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Doctoral Task Forces on High Impact Natural Hazard Events

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Abstract. Around the globe, disasters are becoming more frequent and more damaging. Therefore, forensic disaster analysis is needed that creates a deep and comprehensive, understanding of a recent event and its root causes to inform disaster risk reduction. As part of their qualification within a research training group, PhD candidates at the University of Potsdam formed Task Forces to investigate recent damaging events. Based on eleven semi-structured interviews, two informal interviews and Task Force outputs, this study evaluates past Task Forces with regards to their implementation into structured doctoral training, their contribution to researcher development and to transferring insights both to the academic community and to non-academics. We find that Task Forces in doctoral training programs serve a dual purpose in providing problem-based and experiential learning opportunities for doctoral researchers and at the same time providing the flexible, high-level investigative capacity needed for immediate post-event analysis. For future Task Forces, we recommend forming interdisciplinary teams, aligning the Task Force with the PhD topic and methods and providing targeted support in the initial phase to enable near-real time analysis.

1 Introduction

Despite growing scientific knowledge and technical capacity in the field of disaster management, the community continues to face a paradox: around the globe, disasters are becoming more frequent and associated damage and loss are increasing rapidly (Oliver-Smith et al., 2016, see also White et al. 2001). This trend underscores a pressing need for a deeper understanding of the causes and circumstances that turn hazards into disasters. To effectively inform disaster risk reduction (DRR) strategies and mitigate damage and loss, methodologies are required that can systematically portray disaster events and create a "literature of quality case studies" (Oliver-Smith et al., 2016) on the basis of data that is ideally collected and analysed soon after a damaging event. However, the operational realities of academic research are characterized by tight funding cycles and publication pressures and rarely allow for the necessary spontaneous, rapid deployment and analysis, hindering the uptake of additional research activities.

Even though this gap persists, there have been significant advancements in achieving a more comprehensive understanding of disasters and their root causes as a basis for DRR in the past 15 years. First, Burton (2010) presented a "New Case Study Model" developed by an ad hoc working group in the context of the Integrated Research on Disaster Risk (IRDR) program – the Forensic Disaster Investigations (FDIs). FDIs represent a paradigm shift in the understanding and management of disasters

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in moving away from a narrow focus on geophysical causes towards an explicit recognition of human responsibility and the "complex range and interaction of factors" that shape disasters, including social, technical and environmental dimensions.

Central to FDIs is a critical cause analysis (Burton, 2010). This methodology examines the causes for hazards and damaging processes by identifying critical factors across the pre-disaster, impact and recovery phases. Moreover, critical cause analysis includes the identification of preventive measures and of thresholds for failure or success points with regard to damage prevention or reduction, the definition of critical limits for factors related to warnings, evacuations and building safety, the establishment of monitoring requirements and the identification of corrective and proactive action. Additional analytical approaches proposed for FDIs include meta-analysis, longitudinal analysis and scenario analysis (Burton, 2010).

Burton's research agenda has been advanced through the FORIN (Forensic Investigation of Disasters) program. A defining feature of FORIN is the shift from a primary focus on disaster management and emergency response to risk reduction and control, aligning closely with the Sendai Framework for Disaster Risk Reduction 2015-2030 (UN 2015) and other international initiatives (Oliver-Smith et al. 2016).

A core principle of forensic disaster investigations is their interdisciplinary nature. Generic causes of disasters can locally manifest in diverse ways, mediated by socio-economic conditions and social processes. From holistically portraying cases of disasters, we can extract fundamental lessons on root causes, circumstances and consequences of damage and loss that feed back into DRR. Achieving such a comprehensive analysis of disaster cases requires integrating perspectives from human and critical geography, political ecology, history, ethnography and sociology alongside physical sciences and engineering (Oliver-Smith et al. 2016).

Building on and operationalizing this comprehensive understanding of disasters, the Center for Disaster Management and Risk Reduction Technology (CEDIM) at the Karlsruhe Institute of Technology (KIT), Germany, introduced the CEDIM - Forensic Disaster Analysis (FDA) in 2011. In this approach, "forensic" denotes the rigorous, evidence-based investigation of disasters using a combination of available methodologies and modeling techniques from science, engineering, remote sensing and crowd sourcing (Wenzel et al. 2011). Outputs need to be integrated and updated against ground-level information in real time. The resulting interdisciplinary, science-based assessments enable the critical evaluation, appraisal and quantification of the event. Wenzel et al. (2011) emphasize the importance of carrying out the forensic analysis in near real time, that is, within the first days following a damaging event. During this critical window, interaction with stakeholders is most intense and open and interest of potential users is highest.

The interdisciplinary CEDIM-FDA Task Force remains active today. Within only few days of an event, comprehensive reports are published on the CEDIM Website and distributed via the FDA mailing list (CEDIM 2025). Often peer-reviewed research articles follow, based on the work of the Task Force. In 2025, the Task Force covered three events, including Hurricane Melissa, the Kamchatka tsunami and Mandalay Earthquake Myanmar. The Helmholtz Centre for Geosciences (GFZ) in Potsdam was a co-founder of CEDIM. Today, the GFZ has its own Hazard and Risk Team (HART), which is focused on seismic and volcanic hazards (for examples see Walter et al. 2021 and Dietze et al. 2022).

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The CEDIM-FDA Task Force represents a pioneering model for applied disaster research aligned with the FORIN research agenda. However, to address the breadth of global disaster occurrence, forensic disaster analyses must be established more widely and at a greater scale. As noted above, a critical gap persists between the urgent demand for immediate, applied disaster research and the operational constraints of conventional academic projects. While publication of research articles takes some time, other publication formats need to be taken into consideration to meet the need for a rapid analysis of events and a quick dissemination of (initial) results.

Bridging this gap also requires a flexible and motivated group of academic investigators seeking opportunities to gain experience in applied research projects. In a research training group (RTG) funded by the Deutsche Forschungsgemeinschaft (DFG) from 2015 to 2024, doctoral researchers took on this role. This study is based on experiences from the RTG "Natural Hazards and Risks in a Changing World" (NatRiskChange) (Lebek & Thieken, 2026). A mandatory component of the qualification program of the RTG were the so-called Task Forces – interdisciplinary teams formed by doctoral members that aimed to analyze and investigate recent damaging events under real-time conditions.

Such forensic disaster analysis aligns well with doctoral training needs. Based on interviews with postdoctoral researchers, Crossouard (2013) found that respondents emphasized the need for opportunities to gain experience, for instance in teaching, project management, grant writing or applied research, rather than additional formal training. This highlights the importance of integrating research training into doctoral candidates' lived research practice rather than treating it as a distinct preparatory phase (Crossouard, 2013). Similarly, Solmon (2009) argues that learning outcomes are most effectively achieved when research skills and competencies learnt in courses are applied to subject matter in problem-based and experiential learning. Doctoral programs should therefore incorporate research experiences at an early stage, alongside formal courses (Solmon, 2009).

We hypothesize that embedding rapid FDA case studies directly into the qualification programs of doctoral researchers serves a dual purpose: It provides the flexible and capable personnel necessary for the immediate post-disaster deployment while simultaneously addressing identified needs among PhD candidates for experiential learning and applied research opportunities. This study investigates the strengths and challenges of integrating continuous, comprehensive disaster analysis with the educational and career development requirements of doctoral researchers. To assess the effectiveness of this integration, the study analyses the eleven NatRiskChange Task Forces from 2016 to 2023, drawing on 18 semi-structured interviews with Task Force participants and supervisors.

In detail, this study addresses three research questions:

1) *How can Task Forces be effectively implemented within a structured doctoral training program?*
   This question relates to the integration of a Task Force exercise in the proposal phase, and to the establishment and management of Task Forces in an ongoing doctoral training program.
2) *How did Task Forces contribute to gaining new and important insights and transferring knowledge to non-academics?*
   This focuses on interdisciplinary collaboration, collaboration with academic partners, science communication and the quality of scientific output.

