RESILIAGE
Revolutionising community resilience

D2.2

Report on risk adaptation, risk awareness & threat reaction

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Main Author(s)	Aude Naud (UNIMES), Margaux Fenard (UNIMES), Oscar Navarro (UNIMES)
Contributor(s)	Veronika Takacs (DBL), Leonie Stieren (DBL)
Reviewer(s)	Esra Demir (DEMIR), Raquel Pinheiro (ENB), Anastasia Koumoula (Advisory Board member)

Revision History

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0.1	18/11/2024	POLITO, VICESSE, DBL, SINTEF	ToC structure
0.2	10/12/2024	DBL	DBL contribution added
0.3	28/01/2025	DEMIR, ENB, Advisory Board member, VICESSE	Review
1.0	17/02/2025	UNIMES	Final report

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Table of Abbreviations and Acronyms

Abbreviation	Meaning
CNH	Cultural Natural Heritage
CORE lab	Community Resilience laboratory
ENB	Escola Nacional de Bombeiros
F-A	Famenne-Ardenne Geopark CORE lab
FR	First Responders
ILT	Illustration and Text
IO	Icons only
IT	Icons and Text
LL	Lesson Learned
NPC	Non-Player Character
PP	Preparedness Plans
PTG	Post-traumatic Growth
PTSD	Post-traumatic Stress Disorder
RAISE tool	Resilience Assessment Interactive Self-Enabler tool
TRC	Trondheim Red Cross CORE lab
UoC-NHMC	University of Crete – Natural History Museum of Crete CORE lab
VR	Virtual Reality

1. Executive Summary

Deliverable D2.2, 'Report on risk adaptation, risk awareness & threat reaction', is based on the work carried out from December 2023 to February 2025 as part of T2.3 (Investigating risk adaptation through temporal dimension (pre/post- crisis)) and T2.4 (Risk awareness & threat reaction simulation) of the RESILIAGE project.

This deliverable is a major contribution to WP2 in terms of individual relationship to natural disaster risk. This WP mainly contributes to conceptualizing Community Resilience guiding the implementation of the project. It follows on from WP1, which took stock of knowledge on community resilience and natural disaster management based on international standards and policies and pre-existing scientific literature. WP2 then aims to collect contextualized data within the framework of the RESILIAGE project, using different approaches, both qualitative and quantitative, in order to be able to conceptualize community resilience and measure it using indicators developed within the framework of this project (T2.5).

This deliverable is the result of extensive work both in person in the field and through online surveys, and therefore required considerable coordination in view of the richness and variety of the studies carried out. T2.3 and T2.4 aim more specifically to understand the individual human factors of resilience to natural disasters through two approaches. The first is to address the issue of resilience from a temporal approach by studying risk communication in the pre-crisis phase and the psychological impacts of past experiences of natural disasters in the post-crisis phase. The second approach tackles the issue of risk perception and protective behaviour in a more concrete way through visual prevention campaigns and virtual reality (VR) simulations.

This deliverable is therefore anchored in the bottom-up approach of the RESILIAGE project by offering, upstream of the development and improvement of tools, solutions and PP by the following tasks, knowledge specific to the RESILIAGE five Community Resilience laboratories (CORE labs) enabling the future developments of the RESILIAGE project to be tailored as closely as possible to local needs and issues. Furthermore, innovative approaches using technological tools such as eye-tracking and VR will enable us to go further than most of the literature on adaptation to natural disasters currently offers. The data collected in this way is intended not only to feed into some of the project's digital tools, but also to supplement the knowledge base to support future tasks and work packages.

This deliverable also includes the results of T4.1 that could not be included in deliverable D4.1, concerning the four CORE labs namely: Naturtejo Geopark, Karsiyaka Municipality, Trondheim Red Cross and University of Crete - Natural History Museum of Crete.

2. Introduction

2.1. Aims and report structure

The aim of the RESILIAGE project is to provide a systemic and holistic understanding of community resilience to natural disaster risk, integrating heritage as a vector of resilience. This objective requires understanding and conceptualising community resilience (OBJ2), which is the main objective of WP2. T2.3 and 2.4 contribute more specifically to investigating human factors in risk adaptation and modelling qualitative behavioural aspects into quantitative indicators. The data collected by four different studies implemented in the CORE labs, two surveys (online) and two experiments (on field), contribute to these objectives. These data will also feed the different tools developed by the project and their analyses constitute a source of LL and recommendations to help designing digital tools, soft solutions, PP and validation activities throughout the project.

The report is divided into the following chapters:

- Section 1 – "Executive summary" describes the main objectives and the content of this deliverable;
- Section 2 – "Introduction" describes the structure of the deliverable and the relations to other activities in the project;
- Section 3 – "Methodology" describes the methodology of the four studies of T2.3 and T2.4;
- Section 4 – "CORE Reports" describes the results from the four studies of T2.3 and T2.4, as well as results from T4.1 concerning four CORE labs (Naturtejo Geopark, Trondheim Red Cross, University of Crete-Natural History Museum of Crete, Karsiyaka Municipality);
- Section 5 – "Conclusion and next steps" provides a global conclusion of the insights provided by T2.3 and T2.4 efforts and links those with the next steps of RESILIAGE project;
- Section 6 – "References" provides references evoked in this deliverable
- Section 7 – "Appendix" provides the annexes of the deliverable, including ethical documents for empirical investigation, methodological guidelines, LL inventory from T2.3 and T2.4 studies and a glossary of psychological terms.

2.2. Relations to other activities in the project

Relations to other activities in RESILIAGE project are represented in Figure 1. First of all, both tasks are fed by T1.2 as a knowledge baseline, allowing to design the study taking into account previous work on these topics. T3.2 Resilience Assessment Interactive Self-Enabler (RAISE) tool constitutes a media to host and spread the T2.4 longitudinal survey among CORE labs population. But the RAISE tool itself includes a questionnaire assessing people's perception of and preparedness for the risk of natural disasters, as well as past experience. This tool is therefore also a resource in the design of the longitudinal survey questionnaire, some of whose variables are common. T2.4 aims to evaluate the psychological and behavioural impacts of disaster risk awareness campaigns in order to advise T4.3 on the design of new and CORE lab specific

awareness campaigns. The partners of this task therefore identified pre-existing campaigns that we were able to test in our study.

T2.3 and T2.4 contributes to several tasks and WP of the project by providing data and knowledge from the field, in particular through LL and recommendations. Both tasks contribute to WP3 helping to develop some of the digital tools:

- Data will feed T3.3 Atlas
- LL will feed the Decision Support System developed in T3.3
- The design of the longitudinal survey questionnaire contributes the RAISE tool one (T3.2).

Virtual Reality (VR) simulations designed in T2.4 also constitutes a basis to develop with WP3 partners an educational simulation of wildfire to be spread among civil population. Both tasks also contribute to WP4 and WP6 helping to develop soft solutions and to improve Preparedness Planning (PP) by providing LL and recommendations about risk communication, trust in institutions, risk perception, risk preparedness, reactions to threats.

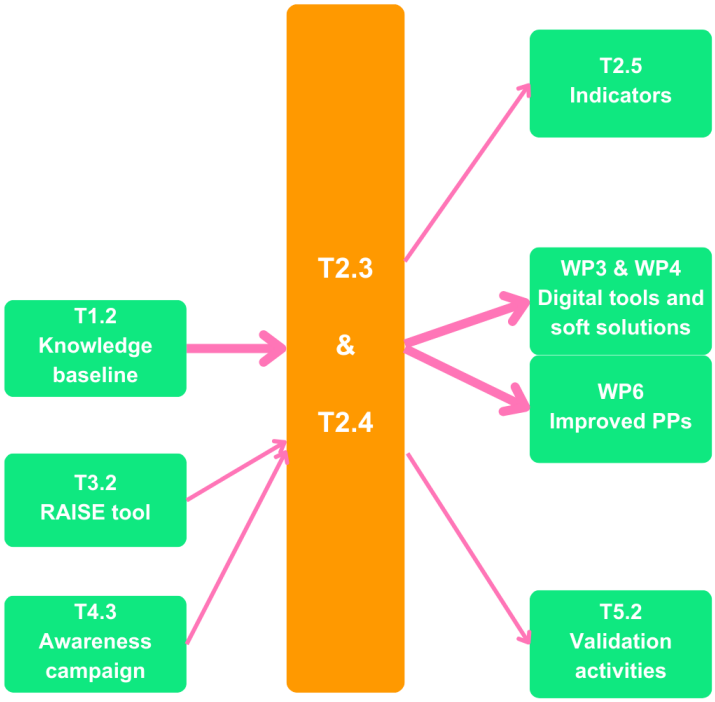

Figure 1: Workflow of T2.3 and T2.4 in RESILIAGE project

The table 1 represents the contribution of different RESILIAGE partners regarding the four studies of T2.3 and T2.4 and D2.2.

POLITO	Coordinator of the project Integration of longitudinal survey on RAISE tool

	Design of longitudinal survey questionnaire
VICESSE	WP leader
DBL	Co-design of surveys and eye-tracking experiments Co-author of D2.2
SINTEF	Facilitator of TRC CORE lab (translation, identification of communication media to be tested, recruitment of participants)
DEMIR	Facilitator of Karsiyaka Municipality CORE lab (translation, identification of communication media to be tested) and Reviewer
ENB	Facilitator of Naturtejo Geopark CORE lab (translation, identification of communication media to be tested) Reviewer
LOBA	Design of studies communication for participants recruitment
All the CORE labs	Translation, identification of communication media to be tested, organisation of field studies, recruitment of participants
VEXIZA	Integration of longitudinal survey on RAISE tool Design of longitudinal survey questionnaire

Table 1: Contributions of partners

3. Methodology

The objective of the empirical research of T2.3 and T2.4 is to better understand human factors in risks adaptation, by studying cognitive, affective and behavioural dimensions of exposure to the risk of natural disaster. Taking into account the different types of actors including citizens, FR and local authorities, this task aims to investigate risk adaptation through temporal dimension (pre-/post-crisis) and to understand how to promote risk awareness, and what are the reactions to threat to then be able to prevent maladaptation. The expected outcomes are LL and recommendations on:

- how to communicate the risk of natural disasters to the public,
- experiences of past disasters and how these impact not only psychological health but also people's relationship to risk,
- people's reactions to natural disasters and their implications in terms of disaster management strategies.

To achieve this, four studies are being carried out as part of these two tasks, two online surveys and two field experiments, represented on Figure 2. The first experiment (T2.3) aims to investigate risk communication on pre-crisis phase, studying the impact of different types of communication media on risk perception and behaviour thanks to an eye-tracking device and questionnaires. Then, an online cross-sectional survey (T2.3) aims to investigates post-crisis phase by studying psychological impacts of previous disasters. A second survey (T2.4) consists in the implementation of an online longitudinal survey aiming to understand the impacts of risk awareness campaigns on risk perception

and preparedness. Finally, a second experiment (T2.4) simulates natural disasters situations through VR allowing to understand psychological, physiological and behavioural reactions influenced by physical and social characteristics of the environment.

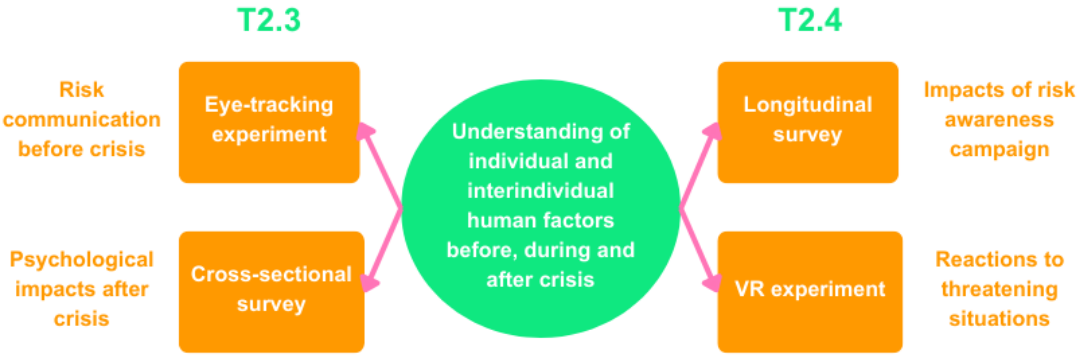

Figure 2: Structuration of T2.3 and T2.4 studies

The timetable of these studies is presented in table 2.

	Cross-sectional survey	Eye-tracking experiment	Longitudinal survey	VR experiment
F-A	Apr 22nd to Jul 31s, 2024	Apr 1st to Apr 14th, 2024	Dec 12th to January 29th, 2024	Apr 1st to Apr 14th, 2024
Naturtejo Geopark	Apr 22nd to Jul 31st, 2024	Apr 22nd to Apr 28th, 2024	Dec 12th to January 29th, 2024	
Karşiyaka	Apr 22nd to Jul 31st, 2024	July 8th to July 12th, 2024		
UoC	May 3rd to July 31st, 2024	May 20th to Jun 1st, 2024		
TRC	Apr 22nd to Jul 31st, 2024	Jun 10th to Jun 22nd, 2024	Dec 12th to January 29th, 2024	Jun 10th to Jun 22nd, 2024

Table 2: Timetable of T2.3 and T2.4 studies

3.1. T2.3 studies methodology

The probability that an event becomes threatening and disruptive depends on the characteristics of the event itself, but also on the way in which it is perceived by individuals. Risk perception is the subjective way to take into account a set of conditions and information and leads to judgments about the dangerousness of the events in question thanks to heuristics. Unfortunately, these heuristic treatments of information are also a source of cognitive biases. We can therefore understand the importance of

effective communication to re-establish a form of objectivity regarding the risks incurred by a population. In addition, natural disasters can be traumatic events with significant negative consequences for people's mental health. The aim of this project is therefore to determine the best way of communicating visually about the risk of natural disasters in each CORE lab, in order to make recommendations to the RESILIAGE project partners, and to determine the psychological consequences of past disasters, in order to adapt risk management and care for the mental health of victims accordingly.

3.1.1. Eye-tracking experiment

3.1.1.1. Study framework and objectives

The aim of the eye-tracking experiment is to study the impact of different types of visual communication on risk perception and preparedness. The study covers the entire population of each CORE lab, including FRs, political decision-makers and the general public. The aim was to obtain 25 participants per CORE lab. This study was carried out with the collaboration of DBL, T4.1 leader, which aimed in particular to determine the communication needs of each CORE lab. The results will then be used to adapt the communication campaigns developed as part of T4.3 and T7.2.

3.1.1.2. Tools and data collection

Based on pre-existing natural disaster risk communication materials, we have developed 3 materials for each of the CORE labs, focusing on each one's main risk: flooding for F-A, wildfire for Naturtejo Geopark, landslide for TRC, earthquake for UoC, and heatwave for Karsiyaka. These materials represent 10 behaviours to adopt in a disaster situation and a QR code redirecting users to an information website. 4 behaviours were identical between CORE labs:

- Stay informed and follow the instructions given by the emergency services and your local council;
- Contact vulnerable and isolated people preferably by text message;
- Prepare an emergency kit containing water, food, copies of identity paper; medical treatment etc. And keep it in an easily accessible place;
- I note down the useful numbers.

Three media were developed by CORE lab because they varied according to the density of information: one infographic presents the behaviours using only homogeneous icons with no text (Icons Only – IO), another is similar but offers a small text for each behaviour (Icons and Text – IT), and a third illustrates the behaviours in greater detail with the same text (Illustrations and Text – ILT). Examples for Famenne-Ardenne (F-A) are presented in Figure 3.

Figure 3: infographics tested in F-A (from the left to the right): IO, IT, ILT

To understand how people observed and interpreted information on the different infographics, eyes movements were recorded thanks to an eye-tracking device. This tool measures the number of fixations, and the average time spent on each infographic per participant. Finally, the tool helps us to understand how infographics guide visual attention. These data were analysed by statistical analysis but can also provide visuals (gaze heatmaps, and video recordings of gaze path) that will feed T3.3 Atlas (Figure ...).

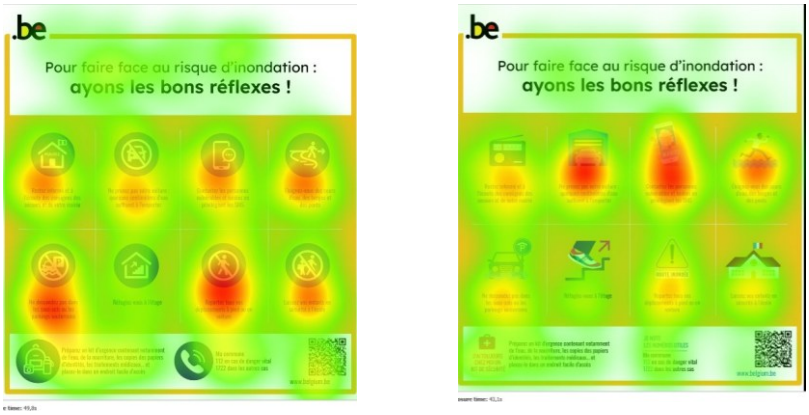

Figure 4: Examples of heatmaps representing visual attention on two different infographics (IT and ILT)

To facilitate the interpretation of eye-tracking data, and to better understand the impacts of visual communication, a questionnaire was proposed before and after the observation to evaluate the impact of visual communication on risk perception, affects, and behaviour. The questionnaire before the observation measured risk perception with the CEFRES (Lemée et al., 2018), measuring coastal risk perception but adapted to the main disaster in each CORE lab, and including four dimensions: risk knowledge, dread, lack of knowledge and collective vulnerability. This questionnaire also evaluated the positive and negative affects with the MAVA scale (Congard et al., 2011). The questionnaire after observation evaluated the same variables, but also coping strategies to face natural disasters, to evaluate if and how risk perception and affects influence the way people face disasters.

3.1.1.3. Sample

The sample per CORE lab is described in Table 3. It can be seen that the target of 25 participants per CORE lab was met for one of the CORE labs, but that the number of participants was particularly low for the F-A and UoC CORE labs. The limited sample size in those two CORE labs particularly reduces the generalizability of findings, as well as the statistical power of the analysis. Future studies should aim for larger sample sizes to confirm these preliminary results. It should also be noted that participants in the Naturtejo Geopark CORE lab are older on average, which nevertheless reflects the overall local population.

CORE lab	N. of participants	Women	Men	Other	Age (mean (SD))
F-A	8	2	6	0	41.13 (12.34)
UoC	11	7	4	0	48.56 (4.72)
TRC	33	16	17	0	44.36 (11.97)
Naturtejo Geopark	20	8	9	3	66.40 (3.82)
Karsiyaka	21	15	6	0	42.9 (9.66)
Total	**93**	**48**	**42**	**3**	**48.86 (12.62)**

Table 3: Sample by CORE lab

3.1.2. Cross-sectional survey

3.1.2.1. Study framework and objectives

The objective of this cross-sectional survey is to understand the individual post-disaster experience, by studying the psychological impacts of natural disasters in the 5 CORE labs. One of the main aims of the study is to identify the consequences of past disasters on the mental health of the various players in a community. Identifying the psychological vulnerabilities of community members, as well as their relationship to risk in terms of perception or trust in institutions, provides a baseline of the individual dimension of vulnerability to natural disasters, enabling the project's subsequent tasks to adapt their activities, tools and solutions accordingly (PP, soft solutions, digital solutions, etc.). In terms of participants, the objective was to collect data from at least 25 participants per CORE lab.

3.1.2.2. Tools and data collection

The survey consisted on an online questionnaire hosted by Qualtrics. The questionnaire has been created in collaboration with DBL, T4.1 leader in charge of evaluating needs of key actors (local authorities, FRs, citizens) in terms of knowledge, information and training as well as use of communication channels. To distribute the online questionnaire to the five CORE labs population, LOBA created visuals for various social networks and emails that the CORE labs shared. The CORE labs and the

facilitators (ENB, DEMIR) helped to improve and translate the questionnaire into the five languages.

The questionnaire evaluated the following variables:

- The risk perception was evaluated on a scale from 1 to 5, asking for 10 kinds of natural disasters to what extent participants consider them a threat for themselves, for human beings in general and for nature.
- Past experiences were evaluated distinguishing direct experience (direct victims) or indirect experience of natural disasters (relatives as victims)
- Post-traumatic Stress Disorder (PTSD) was evaluated by a validated scale (Weathers et al., 2013) to measure psychological negative impacts of experiencing a natural disaster, and Post-traumatic Growth (PTG) was evaluated by Tedeschi & Calhoun (1996) scale to measure psychological resilience.
- Trust in institutions was measured by assessing trust in twelve different institutions to manage natural disasters, and the reliability of these institutions as a source of information.

3.1.2.3. Sample

The sample of the cross-sectional survey is described in Table 4. The limited sample size in Naturtejo Geopark and Karsiyaka CORE labs particularly reduces the generalizability of findings, as well as the statistical power of the analysis. Future studies should aim for larger sample sizes to confirm these preliminary results. We note that the Naturtejo Geopark and Karsiyaka samples include a high number of women rather than men, and that the vast majority of participants in each CORE lab are citizens, with relatively few representatives of local authorities, RFs or volunteers.

	Women	Men	Other	Age (mean (SD))	Citizens	Local authorities	FRs	Volunteers
F-A	28	24		49 (10)	40	2	3	7
Naturtejo Geopark	16	4	1	43,62 (14,40)	20	1	0	0
TRC	23	17	1	48.17 (11.42)	18	4	3	16
UoC	39	24		49,45 (8,34)	42	5	2	14
Karsiyaka	23	4	0	37,59 (8,90)	16	7	0	4
TOTAL	129	73	2	47,36 (10,69)	136	19	8	41

Table 4: cross-sectional survey sample

3.2. Methodology of T2.4

As mentioned above, risk communication is one of the central aspects of the solutions proposed by the RESILIAGE project. But it's not just a question of developing effective communication media, but also of ensuring that they are effective over the long term. Moreover, adapting behaviour to a catastrophic situation helps reduce vulnerability and prevent a situation of deadly collective panic. This is all more true during sudden and unforeseen disasters for which crisis management personnel cannot be deployed on the ground before the event occurs. It is indeed important to study the reactions and decisions taken before and during crisis situations, through the simulation of these.

3.2.1. Longitudinal survey

3.2.1.1. Study framework and objectives

Through its bottom-up approach, the RESILIAGE project aims to include and involve citizens in natural disaster risk management in order to promote community resilience at all levels. Taking responsibility for one's own safety means adopting disaster-preparedness behaviours. A number of tools and solutions to promote community resilience are being developed as part of this project. One of these, the awareness campaigns, aims to increase people's perception of the risk of natural disasters and encourage them to adopt appropriate behaviour. These campaigns are being developed as part of T4.3. In order to help the partners in this task to develop campaigns that are relevant and appropriate to the different CORE lab, this study aims to determine the extent to which pre-existing video awareness campaigns influence risk perception and preparedness, as well as other associated variables (affects, sense of control). T4.3 partners will be able to draw on the results and recommendations of this study to design relevant campaigns.

3.2.1.2. Tools and data collection

In order to study the impact of prevention campaigns on risk perception and preparedness behaviour, a longitudinal online questionnaire survey was designed to measure changes in these different variables before, just after and several weeks after viewing prevention video campaigns. The timetable for distributing the survey was the following:

- 06/12/2024 – 20/12/2024: Phase 1 consisted of distributing the link to the RAISE tool hosting the first questionnaire on the social networks of each CORE lab for 2 weeks in order to obtain as many participants as possible, thanks to several reminders;
- 20/12/2024 – 03/01/2025: Participants of the first phase were contacted by email (collected by the Phase 1 questionnaire) to answer the second phase questionnaire two weeks after their first answer;
- 15/01/2025 – 29/01/2025: Each participant was then contacted again approximately one month after completing the second questionnaire to complete Phase 3.

Various prevention video campaigns were identified in advance by DBL, the T4.3 task leader, for each of the CORE labs. For each CORE lab, these videos focused on the main risk identified as part of the project: flooding for F-A, wildfire for Naturtejo Geopark, earthquake for UoC-NHMC, and heat wave for Karsiyaka Municipality. No video campaign could be identified for landslides in Norway. A video on the preparation of an emergency kit was therefore selected. Each video was selected so that it presented behaviours to adopt or avoid in the disaster preparation or response phase. The length of the video was also an important criterion, since the aim was to offer participants a short video to avoid making the protocol too long and to reduce experimental mortality. The total viewing time was therefore set at between 1 minute 30 and 2 minutes.

This survey was distributed to the various CORE labs using the RAISE tool developed by our partners (POLITO, VEXIZA, LOBA) as part of T3.2. The RAISE tool includes a questionnaire enabling users to self-assess their level of risk preparedness. But for the duration of the longitudinal survey, the RAISE tool also hosts the longitudinal survey questionnaire. Certain dimensions are therefore common to the objectives of the RAISE tool and those of T2.4, enabling T2.4 partners to collaborate with T3.2 partners (developing RAISE tool) in the development of each of these two questionnaires (the self-evaluation one, and the longitudinal survey one). Table 5 shows the different variables measured in each phase of the survey. Some were measured or inspired by scientifically validated scales:

- The Brief Positive and Negative Affect Schedule (PANAS) (Boiroux, 2024) Ameasuring the level of positive and negative affects;
- The CEFRES (Lemée et al., 2018);
    - Other variables were created for the purpose: the feeling of control on natural disaster risk, the vulnerability of Cultural Natural Heritage (CNH), the CNH as driver for individual disaster risk preparedness, evaluation of the document (awareness campaign video(s)) features. The complete questionnaires are presented in 14.1. These questionnaires were translated by the 5 CORE labs and the facilitating partners (ENB, DEMIR). The RAISE tool was used to disseminate the survey online via social networks (Facebook, Instagram, LinkedIn) using posts designed by LOBA and distributed to the CORE lab networks. The inclusion criterion was being a resident or user of one of the CORE labs, and the only exclusion criterion was being a minor (in which case the questionnaire was interrupted). The timing of the survey could not be the same for all the CORE labs. Indeed, the launch of the survey at UoC-NHMC was awaiting validation by the University of Crete's ethics committee at the time of the launch, while Karsiyaka Municipality's schedule of activities was not compatible with this launch period. The results from these two CORE labs will therefore be presented in a later deliverable (5.2).

Phase 1	Phase 2	Phase 3
Socio-demographic characteristics	/	/
Positive and Negative affects	Positive and Negative affects	Positive and Negative affects
Risk perception	Risk perception	Risk perception
Feeling of control	Feeling of control	Feeling of control
CNH as driver for preparedness	/	/
Previous experiences	/	/
Response capabilities	Response capabilities	Response capabilities
Vulnerability of CNH	/	/
/	Document features	/

Table 5: Variables measured by the longitudinal survey

3.2.1.3. Sample

A total of 37 participants responded to the longitudinal survey, including 6 participants from Naturtejo Geopark, 12 from TRC and 19 from F-A. The target was 25 participants per CORE lab, so this objective was not fully met. This low number of participants can be explained by several factors, which are discussed in the 'Challenges of the methodology' section. Table 6 escribes the characteristics of the sample for each CORE lab. The limited sample size particularly reduces the generalizability of findings, as well as the statistical power of the analysis. Future studies should aim for larger sample sizes to confirm these preliminary results.

	Gender (% of CORE lab population)			Age (m (SD))	Status (% of CORE lab population)				
	Men	*Women*	*Prefer not to say*		*Citizens & civil society*	*FRs*	*Knowledge organisations*	*Decision or policy makers*	*Other*
F-A (N=19)	31,6%	63,16%	5,26%	32,83 (12,27)	63,16%	0%	10,53%	5,26%	21,05%
Naturtejo Geopark (N=6)	0%	83,33%	16,67%	47,84 (13,26)	83,33%	0%	16,67%	0%	0%
TRC (N=12)	66,67	33,33%	0%	49,58 (10,11)	33,33%	41,67%	25%	0%	0%

Table 6: description of the sample of the longitudinal survey

3.2.2. Virtual Reality experiment

3.2.2.1. Study framework and objectives

The community resilience that the RESILIAGE project aims to encourage involves, in particular, appropriate reactions and decisions on the part of individuals in natural disaster situations. Various projects within the framework of this project will make it possible to encourage individuals to react appropriately, in particular by improving PP (WP6) or through prevention campaigns or training (WP4). However, in order to develop these different tools, it is first necessary to understand how individuals react in natural disaster situations in order to anticipate inappropriate behaviour and guide decisions towards appropriate behaviour. The aim of this study is to understand the reactions of individuals in two different threat situations, simulated in virtual reality (VR): a flood situation and a wildfire situation. As the experimental protocol is complex and the development of the virtual environments time-consuming, this experiment was only carried out in two CORE labs: the flood simulation for F-A and the wildfire simulation for TRC. Flood is the main risk considered by RESILIAGE project in F-A. Regarding TRC, we were unable to develop a landslide virtual environment (main risk for this CORE lab) because this type of phenomenon was too complex to model in the time available to us and there were too few visual references. We therefore chose to simulate one of the secondary risks of this CORE lab, wildfire (which is also a major risk in the other CORE labs, so we feel it is relevant in terms of potential re-use of the material developed).

3.2.2.2. Tools and data collection

Before starting the natural disaster simulation, participants are immersed in a familiarization environment to get used to VR and to learn how to use the controller to move around. After a few minutes, once the participants are comfortable, they are immersed in one of the natural disaster simulations.

First of all, the flood simulation represents a shopping street in an urban environment (Figure 5). The participant begins the simulation sitting on the terrace of a fast-food restaurant and gets the following instructions. “You're sitting on the terrace of a fast-food restaurant. The street is made up of different shop windows. At the end of the street, to your right, is an emergency staircase for climbing to the top of the buildings”. The flooding begins, and the participant can then choose to stay in the street (‘maladaptive decision’), enter the restaurant which is on the ground floor (‘maladaptive decision’), or climb to the top of the outside fire escape of one of the buildings in the street (‘adaptive decision’).

Figure 5: Screenshots of the flood simulation in VR: (from the left to the right) the rain starts to fall, Non-Player Characters (NPC) are leaving to safe location, the street is flooded.

The wildfire simulation represents a hiking trail through a forest (Figure 6). The participant begins the simulation sitting on a bench, after hearing the following instruction: 'You have come to this place by car to go hiking, but after walking you are tired and have decided to rest on a bench'. The bench faces the path and the forest. The path descends to the right towards the forest and the car park (indicated by a sign opposite the bench). The same path climbs to the left, away from the forest and the car park. The fire comes from the right-hand side of the forest, so it's more likely to be in the direction of the car park. So the participant can decide to stay close to the bench (maladaptive decision), to follow the path towards the car park and get closer to the fire (maladaptive decision), to follow the path to the left and get further away from the fire (adaptive decision).

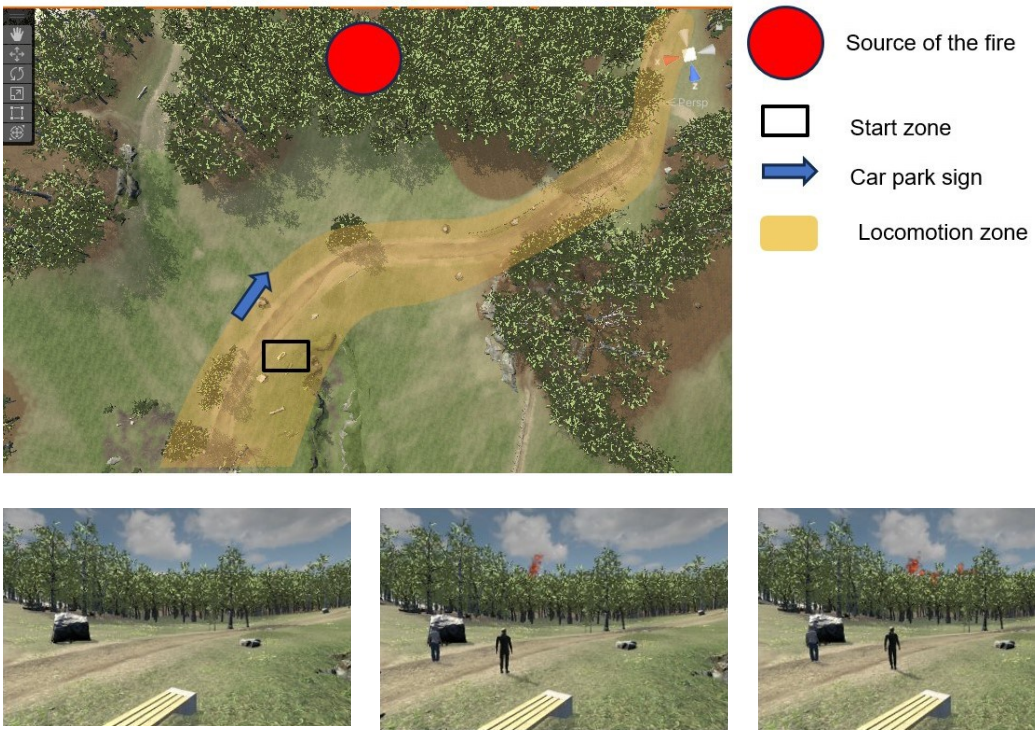

Figure 6: Screenshots of the wildfire simulation in VR: (from the left to the right) the view close to the bench, the fire is visible and Non-Player Characters (NPC) are looking at it, the fire gets bigger.

Each simulation follows a precise timeline with the appearance of different visual or sound stimuli during the simulation, in order to determine the factors influencing the reactions of individuals. The timelines for each simulation are shown in Table 7.

Wildfire simulation		Flood simulation	
Time	**Event**	**Time**	**Event**
T0	Simulation starts	T0	Simulation starts
T0+20sec	Smoke appears	T0+20sec	Water begins to stagnate on the ground
T0+40sec	Fire is visible and ambiant sound (birds) stops	T0+50sec	The water rises
T0+50sec	NPC stops to watch the fire	T0+90sec	The water keep rising and an alert notification appears
T0+80sec	Fire gets bigger	T0+110sec	Water is above knees

T0+110sec	Alert notification	T0+115sec	NPC start evacuating

Table 7: Timeline of the VR disaster simulations.

In order to also determine possible social influences, we created three experimental conditions allowing us to compare reactions as a function of the presence and behaviour of other individuals: a 'control' condition in which the participant is alone, an 'organised' condition in which the participant is in the presence of NPC evacuating the area in a homogeneous manner, and a 'disorganised' condition in which NPC evacuate the area by taking different paths. So, a total of six conditions were created (3 flood conditions, three wildfire conditions). Psychological, physiological and behavioural reactions are measured during the simulation:

- A questionnaire at the end of the experiment provides a better understanding of how the person experienced the situation and what their reactions were (see 14.1);
- State anxiety (Marteau & Bekker, 1992) is measured before and after the simulation to assess the emotional impact of the simulation;
- The feeling of presence (IPQ, Schubert, 2003) is measured after the simulation to control the ecological value of the experimental measures;
- Physiological stress is measured by four indicators: heart rate (bpm/min), electrodermal conductance (µS), respiration (%) and body temperature (°C);
- The participant's gaze was also analysed to identify the visual cues observed.
- Decision-making is measured in three ways:
    - The direction of evacuation, comparing people evacuating by the safe path and people evacuating by the unsafe one;
    - The reaction time, i.e. the moment at which the participant starts to move;
    - Evacuation time in second.

