it would be productive if local officials (Muhtars) actively promoted the films, and to ensure that locally known personalities were involved (in the films) to allow for

stronger identification with the content. However, this also raises the question of how to embed 'local' risk communication within the political sphere, a question which I will discuss in the next section.

6.2.4 Pillar 4: Balancing Societal Power Structures

The Istanbul case study clearly shows that power imbalances exist in the realm of risk communication, an issue which I tried to address through the methodological approach I chose. Schneidewind et al. (2016) state:

> By increasing reflexivity, facilitating participation and the search for innovative solutions, science can help re-balance power in society. Power asymmetries benefitting established agents in politics, science and society can be shifted by strengthening niche actors through new forms of participation, by increasing the scope for action in relevant societal fields and by increasing reflexivity with regard to existing technologies and (political) strategies. (p. 6)

In contrast to risk communication approaches that aim for behavioural change and perceive residents of risk-prone neighbourhoods primarily as passive recipients of technical risk information, my aim in using participatory audiovisual methods was to support collective processes of shaping risk communication and to actively set a visible counterpoint against social marginalisation as proposed by authors such as Pink (2006a) and Shaw (2015). Thus, the aim was not to dissuade people from their opinions, to lecture them, to represent them as victims, or to make essentialist a priori assumptions about 'at-risk communities' and thus fail to recognise the multi-layered nature of participants (also see Köhn, 2016; Rollason et al., 2018; Scolobig et al., 2015a). Instead, the intention was to support the aforementioned 'hybrid collectivity' and to practice 'cultural mediation' (Pink, 2006a) as outlined in Chapter 2.

As exhaustively outlined, long-standing experience for countering power imbalances in the realm of representation exists in the field of research on participatory video and applied visual anthropology, with those insights hardly being used in disaster risk communication. In particular, Prototype 1 and 3, and the use of reflexive photography exercises and photo elicitation interviews provided important insights regarding the active inclusion of often marginalised perspectives into the research on local risk communication (e.g., Harper, 2002; Lapenta, 2011). My research shows how access to non-scientific populations can be sought and how space can be created (partly with the help of communication technologies) to support residents to communicate their thoughts, emotions and experiences regarding the current transformation processes through images. Furthermore, the attempt to foster a more nuanced view on risk-affected citizens, and to seek to understand them in their local context, can counter stereotypical representations of 'vulnerable communities'.

However, a key question arises from the contention of Shaw (2015) regarding the lack of a 'transformative' effect of participatory video: How can the use of participatory audiovisual methods contribute to actual *structural* change? Two areas of action seem appropriate.
The first concerns the problem of the lack of *shared ownership* (Lang et al., 2012), already briefly mentioned in Chapter 2. Even though my participatory use of audiovisual methods has contributed to treating perspectives and input from non-experts on the same level as input from experts, there are still 'power imbalances'. In retrospect, it can be said that truly transdisciplinary research is difficult to realise within the framework of a dissertation. The research questions and research goals of this thesis, as well as the chosen methodology, were conceived primarily by me, even though these elements were developed on the basis of a collective problem framing. Moreover, though the inhabitants of the risk areas as well as geoscientists were actively involved in the development of the prototypes, the inhabitants only *participated* and did not *collaborate* (such as intended in Prototype 3), which is a significant difference (e.g., Mistry et al., 2015). Since I can only speak of participation regarding the integration of feedback during the prototype development, an important building block for the success of a transdisciplinary research concern is missing.
According to Ober (2018), this lack of shared ownership can have a negative impact on how research participants take up the results from research projects and integrate them into their practice. Thus, the step of re-integrating research findings as described by Lang et al. (2012) is jeopardised in this case, as participants might be reluctant to adequately test the prototypes, to implement them or support them in the social problem field being worked on. Provocatively, I must ask here whether my prototypes are not in danger of once again becoming the 'deficit' communication I criticised at the beginning, since in Ober's sense 'research results are communicated from science into society, but the flow of knowledge in the opposite direction fails to materialise' (p. 386). In addition, of course, there are other structural problems inherent here, such as that my participants had different time and personal resources to contribute, and that existing power relations were to a certain degree reproduced by the chosen formats (for example, when white male researchers represented certain themes) (see also Chapter 4).

Secondly, a key point is the lack of connection to the political sphere of action, which may be particularly problematic in light of the urgency of adaptation and mitigation of geo- and climate risks. A key problem here is reflected by Hickey and Mohan (2004), who state that participatory projects are often connected to unanswered questions about how and if the project results of the various small-scale patchwork projects can be scaled up on an institutional or political macro-level. Arguably, the same is true for my project. In the case of the Istanbul case study, for example, it would be highly relevant for the scientists involved to actively incorporate the residents' substantive inputs into processes of scientific policy advice. For example, it became evident that social or environmental organisations (such as SİTEDER or OCKD) lack scientific support for their issues and concerns. Similarly, in line with Scolobig et al. (2015a), it would be desirable that local authorities in Istanbul 'not only integrate the public as partners, but also share their decision-making power with the public by taking into account their needs and perspectives through open engagement and deliberation' (p. 210). However, especially in Istanbul, where people-centred approaches are hardly established or absent, the question can be asked how successful my approach is if there are no connection points for my results in light of an autocratic regime that seems to take decisions jointly with real estate agencies but not with inhabitants of Urban Renewal areas. If political entities have neither the will nor perhaps the resources/experience for transdisciplinary approaches to risk communication, my research results can only raise awareness of, or possibly increase the political pressure for knowledge-based, democratic change.

Here, following authors such as Ismail-Zadeh et al. (2017), Oreskes (2015), König (2015) Schneidewind et al. (2016), Scolobig et al. (2015a) and Shaw (2015), I highlight that it takes profound changes at the institutional and cultural levels to promote truly transformative participation, which brings me to the institutional innovation and capacity-building that Schneidewind et al. (2016) refer to in order to facilitate an implementation of transformative science and research endeavours. The exploration of the kind of novel methodologies developed in this thesis can only contribute to facilitating transdisciplinary collaborations, if transdisciplinarity, or in my case a transformative risk communication, is more rigorously embedded and supported by scientific institutions. But also here, the question remains of who commissions the research and how this commission is linked up to decision-making processes.

Although the discourse around transformative science and transformative literacy is increasingly reflected by scientific institutions and initiatives (e.g. Future Earth, Leuphana University, The New Institute, University of Oldenburg, the NaWis network, Stockholm Environmental Institute, or IASS Potsdam), scientific bodies that are fostering a 'transformative risk communication' are still sparse examples compared to the more mainstream research networks and organisations. Therefore, it seems necessary to embed transformative risk communication much more within Earth Science institutions and possibly also in research and innovation policies (Stewart & Hurth, 2021).

For this step, it is important to proactively address the doubts or resistance in the mainstream of the current Earth science community, and to discuss transparently conflicts of values and norms. Still, the concept of a transformative science is at the core of far-reaching science-political debates, and the situation of science in this new, transdisciplinary process has long been a subject of contention. As can be seen in the controversial exchanges between Schneidewind (2015), Grunwald (2015), and Strohschneider (2014), themes that are negotiated refer to questions such as whether 'problem-solving' should be the responsibility of academia, if this affects the autonomy of the university, or if academic excellence is undermined by transdisciplinarity. For example, Weingart (2011) has criticised Nowotny's concept of 'socially robust' knowledge (see Chapter 2) as 'it points to the nature of scientific knowledge rather than to institutional mechanisms' and to 'democratic procedures of representation and decision by compromise' (Weingart, 2011, p. 132). By the same token, as outlined by Stewart and Hurth (2021), many Earth scientists still see a transformative science as 'science of persuasion' that is seen as 'ethically dubious' (p. 278). As outlined in Chapter 3a, whether or not 'mode 2-science' is taken up strongly depends on the perceived roles and responsibilities of scientists and institutions.

Against this position, I would argue that hazard science can only create *relevance* when it is open to taking up new methodologies needed to co-design risk communication, integrates knowledge from non-scientific agents and also incorporates these findings into scientific policy advice. In line with Ober (2018), I would also counter that the balancing of different interests for processes of decision making belongs, of course, to the political sphere. However, politics is also power-oriented and closely linked to timeframes of legislative periods. Therefore, advocates for long-term interests, such as those of future generations or the preservation of ecosystems, need to much more strongly represented in the policy negotiation arenas. Earth science institutions play a significant role to foster a more 'society-driven' research (e.g., Stewart & Gill, 2017; Stewart & Hurth, 2021; Wyss & Peppoloni, 2014)

6.2.5 Pillar 5: How can audiovisual methods contribute to the development of a 'transformative risk literacy'?

The last question I would like to address here is how the use of audiovisual methods can lead to an increase in transformative risk literacy and thus to research participants' willingness to resonate and actually advocate for change processes in the field of risk communication. Adapted from Ober (2018), the question is thus whether the use of audiovisual methods awakens 'desire for co-creation, future and change processes' (p. 6) in the realm of risk communication. The focus here is thus on the last aspect that Schneidewind (2013) addresses in his definition of transformative literacy, which is 'the ability to read and utilise information about societal transformation processes, to interpret accordingly and *get actively involved* in these processes' (Schneidewind, 2013, p. 83).

