Supplement of "**What does my technology facilitate? A toolbox to help researchers understand the societal impact of a technology in the context of disasters"**

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Case study/subject	Authors/County	Main conclusion	Methods/research design	Contribution to disaster risk reduction	What is the technological potential? 1) Development costs 2) Transferability 3) Functionality 4) Reliability	What is the practical potential? 1) Practicality 2) Applicability 3) User groups 4) Effectiveness	What is the social potential? 1) User needs 2) Accessibility 3) Inclusiveness 4) Ethical issues
Terroristic attack	(Barzman et al., 2018) /USA	The machine learning algorithm proofed to be very accurate in identifying possible terrorists.	Pilot study with 103 students at a school, using automated scales to assess the risks of terroristic attacks and to compare with forensic risk assessments.	Prediction of school violence	1) N/A 2) N/A 3) Functionality not fully established 4) N/A	1) Not yet used 2) Useful for specific case 3) Schools 4) N/A	1) N/A 2) N/A 3) Considering race and gender and home income 4) N/A
Terroristic attack	(Kahn, 2022) /USA	AI has little potential in disaster risk reduction, mostly it has just economic benefits. However, there are a lot of ethical loop holes that need to be considered. The best solution would still be 'stricter gun regulation' to prevent gun shootings.	Opinion piece	Small preventive measures to flag possible terror attacks.	1) N/A 2) Mentions the possibility of using it in different settings e.g. schools, concerts. 3) Functionality is not sufficient 4) High quote of false alarms	1) Some technologies mentioned in the article are already used 2) Article describes multiple application 3) Schools and law enforcement 4) The solutions are not always effective when implemented	1) N/A 2) N/A 3) Inclusiveness: AI could unfairly label people (biases e.g. racism and socioeconomic biases) 4) Ethical issues: Commercial opportunism
Terroristic attack	(Brennan, 2017)/USA	AI has the potential for mass shootings prevention, but the pit falls should not be underestimated.	Opinion piece	AI and other smart technologies could help prevent shootings	1) N/A 2) Article describes different possibilities to use AI technology (robocops, door systems) 3) Functionality is not sufficient (false warnings, biases)	1) Some uses (e.g. in schools) 2) Article describes different fields for these types of technologies used.	1) N/A 2) N/A 3) Cannot be secured 4) Bias in the models, possible misuse and data protection issues

					4) Not yet reliable	3) Schools and law enforcement 4) N/A	
Terroristic attack	(Bringsjord et al., 2021) /USA	This article ends with saying that AI could be further developed into ethically correct entities.	Ethical simulations of AI in disaster risk reduction	Mass shooting prevention	1) N/A 2) N/A 3) Functionality is sufficient, when correctly engineered 4) N/A	1) Not used yet 2) Article describes different fields to prevent mass shootings 3) Schools and police forces 4) N/A	1) N/A 2) N/A 3) N/A 4) Ethical issues are described but then also overcome with ethical AI
Terroristic attack	(Singer, 2022) /USA	There are a lot of possibilities for smart technologies, such as AI, however there is the question of their effectiveness.	Opinion piece	Prevention and early warning before mass shootings	1) N/A 2) Not necessarily given 3) Functionality is not sufficient, as described in happened failures 4) Not reliable, as described with false alarms and not stable against cyber attacks	1) Technology is being used for alerting police officers 2) Only applicable for shootings 3) Schools 4) Not really effecitve	1) N/A 2) N/A 3) N/A 4) A lot of ethical issues: biases in the model, false warnings, limitation to models, pupils feeling less safe in school
Terroristic attack	(Rieland, 2018)/USA	This article highlights the possibilities of AI applications to stop school shootings, but also covers the possible side effects of the use of AI.	Opinion piece	AI as prevention of school shootings	1) N/A 2) N/A 3) Functionality is provided in different cases 4) N/A	1) AI is already used 2) Applicable to school shootings 3) Schools 4) N/A	1) N/A 2) N/A 3) N/A 4) A lot of open questions and the impact of implementing these tools not elicited to full extent.
Flash floods	(Costache, 2019)	The model shows to offer a high predictability and a high reliability.	Proposition of a combination of a model and AI to predict flash floods for a case study	Flood prediction and prevention	1) N/A 2) N/A 3) Technically feasible 4) The authors say that the models are a reliable tool for flash flood prediction.	1) N/A 2) N/A 3) N/A 4) N/A	1) N/A 2) N/A 3) N/A 4) N/A

Flash floods	(Arabameri et al., 2020)	This study uses a machine learning model and remote sensing to create maps that are robust and can be used to advise flood management.	New model for flash flood prediction including a case study. The study is combination of AI and remote sensing.	Possibility to predict floods using a model that works and could be further assessed.	1) N/A 2) N/A 3) Technically feasible 4) The authors state a high robustness.	1) According to the authors it can be used 2) N/A 3) N/A 4) N/A	1) N/A 2) N/A 3) N/A 4) N/A
Flash floods	(Mitra et al., 2016)	This article shows a combination of a wireless sensor network, machine learning and IoT to predict the probability of floods	Testing a model to forecast flash floods. This study is a combination of machine learning and IoT.	Flood forecasting and thus better evacuation and disaster risk management	1) N/A 2) N/A 3) Technically feasible 4) Further research is needed	1) According to the authors, further research is needed to be usable 2) N/A 3) N/A	1) N/A 2) N/A 3) N/A 4) N/A
Flash floods	(Khan et al., 2018)	This study proposed new approach (scaled conjugate gradient), which performs better than recent approaches to identify and investigate flash floods.	Flash flood models using sensors, radars and AI and drones	A robust flood forecasting model	1) According to authors, the proposes solution is cost-effective 2) N/A 3) Technically feasible 4) Reliable	1) N/A 2) N/A 3) N/A 4) N/A	1) N/A 2) N/A 3) N/A 4) N/A
Earthquake	(Marhain et al., 2021)	The authors develop a model capable of detecting the recurrence behavior of earthquakes to help forecasting them	Model with a combination of meteorological data and different algorithms to analyze recurrences and possibly try to predict earthquakes and prevent casualties	Forecasts to prevent casualties	1) N/A 2) N/A 3) Technically feasible 4) N/A	1) N/A 2) N/A 3) N/A 4) N/A	1) N/A 2) N/A 3) N/A 4) N/A
Earthquake	(Wu et al., 2021)	The system Crowdquake + proves to be working faster than a traditional earthquake warning system	Using smart phones as sensors for data to feed in a model for earthquakes early warning, a combination of IoT (sensors) and machine learning.	Fast earthquake warning	1) N/A 2) N/A 3) Technically feasible 4) Reliable and fast	1) N/A 2) N/A 3) N/A 4) N/A	1) N/A 2) N/A 3) N/A 4) N/A

Earthquake	(Banna et al., 2020)	This study shows that there is a potential for AI for earthquake early warning, however it depends on the method used.	Literature review on 84 research papers and comparative analysis of performances to outline the research gaps	AI has potential and can be further developed to have even more accurate models.	1) N/A 2) N/A 3) Technically feasible 4) Reliability depends on the model	1) Used, but depends on the model 2) N/A 3) N/A 4) N/A	1) Depends on the model 2) N/A 3) N/A 4) N/A
Earthquake	(Syifa et al., 2019)	The method and map can be used to mitigate damage in the event of future earthquakes.	Using remote sensing imagery and an artificial neural network to create a post-earthquake map to assess the distribution of seismic damage.	Understanding of damage	1) N/A 2) N/A 3) Technically feasible 4) Reliability depends on the model	1) Usable 2) N/A 3) N/A 4) N/A	1) Depends on the model 2) N/A 3) N/A 4) N/A
Wildfires	(Jain et al., 2020)	Machine learning/AI methods have steadily been increasing in the wildfire management community: however, these models still require a high knowledge of wildfires, and a lot of input data and knowledge on wildfires is needed to use these models.	Review (300 publications)	Help with wildfire management	1) N/A 2) N/A 3) Technically feasible 4) N/A	1) The models are usable when their application is understood by their users 2) N/A 3) Improving wildfire management 4) N/A	1) Wildfire community 2) N/A 3) Not inclusive, because you need to understand the model 4) N/A
Wildfires	(Mirzaei et al., 2021)	To evaluate health effects of wildfire smoke, an artificial neural network (ANN) is used to predict concentration levels.	Using AI to predict smoke	Helps to reduce the health impacts of wildfire.	1) N/A 2) N/A 3) Technically feasible 4) N/A	1) N/A. 2) N/A 3) N/A 4) N/A	1) N/A 2) N/A 3) Not inclusive, because you need to understand the model 4) N/A
Wildfires	(Zhao et al., 2021)	The authors conclude that an AI-based engineering models	Framework to integrate AI in existing wildfire evacuation	Helps in evacuation	1) N/A 2) N/A 3) Technically feasible 4) N/A	1) AI is usable. 2) N/A 3) Wildfire community and law enforcement	1) N/A 2) N/A 3) N/A 4) N/A

		would help in wildfire evacuation					
Wildfires	(Guerrero, 2022)/USA	AI is actively used to model and predict wildfires in the US. The authors call the AI they use positive AI.	News-report on Abc-television (new show on American television)	Prediction of natural wildfires as well as planning of artificially induced wildfires	1) N/A 2) N/A 3) Technically feasible 4) N/A	1) Model is usable. 2) Model is applicable 3) Wildfire community 4) Used and effective	1) N/A 2) N/A 3) N/A 4) N/A

Table lr 2: Literature review on IoT in DRR for the hazards – terroristic attack, flash floods, earthquakes, wildfires

Case study/subject	Authors/County	Main conclusion	Methods/research design	Contribution to disaster risk reduction	What is the technological potential? 1) Development costs 2) Transferability 3) Functionality 4) Reliability	What is the practical potential? 1) Practicality 2) Applicability 3) User groups 4) Effectiveness	What is the social potential? 1) User needs 2) Accessibility 3) Inclusiveness 4) Ethical issues
Terrorist attack	(Gao, 2016)	The authors use an intelligent IoT-system to evacuate civilians during internal mass shootings in a sample environment. The system uses building sensors to direct occupants during public building shootings to find the safest way and open and lock doors automatically.	Intelligent model using "agents" in a test setting, based on a real-time event	Safe(r) evacuations during terrorist shootings	1) N/A 2) N/A 3) Functions in a test setting 4) N/A	1) N/A 2) N/A 3) N/A 4) N/A	1) N/A 2) N/A 3) N/A 4) N/A
Terrorist attack	(Alsalat et al., 2018)	In this study the authors propose a real-time detection method of abnormal crowd behavior in mass gatherings. The method is based on wireless wearable sensors (wristbands) that measure heartrate increase and abnormal motions and combined with a deep machine	Using a biodata collection device, data was gathered by study participants. Firstly, it was data of normal daily activities and, secondly, it was data of abnormal activities (pretended). This data was then introduced into a model. **The study hence consists of both IoT and MACHINE LEARNING.**	Better detection of mass panic e.g. induced by terror attacks	1) Cost could limit the usage 2) N/A 3) Functions in specific settings, such as pilgrimages 4) Not reliable if e.g. the crowd is excited	1) Not used yet, planned for crowd meetings. 2) Only applicable to crowds 3) Crowds 4) N/A	1) N/A 2) Possible cost issues 3) Everyone can wear this armband 4) The data protection issue is looked at

		learning model. The method was tested in a test-setting and was able to show that it can indeed offer a fast panic detection solution in gatherings that do not involve extreme excitement e.g. concerts.					
Terrorist attack	(Haider et al., 2018)	In this study the authors propose an IoT-based system to prevent terrorist attacks on schools.	Using a combination of different layers (user-interface, data storage, functional service, communication and IoT)	Possible prevention and protection of terrorist attacks	1) N/A 2) N/A 3) Functions in a test setting 4) N/A	1) Not used yet 2) N/A 3) Schools 4) N/A	1) N/A 2) N/A 3) N/A 4) N/A
Terrorist attack	(Buntz, 2017)	In this newspaper article the author describes possible IoT-solutions to prevent mass shootings as happened in Las Vegas	Opinion and research article on technologies	Possible prevention and reaction to terrorist attacks	1) N/A 2) N/A 3) Technically feasible and functions in test settings 4) N/A	1) Some hotels test this 2) N/A 3) N/A 4) N/A	1) N/A 2) N/A 3) N/A 4) Legal and ethical issues impacting privacy
Terrorist attack	(Tzezana, 2016)	This article describes how IoT can be misused for crime. It stresses the positive potential IoT can have but mentions the vulnerability of misuses, stating "when everything is connected, everything is vulnerable" (Goodman 2015 as	Expert interviews and scenarios that describe the future potential of IoT and crime terrorist attacks.	This study describes rather the opposite of disaster risk reduction, because it is the misuse of IoT to cause disasters.	1) N/A 2) N/A 3) Functions in different settings 4) N/A	1) Misused by criminals 2) N/A 3) N/A 4) N/A	1) N/A 2) N/A 3) N/A 4) This study describes the full misuse potential of IoT

		seen in Tszezana)2016)					
Flash Floods	(Furquim et al., 2018)	In this paper it is described how fault tolerance can be improved in disaster predictions, **using IoT, machine learning and real data**. This is of utter importance, because the number and the intensity of natural disasters is a serious problem. This study evaluates how using IP-based sensor networks can help out monitoring and forecasting disasters.	The authors use a combination of **a sensor network and fog computing (machine learning)** to be able to better predict disasters applied to a River in Brazil.	Possible prevention through prediction	1) N/A 2) Technically feasible 3) Reliable in the context of the study 4) N/A	1) Usable for flash floods 2) N/A 3) N/A 4) It is described to be effective	1) N/A 2) N/A 3) N/A 4) N/A
Flash Floods	(Basnyat et al., 2020)	This paper presents a detailed architecture and design approach used in three different kinds of flash flood detection IoTs.	The authors use various IoT deployment to detect flash floods.	Prevention of flash floods	1) N/A 2) N/A 3) Technically feasible 4) Reliable	1) Usable for flash floods 2) N/A 3) N/A 4) N/A	1) N/A 2) N/A 3) N/A 4) N/A
Flash Floods	(Goyal et al., 2021)	To be able to manage floods better, the authors develop a flash flood management model using smart real-time IoT devices.	The authors uses reinforcement learning (RL) to create a flash flood management model (FFMM) which proves to be more sensible than the traditional model. **Hence this study uses a combination of machine learning and**	Prevention and fast reaction to flash floods.	1) N/A 2) N/A 3) Technically feasible 4) Reliable	1) N/A 2) N/A 3) N/A 4) Said to be effective	1) N/A 2) N/A 3) N/A 4) N/A