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3) *How did Task Forces enhance skills and researcher development?*
This question relates to candidate competencies in establishing and managing a Task Force, conducting field work, interdisciplinary collaboration and science communication.

To address these questions, the analysis is structured around the related overarching themes: establishing a task force, managing a task force, in the field, collaboration within academia, science communication, interdisciplinarity, researcher development and scientific output. The remainder of this paper is structured as follows. The next section introduces the operational model of the NatRiskChange Task Forces and reviews the output from each Task Force. The Data and Methods section describes the collection of semi-structured interview data from NatRiskChange members and principal investigators. The Results section presents the findings across the identified themes. Finally, the Conclusions section synthesizes the broader lessons learnt and provides important recommendations for the implementation of similar elements in the qualification and training programs of doctoral researchers in disaster risk research.

2 Task Forces within the Research Training Group "Natural Hazards and Risks in a Changing World"

"Natural Hazards and Risks in a Changing World" (NatRiskChange) was a research training group (RTG) funded by the Deutsche Forschungsgemeinschaft (DFG) from 2015 to 2024. The overall objective of NatRiskChange was to develop and advance methods of analysing and quantifying natural hazards and risks in a changing world (Lebek & Thieken 2026). The key scientific aims were the development, testing and pilot application of methods that identify, quantify, and predict natural hazards and associated risks that are under the influence of changing boundary conditions or altered intrinsic dynamics (Sieg et al. 2023, Vogel et al. 2024). Next to research, NatRiskChange contained a qualification program requiring PhD candidates to complete 30 credit points (ECTS), with the Task Forces constituting a central element worth six ECTS.

Table 1: Overview over NatRiskChange Task Forces

NatRiskChange Task Force	No of participants*	Field work (y/n)	Output	No of interviews with Participants	PIs
Kumamoto Earthquake 2016	3	y	Von Specht et al. 2019	2	1
Braunsbach Flash Flood 2016	12	y	Agarwal et al. 2016, Bronstert et al. 2017, Bronstert et al. 2018, Bronstert et al. 2020, Laudan et al. 2017, Ozturk et al. 2018, Vogel et al. 2017a, Vogel et al. 2017b	2	1
Randi forest land degradation 2017	1	y	Von Keyserlingk, in prep.	0	0
Pluvial Flooding in Berlin 2017 and 2019	7	y	Berghäuser et al. 2021	1	1
Avalanche Austria / Italy 2019	2	y	Rottler and Schmidt, in prep.	1	1

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Wildfires in Australia 2019/2020	5	n	Kemter et al. 2021	1	1
Eifel Floods 2021	11	Y	Dietze and Ozturk 2021, Apel et al. 2022, Dietze et al. 2022, Thieken et al. 2023, Vorogushyn et al. 2022	5	1
Pre- and post-lockdown noise levels during Covid-19 pandemic 2021	2	n	Sharma and Esfahani, in prep.	0	0
Marche Italy Flood 2022	5	y	Bryant et al., in prep.	2	1
Turkey Earthquake Sequence 2023	3	n	Asayesh, Dietrich and Lin, in prep.	1	1
Multi-hazard Event in São Sebastião 2023	7	y	Arango et al. 2023, Bastos Moroz & Thieken 2024, Arango-Carmona et al., in prep.	3	1

* For the purpose of this study, only participants that were core members or associated members of NatRiskChange were included in the count of Task Force participants. Please note that the large Task Forces (Kumamoto, Braunsbach Australia Wildfires and Eifel floods) had further members from the institute of Environmental Sciences and Geography and from other research institutes.

The NatRiskChange Task Forces are summarized in Table 1. Below, they are briefly outlined and their output is reviewed.

In April 2016, an earthquake sequence (mainshock of 7.3 at 01:25 JST) occurred near Kumamoto on Kyushu Island (Japan) along the Futagawa/Hinagu fault. It triggered more than 600 landslides. Two members of the **Task Force "Kumamoto Earthquake 2016"** were geomorphologists with a focus on landslides while one member was a seismologist (Ozturk, Veh and von Specht in prep.). They combined their expertise and investigated the impact of seismic rupture directivity on landslide occurrence during the event. The output of this Task Force was a collaborative research article (von Specht et al. 2019). The study ruled out other landslide susceptibility factors such as hillslope inclination, lithology or land cover as none of them sufficiently explained the landslide distribution or orientation. The analysis demonstrates that the seismic radiation pattern is consistent with the overall landslide distribution and thus proposes a new physics-based ground-motion model that accounts for seismic rupture effects.

The flash flood in Braunsbach, Baden-Württemberg, Germany, was an intense and localized event during the southern Germany floods in late May to early June 2016. On May 29, 100 to 140 mm fell within only two hours, resulting in a strong flash flood that hit the small town of Braunsbach with high intensity. The **Task Force "Braunsbach flash flood 2016"** was formed within few days of the event (Agarwal et al. in prep.). This large and interdisciplinary Task Force investigated several elements of the risk chain, including meteorology, hydrology, geomorphology and impacts. Overall, the Task Force resulted in six peer-reviewed publications (see Table 1) and two publications via the Potsdam University Press (Agarwal et al. 2016, Vogel et al. 2017b). Furthermore, it received much attention both from the media and from local stakeholders and citizens, e.g. during a townhall meeting. Below, the resulting research articles are briefly reviewed.

The forensic hydrological analysis of the Braunsbach flash flood revealed that an extremely rare and intense rainfall event, combined with catchment properties, triggered extreme surface runoff and severe debris flows. The event surpassed existing flood design guidelines by a factor of 10, with all components—rainfall, peak discharge, and sediment transport—exceeding

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a 100-year return period. Due to the complex and cascading nature of the processes, no single cause could be identified, but human activities may have influenced the event's severity (Bronstert et al. 2017, Bronstert et al. 2018, Bronstert 2020). The floods led to 42,000 m³ of sediment deposition, including boulders and mud, from 50 riparian landslides. The sediment yield, ranked among the top 20% globally, significantly impacted the landscape. Past flood records suggest these events have occurred periodically, highlighting the underestimated debris flow hazards in the region's gentle, cuesta landscape (Ozturk et al. 2018c). Damage assessment eight to ten days after the flash flood event used KoBoCollect for data collection and analyzed the influence of flood processes and building features on damage. Post-hoc analysis revealed that building exposition to flood flow direction had a strong correlation with damage, and factors like building materials and surrounding features also played a role (Laudan et al. 2017, Vogel et al. 2017a).

The Randi Forest area is a dry rangeland in southern Cyprus that is severely affected by land degradation, driven soil erosion related to climate variability and amplified by an increase in livestock grazing. In April 2017, the **Task Force "Randi Forest"** visited the area to directly assess local land degradation dynamics (Von Keyserlingk in prep.). The Task Force collaborated with researchers from Cyprus University of Technology and from University of Utrecht, a local consultant and a scientist from the Ministry of Agriculture in Cyprus. This collaboration contributed to a study on the resilience of vegetation to drought (Von Keyserlingk et al. 2021).

Heavy rainfall in Berlin in the summers of 2017 and 2019 caused urban flooding, disrupting daily life and causing property damage. The **Task Force "Pluvial Flooding in Berlin 2017 and 2019"** analyzed the meteorological characteristics and population vulnerability and issued a report published via the Potsdam University Press (Berghäuser et al. 2021). The Task Force found the 2017 event to be extreme, with return periods over 100 years, and the 2019 event more typical for an urban pluvial flood but intense. A household survey revealed disruptions in daily activities and gaps in preparedness, highlighting the need for improved support for vulnerable groups. Recommendations include better early warning systems and targeted information campaigns to enhance resilience and preparedness.