An essential prerequisite for the 'desire for co-creation, future and change processes' outlined by Ober (2018) is, as already mentioned above, that these processes have *relevance* (e.g., are incorporated in scientific policy advice, create visible impact or at least a more socially accepted representation of results) and that institutional and organisational frameworks allow these processes to happen. Furthermore, a transformative risk communication depends on the will and motivation of research participants to co-design people-centred approaches in risk communication that 'will be effective to avoid loss and suffering only when the people looking at them are willing and able to really see what's there' (Suarez, 2015, p. 1745).

Especially regarding that 'willingness' or 'motivation', I argue that audiovisual methods — under specific framework conditions — can be very productive. Based on my case studies and prototype developments, I would argue that practices such as the use of reflexive photography/video exercises in combination with the elicitation interviews as well as the different training methods during the risk communication workshop, but also Prototype 3 and procedures such as co-developing storyboards and moodboards were highly motivating. The storyboards and moodboards were not only perceived as a valuable occasion for a more nuanced representation of opinions and perceptions regarding seismic risk communication, they also appealed to the senses and creativity of the different research participants, 'in ways that more closely resemble how people navigate the social world, namely through language, experience, and basic metaphors and analogies' (Goldberg, 2019, p. 670). (Goldberg, 2019, p. 670). Further, I was able to demonstrate how audiovisual methods help to create vividness (Nisbett & Ross, 1980), reduce psychological distance to the topic of seismic risk (Fox et al., 2020), and how this contributed to the facilitation of co-designing risk communication. These insights were conveyed both through the feedback of my research participants, the elicitation interviews, and through the evaluation interviews of the risk communication training, where there was strong evidence that participants were particularly motivated *through* the audiovisual course methodology. As outlined in Chapter 1, the particular capacity of narrative formats also plays a role here, as narrative science messages were expected to be associated with greater variance in affective responses than conventional science messages, a finding also broadly supported by research literature as shown in Chapter 1 (e.g., Dahlstrom, 2014; Green & Fitzgerald, 2017; Goldberg, 2019; Shanahan et al., 2019).

However, it is essential to emphasise that the focus on the use of audiovisual methods is not understood as an end in itself. In fact, the focus must be on relevant research questions, which should be answered with an appropriate range of methods, such as those presented in this thesis. It will also not be possible to use audiovisual methods 'mechanistically' to achieve a certain effect. Their strength can be assessed not by technical standards but rather by the strength and frequency of resonance that Ober (2018) refers to, and the social interactions it helps to generate between experts and non-experts. This requires spaces where the different systems and ways of thinking meet, where trust can be built, and understanding of the different perspectives can be acquired. Here I would like to cite Ober's point that *informal* structures are particularly suitable. She quotes the social researcher Richard Sennett, who emphasises:

> Humanism's emphasis on life-narratives, on the enriching experience of difference, and on evaluating tools in terms of human rather than mechanical complexity are all living values and, I would say, these are critical measures for judging the state of modern society. (Sennett, 2011, as cited in Ober, 2018, p. 386)

Using audiovisual methods to motivate different participants to proactively engage in a co-design of risk communication requires long-term processes and the clarification of benefits for those involved. Since the focus of many participants is on coping with their everyday life, it is also important to emphasise that the use of audiovisual methods can not only add value sensorily, aesthetically, and narratively but also provide other occasions to address needs, such as the desire for social contact and exchange, keeping the memory of past disasters alive, a commitment to developments in the neighbourhood, or educational reasons (e.g., Hicks et al., 2017; Körkel & Hoppenhaus, 2016; Suarez et al., 2005). The fact that increasing one's own resilience, albeit a vital one, is understandably only one factor among many is why it makes sense to include audiovisual methods in a range of methods for transdisciplinary collaboration.

This range shows once again that scientists who engage in transdisciplinary formats of risk communication need special training in conflict resolution, engagement, and deliberation exercises and processes. At the same time, these approaches imply an innovative role for academic advisors in providing knowledge and support for participatory processes (Hoinle et al., 2021; Stewart & Hurth, 2021). This is, of course, a skill that is especially important for facilitators of such formats, but it is also required by the participating scientists themselves (Wiek et al., 2011).

6.3 Future Research Avenues

Transformative risk communication raises questions about the societal responsibility of hazard scientists, about the institutional changes needed to translate the concept of transformative science into the realm of learning, teaching and research, or, more specifically, about methodological frameworks that can help implement transdisciplinarity as a new paradigm in research and its communication (e.g., Ismail-Zadeh et al., 2017; König, 2015; Scolobig et al., 2015a)

This gives rise to a number of emerging research questions, such as:

- How can the methods I have proposed here (e.g., those for audiovisual risk communication training) be further developed or supplemented to open up access to transformative risk communication for early-career scientists and to stimulate their active (further) engagement with topics such as transdisciplinarity, reflexivity and transformative risk literacy? And how can institutional barriers be overcome when embedding transformative risk communication workshops in highly structured learning environments with fixed curricula specifications?
- Which theoretical concepts and current research findings should definitely be part of teaching transformative risk communication?
- What skills are needed by teaching staff who are committed to a reorientation of georisk communication? Although the use of audiovisual methods for a transformative risk communication is something that would certainly not resisted by hazard scientist in light of increasing disaster risk and the need for people-centred approaches, I have doubts if it would be sufficiently supported.
- What factors would thus motivate teachers to turn more towards transformative risk communication?

In addition to the above-listed questions, I would like to outline in more detail three possible areas of research that I believe could lead to exciting further research and help to effectively bring together the different findings of my research so as to translate them into results more applicable for risk communication practitioners.

6.3.1 Evaluation of Suggested Prototypes

It is important to note that the use of qualitative case studies limits the possibility of empirically testing or generalising the results of my work. However, my case studies were not conducted with the aim of being 'representative' but rather to explore and discuss important qualitative insights about novel methodological approaches to risk communication. The focus was on providing case-related insights into the application of post-Sendai risk communication with audiovisual methods. Nevertheless, in retrospect, it has become clear that more empirical research on the potential of audiovisual interventions to facilitate the co-creation of risk communication would be of scientific value. For example, a comprehensive evaluation of the prototypes is lacking at this stage, which makes it difficult to accurately capture the impact of my research on the participants involved in risk communication.

However, the positive feedback from my research participants, the praise from leading research figures in the field of risk communication and geoethics, and requests from conference organisers all motivate me to go further in my evaluation of Prototype 4 in particular, and to implement the planned evaluation workshops for Prototype 3. In the case of Prototype 3, for example, it would be necessary to investigate the usability of the collaborative editing tool, considering which functions are missing or still desired, how the users' attitude towards artificial intelligence influences their trust in the prototype, or under which conditions they are motivated to contribute own audiovisual content. In addition, the relationship between the editing process and social learning, as well as experience-based learning, would be of elevated interest. Another field of research would be to investigate how the collaborative editing process strengthens the trust between the participants and which target groups the resulting moving image works are able to reach. Regarding Prototype 4, it would be interesting to examine the individual training modules more closely for their impact and to explore whether sustainability skills were actually developed. For example, participants could take part in transdisciplinary processes of co-designing risk communication at a later stage and actively apply what they have learned here.

It would also be exciting to anchor Prototype 3 and 4 more strongly within existing transdisciplinary research projects. At the IASS Potsdam, for example, the *Science Platform Sustainability 2030* was recently launched, offering an innovative way to conduct a dialogue on the implementation of the SDGs between the research community and representatives from politics, business and civil society. The aim of this dialogue is to make different expectations of and perspectives on sustainability-related problems more transparent and comprehensible, to communicate these to the scientific community and policy-makers, and to mobilise broad support from appropriate, interested parties for each topic area (IASS, 2017, pp. 9-10). Since much of the platform's work takes place virtually, Prototype 3 might help to bring the 'lifeworld' of individuals and communities back into the digital space and thus support a more context-sensitive, multi-vocal or 'richer' dialogue. Especially in system-oriented research projects, it would be of interest to investigate the mediating potential of audiovisual methods to support knowledge integration between social, behavioural, economic and ecological knowledge. It would also be worth investigating whether scientists who have undergone training such as proposed in Prototype 4 can successfully contribute with their 'sustainability skills' to the work of the platform.

Although my research project has taken another approach, it might also be of interest to generate more empirical data on the design and effects of the ArcGIS StoryMap (Prototype 1) on user perception, such as investigating whether the combination of multiple videos with different stakeholder perspectives increases the StoryMap users' understanding of different perspectives and leads to a more nuanced understanding into the social context of risk communication. Following Goldberg et al. (2019), however, it must be noted that it is methodologically challenging to accurately measure audience effects of (interactive) audiovisual formats, because it is unclear 'which facets of the video most strongly drive its effects on beliefs and attitudes' (p. 669) (see also Chapter 1). Moreover, there are far fewer differentiated methods of interpretation and analysis for audiovisual language than there are for text and image analysis (Faulstich, 2013). Nevertheless, there is still much need for research in the field of audiovisual media analysis to learn about the mechanisms driving users (risk) perceptions.