			IoT to predict and evaluate flash floods.				
Flash Floods	(Arshad et al., 2019)	The authors summarize and review literature regarding IoT based sensors and computer vision applications in flood monitoring and mapping. They can show that there is a wide range of applications using IoT in flash flood early warnings and real-time monitoring.	The authors used a systematic literature review Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA).	Prevention is possible	1) N/A 2) Transferrable within different flash floods settings 3) Technically feasible 4) Reliable	1) Usable for flash floods 2) Applicable in multiple settings 3) Depends on the approach 4) Depends on the approach	1) N/A 2) N/A 3) N/A 4) N/A
Wildfires	(Bushnaq et al., 2021)	The authors numerically show that using an IoT-based wildfire detection can be a faster and more reliable wildfire detection solution than the state-of-the-art satellite imaging.	The authors propose a novel **UAV-IoT network complementing satellite imaging** to be able to maximize the wildfire detection probability.	Wildfire detection	1) Cost-efficienct 2) N/A 3) Technically feasible 4) Reliable	1) N/A 2) N/A 3) Approach helps to detect wildfires faster 4) Effective alternative to satellite imaging	1) N/A 2) N/A 3) N/A 4) N/A
Wildfires	(Verma et al., 2021)	The authors offer a solution to limited energy resources of IoT-based sensor nodes which offer an early-wildfire-detection, using an optimization framework. That proves to work	The authors use a simulation model to optimize the network	Early wildfire detection	1) N/A 2) N/A 3) Technically feasible 4) N/A	1) N/A 2) N/A 3) N/A 4) N/A	1) N/A 2) N/A 3) N/A 4) N/A

Wildfires	(Kaur & Sood, 2019)	The authors propose a fog-assisted IoT network for wildfire surveillance. The efficacy was tested also using a real-time alert.	The authors use a fog-assisted IoT-network to predict wildfires. This means that they use different layer and models to analyze and survey wildfire, using IoT and machine learning.	Fire surveillance and detection	1) N/A 2) N/A 3) Technically feasible 4) N/A	1) Usable for flash floods 2) N/A 3) Said to be reliable 4) Said to be effective	1) N/A 2) N/A 3) N/A 4) N/A
Earthquake	(Zambrano et al., 2017)	Using the increasing diffusion of smartphones, it is possible to monitor the environment and thus also allow to achieve an enhanced early warning system for natural hazards.	The authors provide a three-layer-framework, which is IoT-based to provide earthquake early warning. The three layers consist of IoT, message queue telemetry transport and decision-making.	Provision of earthquake early warning	1) N/A 2) Possibly transferrable to other natural hazards 3) Technically feasible 4) Reliable	1) Usable for enhancing earthquake early warning 2) Applicable by all smartphone-users 3) N/A 4) Depends on the sample	1) Mentions that the user requests a low-energy consumption as well personal security 2) N/A 3) N/A 4) N/A
Earthquake	(Taale et al., 2021)	The authors test smart metering for earthquake early warning. Despite some challenges, the use of IoT is technically feasible and, thus, smart metering can be used for improved disaster management.	The author created a framework to integrate smart metering into earthquake early warning grid, thus this is a combination of big data and IoT.	Provision of usable earthquake early warning.	1) The authors call it sustainable. 2) N/A 3) Technically feasible 4) Reliable	1) Possibly usable 2) N/A 3) Depends on the earthquake 4) Depends on the earthquake	1) Regional earthquake warner 2) N/A 3) N/A 4) N/A
Earthquake	(Abdalzaher et al., 2022)	The authors combine an IoT-System with a deep learning model to be able to enhance the determination of the magnitude and the location. The model is able to	The authors design a new deep learning model using IoT.	Provision of fast(er) earthquake early warning.	1) N/A 2) N/A 3) Technically feasible 4) Reliable due to high functionality	1) N/A 2) N/A 3) N/A 4) Proposed solution seems to be effective	1) N/A 2) N/A 3) N/A 4) N/A

		determine the parameters (magnitude and location) and according to the authors has a high functionality.					
Earthquake	(Wu et al., 2021)	The authors describe how they expanded their earthquake early warning system using 300 smartphones to support 8000 IoT sensors to overcome identified challenges and, thus, are able to detect earthquakes earlier than traditional earthquake early warning systems.	The previous Crowdquake system is expanded by adjusting the sensor density, which increases the scalability. Additionally, the system was distributed to process large-scale sensor data. This study combines machine learning efforts and IoT.	Earthquake prevention	1) N/A 2) N/A 3) Technically feasible 4) Reliable	1) Usable for EEW 2) N/A 3) Approach helps to accelerate earthquake early warning. 4) Effective, since it is better than the previous crowdquake system as well as promising	1) N/A 2) N/A 3) N/A 4) N/A

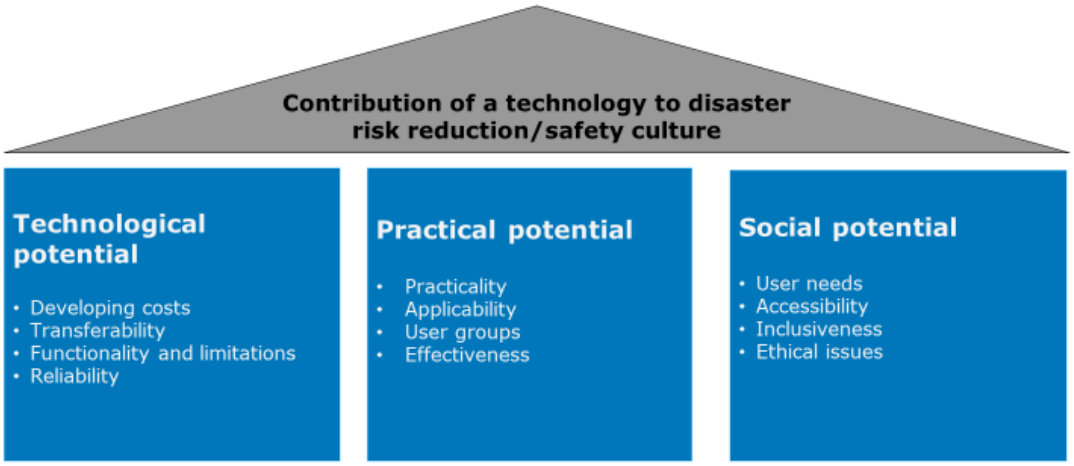
Table lr 3 Literature review on remote sensing in DRR for the hazards – terroristic attack, flash floods, earthquakes, wildfires

Case study/subject	**Authors/County**	**Main conclusion**	**Methods/research design**	**Contribution to disaster risk reduction**	**What is the technological potential?** 1. Development costs 2. Transferability 3. Functionality 4. Reliability	**What is the practical potential?** 1. Practicality 2. Applicability 3. User groups 4. Effectiveness	**What is the social potential?** 1. User needs 2. Accessibility 3. Inclusiveness 4. Ethical issues
Terrorist attack	(Buffa et al., 2022)	Using a combination of machine learning, remote sensing and socio-environmental data, models were tested to gain insights into terrorist activity and behavior.	Data sample combined with a machine learning model, a neural model to detect hotspots for terrorism.	Remote sensing and spatial techniques provide valuable insights into terrorist activity.	1) N/A 2) Study mentions the use for different terror types 3) Proves to provide valuable insights 4) Shows to be reliable	1) N/A 2) N/A 3) N/A 4) N/A	1) N/A 2) N/A 3) N/A 4) N/A
Terrorist attack	(Pani, 2021)	This study presents a useful overview on the role of remote sensing and GIS in military information.	Different maps in different disciplines have been compared and the capabilities of these different methods have been compared	Understanding the use of remote sensing to enhance military information	1) N/A 2) This study shows differences in separatist and non-separatist terrorism 3) Remote sensing functions in this context 4) N/A	1) Used in military operations 2) N/A 3) Helpful in military operations 4) N/A	1) N/A 2) N/A 3) N/A 4) N/A
Flash floods	(Ding et al., 2021)	The main conclusion of this literature review is that there are various applications of remote sensing and GIS in the field of flash flood.	Literature analysis as well as categorization of remote sensing and GIS technologies in flash flood disasters	Analysis of the use of remote sensing for flooding	1) N/A 2) Can be transferred to different hazards 3) Functions 4) Maps are reliable	1) Used for mapping flood risks 2) Maps can be generated for different hazards 3) N/A 4) Maps are an effective tool	1) N/A 2) N/A 3) N/A 4) N/A
Flash floods	(Hussein, 2019)	The authors use active microwave and visible/near IR remote sensing data for flash flood prediction	Combination of microwaves and remote sensing data to predict potential flash floods	Prediction of flash floods	1) N/A 2) N/A 3) The remote sensing technology is working in this context 4) Is reliable	1) N/A 2) N/A 3) Red-sea-decision-makers 4) The method proves to be effective	1) N/A 2) N/A 3) N/A 4) N/A

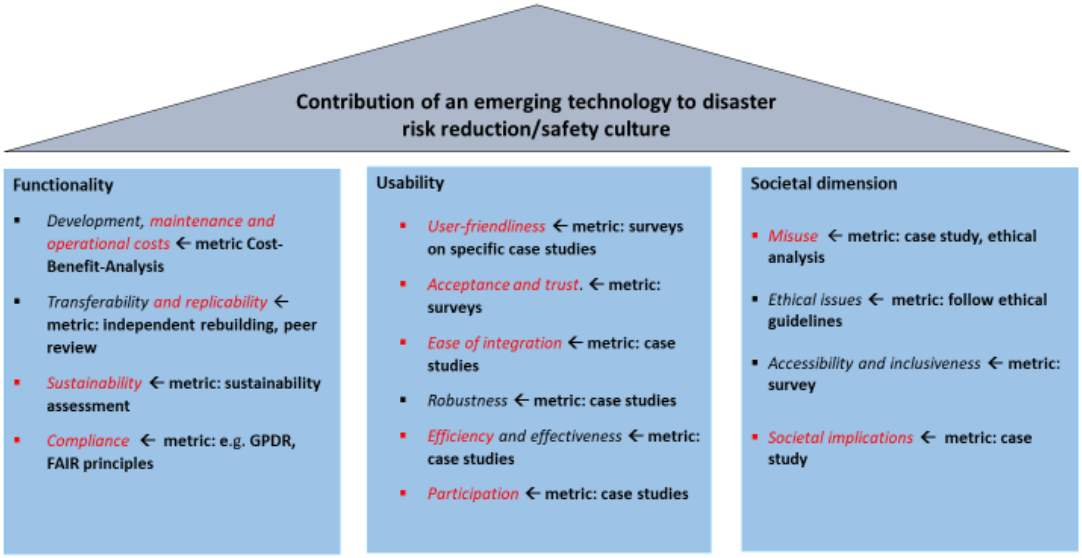
Flash floods	(Mishra, 2021)	The authors analyze flooding events that affected two southern states of India in 2020 and how remote sensing is important to monitor and manage such disaster	Using a model to analyze precipitation data as well as monitoring this data.	Monitoring flash floods	1) N/A 2) N/A 3) Remote sensing functions in this context 4) Reliable and robust	1) N/A 2) N/A 3) Red-sea decision-makers 4) Significance of remote sensing observations for effective flash flood monitoring	1) N/A 2) N/A 3) N/A 4) N/A
Earthquakes	(Dong, 2013)	The authors review the use of remote sensing to evaluate building damage.	Comparison of pre- and post-data to detect building damage.	Reaction to earthquakes	1) N/A 2) N/A 3) High functionality 4) Reliable	1) Maps are already used to detect 2) N/A 3) N/A 4) Effective contribution for damage analysis	1) N/A 2) N/A 3) N/A 4) N/A
Earthquakes	(Rathje & Franke, 2016)	The authors analyze efforts of including remote sensing techniques to document damage patterns, collect three-dimensional geometries of failures, and measure ground movements and find that remote sensing is helpful in analyzing ground movements.	Comparison of different types of remote sensing technologies.	Monitoring ground movement	1) N/A 2) Functions well in analyzing ground movement and monitoring earthquakes, if there is comparison possible 3) Is reliable 4) N/A	1) Usable if there is effort put in to enhance the technologies 2) N/A 3) N/A 4) N/A	1) N/A 2) N/A 3) N/A 4) N/A
Wildfires	(Cao et al., 2017)	The authors try to identify effective and useful online-mapping for wildfire warnings; and find that there are different aspects that need to be considered when mapping dangers.	Testing of different maps to warn the public	Effective warning and protection	1) N/A 2) N/A 3) Functionality is tested 4) Is reliable	1) Practocality is specifically analyzed 2) N/A 3) Individuals 4) Effective wildfire warning	1) The need of individuals is specifically elicited 2) They try to include the broad public 3) Try to be able to warn all societal groups 4) N/A
Wildfires	(Huot et al., 2022)	The authors aggregate historical maps and combine it with machine	Combination of aggregated historical data and machine	Wildfire prediction	1) N/A 2) N/A 3) Functions	1) Usability is specifically analyzed 2) N/A	1) Academia 2) N/A 3) N/A