On December 28, 2019, a large avalanche in South Tyrol's Schnals valley buried several skiers, killing three German tourists. The **Task Force "Avalanche 2019"** analyzed media coverage, summarized the accident and assessed changes in avalanche risk in the European Alps (Rottler and Schmidt, in prep.). They also visited the accident site with colleagues from the University of Innsbruck and examined climate station data related to wind-driven snow redistribution. The field trip combined practical and theoretical lessons on snow research and avalanche awareness. The full report of this NRC task force was provided as dashboard (Rottler and Schmidt, in prep.).

The Black Summer wildfires in Australia (2019/2020) were part of a cascading series of events, starting with an extreme drought that made 2019 the driest year on record. The subsequent exceptional wildfires burned over 24 million hectares, exacerbating soil water repellency which contributed to the flooding that followed heavy rainfall in early 2020. This caused soil erosion and drastically reduced water quality in rivers and lakes. The **Task Force "Wildfires in Australia 2019/2020"** investigated the hazard cascade in the Manning River catchment in New South Wales to understand the complex interactions among the different hazards (Banerjee et al., in prep.). The Manning River was severely affected, with post-fire erosion leading

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to higher turbidity. The Task Force's analysis was published (Kemter et al. 2021). The study stresses the need for multi-hazard risk management and highlights the increasing role of climate change in amplifying such compounded disasters. It calls for better monitoring systems and adaptive strategies to prepare for and mitigate future cascading hazard events.

In July 2021, extreme rainfall caused record-breaking floods across Germany, the Netherlands, and Belgium, with damages in Germany reaching EUR 30 billion. The disaster, worsened by landscape interactions and debris transport, led to 185 deaths and significant infrastructure damage in North Rhine-Westphalia and Rhineland-Palatinate, the two most affected federal states in Germany. In response, NatRiskChange researchers from the University of Potsdam, GFZ, and Free University Berlin launched a large interdisciplinary Task Force to investigate the event (Berghäuser et al., in prep.). Similar to the Braunsbach Task Force, the **Task Force "Eifel Floods 2021"** split into specialized working groups, each of them analyzing one component of the risk chain (meteorology, hydrology, geomorphology, impacts and flood warnings). The meteorology analysis identified discrepancies in rainfall intensity models, suggesting improvements for future studies by considering climate change and expanding the region. Hydrological findings emphasized the need to reassess flood frequency statistics by incorporating historical flood data, revealing that extreme floods might be more probable than previously thought (Vorogushyn et al. 2022). The geomorphology study highlighted how the rapid flood dynamics reshaped landscapes, showing the importance of considering high-resolution data for future flood predictions (Dietze and Öztürk 2021, Dietze et al. 2022). The Task Force used the M. DELENAH and Random Forests models to estimate flood damage in six counties, but decided not to publish the estimates due to high data uncertainties (Lebek and Thieken 2026). The 2021 floods highlighted issues with the flood forecasting, warning and response system (FFWRS), as many individuals did not receive timely warnings or were unprepared according to a survey conducted jointly by NatRiskChange and another research project. This suggests that clearer communication of flood risks and protective actions is essential for improving flood response (Thieken et al. 2023). The Task Force not only resulted in several peer-reviewed papers and reports, but also paved the way for a the BMBF-funded HoWas2021 project which analyzed the governance and communication surrounding the event (Heidenreich et al. 2025; DKKV, 2024). Furthermore, the Task Force supported the collection of remote sensing data, which is now available in a repository (Brell et al. 2023).

In 2021, the **Task Force "Pre- and post-lockdown noise levels during Covid-19 pandemic 2021"** formed with the aim of comparing seismic noise levels before and during the COVID-19 lockdown (Sharma and Esfahani, in prep.). The team used probabilistic power spectral density as a method for the analysis, focusing on seismic stations in Kolkata, India; Paris, France; Berlin, Germany; and New York, USA. The study found a notable difference in seismic noise levels between the pre-lockdown and lockdown periods, with Kolkata showing the greatest variation, followed by Paris, Berlin, and New York in that order. The Task Force issued a report (Sharma and Esfahani, in prep.).

In September 2022, extreme rainfall in Italy's Marche region led to catastrophic flooding, causing river overflows, erosion, infrastructure destruction, and eleven fatalities. The **Task Force "Marche Italy Flood 2022/23"** aimed to investigate the flood's causes and impacts in collaboration with Italian scientists (Bryant et al., in prep.). The first team joined a field trip in February 2023 to assess flood-affected villages and high watermarks, shifting focus to warnings and long-term infrastructure

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damage. Findings emphasized the need for better preparedness, as residents underestimated the event's severity, and disruption of roads prolonged regional recovery. The second team conducted a field visit in May 2023 to map road network damage, identifying 16 damaged roads, three closures, and affected bridges in Cantiano and Sassoferrato. Their analysis highlighted the role of river channeling, woody debris, and prior drought conditions in worsening the disaster and recommended using drones and DEMs for improved damage assessments. The Task Force issued two short reports (Bryant et al., in prep.) and an online GIS storymap (Bryant et al. 2023).

The **Task Force "Turkey Earthquake Sequence 2023"** studied the February 2023 earthquake sequence in southeastern Turkey and northwestern Syria, where two major earthquakes (MW 7.8 and MW 7.5) occurred within nine hours (Asayesh, Dietrich and Lin, in prep.). The three members of the Task Force all have a background in seismology. They analyzed static ground displacement using Sentinel-1 InSAR data, revealing complex fault interactions that led to varying offsets. Moreover, they assessed felt intensities through logistic regression, identifying discrepancies between expected and reported shaking, particularly east of the fault lines. Lastly, the aftershock analysis recorded about 55,000 events, linking their distribution to stress metrics like Coulomb stress. The Task Force issued a short report (Asayesh, Dietrich and Lin, in prep.). The analysis highlights the earthquakes' severe humanitarian and economic impacts, emphasizing the need for accurate aftershock predictions.

During the Carnival weekend of 2023, an extraordinary rainfall event surpassing 600 mm in less than 24 hours triggered over 500 landslides on the coast of São Paulo State, Brazil. The event led to significant human impacts, including 65 fatalities, displacement of over 1000 people, and extensive destruction. In their analysis, the **Task Force "Multi-hazard event in São Sebastião 2023"** focused on rainfall, landslide dynamics, historical changes in exposure to landslides, and the efficacy of the early warning systems in place (Arango-Carmona et al., in prep.). The main output of the Task Force was a conference paper in the Proceedings of the XXV Brazilian Symposium on Water Resources (Arango-Carmona et al. 2023). It provides an analysis of the event. The study argues that disasters are the result of interactions between natural hazards, human exposure, and vulnerability rather than being purely natural events. Moreover, the Task Force fed into a research article by one of the Task Force members (Bastos Moroz and Thieken 2024) and field data were used in the related PhD (Bastos Moroz 2025).

3 Data and Methods

This research is primarily based on five semi-structured interviews with principal investigators (PIs) and eleven interviews with members of the NatRiskChange RTG (PhD candidates).

Of the eleven interviewed Task Force members, nine interviewees were core members of NatRiskChange, two was associated. In total, NatRiskChange had 36 core members (twelve in each cohort).

The interviewees were selected based on their availability and their level of engagement within the Task Force. At least one member of each of the eleven Task Forces was interviewed, with two exceptions. Members of the "Task Force pre- and post-lockdown noise levels during Covid-19 pandemic 2021" and the Task Force "Randi Forest" were not available for interviews.

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In the case of Task Force "Braunsbach Flash Flood 2016" and the Task Force "Eifel Floods 2021", two members each were interviewed to account for the large number of people involved in these Task Forces. Five interviewees had been members of more than one Task Force. One of the associated members who were interviewed had voluntarily taken part in three different Task Forces, in one of them as an associated postdoctoral researcher.