3.2.2.3. Sample

Thirty-eight participants took part in the experiment at TRC, and six at F-A. The target of 30 participants per CORE lab was only partially met. We encountered recruitment difficulties in F-A, which can perhaps be explained by the fact that recruitment was mainly online using social networks and email, which is perhaps not the best solution for this CORE lab. Given the lack of participants, it was decided during the collection period to use posters in local shops, as well as a local TV interview in the local news. Unfortunately, this was not enough to recruit an adequate number of participants. The limited sample size F-A CORE lab (N=6) particularly reduces the generalizability of findings, as well as the statistical power of the analysis. Future studies should aim for larger sample sizes to confirm these preliminary results. The experimental sample is described in Table 8.

Table 8: description of the sample of VR experiment

Gender (% of the sample)	**Age (m (SD))**	***Profession related to disaster management (local government, NGO, medical institution, scientific community, etc.)***

	Men	*Women*		*Yes*	*No*	*Doesn't know*
F-A (N=6)	67%	33%	42,67 (16,91)	17%	83%	0%
TRC (N=38)	58%	42%	41,25 (14,25)	39%	55%	6%

3.3. Challenges of the methodologies

The RESILIAGE project proposes a bottom-up approach to community resilience, with a large amount of data collected in the field, enabling the tools and solutions developed in the project to be adapted to the specific characteristics of each CORE lab. However, this is also a challenge from an organisational point of view, as these various studies represent a major burden for the various CORE labs hosting them. As a result, extensive upstream coordination by the project coordinator, with contributions from all the partners involved in these studies, has made it possible to define a common timetable for the various tasks involved in this work. As these data collections took place in different countries, it was also necessary to translate all the material required for each study beforehand, and sometimes to adapt certain vocabularies or classifications to bring them into line with those of the CORE labs. Communication with the CORE labs was therefore important prior to the fieldwork, both by meeting and by email.

Setting up the experiments and the longitudinal survey required a great deal of upstream preparation, particularly in terms of developing tools and materials. The eye-tracking experiment required us to develop visual communication aids for testing during the study, while the virtual reality experiment required us to develop a total of six simulations (three of a forest fire and three of a flood) in a relatively short space of time.

Another major challenge was recruiting participants. The four studies to be carried out over a relatively short period of time (around a year) and in 2 to 5 different CORE labs represented a major challenge. This involved not only coordinating the various studies, which sometimes overlapped (the two experiments), but also recruiting a large number of participants in what was sometimes a very short space of time (field experiment, first phase of the longitudinal survey). In order to respond as effectively as possible to these constraints, LOBA, as the partner responsible for communicating about the project, made a major contribution to the communications set up to recruit participants, as did the CORE labs, which were responsible for recruiting participants themselves, both face-to-face (experimentation) and online (surveys).

Regarding participation in online surveys, there was also the risk of asking people who were not well connected and not used to using digital tools, particularly in Naturtejo Geopark, where it was known that the rural and older population would be less likely to respond to this type of survey. However, the logistical resources and the short time available to set up this survey meant that it was not possible to offer an alternative to online surveys (e.g. by post or face-to-face).

One of the strengths of this project is the strong connection between the various project activities, enabling close collaboration between the partners and very rich multidisciplinary approaches. However, this strong intertwining between activities is also a risk when the activity schedule is tight, since the slightest delay or difficulty can lead to other difficulties cascading down. This was one of the difficulties encountered in the longitudinal survey, whose duration was limited by the time lag of certain activities on which it depended. This difficulty was resolved by adapting the length of the longitudinal survey and, above all, by adapting the tools on which it was based (awareness campaigns), but it is also undoubtedly what led to the very low take-up of this online survey (developed later in this deliverable). To counter this drawback, the longitudinal survey could again be implemented as part of the validation plan (T5.2) in order to assess the impact of the prevention campaigns developed in T4.3 and 7.2.

Finally, the cross-sectional survey and the eye-tracking experiment were conducted in collaboration with our partner DBL, leader of T4.1. These two studies therefore had to meet different objectives, which although enriching for the questions relating to the two studies also meant that we had to make certain compromises in the construction of the studies so as not to make them too cumbersome.

4. CORE reports

4.1. Risk adaptation through temporal dimension (pre-/post-crisis)

4.1.1. Communicating the risk before the disaster

4.1.1.1. General results

The results suggest that viewing visual communication on preparedness behaviourss increases risk perception (*W*=230*; *z*=-2.77), as it is higher after the observation (m=4.21, SD=0.89) than before (m=4.11, SD=0.92). In addition, we notice that preparedness infographics also facilitates emotional regulation, as both positive (W=4094***; z=8.234) and negative emotions (W=3478***; z=7.877) decrease after the observation. Finally, correlational analyses suggest that risk perception and affect are not enough to prompt individuals to adopt active coping strategies (protective behaviourss or information seeking). In fact, active coping strategies are not correlated with risk perception and/or affect.

Regarding the nature of the infographics and their density of information, the fewer fixations on the IT infographics (*F(*2,88) =6.912**) indicates that the infographics may direct attention more effectively to the relevant elements. On the other hand, the longer fixations on ILT infographics (*F*(2,88) =3.314*) indicates that a more detailed support may require more time to encode the information. But as this infographic is also the one increasing the feeling of risk knowledge *(W*=36.5; *z*=-0.523), the level of details should be defined regarding the objectives of the communication strategy.

4.1.1.2. Recommendations from the results

To create adequate visual awareness campaigns, we can first recommend to communicate about preparedness behaviour as it seems to promote risk perception and

facilitate emotional regulation. Then, the level of details of the visual support has to be defined according to the objectives. If the communication needs to be fast, for example, so that people can understand a message at a glance during an emergency, we recommend to use simple icons to illustrate the message but also to have a brief text to explain them. Indeed, icons without text may require longer cognitive processing because they are more open to interpretation. On the other hand, if there is no time pressure, a more detailed illustration of the message, with explicit details may be more helpful to increase people feeling of knowledge. Finally, we can add that visual communication on preparedness behaviour is effective to increase risk perception, but risk perception is not sufficient enough to male people be more active to face disasters. So visual communication campaign would perhaps benefit from being accompanied by more interactive and engaging exchanges, exercises or training.

4.1.1.3. Analysis of CORE needs (T4.1)

Naturtejo Geopark

According to the results (Figure 7), participants with the IO infographic condition rated their visual content the highest in terms of understandability, relevance and usefulness. Regarding the colours of the visual stimuli, icons with simple texts (2-3 colours) were rated as most attractive, easy to read and capable of conveying the message. For non-Portuguese speakers the solution of icon and simple text was rated as the most helpful one. In case of vulnerable groups specifically, participants of the experiment were suggesting sound aid and/or Braille signs for the ones with problems of eyesight. Moreover, participants also suggested that the preventive measures depicted by the icons should be mandatory to follow up in case of disabled people.

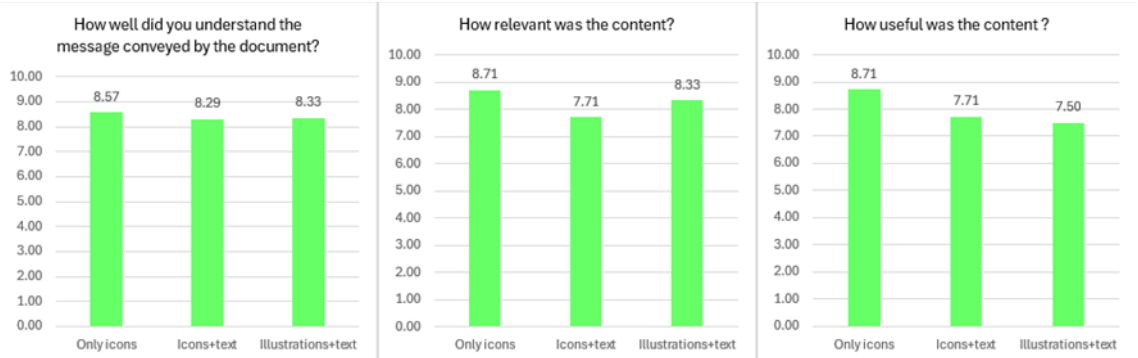

Figure 7: Naturtejo Geopark CORE lab: comparison of the ratings of "only icons", "icons+text", "illustrations+text" condition. Left: How well did you understand the message conveyed by the document? Centre: How relevant was the content? Right: How useful was the content

Karsiyaka

According to the results (Figure 8), visual stimuli related to the ILT infographic condition were rated as the highest in terms of understandability, relevance, usefulness and comprehensiveness for non-Turkish speakers. Related to the colours, single icons with 2-3 colours and a short description were rated as the highest in terms of how easy it was to read them, how much they attracted attention and how well they conveyed the

message. In addition, participants underlined the importance of developing a special sign addressing disabled users or vulnerable groups.

Participants also highlighted the importance of warning signs that should be reconstructed for the visually impaired: audio warning should be added to each of them. Furthermore, warning signs should allow visually impaired individuals to touch them, with special alphabets. One participant suggested the idea of these warning signs functioning as information stalls where citizens can communicate and ask questions, by using a simple keyboard or voice questions.

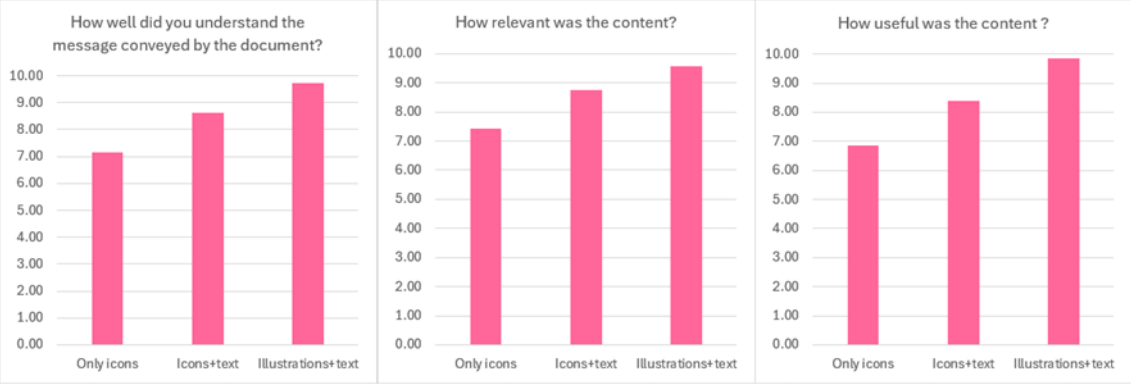

Figure 8: Karsiyaka CORE lab: comparison of the ratings of "only icons", "icons+text", "illustrations+text" condition. Left: How well did you understand the message conveyed by the document? Centre: How relevant was the content? Right: How useful was the content

Crete

According to the results (Figure 9), visual stimuli related to the ILT infographic condition were rated as the highest in terms of understandability, relevance and usefulness, indicating a clear preference for more detailed visual stimuli along with a short description of what they represent. When it comes to the colour design of the stimuli, participants rated the simplest version of the warnings (only icons) as the most eye-catching, the easiest to read and the best solutions to convey the meaning of the warning. IO infographic condition was also rated as the most comprehensible for non-Greek speakers. When asked about further ideas related to how to improve the design of the warning signs, participants highlighted the importance of solutions for disabled individuals, such as the use of Braille alphabet, audio support and colour codes for individuals with colour vision deficiency.

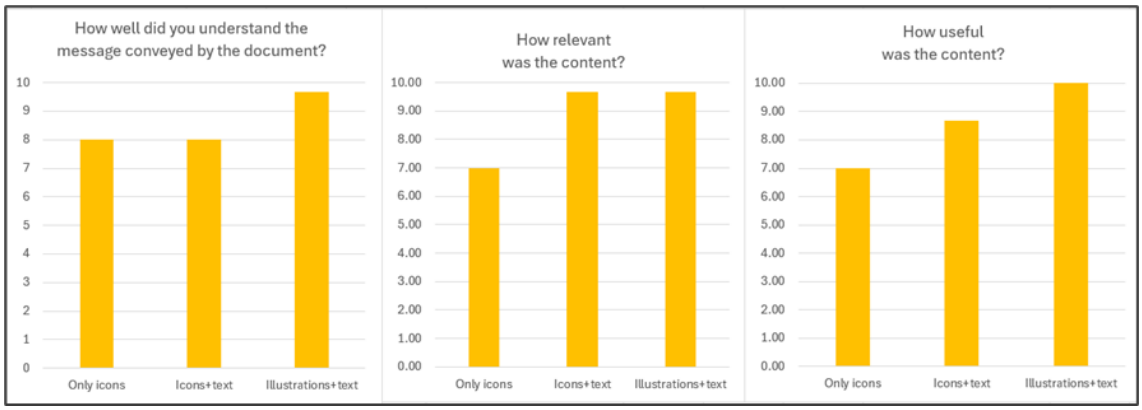

Figure 9: Crete CORE lab: Comparison of the ratings of "only icons", "icons+text", "illustrations+text" condition. Left: How well did you understand the message conveyed by the document? Centre: How relevant was the content? Right: How useful was the content?

Trondheim Red Cross

According to the results (Figure 10), while the visual stimuli of ILT infographic condition were rated as highest in its ability to convey the warning message, respondents rated IT stimuli as the most relevant and useful. On the other hand, illustrations were rated as the highest in terms of the use of colours to attract attention, to convey the message and to make the sign easy to read. Participants rated the visual stimuli of IO as the most comprehensible for individuals who do not speak Norwegian. As potential improvements, participants highlighted the importance of larger and more readable font size, high contrast of colours, larger illustrations, tactile description and sound aid for visually impaired individuals. Moreover, one of the experiment participants shared the exciting idea of assigning a letter to each sign, thus building up a mosaic word which would help citizens to memorize the basic instructions in case of a landslide.

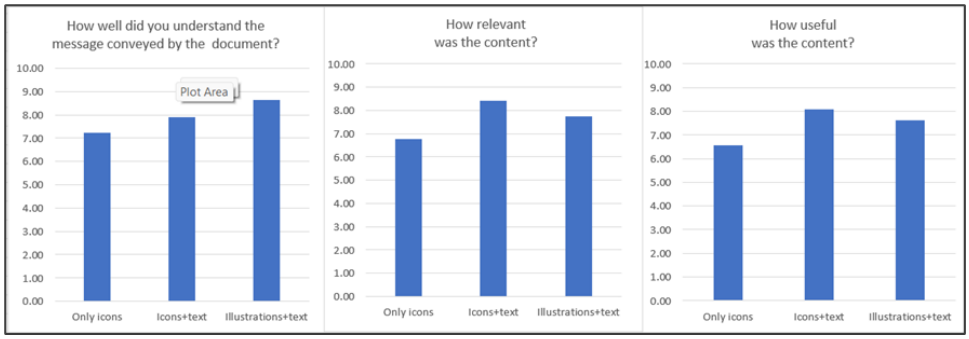

Figure 10: Trondheim CORE lab: comparison of the ratings of "only icons", "icons+text", "illustrations+text" condition. Left: How well did you understand the message conveyed by the document? Centre: How relevant was the content? Right: How useful was the content

4.1.2. Psychological post-disaster impacts and resilience

4.1.2.1. General results

Risk perception

In general, CORE labs participants perceive environmental disasters as more dangerous for humans than for nature ($F(2)=171$; $\eta^2 =0.095$), but also for themselves.

This can be assimilated to comparative optimism (Weinstein 1980): People are more optimist for themselves than for others, which can be an issue in the context of disaster management and preparedness. Regarding past experiences, whether people have experienced natural disasters does not seem to be linked to risk perception.

Figures 11 to 15 represent the risk perception for each type of natural disaster respectively in UoC, Naturtejo Geopark, TRC, F-A and Karsiyaka. In TRC, Naturtejo Geopark and UoC, the risks perceived as the most threatening for oneself, human being, and nature are the respective main risks: earthquakes in UoC, wildfire in Naturtejo Geopark and landslides in TRC. But in F-A, the most perceived risk are droughts and wildfires (while the main natural disaster investigated in RESILIAGE project is flood), and in Karsiyaka, earthquakes are the most perceived risk, while heatwaves are considered as the main natural disaster in RESILIAGE. This is no surprise as Turkey recently suffered, in 2023, significant damages due to earthquakes. However, heat-related disasters, such as droughts, heatwaves and fires (urban and wildfires), are also perceived as primarily impacting self and others in these CORE labs, which can be linked with the effects of climate change with increasing media coverage.

In a general way, we can see that women perceive most of disaster risks as more threatening than men. Given that the perception of risk can generate negative emotions, but also impede behavioural adaptation (Blondé & Girandola, 2016), these results confirm the specific vulnerability of women. We also note that TRC participants have relatively lower levels of perception of the risk of natural disasters overall than in the other CORE labs. However, risk perception and risk awareness are two different things and it is possible that these participants are well aware of these risks but consider them to be less of a threat than participants in the other CORE labs. We might also point out that many risks are assessed as very important in the Karsiyaka CORE lab.

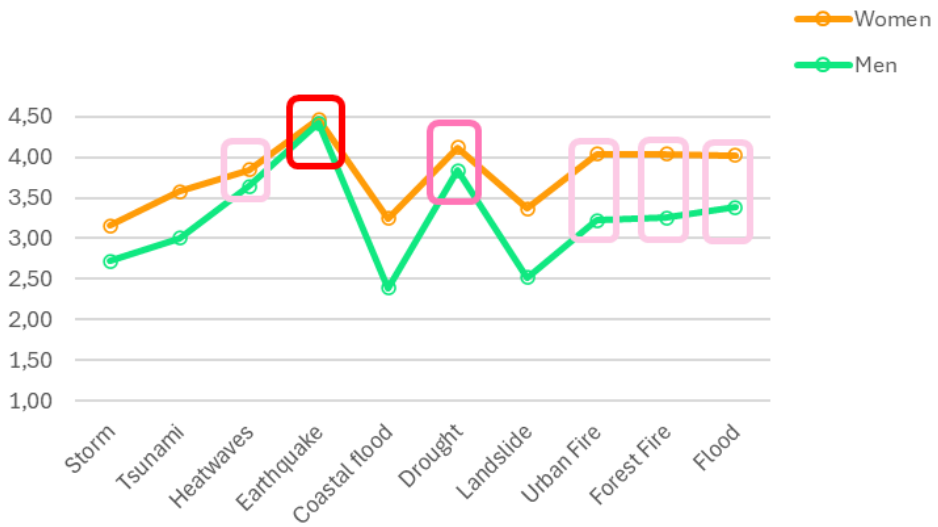

Figure 11: UoC-NHMC: Level of risk perception of different natural disasters

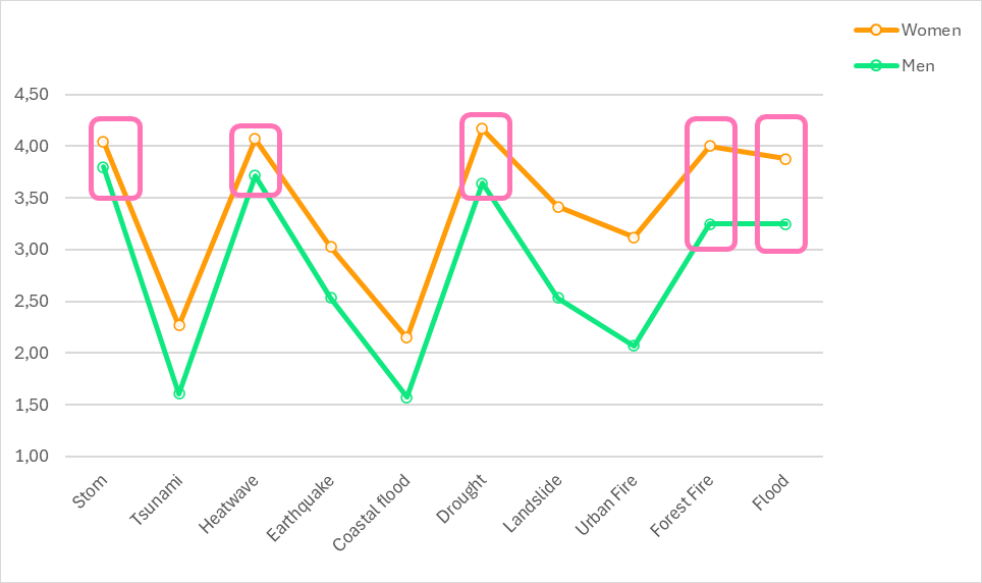

Figure 12: F-A: Level of risk perception of different natural disasters

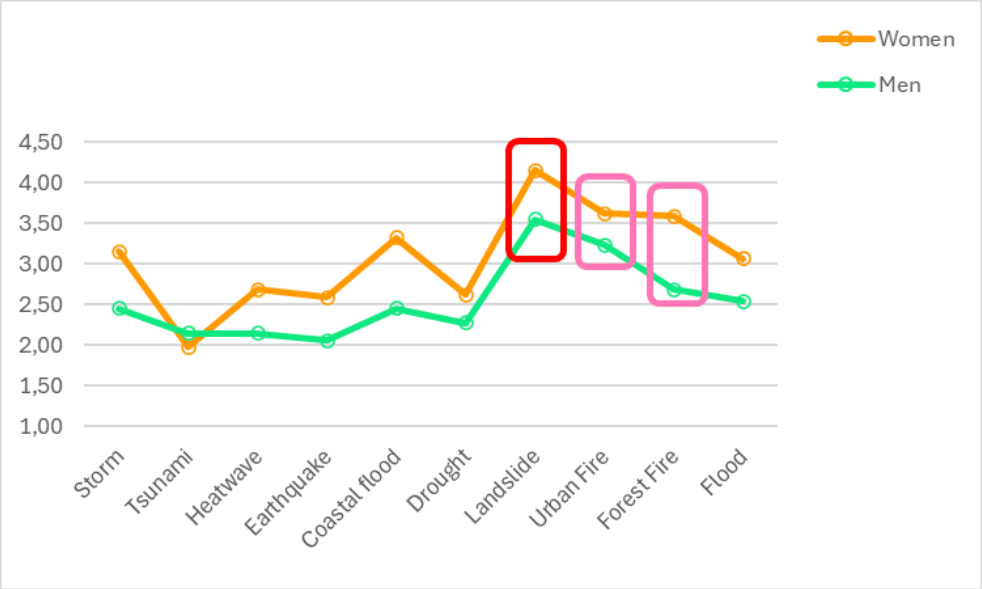

Figure 13: TRC: Level of risk perception of different natural disasters

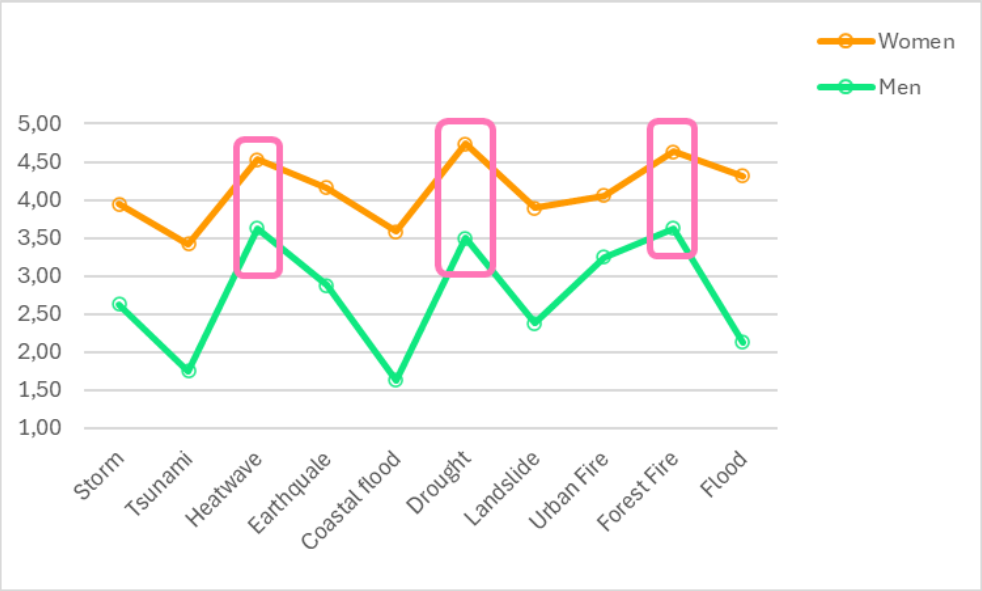

Figure 14: Naturtejo Geopark: Level of risk perception of different natural disasters

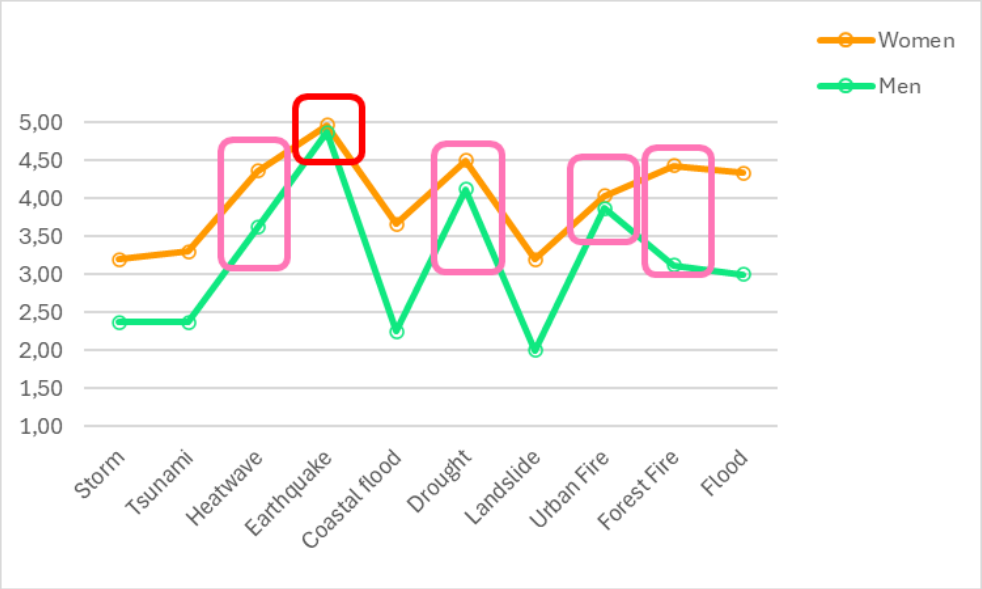

Figure 15: Karsiyaka: Level of risk perception of different natural disasters

PTSD and PTG

The survey shows that in the whole sample, 12.7% of the participants experience important PTSD symptoms, whereas the prevalence in the world population is only 3.9%. Among those respondents, women showed a higher prevalence (83.3%) of signs of PTSD (Figure 16) than men, who only represented 16.67% (Figure 16), especially in Karsiyaka where 88% of the women who responded to the survey are releving signs of PTSD. In addition, among people affected by PTSD, 72% have indirectly experienced a natural disaster (Figure 16). As a reminder, indirect experience corresponds to the

experience of the disaster through the media or other people (relatives, neighbours...). It is therefore an important element to take into account in managing the mental health of individuals, by extending the means put in place to promote psychological well-being to indirect victims as well.

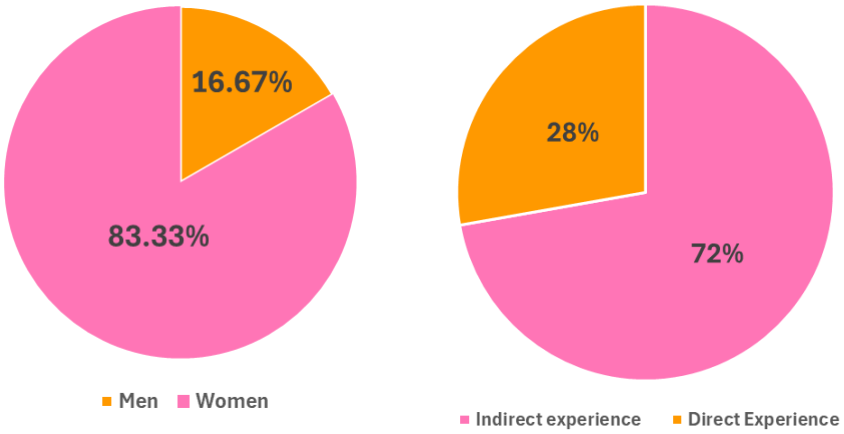

Figure 16: Gender distribution among people releving signs of PTSD (left), risk experience among people having PTSD (right)

However, PTSD can also be accompanied by PTG which refers to psychological resilience (rho=0.91***; z=1.55). Furthermore, the more participants perceive the risks of natural disasters to be important for oneself (rho=0.314***; z=0.33), human beings (rho=0.14*; z=0.15) and nature (rho=0.21***; z=0.22), the more likely they are to develop PTSD. But in the same way, the more they perceive the risk as important for oneself (rho=0.22***; z=0.23) or for nature (rho=0.19** z = 0.19), the greater his/her psychological resilience (PTG).

If we consider each CORE lab separately, we see that in F-A, people having PTSD represent 11,8% of the sample, two third of them are women, but no FRreported high score in PTSD. In Naturtejo Geopark, one participant on the 11 of the sample has PTSD, and she is a women. In UoC, PTSD is declared by 12,7% of the sample, which is quite high, and 86% of them are women, and 29% are volunteers, which potentially identifies them as a psychologically vulnerable population. No one in TRC seems to experience PTSD, which is an indicator of good mental health, and could partially explained by the fact that risk perception is lower in this CORE lab than in others, as we know that risk perception can be associated with negative emotions. Finally, Karsiyaka sample has a very high rate of PTSD as 51,5% of the sample express symptoms. 88% of them are women and 12% are volunteers. These results highlight an urgent mental health issue.

Trust in institutions

Global results show that the more participants trust their institutions, the less they experience PTSD symptoms (rho=-0.12**, z=-0.07). We can also add that the more confidence participants have in health and safety institutions, and in scientists (rho=0.13*;z=0.07) the greater their psychological resilience. So, the question of trust in

institutions seems to be a crucial dimension of mental health in the face of natural disasters.

The table 9 presents the institutions in which participants have the most and least confidence.

	Disaster management		Reliable information	
	Higher trust	Lower trust	Higher trust	Lower trust
F-A	Relatives (family, friends), rescue organizations	Religious organizations, local authorities, national government	Scientists, rescue organizations, healthcare services	Religious organizations, local authorities, national government
Naturtejo Geopark	Scientists, civil defense, EU	Religious organizations, local authorities	Scientists, civil defense, EU	Religious organizations, neighbourhood
UoC	Relatives, neighbourhood, scientists	Religious organizations, local authorities	Scientists, healthcare services, relatives	Religious organizations, local authorities, police
TRC	Rescue organizations, civil defense, healthcare services	Religious organizations	National government, police, healthcare services, local authorities	Religious organizations, neighbourhood, relatives
Karsiyaka	Relatives, neighbourhood, scientists	Religious organizations, police, local authorities	Scientists, relatives, UE	Religious organizations, national government, police

Table 9: Trust in different institutions in each CORE lab

4.1.2.2. Recommendations from the results

Firstly, in view of the comparative optimism highlighted, it seems necessary to communicate on the risks of natural disasters by emphasising the vulnerability of the populations of the CORE labs. Secondly, the fact that the main risks of Karsiyaka and F-A are not those perceived as the most threatening probably means that individuals would turn their attention more towards the natural disasters that they consider to be more important. It is even possible that individuals minimise the importance of the actions taken to manage the flood disasters in F-A and the heat wave in Karsiyaka. It is therefore important to take into account the fact that these risks may not be considered a priority by the CORE labs community before taking any specific action in relation to them.

Secondly, it is also important to consider the fact that women in all CORE labs are a more vulnerable group from a psychological point of view, both in terms of risk perception (and negative consequences associated) and PTSD. The FRwho responded to this study do not appear to be at psychological risk, but volunteer rescue workers sometimes suffer from PTSD and therefore need to be prepared and supported to deal with these problems. The Karsiyaka population is of particular concern from a mental health point of view and requires priority action to be taken in this CORE lab, whereas TRC participants are not at all affected, making this CORE lab a lower priority on this issue. Finally, it should be noted that PTSD is positively correlated with psychological resilience, which gives us reason to insist on and encourage positive outcomes from traumatic experiences such as natural disasters.

Finally, trust in institutions seems to be an important factor to consider in mental health, since it is associated with PTSD and PTG. However, the institutions to which this trust is directed vary greatly from one CORE lab to another, so we encourage the following tasks in the project to take account of the results associated with this variable when setting up their activities associated with or relating to the different institutions.

4.2. Risk awareness and threat simulation reaction

4.2.1. Psychological and behavioural effects of risk awareness campaign

4.2.1.1. Preliminary analyses

Firstly, participants in the various CORE labs indicated the nature of the most recent natural disaster in their CORE lab. 89% of F-A participants cited flooding (the main risk identified in this CORE lab), and 11% cited heat waves. Naturtejo Geopark participants all cited the risk of wildfire (main risk). TRC participants cited landslides (42%) (main risk), flooding (25%), heat waves (8%) and other risks (hurricane, urban fire) (25%). Figure 17 then shows when people last thought about this disaster. It can be seen that these thoughts are more recent among Naturtejo Geopark and F-A participants, which is less the case for TRC participants. These different results therefore show that the risk of a natural disaster is somewhat prevalent in the minds of CORE lab participants in Naturtejo Geopark and F-A, although this may be less the case for TRC participants.

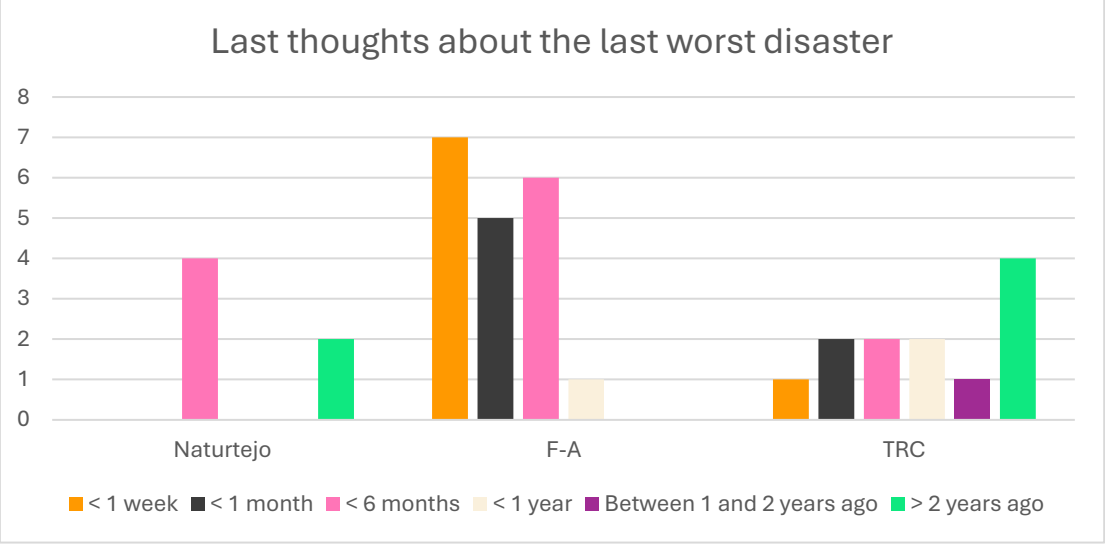

Figure 17: Last thoughts about the last worst natural disaster

Then, statistical analyses show that the perception of the risk of a natural disaster (Figure 18) and the feeling of control (Figure 19) with regard to this risk are statistically equivalent between the 3 CORE labs. However, there is a tendency for TRC participants to have a lower perception of risk, which seems to be essentially linked to a lower fear of risk. We also note that the feeling of being aware of the risk of natural disasters is relatively high for all participants.