		learning models in order to predict wildfire spread.	learning models that are compared.		4) Can be further developed	3) N(A 4) Effective wildfire warning	4) N/A

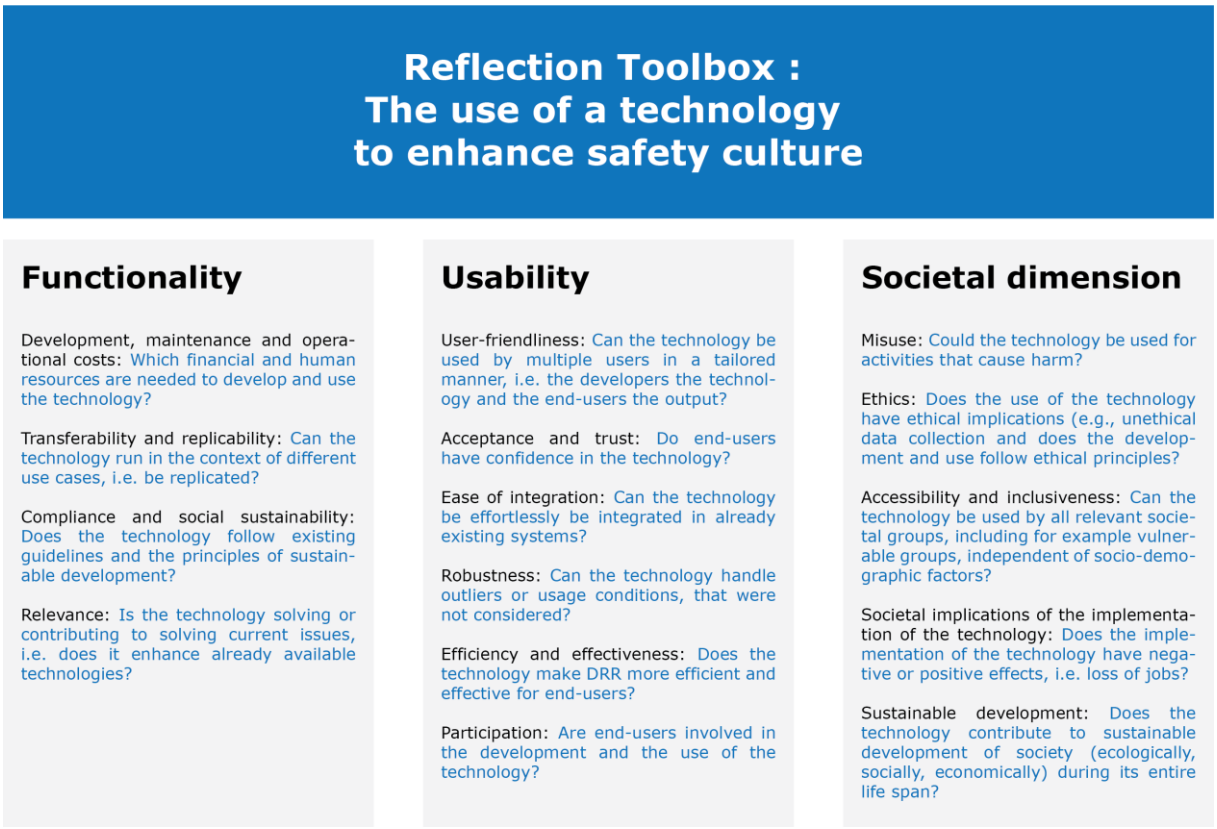
The Toolbox



Version 1 of Toolbox



Version 2 of Toolbox



Version 3 of Toolbox

Delphi – Survey (DS) – Round 1

The survey:

Consent Form

Welcome and thank you for participating in this Delphi-Study to assess a framework to explore and define the potential of emerging technologies to support or enhance disaster risk reduction.

Using the example of the use of artificial intelligence in seismology to inform and improve disaster risk reduction, you will be asked to provide an expert opinion. In addition, we will collect some socio-demographics to ensure diversity among participants.

The survey will take about 20 minutes to complete. Participation is voluntary and you may withdraw at any time. All information you provide will be analyzed anonymously, in accordance with the Swiss Federal Act on Data Protection. The results of the survey will only be used for research purposes, published in a research article, and will not be passed on to third parties.

If you have any questions, please contact lorena.kuratle@sed.ethz.ch

- ☐ I voluntarily participate in this study and agree to the processing of my personal data in accordance to the information mentioned above.
- ☐ I do not wish to participate

The study is conducted in the framework of the EU-funded project "sCience and human factor for Resilient sociEty" (CORE) and part of the doctoral project of Lorena Kuratle.

Start the Survey

AI in general

Artificial intelligence (AI) as an emerging technology is omnipresent. In almost every field of research, we can read about breakthrough results supported by AI. However, definitions of AI vary widely and the range of applications is broad.

How would you define AI in general? Do you have a reference for a definition you especially like? (max. 200 words)

Overall, do you think that AI applications help the different phases of the disaster risk cycle (planning, response planning, evacuation planning or prevention)?

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The Framework to assess an emerging technology

Given the diversity of different AI technologies, we think there is a need to critically and comprehensively evaluate them before their application Therefore, based on a thorough literature review, we developed a framework to elicit emerging technologies' potential to enhance safety culture and contribute to disaster risk reduction (DRR). The framework consists of three potentials (=pillars) that determine whether the emerging technologies can contribute to DRR; namely the technological, practical, and social potential. These three pillars themselves address different, relevant issues; see Figure 1.

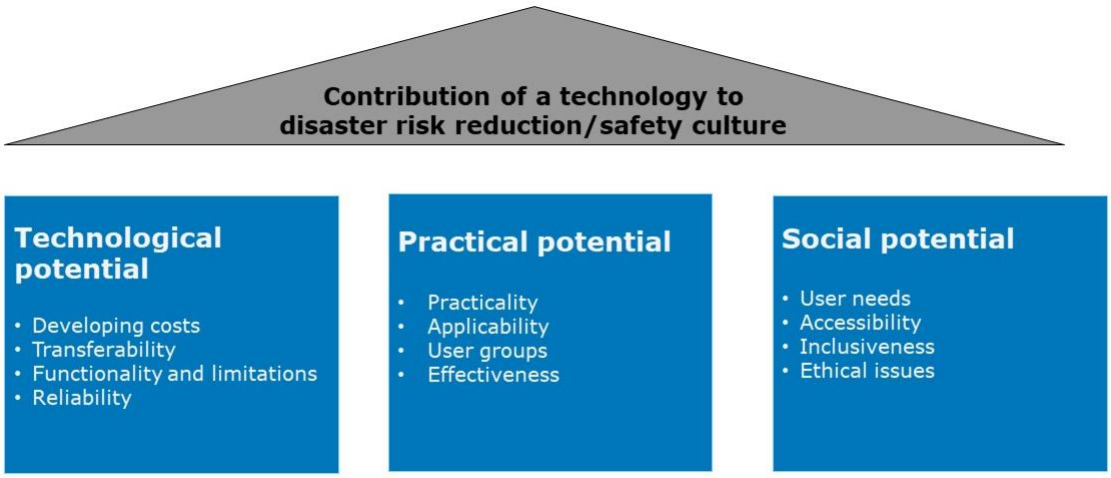


Figure 1: The three pillars for the technological, practical, and social potential of emerging technologies

What is your first impression of this framework?

We will ask you first to evaluate the individual pillars and then share your opinion of the overall framework again.

After having shared your first impressions, please have a look at the descriptions of each of the three pillars. We will first ask you to assess the pillars individually and then to share in the end again your opinion about the framework overall.

The **technological potential** describes the functionality of a technology and whether it contributes to already existing or newly developed DRR efforts. It can be evaluated by testing the technology in existing applications in laboratory or real-world settings. The technological potential is evaluated based on the following assessment categories:

- *Development costs:* describe how costly (financial and human resources) it is to develop this technology.
- *Transferability:* describes whether a technology can perform in different settings, e.g. different hazards, locations, or use cases (before, during or after an event).
- *Functionality and technical limitations:* describe the performance of a technology in general.
- *Reliability:* describes whether the performance of a technology is dependable.

What is your first impression of the categories within the pillar describing the **technological potential,** e.g. are the categories all needed, well described etc.?

Are there any missing aspects you would consider when looking at the **technological potential** of a technology?

The **practical potential** describes the usability as well as applicability of a technology for targeted end-users, i.e. early-adapters. Further, this potential assesses if a technology contributes to improving DRR through informing or supporting risk management, preventive actions, or recovery actions. The practical potential is elicited with the following assessment categories:

- *Practicality:* describes whether a technology can be used within DRR, by practitioners.
- *Applicability:* describes, in contrast to practicality, whether a technology can be used for different, specific tasks.
- *User groups:* describes whether a technology is practical across different user-groups

- *Effectiveness:* describes whether a technology produces the desired effects.

What is your first impression of the categories within the pillar describing the **practical potential,** e.g. are the categories all needed, well described etc.?

Are there any missing aspects you would consider when looking at the **practical potential of a technology**?

The **social potential** analyzes the contribution of AI to DRR from a societal perspective. It assesses the end-user's needs, evaluates if the technology is accessible, and addresses possible ethical issues such as misuse of the technology. The social potential is evaluated using the following categories:

- *User needs:* describes whether a technology responds to an existing or potential need of end-users.
- *Accessibility:* describes whether a technology is accessible for different end-users.
- *Inclusiveness:* describes if a technology can be used by all relevant societal groups, including for example vulnerable groups, independent of socio-demographic factors.
- *Ethical issues:* describes ethical issues such as biases, injustice, misuse or data protection, occurring as an effect of the use of the technology.

What is your first impression of the categories within the pillar describing the **social potential,** e.g. are the categories all needed, well described etc.?

Are there any missing aspects you would consider **when looking at the social potential** of a technology?

Finally, after reading all these details, what is your impression of the framework as a whole?

Are there missing aspects?

After we have reviewed our assessment framework, we will now apply this directly to AI technologies for seismology and disaster risk reduction.

Specific questions concerning Artificial Intelligence in seismology

In which fields of seismology does or will AI play an important role?

_____

Where do see the greatest potential for AI in seismology?

_____

More specifically in seismology, how would you describe the *current use of AI* in seismology? (max. 200 words)

*What is your opinion about the following **statements** concerning AI in general and in the field of seismology: (1 = do not agree at all, 5 = fully agree)?*

	1	**2**	**3**	**4**	**5**
AI is a synonym for machine learning.					
AI is a synonym for deep learning.					
AI can be used by anybody, not just data scientists.					
AI has the potential to revolutionize the field of seismology.					
AI will make it possible to predict earthquakes.					
The potential of AI should not be overestimated.					
The use of AI should be critically reviewed, especially also in seismology.					
Current research already shows that AI will be helpful for earthquake early warning.					
Current research already shows that AI will be helpful for rapid impact assessment.					

Current research already shows that AI will be helpful for earthquake prediction.					
AI in seismology always requires a big data set to be trained and labelled. This cannot always be easily transferred to other regions and data sets.					
It is important not to rely fully on the results of machine learning calculations					

Do you have any comments concerning the statements about AI in general?