Similarly, at least one PI of each Task Force was interviewed, with the exception of the "Task Force pre- and post-lockdown noise levels during Covid-19 pandemic 2021" and the Task Force "Randi Forest", whose PIs were not available. Most of the interviewed Task Force PIs had supervised more than one Task Force. The PI of one Task Force was an alumnus of the first cohort and thus member of an earlier Task Force. Within the total funding period, NatRiskChange had 18 PIs and 13 additional co-supervisors and mentors. Of these, seven PIs and two co-supervisors took on the role of Task Force PIs. For this study, four of these PIs and one co-supervisor were interviewed, based on their availability.

The semi-structured interviews were conducted in June and July 2024. At the time, five interviewees were still PhD-candidates (see Table 2, members of 3rd cohort). Most interviews lasted around 30 minutes and some interviews lasted longer (up to an hour). In addition, two PIs of NatRiskChange, but not of the Task Forces, were briefly interviewed on specific questions regarding both the implementation of the Task Force Exercise into the proposal for the NatRiskChange RTG and a current doctoral training program, that also includes disaster-related Task Forces.

For the analysis, interviews were numbered to ensure anonymity (Table 2). References in the analysis cite either the interview number or the respective Task Force. Interview numbers were deliberately not linked to Task Force names in order to prevent any inferences about the interviewee.

Table 2: Interviewees of this study

Principle Investigators (PIs) of Task Forces	I-P1, I-P2, I-P3, I-P4, I-P5	Semi-structured interviews (in person or via zoom)
PIs of NatRiskChange	I-B1, I-B2	Brief telephone interviews
Members of 1st cohort (2015 – 2018)	I-A1, I-A2, I-A3	Semi-structured interviews
Members of 2nd cohort (2018– 2021) and one associated member	I-A4, I-A5, I-A6	Semi-structured interviews
Members of 3rd cohort (2021 – 2024) and one associated member	I-D1, I-D2, I-D3, I-D4, I-D5	Semi-structured interviews

The interviewees provided consent for the interviews to be recorded. Additionally, notes were taken during the sessions. The recordings were transcribed verbatim using an AI-powered speech recognition software (Amberscript 2024). The transcripts were subsequently checked for accuracy and edited with reference to the notes. When all transcripts were finalized, a stage of familiarization with the data followed. The text was then inductively coded and grouped into categories. The data were then analyzed and discussed around the overarching themes that were developed from the research questions (see introduction).

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Next to the interviews we used other data sources, particularly the outputs that were created by the Task Forces: resulting research articles, reports, website texts, photos and online visuals (see Table 1). Additionally, newspaper articles on Task Forces and minutes from meetings with stakeholders were used.

4 Results

This section summarizes and analyses results from the interviews with participants and PIs of NatRiskChange Task Forces with a subsection for each of the overarching themes introduced in section 1. The analysis includes benefits, challenges and recommendations with regards to the Task Forces.

4.1 Establishing a Task Force

One of the primary challenges of Task Forces in natural hazards is the unpredictability of damaging events and the difficulty of planning them in advance. Across all three PhD cohorts, participants approached the assignment of starting a Task Force with uncertainty and hesitation, often perceiving it as vague and open-ended (I-P1) and thus challenging. The absence of a clear starting point made it difficult to integrate the Task Force into existing timelines and tasks (I-P1). Since specific damaging events cannot be predicted, participants could not prepare for particular scenarios. Instead, they had to identify types of events that they wished to address in their Task Force. Based on the topics of their PhD research projects, Task Force groups had often already formed around these event types before the actual event had taken place – a strategy also recommended by several interviewees (I-A1, I-A4, I-D2). I-A4 also advised contacting a potential PI beforehand, who could assist in identifying a suitable event.

Finding a suitable event and initiating a Task Force differs from PhD-research, where in most cases research topics are predetermined by supervisors. From the beginning of the qualification program, the PhD candidates were mindful of the Task Force assignment and actively looked for potential events to address. In their efforts to identify suitable cases, they became more attentive to ongoing natural hazards and engaged in discussions about them with their peers (I-A5). Some participants were concerned that no suitable event would take place within the duration of their PhD funding period (I-D2). In such cases, an event that occurred further in the past was selected (I-P1). For instance, the Task Force on Pluvial Flooding in Berlin was established several months after the event. From April to June 2020 a part of the group conducted an online-survey with residents of Berlin who had been affected by heavy rainfall events in the past, particularly in the summers of 2017 and 2019 (see Berghäuser et al. 2021).

Task Forces were initiated either by a PI or by the PhD candidates themselves. For instance, both the "Braunsbach flash flood 2016" and the "Eifel floods 2021" Task Forces were initiated by PIs within days of the event. In other cases, such as the Avalanche in December 2019, the initiative came from the PhD candidates themselves. I-A1 recommended that Task Forces be commonly initiated by PIs, drawing from their broad experience (I-A1), while I-A5 emphasised the value of PhD candidates taking independent initiative in identifying an event and establishing a Task Force.

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A key element in initiating a Task Force is to identify a suitable event that sustains participants' motivation and engagement (I-P1). The interviews revealed a number of criteria for selecting events appropriate for a Task Force within a graduate qualification program. The event should be intellectually challenging - for example, due to the extent of the damage it caused, which is worth exploring in more detail, or due to unique characteristics in its magnitude and development (I-P1). Practical considerations also play an important role for the selection of an event, such as language proficiency relevant to the affected region, accessibility and travel distance. For instance, the Task Force investigating the floods in the Marche region in Italy chose this event in part because one of the participants was fluent in Italian and the area is easily accessible via train. In the case of the Braunsbach floods, it was seen as beneficial that the study area was easy to reach (within Germany), allowing several Task Force subgroups to travel there repeatedly. Another criterion was the existence of networks with partners in the affected area, especially abroad. In the cases of both the Marche floods Task Force and the Avalanche Task Force, the supervising PI had established connections with local researchers which enabled potential collaboration for the Task Force and facilitated field work.

At the outset, Task Force members need to decide whether to undertake field work. In the NatRiskChange graduate qualification program, Task Forces often participated in at least one field trip to the affected regions, funded by the program. Nonetheless, field work was optional and certain Task Forces chose not to conduct field work for a number of reasons, such as travel distance, ongoing hazards in the area, ongoing search and rescue activities and repair works in the area or the severity of the disaster, including events that had resulted in fatalities. For instance, the Australia Wildfire Task Force opted not to travel to Australia due to the long distance, but instead focused on analyzing data from the event remotely. Similarly, the Syria Earthquake Task Force did not travel to the severely affected region, but used existing remote sensing and survey data.

Task Forces were generally expected to respond rapidly to hazardous events - a demand that contrasts with the slower pace and routines typical of academic research and is thus particularly challenging. Interviewees identified two main reasons why early activation of a Task Force is essential. First, event impacts and damage are most visible shortly after the event, allowing for optimal data collection in the field. For example, in the case of the Braunsbach flood 2016, the high-water marks could still clearly be seen although the post-event clean-up was already ongoing. It should be noted that the duration of this window varies by event type and magnitude and affected region. Second, media and public attention is highest following a disaster but typically declines after a few weeks (see "Introduction" above and "Science Communication" below). Ideally, Task Forces produce preliminary findings in form of a brief report within the first two weeks after a hazardous event, increasing the likelihood of media coverage and public engagement. However, the NatRiskChange Task Forces generally did not produce results this soon after the event (see Table 1).

For implementing disaster-related Task Forces into future doctoral training programs, several interviewees recommended preparatory workshops in the initial phase that would support Task Forces with regards to a number of challenges that they themselves had faced. These include a general overview over what is expected (I-A5), training in data collection methods, such as KoBoCollect (I-A2, I-D1), addressing safety concerns and logistical challenges in the affected area (I-A1, I-A2), and training of Task Force-specific project management skills (I-D3, I-D4). However, others emphasized that the potential for preparing for an unknown future event is very limited (I-P4).