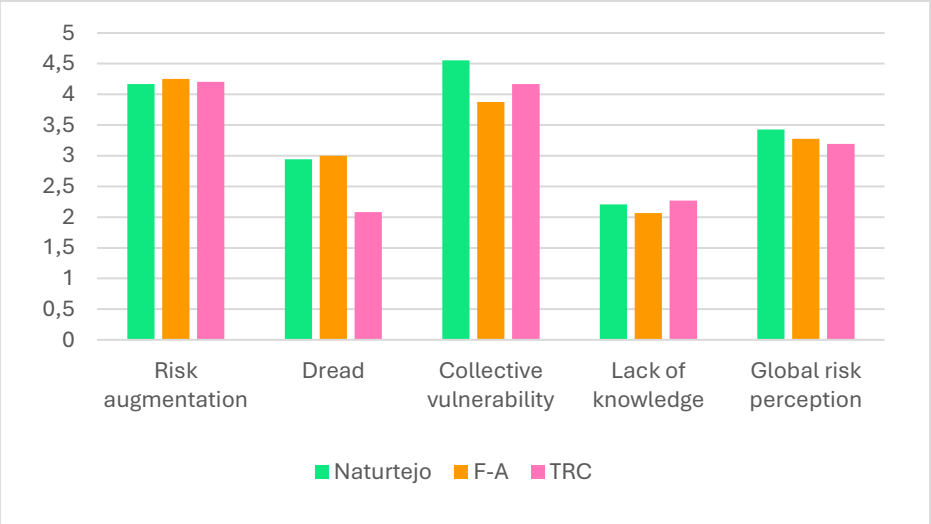

Figure 18: perception of the risk of natural disaster (and sub-dimensions) for participants of each CORE lab

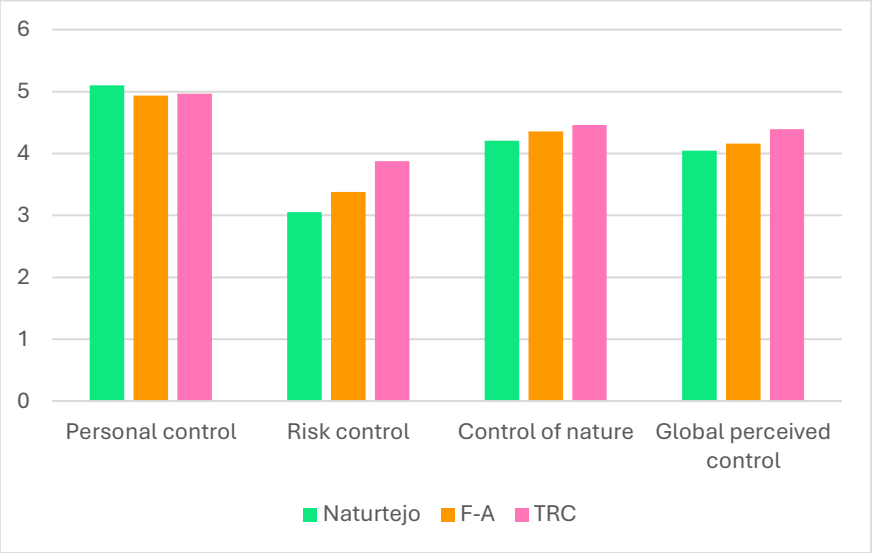

Figure 19: Feeling of control (and sub-dimensions) for participants of each CORE lab

However, we find that TRC participants are significantly more prepared for the risk of natural disasters than those in the other CORE labs ($X^2(2) = 9.94^{**}$, ε=0.28) (Figure 20). This difference can be explained by the fact that 41.7% of respondents in the TRC CORE lab are FRand are therefore probably more aware of the preparedness measures to be applied.

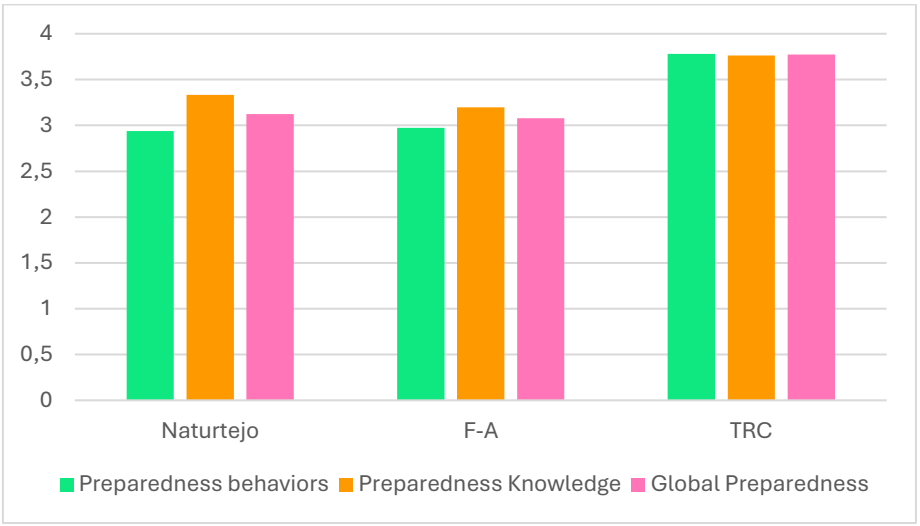

Figure 20: Preparedness level (and sub-dimensions) for participants of each CORE lab

Finally, with regard to the variables relating to the Cultural Natural Heritage (CNH), we note that for the Naturtejo Geopark and F-A CORE labs, natural sites are the heritage most vulnerable to the risk of natural disasters, while the different types of heritage are assessed as equally vulnerable to TRC (Figure 21).

Figure 21: Perceived vulnerability of different types of CNH for participants of each CORE lab

4.2.1.2. Impact of past experiences

With regard to the impact of past experience on people's relationship with risk, correlational analyses carried out on the sample as a whole show firstly that the more natural disasters participants have experienced, the more they perceive this risk to be important (rho=.51**, z=0.47), particularly through fear (rho=.40*, z=0.42) and the feeling of collective vulnerability (rho=.34*, z=0.36). The number of disasters experienced is also positively correlated with the feeling of personal control over risk (rho=.48**, z=0.53) and although the relationship is not significant, this number also tends to be correlated with the level of negative affect experienced (rho=30, p=.08, z=0.31). But it is not associated with the level of risk preparedness. The analyses also show that the relationship to risk on all these variables does not depend on the distance in time from the last disaster experienced. Thus, the number of disasters experienced, whether recent or distant, seems to be a determining factor in the way risk is perceived and the response capacity that citizens perceive, although this does not necessarily lead to better preparation for risk.

The same analyses, separating the samples by CORE lab, show that there is no correlation between the number of natural disasters experienced and the perception of risk among TRC participants. This can be explained by the large number of participants who had not experienced any natural disasters (42%), unlike the other two CORE labs, where the vast majority had experienced at least one. With regard to the feeling of control and negative affect, the analyses by CORE labs show no correlation with past experiences, which may be explained by the absence of this relationship or by the small sample sizes.

4.2.1.3. Impact of affects

Secondly, the analyses also show a potential phenomenon of intolerance to uncertainty (Ladouceur et al. 2000), since the feeling of ignorance of the risk of natural disasters is accompanied by low positive affect (rho=-.41*, z=-0.44). Risk communication, which generally aims to inform and share knowledge, can therefore help to overcome this phenomenon. However, it must be cautious, since the more participants fear the risk of a natural disaster, the more likely they are to feel negative emotions (rho=.54***, z=0.60), which is an issue to be taken into account with regard to the mental health of the population. It is therefore important to communicate, but the appeal to fear must be handled with caution and discernment. The feeling of control, in particular the feeling of personal control, is associated with positive affects (rho=.50*, z=0.55), which is also observed despite the small samples in each CORE lab separately (F-A: r=.59*, z=0.67; TRC: r=.66*, z=0.79), although this is only a trend in the Naturtejo Geopark (rho=.77, p=.07, z=1.02). However, the overall feeling of control is also positively correlated with the level of risk preparedness (rho=.36*, z=0.39). We might therefore deduce that feeling in control in the face of natural disasters promotes risk preparedness and positive affect.

4.2.1.4. Risk perception, feeling of control and preparedness

Correlational analyses show that the less familiar participants are with the risk of natural disasters, the less control they perceive over it, and vice versa (rho=-.36*, z=-0.38). In addition, there is a trend whereby the more participants feel able to control the risk of natural disasters, the less they fear them (rho=-.32, p=.06 z=-0.33).

With regard to risk preparedness, in the overall sample, the more participants feared the risk, the less prepared they were (rho=-.39*, z=-0.41), which is in line with research that has shown the possibility of defensive biased processing in people who feel fear towards a stimulus, a defence mechanism that enables them to avoid the source of fear (Blondé & Girandola, 2016). We might add that in the overall sample, the more participants perceived the risk as a collective threat, the higher their level of preparedness (rho=.34*, z=0.35). Emphasising CNH as a collective form of community vulnerability could therefore promote preparedness for natural disasters. The feeling of control over the risk of natural disasters also plays an important role in preparedness (rho=.37*, z=0.39).

These same interactions were observed among F-A participants, but also the fact that the less participants feel they know about the risk of a natural disaster, the less they know about preparedness measures (r=-.54*, z=-0.60). However, regarding the Naturtejo Geopark participants, we see that preparation is favoured by fear of the risk of natural disaster (rho=.88*, z=1.36), and by the fact of perceiving it as increasing (rho=.87*, z=1.32). These results potentially corroborate the variable effect of fear on protective behaviour and therefore the importance of knowing the context in which this emotion can or cannot be used to communicate. Among TRC participants, fear of risk and collective vulnerability are not correlated with the level of preparation. However, the less participants know about the risk, the less prepared they are (r=-.74**, z=-0.94).

4.2.1.5. Impact of Cultural Natural Heritage

The role of the CNH in risk preparedness was measured by the perceived vulnerability of the CNH, and by the CNH as a driver for action. These two variables are not correlated with risk perception, sense of control or level of risk preparedness.

However, the TRC sample shows that the perceived vulnerability of the CNH is associated with greater preparedness for the risk of natural disasters (r=.68*, z=0.81) and in particular with the implementation of protective behaviours (r=.71**, z=0.89). Although the underlying mechanisms are not highlighted here, these results demonstrate the potential role of the CNH as a driver of public resilience to natural disasters.

4.2.1.6. Impact of awareness campaign

7 people responded to the second phase of the survey (T1) from F-A, one person from Naturtejo Geopark and 4 people from TRC. Looking at the sample as a whole (all CORE lab combined), the video campaign had no influence on positive or negative affect, on the perception of the risk of natural disasters, or on risk preparedness immediately after watching the video (T1). However, there was a tendency, albeit not significant, for risk preparedness, both in terms of knowledge (knowledge of areas at risk, sources of information, etc.) and behaviour (downloading an alert application, preparing an emergency kit, etc.) to decrease immediately after watching the video, but also several weeks later. This reduction in risk aversion suggests that the motivational dimension of this type of communication is weak, which also justifies the relevance of developing different types of tools and solutions in this project, some of which are more involving (e.g. WP4 training sessions).

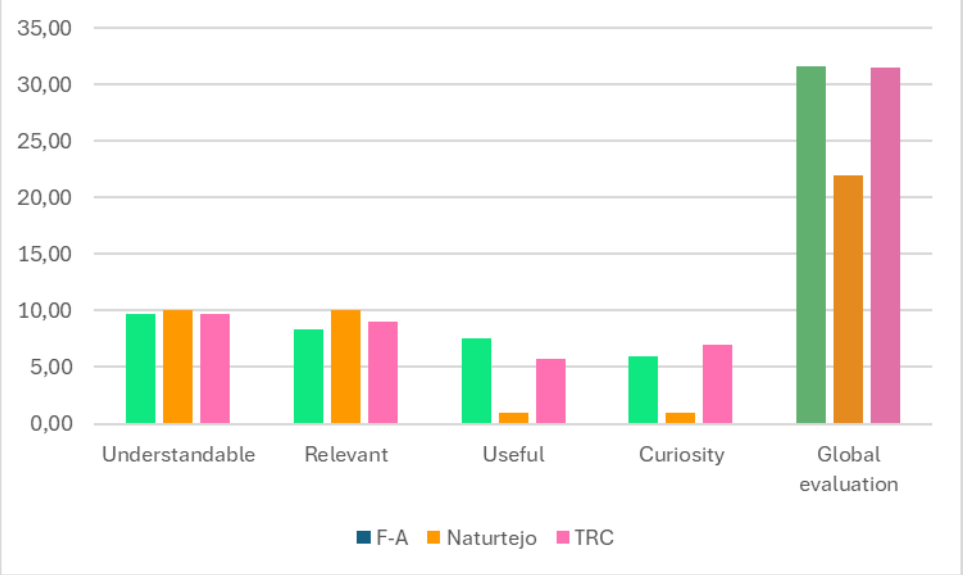

Figure 22: Evaluation of the video document specific to each CORE lab presented to the participants

The three videos presented were judged to be very clear and relevant, but received lower scores for their usefulness and their tendency to encourage people to seek information on preparing for the risk of natural disasters (Figure 22). This is particularly the case for the video proposed in the Naturtejo Geopark CORE lab, which was judged to be useless and not at all conducive to curiosity on the subject. As this person was the

only one to respond to this phase of the survey, this response cannot be considered representative of the entire CORE lab population.

The results show that the more people found the videos useful, the more they also felt they were prepared for the risk of natural disasters in terms of knowledge immediately after watching the videos (rho=.68*), which testifies to the usefulness of these videos in transmitting knowledge. However, there was no correlation with the application of protective behaviour in the short term (or even in the long term). We also note that participants who perceived the risk of a natural disaster as collective prior to viewing the videos tended to evaluate the videos as less useful (rho=-.73**). This is because the videos focus on individual behaviour. Viewing risk as a collective issue requiring global management may well lead people to minimise the value of individual action. Secondly, participants who perceived the risk as unfamiliar and unknown prior to viewing the video rated the videos as arousing their curiosity about preparing for the risk (rho=.66*). People's search for information is an active strategy for coping with risk, which is essential if they are to be properly prepared. We also note that the feeling of ignorance of the risk at the start of the survey (m=8.42, SD=2.63) decreased significantly not just after viewing the video, but several weeks later at the third data collection stage (m=6.86, SD=3.09)(t(13)=2.51, p<.05). This decrease could be explained by the fact that some participants had informed themselves between viewing the video and the third data collection session. Finally, when the video was less well understood, the participants maintained or increased their feeling of ignorance of the risk (rho=-.63*), but this time it was not correlated with the search for information.

The very small sample should, however, put the significance of these results into perspective. In addition, no analysis could be carried out on the CORE labs separately given the sample sizes, and the videos differ from one CORE lab to another, which therefore constitutes a significant bias in the analyses common to the various CORE labs.

4.2.1.7. Note on analyses by CORE lab

Generally speaking, it can be seen that many of the correlations identified in the sample as a whole are no longer significant when analysed by CORE lab. This is particularly true for the Naturtejo Geopark and TRC CORE labs, which have smaller samples. This may indeed reflect the absence of these phenomena in certain CORE labs, but as very small samples considerably increase the risk of beta error (risk of rejecting the hypothesis of a significant relationship when it is in fact significant), we suggest here that this lack of significance is essentially due to the very small samples.

4.2.1.8. Recommendations from the results

General recommendations

In the light of the results, emphasising the collective dimension of the community's vulnerability could promote risk preparedness. In particular, this collective vulnerability could be presented through the threats to the CNH, as a pillar of the community's identity. Relying on the vulnerability of the CNH to promote risk preparedness seems all the more appropriate in TRC, where this correlation has been observed to be significant. However, this relationship between CNH vulnerability and risk perception or preparedness was not

observed in the other two CORE labs. This difference could possibly be explained by the fact that the vulnerability of the CNH is not necessarily identified as a form of collective vulnerability. In fact, the type of heritage considered to be the most vulnerable by the participants in the Naturtejo Geopark and F-A CORE labs is represented by natural sites, the only non-anthropogenic heritage. This is not the case for TRC, whose participants consider the different types of heritage to be equally vulnerable. We can therefore assume that the participants in the F-A and Naturtejo Geopark CORE labs do not see the vulnerability of natural sites as a form of collective vulnerability. It would therefore seem useful in these two CORE labs either to raise awareness of the vulnerability of man-made heritage or to emphasise the contribution of natural sites to the identity of the community. In any case, the fact that the variable “CNH as a driver of preparedness” is not correlated with any other variable also shows that individuals are not necessarily aware of the role of CNH in community resilience, which confirms the value of the RESILIAGE project approach and its innovative nature.

However, the results also show that people who perceive the risk of natural disasters as collective also tend to evaluate videos promoting individual protective behaviour as less useful. It is therefore still necessary to emphasise the complementary nature of the individual and collective dimensions of risk and preparedness, and possibly to encourage the perceived behaviouralal control so that people feel able to act individually and perceive it as useful.

Finally, it would appear that the observation of videos on individual risk-preparedness behaviour does not encourage effective risk preparedness. However, this type of communication is still useful, as it seems to promote a feeling of knowledge about the risk, particularly by encouraging people to seek out information. We can therefore suggest that communication specialists build on these positive effects by, for example, highlighting existing sources of information to facilitate this search. This type of video therefore shows some effectiveness, but it must certainly be accompanied by more engaging measures to really bring about a change in behaviour through a stronger motivational dimension.

It is also important to note the low level of participation in this online survey. The number of participants in these three CORE labs, and especially in Naturtejo Geopark, suggests that they are less familiar with digital technologies and tools. However, a number of digital tools are being developed as part of this project, including some aimed at citizens who are not experts in natural disaster risk management. We recommend that the partners developing these tools take account of these difficulties, either by putting in place the means to facilitate access to digital technology for the least connected populations, or by proposing alternatives that are better adapted to their practices.

CORE lab specific recommendations

Some results are specific to certain CORE labs and therefore give rise to specific recommendations:

- TRC: results showed that TRC participants have a lower perception of the risk of natural disasters, which seems to be mainly due to a lower fear of the risk. This is not necessarily a problem, since in this CORE lab, the feeling of fear is not correlated with risk preparedness, and it can encourage negative affect, which can be harmful to the psychological well-being of individuals. Conversely, a feeling of personal control over risk encourages positive affect. The CORE lab

project's awareness campaigns should therefore not necessarily emphasise the serious and dangerous nature of natural disasters, but rather provide information on the risks themselves, and on the collective and individual resources that can be put in place to prepare for this type of event. After all, the feeling of being in control also seems to encourage risk preparedness. We also suggest communicating the vulnerability of CNH to natural disasters, making it clear that this is representative of the community's collective vulnerability, in order to encourage risk preparedness.

- F-A: we can recommend the same advice on risk communication as for TRC, since the interactions were broadly the same, with a greater emphasis here on the potentially harmful role of fear of risk on preparedness. We also recommend raising awareness of the vulnerability of man-made heritage to natural disasters and emphasising the contribution of natural sites to community identity.
- Naturtejo Geopark: we have seen that for this CORE lab, fear of the risk of natural disaster and the perception of its increase are positively correlated with risk preparedness. We therefore suggest that communication in this CORE lab would benefit from emphasising the threatening nature of the risks and their increase over time. But it is also important to emphasise the ways in which people can prepare and adapt in order to foster a sense of control and therefore positive affect. We also recommend raising awareness of the vulnerability of man-made heritage to natural disasters and emphasising the contribution of natural sites to community identity.

4.2.2. Reactions to disaster exposition through virtual reality simulation

4.2.2.1. Results from Trondheim Red Cross

Control of the effects of wildfire simulation

To control the ecological validity of the collected data, we measure the sense of presence using a questionnaire on a scale from 1 to 7. The global sense of presence is average (m=3.92, SD=0.37) and the score of each subscale is detailed in figure 23. The realism score is the lowest, with a mean of 3.51 (SD=0.63). There is no threshold at which these scores can be considered insufficient, but these scores around the mean means that the results of this study must be put into perspective with regard to their transposability in a real-life life-threatening situation. These average scores can be explained in part by the fact that 60.5% of participants have already used VR, and therefore possibly have a fairly high degree of requirement in terms of realism (lowest

sub-dimensions of the presence score). Nevertheless, the results remain interesting in terms of individuals' analysis of the situation and decision-making.

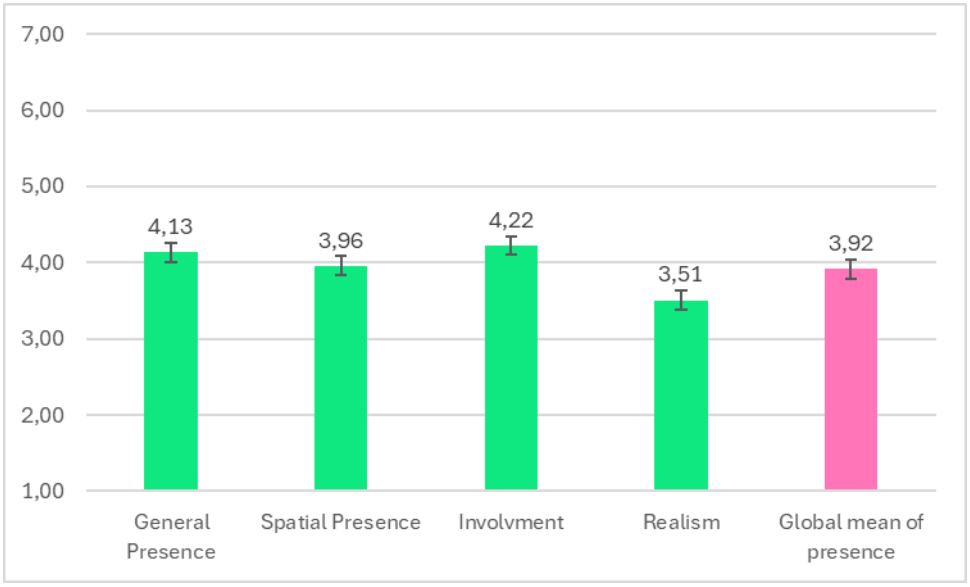

Figure 23: average level of presence (and sub-dimensions in green) across all participants of TRC

Influence of environmental factors

Firstly, with regard to the impact of environmental factors on the analysis of the situation, 55% of participants said that they first identified the fire by sound, 8% said that they identified it by smoke and 32% said that they identified the fire by seeing it. The participants therefore seemed sensitive to the first stimulus and alerted themselves fairly quickly.

However, in terms of behaviour, 24% of participants went out of their way to try and locate the source of the fire, which may constitute dangerous and inappropriate behaviour. Secondly, in terms of protective behaviour, 39% said that they had identified the car park as a safe evacuation area or as the quickest way to evacuate (using their car) even though the fire was coming from that direction. Only 8% said they had voluntarily gone in the opposite direction to escape the fire. Around 30% of participants said that they evacuated after reading the warning, indicating the decisive role of warning messages in the decision-making of many individuals. This notification came after the fire was visible and audible, but these cues did not appear to be sufficient to prompt the participants to evacuate, who waited to receive an alert message.

Influence of social factors

With regard to the individuals' analysis of the situation, social factors seem to partly determine the way in which the participants directed their attention during the scenario. Indeed, in the control condition, i.e. alone, the participants essentially directed their visual attention towards the fire, whereas in the presence of other people (organised and disorganised conditions), the participants observed the NPC more. Thus, the other individuals appear to be either a source of information or a source of concern for the

participants. In addition, in the disorganised condition, participants observed most of the environmental and social cues (NPC, fire, car park sign) for longer, possibly indicating that this situation is more ambiguous and therefore requires more information-seeking in order to make a decision (Figure 24).

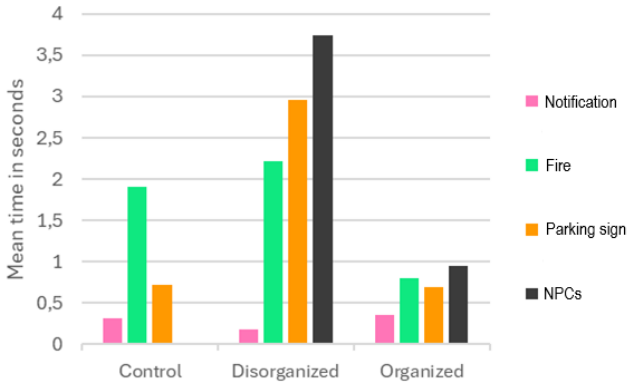

Figure 24: mean observation time per visual stimulus by participants in each experimental condition

On the behavioural aspect, participants of the disorganized condition needed more time to evacuate than those in other conditions (Figure 25), meaning that participants in ambiguous situations evacuate less effectively. Social cues therefore seem to play an important role here, since if they are not consistent with environmental cues (e.g. the location of the source of danger), evacuation is less effective because of a certain amount of confusion.

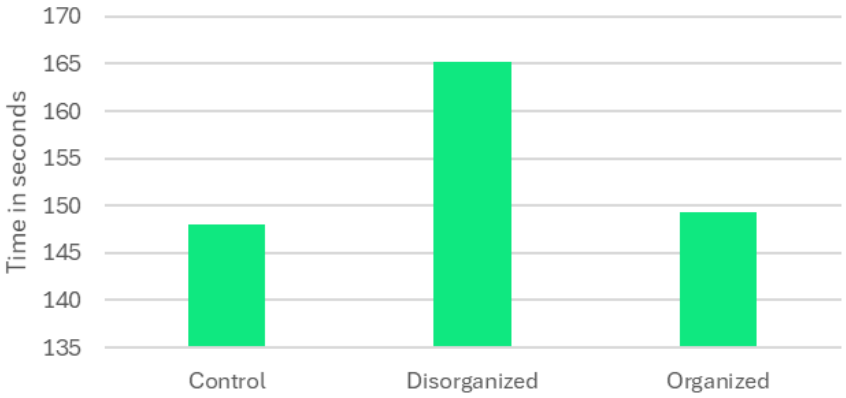

Figure 25: average duration of the scenario (in seconds) as a function of the experimental condition

In terms of deciding where to evacuate, half of the participants ended the simulation by the safe path and the other half by the unsafe path (car park) (Figure 26). But individuals in control condition took the dangerous path more than those in the other conditions, while it's in organized situations that more participants took the safe path.

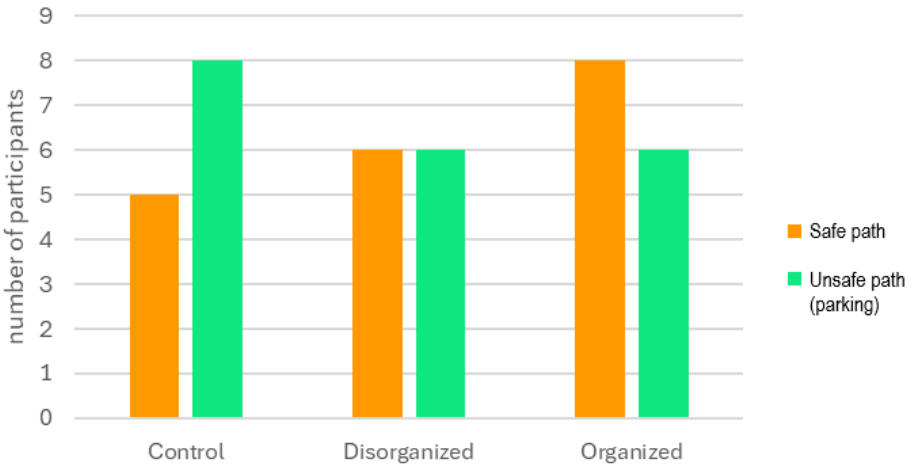

Figure 26: Number of participants who took safe or unsafe path according experimental condition

Finally, 13% of the participants said they had wanted to contact the NPC either to help them or to ask for information, and 2 participants said they had wanted to call for outside help. 36% of participants in the presence of NPC said they had followed them to evacuate, indicating that social influence in crisis and evacuation situations can be an important factor in decision-making. However, this was not necessarily imitative behaviour, since about half of them said they had actually imitated the NPC, the others having wanted to make sure they were safe, for example.

Physiological stress indicators measured for each participant (example in Figure 27) show no difference in the overall stress level over the whole simulation between the different experimental conditions. Thus, social cues and the degree of ambiguity of the situation influence behaviour but not stress levels. The fact that people do not panic more in ambiguous situations must be taken into account in PP, which are too often based on the assumption that people panic in disaster situations (Fahy & Proulx, 2009).

Finally, it should be pointed out that gender does not influence the decision in terms of direction of evacuation, with men and women equally choosing the direction of the car park (and fire) or the opposite direction. The average stress level is also the same between men and women.

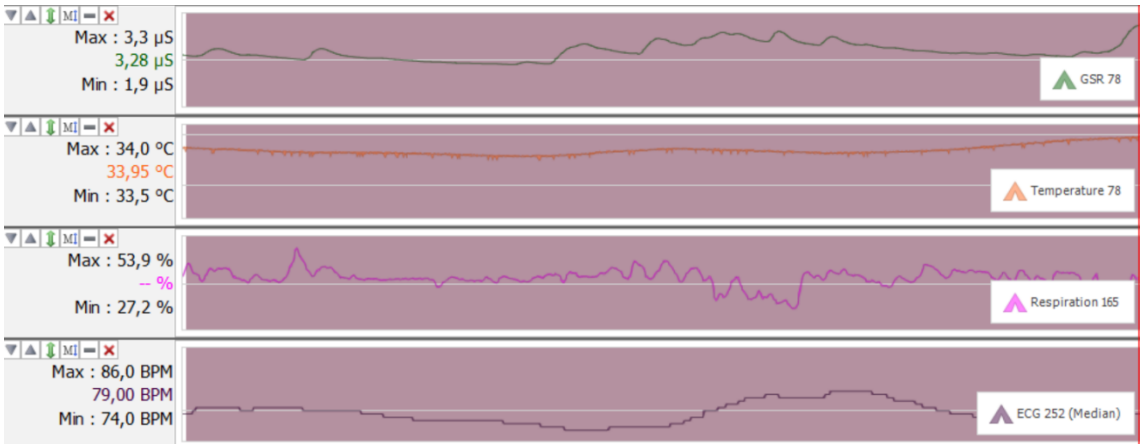

Figure 27: example of the recording of a participant's physiological data

4.2.2.2. Recommendations for Trondheim Red Cross

Firstly, the results show that TRC participants are very alert to the first environmental signs of danger, which is encouraging in terms of their ability to identify a dangerous situation. However, the subsequent evacuation decision may vary. The evidence shows that social cues seem to take precedence over environmental cues when it comes to choosing the direction of evacuation, since people on their own made poorer decisions than people in the presence of NPC evacuating in the right direction. We can therefore stress the importance of training referents in crisis situations, capable of guiding the individuals present towards the right behaviour in an orderly and consistent manner. Nevertheless, some of the participants who indicated that they had followed or at least monitored the NPC certainly showed a form of altruism, but also a possible self-endangerment under certain conditions. The sample includes a large number of FRor volunteers, which may explain the importance attached to protecting others. However, it still seems necessary to prevent any altruistic behaviour that may be inconsiderate in view of the danger and urgency of certain situations.

Secondly, as the majority of people alone had made an inappropriate decision (to drive towards the fire), we can only stress the importance of effectively communicating the correct behaviour to adopt in a disaster situation, as this is not necessarily a given. Furthermore, only two people out of the whole sample said they had wanted to notify emergency services or any outside help, so this should also be encouraged.

Finally, alert notification played an important role in the decision-making of many participants. It is therefore crucial to develop an early warning tool that is fast enough to evacuate people as soon as possible.

4.2.2.3. Results from Famenne-Ardenne

Only six participants realized the flooding simulation. As a result, we were unable to carry out any statistical analysis, but here we offer a few qualitative observations.

The participants of the organized scenario took less time to realize the simulation and followed the NPC to the safe location (i.e., the stairs), unlike the participants in control and disorganised conditions, who either stayed on the terrace or took refuge in the fast-food restaurant (see example in Figure 28). These participants explained that they

wanted to get up on the table (on the terrace or in the fast-food restaurant). One of the two participants in the control situation even tried at first to move away into the street, before being blocked by the limits of the virtual environment and finally deciding to take shelter in the fast-food restaurant. These behaviours were inappropriate as the water was rising rapidly,and being uncertain of the maximum height of the water, the participants should instead have tried to get to higher ground quickly using the fire escape in the street. Participants in the Organised condition started to move to safety when the NPC themselves moved. In each of the other two conditions, one of the participants only started to move when the water level was already high. The fact that the most adapted behaviours were observed in the Organised condition (in other words, the condition in which the NPC all moved in the safe direction) shows the important role of social cues in the decision to adopt adapted behaviours in situations of immediate danger. Furthermore, of the three people who took refuge in the fast-food restaurant, two of them said they felt safe there, unlike the people who took refuge in the high staircase, only one of whom said she felt safe. This may reflect a minimisation of the danger, or at least of the possible extent of the flooding, since the people who behaved less appropriately were also more likely to have felt safer.

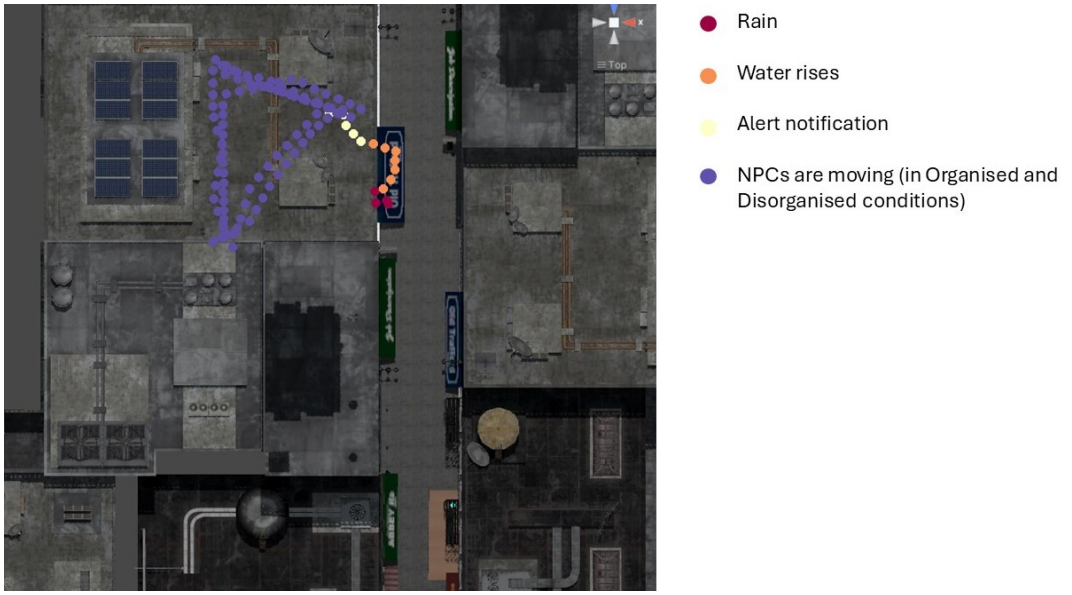

Figure 28: plot movement of the first participant (Control condition) according the timeline

Communication in an emergency situation is also important for identifying the dangerous situation, since three of the six participants explained that they understood that it was a flood when they received the flood alert notification. The other participants identified the flood as soon as the water began to rise, i.e. before receiving the notification.