Technological potential

The **technological potential** describes the functionality of a technology and whether it contributes to already existing or newly developed DRR efforts. It can be evaluated by testing the technology in existing applications in laboratory or real-world settings. The technological potential is evaluated based on the following assessment categories:

- *Development costs:* describe how costly (financial and human resources) it is to develop this technology.
- *Transferability:* describes whether a technology can perform in different settings, e.g. different hazards, locations, or use cases (before, during or after an event).
- *Functionality and technical limitations:* describe the performance of a technology in general.
- *Reliability:* describes whether the performance of a technology is dependable.

*With regards to the technological potential of AI as defined in our framework how would you judge the following statements: (1 = do not agree at all5 = fully agree)? (The **technological potential** describes the functionality of AI and whether it contributes to already existing or newly developed DRR efforts)*

	1	**2**	**3**	**4**	**5**
The development costs of AI for seismology are decreasing constantly.					
AI tools once developed is easily transferable to different geographical areas					
AI tools have a high functionality for earthquake early warning.					
AI tools have a high functionality for earthquake forecasting.					
AI tools have a high functionality for earthquake prediction.					
AI tools have a high functionality for rapid impact assessment.					
The availability of data is a limiting factor for the reliability of the results.					
The AI needs technological conditions, not possible to be provided everywhere, e.g. computational capacities.					

AI for seismology is not reliable yet for earthquake forecasting.					
An AI model is always relying on an existing dataset coming from sensors, e.g. is locally bound.					

Do you have any comments concerning the statements about the technological potential of AI in seismology?

Practical Potential

The **practical potential** describes the usability as well as applicability of a technology for targeted end-users, i.e. early-adapters. Further, this potential assesses if a technology contributes to improving DRR through informing or supporting risk management, preventive actions, or recovery actions. The practical potential is elicited with the following assessment categories:

- *Practicality:* describes whether a technology can be used within DRR, by practitioners.
- *Applicability:* describes, in contrast to practicality, whether a technology can be used for different tasks.
- *User groups:* describes whether a technology is practical across different user-groups
- *Effectiveness:* describes whether a technology produces the desired effects.

*With regards to the practical potential as defined in our framework, how would you judge the following statements: (1 = do not agree at all5 = fully agree)? (The **practical potential** describes the usability as well as applicability of AI for targeted end-users, i.e. early-adapters)*

	1	**2**	**3**	**4**	**5**
AI is only useful for specific users such as early adapters					
For the development of the AI model, the public must not be involved.					
The public will not access AI models but only their outputs.					
The use of AI is limited to the developers.					
AI tools are very useful in seismology, especially in earthquake early warning.					
AI tools are very useful in seismology, especially for rapid impact assessment. .					
AI tools are very useful in seismology, especially for earthquake forecasting.					
AI tools are very useful in seismology, especially for earthquake prediction.					

AI in seismology is only usable in research, thus other user groups (such as lay people, government employees) do not have to be considered in the development.					
There is a direct link between the AI models and the warning entity e.g. seismological service					
AI makes earthquake early warning more effective.					
AI makes earthquake forecasting more effective.					
AI makes rapid impact assessment more effective.					
AI makes earthquake prediction more effective.					

Do you have any comments concerning the statements about the practical potential of AI in seismology?

Social potential of AI

The **social potential** analyzes the contribution of AI to DRR from a societal perspective. It assesses the end-user's needs, evaluates if the technology is accessible, and addresses possible ethical issues such as misuse of the technology. The social potential is evaluated using the following categories:

- *User needs:* describes whether a technology responds to an existing or potential need of end-users.
- *Accessibility:* describes whether a technology is accessible for different end-users.
- *Inclusiveness:* describes if a technology can be used by all relevant societal groups, including for example vulnerable groups, independent of socio-demographic factors.
- *Ethical issues:* describes ethical issues such as biases, injustice, misuse or data protection, occurring as an effect of the use of the technology.

*With regards to the social potential as defined in our framework, how would you judge the following statements: (1 = do not agree at all5 = fully agree)? (The **social potential** analyzes the contribution of AI to DRR from a societal perspective*)

	1	**2**	**3**	**4**	**5**
AI models do consider the needs of multiple end-users.					
Because the quality of AI depends on the regional data availability for the training of the models, there is a big inequality in the quality of the models.					
Because the quality of AI depends on the computing capacity, there is an inequality of the quality of models.					
Applications from AI models in seismology do specifically target vulnerable groups.					
AI in seismology do not have biases in the model that are ethically critical.					
AI in disaster risk reduction efforts can be ethically critical because of possible misuses.					

AI models should be more critically reflected.					
There is limited data governance in AI in seismology-					
AI models can easily be misused, e.g. to do harm to society.					

Do you have any comments concerning the statements about the practical potential of AI in seismology?

Demographic information

Would you consider yourself an expert of AI in seismology? (rating)

- No expertise
- Very low expertise
- Medium expertise
- High expertise
- Very high expertise

What is your specific research focus?

- ☐ Earthquake early warning
- ☐ Rapid impact assessment
- ☐ Earthquake forecasting
- ☐ Earthquake prediction
- ☐ Other, which

_____

How many years have you been in your position?

What is your current place of work?

Have you worked in other countries for more than a year? If so, which?

_____

What is your year of birth (e.g., 1982)?

_____

What is your gender?

- ☐ Female
- ☐ Male
- ☐ Non-binary
- ☐ Prefer not to say
- ☐ Other

Thank you for contributing to this first round! Please provide your e-mail address, so we can share the second survey which only includes the divergent statements: _____

Thank you for filling out the first part of this Delphi-Study. We will contact you for the second round, if you have given us your e-mail adress.

Results – round 1

The results are presented in the order of the survey, thus there are also the heading that can be found in the original questionnaire as visible above.

1. AI in general

Table DS1.1: Answers to the question: How would you define AI in general? Do you have a reference for a definition you especially like?

ID 1	Today's AI for science is very naive compared to CV and NLP. Few studies regarding AI for science involve true big data, foundation models, or multimodal learning. So definitions are quite different.
ID 2	Artificial intelligence is any tool used by a machine to reproduce human-related behaviors, such as reasoning, training, visualization and analysing based on data
ID 3	AI is the application of statistical data-driven models that can be used to interpret, analyze, or invert any kind of data.
ID 4	In general, AI can be defined as the ability of the machines to make their own decisions. Any machine making its own decision based on certain input can be said to be artificially intelligent.
ID 5	AI is currently often used as a synonym for machine learning: a process in which we make computers learn about phenomena using incomplete information about the phenomena.
ID 6	AI is the simulation of human intell. processes by machines. It can include learning, reasoning, problem-solving, perception &natural language understanding, & adapt to new situations & improve perf.
ID 7	AI is intelligence which is programmed in computer systems, which can mimic the human intelligence as manifest in the human brain.
ID 8	A portable predictive model trained on finite dataset, validated with a test dataset, allowing to process similar data with similar accuracy than validated with leading computational efficiency.
ID 9	AI is the concept to implement algorithms and workflows on computers in an attempt to mimic the behavior of the human brain (as much as known)
ID 10	AI learns from past behavior, documented by data, to predict future behavior (of any system). The methods underlying AI are also used by scientists to infer parameters of physical models, given data on the system.
ID 11	I think the original definition for a machine to be considered artificially intelligent would be when it passes the Turing test. So, when it is able to hold a conversation with a person without the person being able to tell whether this is a machine or a human. This definition does have a strong emphasis on conversation, and I don't think this is the definition most people have in mind nowadays when they talk about AI.
ID 12	I am not entirely sure what qualifies as AI. I am mostly interested in machine learning applications.

Table DS1.2: Answers to the question: Overall, do you think that AI applications help the different phases of the disaster risk cycle (planning, response planning, evacuation planning or prevention*)?*

ID 1	Yes. AI applications can be very helpful to the phases listed above.
ID 2	At the moment not. In the future why not. Must be assessed in depth regarding for example the false information and the treatment of uncertainties

ID 3	It depends on the availability of data that are needed to train any AI models and on the inherently present biases within any of the employed datasets
ID 4	AI do have its part, directly or indirectly, in planning, response, evacuation and prevention phases of the disaster risk cycle.
ID 5	Yes.
ID 6	Yes, it can automatize part of the procress. It can help assess risk, warn people or autoamtize the spread & collect of information for instance
ID 7	There is potential for AI applications to help in the future.
ID 8	Yes
ID 9	perhaps - but probably not significantly with today's technology / solutions / applications
ID 10	yes
ID 11	yes, I think there can be various ways in which AI applications can help.
ID 12	Potentially yes

Table DS 1.3 Answers to the question What is your first impression of this framework? We will ask you first to evaluate the individual pillars and then share your opinion of the overall framework again.

ID 1	It's overall good. I think you may add a 'scientific potential' pillar. New scientific discoveries may occur when studying disaster risk reduction.
ID 2	To vague ! Without additional information/explanation, do not represent the main question during crisis management.
ID 3	It seems reasonable.
ID 4	This framework includes all phases of a technology in disaster risk reduction, starting from its development phase to the end benefit phase.
ID 5	It's a reasonable split to assess the usefulness of an application.
ID 6	maybe the order of the internal component could be adjust. Also maybe add usability in it ?
ID 7	This framework is logical.
ID 8	I don't get the application context of this framework. Where and when will be used and by who? Developper are supposed to apply it themselves?
ID 9	(not sure if I understand - should I now evaluate first the individual pillars in this textbox and then overall?) If you here want my first impression, it is probably a bit too limited? e.g. in the technology pillar, operational costs are not mentioned (and they may be more

	important than development), not sure what you mean by 'transferability' (of one AI framework across multiple disaster types?)
ID 10	looks good
ID 11	I am not sure if I fully understand it. Does an emerging technology have to have potential in all three categories to be considered promising? I am also not sure what the bullet points for each category symbolise. Are they problems that could be encountered with the new technology, or problems that the technology can solve? The category of technological potential seems difficult to separate from practical potential - if something has high developing costs, isn't that a practical limitation?
ID 12	I don't really know what each of the points refer to (e.g. developing costs, transferability, applicability vs practicality, etc).

Table DS 1.4: Answers to the question: What is your first impression of the categories within the pillar describing the technological potential, e.g. are the categories all needed, well described etc.?

ID 1	Yes.
ID 2	I do not understand at the end the relevancy of such catagerories for DRR. For example cost has no sense if benefit is not added.
ID 3	I think it is missing a brief explanation of a metric or method to assess each of the categories.
ID 4	Technological potential includes almost all phases.
ID 5	The category of reliability could be better described, especially in a machine-learning-as-black-boxes context.
ID 6	I wonder if something could be added about where the idea comes from (who identified the problem VS techno. that are developed without specific needs)
ID 7	The functionality category is rather vague. Users will want to know if the technology is actually useful in a practical way.
ID 8	It is missing aspects of operation cost, sustainability, compliance with existing standards in seismology (coding language, fdsn/seed conventions) ...
ID 9	operational costs is missing; functionality ... is a bit vague (the description); reliability has (at least) two aspects - 'operational' and 'result
ID 10	I'd say that reliability is part of functionality. If the technology is not reliable, it is not functional. That functionality can be subdivided in more precise categories. For example does reliability mean reproducibility, an acceptable false positive rate, an acceptable false negative rate, does it critically depend on one or two bottle neck components in a network, etc?
ID 11	I like these categories and I believe they are well described. But it will be hard to quantify how transferable or how limited a technology is.
ID 12	Development costs seems more like a dimension for practical potential . Versatility might be a better word for what is described here as transferability. I am also not sure whether the word functionality describes performance. To me it is a bit closer to practicality. Performance or effectiveness would be better.

Table DS 1.5: Answers to the question: Are there any missing aspects you would consider when looking at the technological potential of a technology?

ID 1	No.
ID 2	Cost-benefit, environmental impact
ID 3	I believe it is missing feasibility. It is not certain that a given technology can be deployed or developed within the bounds of a project.
ID 4	I would like to add Pre-development phase which describes on what grounds (data) particular technology is developed.
ID 5	No.
ID 6	I think the previous point is important as it may impact the way it will be adopted by people who may already have procedures in place (yr next point)
ID 7	The technological potential should be manifestly cost-effective, with the benefits clearly outweighing the technological costs.
ID 8	- Maintenance cost: requires again more CPU, RAM, internet access or energy in general? - Sustainability: Code with LTS?... - Standards:...
ID 9	I continue from above (text limit) - ... 'result'; maintenance effort is missing (i.e. how often would a software need to be updated or renewed); ***
ID 10	Yes, can the technology be replicated by an independent team of developers? This might need to become part of the development costs (rather than providing classical peer review, reviewing developers get paid for their time to document to what extent the technology can be replicated).
ID 11	Maybe one could distinguish the costs of developing the technology and the cost of keeping it operational.
ID 12	no

Table DS. 1.6: Answers to the question: What is your first impression of the categories within the pillar describing the practical potential, e.g. are the categories all needed, well described etc.?