4.2 Managing a Task Force

At the outset, a Task Force must develop a clear understanding of the damaging event it is addressing and carefully define its intended outcomes. This involves establishing a solid research framework, identifying key areas of interest, and formulating specific research questions and objectives. Equally important is ensuring that the scope of work is realistic given the time constraints, setting manageable deadlines, and defining a clear project endpoint. As one principal investigator put it: *"You should be capable of producing a well-founded, objective, and scientifically informed summary of a natural disaster—within a limited and clearly defined timeframe, I'd say roughly a maximum of three months, give or take – following a predefined format."* (I-P3).

Since the Task Force was part of the doctoral qualification program clearly defining and limiting its scope—as well as effective time management – were essential to prevent it from becoming overly time-consuming or a distracting burden during the three-year PhD period (I-D5, I-A4, I-P1). Unlike academic research, which often lacks clear boundaries and continuously generates new questions, the Task Force format thus required participants to set limits, work efficiently and define when a task was sufficiently completed, often with help of their PI (I-P1, I-P2, I-P5, I-A6). This helped them develop a more pragmatic and outcome-oriented approach, which was a valuable learning outcome (I-D4, I-A6). I-D5 and I-D3 stated that the members of their Task Force had different ideas on how much time they were willing to invest in the Task Force. I-D3 said that overall, they felt they did not have enough time. Similarly, I-D1 said that they had underestimated the amount of time required for the Task Force and they felt that the number of credits they received within the qualification program (6 credits) was too low and did not align with the effort that they had put into the Task Force.

The Task Forces handled their project organization and management internally and largely independently, with minimal involvement from PIs (I-P2). This fostered a high degree of self-organization among PhD candidates. They learned to take full ownership of the project. This was seen as challenging and time-intensive if none of the Task Force members had prior project management experience (I-A3). The members of the Task Forces each assumed different roles and responsibilities, such as managing and facilitating meetings or coordinating among the subgroups (I-P3, I-D2, I-A4, I-A6, I-D1). In some instances, these roles were flexible, with members taking on different responsibilities at different times (I-D4).

In particular, the task force exercise provided an opportunity to develop and demonstrate leadership skills. Most Task Forces had at least one member who emerged as a driving force, taking on leadership roles in various forms. This included contributing ideas, showing initiative, maintaining high levels of engagement and demonstrating strong commitment to the subject matter. Leadership also involved taking on responsibility, fostering team cohesion, motivating others and ensuring that meetings remained focused and productive (I-A4. I-D4).

Several interviewees emphasised that working in a team of colleagues that brought together diverse areas of expertise and skill sets was a unique, motivating and rewarding experience (I-A2, I-A3, I-A4, I-D5). Rather than being limited to co-authoring a

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publication, collaboration occurred throughout the entire process, from establishing the Task Force, planning, conducting field work where applicable, analysing data and writing up results. This comprehensive team work sets the Task Force experience apart from typical academic research in a university setting (I-D2, I-D3, I-D5).

Despite the overall positive experience of close collaboration, some Task Forces encountered challenges related to team dynamics. Issues included members missing meetings without prior notice, lacking initiative, or contributing minimally to the project (I-A4, I-D5). In several cases, it was difficult for teams to reach consensus on research objectives and scope (I-D1, I-D2, I-D3, I-D4, I-D5, I-A3). In one example, each of the three members pursued their own approach, making it difficult to align their work and produce a cohesive outcome (I-D1). Support from the PI helped guide the team through these difficulties (I-P5, I-A3). I-A4 described it as a valuable learning experience to recognize when collaboration was not functioning effectively and to respond constructively — for instance, by offering a different task to a team member who was struggling to contribute.

A particular challenge to collaboration in the second and third cohorts was the shift to remote work during the COVID-19-pandemic, which largely persisted thereafter. Members of these cohorts sometimes went weeks without seeing one another in person and relied heavily on remote and online communication, which made coordination and teamwork more difficult. By contrast, the first cohort benefited significantly from regular in-person interactions, as team members were present in the office daily. This facilitated informal discussions and spontaneous exchanges about the Task Force projects. In some cases, teams even shared an office space, further enhancing collaboration (I-A1, I-A3).

The PIs played a supportive yet deliberately restrained role in the Task Forces. They often initiated Task Forces or advised on the appropriateness of fieldwork and the suitability of a particular event based on factors such as data availability. PIs also facilitated collaboration with local partners and, in some cases, provided formal documentation of the doctoral researchers' affiliation and purpose, as in the Braunsbach Task Force. While generally remaining in the background to encourage self-organization and independent work, PIs helped define the scope and timeframe of a Task Force, responded to requests for advice, attended group meetings when necessary, and helped resolve team-related challenges (I-P3, I-P4, I-P5).

Some groups initially struggled to find a PI who could dedicate time to support their Task Force (I-D2). Interviewees emphasized that PIs should be clearly informed about their expected role in the Task Forces at the outset of the graduate program. This additional responsibility should be formally incorporated into the graduate program's proposal, with PIs consenting to mentor a Task Force and being held accountable for fulfilling this role (I-P2).

4.3 In the Field

"It's one thing to think it through theoretically beforehand, but quite another to actually see it in practice," stated I-A1. Organizing and carrying out field research is an important skill gained through experience rather than traditional education. For PhD candidates whose own research did not involve fieldwork, the task force served as a welcoming and motivating opportunity to gain hands-on field experience.

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Several interviewees emphasized that fieldwork was an essential component of their Task Force experience and their academic training. Being on-site in an area recently affected by a disaster provided a deeper understanding of the processes and (potential) impacts associated with natural hazards. It was seen as especially important for researchers working in the field of natural hazards "to gain a sense of what it truly means" (I-A1). Being directly exposed to the aftermath of an event and interacting with affected individuals offered a valuable shift in perspective and influenced how they later handled anonymized datasets involving significant damage or injuries.

Although preparation time is often very limited, it is crucial to thoroughly conceptualize and prepare any field trip to affected areas. Entering the field without a clear purpose, can mean reducing the field visit to disaster tourism, which must be avoided (I-P1). To conceptualize the trip effectively, Task Forces should define clear objectives, specify the types of data to be collected, and determine appropriate data collection methods, which ideally should have been pre-tested or derived from the literature. Some Task Forces needed to coordinate their field work with international partners and in doing so encountered challenges such as delayed responses and uncertainty in planning (I-P5, I-D4).

The Task Forces engaged with local partners in multiple ways throughout their work. First, they obtained access to valuable data and official reports from local authorities – for example, the Syria earthquake Task Force utilized resources provided by the Turkish Disaster and Emergency Management Authority (AFAD). Second, local partners provided logistical support and orientation within the study areas. In the case of the Brazil landslide Task Force, participants were accompanied by a member of the local civil defense during the first two days of their field trip. Third, Task Forces gained qualitative insights through direct interaction with local actors. These included informal conversations – such as with a mountain hut warden near the avalanche site – and the collection of contextual material like photographs of the area before the disaster (e.g. in the Braunsbach-Task Force, see Vogel et al. 2017a) or of previous, comparable events (e.g. in the Kumamoto-Task Force).

When conducting field research in areas recently affected by damaging events, Task Forces must take precautionary measures and ensure that the area is secure and safe for access. For instance, after a flood, buildings may be at risk of collapse, while in landslide zones, researchers must avoid walking on recent deposits, as secondary landslides can occur days later. Such safety concerns could be addressed and appropriate precautions reviewed in a preparatory training (I-A1) (see above).

In addition to the safety concerns, several Task Forces encountered logistical challenges arising from the very impacts they were tasked with assessing. For example, during the Marche Floods response, road damage prevented direct access to further road damage sites, forcing the team to take detours and ultimately limiting the number of locations they could visit. In flood-affected crisis zones, damaged infrastructure and ongoing clearing operations often made vehicle access impossible. Researchers therefore lodged in unaffected areas, traveled by car as close to the affected zones as feasible, and conducted fieldwork on foot. The Kumamoto Task Force spent two nights in hotels that still exhibited damage from the earthquake six months prior. Local partners played a crucial role in helping the team navigate areas affected by both landslides and seismic activity.