4.2.2.4. Recommendations for Famenne-Ardenne

As with TRC CORE lab, the results highlighted the important role of social influence in a situation of uncertainty and immediate danger. We can therefore insist on the importance of training referents in crisis situations, capable of guiding the individuals

present directly or simply by example towards the right behaviours. The fact that half of the participants chose a safety zone that was in fact dangerous, and felt relatively safe there, also shows the need to better prepare individuals on how to react to this type of event, in particular by stressing the importance of not minimising the risk and the scale of the phenomenon. Finally, alert notification played an important role in the decision-making of many participants. It is therefore crucial to develop an early warning tool that is fast enough to evacuate people as soon as possible.

4.3. Limits of the field studies (T2.3 and T2.4)

The first and most important limitation concerns the number of participants in each of the studies. The samples did not meet the objectives set in the project proposal for several CORE labs. These small sample sizes therefore limited the possibilities for statistical analysis, as well as the power of the tests applied. But it also limits the generalizability of findings to the global population of each CORE lab.

Various factors may explain this low participation rate. The first certainly concerns the use of digital technology, which seems to vary from one CORE lab to another. The data collected at Naturtejo Geopark for the eye-tracking experiment, which required participants to use a laptop computer, showed that this type of tool was much less widely used by this population than in the other CORE labs. This low level of use of digital tools may therefore also explain the very low take-up of online surveys. In the case of F-A and UoC, although participants seemed to be comfortable with digital tools, the participation rate in experiments and even surveys was sometimes very low. The studies were mainly communicated via social networks, so it seems that this method of communication should not necessarily be favoured for future activities in these CORE labs.

Another limitation concerns the lack of ecological validity of VR. The participant knows that he is in a simulation, and even more so in this study where the presence scores are average. It is therefore necessary to put the transposability of these results to a real natural disaster situation into perspective. It should also be added that for obvious reasons of feasibility, the flooding scenario is spread over a few minutes, and not over several days as was the case during the recent floods in F-A Core lab. However, this situation, although exaggerated in terms of the speed of the disaster, allows us to better understand cognitive, emotional and behavioural processes in a situation of uncertainty and immediate danger such as that of a natural disaster, and to study the role of different environmental factors (visual, sound, social).

Finally, we might also mention the fact that the CNH was not included to any great extent in these four studies, since associated variables are only to be found in the longitudinal survey. These different studies were designed to meet very specific objectives and already included lengthy protocols or questionnaires, so the choice was made to first meet the objectives relating to individual human factors in the management of natural disasters, rather than integrate this heritage dimension, which is nevertheless being explored in other tasks in this first data acquisition phase of the RESILIAGE project. Nevertheless, integrating the role of the CNH into the longitudinal survey did yield some interesting results, enabling us to formulate recommendations for the project's subsequent activities.

5. Analysis of CORE labs communication characteristics from cross-sectional survey (T4.1)

5.1. Naturtejo Geopark

By distributing the cross-sectional survey in the CORE lab, a total number of 54 responses have been collected from which 27 answered most of the questions thus providing valuable data for analysis. Regarding their status, 25 of the responders (93.6%) are civil residents of their community, 1 respondent (3.7%) is a member of the local authority, and 1 respondent (3.7%) is a first responder.

In terms of demographic characteristics of the participants, 66.6% of them are female while 29.6% are male (1 respondent preferred not to answer this question), with the average age of the respondents being 43.19 years (SD=15.24). Participants reported to have been living in the area for the average of 20.07 years (SD=11.58). The majority of them share their household with other relatives (33.33% with a partner, 3.3% with children, 11.11% with partner and children, 3.7% with other relatives) while 25.9% live alone. 44.44% of the responders live in council flats, while 33.33% reported to live in other types of accommodations. In terms of education, 1 person (3.7%) reported not to have any school certificate, 29.63% of the participants have a high school or secondary school degree, while 44.44% reported to have bachelor's or master's degree. 30% of the participants reported to be religious or strongly religious, 26% reported not being religious at all, and 22% preferred not to answer this question. In terms of economic status, the larger proportion of respondents have an average household income (44%), 4% reported to have a slightly higher, while 29% reported to have a slightly lower or much lower income than the average. In terms of physical proximity to other residents, respondents live within 2 minutes of walking distance from their closest neighbour. 48.11% of the respondents rated their relationship with their closest neighbour rather close of very close, while 29.6% of the respondents rated their relationship with neighbours as rather weak or very weak.

When it comes to communication channels, members of firefighters and local authorities seem to show a greater reliance on diverse sources of information, as they both have reported to consult the majority of these communication channels to a larger extent than citizens. It is also important to underline that citizens reported traditional communication channels like radio and television as the most frequently consulted channels. Furthermore, all the three groups reported printed media as the least consulted and one of least intuitive sources of information. Interestingly however, face-to-face communication has been rated as rarely consulted as even less intuitive by citizens, indicating that the information that is spread this way is treated with reservation. Finally, it is important to underline that the respondents of the survey rated the category of elderly and children as the two most vulnerable groups of the community to future crises.

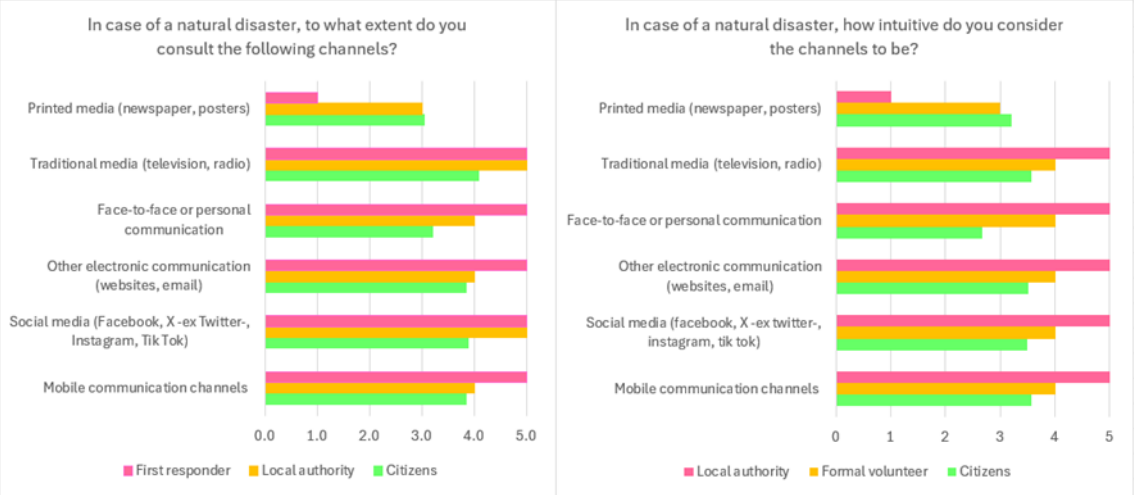

Figure 29: Left: communication channels consulted by Naturtejo Geopark survey participants; Right: participants' perception of the intuitiveness of communication channels

5.2. Karsiyaka

By distributing the cross-sectional survey in the CORE lab, a total number of 46 responses have been collected from which 38 answered enough questions to provide valuable data for analysis. Regarding their status, 55% of the responders are civil residents of their community, 34.6% of the respondents are members of the local authority, and 15.38% are volunteers.

In terms of demographic characteristics of the participants, 84% of them are female while 16% are male, with the average age of the respondents being 38.21 years (SD=9.61). Participants reported to have been living in the area for the average of 29.07 years (SD=13.39). The majority of them share their household with other relatives (18.18% with partner, 31.81% with partner and children, 36.36% with parents) while 13.63% live alone. 44.44% of them live in council flats, while 33.33% reported to live in other types of accommodations. In terms of education, 57.69% reported to have bachelor's, while 26.92% to have master's degree. 7.69% of the respondents have high school degree, while another 7.69% has PhD degree. 33.33% of the participants reported to be religious or strongly religious, 37% reported not being religious at all, and 29.62% preferred not to answer this question. In terms of economic status, the larger proportion of respondents have an average household income (53.84%), 34.61% reported to have a slightly higher, while 7.69% reported to have a slightly lower income than the average. In terms of physical proximity to other residents, respondents in average live within less than 3 minutes of walking distance from their closest neighbour, however, 66.66% of the respondents rated their relationship with their closest neighbour rather weak or very weak, while only 33.33% of the respondents rated their relationship with neighbours as rather close or very close.

When it comes to communication channels, social media (Facebook, X -ex Twitter-, Instagram, Tik Tok) by far seems to be the most consulted and most intuitive channel by all citizens, local authorities and volunteers, too, however, volunteers reported face-to-face communication as an equally important way of sharing and receiving information, and traditional media (television, radio) as equally intuitive.

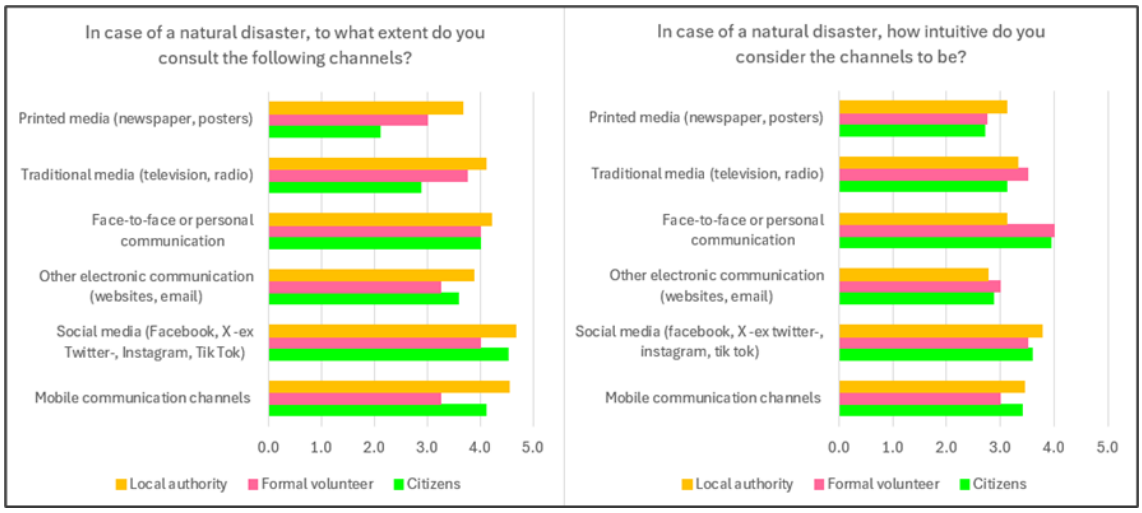

Figure 30: Left: communication channels consulted by Karsiyaka survey participants; Right: participants' perception of the intuitiveness of communication channels

5.3. Crete

By distributing the cross-sectional survey in the CORE lab, a total number of 144 responses have been collected from which 63 answered enough questions to provide valuable data for analysis. Regarding their status, 66.67% of the responders are civil residents of their community, 9.7% of the respondents are members of the local authority, and 22.22% are volunteers, and 1.39% are first responders.

In terms of demographic characteristics of the participants, 63.9% of them are female while 36.1% are male, with the average age of the respondents being 49.46 years (SD=9.97). Participants reported to have been living in the area for the average of 30.03 years (SD=16.01). The majority of them share their household with other relatives (22.2% with partner, 43.1% with partner and/or children, 8.3% with parents) while 11.1% live alone. In terms of education, 58.3% reported to have university degree, while 15.3% of the respondents have high school degree, and 12.5% has PhD degree. 56.9% of the participants reported to be religious or strongly religious, 30.6% reported not being religious at all, and 12.5% preferred not to answer this question. In terms of economic status, the larger proportion of respondents have an average household income (38.9%), 31.9% reported to have a slightly higher, while 12.5% reported to have a slightly lower income than the average, and 4.2%reported to have an income that is much higher than the average. In terms of physical proximity to other residents, respondents in average live less than 2 minutes of walking distance from their closest neighbour, and while 40.2% of the respondents rated their relationship with their closest neighbour rather weak or very weak, 47.3% of the respondents rated their relationship with neighbours as rather close or very close.

When it comes to communication channels, citizens, local authorities and formal volunteers consult mobile communication channels (SMS, text applications), websites, emails or face-to-face communication the most frequently, while first responders marked social media as their most consulted channel. However, when asked about the intuitiveness of these channels, the four groups marked four different types of media: citizens marked mobile communication, formal volunteers marked email and websites, local authorities marked face-to-face, while first responders marked printed media as the

most intuitive communication channel. This discrepancy between the perceptions might occur as a potential challenge in communicating between the actors, due to their different attitudes towards these channels.

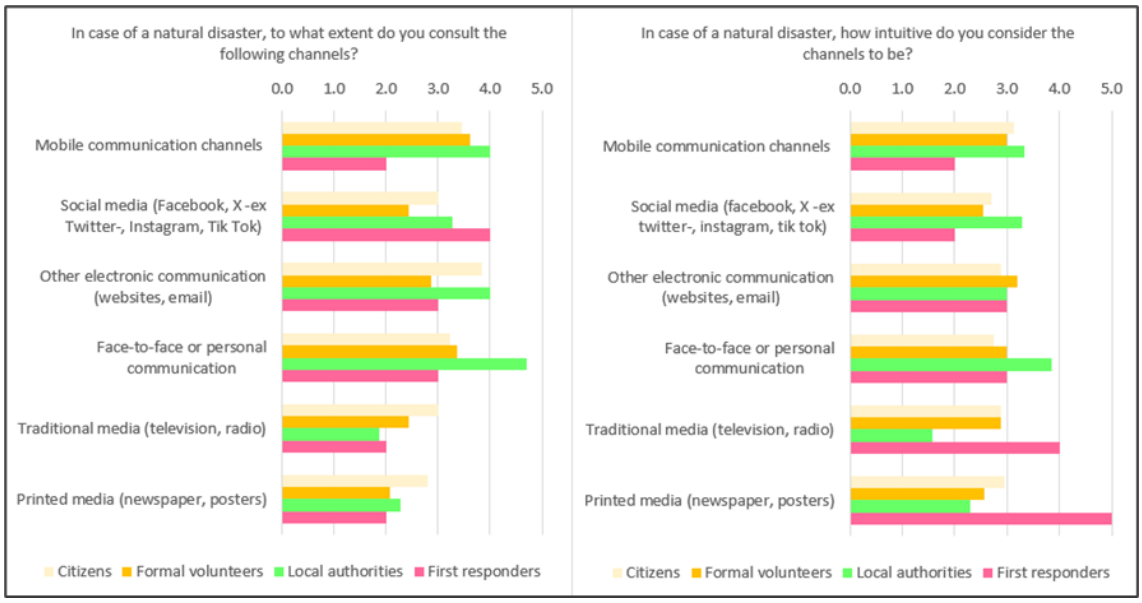

Figure 31: Left: communication channels consulted by Crete survey participants; Right: participants' perception of the intuitiveness of communication channels

5.4. Trondheim Red Cross

By distributing the cross-sectional survey in the CORE lab, a total number of 94 responses have been collected from which 57 answered enough questions to provide valuable data for analysis. Regarding their status, 44.7% of the responders are civil residents of their community, 10.64% of the respondents are members of the local authority, 44.7% are volunteers, and 4% are first responders.

In terms of demographic characteristics of the participants, 59.64% of them are female 38.6% are male, while 1.7% preferred not to answer. The average age of the respondents is 49 years (SD=14). Participants reported to have been living in the area for the average of 24.9 years (SD=18.22). The majority of them share their household with other relatives (47.8% with partner, 21.14% with partner and/or children, 8.69% with other relatives) while 21.17% live alone. In terms of education, 67.44% reported to have university degree, while 20.93% of the respondents have high school degree, and 6.97% has PhD degree. 17.07% of the participants reported to be religious or strongly religious, 63.41% reported not being religious at all, and 19.51% preferred not to answer this question. In terms of economic status, the larger proportion of respondents have an average household income (39.02%), 41.46% reported to have a slightly higher, while 14.63% reported to have a slightly lower income than the average, and 4.87% reported to have an income that is much higher than the average. In terms of physical proximity to other residents, respondents in average live 1 minute of walking distance from their closest neighbour, and while 34.15% of the respondents rated their relationship with their closest neighbour rather close, 65.84% of the respondents rated their relationship with neighbours as rather weak or very weak.

When it comes to communication channels, first respondents, local authorities and formal volunteers consult mobile communication channels (SMS, text applications) the most frequently, while citizens (along with first respondents) marked traditional media (television, radio) as their most consulted channel. However, when asked about the intuitiveness of these channels, the four groups marked four different types of media: citizens marked traditional media (television, radio), formal volunteers marked mobile communication and traditional media, local authorities marked websites and emails, while first responders marked mobile and face-to-face communication as the most intuitive communication channel. When asked about vulnerable groups who would have specific difficulties in accessing relevant information in case of a disaster event, respondents mentioned refugees and displaced persons as the most vulnerable groups.

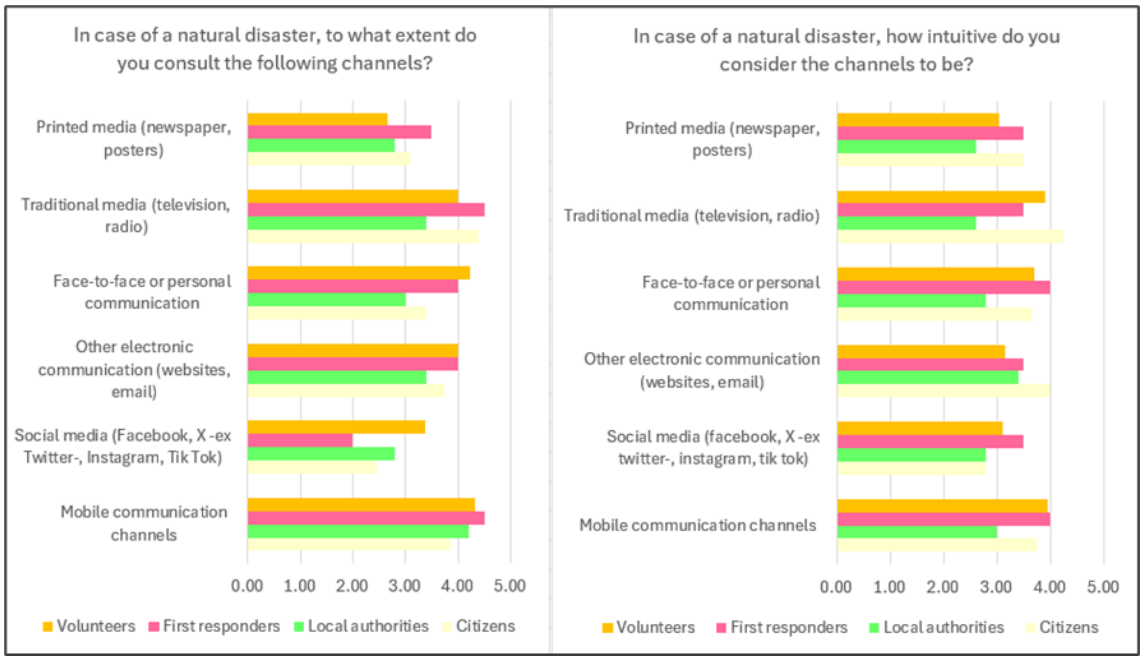

Figure 32: Left: communication channels consulted by Trondheim survey participants; Right: participants' perception of the intuitiveness of communication channels

6. Introduction to the focus group sessions (T4.1)

6.1. Naturtejo Geopark

The Focus Group sessions took place as part of the field activity organised in the "Centro Ciência Viva da Floresta" in Moitas, Proença-a-Nova, on the 22nd and 23rd of April 2024. A total number of 17 participants were present on both days. The participants represented the following stakeholder groups:

- "Gestão de Fogos Rurais Núcleo Sub-Regional da Beira Baixa" (AGIF – Agency for Integrated Management of Rural Fires, Beira Baixa sub-region);
- "Instituto para a Conservação da Natureza e Florestas" (Institute for Nature Conservation and Forests);
- "Força de Sapadores de Bombeiros Florestais do Centro" (Central Forest Firefighters Force);

- “Posto de Intervenção Proteção e Socorro de Proença-a-Nova (UEPS)” (“Emergency Protection and Relief Unit” of Proenca-a-Nova)
- “Gabinete Forestal do Municipio de Prença-a-Nova" (“Forestry Office of the Municipality of Proença-a-Nova")
- “Associação para o Desenvolvimento de Sobral Fernando” (Association for the Development of Sobral Fernando)
- “Centro Ciência Viva da Floresta” (“Live Science Center of the Forest”)
- “Associação cultural e recreativa amigos da Giesteiras” (Giesteira Cultural and Recreational Association)

Figure 33: Focus Group activity in Naturtejo Geopark CORE Lab

Similarly to the field activity in Famenne-Ardenne CORE lab, on the afternoon of Day 1, the first 90-minutes focus group session was conducted. The second session took place on Day 2, in the morning. Participants have been grouped into two focus groups that were running in parallel, both on Day 1 and Day 2, focusing on the same exact question groups, as introduced in the Methodology Chapter (see D4.1 Section 2). The focus group sessions started with a general welcome session where the objectives of the project in general, as well as the focus group session were introduced. This was followed by the introduction of the past crisis scenario of the wildfires in 2023 August to serve as the context of reference during the sessions. The information shared was based on the crisis description delivered in D1.1 (see Section 5.4.2, p.109-110). At the end of the presentation, participants have been assigned to one of the two parallel focus groups, by following the principle of the key actors being evenly represented in both groups. After each focus group session, facilitators were briefly video interviewed by the researchers of Deep Blue and Vicesse, asking for a high-level explanation of the topics discussed during the session, along with the most relevant results and gaps identified as well as explanation of the Interaction Map created by the participants.

6.2. Karsiyaka

The Focus Group sessions took place as part of the field activity organised in the “Kal Kadoş Synagogue” in Karsiyaka, on the 7th and 8th of May, 2024. A total number of 39 participants were present on both days. The participants represented the following stakeholder groups:

- Karşıyaka Municipality, Disaster Affairs Directorate (Karşıyaka Belediyesi Afet İşleri Müdürlüğü)
- İzmir Katip Çelebi University / Chamber of Landscape Architects Izmir Branch Board of Directors
- İZAFED - Disaster Awareness, Environment and Climate Awareness Association (İZAFED - Afet Bilinci Çevre ve İklim Farkındalığı Derneği)
- Karşıyaka Municipality, Information Technology Directorate (Karşıyaka Belediyesi Bilgi işlem Müdürlüğü)
- İzmir Metropolitan Municipality / Project Department
- IBB - Department of Parks and Gardens (BB,Park ve Bahçeler Dairesi Başkanlığı)
- İzmir Metropolitan Municipality / Climate Change and Clean Energy Department
- Ege University / Department of Landscape Architecture
- Dokuz Eylül University / Dokuz Eylül Üniversitesi
- İzmir Katip Çelebi University
- Social Development and Solidarity Association
- Izmir University of Economics / Chamber of Landscape Architects Izmir Branch Board of Directors
- Kavram University / Kavram Üniversitesi
- Yer Çizenler Derneği
- TEMA, The Turkish Foundation for Combating Soil Erosion, for Reforestation and the Protection of Natural Habitats
- Kentimiz İzmir Derneği
- Izmir Water and Sewerage Administration General Directorate (İZSU)
- Youth Association / Pi Gençlik Derneği
- İzmir Metropolitan Municipality / Fire Department
- Izmir Chamber of Geological Engineers / İzmir Jeoloji Mühendisleri Odası

Figure 34: Focus Group activity in Karsiyaka CORE Lab

On the afternoon of Day 1, the first 90-minutes focus group session was conducted. The second session took place on Day 2, in the morning. Participants have been grouped into two focus groups that were running in parallel, both on Day 1 and Day 2, focusing on the same exact question groups, as introduced in the Methodology Chapter (see D4.1 Section 2). The focus group sessions started with a general welcome session where the objectives of the project in general, as well as the focus group session were introduced. This was followed by the introduction of the general crisis of heatwaves to serve as the context of reference during the sessions, by listing the most important facts and statistics related to this type of hazard in Izmir. The information shared was based on the crisis description delivered in D1.1 (see p.115-119). At the end of the presentation, participants have been assigned to one of the two parallel focus groups, by following the principle of the key actors being evenly represented in both groups. After each focus group session, facilitators were briefly video interviewed by the researchers of Deep Blue and Vicesse, asking for a high-level explanation of the topics discussed during the session, along with the most relevant results and gaps identified as well as explanation of the Interaction Map created by the participants.

6.3. Crete

The Focus Group sessions took place as part of the field activity organised in the “Natural History Museum of Crete” in Heraklion, on the 21st and 22nd of May 2024. A total number of 27 participants were present on both days. The participants represented the following stakeholder groups:

- Filios Zeus Volunteer Group
- Epidrasis Humanitarian Crisis Management Group
- Civilians of Arkalochory
- Protecta Volunteer Group
- Development Agency of Heraklion
- Municipality of Minoa
- Red Cross
- EKAB (National Center of Emergency Aid)
- Historical Museum of Crete
- Aarcheological Museum of Heraklion
- Municipality of Verdiada
- Athletics Team of Filios
- Athletics Club of Arkalochori
- Environmental Education Center of Arkalochori

Figure 35: Focus Group activity in Crete CORE Lab

On the afternoon of Day 1, the first 90-minutes focus group session was conducted. The second session took place on Day 2, in the morning. Participants have been grouped into two focus groups that were running in parallel, both on Day 1 and Day 2, focusing on the same exact question groups, as introduced in the Methodology Chapter (see D4.1 Section 2). The focus group sessions focused on the earthquake of Arkalochori as a context of reference that occurred in 2021. The information shared was based on the crisis description delivered in D1.1 (see p.92-98). At the end of the presentation, participants have been assigned to one of the two parallel focus groups, by following the principle of the key actors being evenly represented in both groups. After each focus

group session, facilitators were briefly video interviewed by the researchers of Deep Blue and Vicesse, asking for a high-level explanation of the topics discussed during the session, along with the most relevant results and gaps identified as well as explanation of the Interaction Map created by the participants.

6.4. Trondheim Red Cross

The Focus Group sessions took place as part of the field activity organised in the "Trondheim Røde Kors" in Trondheim, on the 12th and 13th of June 2024. A total number of 18 participants were present on both days. The participants represented the following stakeholder groups:

- The Museums of Southern Trøndelag (Museene i Sør- Trøndelag)
- SINTEF
- Trondheim kommune
- Pådriv Trondheim
- ECHOIng project (NTNU – Norwegian University of Sciences and Technology)
- Norwegian Women's Public Health Association (Norske Kvinners Sanitetsforening)
- Trondheim Red Cross Emergency Guard (Trondheim Røde Kors Beredskapsvakt)
- Southern Trøndelag Red Cross (Sør- Trøndelag Røde Kors)
- Trondheim Prison (Trondheim Fengsel)
- Norwegian Civil Defence (Sivilforsvaret)

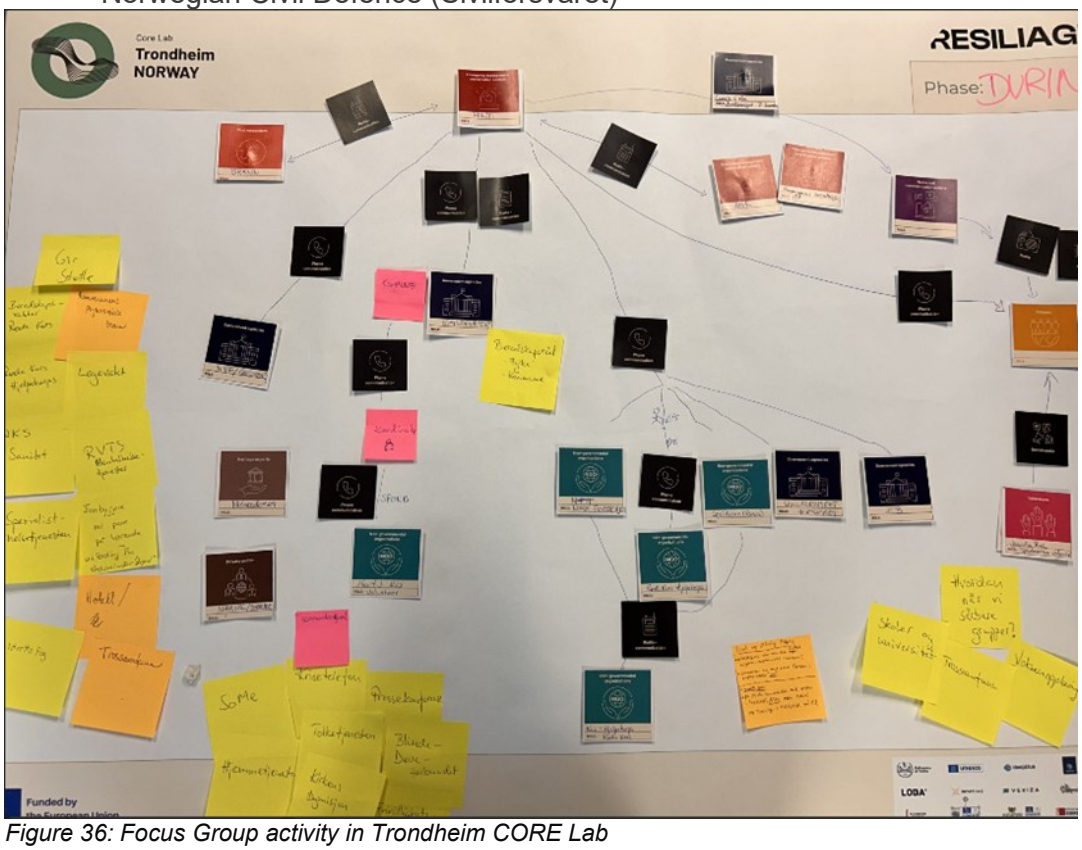

Figure 36: Focus Group activity in Trondheim CORE Lab

On the afternoon of Day 1, the first 90-minutes focus group session was conducted. The second session took place on Day 2, in the morning. Participants have been grouped into two focus groups that were running in parallel, both on Day 1 and Day 2, focusing on the same exact question groups, as introduced in the Methodology Chapter (see D4.1 Section 2). Lacking a relevant near-past landslide event in Trondheim, the focus group sessions focused on the hypothetical scenario of a potential future landslide. The information shared was based on the crisis description delivered in D1.1 (see p.102-106). At the end of the presentation, participants have been assigned to one of the two parallel focus groups, by following the principle of the key actors being evenly represented in both groups. After each focus group session, facilitators were briefly video interviewed by the researchers of Deep Blue and Vicesse, asking for a high-level explanation of the topics discussed during the session, along with the most relevant results and gaps identified as well as explanation of the Interaction Map created by the participants.

7. Introduction to the semi-structured interviews (T4.1)

7.1. Naturtejo Geopark

As a supplemental step of the focus group sessions, an online semi-structured interview has been conducted with the participation of the representative of the Emergency Protection and Relief Unit" (UEPS) of Proenca-a-Nova. The 60-mins interview took place in Portuguese on the 2nd of May, with the support of one of the native language research facilitators from the National School of Firefighters (ENB). The objective of the semi-structured interview was to gain a more specific understanding of the CORE lab's needs related to soft solutions, digital solutions and training: their content, format and most important characteristics. The facilitator was provided with several questions to be covered in a semi-structured way during the unfolding conversation with the interviewee. The questions were prepared based on the debriefings with the Focus Groups facilitators, to deep dive into the key issues reported in the focus group sessions and their potential mitigation by digital and soft solutions and training (for the whole list of questions, see Annex 3 of D4.1., p 95). At the end of the interview with the participant, the facilitator and DBL held a half-hour debriefing to summarise the discussed topics. Later, the transcripts of the interviews were provided to DBL in their whole length for further analysis.

7.2. Karsiyaka

In the case of Karsiyaka, the online semi-structured interview has been conducted with three participants (an academician, a first responder and a representative of the Izmir Metropolitan Municipality). The 60-mins interview took place in Turkish on the 16th of May, with the support of one of the native language research facilitators from DEMIR. The objective of the semi-structured interview was to gain a more specific understanding of the CORE lab's needs related to soft solutions, digital solutions and training: their content, format and most important characteristics. The facilitator was provided with several questions to be covered in a semi-structured way during the unfolding conversation with the interviewee. The questions were prepared based on the

debriefings with the Focus Groups facilitators, to deep dive into the key issues reported in the focus group sessions and their potential mitigation by digital and soft solutions and training (for the whole list of questions, see Annex 3 of D4.1., p 96-97). At the end of the interview with the participants, the facilitator and DBL held a half-hour debriefing to summarise the discussed topics. Later, the transcripts of the interviews were provided to DBL in their whole length for further analysis.

7.3. Crete

In the case of Crete, three separate online semi-structured interviews have been conducted with three participants. The first two interviews took place on the 30th of May. One of them has been conducted in German with a German-born independent volunteer who was involved in the immediate response after the earthquake, while the other one has been conducted in English with a resident of Arkalochori who organised the immediate response through the sports club. The third interview took place on the 5th of June in English with a person from the archaeological service. The objective of the semi-structured interviews was to gain a more specific understanding of the CORE lab's needs related to soft solutions, digital solutions and training: their content, format and most important characteristics. The questions were prepared based on the debriefings with the Focus Groups facilitators, to deep dive into the key issues reported in the focus group sessions and their potential mitigation by digital and soft solutions and training (for the whole list of questions, see Annex 3 of D4.1., p 97-99). All three interviews have been conducted by the colleague of Deep Blue, and each lasted approximately 60 to 90 minutes.

7.4. Trondheim Red Cross

In the case of Trondheim, the online semi-structured interview has been conducted with two participants from the municipality. The 60-mins interview took place in Norwegian on the 3rd of July, with the support of one of the native language research facilitators from Trondheim Red Cross. The objective of the semi-structured interview was to gain a more specific understanding of the CORE lab's needs related to soft solutions, digital solutions and training: their content, format and most important characteristics. The facilitator was provided with several questions to be covered in a semi-structured way during the unfolding conversation with the interviewee. The questions were prepared based on the debriefings with the Focus Groups facilitators, to deep dive into the key issues reported in the focus group sessions and their potential mitigation by digital and soft solutions and training (for the whole list of questions, see 14.1.5). At the end of the interview with the participants, the facilitator and DBL held a half-hour debriefing to summarise the discussed topics. Later, the transcripts of the interviews were provided to DBL in their whole length for further analysis.

8. Overview of Naturtejo Geopark CORE lab needs (T4.1)

"If it burnt five years ago, it would burn in seven."