6.3.2 Deeper Exploration of Metadata

This research has taken a first step in exploring video as a method of co-designing risk communication in the context of collaborative editing. Although the process of co-editing in a virtual space is in itself a novel phenomenon that deserves more scholarly attention, I assume that particularly a deeper analysis of metadata of audiovisual methods can generate meaningful insights. As presented in Chapter 4, a virtual use of video allows users to generate metadata in the form of annotations, tags or through the use of artificial intelligence (e.g., Pustu-Iren et al., 2020; Varghese et al., 2020). This includes not only 'quantitative' data (such as click rate of a video, shot sizes, or editing rhythm) but also qualitative data, for example, on decisions made during the editing process. In the case of Prototype 3, this could help to further interpret co-design processes. Questions worth following could be: Why specific footage was selected and others omitted by users? Why and how certain aesthetic choices were made during the editing process? Why was a particular 'route' of audiovisual narration chosen? What thoughts and feelings did users have during the editing process? Metadata related to such questions could also be generated for other visual methods, such as for storyboarding or the creation of moodboards, or the 'performative i-Docs' mentioned in Chapter 4. In combination with complementary methods, the collection of metadata could help to support a better understanding of transdisciplinary processes or processes of decision-making in the framework of creative methodologies. Retrospectively, I would also argue that such metadata — for example, in combination with qualitative evaluation interviews — could help to better understand learning processes as explored in Case Study 2.

6.3.3 Researching Institutional Change Mechanisms to Explore Pathways for Implementing a Transformative Risk Communication Curricula

At present, risk communication training is still strongly shaped by a disciplinary perspective, with problem-oriented study and teaching concepts being far from an established standard (e.g., Besley et al., 2016; Kurz et al., 2014). Hand in hand with the need for 'sustainability skills' of hazard researchers (outlined in Chapter 5) is therefore a need for more (audiovisual) transformative risk communication training, ideally embedded in transdisciplinary research contexts.
Associated research questions would be: 'What prevents institutions and their teaching staff from embedding transformative risk communication training and transdisciplinary educational frameworks? What would stimulate change and help overcome barriers?'.
Future research on transformative risk communication must analyse challenges and develop ways of overcoming specific institutional hurdles. For example, it is important to acknowledge that transdisciplinarity is highly time- and labour-intensive, and may presently limit career opportunities for academics. There are

still few transdisciplinary publication journals, and team-based transdisciplinary (or even interdisciplinary) doctorates are currently not possible. In addition, there is an intensive effort in funding and review procedures, and the open question of appropriate remuneration for research participants from civil society (e.g., Blassnigg & Punt, 2012; Lang et al., 2012). A comprehensive analysis of how participants in other transdisciplinary research frameworks have experienced the co-creation of risk communication, or how other universities and research institutions have managed to adopt the concept of transformative science, would provide valuable findings.
Furthermore, many transdisciplinary research projects are already producing audiovisual risk communication in the form of 'production for an audience' (Garrett, 2010). However, the methodologies and the epistemic value of the film production processes are usually not transparent. Here, comparative studies would be of interest in analysing heterogeneous film productions with their different focuses, and exploring the potential for knowledge integration proposed by Jahn (2008). Demonstrating through research how the co-production of audiovisual risk communication can lead not only to 'audiovisual content' but also to mutual learning processes could serve as a motivating factor for intra- and extra-scientific participants.

Finally, I believe that exploring the risk communication prototypes presented here in other application areas will lead to further insights, e.g., setting other risk communication processes in motion, leading to other user experiences, and also raising new questions. My contention that audiovisual methods can facilitate the co-creation of risk communication, leading to more 'socially robust' outcomes, offers much potential for further research. Highlighting the complexity of effects, while also identifying contradictions and shortcomings through further qualitative and quantitative research, for example, using audiovisual methods other than those presented here, would greatly advance the debate on transformative risk communication.

Conclusion

In face of increased disaster vulnerability, more and more scientists and practitioners involved in Disaster Risk Reduction and Management efforts acknowledge that conventional deficit-oriented risk communication has largely failed to strengthen the resilience of at-risk publics. Consequently, motivated by the Sendai Framework for Disaster Reduction 2015-2030, there is a shift to rethink risk communication principles and practices, specifically to explore and apply new dialogic formats of risk communication based on co-production and transdisciplinary inquiry (e.g., Scolobig et al., 2015; Stewart & Hurth, 2021). The resulting paradigm shift towards participation, action, and prevention is firmly outlined in the Sendai Framework's call for (1) more people-centred approaches and (2) the broader use of innovative ICTs. 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 manifold societal dimensions of risk. However, this call raises many open questions about how scientists will translate these novel requirements into their daily research practice. This thesis has analysed the implications these two Sendai Framework requirements have in the area of risk communication and explored how audiovisual methodologies can help accommodate them productively in research, training, and transdisciplinary collaboration. By doing so, this research breaks new ground in transformative science, specifically in setting out the emergent field of 'transformative risk communication' as a critical interface between hazard science and society.

Based on intense literature review and case study research, I have shown that confronting challenges of power imbalances, a lack of reflexivity, silo thinking, deficit-orientation and inefficiency of risk communication requires transformative approaches to risk communication. The ethnographic fieldwork in Istanbul that informed Case Study 1 has especially highlighted how general and abstract disciplinary and interdisciplinary knowledge needs to be placed in relation to people's local and contextual knowledge to make this knowledge 'useful, useable and used' (Aitsi-Selmi et al., 2016, p.3). This essentially sets up the transdisciplinary framework for the further course of my research.

My fieldwork in Istanbul also demonstrated that due to their social relevance, complex topics such as earthquake risk communication and earthquake risk mitigation represent good ‘entry points’ for the participation of different stakeholders in transdisciplinary processes. Here, risk communication did not take place only after the research results were available and was not a one-way transmission of information, but instead was part of a mode of ‘co-production’ of new strategies and applications of risk communication together with non-scientific actors. Rather than exclusively making expert knowledge available to a non-scientific public or publishing specialist knowledge that is usually only accessible to representatives of science, I have co-created means and formats to generate scientific and societal knowledge based on assessments of what is relevant for different target groups. The developed ‘prototypes’ make my research shareable with diverse publics and are expected to help in promoting long-term risk dialogues. Furthermore, I have been able to show that the co-design of risk communication among various stakeholders is a process that is in itself a transformative form of risk communication and contributes to transformative risk literacy.

Through focus groups and ongoing discussions, I have also explored how and why adopting a transformative risk communication mode and the manifold opportunities of ICTs for risk communication can pose various challenges for hazard scientists. More ‘people-centred’ processes are often time and labour intense, methodologically challenging, and confront scientists with new roles and responsibilities. Further, they require a broad array of new ‘sustainability skills’ for those involved. At the same time, the nuances of communications technologies that might help support processes of knowledge co-creation or more people-centred forms of outreach are still not familiar to many hazard scientists, as is the fact that increasingly it is the people at-risk themselves who create their own risk communication in newly emerging digital communication spheres.

The most significant contribution to new knowledge this thesis has provided lies in exploring how audio-visual methods can stimulate, support, and facilitate transformative risk communication, from which natural hazard researchers — and potentially all those involved in co-designing risk communication — can benefit. To inform that research endeavour, I have conducted what, to my knowledge, is the first critical analysis of the current use and research of audio-visual methods in the field of disaster risk communication. This review provides evidence that while the potential of audiovisual media is widely celebrated by risk communication scholars and practitioners as a powerful risk communication tool, a critical exploration of its use beyond outreach and classroom teaching is widely lacking. Furthermore, it highlights that the conventional use of film in risk communication measures the effectiveness of audiovisual media almost entirely in terms of information gain and behaviour change. In contrast, my work has taken a new research angle by looking at effectiveness in terms of the 'facilitation' of interaction and dialogue, partly with the help of technological innovations such as represented in Prototype 3.

Another distinctive and innovative feature of my work is that it uses methods and theoretical frameworks from the field of (applied) visual anthropology within a transdisciplinary research framework. Bringing these fields together, I was able to develop a research design that aimed to generate 'socially robust' results. Therefore, two case studies and prototype developments with different combinations of visual and verbal research methods helped to better understand individual experiences of the research participants in conceptualising, deploying, and being trained in using audiovisual methods for transformative risk communication. They also aided in understanding methodological shortcomings and the institutional conditions under which these methods can be further applied and develop their potential.

Operating at this novel intersection between applied visual anthropology and transdisciplinary research has generated insights about the potential, but also about shortcomings of using audiovisual methodologies. I have generated new insights into how the use of audiovisual methods in different risk communication settings can contribute to productively shaping the complex processes of knowledge co-production and the co-design of risk communication and serve as valuable training and research tool.

Both the case studies and the prototypes presented in this thesis— the ArcGIS StoryMap (Prototype 1), the animation film (Prototype 2), the collaborative editing tool 'Directors' Room' (Prototype 3) as well as the video-based training framework (Prototype 4) — provide a practical way to implement 'people-centred' approaches and also use innovative ICTs through them. When being watched (Prototype 1 and 2) or used (Prototype 2, 3, and 4), they clearly complement language and text-based approaches and enrich discourses. Compared to visual and verbal methods, audiovisual methods can offer numerous advantages because they have specific qualities, not least their multi-modal, expressive, projective, and mediating capacities.