ID 1	Yes.
ID 2	To vague
ID 3	They seem pretty complete.
ID 4	All the categories are needed and well explained.
ID 5	The practicality category should have also the cost of training and usage in the description.
ID 6	I feel like users groups is a transversal concept that is relevant for all others concepts of this category maybe add usability ?
ID 7	Ease of general use is a key criterion for practical potential.
ID 8	This is basically peer review?

ID 9	it probably really depends on the intended users / usage scenarios : 'recognize' a disaster from data; 'characterize' the disaster and its po***
ID 10	I would reframe effectiveness as describe to what extent a technology produces the desired effects . The user groups category can be a subcategory of Practicality (practitioners would be the other subcategory)
ID 11	I find these categories less well described than the previous ones. user groups sounds like the category transferability from the previous pillar, just between user groups instead of between hazards, locations, etc. In general I find the descriptions of the categories good, but the titles of the descriptions not so fitting.
ID 12	The descriptions (except for effectiveness) seem very similar to me...

Table DS 1.7: ***Answers to the question: Are there any missing aspects you would consider when looking at the practical potential of a technology?***

ID 1	I think you should include 'efficiency' in your categories. Rapid response to disaster is always needed.
ID 2	yes certinly but the survey not clear so ...
ID 3	Robustness: describes whether a technology can handle outlier or not considered usage conditions
ID 4	The categories sufficiently describe the practical potential.
ID 5	No.
ID 6	not that i can think of
ID 7	User-friendliness is missing.
ID 8	yes all the other aspects addressed in peer review
ID 9	***tential; support decision making (different stakeholders / users) - I find it impossible to assess practicability 'in general'
ID 10	Yes, under what conditions if this technology practical, applicable, and effective? (e.g. assuming everyone has a cell phone in their pocket, even when sleeping)
ID 11	no
ID 12	Ease of integration into existing systems Acceptance by users and/or ease of use (adoption by users without previous experience) Costs for implementation Costs/effort for maintenance, updates Implications on safety/data protection (e.g. required efforts/costs to ensure safety)

Table DS 1.8: Answers to the question: What is your first impression of the categories within the pillar describing the social potential, e.g. are the categories all needed, well described etc.?

ID 1	Yes.
ID 2	Potential need of end-users is not relevant. Accessibility: to do what? Ethical issues: no sense
ID 3	These seem well described.
ID 4	Categories are sufficient.
ID 5	The accessibility category should also state how accessible are the products (i.e. how much effort and resources it requires from a user).
ID 6	all needed : yes well described : yes also
ID 7	This is fit for purpose.
ID 8	None of this is related to the tech itself but to the way it is used by the operator. It is unfair to blame the developer of tech on these aspects.
ID 9	is it really the technology that relates to the social potential (as defined) - not the 'outcomes' (results of AI applications)? a user doesn't need**
ID 10	Inclusiveness and accessibility go hand in hand.
ID 11	I like the categories. I am not sure if accessibility is something that is inherent to a technology. depends on how accessible it is made to the end-users.
ID 12	User needs and accessibility for me go under the practical potential . Inclusiveness maybe too.

Table DS 1.9: Answers to the question: Are there any missing aspects you would consider when looking at the social potential of a technology?

ID 1	No.
ID 2	yes cartianly but the survey not clear so....
ID 3	Financial response: a technology might have financial repercussions, either positive or negative
ID 4	Categories are sufficient.
ID 5	No.
ID 6	not that i am now thinking about
ID 7	Consideration of language and cultural barriers. AI may be tied narrowly to a standardized western way of thinking.
ID 8	These should rather be continuously evaluated for all operator of ML technologies. In this context it is missing many aspects of GDPR and IHRL

ID 9	**to understand AI to be able to make use of its results - so I don't find that aspect very relevant
ID 10	I'd add community-engagement: The users for which the technology is developed need to be part of the process, as this could generate trust and wide acceptance of the technology. There are load of people who make choices that are not in their own best interests because of a lack of trust.
ID 11	no
ID 12	Facilitation of malicious actions, e.g. misuse of AI for misinformation. Maybe it falls under ethical, but maybe it makes sense to distinguish between AI having unintended bias (trained on biased data) vs being used with unethical intent. Replaces jobs Possible consequences of unsupervised AI

Table DS 1.10: Answers to the question: Finally, after reading all these details, what is your impression of the framework as a whole?

ID 1	The framework is a little bit vague and general.
ID 2	To vague, not relevant and whitout stating clearly the objective.
ID 3	I think the framework is fine, but the inclusion of only AI seems limiting other potential disruptive technologies that are being developed.
ID 4	This framework can be considered as an excellent method to completely describe a technology.
ID 5	The framework is reasonably set-out and detailed enough.
ID 6	it's interesting
ID 7	It is good as a starting point.
ID 8	I don't understand the intent of this initiative.
ID 9	not sure whether it's really that useful (maybe especially when the question is so general as 'AI for DRR'...)?
ID 10	a good starting point
ID 11	I think the three pillars are a good framework, the description/names of the categories can be improved. And what I would like to know is how this framework will be used in practice to assess a technology. How is all of this going to be quantified? How are decisions made based on it?
ID 12	A bit confusing... sorry!

Table DS 1.11: Answers to the question: Are there missing aspects? [for comprehension added: when looking at the framework as a whole]

ID 1	No.
ID 2	yes certainly but the survey not clear so...
ID 3	
ID 4	These three pillars are sufficient to present all phases of a technology.
ID 5	No.
ID 6	not that i can think of
ID 7	It is known that counterfactual thinking is very hard to encode into artificial intelligence. This is a key limitation.
ID 8	Yes! The development of a common computational framework, evaluation of platforms whether based on central cloud, local hubs, IOT .. new data types..
ID 9	rather the questions should be more specific (different scenarios of DRR)
ID 10	examples
ID 11	see above
ID 12	no

2. Specific questions concerning AI in Seismology

Table DS 1.12: Answers to the question: In which fields of seismology does or will AI play an important role?

ID 1	Earthquake monitoring for now. And hopefully, short-term earthquake forecasting in the future.
ID 2	All
ID 3	Picking, automatic interpretation (e.g., faults), event detection, compression
ID 4	Archaeoseismology, Fault mechanics and Seismic tomography
ID 5	Seismic network routine, Earthquake Early Warning, Seismicity analysis
ID 6	risk assessment, risk communication
ID 7	signal processing
ID 8	New massive data type (optic fibre, IOT) and EEW
ID 9	recognizing and characterizing earthquakes and their impact (and probably support DRR 'emergency decision making' - that's not seismology any more)
ID 10	early warning, rescue efforts, perhaps planning
ID 11	earthquake detection, earthquake forecasting
ID 12	Not a seismologist, so cannot answer that

Table DS 1.13: Answers to the question: Where do you the greatest potential for AI in seismology?

ID 1	Short-term earthquake prediction.
ID 2	Exploring the amount of data and predicting damage
ID 3	Novel event detection and mining
ID 4	AI can be used in the study of past earthquakes and Seismic tomography. Combining these two fields, AI can potentially forecast the upcoming seismological events.
ID 5	Seismic network routine automation, Earthquake Early Warning
ID 6	information to the public and to emergency services (collect and spread)
ID 7	spotting precursors
ID 8	New data driven understanding of earthquake source processes
ID 9	characterizing earthquakes and their potential impact
ID 10	not sure
ID 11	combining different data sources and use them for forecasting
ID 12	Likewise

Table DS 1.14: Answers to the question: More specifically, how would you describe the current use of AI in seismology?

ID 1	The current use of AI in seismology shows great potential in nearly all aspects yet it is quite naive. And it is years behind AI in computer vision and neural language processing.
ID 2	Exploring the amount fo data
ID 3	Among the most impressive achievements of AI in seismology is the ability to use already processed datasets for which catalogs exist and form new event catalogs where smaller earthquakes are detected.
ID 4	Current use of AI can be considered as the beginning of its application in seismology. There is much to explore in seismology with AI.
ID 5	AI (ML) is currently being used mostly to develop new algorithms, with additional benefits in methodology and standardization improvement in general.
ID 6	a lot of initiatives (for risk assessment and RIA, for misinformation fight etc) but need to be better studied and to assess also ethical issues
ID 7	The use of AI is limited at the moment.
ID 8	Disorganised, not sustainable, but one of the greatest open source communities
ID 9	just getting started (detection and location) - it's not really relevant for 'rapid assessment' of damaging quakes so far (I think...)
ID 10	not sure
ID 11	it is mostly used for waveform analysis. it is used to create high-resolution catalogs, maybe also focal mechanism catalogs. Basically it is used to do the same tasks that were already done previously, but more efficiently, more precisely, for smaller magnitudes, etc.
ID 12	I know it is being used for ground motion prediction. Otherwise, I am not following seismology literature.

Table DS 1.15: Answers to the question: What is your opinion about the following statements concerning AI in general and in the field of seismology, from 'do not agree at all' to 'fully agree'? (Answers are in percentage)

	Do not agree at all	Do not agree	Neutral	Agree	Fully agree
AI is a synonym for machine learning.	0.167	0.417	0.083	0.25	0.083
AI is a synonym for deep learning.	0.167	0.583	0.083	0.083	0.083
AI can be used by anybody, not just data scientists.	0	0.333	0.167	0.25	0.25
AI has the potential to revolutionize the field of seismology.	0	0.083	0.5	0.083	0.333
AI will make it possible to predict earthquakes.	0.167	0.333	0.25	0.167	0.083
The potential of AI should not be overestimated.	0.083	0.083	0.667	0.167	0
The use of AI should be critically reviewed, especially also in seismology.	0	0.083	0.167	0.417	0.333
Current research already shows that AI will be helpful for earthquake early warning.	0	0.167	0.333	0.417	0.083
Current research already shows that AI will be helpful for rapid impact assessment.	0	0.167	0.333	0.333	0.167
Current research already shows that AI will be helpful for earthquake prediction.	0.083	0.417	0.417	0.083	0
AI in seismology always requires a big data set to be trained and labelled. This cannot always be easily transferred to other regions and data sets.	0.167	0.417	0.083	0.333	0
It is important not to rely fully on the results of machine learning calculations	0	0.167	0.25	0.25	0.333

Table DS 1.16: Answers to the question: Do you have any comments concerning the statements about AI in general?

ID 1	No.
ID 2	no
ID 3	None
ID 4	AI do have the potential to revolutionize the field of seismology but it is also the fact that we should not fully rely on machine learning results.
ID 5	Some statements are too absolute and are problem dependent.
ID 6	ethical and social issues should indeed always be kept in mind when developing and using AI Also always consider limits and how AI was built up,
ID 7	AI is in a developmental stage.
ID 8	Ml and DL are parts of AI..

ID 9	this should not be a mandatory field (if i have no comments concerning the statements :-) ; again, the potential use is so diverse that answers are often neutral because 'it depends' (and that option is not there :-)
ID 10	AI is good for doing things fast, not so good for better understanding each case, given that each disaster comes with new, unique lessons.
ID 11	the synonym questions are strange. this should not be anyones opinion, there are clear definitions for this
ID 12	There is no option for I don't know . E.g. I am not read any research on AI for early warning because I am not working on that. Also some statements are mixed. E.g. AI in seismology always requires a big data set to be trained and labelled. This cannot always be easily transferred to other regions and data sets. . AI requires big datasets for training. They don't always need to be labelled, there are supervised and unsupervised applications. I put disagree because of that, but that's probably not the purpose of the statement. Or Current research already shows that AI will be helpful for rapid impact assessment. . I put not agree because I don't think there has been much research on that. Otherwise, I am pretty certain that it will be helpful on rapid impact assessment.

3. The technological potential

Table DS 1.17: Answers to the question: With regards to the technological potential of AI as defined in our framework how would you judge the following statements, from 'do not agree at all' to 'fully agree'? (The technological potential describes the functionality of AI and whether it contributes to already existing or newly developed DRR efforts) (Answers are in percentage)

	Do not agree at all	Do not agree	Neutral	Agree	Fully agree
The development costs of AI for seismology are decreasing constantly.	0	0.333	0.25	0.417	0
AI tools once developed is easily transferable to different geographical areas	0	0.167	0.5	0.333	0
AI tools have a high functionality for earthquake early warning.	0	0.083	0.5	0.333	0.083
AI tools have a high functionality for earthquake forecasting.	0	0.25	0.417	0.333	0
AI tools have a high functionality for earthquake prediction.	0.167	0.25	0.417	0.167	0
AI tools have a high functionality for rapid impact assessment.	0	0	0.333	0.5	0.167
The availability of data is a limiting factor for the reliability of the results.	0	0	0.083	0.667	0.25

The AI needs technological conditions, not possible to be provided everywhere, e.g. computational capacities.	0	0.25	0.25	0.417	0.083
AI for seismology is not reliable yet for earthquake forecasting.	0	0	0.417	0.333	0.25
An AI model is always relying on an existing dataset coming from sensors, e.g. is locally bound.	0.167	0.167	0.25	0.333	0.083

Table DS 1.18: Answers to the question: *Do you have any comments concerning the technological potential of AI in seismology?*

ID 1	No.
ID 2	no
ID 3	None
ID 4	NA
ID 5	No.
ID 6	nope
ID 7	The potential is limited at present.
ID 8	The development costs of anything for seismology are decreasing constantly! The resources that are available to nowadays students have access to is at the level of science fictions compared to few generations before! Github, (amazon, google) cloud services, jupyter, visual studio, anybody can now develop an app with complex backends to do ~anything starting from ~nothing ...
ID 9	I sometimes find the statements not so relevant; sometimes again 'it depends' on the specific application
ID 10	A lot of these questions have an answer like it depends
ID 11	some of them I don't feel expert enough to answer.. so I put in neutral.
ID 12	I put neutral instead of I don't know . Also I feel that some statements, e.g. the last one do not make sense.