(Representative of Geopark Naturtejo)

In the case of Naturtejo Geopark CORE lab, the quote has been chosen as it well represents the continuous need for members of the community to be prepared and able to respond to a potential upcoming crisis. Compared to some other types of natural disasters (e.g. earthquakes), wildfires represent a constant challenge to cope with and mitigate, therefore the skills and knowledge, as well as the mitigation strategies need to be refreshed and monitored on a more regular basis. According to the focus group participants, this continuous risk of wildfires is, on the one hand, the result of a gradual change in the demographic characteristics of the inhabitants: Naturtejo Geopark is characterised by an aging population with most of their inhabitants being 65 years old and older. As the younger generation has left the area to reside in bigger cities of the coastline, the area of the geopark has been gradually abandoned, leaving the forests around these towns poorly maintained. Participants of the focus group session have also mentioned how climate change has impacted the applicability of the local community knowledge related to fire response: summers are getting warmer, and the direction of the winds is changing going nowadays more frequently from the South to the North, resulting in a difficulty to predict the spread of the fire, and therefore, to respond effectively to crisis.

In Table 10 the key stakeholders participating in Naturtejo Geopark's CORE sessions are clustered, to give an overview on the roles that were part of the conversation and that actively co-shaped the discussions on the past crisis, from which the data analysed here was gathered from.

KEY STAKEHOLDER	DESCRIPTION
LOCAL AUTHORITIES	• Institute for Nature Conservation and Forests (ICNF) • National Emergency and Civil Protection Authority • Ministry of Education
FIRST RESPONDERS	• Fire Brigade • Volunteers • Portuguese Institute of the Sea and Atmosphere (IPMA)
CITIZENS	• Residents • Tourists / camper • Farmers

Table 10: Stakeholder groups in Naturtejo Geopark

The major highlights that are to be reported on the maps are summarised in Figure 37, where a simplified Interaction Map was recreated by DBL, visualising the communication chain of the most relevant stakeholders.

Regarding the communication between these actors, the most important findings are the following: there is a significant lack of communication between governmental agencies (e.g. between municipalities) when it comes to crisis response. As focus group participants reported, municipalities at the two sides of the river did not communicate and cooperate effectively with each other which significantly slowed down their crisis

response mechanisms. According to the perception of citizens, the government lacks effective communication with them: they often use television as a media to communicate, however, it is reported as being highly sensational and often causing panic. On the other hand, there are regulations in place to try to manage the forest and places around the villages, but citizens either do not know about their existence, or they do not comply because there are no consequences from the government's side to break the law. Furthermore, there are a lot of regulations currently in place that simply do not correspond to the characteristics and needs of the field, therefore are very difficult to apply. Finally, there is a lack of communication towards foreign campers who reside in the forests in camper vans. When it comes to frequently applied communication channels, citizens prefer face-to-face communication, television and phone communication the most, while first responders reported to frequently use informal communication channels (e.g. text applications). Finally, the challenges related to foreign campers are crucial to underline: these individuals, on the one hand, do not speak Portuguese, on the other hand, do not register themselves at the authorities, thus being considered very vulnerable to a potential wildfire, as first responders are simply not aware of their existence, their location and have no contact with them.

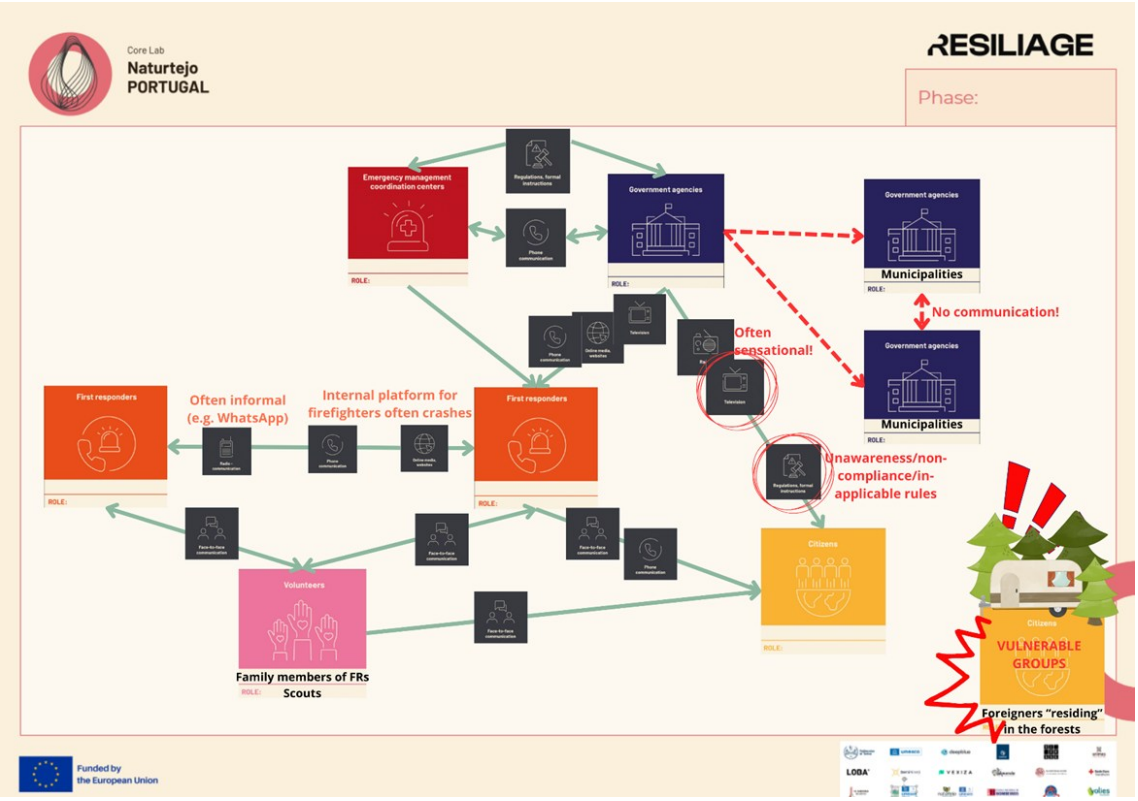

Figure 37: Recreated Interaction Map, visualising the communication of key stakeholders in the Naturtejo Geopark

8.1. Before the crisis

Introduction to the context

As mentioned earlier, the area has been undergoing a remarkable demographic change, resulting in an aging community where cultural knowledge related to forest maintenance and fire preparedness is not transferred to younger generations anymore. When it comes to the preparedness of the community, as respondents highlighted, television is very often used for awareness raising purposes, however, due to the outdated, repetitive format, these campaigns do not reach their purpose anymore. Alternative campaigns (e.g. Safe Village, Safe People) on the other hand often prove to be ineffective due to the lack of citizens' willingness in taking responsibility. As reported, for citizens of smaller towns, personal relationships are very important, and therefore feared to be at risk due to ineffective acts of volunteering. When it comes to education, there are training available to prepare citizens for what to do in crisis, however, these are not available in every village, and often not in appropriate format to address older generations, too.

Identification of gaps, best practices, needs

In the following, the key stakeholders analysed (Local Authorities, FRs, Citizens) are described in more detail. A comprehensive overview of the existing gaps that hinder their response capabilities are identified and best practices to address these issues are presented, if available. Best practices include possible implementation priorities that were addressed by participants during the Focus Group sessions, as well as successful strategies already put in place that represent success examples and/or inspiring approaches that could be considered to support key stakeholders in the enhancement of their preparedness.

- **Local authorities**

There is a great need for local authorities to be trained to recognize misleading or distorted communication, especially in emergency situations where accurate information is critical. In addition, it is important to learn how to work effectively with different stakeholders, including first responders and fellow citizens. The approach of local authorities to use television and media communication has been criticized for sensationalizing emergency situations. In 2017, this led to widespread panic, causing people to leave their designated safe areas and move to open fields, which inadvertently put them at greater risk of fire.

- **First responders**

The perception is that the fire fighters are knowledgeable about procedures as well as they are well-prepared and trained for emergencies. They are also aware of where vulnerable people (e.g. elderly or disabled individuals) live, and in case of a fire, their priority is to make sure these people are evacuated to safe areas. To enhance fire response capabilities, there is a recognized need for volunteers to adopt new technologies that enable quick and efficient communication. Additionally, ongoing training for both volunteers and professionals is considered essential.

The fire brigade proactively engages with the community by presenting their fire vehicles and ambulances at all council's educational institutions twice a year. This initiative aims to raise awareness among children and provide them with instructions on how to act in emergencies. Firefighters also distribute business cards and magnets, which can be placed on refrigerators, featuring instructions for fire emergencies and the contact number of the fire brigade. During these distributions, they take the opportunity to explain the alert chain and emergency procedures to ensure the community is well-informed and prepared.

- **Citizens**

Risk awareness campaigns on television, which are crucial for educating citizens about fire safety measures, have become less effective over time. The same campaign is broadcasted every year, leading to a sense of fatigue among the public, who often pay no attention to it. This apathy poses a challenge to fire prevention efforts, as the repeated message fails to engage and inform individuals on what to do in case of a fire, such as refraining from barbecuing in the forest. It underscores the need for innovative approaches to maintain public interest and awareness regarding fire safety. To address this, each municipality is set to implement a program aimed at raising awareness about the importance of maintaining clean forest areas around homes. This initiative includes training for citizens, using simulations, to educate them on the appropriate actions to take in case of a fire warning. It has been mentioned that awareness-raising campaigns for fire safety should indeed focus on “simple things” that are easy to remember and apply in case of a fire. These campaigns should not be limited to forest fires but also include general fire safety tips that can be practiced in any environment. It’s essential to tailor the information to the target audience to ensure that the message is relevant and engaging.

Furthermore, the following needs have been identified: the distribution of informative flyers at strategic public locations, direct community engagement (face to face dialogue) to discuss the risks associated with wooden housing and the importance of alert systems, and the strategic allocation of resources to develop prevention campaigns that effectively reach all segments of the population.

In addition, the following need emphasizes the importance of making citizens aware that firefighters are also humans, with limitations and challenges of their own. There is a necessity for clear and transparent communication regarding the collaborative efforts of various organizations involved in fire management, their methodologies, and the shared responsibilities. Additionally, it is crucial to establish a partnership with the media to ensure that this information reaches the public at large, fostering a well-informed community that understands the human element in firefighting operations

There is further a recognized need for workshops that inform citizens about the application of existing tools, such as agricultural equipment for protection purposes and instruct on the correct use of fire extinguishers. The concern expressed by a citizen about the lack of education on what to do during a fire underscores the critical need for educational initiatives. Additionally, there is a need for better management of resources to ensure that prevention campaigns are not only funded but also designed to reach the entire population, rather than focusing solely on specific groups like students.

To enhance crisis management, firefighters and forest keepers access remote villages to conduct informative events that update and educate citizens on emergency protocols. These sessions are important in teaching the general public what actions to take during a crisis. Additionally, the community plays a supportive role for first responders, such as preparing meals during emergencies. Communication is primarily face-to-face, allowing citizens to organize and mobilize assistance effectively.

Elderly people and individuals with disabilities are also recognized as vulnerable groups within these communities. They are systematically registered and identified, enabling firefighters to locate and assist them promptly if an emergency arises. This proactive approach ensures that all members of the community, especially those who are most vulnerable, are accounted for and can receive the necessary help in a timely manner.

To further this effort, two educational programs titled “Safe Village” (Aldeia Segura) and “Safe People” (Pessoas Seguras) have been introduced. Safe Villages is a program to protect the population and the forests through the implementation and management of protection zones, strategic infrastructure, the identification of critical points and safe havens. On the other hand, Safe People is an awareness raising program, to prevent risk behaviour, self-protective measures and carrying out evacuation drills, together with the municipalities, by featuring checklists that residents can follow during emergencies. The program encourages the appointment of a responsible individual from the village to oversee the completion of the checklist. This includes verifying if anyone requires evacuation and ensuring that everyone is in a safe location with adequate fresh air. While the national program for crisis management is in place, not all villages have access to it, and some even opt out of participating. The success of the program at the village level hinges on the initiative of a responsible individual to take action. Community members are tasked with identifying residents who may have low mobility or lack internet access, among other vulnerabilities. This crucial information is then communicated to the firefighters, ensuring they have the necessary data to provide assistance effectively during emergencies. It is a collaborative effort that requires both top-down support and grassroots engagement to be successful. In the context of emergency management, there is a general willingness among people to collaborate and assist one another. However, there is a reluctance to bear the weight of responsibility, particularly in high-stakes situations such as a house fire, where the fear of being blamed if the situation deteriorates is prevalent.

An identified need within this framework is the distribution of responsibility, not just to a single individual but among a group. This approach could potentially foster a sense of encouragement and security, as shared responsibility may lead to increased confidence and collective ownership of the situation.

This need is especially pertinent in areas with an elderly population that may not use technology or even television. In such communities, face-to-face interaction remains the most effective method of engagement, ensuring that vital information and support are provided in a manner that is accessible and reliable for all residents. The experience of those working in these areas underlines the importance of adapting communication and responsibility strategies to the specific needs and preferences of the community.

8.2. During the crisis

Introduction to the context

When it comes to delivering warnings to citizens, the Portuguese Institute of Sea & Atmosphere (IPMA) has a crucial role by communicating via phones, emails and various online media. Once the crisis occurs, one of the greatest challenges in crisis response are the geographical characteristics of the area: the community is an isolated area with many villages being relatively far from each other which makes it difficult for firefighters to reach all of them, be present and protect citizens, properties and animals. As respondents of the field activity explained, firefighters are often recruited from the North to join the local forces, however, in the lack of local knowledge of the field, crisis response as well as coordination between these teams are often demanding. On the other hand, firefighters are to a great extent supported by the volunteers of the community, who prepare meals and provide support in accommodating people.

Identification of gaps, best practices, and needs

In the following, the key stakeholders analysed (Local Authorities, FRs, Citizens) are described in more detail. A comprehensive overview of the existing gaps that hinder their response capabilities are identified and best practices to address these issues are presented, if available. Best practices include possible implementation priorities that were addressed by participants during the Focus Group sessions, as well as successful strategies already put in place that represent success examples and/or inspiring approaches that could be considered to support key stakeholders in the enhancement of their preparedness.

- **Local authorities**

Alerting the public in emergency situations involves multiple channels. Civil protection sends SMS alerts, which are somewhat effective. Additionally, radio and television broadcasts are used, although the information on television can sometimes be distorted and not well-filtered. A national solution for sending SMS alerts during fires exists, but it does not reach everyone due to varying levels of technology access. Language barriers also pose a challenge; not all residents speak Portuguese or English, suggesting that an smart application could be beneficial in overcoming this obstacle. The Portuguese Institute of Sea & Atmosphere engages in extensive internal communications, including phone calls, emails, checklists, websites, and online media, to issue warnings to citizens.

Local authorities have identified social media (Facebook, X, Instagram, Tiktok) and traditional media (television, radio) as the most consulted channels for communication during disasters, with printed media being the least intuitive and least consulted. They have expressed difficulties in overseeing the situation due to a lack of sufficient information, which hampers their ability to convey accurate messages. To address this, they have highlighted a need for clear, actionable instructions for prompt intervention, continuous updates on the disaster's progression, and awareness of other actors' activities to ensure synchronized disaster management efforts. A potential soft solution includes the creation of simple guidelines and plans for citizens that describe the steps to take in case of a crisis. For digital solutions, there is a need for the general community to receive updated information through an early warning system. A mobile application could serve as an important tool to provide timely alerts and instructions to the public during emergencies.

- **First responders**

In the phase during the disaster management, it has been observed that printed media ranks low in terms of consultation and intuitiveness. Communicating crucial information to vulnerable groups such as children, the elderly, and refugees or displaced individuals poses significant challenges. First responders, including coordination centres, predominantly rely on radio communication, which is susceptible to failure due to overcrowding of channels. The reliance on backup communication systems is not always suitable, as these systems are vulnerable to power network instabilities.

However, firefighters employ a variety of communication tools including television, radio, phones, local radios, WhatsApp groups, and radio alerts to both local stations and citizens. Informal channels like personal WhatsApp groups are also in play among first responders and firefighters for internal communication. Online media serves as a fallback for information when radio communication falls short. The telecommunications infrastructure is notably vulnerable during disasters, underscoring the need for resilient communication systems that can withstand damage and sustain critical communications. Direct contact is also crucial for providing reassurance about fire proximity, the safety of

specific towns or villages, and guidance on locating safe places. Additionally, the digital solution 'focus.pt' is an app designed for monitoring fires, contributing to the array of tools available for managing and communicating during fire emergencies.

In addition, firefighters utilize a dedicated internal platform that requires login credentials to upload photos and share location updates. However, this platform is not robust enough to handle high traffic and tends to crash when too many users access it simultaneously. There is a clear need for a solution that can provide stable performance even with multiple users accessing the system concurrently.

Volunteers and Scouts are integral to the disaster response mechanism, providing essential logistical support such as accommodating people in schools and assisting with food preparation.

- **Citizens**

In rural areas, the aging population, widespread residences, and scarce technological resources pose significant challenges, particularly during emergencies. The primary modes of communication are telephones and television. Residents rely on telephones to stay informed about immediate dangers, such as the location and expected path of wildfires, and to check on the well-being of family members. Television also plays a crucial role, especially for those who own property in the area but live elsewhere, allowing them to stay updated and return if necessary.

Despite the prevalence of modern communication methods, face-to-face interaction is still the most favoured in these communities, notably among the elderly who may not have access to the latest technology. The absence of social media and internet usage is significant, as the older demographic (ages 70-80) typically does not engage with these platforms. Instead, they depend on traditional information sources like phone calls, radio, and television.

The telecommunications infrastructure, a critical component often compromised during natural disasters, becomes a significant concern when communication networks fail. This failure leaves residents unable to use phones, leading to panic due to the lack of news about the safety of their loved ones.

Misinformation is a critical factor that can severely compromise emergency responses, with the rapid dissemination of false information through digital channels posing significant risks.

A pressing issue is the presence of foreigners living a hippie lifestyle in the forest, who remain undetected by firefighters and authorities. These individuals often build unauthorized infrastructures and, due to their secluded location, cannot be reached or communicated with, as their whereabouts—and even their existence—are unknown. They are not mere tourists; they arrive in vans and settle in, yet they lack knowledge of the terrain, the associated risks, and do not have strategic emergency plans. This lack of awareness and preparation leaves them highly vulnerable, and without precise information on their location, it is uncertain whether they require assistance or not. This situation presents a complex challenge for emergency response efforts in such environments.

The uncertainty surrounding governmental recovery funds has led to a condition where individuals prefer to stay and protect their homes during emergencies. This decision is driven by the sentiment that their homes represent their life's work and all their

possessions. Faced with the prospect of losing everything, they choose to defend their property, reflecting a change in behaviour due to the realization that not everyone can be reached or assisted in times of crisis.

The need for direct contact to inform and reassure residents about the proximity of a fire has been identified. This includes confirming whether a specific town or village will not be affected by the fire and providing instructions on where to find a safe place to stay.

8.3. After the crisis

Introduction to the context

When it comes to after the crisis, participants of the focus group sessions highlighted the importance of investigating the past in more details, including the identification of best practices ("what went well") and challenges in communication, coordination as well as the practical evaluation of the feasibility of instructions and regulations. As it has been articulated, citizens of the area are often not entirely aware of the available resources after the crisis, which poses a further challenge on recovering from the crisis.

Identification of gaps, best practices, and needs

- **Local authorities**

As highlighted before, one of the most important gaps related to local authorities is that they are often perceived as ineffective in providing crucial, up-to-date information to citizens. It would also be important to identify current rules and instructions that are not feasible when it comes to practice. Collecting this information would support local authorities to re-evaluate the already existing preparedness plans and adjust them to the characteristics of the crisis. One important best practice of the recovery phase to mention is the "Village Condominiums Program" (Condomínios de Aldeia) implemented to change the landscape from forest landscape to trees that are more resistant to fire. Where this program is implemented, a circle of this type of trees is planted around the village, and the fire did not reach this village.

- **First responders**

Similarly to what has been reported previously, firefighters reported to have a great collaboration with local volunteers (they are usually family members) who together with the associates of the firefighters provide support at the fire station, once the crisis is over. On the other hand, they also reported the need of actively evaluating past crises to identify best practices and challenges related to crisis response.

- **Citizens**

One of the greatest challenges related to citizens in the recovery phase is their difficulty to receive up-to-date information about the available resources provided, as well as the difficulty of receiving financial aid when they are indirectly affected by the fires (e.g. having their crops heavily damaged by the heat of the fire). They reported the need for support in the proper cleaning and maintenance of the village and forest area: due to their age, citizens are often physically incapable of taking care of it.

8.4. Overview of the needs identified for the key stakeholders under analysis

The stakeholders' needs presented in the before/during/after phases are summarised as main outcomes of this analysis in Table 11.

Table 11 offers a comprehensive overview on the analysis of local authorities', FR and citizens' gaps and needs, relevant to the analysed phase. The table shows the existing gaps that hinder the response capabilities of Local Authorities and presents best practices to address these issues. Best practices include possible implementation priorities that were addressed by participants during the Focus Group sessions, as well as successful strategies already put in place that represent success examples and/or inspiring approaches that could be considered in order to address the needs of the key stakeholders supporting in the enhancement of their preparedness. Should the circumstances also arise in more than one phase of the crisis, this is also indicated in the left-hand column.

PHASE	KEY STAKEHOLDERS	GAPS	BEST PRACTICES	NEED
LOCAL AUTHORITIES				
Before/During	Local authorities	• No effective communication with citizens. • Channels are in some cases inappropriately chosen (e.g. social media) and used (e.g. television)	• "Safe Villages" and "Safe People" program to protect lands and citizens and to prepared them for future crises. • A variety of channels are used to reach the public.	Need to understand and build a strategy of what, how, and on which channels to communicate to citizens of different demographic backgrounds, to keep them updated and avoid causing panic.
Before/During	Local authorities	Difficulty in receiving and identifying up-to-date and valid information of the actual state of the crisis	N/A	Need for local authorities to be trained to recognize misleading or distorted communication, especially in emergency situations where accurate information is critical.

Table 11: Overview of needs according to the phases before, during and after the crisis (N Naturtejo Geopark)

During	Local authorities	Local authorities often do not communicate and coordinate effectively with each other, first responders and citizens.	N/A	• Need to learn how to communicate and work effectively with different stakeholders, including first responders and fellow citizens. • Need for clear, actionable instructions for prompt intervention. • Need for continuous updates on the disaster's progression. • Need for awareness of other actors' activities to ensure synchronized disaster management efforts. • Need for revising laws and regulations in terms of their feasibility and applicability in real operation

During	Local authorities	Language barriers to communicate with non-Portuguese and non-English speaker individuals	N/A	A need to communicate “what to do in crisis” in multiple languages.
After	Local authorities	No effective communication about the available resources for financial compensation or other types of support in recovery	“Village Condominiums Program” to change the landscape (e.g. types of trees) to become more resistant to future crises.	Need for effective communication with citizens about the available resources to support the recovery from the crisis.
After	Local authorities	The issue of centralisation: regulations do not always work effectively once put in practice.	N/A	Need for revising laws and regulations in terms of their feasibility and applicability in real operation
PHASE	**KEY STAKEHOLDERS**	**GAPS**	**BEST PRACTICES**	**NEED**
FIRST RESPONDERS (FRs)				
Before/During	Firefighters	Unawareness of the current list individuals belonging to vulnerable groups (elderly, children, disabled, tourists, campers).	• Perceived as knowledgeable about procedures, well-prepared and trained for emergencies. • Awareness of where vulnerable people live, and in case of a fire, their priority is to make sure these people are evacuated to safe areas. • Regular raise awareness campaigns and education of citizens - instructions on how to act in emergencies (business cards, magnets, contact numbers to put on refrigerators)	• Need for an updated list of vulnerable individuals within the villages and in the forests, too (tourists, campers). • Need to be able to contact and communicate with vulnerable groups in different languages and prepare them for crisis.

During	Firefighters	• Difficulty communicating and coordinating with other actors, often informal communication (e.g. WhatsApp groups) where information is difficult to search and manage. • Difficulty of coordinating with non-local firefighters joining them on the field.	Internal online website to share information among firefighters (credentials needed, and often breaks down)	• There is a need for training on how to best collaborate with volunteers and local authorities in crisis. • Need for training on how to team up and collaborate with firefighters of other regions. • Need for more robust, easy-to-use, formal communication channels
During	Volunteers	N/A	Assisting first responders by preparing meals and helping to accommodate citizens	• Need for volunteers to adopt new technologies that enable quick and efficient communication. • Ongoing training on how to collaborate with authorities and first responders and citizens • Direct contact is also crucial for providing reassurance about fire proximity, the safety of specific towns or villages, and guidance on locating safe places
After	Firefighters	N/A	N/A	• Need for reflecting on past crises, identifying best practices, points of challenges and lessons learned for future purposes.
PHASE	**KEY STAKEHOLDERS**	**GAPS**	**BEST PRACTICES**	**NEED**
CITIZENS				

Before	Citizens	• Risk awareness campaigns have been repetitive over the last few years and no longer attract attention • Social media communication is absolutely lacking in this field, because people are older (70-80), they do not use social media and internet. • Face-to-face communication, phone calls, radio and television are the main sources of information.	• Risk awareness campaigns running on television to inform citizens what to do in case of a fire (e.g. do not barbecue in the forest.). • They access information through firefighters or forest keepers that go to these villages and organize an event where they update and inform village citizens – educate people what to do during crisis. • Educational program: „Safe Villages" and "Safe People" – checklists to follow during the emergency. One village person should be responsible to double-check and make sure the checklist is done. Check if there is anyone who needs help to be evacuated. To check if everyone is in a safe place with enough fresh air.	• Face to face contact and updated risk awareness campaigns that spark the citizens' interest. • Consider not only leaving one person in charge but distribute the responsibility among a group of people - benefit as they would feel more encouraged, more secure. • Easy-to-use and easy-to-remember information related to what to do, who to contact, where to go in case of fire.
Before	Citizens	• The heritage of local knowledge related to how to maintain forests and villages to keep them safe is not transferred to younger generations, therefore fading away.	• N/A	• Need for face-to-face occasions where knowledge, best practices and lessons learned related to the maintenance forests, villages and streets can be shared among citizens of different generations.

Before/During	Citizens	• Citizens with special needs (problems with hearing or vision, digital illiteracy) having difficulty understanding official warnings	• Vulnerable individuals registered at first responders – they are priorities to evacuate	• Need for targeted awareness campaigns, and information material tailored to the needs of the audience: e.g. using multiple (traditional) channels, simplified information and further aides like Braille text, sound amplification of warnings)
Before/During	Citizens (vulnerable groups of van campers and tourists)	• Foreign van campers in the forest do not contact and inform authorities about their existence and whereabouts, which makes them particularly vulnerable • Van campers and tourists are not aware of the regulations related to "how to behave" in the forest areas.	N/A	• Education of these individuals to raise their awareness of the risk of fires • Educating them about how to inform themselves about the crisis, what to do, who to contact and how to locate themselves in case of a fire • Education related to regulations in practice – what NOT to do to avoid fire. • An online list of campers and tourists including names, preferred languages, planned locations and contact number would be important.
Before	Citizens	Citizens often lack knowledge related to the application of already existing tools (e.g. fire extinguishers, agricultural equipment).		• Education and training would be needed to support citizens in acquiring practical, easy-to-use, easy-to-remember knowledge related to the use and maintenance of special equipment.
After	Citizens	Citizens are often uncertain of the available resources to support them in recovering from the crisis	N/A	• Need to inform citizens about existing and available resources

8.5. Overview of solutions and user requirements

As the final step of the analysis of the needs in Naturtejo Geopark, a preliminary tentative matching has been created between a selection of needs and the solutions that RESILIAGE project has to offer, namely: **soft solutions** (Risk awareness campaigns, Preparedness toolkits, Communication guidelines), **training** and **digital solutions** (RAISE tool, Monitoring Dynamic Resilience Dashboard, Multihazard Early Warning Detection System, Multi-agent Social Network Modelling, CORE Digital Network, Decision Support System, ATLAS tool). At this stage, the table only contains a preliminary comparison of the selected needs that could potentially be addressed by RESILIAGE solutions and tools in order to discuss and prioritise them further with the research and CORE laboratory partners. In addition to mapping the needs, this table also contains generic, high-level user requirements that are results of the combined research process of T4.1. and should be taken into consideration when developing the solutions.

8.5.1. Soft solutions

The following table reports the preliminary match between key stakeholders' (local authorities, first responders, citizens) needs and requirements and the soft solutions to be developed within RESILIAGE project: risk awareness campaigns, preparedness toolkits and communication guidelines.

Table 12: Preliminary match of needs and requirements with soft solutions (LA= local authorities, FR= first responders, C= citizens)

Type of solution	*Stake-Holders*	*Needs*	*User Requirements*
Risk awareness campaigns	**LA**	N/A	
	FR	N/A	
	C	• Updated risk awareness campaigns that spark the citizens' interest. • Easy-to-use and easy-to-remember information related to what to do, who to contact, where to go in case of fire. • Education related to regulations in practice – what NOT to do to avoid fire.	• Revised, renewed content that spark citizens' interest • Targeted to needs of the audience • Using multiple channels (face-to-face, social media, television, radio) • Simplified information • Further aides for vulnerable groups (e.g. Braille text, sound amplification)
Preparedness toolkits *(infographics, safety plan checklist, safety plan templates)*	**LA**	• Need to receive clear and actionable instructions about how to promptly intervene.	
	FR	N/A	
	C	• Consider not only leaving one person in charge but distribute the responsibility among a group of people - benefit as they would feel more encouraged, more secure. • Easy-to-use and easy-to-remember information related to what to do, who to contact, where to go in case of fire. • Educating citizens about how to inform themselves about the crisis, what to do, who to contact and how to locate themselves in case of a fire	• Simplified information • Practical information, highlighting how citizens are personally affected. • Practical, easy-to-use, easy-to-remember • List of actions: what to do, what not to do

		• Education related to regulations in practice – what NOT to do to avoid fire. • Education and training would be needed to support citizens in acquiring practical, easy-to-use, easy-to-remember knowledge related to the use and maintenance of special equipment • Need to inform citizens about existing and available resources	• Opportunity to share best practices, personal stories (face-to-face). • Available in multiple languages
Communication Guidelines	**LA**	• Need to understand and build a strategy of what, how, and on which channels to communicate to citizens of different demographic backgrounds, to keep them updated and avoid causing panic. • Need to receive clear and actionable instructions about how to promptly intervene. • Need for effective communication with citizens about the available resources to support the recovery from the crisis.	• Simple guidelines and plans • Actionable items and information • Available in multiple languages
	FR	• Need to be able to contact and communicate with vulnerable groups in different languages and prepare them for crisis.	• Simple guidelines and plans • Actionable items and information • Available in multiple languages
	C	N/A	

8.5.2. Training

Table 13 represents the preliminary match between key stakeholders' (local authorities, first responders, citizens) needs and requirements and the *trainings* to be developed within RESILIAGE project has been mapped.

Table 13: Preliminary match of needs and requirements with training (LA= local authorities, FR= first responders, C= citizens) of the key stakeholders

Stake-holders	*Needs*	*USER REQUIREMENTS*
LA	• Training on how to communicate with people through the media. • Receive training or education on how to identify misleading, distorting communication. Receive training on how to best collaborate with different actors (first responders and citizens). • Need to learn how to communicate and work effectively with different stakeholders, including first responders and fellow citizens. • Need for awareness of other actors' activities to ensure synchronized disaster management efforts. • Need for revising laws and regulations in terms of their feasibility and applicability in real operation	• Need for clear, actionable instructions for prompt intervention.

FR	• Continuous training of volunteers and professionals is seen as crucial for improving fire response capabilities. • Need to develop more structured response systems. Need to establish effective collaboration among local authorities, firefighters, and communities to streamline responses and maximise the efficacy of rescue operations. • Need to be able to contact and communicate with vulnerable groups in different languages and prepare them for crisis. • There is a need for training on how to best collaborate with volunteers and local authorities in crisis. • Need for training on how to team up and collaborate with firefighters of other regions. • Need for volunteers to adopt new technologies that enable quick and efficient communication. • Need for reflecting on past crises, identifying best practices, points of challenges and lessons learned for future purposes.	Cross-sectoral collaboration would include first responders, citizens, property managers, volunteers, and representatives from governmental and non-governmental organisations.
C	• Easy-to-use and easy-to-remember information related to what to do, who to contact, where to go in case of fire. • Need for face-to-face occasions where knowledge, best practices and lessons learned related to the maintenance of forests, villages and streets can be shared among citizens of different generations. • Education of individuals to raise their awareness of the risk of fires • Educating citizens about how to inform themselves about the crisis, what to do, who to contact and how to locate themselves in case of a fire • Education related to regulations in practice – what NOT to do to avoid fire. • Education and training would be needed to support citizens in acquiring practical, easy-to-use, easy-to-remember knowledge related to the use and maintenance of special equipment • Need to inform citizens about existing and available resources	• Simplified information • Practical information, highlighting how citizens are personally affected. • Practical, easy-to-use, easy-to-remember • List of actions: what to do, what not to do • Opportunity to share best practices, personal stories (face-to-face).

8.5.3. Digital solutions

In table 14 the preliminary match between key stakeholders' (local authorities, first responders, citizens) needs and requirements and the digital solutions to be developed within RESILIAGE project is reported. The digital tools taken into consideration for the mapping are the following: RAISE tool, Monitoring Dynamic Resilience Dashboard, Multihazard Early Warning Detection System, Multi-agent Social Network Modelling, CORE Digital Network, Decision Support System, ATLAS tool.

Table 14: Preliminary match of needs and requirements with digital solutions (LA= local authorities, FR= first responders, C= citizens)

Type of solution	*Stake-holders*	*Needs*	*USER REQUIREMENTS*

The Resilience Assessment Interactive Self-Enabler tool (RAISE)	LA	N/A	N/A
	FR	N/A	N/A
	C	• Information related to what to do, who to contact, where to go in case of fire. • Education of these individuals to raise their awareness of the risk of fires • Educating citizens about how to inform themselves about the crisis, what to do, who to contact and how to locate themselves in case of a fire • Education to support citizens in acquiring practical, easy-to-use, easy-to-remember knowledge related to the use and maintenance of special equipment • Need to inform citizens about existing and available resources	• Easy-to-use and easy-to-remember, actionable and practical information
Monitoring Dynamic Resilience Dashboard	LA	• Need for continuous updates on the disaster's progression (if the data is public)	• Need for more robust, easy-to-use, formal communication channels
	FR	N/A	N/A
	C	N/A	N/A
Multi-hazard early warning detection system	LA	N/A	N/A
	FR	N/A	N/A
	C	• To receive credible information as fast as possible an alert system was indicated as the strongest need of digital solutions. • A need for the general community to receive updated information	• Need for more robust, easy-to-use, formal communication channels
Multi-agent social network modelling	LA	• Need for local authorities to be trained to recognize misleading or distorted communication, especially in emergency situations where accurate information is critical.	

for Resilient Behaviour		• Need to learn how to communicate and work effectively with different stakeholders, including first responders and fellow citizens.	
	FR	N/A	N/A
	C	N/A	N/A
CORE Digital Network	LA	• Need to learn how to communicate and work effectively with different stakeholders, including first responders and fellow citizens. • Need for awareness of other actors' activities to ensure synchronized disaster management efforts. • Need to communicate "what to do in crisis" in multiple languages. • Need for effective communication with citizens about the available resources to support the recovery from the crisis.	
	FR	• There is a need for training on how to best collaborate with volunteers and local authorities in crisis. • Need for training on how to team up and collaborate with firefighters of other regions. • Ongoing training on how to collaborate with authorities and first responders and citizens. • Need for reflecting on past crises, identifying best practices, points of challenges and lessons learned for future purposes.	
	C	• Face to face contact and updated risk awareness campaigns sparking the citizens' interest. • Education of these individuals to raise their awareness of the risk of fires. • Educating them about how to inform themselves about the crisis, what to do, who to contact and how to locate themselves in case of a fire. • Education related to regulations in practice – what NOT to do to avoid fire. • Need to inform citizens about existing and available resources.	