In some cases, members of the Task Force conducted field work alongside emergency responders, cleanup crews and affected residents, placing them in socially sensitive situations. Interactions with local residents were often marked by curiosity and

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required the researchers to carefully explain the purpose of their visit and build mutual understanding (I-A2). Locals generally valued that the researchers were taking scientific interest in the event.

The timing of the fieldwork in relation to the event played a role for the level of engagement with local residents. For instance, during fieldwork in Braunsbach shortly after the event, researchers avoided entering homes or directly questioning individuals out of respect for the affected residents. They recognized that, so soon after a disaster, residents were likely focused on recovery and not in a position to engage in conversations. By contrast, when fieldwork was conducted several months after an event, Task Forces more actively engaged with locals to gather information. In the case of the Marche Flood Task Force, for instance, residents provided valuable assistance by offering directions and details about road damage. Preparatory training for future Task Forces (see above) should also include guidance on field communication – particularly with affected residents – to help researchers navigate such emotionally and socially complex post-disaster settings.

In the case of the Braunsbach-Task Force, each subgroup carried a letter from the PIs confirming their affiliation with the University of Potsdam and outlining their planned research activities. This official document helped build trust and facilitate engagement with locals. Some members also wore T-Shirts with the logo of the University to underline that the field visit has an official/professional purpose.

4.4 Collaboration Within Academia

NatRiskChange Task Forces benefited in multiple ways from collaborating with academic partners. In one instance, an academic partner brought a relevant event to the attention of a Task Force. Often, PIs facilitated the contact with academic partners. PhD candidates who had already established contacts with academic partners due to their PhD research, were able to deepen these collaborations through their involvement in the Task Forces. In three cases, Task Forces accompanied their academic partners on field trips and benefited significantly from their local knowledge and networks (I-A1, I-A3, I-A5, I-D4). At times, communication proved challenging, not least due to language barriers (I-P5).

In cases where events attracted significant international attention from both the scientific community and the public, Task Forces faced challenges in defining a distinct research niche that could provide added value. The Kumamoto Task Force, for instance, was distinctive in its integrative approach, effectively combining seismology and geomorphology (Von Specht et al. 2019). This distinguished from other research efforts. In another case, by the time the Task Force had defined its research topics, much of the relevant work had already been published by other groups. Consequently, the team decided not to pursue a publication. This underscores the importance of early engagement in the aftermath of such events and effective and timely performance of the activities including their documentation, as described above. During the Braunsbach and Eifel flood events, research groups from different universities were conducting parallel investigations. An academic partner assumed a coordinating role, helping to organize the different research efforts, e.g. by assigning different segments of the study area to specific groups and minimizing duplication of work. These groups collaborated closely, sharing data and exchanging information throughout the process (I-A1).

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Overall, the close collaboration with academic partners during Task Forces opened new opportunities for PhD candidates, expanding their international networks and advancing their career development (see below). I-A5, for instance, went on to join the research group with which they had collaborated during the Task Force.

4.5 Scientific Output and Science Communication

Many of the events analysed by Task Forces were of high relevance to both the public and the media, which helped maintain motivation throughout the Task Force (I-P1, I-P2, I-D5). Task Forces addressing natural hazards can contribute to a scientifically grounded representation of the event (I-P1) and thus play an important role in informing media and the public after a disaster. Their findings may be relevant for policy decisions on disaster response, recovery and future mitigation (I-A1) and can also help counteract misinformation and conspiracy theories (I-D2).

The expected outcome of NatRiskChange Task Forces was not strictly defined. Each Task Force had the autonomy to choose its output format, ranging from an interactive GIS dashboard and blogposts to reports or peer-reviewed journal articles. Interviewees agreed that this flexibility was beneficial and motivating (I-D4, I-P1, I-P5). Moreover, it enabled several participants to incorporate Task Force results and related follow-up studies into their doctoral dissertation (I-A3).

It is important to recognize that in some cases, Task Force findings should not be published immediately due to political or legal sensitivities. In one instance, a police and judicial investigation was underway to determine whether the damage and fatalities from a particular event could have been prevented. As a result, the Task Force exercised caution and password-protected their report during the first year following the event, only releasing it after the investigations had concluded. In another case, the findings were politically sensitive. Authorities were reluctant to draw public attention to the event, and local academic partners expressed concerns that increased scrutiny might hinder access to geophysical data. Consequently, household surveys were discouraged and finally omitted.

Participants were available for media requests, with the Braunsbach Task Force receiving the most extensive media coverage (see Table 3). Another example is the Australia Wildfire Task Force, where a member gave several interviews to newspapers in both Australia and Germany.

Table 3: Media coverage of the Braunsbach Task Force

Media outlet	Date	Title	Link
Haller Tagblatt / Südwest Presse	09.06.2016	Forscher nehmen Schäden in Braunsbach auf	
Potsdamer Neueste Nachrichten	17.08.2016	Potsdamer Forscher untersuchen die Braunsbach-Sturzflut: Die Jahrhundertflut	https://www.tagesspiegel.de/potsdam/landeshauptstadt/die-jahrhundertflut-7175443.html
Haller Tagblatt / Südwest Presse	20.08.2016	Wissenschaftler untersuchen Zusammenhänge der Sturzflut in Braunsbach	

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Portal Wissen Eins	28.02.2017	Ein Jahrhundertereignis: Promovierende des Graduiertenkollegs „NatRiskChange“ untersuchen Ursache und Folgen der Sturzflut von Braunsbach	https://doi.org/10.25932/publishup-44089
BILD	27.05.2017	Forscher: Flut in Braunsbach so stark wie alpines Unwetter	https://www.bild.de/regional/aktuelles/baden-wuerttemberg/forscher-flut-in-braunsbach-so-stark-wie-51927582.bild.html
Heilbronner Stimme	27.05.2017	Mit Foto-Drohne und Notizbuch ins Katastrophengebiet	https://www.stimme.de/hohenlohe/nachrichten/mit-foto-drohne-und-notizbuch-ins-katastrophengebiet-art-3854534
Südkurier	29.05.2017	Braunsbach: Flutwelle vor einem Jahr: Mit Foto-Drohne ins Braunsbacher Katastrophengebiet	https://www.suedkurier.de/baden-wuerttemberg/Flutwelle-vor-einem-Jahr-Mit-Foto-Drohne-ins-Braunsbacher-Katastrophengebiet;art417930,9271777
Haller Tagblatt / Südwest Presse	29.05.2017	Orlacher Bach so breit wie der Neckar: Tübinger und Potsdamer Forscher vergleichen die Braunsbacher Flut mit alpinem Unwetter	
Haller Tagblatt / Südwest Presse	18.10.2017	Braunsbach: Als flösse der Neckar durch den Ort	

Some Task Forces also engaged in outreach activities, communicating their results beyond academia. In October 2017, 17 months after the event, members of the Braunsbach Task Force, their PI and academic partners held a townhall meeting with the mayor and approximately 90 local citizens. They presented their findings on meteorological, hydrological and geomorphological processes as well as on impacts and damages, and answered questions from the community. In November 2023, nine months after the event, two members of the Brazil Task Force participated in a non-academic conference in Brazil attended by public authorities where they presented a paper on their Task Force results (Arango Carmona et al. 2023).

I-P2 and I-P4 both recommended focusing more on science communication in future Task Forces, for example by collaborating with the University's press office, disseminating press releases and being more present on social media. This public relations and science communication could be an additional task of the coordinator of an RTG or another graduate program.