4. The practical potential

Table DS 1.19: Answers to the question: With regards to the practical potential as defined in our framework, how would you judge the following statements, from 'do not agree at all' to 'fully agree'? (The practical potential describes the usability as well as applicability of AI for targeted end-users, i.e. early-adapters

	Do not agree at all	Do not agree	Neutral	Agree	Fully agree
AI is only useful for specific users such as early adapters	0.167	0.417	0.25	0.167	0
For the development of the AI model, the public must not be involved.	0.083	0.333	0.25	0.333	0
The public will not access AI models but only their outputs.	0	0.333	0.167	0.417	0.083
The use of AI is limited to the developers.	0.083	0.667	0	0.25	0
AI tools are very useful in seismology, especially in earthquake early warning.	0	0.083	0.417	0.417	0.083
AI tools are very useful in seismology, especially for rapid impact assessment. .	0	0	0.417	0.5	0.083
AI tools are very useful in seismology, especially for earthquake forecasting.	0.083	0	0.667	0.25	0
AI tools are very useful in seismology, especially for earthquake prediction.	0.167	0.167	0.5	0.167	0
AI in seismology is only usable in research, thus other user groups (such as lay people, government employees) do not have to be considered in the development.	0.25	0.333	0.25	0.167	0
There is a direct link between the AI models and the warning entity e.g. seismological service	0.083	0.083	0.583	0.25	0
AI makes earthquake early warning more effective.	0	0.083	0.5	0.333	0.083
AI makes earthquake forecasting more effective.	0	0.083	0.667	0.25	0
AI makes rapid impact assessment more effective.	0	0	0.417	0.5	0.083
AI makes earthquake prediction more effective.	0.167	0	0.583	0.25	0

Table DS 1.20: Answers to the question: Do you have any comments concerning the statements about the practical potential of AI in seismology?

ID 1	No.
ID 2	no
ID 3	None
ID 4	NA
ID 5	No
ID 6	maybe consider the open source option ?
ID 7	Not yet practical.
ID 8	
ID 9	too many unknowns (or lack of my knowledge) to answer other than 'neutral' for many statements. and again - so many diverse use cases that it really depends...
ID 10	
ID 11	For the development of the AI model, the public must not be involved. of course the needs of the public should influence how the model is developed, but the public shoud not be asked for advice on how to develop... AI tools are very useful in seismology, especially for not sure here if this includes will become useful There is a direct link between the AI models and the warning entity e.g. seismological service. I don't understand this sentence.
ID 12	Again, put neutral for I don't know. Also some statements are badly formulated. E.g. AI in seismology is only usable in research, thus other user groups (such as lay people, government employees) do not have to be considered in the development. --> I agree that lay people cannot be considered in the development. But AI is not usable only in research. It is an application of science. There is a direct link between the AI models and the warning entity e.g. seismological service. --> I don't know what this means

5. The social potential

Table DS 1.21: Answers to the question: With regards to the social potential as defined in our framework, how would you judge the following statements, from 'do not agree at all' to 'fully agree')? (The social potential analyzes the contribution of AI to DRR from a societal perspective)? (Answers are in percentage)

	Do not agree at all	Do not agree	Neutral	Agree	Fully agree
AI models do consider the needs of multiple end-users.	0	0.167	0.667	0.167	0
Because the quality of AI depends on the regional data availability for the training of the models, there is a big inequality in the quality of the models.	0.083	0.083	0.417	0.333	0.083

Because the quality of AI depends on the computing capacity, there is an inequality of the quality of models.	0.25	0.083	0.333	0.333	0
Applications from AI models in seismology do specifically target vulnerable groups.	0.167	0.333	0.5	0	0
AI in seismology do not have biases in the model that are ethically critical.	0.083	0.167	0.417	0.167	0.167
AI in disaster risk reduction efforts can be ethically critical because of possible misuses.	0.083	0.083	0.417	0.333	0.083
AI models should be more critically reflected.	0.083	0	0.417	0.5	0
There is limited data governance in AI in seismology-	0	0.083	0.667	0.25	0
AI models can easily be misused, e.g. to do harm to society.	0	0.167	0.583	0.25	0

Table DS 1.22: Answers to the question: Do you have any comments concerning the statements about the social potential of AI in seismology?

ID 1	No.
ID 2	no
ID 3	None
ID 4	NA
ID 5	No
ID 6	i'm sometines not enough aware of AI are currently developped to answer questions
ID 7	Insufficient training of users.
ID 8	Applications from AI models in seismology CAN target vulnerable groups IF TRAINED FOR IT... AI in seismology CAN HAVE no biases in the model that are ethically critical WITH ADEQUATE TRAINING...
ID 9	neutral here often means that I don't understand the statement (or would know how to answer)
ID 10	

ID 11	AI models do consider the needs of multiple end-users. This can not be answered. Some models do, some don't. Because the quality of AI depends on the regional data availability for the training of the models, there is a big inequality in the quality of the models. again, depends. if you require a minimum dataset to train a model, then in some areas you might just not have a model at all. AI in seismology have no biases in the model that are ethically critical. So far, I am not aware of any, but I think it could happen in the future. There is limited data governance in AI in seismology. I don't know what is meant by data governance in AI . It co uld mean many things
ID 12	AI models do consider the needs of multiple end-users. --> Which AI models? Not all models are the same

6. Demographics

Figure DS 1.1: Answers to the question: Would you consider yourself an expert of AI in seismology?

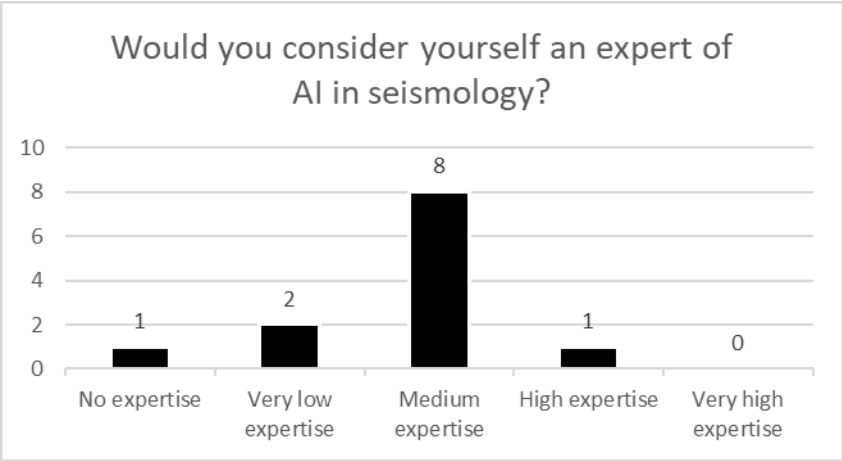


Figure DS 1.2: Answers to the question: *What is your specific research focus?*

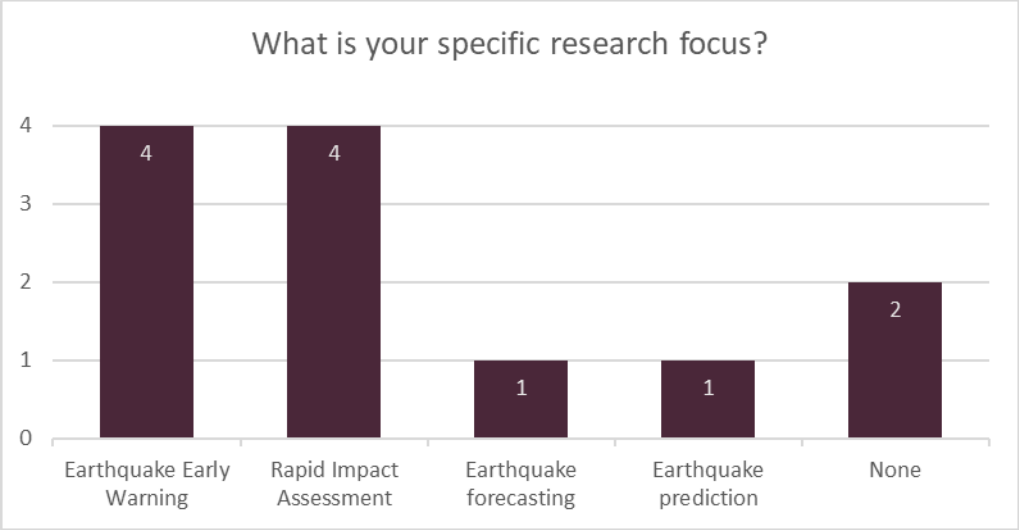


Figure DS 1.3: Answers to the question: How many years have you been in your position? (in full years, e.g. 10)

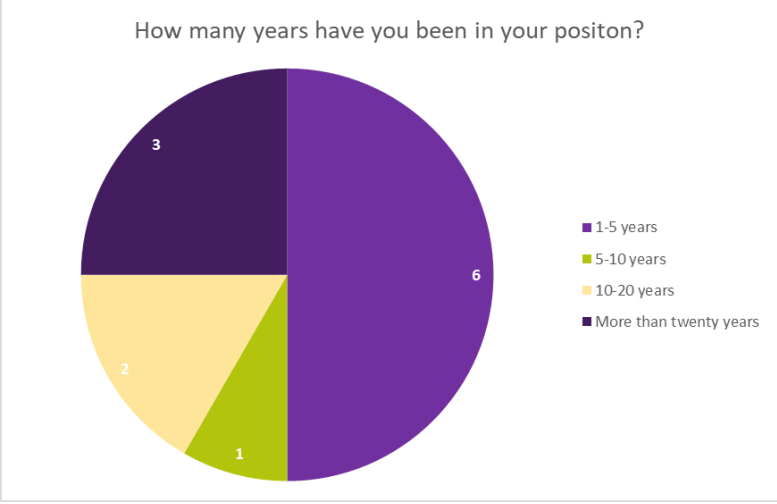


Figure DS 1.4: Answers to the question: *What is your current place of work?*

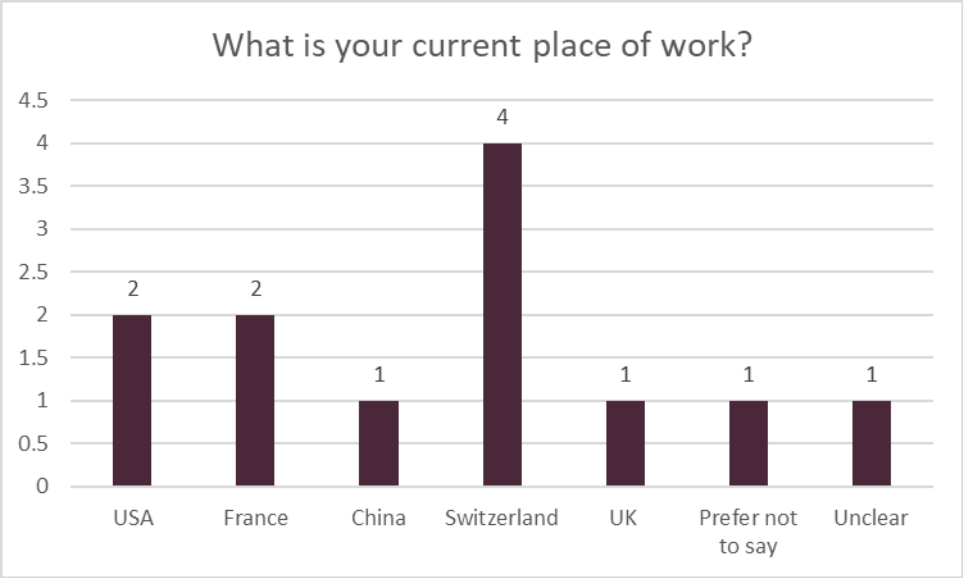


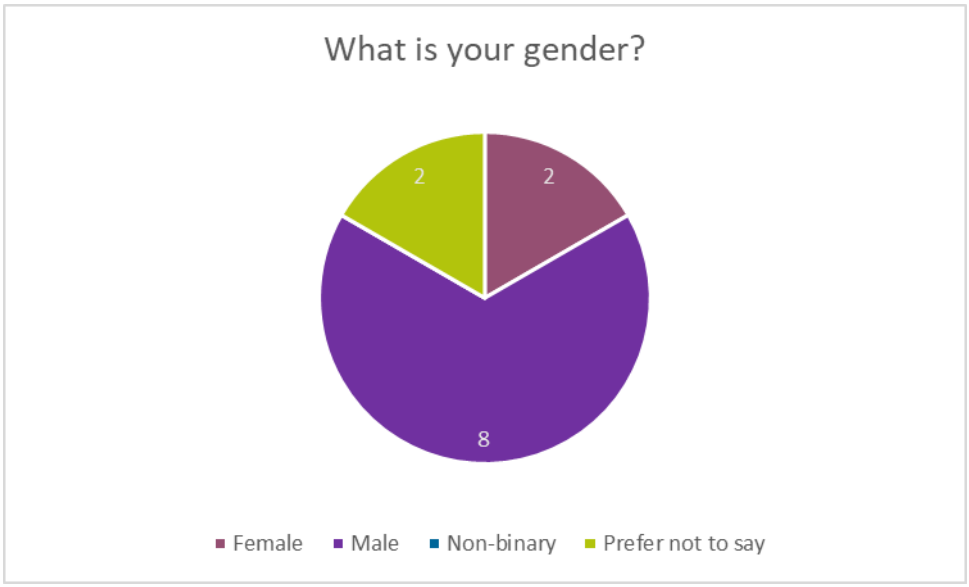
Table DS 1.23: Answers to the question: Have you worked in other countries for more than a year? If so, which?