As a research tool in the context of my ethnographic fieldwork, these methods provided a space to include actors usually marginalised in risk communication, to complement visual, verbal, and textual research findings, to motivate participants through the chosen methodologies, and to bring aspects usually 'invisible' in risk communication to the fore, thereby fostering other ways of seeing seismic risk. Furthermore, the insights gained through my film-based ethnographic fieldwork show that the use of audiovisual methods can support geoscientists with important contextual and local knowledge and allow the development of a greater awareness for multiple audiences and the messages that confront them.

Especially significant were my findings related to the question of how audio-visual methods can enhance and facilitate transdisciplinary collaboration through their potential for *knowledge integration* in groups of heterogeneous actors. I analysed my case studies and prototype developments in the context of their contribution to cognitive-epistemic, socio-organisational and communicative forms of integration. Cognitive integration occurred as different forms of local and expert knowledge were identified and related to each other, for example, through the process of editing, through the joint conceptualisation of prototypes, through the development of storyboard and mood-boards in the risk communication training, but also through the functions that for example Prototype 2 and 3 represent. In this way, the methods have proved to be an incubator for fruitful collaboration among different project partners. Socio-organisational integration took place as audio-visual means enabled actors with different cultural and professional backgrounds, preferences, and interests to collaborate and to bridge discrepancies between different working cultures. For example, collaborative editing, negotiation on procedures, timeframes, and aesthetic and narrative choices, facilitated by moodboards, storyboards and collaborative editing, allowed myriad thoughts to be projected and given new form. Different forms of meanings and communicative practices could be identified and integrated during the editing, and similarities, differences, and other relationships could be discussed, for example, during the photo-elicitation exercises, the joint film analysis and the reflexive interview exercise in Case study 2.

Indeed, the findings from Case study 2 provided hints for initial gains in 'sustainability competencies' (Wiek et al. 2011): anticipatory competencies, including storytelling skills and audio-visual literacy, normative skills including the ability for self-reflection and reflexivity on individual roles and responsibilities, and interpersonal competencies, that involve social learning, empathy, cultural awareness, and skills related to working in inter-and transdisciplinary teams. Furthermore, participants acquired system-thinking competence in the sense that they critically integrated multiple knowledge sources, and strategic competence, as they were conceptualising, creating, and disseminating a communication product in self-set deadlines, responding to complex user requirements, as well as to technical and medium-specific challenges.

Linking those outcomes to the concept of transformative risk communication, I would argue that through the proposed prototypes and case studies, experiential learning took place in which research participants analysed processes of transformation with greater reflexivity. Insights were gained by them actively collaborating with other disciplines and societal actors in an interdisciplinary way. This realisation of the potential of transdisciplinary collaboration, – manifest as more audience-aware films, 'socially robust' or even 'actionable' media, and a combination of different experiences – might embolden participants to be more willing to critically confront power imbalances in the realm of risk communication in the future. There are encouraging indications that particularly the interactive qualities of audio-visual methodologies are motivating for research participants, helping them to absorb and retain transdisciplinary collaboration tools more readily and instil a wish for learning, collaborating, and improvising, that 'standard' ways to teach geoinformation tools rarely do (Suarez, 2015). My methods enrich a transformative risk communication in various ways: through and with them, thoughts and ideas can be developed and communicated; different perceptions, preferences and epistemological standpoints can be given a form; visions can be worked out with them, and decisions can be made on the basis of different film sequences and images; and sustainability competencies can be developed. Together, these findings show that audiovisual methodologies can inspire, support, and facilitate translating transformative risk communication and lead to both scientifically and societally relevant findings.

While my case studies and prototype developments provide insights into an emerging research field on creative methodologies in transformative risk communication, they are only a first provocation for further research and discussion. For a start, their successful application is dependent on various factors, such as the willingness, openness, and motivation of the participants, experienced facilitators, but above all on supportive political and institutional frameworks. If audiovisual methods for facilitating transformative risk communication are only forced into a paradigmatic corset as an 'add-on' in the usual risk communication training and research landscape, my research results will have had negligible impact.

For this reason, my findings suggest a need for more concerted efforts by universities and professional scientific organisations to mobilise hazard scientists not only for more nuanced film-based outreach and engagement beyond the deficit-model but also to acknowledge the process of filmmaking or 'film as method' as an important educational tool for transformative risk communication. To achieve this, action needs to be taken on the institutional barriers of embedding transformative risk communication into highly structured university environments and in finding ways to overcome these. A transdisciplinary co-creation of risk communication as presented here requires considerable preparation, inter-institutional networking, and flexibility of participants. In addition, the time frame allocated for research projects could easily be exceeded, and transdisciplinarity can be intellectually challenging for all participants. Consequently, institutional openness, support and time commitment will be essential to embed transformative risk communication.

Even though 'interdisciplinary' and 'transdisciplinary' collaborations are terms frequently used in public outreach descriptions and funding applications, my proposed novel methodological approach in transdisciplinary co-creation of risk communication needs more in-depth evaluation so that my results can be scaled up (see section on future research). This view is also reflected in current social science literature on transdisciplinarity, where a lack of a commonly shared research framework to ensure valid and reproducible results and the often generalised and unreconstructed use of the term 'transdisciplinarity' are criticised for provoking a devaluation of this important concept (Blassnigg and Punt, 2012; Brandt et al. 2013; Werlen, 2015).

Here, however, the concern is for the practice of transdisciplinary approaches of co-designing risk communication. The purpose of that practice is to implement the Sendai Framework's requirement for people-centred approaches and innovative (audio-visual) information and communication technologies. In that context, the methodological approaches presented in this thesis open up a new research field that promises to break from the current, deficit-dominated risk communication research principles and practices. Given the close interdependency between hazards and society, geoscientists – as specialists in complex interacting systems – as shown in this thesis, are ideally placed to co-design risk communication with those communities that are affected, and in doing so to raise people's interest in the challenges of the dynamics of the Earth and of the places where people live.

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Appendices

From Matters of Fact to Matters of Concern -
a Visual-Anthropological Case Study on the Potential of Interactive Storytelling in the Communication of Earthquake Risk in Istanbul, Turkey

Principal investigator: Johanna Ickert, Plymouth University

RESEARCH INFORMATION SHEET

We would like to invite you to participate in "From Matters of Fact to Matters of Concern", which is a research project funded by the EU Marie Curie Actions program "Initial Training Networks" (ITN). Please read the following information carefully and ask us if you require any further information.

What is the purpose of this study?
Participative visual methods can be an effective tool for earthquake risk communication. Yet, their potential has not been sufficiently evaluated. In this research project, two visual methods will be applied in order to analyse their contribution to
a) supporting a mutual learning process by the linkage of local and scientific knowledge bases
b) creating integrated training methods for geoscientists that are more sensitive to sociocultural aspects
c) increasing the risk adaptation capacity of the inhabitants on a neighbourhood level

What will this study involve?
You have been asked to participate in this study because of your personal or professional experiences with the topic of earthquake risk reduction and its communication.
This study will involve
1. filmed interviews with inhabitants and geoscientists, as well as with planners, architects and engineers and local politicians in order to explore the different

perspectives towards the topic of risk reduction
2. photo/video elicitations (a scientific method that uses the potential of images to better interpret aspects relevant for the interview partner)
3. filmed participant observations in community workshops about earthquake risk reduction

Interviews and photo elicitations generally last less than two hours. Participant observations during the workshops can take longer. Participants have the possibility to get a copy of their personal data, as well as to actively contribute to the design and content of the research. This involves also the possibility that participants can withdraw their participation from the study at any time without having any negative consequences. It is important to underline that the research will lead to research films. It is intended to make these films available to the neighbourhood under study by integrating them into an interactive website that will be designed specifically for the neighbourhood under study. Therefore, the right to withdraw personal film material can only be guaranteed until the date of the finalisation of the films and their screening/publication. If film material is withdrawn, the participant will be asked if the transcripts of the audiovisual data can still be used for the written component of the PhD-project. To prevent a mis-representation, the films will be shown to the participants in several stages of their production, also in order to integrate the participants' feedback into the editing process. The footage of the filmed interviews will be stored on hard disk and transcribed. Transcripts and notes on observations will be stored electronically and in hard copy. Data will remain locked securely at all times.

What are the possible benefits and risks of taking part?
Benefits include being able to feed into the development of more integrated earthquake risk communication strategies with the aim to improve the inhabitants' risk preparedness. Participants may also find working with social scientists and other workshop participants interesting and mutually informative. It is important to stress that we are not seeking to judge people or their behaviour. Our interest is to help to evaluate methods for a better communication between geoscientists and inhabitants.

What will happen to the results of the study?
The evaluation of the research data will lead to a written dissertation. Other written components will be scientific articles for journals, reports and books. It is also planned to present and discuss the results of the study in the framework of lectures, presentations and seminars. We may directly quote from interviews or discussions. It is intended to use part of the audiovisual data to edit a series of research films. It is intended to integrate these research films into an interactive website that is designed for the needs of the neighbourhood under study. Any

other use of the data outside the research project requires a written permission of the participants.