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4.6 Interdisciplinarity

"Within a Task Force, it is important to value diverse areas of expertise, be open to learning from others and to recognize when to seek help from someone more knowledgeable." (I-P3)

Task Forces served as valuable training grounds for interdisciplinary and intercultural communication, bringing together members from diverse educational and cultural backgrounds. Participants knew each other and communicated on equal footing, which allowed them, as I-A3 put it, to *"approach the matter calmly"*. In this relaxed setting, the threshold for asking questions was low, as I-D5 described, *"the opportunity to ask, is this how it works? Is it correct when I say that? Can you explain? Like sort of asking the stupid question. That was a lot easier. […] You weren't afraid of coming across as stupid or ignorant."* Within the Task Forces, participants learnt to communicate openly and broadly, moving beyond disciplinary boundaries as well as cultural and linguistic / terminological differences (I-A3, I-A4, I-D5). They practiced listening, explaining and navigating perspectives. As I-A3 reflected, *"I'd say that's something I really gained from the Task Force. Before, I was the type of person who would say, 'What do you mean you don't understand?'—that kind of mentality. And I've really unlearned that: now I listen first and then look for common ground."*

Most Task Forces adopted an interdisciplinary approach, combining methods from different disciplines and frequently drawing on both quantitative and qualitative data. Some also pursued a multi-hazard perspective, such as the Australia Wildfire Task Force (Kemter et al. 2021) or the Kumamoto Earthquake Task Force (Von Specht et al. 2019). In the cases of both the Braunsbach flood and the Eifel flood in July 2021, the Task Forces organized themselves in disciplinary subgroups, each working independently within its area of expertise. These subgroups regularly reported their activities and findings to the full Task Force group during scheduled meetings and collaborated with regards to the interpretation and discussion of the results (I-A2).

4.7 Researcher Development

Task Force participants highlighted several aspects of their involvement that had supported their development as researchers. As I-A6 reflected, *"I think it really if there was no Task Force and I just had my project, my topic, my qualification would be maybe a third less than it is. The Task Force was a big part of my qualification directly or indirectly."*

Firstly, Task Force participants developed and enhanced their key skills in time and project management, organising field trips and collaborating both within their teams and with external partners. As I-D4 reflected, the Task Force provided a *"low risk environment to practice learning how to manage a research project"*. Another important key skill was being able to improvise and respond quickly to evolving situations. I-P4 emphasized that it is essential for PIs to actively encourage and support this mindset among doctoral researchers.

I-D4 highlighted that Task Forces provided doctoral researchers with opportunities to work in countries or contexts markedly different from those they were familiar with. This exposure allowed them to recognize both the opportunities and the challenges of these settings, fostering a deeper understanding of the environments in which other researchers operate and the obstacles

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that would need to be addressed when initiating projects or pursuing collaboration there. Reflecting on this experience, I-D4 noted *"I could see that some of the other people in the group got frustrated with that. But I think that was a valuable experience actually... I would really recommend doing that."*

In addition to developing key skills, several Task Force participants learnt new research methods. On a task force field trip together with academic partners, I-D4 learnt a new method from more senior and experienced researchers. Similarly, with the support of a colleague from the RTG, I-D1 independently learned a new method from a different field and successfully applied it to their own research area. The Braunsbach – Task Force provided participants with the opportunity to directly apply a post-event data collection tool (KoBoCollect) that they had learnt in a workshop few weeks prior (I-A2, I-P1).

At the same time, the Task Force allowed participants to combine and apply existing methods in practice. I-A1 reflected, *"you really learn how to combine all the things you learn at once and then apply it to a real-life event,"*. Similarly, I-A5 noted, *"We drew on our foundational knowledge in natural sciences and research. In a way, we were able to test in a new field whether it worked—whether we understood what such an event meant. We could apply the analytical skills we had already learned and see to what extent we were able to use them"*. I-A6 emphasized the importance of a practical, outcome-oriented approach in the Task Force, highlighting that participants need to use robust methods that enable them to efficiently complete the task rather than experimenting with newly developed, untested techniques.

The skills acquired during a Task Force had relevance for the later career of some of the participants. I-A2 benefited from the Task Force field experience in their current position at an environmental agency. For I-A4, newly gained management and teamwork skills as well as taking on a broader perspective on natural hazards has been very helpful to them in their career. Task Forces made participants leave their comfort zone and get to know a new way of working. As I-A4 described, *"This fast-paced, highly project-oriented way of working—achieving results quickly with a clear deadline—is definitely a very important step."*

4.8 Integrating Task Forces Into Doctoral Qualification

When the proposal for NatRiskChange was drafted, the idea of integrating a Task Force exercise into the qualification program was on the table, inspired by the CEDIM activities described above (I-B1).

Currently, another funding scheme has integrated forensic disaster analysis into the qualification of doctoral researchers. The so-called "Post-event assessment group (Post-AG)" is part of the second funding phase of "Climate Change and Extreme Events" (ClimExtreme) (I-B2). ClimExtreme is an interdisciplinary research network of 17 cooperating institutions and 25 projects, funded by the German Federal Ministry of Research, Technology and Space (BMFTR).

An interview with one of the leading PIs of ClimExtreme (I-B2), who was at the same time a PI of NatRiskChange, gave insights on the reasons for the incorporation of the Post-AG into the qualification of doctoral researchers and a comparison of the Post-AG with NatRiskChange Task Forces. The proposal for a second phase of ClimExtreme was submitted in 2022 and approved in 2023. During the first funding phase, the flood in the Ahr Valley and surroundings occurred in 2021. At that time, the project sponsor asked whether the consortium could comment on the event. As it was during the summer holidays, no one

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was able to provide an assessment. When preparing the proposal for the second phase, this situation was therefore turned into an opportunity, and the Post-AG was included in the proposal (I-B2). As some of the initiators of ClimExtreme were also involved with NatRiskChange, the concept of the NatRiskChange Task Forces was well-known and served as inspiration.

There are some differences between the Post-AG and NatRiskChange Task Forces. First, the Post-AGs do not involve any field research. Second, events are not proposed by doctoral researchers. Instead, a steering group consisting of the PIs identifies relevant events and considers potential contributions of doctoral researchers. The PIs then approach selected PhD candidates and present these ideas to them. As in NatRiskChange, participation by the PhD candidates is mandatory and they often take part in more than one Post-AG. The additional effort is however relatively small, because the doctoral researchers primarily apply the methods known and commonly used by them to the event-related datasets (I-B2).

5 Discussion and Conclusion

While forensic disaster analysis has been operationalized by different institutions since 2011, NatRiskChange Task Forces have been the first to integrate rapid FDA with educational and career development requirements of doctoral researchers. This study aimed to evaluate this integration on the basis of 18 semi-structured interviews with Task Force participants and PIs and develop recommendations for integrating Task Forces in future doctoral qualification programs. The analysis was guided by three research questions that are discussed in this section.

5.1 How can Task Forces be effectively implemented within a structured doctoral training program?

To manage the uncertainty and unpredictability of future damaging events, identifying event types (e.g. flooding event), forming groups around these event types prior to event was recommended in the interviews. Criteria for a suitable event include intellectual challenge, language proficiency, existence of networks and accessibility of data or of the area affected. For NatRiskChange Task Forces, field research was optional and dependent on the severity of the event and travel distance. Ideally, FDA-Task Forces produce preliminary findings shortly after a hazardous event, increasing the likelihood of media coverage and public engagement, however, this showed not to be feasible for the NatRiskChange Task Forces. While acknowledging that the potential for preparing for an unknown future event is limited, preparatory workshops are recommended that support participants wrt data collection methods, project management skills, communication with affected residents, safety concerns and logistical challenges in the field.

Managing a Task Force project requires clearly defining and limiting its scope and a pragmatic, outcome-oriented approach. The NatRiskChange Task Forces handled their project organization and management internally and independently with little involvement of the PIs. PIs advised on the suitability of an event for a Task Force, facilitated collaboration with local partners, helped define the scope and helped resolve team-related challenges. Where a Task Force exercise is integrated into the proposal for a future doctoral qualification program, the additional responsibility of the PIs as mentors of a Task Force needs to be formally incorporated so that PIs can be held accountable for fulfilling this role.