ID 1	No
ID 2	South America
ID 3	Yes, Italy
ID 4	University of Malaya, Malaysia
ID 5	INGV, Italy
ID 6	no
ID 7	USA
ID 8	Prefer not to say
ID 9	germany, austria, usa
ID 10	yes
ID 11	No
ID 12	Italy

Table DS 1.24: Answers to the question*: What is your year of birth?*

ID 1	1995
ID 2	1970
ID 3	1988
ID 4	1994
ID 5	1992
ID 6	1990
ID 7	1962
ID 8	4242
ID 9	1967
ID 10	1965
ID 11	1992
ID 12	1989

Figure DS 1.5: Answers to the question: *What is your gender?*



Delphi-Survey (DS) - Round 2

Survey

Background information on this survey

Why a framework to assess the potential of emerging technologies for DRR?

Emerging technologies as for example Artificial Intelligence (AI), are developed and implemented in many fields. They can potentially make processes more efficient or enable to evaluate data faster and, consequently, to make disaster risk reduction more efficient. However, the societal consequences of the development and use of these technologies are often not studied or even neglected. The (research) focus in the last years has been mainly on the technological efficiency and feasibility, whereas ethical questions and user needs have been widely neglected. The latter is however indispensable to address to avoid negative consequences of the technologies on societies.

The aim of this study is to assess **the usability of a framework** to help researchers, developers, and stakeholders to reflect on and review the societal relevance and possible consequences of an emerging technology in a structured way. It focusses on ethical issues that need to be addressed when developing a new technology for **disaster risk reduction**.

Why the Delphi-method?

The Delphi-method serves as an iterative tool to explore where there is consensus or dissent among experts on a specific topic. The goal is to derive a common understanding of a topic in consecutive rounds, thus the survey is adapted based on the answers of the previous rounds.

Why AI in seismology?

We chose AI as a technology because of its relevance in research and societal debates. Within the EU-funded project "sCience and human factor for Resilient sociEty" (CORE) , we analyze the potential of emerging technologies to enhance safety culture and disaster risk reduction for different hazards including earthquakes. Therefore, we decided to focus on one case study namely AI in seismology. However, we argue that the framework can be applied to other hazards and emerging technologies.

Consent Form

Welcome and thank you for participating **in the second round** of this Delphi-Study to evaluate our framework. The survey was adjusted based on your constructive comments and feedback in the first round and serves to explore and explore the potential of emerging technologies in disaster risk reduction and safety culture.

In the first part of the survey, we try to find a common understanding of AI in seismology based on your answers in the first survey. In the second part, we ask you to evaluate the adapted framework as a means to ensure structured reflections on the societal relevance and consequences of an emerging technology.

The survey will take about 20 minutes to complete. Participation is voluntary and you may withdraw at any time. All information you provide will be analyzed anonymously, in accordance with the Swiss Federal Act on Data Protection. The results of the survey will only be used for research purposes, published in a research article, and will not be passed on to third parties.

If you have any questions, please contact lorena.kuratle@sed.ethz.ch

- ☐ I voluntarily participate in this study and agree to the processing of my personal data in accordance to the information mentioned above.

The study is conducted as part of the EU-funded project “sCience and human factor for Resilient sociEty” (CORE) and the doctoral project of Lorena Kuratle.

Start the Survey

Part 1: A shared definition of AI

We formulated a definition for AI in disaster risk reduction (DRR) based on your definitions in the first survey. Here the definition **in full:**

AI models are simulations or imitations of the human intelligence which are trained with data and are able to analyze, interpret and learn. AI models will make disaster risk reduction more efficient, robust and more adequate. Within seismology, AI has a high potential in multiple research areas, specifically for more efficient data processing and data analysis, but according to experts in the field the potential should not be overestimated.

The definition entails three major elements. For each of these we are interested hearing what you think of them: To what extent do you agree or disagree with the adjusted definition? *(1 = do not agree at all, 5 = fully agree)?*

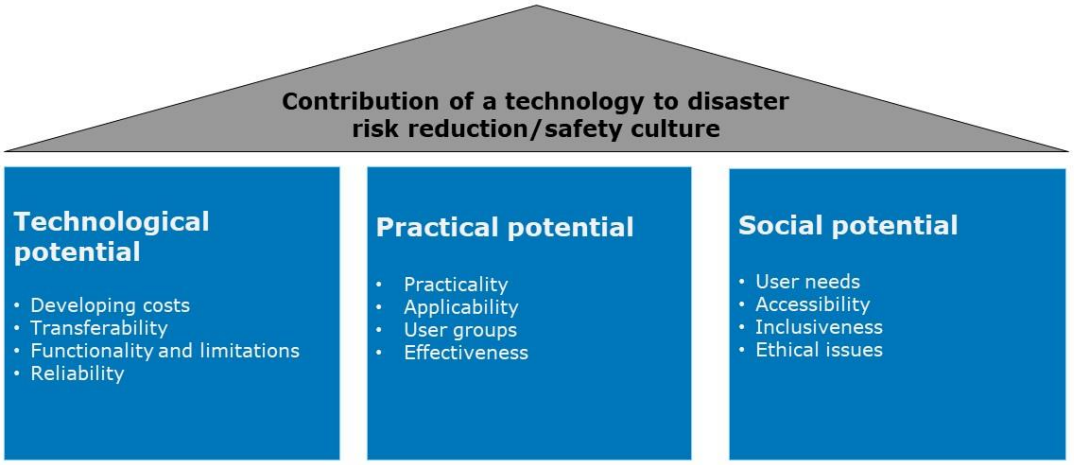
	1 = do not agree at all	**2**	**3**	**4**	**5 = fully agree**
AI models are simulations or imitations of the human intelligence which are trained with data and are able to analyze, interpret and learn.					
AI models will make disaster risk reduction more efficient					
AI in seismology has a high potential in multiple research areas, specifically for more efficient data processing and data analysis for forecasting, rapid impact assessment, but the potential should not be overestimated.					

Do you have anything you would add or cross out of this proposed definition?

Part 2: The adapted framework

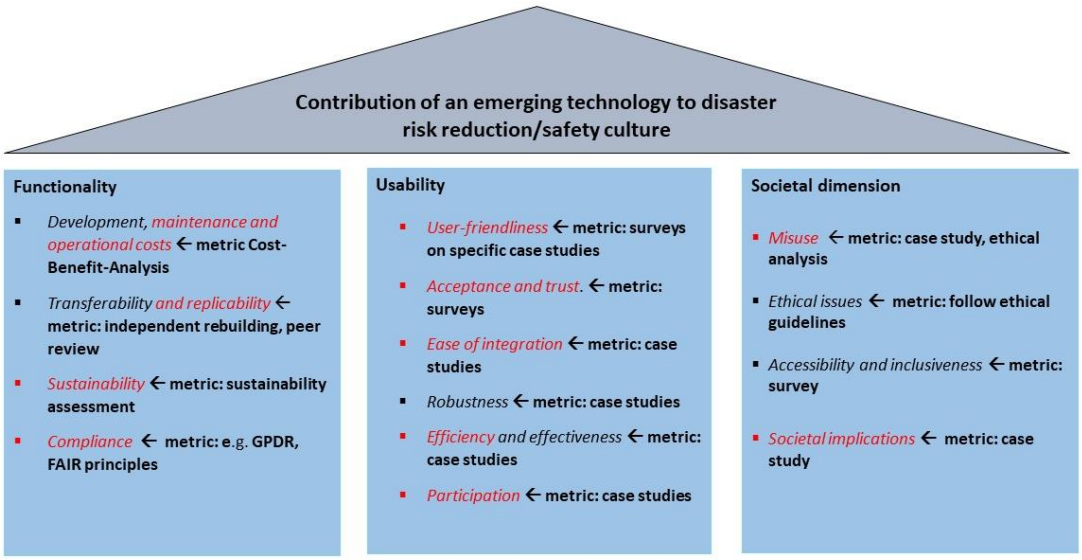
Based on your answers, we adapted the framework both with respect to the three pillars and which categories each of the pillars entails. More detailed in the following in more detail:

Previous draft of framework that you commented on in first survey:



In red, we highlighted the changes for the categories, which are based on your feedback. Additionally, we changed the names of the categories and added possible metrics. All three categories now follow a specific question. The categories in *Functionality* try to answer the question if and how the technology works, the categories in *Usability* whether and how it is used and the categories *in Societal dimension,* what the implementation of the technology mean for the whole society. The categories are elaborated below.

Adapted Framework:



Functionality or does it work?

The pillar *functionality* describes whether a technology functions properly during its whole lifespan. It can be evaluated by testing the technology in existing applications in laboratory or real-world settings. The *functionality* is assessed based on the following assessment categories:

- *Development, maintenance and operational costs* describe the financial and human resources needed to develop and use a technology. (metric: Cost-Benefit-Analysis)
- *Transferability and replicability* describe whether the performance of a technology is reliable. (metric: independent rebuilding, peer review)
- *Sustainability* describes whether a technology contributes to sustainable development of society (ecologically, socially, economically) during its entire life span. (metric: sustainability assessment)
- *Compliance* describes whether a technology follows existing guidelines. (metric: e.g. GDPR, FAIR principles)

Usability or is it used?

The pillar *usability* describes whether a technology is usable and applicable by different targeted end-users (context-independent), and is specifically assessing the active use and the intended use of a technology. The *usability* is assessed with the following categories:

- *User-friendliness* describes if the technology can be used by multiple users in a tailored manner without previous experience. (metric: user-surveys with specific technologies)
- *Acceptance and trust* describe whether the end-users have confidence in a technology. (metric: user-surveys)
- *Ease of integration* describes if a technology can be integrated in already existing systems. (metric: case studies an emerging technology in an existing network for example)
- *Robustness* describes whether a technology can handle outliers or usage conditions that we were not considered (metric: technology assessment)
- *Efficiency and effectiveness* describe whether the technology makes DRR more efficient and effective for end-users. (metric: case studies for specific disasters)
- *Participation* describes whether the end-users are involved in the full life span of a technology (metric: assessment and analysis of the implementation of a new technology)

Societal dimension or what does it mean for society?

The pillar *societal dimension* analyzes the contribution of AI to DRR from a societal and ethical perspective. It addresses possible ethical issues such as misuse of the technology and is assessed with the following categories:

- *Misuse* describes the use of the technology for malicious activities. (metric: case study, ethical analysis of an implemented technology)

- *Ethical issues* describe ethical implications of the use of the technology (e.g., unethical data collection) (metric: follow ethical guidelines)
- *Accessibility and inclusiveness* describe if a technology can be used by all relevant societal groups, including for example vulnerable groups, independent of socio-demographic factors. (metric: survey for specific end-users, i.e. marginalized groups or specific end-users).
- *Societal implications* of the implementation of the technology describes the potential negative or positive effects of the implementation of the technology, i.e. loss of jobs. (metric: case study)

What are your overall impressions of this adapted framework (e.g., what improved or what should be improved, what could be left out)?

More specifically, do you think the names of the three pillars are clearer now through the change from technological, practical and social potential to *functionality, usability* and *societal* dimension?

Do you think this adapted framework covers the above formulated goals, i.e. to guide researchers, developers, and stakeholders to reflect on the societal relevance and possible consequences of an emerging technology in a structured way? If yes, why? If no, why?

What is your impression of the pillar *functionality*? Are there missing or overlapping categories? Something too much here that can be deleted?

What is your impression of the pillar *usability*? Are there missing or overlapping categories? Something too much here that can be deleted?