Decision Support System (DSS)	LA	• Need to understand and build a strategy of what, how, and on which channels to communicate to citizens of different demographic backgrounds, to keep them updated and avoid causing panic. • Need for local authorities to be trained to recognize misleading or distorted communication, especially in emergency situations where accurate information is critical. • Need to learn how to communicate and work effectively with different stakeholders, including first responders and fellow citizens. • Need for revising laws and regulations in terms of their feasibility and applicability in real operation. • Need to communicate "what to do in crisis" in multiple languages. • Need for effective communication with citizens about the available resources to support the recovery from the crisis.	• Clear, actionable and prompt instructions. • Communication "panels" with civilians should be available in multiple languages.
	FR	• There is a need for training on how to best collaborate with volunteers and local authorities in crisis. • Need for training on how to team up and collaborate with firefighters of other regions. • Ongoing training on how to collaborate with authorities and first responders and citizens. • Need for reflecting on past crises, identifying best practices, points of challenges and lessons learned for future purposes.	
	C	• Information related to what to do, who to contact, where to go in case of fire. • Need for sharing best practices and lessons learned related to the maintenance of forests, villages and streets among citizens. • Need for targeted awareness campaigns, and information material tailored to the needs of the audience • Education of individuals to raise their awareness of the risk of fires. • Educating citizens about how to inform themselves about the crisis, what to do, who to contact and how to locate themselves in case of a fire. • Education related to regulations in practice – what NOT to do to avoid fire. • Supporting citizens in acquiring practical knowledge related to the use and maintenance of special equipment. • Need to inform citizens about existing and available resources.	• Easy-to-use and easy-to-remember, actionable and practical information. • Simplified, practical information • Further aides to support vulnerable groups (e.g. Braille text, sound aides) • Multiple channels used
	LA	Need for continuous updates on the disaster's progression.	

FR	• Need for an updated list of vulnerable individuals within the villages and in the forests, too (tourists, campers). • Direct contact is also crucial for providing reassurance about fire proximity, the safety of specific towns or villages, and guidance on locating safe places.	
C	• Need for sharing, best practices and lessons learned related to the maintenance of forests, villages and streets. • An online list of campers and tourists including names, preferred languages, planned locations and contact number would be important.	

9. Overview of Karsiyaka Municipality CORE lab needs (T4.1)

"Heatwave, the silent killer."

(participant of the focus group session)

To describe the most important characteristics of the CORE lab-related crisis, the quotation "Heatwave, the silent killer" has been chosen, as it well represents the core issue related to heatwaves. Compared to other types of disasters (e.g. earthquakes, floods, fire) heatwaves are not visible, although many of the population suffer from its health-related consequences. As a result, the general awareness to this type of risk is perceived as very low among citizens as well as governmental institutions. Being a densely populated municipal city-district within Izmir, the effects of heat are clearly exacerbated because of a large-scale urbanization that has been taking place since the 1980's. The city has been undergoing an extensive growth, resulting in significant change in spaces, materials used for buildings, the design of the buildings, the available green areas as well as the natural mitigative effect of the sea breeze to the inner areas of the city. As it has been understood from the focus group sessions, an important contributing factor to the generally low risk awareness is the lack of well-planned, tailored and correctly targeted communication with the citizens about this type of natural hazard. Because of the above-mentioned urbanization, the city has been witnessing a significant internal immigration, resulting in a dense and highly heterogenous population in terms of demographic characteristics and preferences for media consumption. However, communication towards citizens about the risk of heatwaves has reportedly not been well-executed, in terms of timing, the variety of communication channels used as well as targeting the right population. As it has been learned during the data gathering process, the most affected vulnerable groups are elderly, children, pregnant women, individuals with chronic diseases, as well as employees that are directly exposed to heat due to the nature of their job (e.g. road workers). Partly due to the characteristics of this type of natural hazard, as well as the generally low risk awareness, the CORE lab has reported no recovery plans or measures being available to the city.

Table 15: Stakeholder groups in Karsiyaka CORE lab

KEY STAKEHOLDER	DESCRIPTION
LOCAL AUTHORITIES	• Ministry of Health • Municipality • Meteorology Institution • Ministry of Climate Change
FIRST RESPONDERS	• AFAD - Central Governmental First Responder Organization Agency • Fire brigade • General Practitioners • Volunteers
CITIZENS	• Residents

	• Muhtars (neighborhood representatives)

The major highlights that are to be reported on the maps are summarised in Figure 38, where a simplified Interaction Map was recreated by DBL, visualising the communication chain of the most relevant stakeholders.

According to the results, there is a general pattern of centralized communication related to heatwaves, with reportedly less effective use of communication channels, providing rather vague or sometimes even controversial messages to a less well-targeted group of citizens. In addition, the potential role of Muhtars and building managers in the communication chain was emphasized. While local municipalities usually organize the work of volunteers via social media, this link is missing in the case of heatwaves, although volunteers would be very important to be able to reach the dense and highly heterogenous population of Karsiyaka. While vulnerable people are well looked after by their general practitioners, objective data about medical emergencies or fatalities related to heatwaves are often missing, therefore making the magnitude of the hazard difficult to calculate. Participants furthermore emphasized the role of education institutes in raising citizens' awareness to the risk of heatwaves.

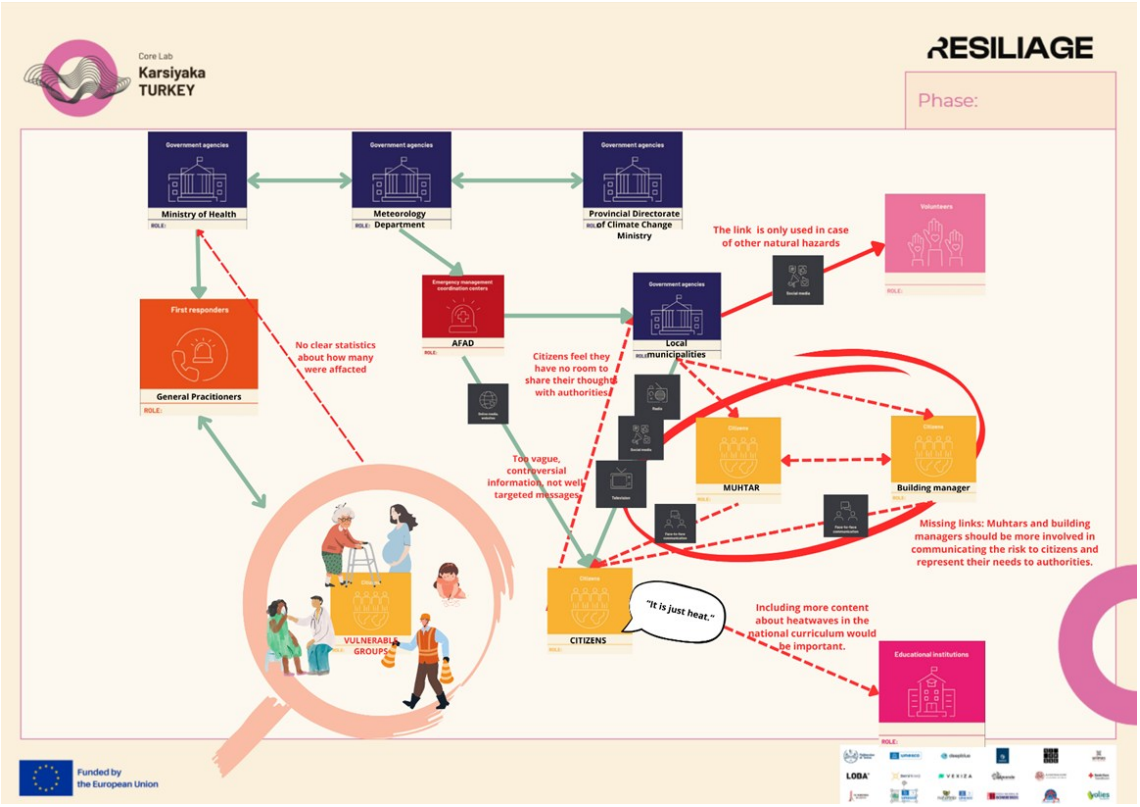

Figure 38: Recreated Interaction Map, visualising the communication of key stakeholders in the Karsiyaka CORE lab

9.1. Before the crisis

Introduction to the context

As highlighted earlier, one of the greatest challenges related to before (as well as during and after) the crisis is the generally very low awareness of this type of natural hazard. As participants explained, compared to other hazards that Türkiye has experienced (natural disasters, terrorist attacks), heatwave seems to be a very light issue. As they reported: “it is always hot, especially in Izmir”. Related to this hazard, it has been underlined that it is very difficult to find objective measures and quantify the most important aspects of heatwaves, making it even less tangible for authorities, first responders and citizens. As a result of the combination of low general awareness and challenges in quantification, there is a lack of risk analysis from the authorities that would, among other measures, take past events and numbers into consideration (although some companies of the private sector have started to develop preliminary analyses). In addition, when it comes to developing preparedness plans, district municipalities, neighbourhoods and citizens are not involved in the process, leaving no opportunity for them to interact with the authorities about their needs and ideas. As participants reported, the Ministry of Health is an important stakeholder working on the climate change adaptation plan, however, at this stage it is rather in its infancy. As other important stakeholders, the role of general practitioners and local health centres were mentioned who could communicate with patients at risk in their neighbourhood. There would be need for education from the central governmental agencies about what and how to communicate with citizens, by also making flyers and brochures about the effects of heatwave available in the local health centres. Participants highlighted the importance of preparedness plans that not only focus on different types of hazards (e.g. heatwaves, draught, fires) individually, but also take the simultaneous occurrence, therefore the combination of these crises into consideration. As it has been understood, it would be important to include heatwaves in the national curriculum of education institutes, to support increasing awareness.

Identification of gaps, best practices, needs

In the following, the key stakeholders analysed (Local Authorities, FRs, Citizens) are described in more detail. A comprehensive overview of the existing gaps that hinder their response capabilities are identified and best practices to address these issues are presented, if available. Best practices include possible implementation priorities that were addressed by participants during the Focus Group sessions, as well as successful strategies already put in place that represent success examples and/or inspiring approaches that could be considered to support key stakeholders in the enhancement of their preparedness.

- **Local authorities**

Karsiyaka, with its population of approximately 350.000 inhabitants, faces a multitude of potential disasters, including floods, earthquakes, and heatwaves. The city’s density poses logistical challenges in reaching all residents during emergencies. To address this, effective regulations are essential to facilitate coordination among citizens, agencies, and volunteers. However, a critical gap exists in risk analysis. Their participation is vital for holistic disaster management, yet their exclusion persists. It is recommended that different scenarios should be studied to find tailored mitigation solutions already before the disaster. Currently, there is no comprehensive assessment of risks prior to disasters. To create viable disaster plans, it is imperative to consider past events and their impact. District-level risk assessments are perceived as crucial for tailored preparedness strategies as well as the participation of district municipalities and neighbourhoods in preparedness planning, who, on the other hand, remain largely uninvolved.

The city already has a preparedness / mitigation plan, but there is nothing about heatwaves in it. It indicates that even authorities themselves are not aware of the risk, and heatwaves are not considered a threat.

The communication before a heatwave occurs starts with the Meteorology Department, the Provincial Directorate of Climate Change Ministry and the local governments. It has been emphasized that the communication to mobilize the citizens should be complemented with building managers and neighbourhood representatives. Clear roles, responsibilities and communication ways among the involved stakeholder was identified as still lacking. However, not all areas of Izmir are equally affected by the heatwave, which makes a warning message sent to all citizen less trustworthy. The messages should be more customised and targeting those individuals who live in the affected areas. Ineffective communication with the public related to an upcoming heatwave can lead to people not taking it seriously anymore when they are in danger. It was recommended to only send digital warning messages to those individuals who are registered to live in the affected areas according to the meteorological predications. The municipality is already sending warning messages to agriculture villagers about upcoming risks (flood, rain, heatwaves). Therefore, a starting point is visible, but this should be formalized and extended to other groups, too. As a digital solution to inform decision making the periodic monitoring of heat island effect has been identified as potentially beneficial.

When investigating the communication flow, one of the biggest difficulties identified was that the central government has the access to more accurate information than the local authorities. This needs to be improved already in times where no disaster is pressing, to ensure efficient communication during disaster interventions. Also, the relation with involved NGO's has been identified as a strong asset, however, the communication among local authorities, NGO's and academia could be improved.

District municipalities have also increased their awareness-raising and training activities. They generally use social media or websites to communicate with citizens, but they are not well tailored to reach vulnerable groups and could be improved. The elderly population is particularly difficult to reach via social media; SMS would be a more suitable option. Local authorities also pointed out the need for guidelines for each group of citizens with whom they should communicate. Regarding risk awareness efforts, participants could further recall that there is a nationwide campaign of draught related to heat, but nothing about heatwaves. Further, they noticed that the warnings coming from the meteorology are seasonal (2-3 days before the actual heatwave) and besides the summer period, no one is talking about heatwaves anymore. The local authority already applies digital boards and billboards at the most places (e.g. at the seaside, at the market or pedestrian bridges on the highway) to make sure the message can be seen clearly and frequently. In addition, the information distributed by the central authorities should be clear and defined. Questions such as "how high will the temperatures rise?", "Who will be most affected?", "Who should be ready to help at that moment?", could be addressed. In the discussions, the importance of planning and authoritative decision-making was emphasized. However, according to the participants a fundamental factor that often shapes these decisions is ownership. Land and building owners are often reluctant to give up their ancestral rights and often strive for more profit. Since intangible values lack immediate monetary impact, many citizens remain disengaged. To address

this, a mindset shift is necessary. To address this issue, the Karsiyaka local government has taken proactive steps. They conduct both online and face-to-face citizen training, employing various tools. However, bridging the gap between material concerns and the perception of heatwaves not being dangerous or a minor concern compared to other threats remains a challenge.

Heatwaves have significant impacts and casualties but often lack comprehensive statistics. Unfortunately, the annual number of heatwave-related deaths remains unknown. If this data were available, the public could better manage the crisis. The health system doesn't always recognize or record the root causes of health issues during summer, hindering our understanding of risks. While GIS-based studies exist, vulnerabilities remain unclear. It was further demanded to identify together with the health system which individuals with chronic diseases should be advised to stay at home and be released from work during heatwaves. To address this, central governmental agencies should educate local health centres through guidelines or brochures. Beyond health problems, wildfires, droughts, climate refugees, and irregular rainfalls also need consideration. The Ministry of Health is working on a climate change adaptation plan, but obtaining information from them can be challenging for other actors. For this purpose, also the identification of climate-related health issues and deaths is performed.

In Karsiyaka, preparation includes public open spaces, which are crucial during heatwaves. There is already a preparedness plan for heatwaves available on municipal level. A publicly accessible map of these spaces would be beneficial. Additionally, comparing this map with a "vulnerable groups" map could reveal overlaps. Vulnerable groups include the poor, elderly, children, disabled individuals, and workers who must be outdoors during heatwaves.

In the previous year, during heatwaves, the government informed citizens about crisis management, especially for vulnerable groups like the elderly and pregnant women. They especially emphasized what not to do (e.g. do not leave the house). This approach was perceived as a good example. However, staying indoors during heatwaves raises questions about building safety. Poorer areas often have lower-quality buildings (such as concrete blocks) that absorb and retain heat. To address this, cooling centres are needed in every neighbourhood. Moreover, it has been suggested to also educate the kids and youth: they need to be trained and understand the risk.

- **First responders**

Since heatwaves also increase the risk of fires, emergency plans and strategies should be prepared and aligned to the multi-hazard circumstances. The fire department of Izmir has good practices regarding also specialising for vulnerable groups. Metropolitan Fire Departments have started working separately on working groups to incorporate this as well, but the organisation should also include more locals (district management, neighbourhood managements). Further, it has been highlighted that the fire department has been working in the city more than 100 years, therefore having a broader historic knowledge than the AFAD. In Turkey, different than in other countries, the fire brigade it is the responsibility of the local governments instead of the central, which sometimes can lead to conflicts between central and local authorities.

Volunteers underlined the importance of the community of practice: sharing of best practices on the community level, as well as to receive psychological support when

needed. Further they stressed that people with disabilities are also important vulnerable groups to consider.

The health sector has been reported as being in a “really good shape”, well organized, but all the rest of the response team needs to be improved in terms of preparedness. The family doctors/general practitioners affiliated with the Ministry of Health can be the first responders. However, the population vulnerable to heatwaves needs to be identified at the household level. The elderly and those with chronic illnesses should be identified through collaboration between healthcare institutions, public health departments at the University, NGOs, and the municipality. Based on this database, these individuals can be informed during disasters, with direct communication established during crises. The accuracy of this data is crucial. It has been also stated that some general practitioners already take very good care of their older patients.

- **Citizens**

The residents raised one of the strongest needs already in the stage before a disaster occurs to receive credible and up-to-date information. Additionally, residents would also like to have the opportunity to actively share information in a timely manner with the authorities or relevant actors in the field. Concern was also expressed that it seems difficult to check the various communication content. In addition to billboards and fire department websites, there is also digitally available local information via apps. It was, however, not clear from the focus group how these are used or how trustworthy they are. Neighbourhood committees could potentially close this gap and serve as a trusted source.

The citizens participating in our focus group expressed significant gaps in their knowledge about heatwave preparedness. They are largely unaware of existing plans and their own roles during such events. Heatwaves are a relatively new subject and are not perceived as a threat since the temperature have been always high in this region. One issue also arose that the planning is usually the responsibility of the central government, and civil initiates are invited to support and express their concern. Nevertheless, most decisions are taken despite their input.

For earthquake preparedness, it has been underlined that the personal precautions are not always adequate, but families cannot rely on support within the first hours of a disaster and therefore need to understand what to do and where to go. Even the participants who claimed to have a high awareness, complained that they do not even know what is being done by their local authorities. The need for an early warning system is present as well.

Volunteers have identified the following list of information important for community members to receive, to enhance the overall response effectiveness of the community:

- What to store at home as a preparedness package for crisis (e.g. drink or food)
- How to activate and best use their communication network to receive updated information about the disaster event.
- How to best collaborate with first responders and local authorities during the disaster event.
- What kind of services and safety measures are available within the community during the disaster event (e.g. shelter, food).
- First aid course
- Fire safety training

- Search and rescue techniques

Vulnerable group of older people are often perceived as often reluctant to adhere to the warning and prefer to maintain their routine. To tackle this problem, it was recommended to start with the most vulnerable areas and then transfer the solutions to more low-impact areas.

Another group that was discussed was children and young people. The need for tailored education about potential disasters was pointed out, e.g. through activities and appropriate methods to ideally pass on their knowledge to their families. The training could be even included in the national educational system, so that they already learn about heatwaves and their impacts via formal education.

General input on potential training circumstances for children and adults was highlighted that face-to-face training would be more efficient. Training materials should be practical, learning-by-doing type of education to ensure that they catch the attention and incorporate already existing best practices. It could include also experimental areas, where one can experience the impact of heatwave and the difference in temperature once some mitigations are in place.

9.2. During the crisis

Introduction to the context

As highlighted earlier, authorities and first responders have already developed effective practices to inform affected individuals (e.g. agriculture villagers and vulnerable groups) when it comes to other types of disasters, but the same level of preparedness is lacking related to heatwaves. As participants highlighted, neighbourhoods could be potentially effective units of intervention with the inclusion of Muhtars (neighbourhood representatives) in the communication chain between authorities and citizens. However, due to the already mentioned internal immigration of citizens, the population has become quite heterogeneous, and neighbours do not necessarily know each other anymore. As a result, relying on personal acquaintance to warn citizens of the neighbourhood might be challenging. In addition, communicating with citizens via other channels (e.g. social media, television, radio) is often ineffective due to the conflicting and rather vague information that is provided via different media, as well as the phenomenon of "overcommunicating" without addressing only the inhabitants that are indeed affected by the hazard. Participants of the focus group sessions also highlighted that instructions coming from the authorities are often inapplicable to the specific situations of individuals (for instance, asking them not to leave their homes, while they have no air-conditioning units at home, instead of suggesting them to go to the nearest green area to cool down). Consequently, citizens often develop their own best practices, however, these are very rarely shared with authorities due to the lack of opportunity for bi-directional communication between these actors. Finally, the importance of a closer communication between governmental agencies (e.g. AFAD - Central Governmental First Responder Organization Agency) and non-governmental organizations has been stressed out.

Identification of gaps, best practices, and needs

In the following, the key stakeholders analysed (Local Authorities, FRs, Citizens) are described in more detail. A comprehensive overview of the existing gaps that hinder their response capabilities are identified and best practices to address these issues are presented, if available. Best practices include possible implementation priorities that were addressed by participants during the Focus Group sessions, as well as successful

strategies already put in place that represent success examples and/or inspiring approaches that could be considered to support key stakeholders in the enhancement of their preparedness.

- **Local authorities**

The initial information on disasters comes from AFAD. However, hot weather events lack dedicated infrastructure for disaster evaluation. To qualify as a disaster, the ministry must issue an official announcement. Municipalities lack authority in this matter.

Communication primarily occurs through centralized channels such as social media, government websites, and TV channels. Notably, the risk of maladaptation is present in a multi-hazardous region. For example, during heat waves, advising frequent showers for cooling may not be optimal due to the associated drought. Also, the importance of shading streets with trees and other methods has been emphasized by participants. However, materials used for street shading can be flammable during fire events and harnessing sea breezes for inner areas is hindered by tall buildings.

However, the participants mentioned positively that synergies among the disaster mitigation are possible. The city's master plan contains recommendations for separate city parks in each area. These parks will serve as gathering points during earthquakes and as a refuge for people during heat waves.

The city municipality uses a social media account to organize all the voluntary actions. They are using parts of mapping of the needs, e.g. during the disaster, also with the involvement of influencers. A dedicated database would be very much needed to map the needs of the citizens and compare them to the resources of their environment / neighbourhood. In addition, local authorities raised the need to receive continuous information about the citizens' needs. They also highlighted the importance of community members learning how to collaborate with authorities and first responders, as well as how to activate and best use their own communication network during crisis.

Already in place is a digital system AYDES that all these governmental institutions and some private institutions (such as energy supplier) use. This system is GIS based and people from the institutions put all their data there – what has been already done from their end, what are their needs – in terms of equipment, human resources, etc. and whom they need support from. This system is additionally used to report damage. Working groups and government agencies have access, it is however not effectively used by all the stakeholders.

- **First responders**

AFAD is the stakeholder informing first the local municipalities about heatwaves, which then inform the citizen accordingly. The first news of heatwaves received by AFAD informs the local municipalities, which then inform the citizens. In the past AFAD has been criticised for not managing crisis well and improvement especially regarding information flow from and to local-based municipalities and other institution especially NGO's would be recommended.

When it comes to events requiring prompt actions, first responders distinguish between two types of events: emergencies and disasters. The communication differs accordingly. For emergencies the first responders get the calls from 112 (the integrated emergency call system in Turkey responsible for fire and medical emergencies). The first responders can act immediately and address the issue. In the event of a disaster the first responders get still the calls via 112 but they need to forward the information to AFAD.

Under the umbrella of actors there are 26 working groups formed by different institutions like Fire Departments, Izmir Metropole Region, Red Crescent, etc. Depending on the type of intervention required the 112 is the first institution to communicate between all services, reaching out to the main responsible of the working groups and gather during a disaster. When there is a big disaster the first administrators of the head of these working groups come together at AKOM (the disaster centre of the city). There is a communication system between 112, AFAD, First responders and main responsible of the working groups through wireless. Their communication is mostly via radio because the telephone lines and internet are not stable (in heatwaves they should endure, unless the heat affects the lines).

In addition, the AYDES system already mentioned before for local authorities is also used by first responders. When there is a shortage of equipment, human resources or anything else it is put in the AYDES system. All the statistics and information are put in this system: equipment used, how many casualties, what were the treatments to the wounded, rescued animals, people etc. Others from neighbouring cities or other first responders see the need and try to channel the needs. The system is GIS based, and it is integrated countrywide, however, some of the working groups are still not integrated. The obtained versions differ among the institutions which also make it difficult to work in the system.

The fire department also mentioned logistics support during the crisis, the importance of accommodation and shelters. They all have plans for reserved areas for shelters where they can accommodate 10,000 tents – but how the plans work in practice it is questionable.

The general practitioners play also a role as first responders as they are the first contact to which citizen reach out with their health issues and concern. Consequently, they are the ones most familiar with the overall health status of the citizens in their neighbourhood and follow up regularly. They for example call pregnant women and young mothers every month to check on them. This could be according to the participants a good start to communicate also heatwave-related risks, however, the procedure should be formally developed by the Ministry of Health.

Within the region are a lot of volunteer associations that have trained themselves as First Responders. These efforts from volunteers, however, frequently caused issues as their involvement is by regulation not allowed, as work insurance would not cover in case of accidents. Another regulation would be needed to enable their valuable involvement during different crisis. The communication and information flow has also been investigated and improved for unbound volunteers coming from other cities to help. They need to get informed about the status, how they can announce themselves and what kind of equipment/service they can support with. This would foster also their coordination and direction.

- **Citizens**

During high temperatures and high humidity periods it has been observed that there is an increase of people coming to the health care facilities however, their root causes are not monitored or classified.

In general, citizens are informed via online media and websites. Social media is another important way of communication. In terms of warning participants the problem of not easily getting correct updated information about heatwaves has been raised, as the messages received are not providing the information needed such as how high the

temperatures will rise and what effects might have on people. The warning language could be amended, by providing practical, tangible information (e.g. you might feel these kinds of symptoms and you might need to take these precautions because a heatwave is coming and you're going to feel it much higher than usual, etc.) Making the messages more personal also has an advantage to increase their acceptance. Otherwise, there would be a risk that people would not pay attention to them because they do not feel addressed. As highlighted by the focus group participants, when people receive the messages, the feel taken care of. The residents who seek training on how to respond have usually family members who need to be taken care of. On the other hand, it is crucial that apart from the vulnerable groups everybody understands the importance of the heatwaves. When authorities currently warn them about an upcoming heatwave, the message seems to be ignored, and interpreted as "It is already hot, and it has always been hot here"... Further, the concern was raised that the attention span of citizens (especially younger ones) has decreased significantly: interesting, eye-catching material would therefore be needed to involve them successfully in the information chain (e.g. warnings in the form of cartoons to attract attention and be remembered). Since elderly, pregnant women and people with chronic diseases are considered as the most vulnerable groups according to interview participants it is suggested that elderly could be easily reached through television and radio. There are many people who commute long hours by car, therefore radio could be used to reach them.

Participants have also highlighted the importance of neighbourhood's societies. Bi-directional communication between citizens and authorities or citizens and first responders would be important so that citizens can communicate their ideas and actual needs.

An important role mentioned is the one of Muhtars, the selected representatives of each neighbourhood. Their involvement in risk awareness raising and communication would be beneficial. It was even raised that they officially should have the responsibility to inform and warn the residents as they have a wide personal network among the residents. An identified gap are the differences in their level of involvement and motivation. Some of them only do this job for some extra income, some of them, however, really do want to make a difference. Therefore, a unified approach, and equal levels of involvement would be needed for the Muhtars. In order to reach this, there is a need to increase their awareness as well, considering their background and level of experience. Further, they could be backed up by a neighbourhood volunteer system, as it is believed that not only one person alone can take care of a whole neighbourhood and instead a whole volunteer community would be needed to work also with local governance.

A possibility to exchange is already in place in some of the district municipalities where volunteers and citizens gather every two weeks or once a month. They get together and talk about the problems of the neighbourhood, or organize events (e.g. concerts, exhibitions).

Further, there would be need for a solution that maps the most affected areas (e.g. highest density of vulnerable groups) and compares them to the closest cooling areas, so that citizens are aware of where is the nearest area in their vicinity. This could be a smart application for younger generations - like a google map which shows the directions to shadowy areas, microparks, areas with water, and common buildings with air conditioning. The alternative for the smart app would be flyers and maps hung on the billboards of condominiums, flyers spread in post boxes and face-to-face communication coming from the Muhtars.

For earthquake scenarios participants reported that during a survey 25% of people rescued themselves, 35% were helped by relatives, and 25% received assistance from neighbours. Here the immediate local support manifests, as rescue teams may take time to arrive. During the session it was raised that it would be beneficial to have at least one person from each family to be educated in search and rescue. Even though there are enough teams, enough knowledge but it takes time to get organised and reach to everyone.

9.3. After the crisis

Introduction to the context

As heatwaves have never been experienced as disasters, talking about an after phase was difficult for the participants, and it was hard for them to imagine what a recovery phase would look like. One major cause of the difficulty to build a recovery plan is related to the lack of objective statistical data: there are no medical records existing that would specifically mention heatwave as the cause of hospitalisation or fatalities, neither there is a clear understanding of how the impact of heatwaves could otherwise be objectively measured. On the other hand, the already mentioned lack of bi-directional communication between citizens and authorities makes it difficult for citizens to share their subjective experiences, best practices and needs, therefore, creating a list of lessons learned from past crises is impossible. Alternatively, if solutions are found for heatwave-related issues, no permanent actions are taken on a holistic level.

In light of the above-mentioned lack of empirical data related to the after-crisis phase, the following overarching needs are collected as applying for local authorities, first responders and citizens:

- Need for multi-directional communication between authorities, first responders and citizens where experiences, challenges, best practices and needs could be identified, shared and collected for future purposes.
- Need for creating an accessible interface where a pool of lessons learned and best practices can be created, stored and searched.

9.4. Overview of the needs identified for the key stakeholders under analysis

The stakeholders' needs presented in the before/during/after phases are summarised as main outcomes of this analysis in Table 16.

Table 16 offers a comprehensive overview on the analysis of local authorities', FR and citizens' gaps and needs, relevant to the analysed phase. The table shows the existing gaps that hinder the response capabilities of Local Authorities and presents best practices to address these issues. Best practices include possible implementation priorities that were addressed by participants during the Focus Group sessions, as well as successful strategies already put in place that represent success examples and/or inspiring approaches that could be considered to address the needs of the key stakeholders supporting in the enhancement of their preparedness. Should the circumstances also arise in more than one phase of the crisis, this is also indicated in the left-hand column.

Table 16: Overview of needs according to the phases before, during and after the crisis (Karsiyaka CORE lab)

PHASE	KEY STAKEHOLDERS	GAPS	BEST PRACTICES	NEED
LOCAL AUTHORITIES				
Before	Local Authority	• There is a lack of risk analysis before the disaster. • Local authorities usually use social media or websites to communicate with the citizens, but they are not well customized to reach vulnerable groups • District municipalities and neighbourhoods are not involved in the preparedness plan • Not all areas of Izmir are equally affected by the heatwave, which makes a warning message sent out to all citizens less trustworthy.	• During a previous heatwave, as the temperature started to rise, the government informed the citizens about the crisis and what not to do during the heatwave (especially vulnerable groups like elderly or pregnant women). • Metropolitan municipality is considered in the current preparedness plan • Local authorities already apply digital boards and billboards at the most crowded places (e.g. at the seaside or at the market) to make sure the message can be seen clearly and frequently. They also use billboards at the overpasses (pedestrian bridge). • In Karsiyaka, preparation includes public open spaces, which are crucial during heatwaves. There is already a preparedness plan for heatwaves available on municipal level. • The Karsiyaka local government has taken proactive steps. They conduct both online and face-to-face citizen training, employing various tools.	• Establish risk analysis for each type of hazard. Each occasion with different scenarios should be studied and find mitigating solutions accordingly. • Periodic monitoring of the urban heat island effect using digital tools can be beneficial. • Overarching preparedness plan for municipal and district level • District-level risk assessments are perceived as crucial for tailored preparedness strategies. • Heatwaves also increase the risk of fires; emergency plans and strategies should be prepared accordingly • Integrating more stakeholders in the digital system and the preparedness plan (GIS based AYDES system) to have a robust and guaranteed access also after earthquakes • Need for education from the central governmental agencies to smaller local health centres who could reach the citizens through some guidelines or brochures. • Warning messages should be more customised and targeting those individuals who live in the affected areas. The problem of "too much

				warning" - people do not take it seriously anymore. • Improve communication between NGO, academia and municipality • A publicly accessible map of cooling areas would be beneficial. Additionally, comparing this map with a “vulnerable groups” map could reveal overlaps. Vulnerable groups include the poor, elderly, children, disabled individuals, and workers who must be outdoors during heatwaves. • Educate the kids and youth: they need to be trained and understand the risk. • Develop guidelines for each group of citizens with whom the local authorities should communicate •
	Ministry of Health	• Difficulty to get information from the Ministry of Health. • There are a lot of impacts and casualties in heatwaves. There is a lack of statistics. The health system does not recognise or record the root cause of some of the health issues during summer. The annual number of deaths from heatwaves is unknown. The risks remain unknown although GIS based studies are conducted but vulnerabilities are not clear.	• There is work going on to identify climate related health issues or climate related death. •	• Shared information on number of deaths from heatwaves per year and identified vulnerabilities, the public could use this information to manage the process more effectively.

During	Municipality	• Risk of maladaptation is present in a multi-hazardous region. Example: during heat waves, advising frequent showers for cooling may not be optimal due to the associated drought.	• The city's master plan contains recommendations for separate city parks in each area. These parks will serve as gathering points during earthquakes and as a refuge for people during heat waves. • The city municipality uses a social media account to organize all the voluntary actions. They are using parts of mapping of the needs, e.g. during the disaster, also with the involvement of influencers. • Already in place is a digital system AYDES that all these governmental institutions and some private institutions (such as energy supplier) use. This system is GIS based and working groups and government agencies have access, it is however not effectively used by all the stakeholders.	• A dedicated database would be very much needed to map the needs of the citizens and compare them to the resources of their environment / neighbourhood • To receive continuous information about the citizens' needs. They also highlighted the importance of community members learning how to collaborate with authorities and first responders, as well as how to activate and best use their own communication network during crisis. •

After		• There is not much visible damage in heatwaves and the impacts are not seen – compared to other types of disasters. The statistics are not adequate. • Solutions are often found after the disaster happens and permanent actions are not implemented. Holistic approach is missing.	• Meteorology Institution, the Ministry of Climate Change and the local government. They cooperate to produce risk maps and risk analysis and vulnerability analysis by also involving the district municipalities.	• Identification of populations unable to access energy during heatwaves (such as energy-poor individuals) is necessary. • Health departments – they need to organize themselves for this kind of crisis (aftermath). This is something that is missing. • Multi-directional communication between authorities, first responders and citizens where experiences, challenges, best practices and needs could be identified, shared and collected for future purposes.
PHASE	**KEY STAKEHOLDERS**	**GAPS**	**BEST PRACTICES**	**NEED**
FIRST RESPONDERS (FRs)				
Before	Fire Department		• The fire department of Izmir and others have good practices specialising in vulnerable groups. The fire department have been working in the city more than 100 years, have a historic knowledge far more than the AFAD.	