Who is organizing and funding the research?
The research is funded by the EU Marie Curie Actions program "Initial Training Networks (ITN), and is being conducted by the principal investigator, as part of a collaboration with researchers of the ITN ALErT initiative (http://itn-alert.org/)
This research has been approved by the Faculty of Science and Technology Human Ethics Committee, Plymouth University. If you have any concerns regarding the way this research is being conducted, please contact the secretary to the Faculty of Science and Technology Human Research Ethics Committee, Ms Paula Simson, on +441752 584503.
Thank you for your time, and let us know if you have any further questions.

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RESEARCH WITH PLYMOUTH UNIVERSITY

CONSENT FORM

From Matters of Fact to Matters of Concern -
a Visual-Anthropological Case Study on the Potential of Interactive Storytelling
in the Communication of Earthquake Risk in Istanbul, Turkey

Principal investigator: Johanna Ickert, Plymouth University

I, ____,
confirm that I have received and understood the research information sheet for the research project "From Matters of Fact to Matters of Concern - a Visual-Anthropological Case Study on the Potential of Interactive Storytelling in the Communication of Earthquake Risk in Istanbul, Turkey", and that I have had the opportunity to ask questions.
I understand that images, audio- and video recordings are being made in the framework of Johanna Ickert's research project. The recordings are made for scientific publications in print and web-form and for presentations at public events.

I hereby authorize Johanna Ickert from Plymouth University, School of Geography, Earth and Environmental Sciences to create images, audio- and video recordings for publications in the framework of the research project.
I give permission to the processing and storage of data and for quotes and information from my interview or discussion to be used in a research film, publications and presentations, unless I expressly state otherwise. I understand

that my participation is voluntary and that I am free to withdraw or have my data destroyed under the conditions named in the information sheet.

Any other use of images, video- and soundrecordings outside the research project requires my approval. I have received a copy of this consent form.

Place, Date & Signature of the participant

Name and address of the participants in capital letters:

COVER LETTER, CONCEPT DRAFT & USER QUESTIONNAIRE

Cover Letter

Directors' Room – A prototype for collaborative video editing

Dear XX,

I would like to ask for your participation in a short questionnaire for the development of a prototype for collaborative editing that allows to co-creatively design risk communication. The software is designed to be used as a tool in the framework of virtual workshops in which heterogeneous groups can participate (e.g., hazard scientists, inhabitants of at-risk neighbourhoods, and urban planners).

Directors' Room is a collaborative AI-assisted video editing tool that aims to improve the way how audiovisual methods are used for risk communication.

The production of moving image work is a highly specialised and complex creative process that involves technical and artistic skills. Single hazard scientists or groups of scientists and film professionals spend long days and nights behind the camera and in front of the computer to create a final edit from vast amounts of footage. At the same time, filming, streaming and sharing movie clips have become ubiquitous—the preferred way for many inhabitants of "at-risk neighbourhoods" to express themselves. Yet, both professional and casual filmmaking have one thing in common: a singular perspective or subjectivity—the director's eye. But do director-driven, linear narratives do justice to the diverse and complex reality of risk adaptation and mitigation?

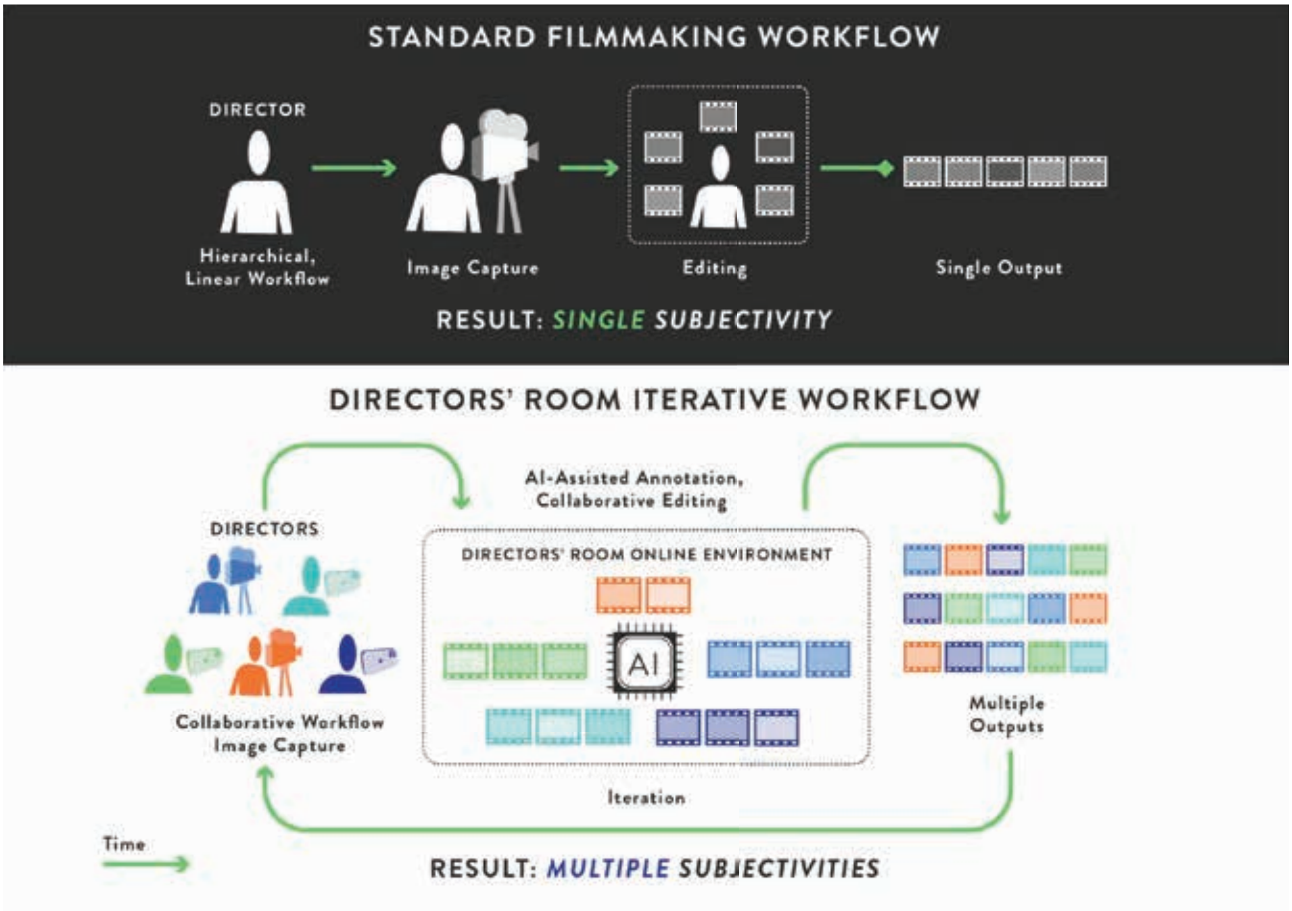
I aim to develop a new approach to audiovisual risk communication that breaks the strict hierarchies of film production in favour of a more democratic process, analogous to the practice of a collaborative writing environment ('writers' room'). Thus, the Directors' Room reimagines the filming and editing process as a joint social activity mediated by artificial intelligence.

To validate my preliminary assumptions about workflows, usability and features, I aim to ask you for your honest feedback regarding the following concept draft that contains five visualisations and short descriptions of the function of the prototype. I would highly appreciate it if you could have a look at the following project concept draft and answer the questions underneath.

Don't hesitate to contact me at any time if you have questions.