What is your impression of the pillar *societal dimension*? Are there missing or overlapping categories? Something too much here that can be deleted?

Part 3: Demographic information

Would you consider yourself an expert of AI in seismology? (rating)

- No expertise
- Very low expertise
- Medium expertise
- High expertise
- Very high expertise

What is your specific research focus?

- ☐ Earthquake early warning
- ☐ Rapid impact assessment
- ☐ Earthquake forecasting
- ☐ Earthquake prediction
- ☐ Other

_____

How many years have you been in your position?

What is your current place of work?

Have you worked in other countries for more than a year? If so, which?

_____

What is your year of birth (e.g., 1983)?

_____

With which gender do you identify?

- ☐ Female
- ☐ Male
- ☐ non-binary
- ☐ Prefer not to say

Thank you for contributing to this second round! Please provide your e-mail address, so we can share the results with you:
[textfield]

As a next step, we plan doing a workshop. Would you be interested in a workshop to discuss the survey results?

a. Yes
b. No, it is enough to receive the results

If you have any questions, please contact lorena.kuratle@sed.ethz.ch

By clicking “Continue”, you will be forwarded to the last page and your answers will be saved.

Results – round 2

A shared definition of AI

Table DS 2.1: Answers to the question: The definition entails three major elements. For each of these we are interested in what you think: To what extent do you agree or disagree with the adjusted definition?

	Do not agree at all	Do not agree	Neutral	Agree	Fully agree
AI models are simulations or imitations of the human intelligence which are trained with data and are able to analyze, interpret and learn.	0	0	0.286	0.286	0.429
AI models will make disaster risk reduction more efficient, robust and more adequate.	0	0.143	0.286	0.286	0.286
AI in seismology has a high potential in multiple research areas, specifically for more efficient data processing and data analysis for forecasting, rapid impact assessment, but according to experts in the field, the potential should not be overestimated.	0	0.429	0.286	0.286	0

Table DS 2.2: Answers to the question: Do you have anything you would add or cross out of this proposed definition?

ID 1	I'm very unsure about the will ... I think AI models won't do anything by themselves for now, we as researchers, practitionners or society have to decide what AI will do. Also nothing is certain AI models could make disaster
ID 2	I would not say AI models are imitations of human intelligence. They are built to based on principles we see in human brains, and their goal is to produce something that a human could produce, but there is no ambition to simulate actual processes that happen in humans.
ID 3	
ID 4	
ID 5	
ID 6	
ID 7	I have an issue still with linking AI to 'simulating/imitating human intelligence' - I am not an expert in human intelligence, but I believe that what exactly that is is still debated... therefore I would rather describe AI as computational implementations of models of learning / reasoning / concluding that are shaped after current understanding of neural (brain) networks. (or so...)

The adapted framework

Table DS 2.3: Answers to the question: What are your overall impressions of this adapted framework (e.g., what improved or what should be improved, what could be left out)?

ID 1	This is much more complete !
ID 2	I very much like the concept of defining the pillars through questions, and providing metrics. The participation part in usability is in my view not necessary because it is covered by the other categories already. I find the case study metrics a bit disturbing - one case study may show very different results than another case study, so the selection of the case has a huge impact. Something less arbitrary would be preferable.
ID 3	It seems a fairly complete and well-designed framework to me.
ID 4	The adapted framework looks much more enhanced and informative. It describes clearly all the aspects of the technology.
ID 5	The framework is good and useful, with some minor issues.
ID 6	Usability should also reflect explainability.
ID 7	Functionality - Sustainability: maybe an issue of wording, but for me the 'sustainability' of a technology (technological implementation of a method, e.g. AI application in the earthquake impact assessment) has not mucht to do with 'contribution to sustainable development' of society, but with the feasibility to continue operating the technology under a given (resource) framework (e.g. address maintenance, renewal, obsolescence,...) Usability - user friendliness: the 'without previous experience' is irritating. There is a reason for experts to exist (and being experts with experience) - claiming that 'anything' should be usable without previous experience is weird... (think of a new method for brain surgery...) Societal dimenison - Accessibility: a bit linked to the 'user friendliness' - shouldn't it be more that 'everybody' should have access to the benefits of the use of the new technology (rather than the 'new technology' itself)? It may well be that it still needs specific experts to 'operate' the technology - just because of its complexity, but then the outcomes (benefits) should be accessible to all?

Table DS 2.4: Answers to the question: More specifically, do you think the names of the three pillars are clearer now through the change from technological, practical and social potential to functionality, usability and
societal dimension?

ID 1	yes
ID 2	yes, much clearer
ID 3	Yes, I think so.
ID 4	The names of the pillars seems much more clearer now. The names exactly represents the content of the pillar, unlike the previous names which were a bit ambiguous.
ID 5	No, I think they are more confusing now. The words functionality and usability can be considered synonyms in some contexts, so they are confusing currently.
ID 6	Yes
ID 7	doesn't matter too much - the content counts... but perhaps the new names are a bit more clear now.

Table DS 2.5: Answers to the question: *Do you think this adapted framework covers the above formulated goals, i.e. to guide researchers, developers, and stakeholders to reflect on the societal relevance and possible consequences of an emerging technology in a structured way? If yes, why? If no, why?*

ID 1	Yes, but something to consider maybe is also the links between the three dimensions
ID 2	overall, yes, but it is not fully clear to me how the framework shold be used. will it be published somewhere and then everyone can interpret it as they want? or will there be an expert group which assesses different technologies based on the framework? in the former case, I believe there should be a bit more guidance on how these metrics have to be used, what they imply, and what to do after a technology has been evaluated based on the framework.
ID 3	Yes, I think gathering the major topics of risk analysis for the applicability of AI in this manner can provide a quantitative manner to assess the impact of new technology.
ID 4	Yes, the adapted framework covers all goals.
ID 5	Yes, because not having a standardized framework leads to researchers often missing some of the aspects needed. With a standardized framework, the researchers have a checklist to go through.
ID 6	Partially.
ID 7	It is a good start for 'reflection' - but it leaves still a lot of questions open (maybe not a bad thing). Probably it depends also on the starting point of the individual interactor.

Table DS 2.6: What is your impression of the pillar functionality? Are there missing or overlapping categories? Is there anything too much here that can be deleted?

ID 1	Maybe the ecological dimension should be even more emphasized to make sure it is truly taken into account especially as AI often requires a lot of calculation and therefore ...of energy.
ID 2	no, all good.
ID 3	Functionality seems reasonable
ID 4	Functionality pillar seems good. All the categories are considerable except Transferability and replicability, which is described as whether the performance of a technology is reliable , which I think is not suitable explanation. The suitable explanation should be if the technology is can be transferred or replicated for different use cases. Also, the reliability of the technology can be added as a separate category in Usability pillar. Or can be merged with Acceptance and trust.
ID 5	The Sustainability and the Compliance categories can be merged, as Compliance can be understood as a form of social Sustainability.
ID 6	OK
ID 7	I guess I answered that already in the first field. Not sure if best in this pillar, but maybe the aspect of 'relevance' of a new technology (compared to what is already available, what are the benefits (vs. costs) of going the 'new way') could be added. Or perhaps 'relevance' is then the sum of everything?

Table DS 2.7: Answers to the question: What is your impression of the pillar usability? Are there missing or overlapping categories? Is there anything too much here that can be deleted?

ID 1	Maybe strenghten more the role of users in this category, they should be included in the dvpt process as their opinion and feedback matter
ID 2	as I said above, the participation part in usability is in my view not necessary because it is covered by the other categories already.
ID 3	I believe that Participation and Accessibility are somewhat redundant.
ID 4	Usability pillar seems good.
ID 5	This pillar is good.
ID 6	There should be consideration of explainability of outputs.
ID 7	see above.

Table DS 2.8: Answers to the question: *What is your impression of the pillar societal dimension? Are there missing or overlapping categories? Is there anything too much here that can be deleted?*

ID 1	Overall i wonder if case studies are metrics or methods to obtain a metric... (but I'm not too sure of what should be the metrics then)
ID 2	no, all good.
ID 3	I believe that Participation and Accessibility are somewhat redundant.
ID 4	Societal dimension pillar seems good.
ID 5	There should be an Error robustness category, which would describe how robust society is to errors in the algorithm predictions (e.g. what is the societal cost of the algorithm producing false alarms).
ID 6	OK
ID 7	see above. further - the current categories are largely focused on negative dimensions, the only one that seems to look (also) at positive effects of a technology for society is the 'societal implication', and that is very general. Maybe make more room for looking specifically at the potential of a technology to have a positive impact on societal issues / development of societiy?

Sociodemographics

Figure DS 2.1: Answers to the question: How much expertise do you have on AI in seismology?

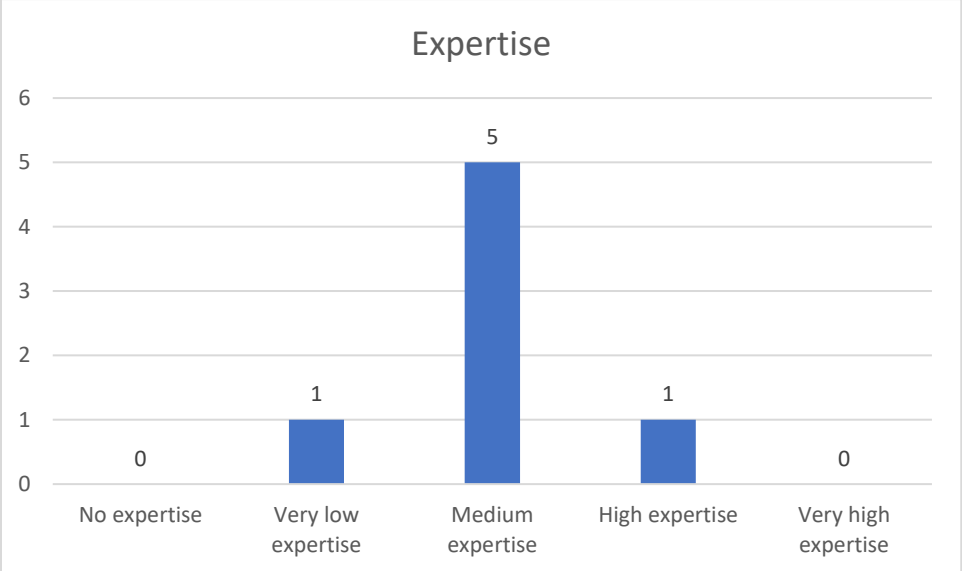


Figure DS 2.2: Answers to the question: *What is your specific research focus?*

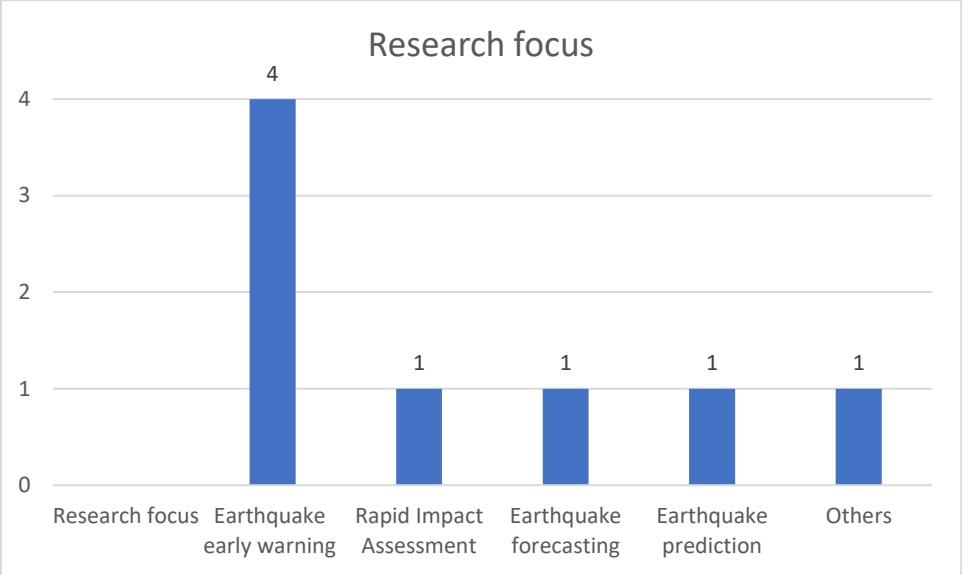


Table DS 2.9: Answer to the question: How many years have you been in your position?

ID 1	6
ID 2	3.5
ID 3	2.5
ID 4	1
ID 5	1
ID 6	20
ID 7	15

Table DS 2.10: What is your current place of work (country)?

ID 1	france
ID 2	Switzerland
ID 3	United States
ID 4	United Kingdom
ID 5	Switzerland
ID 6	UK
ID 7	Switzerland

Table DS 2.11: What is your year of birth?

ID 1	1990
ID 2	1992
ID 3	1988
ID 4	1994
ID 5	1992
ID 6	1962
ID 7	1967

Answers to the question: With which gender do you identify?

2 female, 5 male