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Field research in affected areas needs to be thoroughly conceptualized and prepared to avoid "disaster tourism". Collaboration with local partners is valuable, as they can provide data and logistical support in the study area. Engaging with local residents and other stakeholders can yield qualitative insights that contextualize the data collected. When conducting field research in an affected area, Task Forces must take precautionary measures and ensure that the area is secure and safe for access. Logistical challenges may require locally adapted solutions and support from locals. To build trust and facilitate interaction with locals, Task Force members can carry an official letter from their PI that confirms their affiliation and outlines their planned research activities in the field.

The ClimExtreme Post AG is another recent example of integrating forensic disaster analysis into the training of doctoral researchers and has (partly) been built on the experiences of NatRiskChange. The background of its implementation was the Ahrtal flooding event in 2021, emphasizing the urgent need for scientifically grounded assessments of damaging events. Compared to the NatRiskChange Task Forces, there are some differences in the design of the Post-AG, showing that the details of the implementation are flexible and can be adjusted, depending on the overall project structure and funding scheme.

5.2 How did Task Forces contribute to gaining new and important insights and transferring knowledge to non-academics?

Where Task Forces worked truly interdisciplinary by combining different methods and various qualitative and quantitative data, their mode of analysis was close to the forensic disaster analysis that was proposed by Burton (2010) and FORIN and operationalized by CEDIM. In this way, they gained a deep understanding on the causes, the processes and the impacts related to the disaster. In many cases, this was enhanced by close collaboration with academic partners. The many peer-reviewed papers by NatRiskChange Task Forces offer a rich "literature of quality case studies" (Oliver-Smith et al., 2016) to the scientific community.

However, rapidly transferring knowledge to non-academics has generally not received sufficient attention within the NatRiskChange Task Forces and would need to be expanded in the future for Task Forces to have an impact within the short time window when a disaster receives much media and public attention. It would be ideal if scientific Task Forces could provide essential analyses of events ahead of dubious sources of information that might spread misinformation.

5.3 How did Task Forces enhance skills and researcher development?

Task Forces provided the opportunity to develop and enhance valuable time and project management skills and in particular leadership skills, such as facilitating meetings, coordinating among sub-groups, taking on responsibility and motivating others. For many, the Task Force was a unique experience of close team collaboration throughout the entire process of the Task Force project. Team work was enhanced where Task Force members shared an office, and limited in times of the Covid-19-pandemic and the related self-isolation and remote work.

Beyond project management and teamwork skills, participants developed key skills that are specific to Task Forces. Importantly, they learnt how to improve and quickly respond to evolving situations. In their interdisciplinary and intercultural

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teams, participants learnt to be open, navigate different perspectives and move beyond disciplinary and linguistic /terminological boundaries. Some Task Force members gained practical experience in giving interviews to journalists and communicating their findings to the public.

Moreover, Task Forces offered the opportunity to network and collaborate with partners in various ways, both academic and non-academic, both in Germany and abroad. Task Force members who traveled to the affected area were exposed to an unfamiliar research context. They had the opportunity to develop their skills in organizing and carrying out meaningful field research, and interacting with affected citizens. Field trips offered a shift in perspective and a deeper understanding of processes and impacts related to natural hazards.

The skills learnt in the Task Forces and in particular the project-oriented, applied and fast-paced mindset were highly valuable for the careers of Task Force members who later worked outside of academia.

Next to developing key skills, Task Force members had the chance to apply and combine known methods in practice and also to learn new research methods from colleagues when needed.

5.4 Discussion and Recommendations

Overall, this study confirmed that embedding rapid forensic disaster analysis directly into training programs of doctoral researchers can serve a dual purpose with some limitations. On the one hand, it provides diverse opportunities for doctoral researchers to develop research skills and competencies through problem-based and experiential learning. On the other hand, doctoral researchers can to some extent fulfil the role of flexible and capable researchers that can be deployed for rapid disaster analysis immediately after a damaging event. However, there is some room for improvement.

First, event analyses by NatRiskChange Task Forces were often not comprehensive. The scope of doctoral Task Forces is limited and strongly influenced by doctoral researcher's motivation, their existing methodological and project management skills, team dynamics and time constraints. Importantly, doctoral researchers' primary focus remains their PhD-topic. When Task Force activities are closely aligned with these topics, motivation, time investment the quality of outputs are expected to be highest. We therefore recommend that PIs and doctoral researchers remain alert to events related to PhD topics, that can be analysed using the same methods employed in the PhD project, as demonstrated by the Post-AGs. In the case of a multi-hazard event, different aspects of the event can be linked to a range of different PhD topics allowing an interdisciplinary team of doctoral researchers to form. In such teams, each doctoral researcher contributes expertise on a specific hazard or aspect of the event, ideally combining their expertise and methodological skills to comprehensively assess and understand the multi-hazard or cascading event. While some participants recommended forming groups around event types in advance, this approach may counteract the goal of interdisciplinarity and limit the ability to spontaneously engage with multi-hazard or cascading events.

Second, most NatRiskChange Task Forces did not succeed in carrying out the analysis in near real time, within the critical window when interaction with stakeholders is most intense and open and interest of potential users is highest. The Braunsbach Task Force is an exception and at the same time it is the most productive Task Force in terms of scientific output, science

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communication and media uptake. This underlines the importance of a rapid analysis, while the logistical challenges associated with an immediate deployment are acknowledged.

The preparatory training can be used to prepare for a spontaneous field trip. With a step-by-step guide of what to do when an event occurs, the valuable time window is not wasted for resolving organizational matters. The coordinator of the training group or an associated post-doc should provide support in organizing a field trip. Where experienced PIs support doctoral researchers in rapidly identifying a suitable event or suggest an event themselves such as in the Braunsbach and Eifel-Task Forces, the initiation of a Task Force can be greatly accelerated. The study recommends that PIs and coordinators provide targeted support to doctoral Task Forces in the initial phase to speed up their establishment and enable near-real time analysis of events. Once a Task Force is fully operational, PIs and coordinators can step back and allow doctoral researchers the space for independent, experiential learning within their Task Forces.

Overall, the NatRiskChange Task Forces stand as pioneers in the integration of forensic disaster analysis into structured doctoral training. They offer an innovative model for geosciences education and disaster risk communication and research that transforms recent damaging events into immediate learning opportunities. We hope to inspire the academic community to adopt similar experiential activities in order to expand high-quality insights from recent damaging events and help reduce disaster losses in the long term.

Data Availability

The raw data supporting the findings of this study are not publicly available due to ethical restrictions and the need to protect the anonymity of the participants. Data access requests may be directed to the corresponding author.

Author contributions

K.E. Lebek conceptualized the study, developed the methodology, and conducted the formal analysis and investigation. K.E. Lebek also performed the data curation and prepared the original manuscript. A.H. Thieken provided supervision and contributed to the review and editing of the final manuscript. Both authors have read and agreed to the published version of the manuscript.

Competing interests

The authors declare that they have no financial conflicts of interest. Author Annegret Thieken was one of the interviewees in this study. To ensure the integrity and objectivity of the research, the data analysis and coding were carried out independently by K.E. Lebek. A.H. Thieken provided intellectual input and editorial revisions after the primary analysis was completed.

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Ethical statement

The University of Potsdam did not require a formal ethical approval process for this study, as the research involved qualitative interviews with professional experts regarding institutional and educational structures. However, the study was conducted in strict adherence to the German Research Foundation (DFG) Guidelines for Safeguarding Good Research Practice. All participants provided informed consent prior to the interviews and were notified that their participation was voluntary. To protect the privacy of the participants, all data were anonymized; identifying details have been generalized in the results to ensure that individual doctoral researchers and supervisors cannot be identified.

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During the preparation of this work, the authors used ChatGPT and Gemini 3 Flash for linguistic refinement of the manuscript to improve clarity and readability. All intellectual content and final revisions remain the sole responsibility of the authors.

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