Kind regards, Johanna Ickert

The idea behind Directors' Room

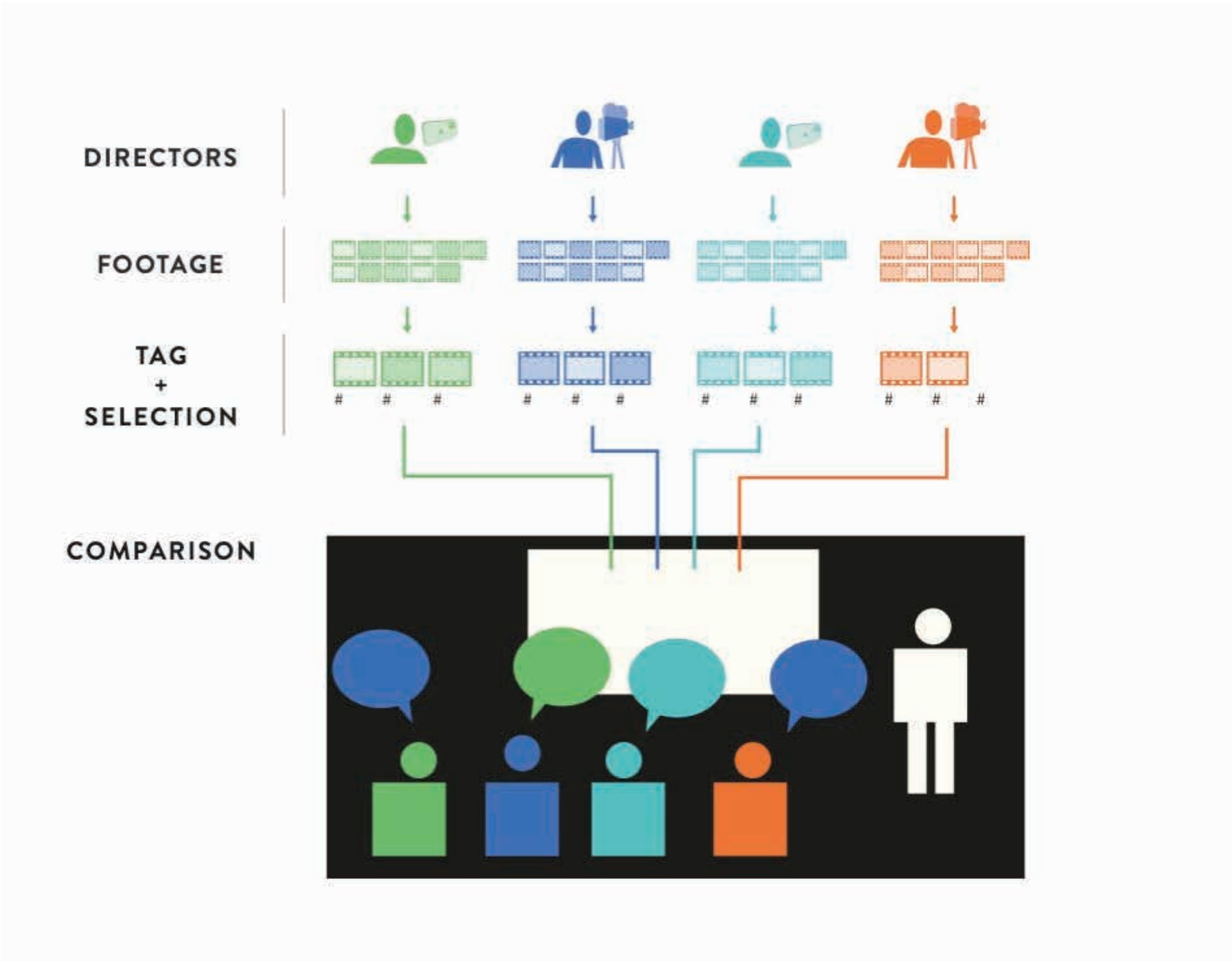


Directors' Room provides a cloud-based user interface that allows multiple remote users to shoot and upload individual clips, to annotate these clips, to create and edit multiple timelines and branching narratives, and to assemble video footage assisted by smart algorithms.
Directors' Room can be used to produce final videos in a participatory way, but can also be used as a tool for deliberation on themes chosen by its users.

Function 1: ***Individual Use of Private Timelines and Multi-User Collaboration on Shared Timelines***

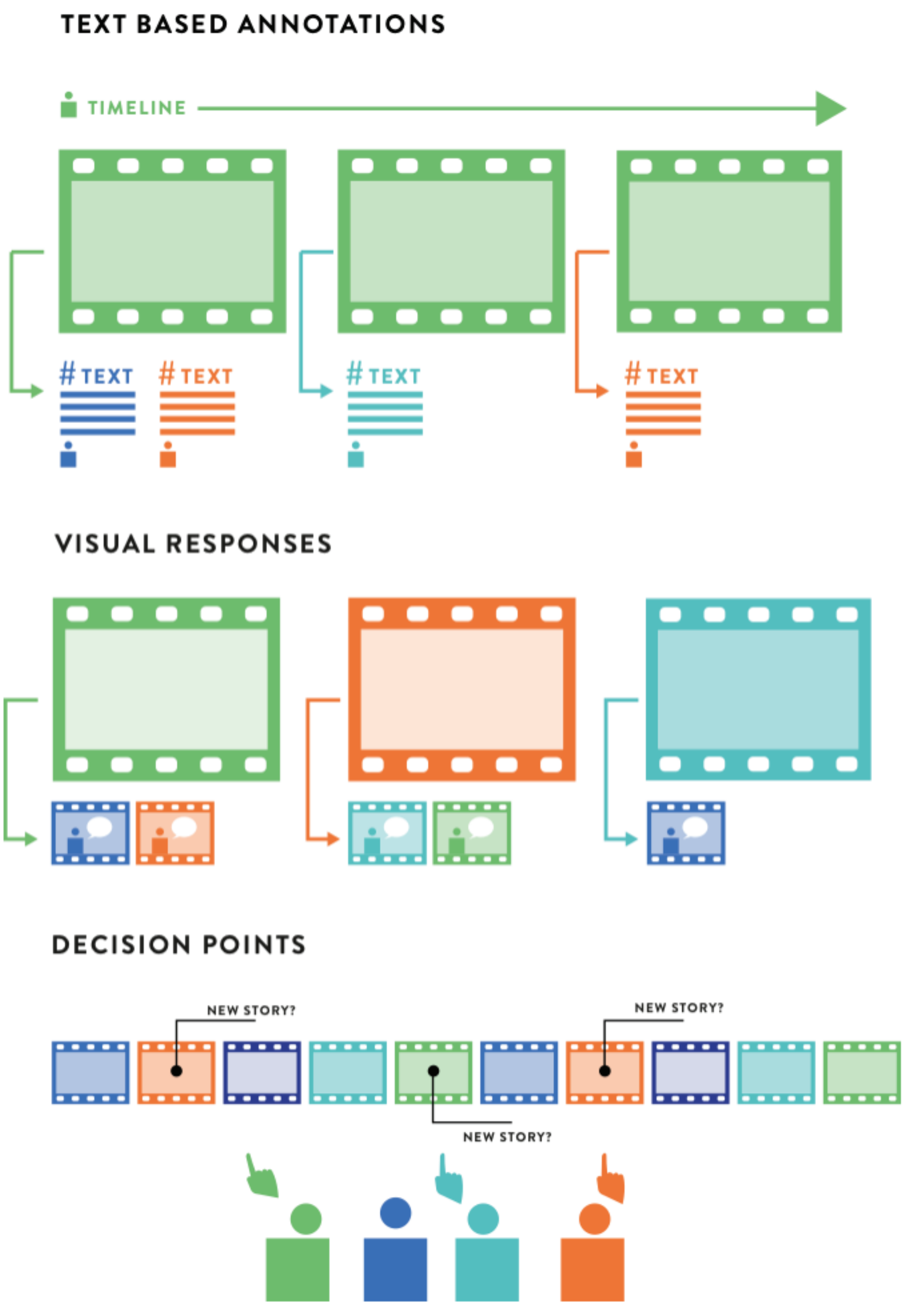
This function allows different users to work on timelines simultaneously and remotely. It allows single users to work on private timelines and several users to work together on shared timelines. Likewise, timelines can we watched in shared spaces as well as private spaces. The project file with the different private and public spaces can be accessed through the cloud, and all the functions that normal editing programs have can be used in real-time, such as editing audiovisual footage, arranging clips, or inserting transitions, titles and effects. Also, every user can upload (self-generated) content. In addition, they can create changes in the project file without interrupting the workflow of other participants. A further feature of this function is the comparison of timelines of different users. All users who use "Directors' Room" are encourages to present their private timelines in a shared space.

The comparison of timelines and the collaboration on shared timelines allows to collect, organise, and interpret and work on diverse video content. This process is intended to provide important local and scientific knowledge for the joint interpretation of disaster risks and the development of possible solutions. It helps establish visual comparative tools to identify and discuss overlaps, similarities or differences, e.g. between locally-identified topics and concerns and the perspectives of hazard scientists and risk managers.