	General practitioners		• Some general practitioners take very good care of their older patients – when there is an urgent situation, they monitor closely their elder patients.	• Family doctors affiliated with the Ministry of Health can function as first responders. The population vulnerable to heatwaves needs to be identified at the household level. The elderly and those with chronic illnesses should be identified through collaboration between healthcare institutions, NGOs, and the municipality. Based on this database, these individuals can be informed during disasters, with direct communication established during crises. (The accuracy of this data is crucial.)
During	Volunteers	• No regulations on the involvement of volunteer associations. • People with disabilities are also important vulnerable groups to consider.	• N/A	• Strong need of volunteers to receive clear and actionable instructions that can help my team to promptly intervene • Communication, direction and coordination is needed for unbound volunteers • If there are other people coming to help from other cities – they need to get informed about the facts, and provide the information that they are there, what kind of equipment they have or need etc.

	AFAD	• AFAD is criticised for mismanagement of crises.	• AYDES system: When there is a shortage of equipment, human resources or anything else it is put in the AYDES system. Others from neighbouring cities or other first responders see the need and try to canalise the needs. The system is GIS-based and all the country is integrated.	• AFAD should cooperate and inform local-based municipalities or other involved institutions better. The already existing information-flow should be improved • Involvement of the NGOs in the communication is needed • Some stakeholders are not integrated in the AYDES system. The version differs among institutions making it difficult to work in the system.
	Fire department		• The fire department provides logistics support during the crisis of an earthquake or flood (accommodation and shelters). They all have plans for reserved areas for shelters where they can accommodate 10,000 tents. Plans are in place but if they are suitable in case of an emergency is unknown.	.
After				• Need for creating an accessible interface where a pool of lessons learned and best practices can be created, stored and searched.
PHASE	**KEY STAKEHOLDERS**	**GAPS**	**BEST PRACTICES**	**NEED**
CITIZENS				

Before	Residents	• Knowledge about heatwave preparedness is missing • Citizens are not aware of existing plans, do not know what to do and how to behave. Some participants claimed although they have high awareness, they don't even know what is being done by local authorities.	• Common representatives, which take care of the buildings and the needs of the residents. They also inform citizens about upcoming heatwaves and/or other types of emergencies.	• General input on potential training circumstances for children and adults: face-to-face training would be more efficient. Training materials should be practical, learning-by-doing type of education to ensure that they catch the attention and incorporate already existing best practices. It could include also experimental areas, where one can experience the impact of heatwave and the difference in temperature once some mitigations are in place. • Receive credible and up-to-date information • Residents would also like to have the opportunity to actively share information in a timely manner with the authorities or relevant actors in the field. • Need for early warning system. • Information important for community members to receive in forms of some solutions, to enhance the overall response effectiveness of the community: - What to store at home as a preparedness package for crisis (e.g. drink or food) - How to activate and best use their communication network to receive updated information about the disaster event. - How to best collaborate with first responders and local authorities during the disaster event. - What kind of services and safety measures are available within the

				community during the disaster event (e.g. shelter, food). - First aid course - Fire safety training - Search and rescue techniques - Early warning systems
During		• In terms of warning participants raised the problem of not easily getting correct updated information about heatwaves. • The messages received are not providing the information needed such as how high the temperatures will rise and what effects might have on people. • The majority of the survey respondents has already experienced difficulty understanding official disaster warnings: most of them complained about the message being too difficult, too technical, or about the difficulty of understanding the context or what the message personally meant to them. • • Different level of involvement of the Muhtar and different understanding of responsibilities	• A possibility to exchange is already in place in some of the district municipalities where volunteers and citizens gather every two weeks or once a month. They get together and talk about the problems of the neighbourhood, or organize events (e.g. concerts, exhibitions)	• The warning language could be amended. It should focus on practical, tangible symptoms to be noticed. Making the messages more personal also has an advantage to increase their acceptance. • Participants have highlighted the importance of neighbourhoods societies. Bi-directional communication between citizens and authorities or citizens and first responders would be important so that citizens can communicate their ideas and actual needs. • Need to involve Muhtar in risk awareness raising and communication • Solution that maps the most affected areas (e.g. highest density of vulnerable groups) and compares them to the closest cooling areas, so that citizens are aware of where is the nearest area in their vicinity. This could be a smart application for younger generations - like a google map which shows the directions to shadowy areas, microparks, areas with water, and common buildings with air conditioning.

				The alternative for the smart app would be flyers and maps hung on the billboards of condominiums, flyers spread in post boxes and face-to-face communication coming from the Muhtars. • There is a need to talk about the situation with others - the importance of sharing experience, feelings, information and best practices with others.
After	Citizens			• Need for creating an accessible interface where a pool of lessons learned and best practices can be created, stored and searched.

9.5. Overview of solutions and user requirements

As the final step of the analysis of the needs in Karsiyaka CORE Lab, a preliminary tentative matching has been created between a selection of needs and the solutions that RESILIAGE project has to offer, namely: soft solutions (Risk awareness campaigns, Preparedness toolkits, Communication guidelines), training and digital solutions (RAISE tool, Monitoring Dynamic Resilience Dashboard, Multihazard Early Warning Detection System, Multi-agent Social Network Modelling, CORE Digital Network, Decision Support System, ATLAS tool). At this stage, the table only contains a preliminary comparison of the selected needs that could potentially be addressed by RESILIAGE solutions and tools in order to discuss and prioritise them further with the research and CORE laboratory partners. In addition to mapping the needs, this table also contains generic, high-level user requirements that are results of the combined research process of T4.1. and should be taken into consideration when developing the solutions.

9.5.1. Soft solutions

The following table reports the preliminary match between key stakeholders' (local authorities, first responders, citizens) needs and requirements and the soft solutions to be developed within RESILIAGE project: risk awareness campaigns, preparedness toolkits and communication guidelines.

Table 17: Preliminary match of needs and requirements with soft solutions (LA= local authorities, FR= first responders, C= citizens)

Type of solution	Stake-Holders	Needs	User Requirements
Risk awareness campaigns	**LA**		
	FR		
	C	Risk awareness campaign for citizens to raise awareness of this type of risk (very low awareness)	• More customised and targeting those individuals who live in the affected areas. • General Practitioners to be involved in the risk awareness c • Muhtars to be involved in the risk awareness campaign • Tangible symptoms, practical and concise information – mo personalised communication • Brochures and flyers in smaller local health centers and common areas of condominiums
Preparedness toolkits *(infographics, safety plan checklist, safety plan templates)*	**LA**	• Overarching preparedness plan for municipal and district level • Heatwaves also increase the risk of fires; emergency plans and strategies should be prepared accordingly	
	FR	Need for education from the central governmental agencies to smaller local health centres who could reach the citizens through some guidelines or brochures.	
	C	• Information important for community members: • -What to store at home as a preparedness package for crisis (e.g. drink or food) - How to activate and best use their communication network to	• More customised and targeting those individuals who live in the affected areas. • General Practitioners to be involved in the risk awareness c • Muhtars to be involved in the risk awareness campaign

		receive updated information about the disaster event. - How to best collaborate with first responders and local authorities during the disaster event. - What kind of services and safety measures are available within the community during the disaster event (e.g. shelter, food). - First aid and fire safety • Flyers and maps hung on the billboards of condominiums, flyers spread in post boxes and face-to-face communication coming from the Muhtars about the most affected areas and the closest cooling places	• Tangible symptoms, practical and concise information – mo personalised communication • • Brochures and flyers in smaller local health centers and common areas of condominiums
Communication Guidelines	**LA**	Develop guidelines for each group of citizens with whom the local authorities should communicate.	• More customised and targeting those individuals who live in the affected areas. • Customised, and based on tangible symptoms and practical, concise information – make it more "personal"
	FR		
	C		

9.5.2. Training

In Table 18 the preliminary match between key stakeholders' (local authorities, first responders, citizens) needs and requirements and the *trainings* to be developed within RESILIAGE project has been mapped.

Table 18: Preliminary match of needs and requirements with training (LA= local authorities, FR= first responders, C= citizens)

Stake-holders	***Needs***	***USER REQUIREMENTS***
LA	Multi-directional communication between authorities, first responders and citizens where experiences, challenges, best practices and needs could be identified, shared and collected for future purposes.	

FR	• Need for education from the central governmental agencies to smaller local health centres who could reach the citizens through some guidelines or brochures. • Multi-directional communication between authorities, first responders and citizens where experiences, challenges, best practices and needs could be identified, shared and collected for future purposes. • Strong need of volunteers to receive clear and actionable instructions that can help teams to promptly intervene.	
C	• Need for training on how to best collaborate with first responders and local authorities during the disaster event. / What kind of services and safety measures are available within the community during the disaster event (e.g. shelter, food). / How to identify misleading, distorting information about the disaster event. / what to store at home as a preparedness package / how to activate and best use communication network / fire safety / first aid. • Educate the kids and youth: they need to be trained and understand the risk. • Multi-directional communication between authorities, first responders and citizens where experiences, challenges, best practices and needs could be identified, shared and collected for future purposes. • Education of Muhtars to be active agents before and during the heatwave.	• Face-to-face training would be more efficient. Training materials should be practical, learning-by-doing type of education to ensure that they catch the attention and incorporate already existing best practices. It could include also experimental areas, where one can experience the impact of heatwave and the difference in temperature once some mitigations are in place.

9.5.3. Digital solutions

In Table 19 the preliminary match between key stakeholders' (local authorities, first responders, citizens) needs and requirements and the digital solutions to be developed within RESILIAGE project is reported. The digital tools taken into consideration for the mapping are the following: RAISE tool, Monitoring Dynamic Resilience Dashboard, Multihazard Early Warning Detection System, Multi-agent Social Network Modelling, CORE Digital Network, Decision Support System, ATLAS tool.

Table 19: Preliminary match of needs and requirements with digital solutions (LA= local authorities, FR= first responders, C= citizens)

Type of solution	*Stake-holders*	*Needs*	*USER REQUIREMENTS*
	LA	Educate the kids and youth to understand the risk.	

The Resilience Assessment Interactive Self-Enabler tool (RAISE)	FR		
	C	Information about what to store at home as a preparedness package for crisis (e.g. drink or food)	
Monitoring Dynamic Resilience Dashboard	LA	• To establish risk analysis for each type of hazard. Each occasion with different scenarios should be studied and find mitigating solutions accordingly • Periodic monitoring of the urban heat island effect • Overarching preparedness plan for municipal and district level • District-level risk assessments for tailored preparedness strategies • A publicly accessible map of cooling spaces (parks) • Additionally, comparing this map with a “vulnerable groups” map could reveal overlaps • Shared information on number of deaths from heatwaves per year and identified vulnerabilities	
	FR		
	C	• Receive credible and up-to-date information • Information about what kind of services and safety measures are available within the community during the disaster event (e.g. shelter, food). • Solution that maps the most affected areas (e.g. highest density of vulnerable groups) and compares them to the closest cooling areas, so that citizens are aware of where is the nearest area in their vicinity.	Like a google map which shows the directions to shadowy areas, microparks, areas with water, and common buildings with air conditioning
Multi-hazard early warning	LA	Warning messages, customised and targeting those individuals who live in the affected areas	

detection system	FR		
	C	Need for early warning system	
Multi-agent social network modelling for Resilient Behaviour	LA	• To establish risk analysis for each type of hazard. Each occasion with different scenarios should be studied and find mitigating solutions accordingly. • Heatwaves also increase the risk of fires; emergency plans and strategies should be prepared accordingly.	
	FR		
	C		
CORE Digital Network	LA	• Integrating more stakeholders in the digital system and the preparedness plan (GIS based AYDES system) to have a robust and guaranteed access also after earthquakes. • Need for education from the central governmental agencies to smaller local health centres who could reach the citizens through some guidelines or brochures. • Improve communication between NGOs, academia and municipality. • To receive continuous information about the citizens' needs. • Need of community members to learn how to collaborate with authorities and first responders, as well as how to activate and best use their own communication network during crisis. • Multi-directional communication between authorities, first responders and citizens where experiences, challenges, best practices and needs could be identified, shared and collected for future purposes.	

	FR	AFAD should cooperate and inform local-based municipalities or other involved institutions better. The already existing information-flow should be improved	
	C	• Receive credible and up-to-date information • Need to involve Muhtars in risk awareness raising and communication • There is a need to talk about the situation with others - the importance of sharing experience, feelings, information and best practices with others.	
Decision Support System (DSS)	LA	• To establish risk analysis for each type of hazard. Each occasion with different scenarios should be studied and find mitigating solutions accordingly. • Overarching preparedness plan for municipal and district level. • Heatwaves also increase the risk of fires; emergency plans and strategies should be prepared accordingly. • Need for education from the central governmental agencies to smaller local health centres who could reach the citizens through some guidelines or brochures. • Educate the kids and youth: they need to be trained and understand the risk. • Develop guidelines for each group of citizens with whom the local authorities should communicate. • A dedicated database would be very much needed to map the needs of the citizens and compare them to the resources of their environment / neighbourhood. • Need of community members to learn how to collaborate with authorities and first responders, as well as how to activate and best use their own communication network during crisis. • Multi-directional communication between authorities, first responders and citizens where experiences, challenges, best practices and needs could be identified, shared and collected for future purposes.	
	FR	Need for creating an accessible interface where a pool of lessons learned and best practices can be created, stored and searched.	

	C	• General input on potential training circumstances for children and adults, also experimental areas, where one can experience the impact of heatwave and the difference in temperature once some mitigations are in place. • Receive credible and up-to-date information. • Information important for community members to receive in forms of some solutions, to enhance the overall response effectiveness of the community: • What to store at home as a preparedness package for crisis (e.g. drink or food) - How to activate and best use their communication network to receive updated information about the disaster event. - How to best collaborate with first responders and local authorities during the disaster event. - What kind of services and safety measures are available within the community during the disaster event (e.g. shelter, food). - First aid course - Fire safety training - Search and rescue techniques - Early warning systems • Need for creating an accessible interface where a pool of lessons learned and best practices can be created, stored and searched.	• Practical, learning-by-doing types of education • Training material that catches attention • Training material that incorporates already existing best practices
The Multidimensional Atlas for Community Resilience	LA	• A publicly accessible map of cooling spaces (parks) would be beneficial. • Additionally, comparing this map with a “vulnerable groups” map could reveal overlaps. • A dedicated database would be very much needed to map the needs of the citizens and compare them to the resources of their environment / neighbourhood.	•
	FR	• Some stakeholders are not integrated in the AYDES system. The version differs among institutions making it difficult to work in the system.	•

	C	• Geolocate neighbourhood societies • Solution that maps the most affected areas (e.g. highest density of vulnerable groups) and compares them to the closest cooling areas, so that citizens are aware of where is the nearest area in their vicinity.	• Like a google map which shows the directions to shadowy areas, microparks, areas with water, and common buildings with air conditioning

10. Overview of Crete CORE lab needs (T4.1)

"It has been a wake-up call."

(Citizen of Arkalochori)

In case of the CORE lab in Crete, the 2021 earthquake event has been described as a "wake-up call" by one of the citizens of Arkalochori. Although the region is no stranger to earthquakes, focus group participants reported that the community was relatively unprepared for such a disaster to take place, therefore, education and training have become the highest priority in the area, as respondents expressed a very strong need for mandatory, practical training (e.g. earthquake drill) for the public, including schools, workplaces and leisure activities (e.g. sport centres). Besides the reported challenges related to citizens' preparedness, centralisation of actions was also reported as a major issue that slowed down the immediate disaster response, along with the actions of volunteers which have been perceived as relatively disorganised and uncoordinated after the event. Even more importantly, citizens of Arkalochori still suffer from the impact of the earthquake, as they reported to feel left alone and to have no means of effective communication with the government. While waiting for financial support, many of the inhabitants decided to move back to their damaged homes, facing a continuous uncertainty and danger, while others have been displaced, living in mobile houses for three years now. Consequently, citizens are reported to have a very strong need for psychological support, in order to improve their mental health, along with an effective way to communicate and express their needs to representatives of the government. Although the community has been relatively unprepared for the earthquake, participants of the focus group sessions considered the 2021 event as a paradigm shift, after which the community has become more receptive to being educated and prepared of what to do in case of a potential future disaster.

Table 20: Stakeholder groups in Crete CORE lab

KEY STAKEHOLDER	DESCRIPTION
LOCAL AUTHORITIES	• Ministry of Climate Crisis and Civil Protection
FIRST RESPONDERS	• Organization for Earthquake Planning and Protection ("OASP") • Hellenic Red Cross • Samaritan Brothers • Volunteers
CITIZENS	• Residents • Athletics Club of Arkalochori (volunteer-based organisation)

The most important characteristics of the communication network are highlighted within the Interaction Map (Figure 39) that has been recreated based on the results of the focus group sessions. According to that, centralisation issues have been identified as major obstacles within the crisis response, as they significantly slow down the effective response on the field. Moreover, volunteer groups that were available to intervene on

the field have been perceived as rather uncoordinated internally, therefore their smooth and coordinated actions are of high priority to improve. Shortly after the earthquake, phone lines became inoperational, thus further increasing the panic and chaos among citizens who were not able to contact their beloved ones. An important contribution of RESILIAGE solutions could be to educate citizens on how to use alternative communication media as well as where are the emergency assembly points near them. Furthermore, citizens reported that since the earthquake there has been no effective communication between them and the government, which leaves them feel frustrated and betrayed. Establishing effective communication between these two actors would therefore be crucial in increasing citizens' empowerment, sense of control and mental health. The most important vulnerable groups identified in the area are elderly, physically disabled individuals, homeless, refugees and children (although they are generally perceived as well prepared due to the education and drills in schools). In addition, focus group participants reported tourists as being vulnerable as they are not included in the preparedness plans, nor the tourism industry is generally involved in the disaster-related education programs.

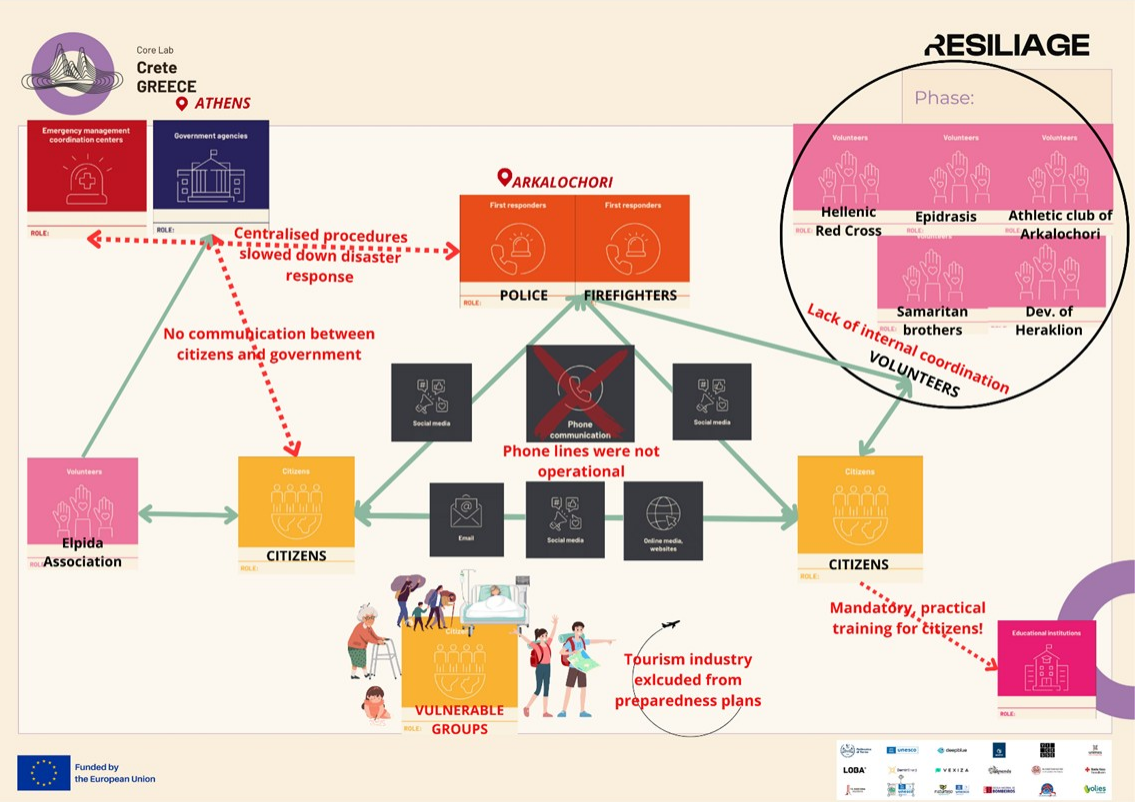

Figure 39: Recreated Interaction Map, visualising the communication of key stakeholders in the Crete CORE lab

10.1. Before the crisis

Introduction to the context

Since the 2021 disaster event there has been an increased awareness of risk and related preparation of citizens. While community members are generally perceived as prepared for a potential future earthquake, this knowledge is rather restricted to the short-

term actions, and relatively less is known about what the available resources on the long run are. In addition, a strong “optimism bias” is still present among citizens, restricting them from further improving their awareness and preparation. Focus group sessions also reported the need for regular, mandatory, practical training not only in elementary of high schools but universities and workplaces as well. Regarding vulnerable groups, while the education of children has been receiving remarkable attention, other vulnerable groups seem to be less included in the preparedness plans. Related to this issue, the importance of face-to-face communication and education, and the inclusion of the Church as a trustworthy communication media has been discussed. Volunteer groups –perceived to be less coordinated and organized during the last earthquake- emphasized the importance of a universal training for all key actors in disaster response, in order to enhance multi-agency team collaboration in the future.

Identification of gaps, best practices, needs

In the following, the key stakeholders analysed (Local Authorities, FRs, Citizens) are described in more detail. A comprehensive overview of the existing gaps that hinder their response capabilities are identified and best practices to address these issues are presented, if available. Best practices include possible implementation priorities that were addressed by participants during the Focus Group sessions, as well as successful strategies already put in place that represent success examples and/or inspiring approaches that could be considered to support key stakeholders in the enhancement of their preparedness.

- **Local authorities**

Since the 2021 earthquake, there has been an increase int the educational efforts that aim to prepare citizens for a potential future disaster. For instance, in April 2024, a large-scale Operational Earthquake Field Exercise (“MINOAS”) took place in the Archeological Museum of Heraklion. The event has been organized by the Ministry of Climate Crisis and Civil Protection and the Organization for Earthquake Planning and Protection (“OASP”) and simulated an evacuation scenario. The General Secretary of Civil Protection has been also putting efforts in distributing information leaflets on protection from natural disasters. Moreover, the Ministry of Climate Crisis and Civil Protection is also reported to have a several short videos that introduce the most important “what-to-do"-s in case of a natural disaster, many of them even being available with sign language to support the preparedness of individuals with impaired hearing. However, as it has been reported, citizens are generally not aware of these videos, only a few people – mainly first responders- know about them. Despite the above-mentioned efforts to educate the public (leaflets, online videos, drills), participants of the focus group sessions highlighted that vulnerable groups (such as elderly, children, physically or mentally disabled individuals, homeless, refugees and pregnant women or new mothers) are often not addressed in the preparation efforts and plans. As one of the interviewees underlined, internet, social media, radio and television are often not enough to distribute information, as there are several individuals who do not have regular access to these media. As an alternative solution, the idea of involving the church as a face-to-face connection and multiplier of risk awareness has been mentioned, along with the importance of considering vulnerable groups in the preparedness plans. As it has been highlighted, messages to citizens should be simple, understandable language without technical expressions. Related to this challenge, local authorities expressed their need for training on how to speak to the affected population considering their individual different backgrounds.

- **First responders**

The Organization for Earthquake Planning and Protection ("OASP") has an important role in informing the public, by preparing leaflets, videos aired on television and providing information on their website. The website is considered to be very informative and up to date by the focus group participants, as citizens have full access to the information hosted on the website. OASP does not only play an important role in informing the public: the Hellenic Red Cross also organizes training based on the information coming from them (along with information collected from international organizations dealing with natural disasters). The Hellenic Red Cross organizes its own education system to inform and train all affiliated volunteers. They regularly renew their information and education system to constantly be prepared for a future disaster, and continuously train their volunteers to refresh their knowledge. Related to the collaboration between actors, however, a few challenges were mentioned. According to the focus group participants, the procedures that volunteers follow are not always clear to other actors (e.g. civil protection officers or police officers) and often seem uncoordinated. As it has been highlighted, police officers do not participate in earthquake related exercises. Consequently, one important need mentioned by the participants would be universal training courses and materials to all the key actors involved in earthquake-related disaster response. On the other hand, the legal framework around volunteerism has been mentioned as an important challenge. As explained, volunteers must be employed, otherwise they are not covered by insurance and must pay by themselves in case of an accident. However, being employed often puts restrictions on the availability of volunteers in case of emergency situations.

- **Citizens**

As it has been discussed during the focus group sessions, Arkalochori has different housing structures, therefore, part of the city was destroyed, while the other part suffered hardly any damage. As participants highlighted, while the danger of houses to collapse is still present, infrastructural prevention seems to lag behind the efforts related to training and education. Consequently, more awareness of the results of the static research related to incidental houses would be needed. According to one of the focus groups, the perception is that the community is well informed, and everybody does know what to do in case of an earthquake. This, however, refers mostly to the immediate behavioural action of seeking protection within the house/apartment (e.g. under a table), and more education would be needed about what to do on the long run (e.g. what are the most important gathering and camping areas, where to meet family members that are not reachable via phone, etc.). Although the community is perceived as well prepared, the optimism bias is strongly prevalent in the region ("it won't happen to us"). Another challenge is related to the format of information materials and education: the available brochures are reported to be overly informative, including recommendations that are usually not followed by individuals during an earthquake. Instead, participants highlighted the need for creating a list with only the 10 most important instructions, and for regularly checking whether these instructions have been properly memorised. In connection with advertising this information, the importance of social media and television has been discussed (e.g. short videos in between sportscasts), by including videos of past events to further raise awareness. In addition, participants discussed the possibility to include an earthquake-related practical exercise into the mandatory safety training at workplaces, to make sure citizens regularly practice these instructions. Participants again highlighted the importance of an infrastructure that addresses

vulnerable groups (e.g. to equip buildings to make them easy to exit by disabled individuals) along with the importance of mapping the characteristics and needs of vulnerable individuals beforehand (e.g. whether they are able to exit the buildings, whether they have any chronic disease that requires continuous medication). While children are considered an important vulnerable group, the results revealed that they are trained by volunteers on a regular basis on how to act when it comes to an earthquake (e.g. how to climb under tables and gather at the assembly points). To further improve schools' preparedness, the possibility of mandatory exercises built in the national curricula of universities has been discussed. In addition, school personnel (e.g. teachers, coaches) should attend mandatory training on how to stay calm, what to do, how to protect children during an earthquake. As another relevant vulnerable group, tourists have been considered during the focus group sessions. As it has been reported, tourists and hotels are not included in the preparedness plans and are generally not aware of what to do during and right after an earthquake. Although there are some positive examples where hotel owners and employees regularly exercise how to evacuate the building in case of a disaster event, these are rather rare. Focus group participants therefore discussed the importance of involving travel agencies in informing tourists, not only about accommodation, leisure activities and restaurants, but also about the core instructions to follow in case of an earthquake.

10.2. During the crisis

Introduction to the context

The Arkalochori earthquake struck central Crete on September 27, 2021, with a magnitude of 5.9. This earthquake was notable for its shallow depth, with the rupture occurring between 6 to 16 kilometers below the surface. The epicenter was near the village of Arkalochori, causing significant ground deformation but no primary surface ruptures. During the earthquake, the area shook significantly, causing the ground to sink by 14 cm in one location and shift by up to 19 cm according to satellite measurements. The next section deals with the statements of the focus group participants on how they perceived the earthquake and how the immediate response was in the first few days afterwards.

Identification of gaps, best practices, and needs

In the following, the key stakeholders analysed (Local Authorities, FRs, Citizens) are described in more detail. A comprehensive overview of the existing gaps that hinder their response capabilities are identified and best practices to address these issues are presented, if available. Best practices include possible implementation priorities that were addressed by participants during the Focus Group sessions, as well as successful strategies already put in place that represent success examples and/or inspiring approaches that could be considered to support key stakeholders in the enhancement of their preparedness.

- **Local authorities**

Official information was received by the Greek police and firefighters within the political region of Arkalochori, prompting them to activate their response protocols. However, a significant challenge within the immediate response after the earthquake was the overload of the emergency number 112 and phone lines were not operational. Additionally, the centralization of many authorization processes in Athens notably slowed down the crisis response.

- **First responders**

The alert chain normally runs via the deputy governor directly to the volunteer first responder groups. In this earthquake, however, it was already clear before the official alert that the cars had to be loaded and that something more serious had happened that required direct help, according to the first responders. The Samaritan brothers have been instrumental in providing first aid to the residents of Arkalochori. Despite their training, even the volunteers admitted to feeling overwhelmed by the situation and unsure of how to proceed. In response, both the volunteers and the Samaritans have established their own communication network to better coordinate their efforts and support the community. According to first responders and volunteers in the focus group, the situation somewhat resembled a refugee crisis, with people being forcibly displaced and facing an emergency. They believe they contributed positively by assisting those who were left without homes and by providing equipment to the shelters set up in the initial days. The communication between the volunteers and first responders is perceived to be going well. Reaching the crowds was, however, more problematic, according to one interview partner. One suggestion would be to use the experience gained in England, for example, during the pandemic: with the use of drones. it would be possible to inform the population on a large scale via the drone loudspeakers about the risks and where they can find shelter if necessary.

The absence of established briefing and debriefing procedures has made it difficult to identify best practices.

Apart from an active early warning system, volunteers stressed the importance of continuous updates on the unfolding events and the needs of citizens. Special attention must be given to disabled individuals, who are currently overlooked in the existing solutions. Also, psychological support for citizens is necessary to provide. First responders highlight social media as a vital communication tool that helped them to organise and receive up-to-date information. Clear, actionable instructions during disasters are mentioned as essential for prompt intervention. Additionally, providing rescue training to citizens would expedite the search and rescue process.

- **Citizens**

The first important aspect once the earthquake occurred was telecommunications. Phone communication was completely off shortly after the earthquake. Essentially, dissemination was done through telephones afterwards as the first thing residents do after ensuring their physical integrity is to start making phone calls to check if acquaintances and relatives are safe.

What lasted the most was the social media, allowing residents to send messages and get information immediately. They also use emails, which are more like SMS, and social media. However, when complete communication is lost, the service becomes useless. They also had a radio, but it was forgotten and not used.

Participants emphasized that TV and phone communication were crucial. Some residents also used an earthquake information app, and Google provided rapid information about the earthquake's magnitude. However, one aspect was strongly underlined that the communication of Richter scale numbers does not provide the public with useful information as it is not known by everybody.

As a best practice the alert of citizen via SMS has been identified as by now almost everyone including the elderly have one. The deriving need is to also entail clear/tailored instructions where to go and where to obtain shelter or help by locating them directly. A

suggestion was to provide a mobile application, especially for young people, that provides education on how to prepare, gives instructions and guides them through the first phase of an emergency, detailing the initial steps to take and what to do next. This could be combined also with an alerting function.

In the absence of state mechanisms, various community bodies, such as the Development of Heraklion, and other community actors stepped in to fill the gaps through private initiatives. For example, the Athletics Club of Arklochori founded a volunteer team to assist residents with urgent needs immediately after the earthquake occurred. They coordinated the arriving volunteers, directing them to where help was needed or assigning them to specific activities. Despite reaching out to the municipality, the coordination responsibilities remained with the volunteer group, who organized themselves effectively.

A crucial need for volunteers in training is learning how to organize into groups to provide assistance during natural disasters. Additionally, citizens need to be educated on how to activate and utilize their communication networks during such events, including knowing how to contact three-digit emergency numbers, which many currently do not know how to do.

The most difficult situation arises for vulnerable individuals, such as people with special needs, who require someone nearby to assist them if something happens. Refugees have considerably less access to information compared to citizens, leaving them particularly unprepared for crises. Tourists are often not considered within the response plans. Additionally, parents tend to rush to schools to check on their children or pick them up and leave as they consider them to be in danger.

There is a strong need for continuous updates about unfolding events. Therefore, residents should adopt alternative communication systems, such as designating a specific meeting point after a disaster, to prevent communication systems from becoming overwhelmed by everyone calling their loved ones simultaneously.

Awareness campaigns, concise instructions, and disaster preparedness plans are crucial. Enhancing and supporting preparedness is important, as the general readiness of citizens is currently low.

Further, residents need reliable information as soon as possible and the ability to contact and share their needs with authorities. For this purpose, an effective early warning system would be essential.

Moreover, when it comes to the need for training and education the following aspects have been mentioned as necessary to train citizens:

- Construction of tents
- Earthquake response training
- Managing panic situations and keeping calm
- Understanding available services and safety measures within the community
- Fire protection
- First aid
- Collaborating effectively with authorities and first responders

10.3. After the crisis

Introduction to the context

After the crisis is the time from when the immediate response ended, and the recovery phase began. In the case of Arkalochori, this state of affairs continues to this day, as there are still people living outside the city, initially in tents and now in containers, with their houses still damaged and uninhabitable within the city centre.

Identification of gaps, best practices, and needs

- **Local authorities**

After the earthquake all municipal buildings were checked, evacuation and contingency plans were updated. Building managers and floor managers were deployed especially for the tall buildings. OSAP experts were hired to train the personnel evacuation practices. Accommodation and emergency shelters are also being found in preparation by the municipality.

- **First responders**

The recent earthquake served as a wake-up call, prompting significant improvements in disaster preparedness. Notably, specific equipment such as tents, clothes, and food has been purchased and stored for future emergencies. This equipment is similar to that used in the rescue of shipwrecked individuals and arriving refugees.

In response to the earthquake, new volunteer groups like the “Epidrasis” Humanitarian Crisis Management Group were established to assist citizens. However, volunteers were initially perceived as disorganized due to a lack of central coordination. Additionally, there were logistical challenges, particularly with storing supplies.

To address these issues, a platform has been set up in Heraklion. This platform allows volunteers to sign up, indicate their availability, and choose their shifts, thereby improving coordination and efficiency in disaster response efforts.

Moreover, there is a recognized need for comprehensive preparation for various disasters, not just earthquakes. This includes being ready for pandemics and other likely events. Online platforms (e.g. from the Ministry of Civil Protection) offering courses on different types of disasters and civil protection can play a crucial role in enhancing preparedness and resilience.

- **Citizens**

The recent earthquake revealed significant gaps in preparedness and the transfer of lessons

festival could serve as a fundraising event to support the community, particularly those affected by the earthquake. By organizing activities such as traditional food sales, the festival could attract sponsors to cover the basic costs of ingredients and supplies. The learned. Many citizens were unsure where to go after the earthquake, as information about designated gathering and camping areas was often outdated and no longer valid. This lack of reliable information left people confused and vulnerable in a critical time.

In schools, only very basic safety instructions are taught, such as going to open air, avoiding cables, and not using elevators. However, mental health support was largely neglected, resulting in poor psychological states among citizens in the days following the earthquake. Only untrained volunteers provided this psychological help. The immediate aftermath required urgent actions, such as clearing rubble from sidewalks, which was a

significant challenge. Despite these difficulties, a positive outcome was the strengthened solidarity among the community, with people coming together to help each other.