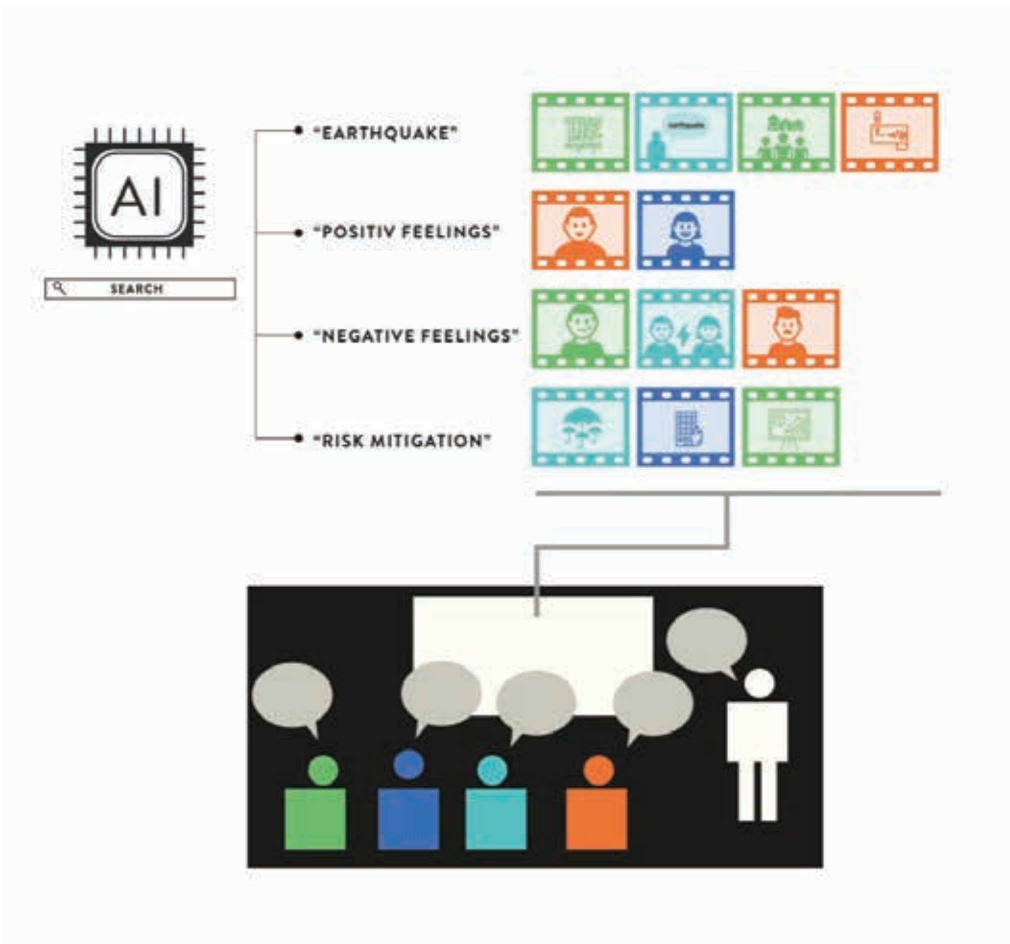
Function 2: Annotation

This function allows the creation of different types of annotations on individual clips, sequences or on the entire timeline. Annotations can be made in added “windows” in which text, images, further video clips (e.g. alternative shots) etc. can be inserted. It is also possible to add private annotations that only the user can see and that help him/her to search, structure and label personal thoughts on the film footage.
This process allows users to further complement video footage with other data. By adding texts, images or other sources, they can share their thoughts and knowledge on the film material, comment on the material or further develop new ideas for the editing. The annotation complements function 1 by allowing users to decode or expand the content of the film footage. It also has the strength to make the different semantic layers of film material more visible/transparent to the audience, and thus to allow for a richer viewing experience.



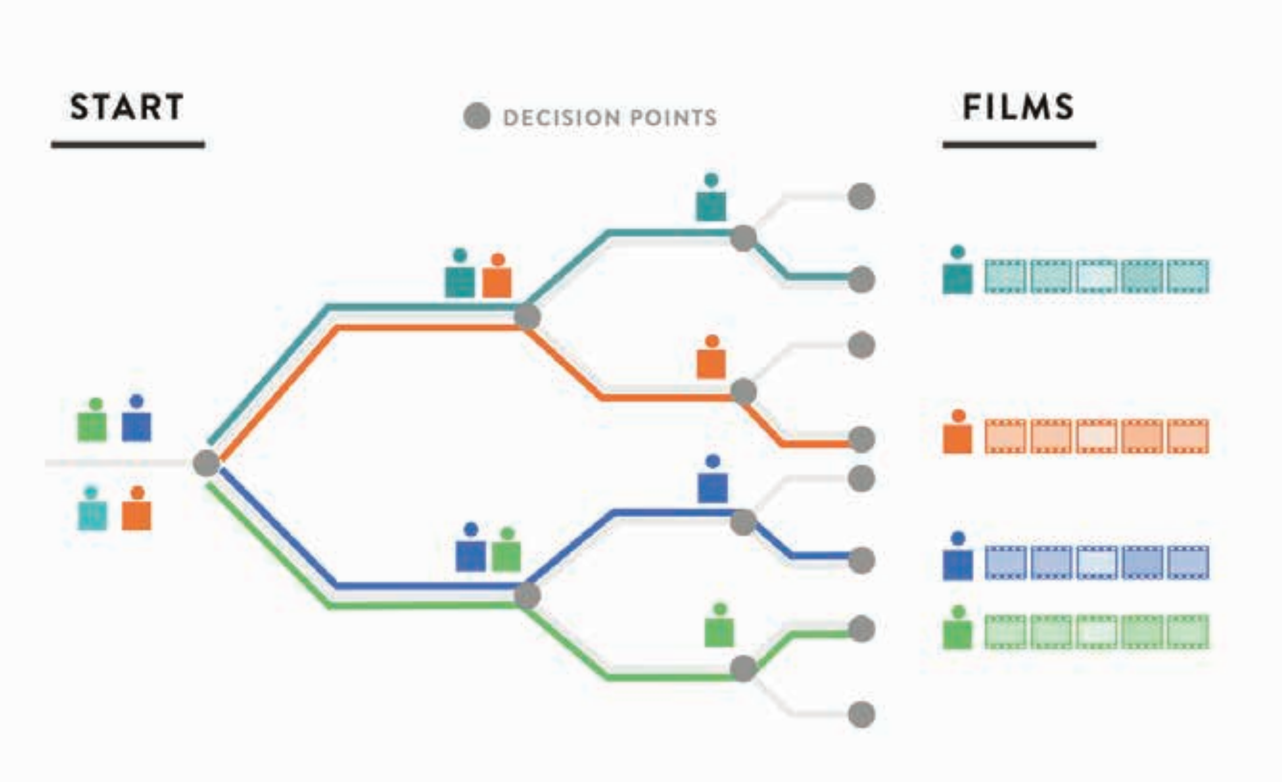
Function 3: Rearrangement of Timelines based on Tags, Annotations or AI-Detectable Features

This function allows users to rearrange timelines or generate new timelines based on specific annotation criteria, tags or "AI-detectable" features. Depending on their search requests, users can determine which tags, kind of annotations or AI-detectable feature they want to draw into a new timeline. With the development of neural networks, the prototype is able to locate images and sounds in the video footage and assign them to known categories. For example, object recognition allows systematising as well as analysing footage and thus can search for specific images, for example, compiling all video material in which a specific person is visible. Moreover, the built-in speech recognition can create a transcript of the sounds in the video with high accuracy or allow for an automatic translation in case multi-lingual users are involved. Users can then search that transcript to find the appropriate location in the video or search video content using keywords. Through this function, it is possible to support new forms of analysing video footage, as clips are reconfigured on timelines depending on criteria set up by a group.
As well as allowing quick searches and a more effective handling of often complex video material, this function provides new perspectives on the film footage and can potentially inspire users to discover novel relationships within the material. Also, a different arrangement of film footage in the timeline could promote empathy with those people appearing in the footage, add humour, or challenge dramaturgical conventions.



Function 4: Nonlinear, “Branched” Timelines

This function allows linear modes of storytelling to be broken up through the creation of “branched” narratives. Decision points can be included in the timeline, allowing users to select options to progress the story in their own way (for example, by adding new sequences or alternatives to existing sequences). This nonlinearity allows the film to be developed progressively as new footage is included. In this way, sequences can be “updated” if more actual footage is available or improved if better footage is available. Often, a linear way of editing “one film” clashes with the desire to capture multiple narratives of different participants in one timeline. The possibility of representing different interpretations - to visualise different interconnections within the film footage/data or to derive sequences with contrary “sub-themes” - could be a powerful alternative to a linear representation. This function could be powerful to transform the rich data inherent in film footage into different narratives and timelines. As such, this function addresses the problems outlined by respondents to integrate their own “version of the story” into risk scenarios.



Questionnaire

1) Would it be of interest for you to apply such a software in the framework of a workshop? Why? Why not?

2) What were your first impressions and thoughts about the concept draft?

3) What feature do you miss in Directors' Room?

4) Does anything seem out of place or unnecessary?

5) What risks and limitations do you see?

6) How likely or unlikely would it be that you would use the product once it's finished?

A brief overview of the Past and Current Role of Audiovisual Media in Geology (Excerpt from a Work-in-Progress Journal Article)

In order to appreciate how geo-communicators might expand and critically reflect on their current use of audiovisual media to better respond to major challenges of our time, it is useful to provide a brief history of (geo)science's relationship with 'moving images'.

Scientific images have always served as a valuable source for geological research, education and dissemination purposes for academic and non-academic audiences (Rudwick, 1976). The use of manifold visual methods such as drawings, charts, slides, maps and photography were from early onwards integral to the production and dissemination of geological knowledge. However, in comparison to static images, the use of film has played a rather subordinate role and was always influenced by technological, financial, methodological and other challenges. In most of the cases, audiovisual media are still unfamiliar tools for most geoscientists. Film at best plays a role at the very beginning or at the very end of research: At the beginning as a means of collecting data, at the end for illustrating theories for classroom teaching or for popularising geological interests. Interestingly, at the turn of the 20th century, the use of audiovisual media was much more experimental than it is now: With the birth of cinema through the Lumière brothers (1895) and the euphoria and excitement related to its technological potential for a new 'way of seeing', its use for scientific experimentation and inquiry was born as well (Blassnigg, 2010; Landecker, 2006). Landecker (2006) emphasises that cinema´s ability to show movement, motion and process introduced a new way of perceiving reality, which was equally important for popular culture as well as for scientific exploration. Given the dominant reliance on static drawings or photographs, film was seen as a way of looking at the world in more dynamic and 'realistic' ways that enabled different perspectives (e.g. under the microscope, through observation, or through exhibition of objects and phenomena that gathered scientific or human interest). Film was broadly seen as an inherently educational resource because of the medium's technological features, especially its ability to archive events, analyse and screen them (Gaycken, 2011). In the first phase of early cinema, there was no strict differentiation between entertainment cinema and science films, and no predefined genres such as 'documentary' or 'fiction'. As a modern urban society emerged, there was a strong public interest in scientific and societal advancements being reflected through this exceptional medium, and a variety of 'scientific' films and other observations of reality (so-called 'actualités') were regularly screened at scientific conferences or in public film theatres.

This complementary experimentation with film that brought together popular culture and science did not last very long. With the development of the technology, distinct genres emerged that targeted specific audiences. Of great interest to audiences in the crowded urban centres were the early expeditionary films of the 1920s. Films such as 'Climbing Mount Everest' (1922) had a significant influence on public imaginations (Jacobson, 2013) and most probably co-constructed the public perception of 'field working' scientists as intellectually and physically potent missionaries of a hegemonic Western culture (Smith, 2006). The interest in geographical and geological themes remained lively, as can be seen in the success of Hollywood films on natural disasters such as 'Deluge' (1933) or 'San Francisco' (1936). Although other visual methods were much more frequently applied, the film camera was used as a research tool for the description of 'objective' scientific reality. For example Kastens et al. (1996) state that 'a moving image can convey fundamental information about how the earth has changed through time'(Kastens et al. 1996, p. 534). Approximately since the 1930s film recordings served as an archival device to capture scientific observations (e.g. during field work) or as a tool for time-lapse film and photography. In this method, a film (or later video) recording was made to capture a distinct time span, or a 're-photography' was taken to duplicate selected aspects of another, pre-existing photograph. The goal was to demonstrate or study visible changes due to geologic activity, sometimes over several years. The recordings then represented a useful resource for educational illustrations of the importance of time in geologic processes (Fahnestock, 1966; Reams, 1981).

A strong interest in film as an educational/teaching resource emerged in the late 1950s (Taylor, 1958; Mühlberger, 1962; Johnson, 1961). Yet, its use in classrooms, usually via 16-mm film screenings, led to widespread debates (Johnson 1961). Critics regarded film as an eye-catching diversion that interrupted more important lectures and laboratory study. Proponents embraced it as a method with multiple benefits. Film was seen as a medium that could trigger students' interest, especially because of its capability to cover aspects of geology which could at that time scarcely be described in classroom lectures. For example, Taylor (1958) highlights that '...one movie shot with sound effects of, let us say, a marsh buggy rolling across trackless swamps and carrying a seismic shooting crew, gives a more vivid and lasting impression of this subject than could hundreds of the best chosen words, or even a sequence of text pictures' (Taylor, 1958, p. 25). Similarly, the potential of film for a more integrated, experiential education was highlighted. For example, Holmes wrote already in 1954 that

> knowledge must be evaluated from the standpoint of its human significance, and this is especially true of scientific knowledge. Although

> for some persons mere possession of knowledge may sometimes appear as an end in itself, it is the integration of that knowledge into the person's total life experience that brings understanding and enrichment of life. This distinction often remains obscure to students, and teachers are prone to overlook it in their primary concern over getting students to learn the factual content of their courses. (p.3)

Film, therefore, combined both, the potential for a more holistic knowledge integration, and for a more effective learning. As outlined by Taylor (1958, p. 25) '...students absorb visual information so rapidly that they will learn the entire contents of a moving picture at one or even several showings'. In addition, film was seen as cost effective, as it was assumed that audiovisual lectures could replace expensive personnel, a notion that came up in the 1960s, where such Fordistic ideas were 'en vogue'. Although the films themselves were 'expensive to produce (...) comparatively fragile and easily damaged' (ibid.), a cumulative catalogue of 16-millimetre films entitled "Educational Film Guide' (1957) listed already about 17,000 films. A 'Directory of Films and Slides of Possible Interest to Geologists" (1951) provided a broad collection of films for daily rental for universities. Even so-called 'Audio-Visual-Tutorials (AVTs)' were designed in which students sat in a row of carrels in front of individual projectors, looking at films designed to prepare them for their work in the laboratory (Sweet et al., 1970), an idea presaged by Thomas Edison in 1911 who predicted that films would soon replace textbooks (Gaycken, 2011). The potential of audiovisual media in the realm of public education was also quickly discovered by interest-led actors, such as the extractive industries. Since the 1950s, many educational films covered key geological resource themes such as coal, oil and gas exploration and were financed by enterprises such as the American Petroleum Institute, the Humble Oil and Refining Company the General Electric Film Libraries, Shell Oil Company, Esso Standard Oil Company, the Anthracite Information Bureau and many others (e.g. 'A is for Atom' (1953), the 3-D film 'A third dimension for oil' (1954), 'Black Diamonds'). These films were often uncritically used for geoscience education. For example, Taylor (1958, p. 27) who reviewed 'Black Diamonds' stated the film had '...a number of publicity plugs, but the film has much of geologic interest to those who are studying coal'. The incorporation of these films as teaching material can be seen as part of a professional alliance, with the extractive industries being one of the main employers of geoscientists. But there were also more critical analyses that questioned how the power of the medium was used for interest-led representations. For example, Holmes described the film 'Hoover Dam' (1953), produced by the U.S. Department of Interior, in the following words:

> It is an admirable record of stupendous engineering achievement carried out with great technological skill under the handicaps of rough, desert terrain in a remote area. In the thrilling entertainment, even a geology teacher may not notice that almost no reference is made to the need for preliminary geological surveys and detailed investigation of site. There is, however, the assumption that every- one will rejoice that now, for the first time in the course of Creation, the mighty Colorado is under control, — conquered (?!) (Holmes, 1954, p. 9).

This geoethical dilemma – to communicate in beautiful ways how geologists explore the formation of planet Earth and its 'resources' while providing scientific means to exploit them is one that remains in the midst of the discipline. An enduring human interest for geological themes has ensured that a regular but selective scientific attention has been given to the representation of geology in the popular media. This is perhaps most apparent in the section as can be read in the 'Geoflicks Reviewed' or 'Hollywood Geology' section of the Journal of Geological Education, where films were analysed in terms of their suitability for geoeducation, with the main criteria for analysis being scientific accuracy and a film's ability to maintain student motivation. 'Filmic text' in geology was in most instances seen as an important complementary source. For example, Brice (1980) recommended the screening of science fiction films in classrooms and described it not only as a valuable resource to enhance student motivation but also to enable different perspectives on geological reasoning. Also Liverman and Sherman (1979) outlined the value of analysing popular disaster films. Despite evident '...scientific inaccuracies...these media deserve attention', because they provide important information about public perception and response to natural hazards (Liverman & Sherman, 1985, p. 94). Similarly, Lighthart (2000, p. 601) contended that '...even bad science can be used to teach critical thought'. With the improvement of computer processing power and the development of sophisticated visualisation software, the last three decades have been marked by an impressive and rapid development of dynamic image generating technologies (Ford et al., 2010). These include various forms of geo-referencing, 3D WebGIS, real-time techniques or 3D virtual reality (VR) environments (Li et al., 2015; Zolnai, 2014; Bilke et al., 2014). These web-based technologies are also frequently used in interactive ways for research and dissemination purposes. For example, GIS-related applications are being used to generate and collect user data (e.g. through mobile technology, such as early warning apps) or to further contribute to making geoscientific data, such as hazard-related information, more accessible to users who might benefit from them. In the Tessin VisLab or at Potsdam University researchers work on improving high- resolution stereoscopic virtual reality (VR) environments to further enhance the possibilities of visualisation by providing an environment that supports collaboration in work groups including people of different backgrounds and to present results of research projects to stakeholders or the public (Bilke et al., 2014). When it comes to film as medium for research dissemination, however, the vast majority of geoscientists prefer text-based publications in peer-review journals. Although geology has always been dealing with very dynamic Earth processes, static images are usually preferred in these publications. In the field of research dissemination for the public, only a few geoscientists produce 'outreach' films themselves (Drake et al., 2014). Most scientists instead leave this task to media professionals to whom they provide their scientific expert knowledge. However, with new technologies it is easier to create, distribute and see video as a means of science communication and geoscientists are increasingly being encouraged to produce audiovisual media themselves (Barrett et al., 2005; Allen et al., 2012; Moloney, 2014). Examples are the European Geoscience Union (EGU) and the American Geoscience Union Science (AGU) Video Competitions (Harned, 2012), that host video workshops and cinema screenings. Courses on (audiovisual) storytelling are still rare, but there is a trend that such topics become an important element science communication training. If online films are being produced, the chosen formats are usually online education videos that explain general geological phenomena or provide background information on different research projects, including field work experiences (e.g. in the form of field work diaries or documentations).