An association named the Elpida Association was created to support earthquake victims and advocate for their rights. Unfortunately, the Municipality views this association as an adversary, which has hindered its efforts. Three years after the earthquake, many houses remain damaged, and people are still waiting for support. This prolonged neglect has left citizens feeling abandoned and betrayed by the government. Unfortunately, there has been no communication from the government regarding when people can expect to receive benefits, further exacerbating the sense of abandonment among the citizens. It also remains unclear what will happen to the buildings which are currently marked as unsafe but in which people are still living as they have no other place to go to or are refusing to leave their homes despite the information about the damaged statics.

There is a significant communication gap between citizens and the government, leading to a lack of trust and frustration. To address this, a dedicated team is needed to facilitate communication between the affected local population and both local and central authorities. This team could also support the affected population to gather their paperwork for application of recovery funds. Regular face-to-face meetings between the government and the local community would be essential to bridge this gap and rebuild trust, along with fostering equal chances for everyone, as in the past the ones with the best connection and the very fast ones had advantages and were the first and only to receive the funds. This approach would be ideally applicable to different types of hazards (e.g. earthquakes, fires).

Also, a volunteer community representative, informally elected by the community, could play a crucial role in informing residents about the criticality of their living situation. This representative would also serve as a spokesperson, conveying the community's needs to the authorities. Ideally, this person should not be involved in politics but should be well-respected within the community.

A potential solution could be the implementation of a chat feature on the official website of local authorities, allowing residents to report their problems and seek assistance. This could help bridge the gap between citizens and the necessary infrastructure and services. However, many citizens feel forgotten in the long run and are considering leaving the area. The initial response to the disaster was strong, with volunteers providing blankets, water, and other essentials. But as time passed, the support dwindled, leaving people living in a container in Arkalochori feeling neglected.

The experience gained during the Arkalochori earthquake could help inhabitants be better prepared for future earthquakes. Observations from a focus group indicate that people who experienced the last major earthquake in 1953 knew what was important and how to behave.

To ensure continuity and knowledge transfer the idea of an information festival held in Arkalochori arose during the focus group session. It could be organized during the summer period where volunteers and professionals educate citizens through interactive sessions. In Greece, festivals often feature music and dancing, which are integral parts of the cultural experience. However, considering the diverse age group of attendees, including the elderly, the festival could also showcase traditional cooking and handcrafting techniques. For example, volunteers could demonstrate how to make

herbal remedies, produce yogurt, or cook traditional dishes like Dolmadakia (stuffed vine leaves), which many young people may not know how to prepare.

Additionally, the money raised from these activities could then be used to help the community, providing a dual benefit of education and financial support. This approach not only preserves intangible cultural heritage but also fosters community solidarity and resilience.

10.4. Overview of the needs identified for the key stakeholders under analysis

The stakeholders' needs presented in the before/during/after phases are summarised as main outcomes of this analysis in Table 21.

Table 21 offers a comprehensive overview on the analysis of local authorities', FR and citizens' gaps and needs, relevant to the analysed phase. The table shows the existing gaps that hinder the response capabilities of Local Authorities and presents best practices to address these issues. Best practices include possible implementation priorities that were addressed by participants during the Focus Group sessions, as well as successful strategies already put in place that represent success examples and/or inspiring approaches that could be considered in order to address the needs of the key stakeholders supporting in the enhancement of their preparedness. Should the circumstances also arise in more than one phase of the crisis, this is also indicated in the left-hand column.

Table 21: Overview of needs according to the phases before, during and after the crisis (Crete CORE lab)

PHASE	KEY STAKEHOLDERS	GAPS	BEST PRACTICES	NEED
LOCAL AUTHORITIES				
Before	Ministry of Climate Crisis and Civil Protection and the Organization for Earthquake Planning and Protection ("OASP")		A large-scale Operational Earthquake Field Exercise ("MINOAS") took place to simulate an evacuation scenario.	
Before	General Secretary of Civil Protection		Efforts in distributing information leaflets on protection from natural disasters	
Before	Ministry of Climate Crisis and Civil Protection	• Citizens are generally not aware of these videos, only a few people –mainly first responders- know about them. • Some citizens (vulnerable groups) have no access to internet, social media, television or radio.	• Short videos that introduce the most important "what-to-do"-s in case of a natural disaster (many of them available with sign language)	• Risk awareness campaign to promote the already available resources on disaster preparedness. • Inclusion of face-to-face communication and the church as a channel into the disaster preparation • Need for training on how to speak to the affected population considering their individual different backgrounds
During		• 112 and phones did not work	• Google provided information about the magnitude of the earthquake rapidly	

After	Municipality Arkalochori	N/A	After the earthquake all municipal buildings were checked, evacuation and contingency plans were updated. Building managers and floor managers were deployed especially for the tall buildings. OSAP experts trained personnel evacuation practices. accommodation and emergency shelters are also being found in preparation.	N/A
PHASE	**KEY STAKEHOLDERS**	**GAPS**	**BEST PRACTICES**	**NEED**
FIRST RESPONDERS (FRs)				
Before	Organization for Earthquake Planning and Protection ("OASP")		• They prepare leaflets, videos aired on television and providing information on their website (informative, accessible). • The Hellenic Red Cross also organizes training based on the information coming from them.	
Before	Hellenic Red Cross	• The procedures that volunteers follow are not always clear to other actors. • The legal framework around volunteerism has been mentioned as an important challenge	• They regularly renew their information and education system to constantly be prepared for a future disaster, and continuously train their volunteers	• Universal and common training with the participation of all key actors in crisis response – to understand each other's role (who does what) and to create a shared mental model of disaster management. • Revision and stabilization of the legal framework around volunteerism for volunteers to

				help effectively and in a safe way (covered by insurance, not facing consequences of leaving their job to help)
Before	Police	Earthquake drill is not part of their regular training		Practical training for police officers (and all actors involved) to simulate an earthquake event and related actions.
During		• Even the trained volunteers admit that they have been overwhelmed by the situation and did not know what to do	• Samaritan brothers - provided first aid to the residents of Arkalochori • Volunteers and Samaritan have set up their own communication network • The situation slightly resembled the refugee one, where people are forcibly displaced and there is an emergency situation. Therefore, the response was helpful in regard to shelter and first aid.	
After	Volunteers	• More volunteer groups (e.g. "Epidrasis" Humanitarian Crisis Management Group) were created after the Aralochori earthquake to help citizens. • Volunteers were perceived as being disorganized, not having a central head to coordinate them.	• Online platform with online courses on different disasters (Civil protection) • The earthquake was a wake-up call, and many improvements were made. for example, specific equipment was purchased and already stored in case of an earthquake. This had never been	• Need for preparing not only for earthquake but also for other likely to happen disaster such as pandemic

		Issues with logistics: supplies were difficult to store.	done before. this entails tents, clothes, food. this equipment is similar to the one which is stored for the for use in the rescue of shipwrecked and arriving refugees. • A platform has been set up from Heraklion, where volunteers can sign up and indicate which day they could come to help and in which shift.	
PHASE	**KEY STAKEHOLDERS**	**GAPS**	**BEST PRACTICES**	**NEED**
CITIZENS				
Before	Citizens (general)	• Inappropriate housing infrastructure – some houses were destroyed while others suffered almost no damage. Infrastructural prevention seems to lag behind the efforts related to training and education		• More awareness of the results of the static research related to incidental houses would be needed
Before	Citizens (general)	• This refers mostly to the immediate behavioural action of seeking protection within the house/apartment (e.g. under a table), however more education would be needed about what to do on the long run. • The optimism bias is strongly prevalent in the region ("it won't happen to us").	• The community is well informed, and everybody does know what to do in case of an earthquake	• Risk awareness campaigns to communicate the risk of potential future earthquakes (to fight the optimism bias). • Printed and digital materials / training on what to do on the long run (what are the most important gathering and camping areas, where to meet family members that are not reachable via phone, what are

		• The available brochures are reported to be overly informative.		the available resources to support them). • Need for creating a list with only the 10 most important instructions, and for regularly checking whether these instructions have been properly memorized. • Using social media and television (ad breaks in between sportscasts). • Mandatory practical exercise built in the safety training of workplaces.
Before	Citizens (vulnerable groups)	• Poor building infrastructure that does not allow disabled individuals to exit buildings	• Children are trained by volunteers on a regular basis on how to act when it comes to an earthquake (e.g. how to climb under tables and gather at the assembly points).	• Revising and improving building infrastructures to allow disabled individuals exit the buildings. Collecting the characteristics of vulnerable groups (level of mobility, need for continuous medication), at least in public buildings (retirement homes). • Mandatory exercises built in the national curricula of universities. • School personnel (e.g. teachers, coaches) should attend mandatory training on how to stay calm, what to do, how to protect children during an earthquake.

Before	Tourists	• Tourists and hotels are not included in the preparedness plans and are generally not aware of what to do during and right after an earthquake.	• There are some positive examples where hotel owners and employees regularly exercise how to evacuate the building in case of a disaster event, but these are rather rare.	• Involving travel agencies in informing tourists, not only about accommodation, leisure activities and restaurants, but also about the core instructions to follow in case of an earthquake.
During			• Athletics Club of Arkalochori founded a volunteer team to assist the residents in urgent needs right after the earthquake occurred. They also coordinated the volunteers arriving and sending them where help was needed or assigned them to activities • Used earthquake information app	• Mobile application, especially for young people, providing instructions on how to prepare and behave in case of an emergency. • Effective crowd information in case phone lines are out of service (e.g. drones with loudspeaker) The warning should entail clear/tailored instructions where to go and where to obtain shelter/help by locating them • Training for citizen volunteers
After	Residents	• It remains unclear what will happen to the buildings which are currently marked as unsafe but in which people are still living. • No psychological help was offered from the official side for the affected population • Residents to refuse to leave the house even though they have been informed about the damaged statics • Missing communication link between citizens and	• Untrained volunteers supported the residents with psychological support. • Very basic behavioural instructions are taught in schools, e.g. go to open air, do not grab cables, do not use the elevator, etc. • The experience gained during the Arkalochori earthquake can help the inhabitants to be better prepared should another earthquake hit their region. one	• Organised psychological support for affected population addressing both children and adults over a long time and involving them also in social activities • Team needed that enables the communication between affected local population, local and central authorities

		government, resulting also in lack of trust and frustration. • After 3 years: the houses are still damaged and people are still waiting for support. Citizens feel abandoned and betrayed by the government. • Citizens did not know where to go after the earthquake, whether there gathering and camping areas. Information about these places is often outdated, not valid anymore. • Lack of continuity in preparedness and lessons learnt transfer	focus group reports the observation that the people who experienced the last major earthquake in 1953 knew what was important and how to behave. • Solidarity was strengthened through this incident. • An association was created, the Elpida Association, for such cases and for the rights of earthquake victims	• Face to face meetings with the government & local community • Team that supports the affected population to gather their paperwork in order to apply for recovery funding or housing. trusted team that supports especially the elderly/non digital experienced people during this process of online application forms. The team also takes over the communication and collaboration with relevant authorities. • A map that shows where the nearest gathering and shelter area is • An "information festival" could be organised during the summer period where volunteers come and educate citizens through interactive sessions to • Ensure continuous transfer of knowledge

10.5. Overview of solutions and user requirements

As the final step of the analysis of the needs in Crete CORE Lab, a preliminary tentative matching has been created between a selection of needs and the solutions that RESILIAGE project has to offer, namely: soft solutions (Risk awareness campaigns, Preparedness toolkits, Communication guidelines), training and digital solutions (RAISE tool, Monitoring Dynamic Resilience Dashboard, Multihazard Early Warning Detection System, Multi-agent Social Network Modelling, CORE Digital Network, Decision Support System, ATLAS tool). At this stage, the table only contains a preliminary comparison of the selected needs that could potentially be addressed by RESILIAGE solutions and tools in order to discuss and prioritise them further with the research and CORE laboratory partners. In addition to mapping the needs, this table also contains generic, high-level user requirements that are results of the combined research process of T4.1. and should be taken into consideration when developing the solutions.

10.5.1. Soft solutions

The following table reports the preliminary match between key stakeholders' (local authorities, first responders, citizens) needs and requirements and the soft solutions to be developed within RESILIAGE project: risk awareness campaigns, preparedness toolkits and communication guidelines.

Table 22: Preliminary match of needs and requirements with soft solutions (LA= local authorities, FR= first responders, C= citizens)

Type of solution	*Stake-Holders*	*Needs*	*User Requirements*
Risk awareness campaigns	**LA**		
	FR		
	C	• Risk awareness campaign to promote the already available resources on disaster preparedness. • Risk awareness campaigns to communicate the risk of potential future earthquakes (to fight the optimism bias). • Need for creating a list with only the 10 most important instructions, and for regularly checking whether these instructions have been properly memorized. • Involving travel agencies in informing tourists, not only about accommodation, leisure activities and restaurants, but also about the core instructions to follow in case of an earthquake. • Effective crowd information in case phone lines are out of service (e.g. drones with loudspeaker) The warning should entail clear/tailored instructions where to go and where to obtain shelter/help by locating them	• Inclusion of face-to-face communication and the church as a channel into the disaster preparation • Using social media and television (ad breaks in between sportscasts). • List the 5-10 most important actions to take, but no more. Lists should be easy to understand, see through, apply to and remember, too. • Inclusion of Church
Preparedness toolkits *(infographics, safety plan*	**LA**		
	FR		

checklist, safety plan templates)	**C**	• Printed and digital materials / training on what to do on the long run (what are the most important gathering and camping areas, where to meet family members that are not reachable via phone, what are the available resources to support them). • Need for creating a list with only the 10 most important instructions, and for regularly checking whether these instructions have been properly memorized. • Effective crowd information in case phone lines are out of service (e.g. drones with loudspeaker) The warning should entail clear/tailored instructions where to go and where to obtain shelter/help by locating them	• List the 5-10 most important actions to take, but no more. Lists should be easy to understand, see through, apply to and remember, too.
Communication Guidelines	**LA**	Need for training on how to speak to the affected population considering their individual different backgrounds	
	FR	Need for training on how to speak to the affected population considering their individual different backgrounds	
	C		

10.5.2. Training

In Table 23 the preliminary match between key stakeholders' (local authorities, first responders, citizens) needs and requirements and the *trainings* to be developed within RESILIAGE project has been mapped. The table also marks which needs should be fulfilled with training, focusing on knowledge (K= bodies of information that are applied directly to the performance of work functions), skills (S= technical or manual proficiencies which are usually acquired through training) and/or abilities (A= proficiency to be innate or acquired without formal instructions).

Table 23: Preliminary match of needs and requirements with training (LA= local authorities, FR= first responders, C= citizens)

Stake-holders	***Needs***	***USER REQUIREMENTS***

LA	Universal and common training with the participation of all key actors in crisis response – to understand each other's role (who does what) and to create a shared mental model of disaster management.	
FR	• Universal and common training with the participation of all key actors in crisis response – to understand each other's role (who does what) and to create a shared mental model of disaster management. • Practical training for police officers (and all actors involved) to simulate an earthquake event and related actions. • Need for preparing not only for earthquake but also for other likely to happen disaster such as pandemics	
C	• School personnel (e.g. teachers, coaches) should attend mandatory training on how to stay calm, what to do, how to protect children during an earthquake. • Organised psychological support for affected population addressing both children and adults over a long time and involving them also in social activities	

10.5.3. Digital solutions

In Table 24, the preliminary match between key stakeholders' (local authorities, first responders, citizens) needs and requirements and the digital solutions to be developed within RESILIAGE project is reported. The digital tools taken into consideration for the mapping are the following: RAISE tool, Monitoring Dynamic Resilience Dashboard, Multihazard Early Warning Detection System, Multi-agent Social Network Modelling, CORE Digital Network, Decision Support System, ATLAS tool.

Table 24: Preliminary match of needs and requirements with digital solutions (LA= local authorities, FR= first responders, C= citizens)

Type of solution	*Stake-holders*	*Needs*	*USER REQUIREMENTS*
	LA	Risk awareness campaign to promote the already available resources on disaster preparedness.	• Practical, easy-to-understand information • Inclusion of vulnerable groups (audio and visual support)

The Resilience Assessment Interactive Self-Enabler tool (RAISE)	FR		
	C		
Monitoring Dynamic Resilience Dashboard	LA		
	FR		
	C	Printed and digital materials / training on what to do on the long run (what are the most important gathering and camping areas, where to meet family members that are not reachable via phone, what are the available resources to support them). A map that shows where the nearest gathering and shelter area is.	• List the 5-10 most important actions to take, but no more. Lists should be easy to understand, see through, apply to and remember, too. • Like a google map that shows available resources within the area. • The potential involvement of the Church as a trustworthy communication media.
Multi-hazard early warning detection system	LA		
	FR		
	C	• Printed and digital materials / training on what to do on the long run (what are the most important gathering and camping areas, where to meet family members that are not reachable via phone, what are the available resources to support them). • Mobile application, especially for young people, providing instructions on how to prepare and behave in case of an emergency. • A map that shows where the nearest gathering and shelter area is	• List the 5-10 most important actions to take, but no more. Lists should be easy to understand, see through, apply to and remember, too. • Like a google map that shows available resources within the area.

Multi-agent social network modelling for Resilient Behaviour	LA		
	FR		
	C	• Effective crowd information in case phone lines are out of service (e.g. drones with loudspeaker) The warning should entail clear/tailored instructions where to go and where to obtain shelter/help by locating them	• List the 5-10 most important actions to take, but no more. • Lists should be easy to understand, see through, apply to and remember, too.
CORE Digital Network	LA	• Risk awareness campaign to promote the already available resources on disaster preparedness. • Inclusion of face-to-face communication and the church as a channel into the disaster preparation	
	FR		
	C	• More awareness of the results of the static research related to incidental houses. • Risk awareness campaigns to communicate the risk of potential future earthquakes (to fight the optimism bias). • School personnel (e.g. teachers, coaches) should attend mandatory training on how to stay calm, what to do, how to protect children during an earthquake. • Involving travel agencies in informing tourists, not only about accommodation, leisure activities and restaurants, but also about the core instructions to follow in case of an earthquake. • Mobile application, especially for young people, providing instructions on how to prepare and behave in case of an emergency. • Organised psychological support for affected population addressing both children and adults over a long time and involving them also in social activities.	• List the 5-10 most important actions to take, but no more. Lists should be easy to understand, see through, apply to and remember, too.

		• An information festival could be organised during the summer period where volunteers are invited educating citizens through interactive sessions to ensure continuous transfer of knowledge. •	
Decision Support System (DSS)	LA	• Risk awareness campaign to promote the already available resources on disaster preparedness. • Need for training on how to speak to the affected population considering their individual different backgrounds	• List the 5-10 most important actions to take, but no more. Lists should be easy to understand, see through, apply to and remember, too. •
	FR	• Universal and common training with the participation of all key actors in crisis response – to understand each other's role (who does what) and to create a shared mental model of disaster management. • Revision and stabilization of the legal framework around volunteerism for volunteers to help effectively and in a safe way (covered by insurance, not facing consequences of leaving their job to help. • Need for preparing not only for earthquake but also for other likely to happen disaster such as pandemics.	
	C	• Risk awareness campaigns to communicate the risk of potential future earthquakes (to fight the optimism bias). • Printed and digital materials / training on what to do on the long run (what are the most important gathering and camping areas, where to meet family members that are not reachable via phone, what are the available resources to support them). • School personnel (e.g. teachers, coaches) should attend mandatory training on how to stay calm, what to do, how to protect children during an earthquake. • Mandatory exercises built in the national curricula, extending training to high schools and universities. • Training for citizen volunteer. • A map that shows where the nearest gathering and shelter area is.	• List the 5-10 most important actions to take, but no more. Lists should be easy to understand, see through, apply to and remember, too.

		• An "information festival" could be organised during the summer period where volunteers are invited educating citizens through interactive sessions to ensure continuous transfer of knowledge.	
The Multidimensional Atlas for Community Resilience	LA	Risk awareness campaign to promote the already available resources on disaster preparedness.	
	FR		
	C	• More awareness of the results of the static research related to incidental houses. • Revising and improving building infrastructures to allow disabled individuals exit the buildings. Collecting the characteristics of vulnerable groups (level of mobility, need for continuous medication), at least in public buildings (retirement homes) (can demonstrate the places/zones under risk by mapping).	

11. Overview of Trondheim CORE lab needs (T4.1)

"There is probably no one you know worse than your closest neighbours."

(Citizen Trondheim)

The quote has been chosen to reflect the perceived connectedness of citizens with their neighbours. Even though it has been reported that the CORE lab in general has a strong community culture (e.g. "dugnad", a type of voluntary work carried out as a community), it somehow contradicts the findings of the cross-sectional survey where more than 65% of the respondents rated their relationship with their neighbour as weak or very weak. In terms of information accessibility, students have been identified as one of the most important vulnerable groups due to their relatively poor social network (compared to local inhabitants) and therefore poor access to relevant information related to a potential disaster. In addition, citizens in the community have been reported as having a great trust in the authorities, and therefore they are perceived as rather passive and lacking the sense of empowerment and individual responsibility. A challenge, therefore, to address would be to support citizens in improving their sense of control and train them how they can best contribute to crisis responses as active agents.

In the case of Trondheim, one important difference related to the results of the focus group session compared to other CORE labs is the hypothetic nature of the scenario that focus group participants have worked on. Although hypothetic, participants have managed to draw a particularly detailed map of the actors involved in the crisis response which implicates a generally high awareness level related to disasters. On the other hand, as it has been underlined, there is a general confusion around the different levels, roles and responsibilities in crisis response which can be explained by the high number of actors involved in the multi-agent teamwork, as well as the pattern of "silo thinking" in crisis response, as explained by the participants. Consequently, this challenge should be addressed to ensure a smooth coordination among actors in the case of a potential future disaster. Related to this, the need for situational plots has been mentioned to keep actors updated about the unfolding event.

Table 25: Stakeholder groups in Trondheim CORE lab

KEY STAKEHOLDER	DESCRIPTION
LOCAL AUTHORITIES	• Norwegian Directorate for Civil Protection (DSB) • Trondheim Municipality • NVE - Norges Vassdrags- or energiedirektorat • The Norwegian Water Resource and Energy Directorate under the Ministry of Petroleum and Energy • Police

Funded by the European Union

	• Civil Defense
FIRST RESPONDERS	• Trondheim Care Emergency Response Group • Red cross (relief corps, shelter care, emergency watch) • Rescue Professional Forum for Voluntary Organizations (FORF) • Care Emergency at Norske Kvinners Sanitetsforening (NKS) / Norwegian Women's Public Health Association • RVTS (mental health support) • Akuttmedisinsk kommunikasjonssentral (AMK) Emergency Medical Communications Center • Trondheim Museums Crisis Management Team
CITIZENS	• Residents • Museums of Trondheim

As can be seen on the recreated Interaction Map, Trondheim has a well-established alert chain with a variety of different communication channels involved in the response. In addition, focus group participants reported that these communicational channels are all bidirectional, allowing participants to inform and feedback to each other about the current state of the crisis. As explained, however, a well-functioning digital system has been recently replaced by a new one (RAVEN) which may be a contributing factor to less coordinated initial actions, until key actors learn how to use it effectively. In addition, participants of the focus group session highlighted the importance of situational plots to effectively update and collaborate with each other during crisis.

Funded by the European Union

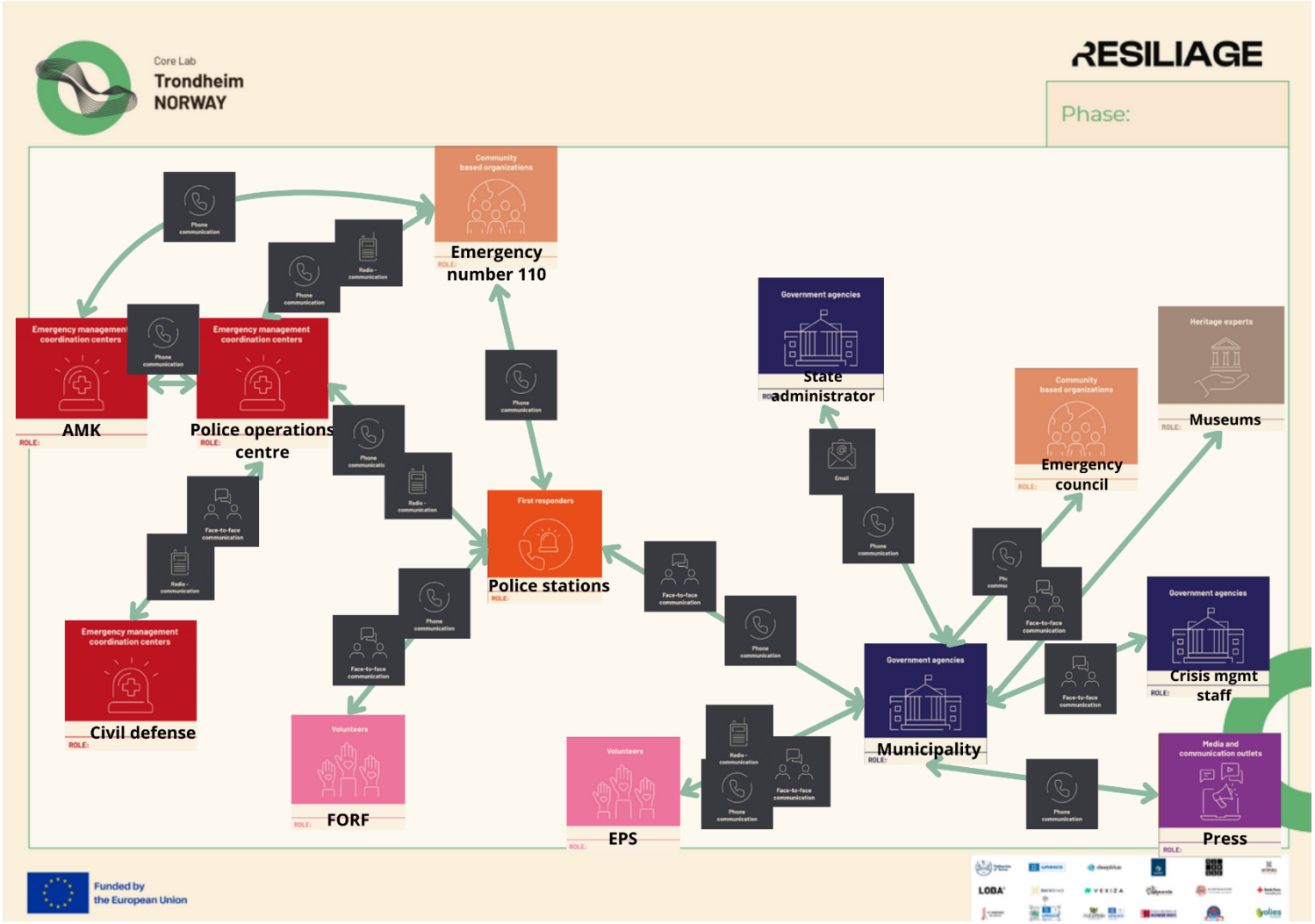

Figure 40: Recreated Interaction Map, visualising the communication of key stakeholders in the Trondheim CORE lab

11.1. Before the crisis

Introduction to the context

While there has been a wide variety of solutions and information being publicly available to the citizens in Trondheim, they are mostly perceived as rather passive participants of activities related to disaster risk management. An important explanation behind this phenomenon is citizens' great trust in authorities and in their capability to manage large scale events without the active participation of citizens. As a result, the sense of individual responsibility and empowerment is generally seen as low. Students have been mentioned as one of the most important vulnerable groups due to their potentially poor access to official information. First responders and authorities expressed the need for a stronger collaboration and more effective communication when it comes to multi-agent teamwork. While much information is already available on different public websites, the importance of multilingual and printed solutions has been mentioned to include foreigners (tourists, refugees, immigrants, foreign students) and digitally illiterate individuals in the preparedness plans.

Identification of gaps, best practices, needs

In the following, the key stakeholders analysed (Local Authorities, FRs, Citizens) are described in more detail. A comprehensive overview of the existing gaps that hinder their response capabilities are identified and best practices to address these issues are presented, if available. Best practices include possible implementation priorities that were addressed by participants during the Focus Group sessions, as well as successful strategies already put in place that represent success examples and/or inspiring approaches that could be considered to support key stakeholders in the enhancement of their preparedness.

- **Local authorities**

When it comes to the communication media used by authorities, mobile communication is the most consulted type of media during crisis, while emails and websites are perceived as most intuitive. Local authorities who responded the cross-sectional survey also reported that they never had to deliver an official disaster warning before, which might be a potential training gap to address in the future. When it comes to emergency situations, the warnings that authorities send out (e.g. colour codes for rain) are often perceived as overused, therefore, focus group participants reported the risks of these warnings not being taken seriously enough in the future. As important best practices, authorities mentioned that maps of the quick clay risk areas are publicly available online, as well as emergency lists prepared by DSB (Norwegian Directorate for Civil Protection) about what to have at home in case of a disaster event. On the other hand, participants underlined the importance of target audience management as well as a preparedness plan for a larger scenario that includes the combination of different disaster events and the related what-to-dos for authorities and first respondents, including specific gathering points for emergency services.

- **First responders**

When it comes to the communication media used by first responders, mobile communication has been mentioned as the most consulted and most intuitive form of communication, but they also reported to consult traditional forms of media and to perceive face-to-face communication as highly intuitive.

While the most important aim of first responders and local authorities would be to enhance citizens' empowerment and individual responsibility, focus group participants reported general communication in crisis management as a relevant field that needs improvement in the future. As it has been highlighted, citizens (but also authorities and first responders) are often somewhat uncertain regarding the roles and responsibilities of different actors in crisis response. Not surprisingly, communication across different levels of responsibility is often mentioned as an issue in evaluation reports. One important explanation behind this issue is the lack of frequent contact between key actors. Even though there are professional meetings regularly taking place, when it comes to a real scenario, coordination across these actors is at risk, due to the many different players being involved without their multi-agent teamwork being sufficiently practiced. As it has been underlined, in Norway, crisis management often involves in-person meetings and courses to build personal relationships. This approach helps establish trust and collaboration. However, when key individuals like incident leaders or police chiefs retire, these personal connections are lost, thus disrupting continuity. To address this, a system that focuses on roles and functions rather than personal relationships could be beneficial. This would ensure consistent and effective crisis management, even if specific individuals are unavailable or replaced. In addition, focus group participants also mentioned the importance of diverse response teams in order to enhance mutual understanding and collaboration across different actors during crisis response. As it has been highlighted, there are many potential actors within Trondheim that will be of support in case of an emergency, however, there is a need to identify them and understand their resources (e.g. NTNU, Refugee Services...).

When it comes to volunteers of Trondheim, they reported mobile communication as the most consulted and most intuitive communication channel, along with traditional media (television, radio) which has been also perceived as highly intuitive. When asked about official disaster warnings, respondents from volunteers reported that they never had to issue one before which might be a potential gap to train them. They also mentioned the need to receive clear and actionable instructions that would help them to promptly intervene in case of a disaster.

- **Citizens**

When it comes to preparing citizens to different types of emergency situations, focus groups participants mentioned several already existing best practices. There are for instance nationwide available e-learning courses on basic first aid and home fire safety, as well as information campaigns to different audience (e.g. foreign truck drivers) and self-preparedness brochures are available to challenge citizens to develop their individual preparedness plans. In addition, a preparation book ("in case of a doomsday") for individuals with poor digital skills, and a mascot ("Bjornis") for educating children on fire related hazards is also available. Despite the afore-mentioned preparatory actions, however, citizens are generally perceived as lacking proactiveness and empowerment in crisis situations. One important explanation behind this phenomenon is related to citizens' great trust in authorities. As one focus group participant mentioned: "there is a strong perception that the "authorities will save each and every one, and that within 72 hours everything will be up and running again". On the other hand, in reality, the authorities' aim would be to prepare citizens who have the capacity to look after themselves, thus having more resources left to concentrate on vulnerable groups who need greater support and closer follow up during a potential disaster event. For instance, citizens are now advised to store an emergency package at home that would allow them

to self-manage themselves for seven days, while in the past, the general instructions were suggesting to have resources only three days. Besides elderly, children, refugees, tourists and individuals with physical or mental disabilities, focus group participants reported students (especially foreign students) as a specific vulnerable group to pay attention to. Coming from many different countries, the availability of multilingual preparedness plans (online and printed) would therefore be especially important. In addition, as it has been highlighted, students who relocated from other cities or countries may not have the same social network, and therefore same access to crucial information as individuals who have been residents of the city for many years (e.g. the importance of home insurance for potential future disaster events). In addition, authorities reported the challenge of reaching students, as many of them do not register their relocation, therefore, are difficult to contact. A potential mitigation is related to the importance of finding the right communication channel – in the case of students the involvement of universities in the communication loop with students has been mentioned. As it has been underlined, cultural diversity could and should be seen as a resource –instead of a burden- to take advantage of when building community preparedness and resilience of the city (e.g. interactive workshops to share individual coping strategies). One important best practice to mention has been reported by the "Sanitetsforeningen" who handed out small cards for people with language barriers with the relevant emergency numbers and with text to show that they understand/not understand what is being said to them. Related to that, the importance of printed materials was mentioned by the focus group participants, as many of the solutions are available only in digital format. Finally, it was understood that the combination of different emergency and disaster events would be important to prepare the citizens (e.g. landslides and fire), with further practical information included (e.g the consequences of a mudslide or publicly available places where one can stay warm when the heating system breaks down).

11.2. During the crisis

Introduction to the context

The alert chain and responsibilities of actors involved in the response to a landslide in Trondheim is well established. It is clear how important it is to provide an up-to-date picture of the situation. A well-functioning digital system has recently been replaced by a reportedly less useful one, which hampers coordination and clarity in the event of a crisis. The need for situational plots and maps was emphasized for both local authorities and first responders. Participants also noted a decline in traditional volunteering but highlighted Norway's strong community culture, which is beneficial during crises. A hotline and press conferences would provide support and information for citizens, with social media used for rapid updates. Key needs include managing information, addressing fake news, and using platforms like TikTok to reach younger generations.

Identification of gaps, best practices, and needs

In the following, the key stakeholders analysed (Local Authorities, FRs, Citizens) are described in more detail. A comprehensive overview of the existing gaps that hinder their response capabilities are identified and best practices to address these issues are presented, if available. Best practices include possible implementation priorities that were addressed by participants during the Focus Group sessions, as well as successful strategies already put in place that represent success examples and/or inspiring

approaches that could be considered to support key stakeholders in the enhancement of their preparedness.

- **Local authorities**

In the event of a landslide, the first group the municipality communicates with is the police chief's staff. This communication is bidirectional and can be initiated by either party, typically over the phone. Once the landslide has occurred, alerting is initiated through both the population alert system and the police's new emergency alert system. Additionally, there is a radio system, known as the emergency network, which the municipality also uses. While the telephone is the primary means of communication, the emergency network can quickly become the main channel in such situations. Video conferencing has become a significant tool, especially since the pandemic. Platforms like Teams, which can be accessed via phone, allow resources to connect and manage crises from any location in addition to the office. However, there is a critical dependency on electricity and electronic communications (ECOM), including phone and data services. This reliance represents a significant vulnerability in crisis management. Also, police communication is carried out via the telephone network from police staff to the police operations centre and from there to the fire brigade operations centre. Civil defence is informed only if assistance is needed. It becomes apparent that it is a very vulnerable system if the telephone network does not work.

The municipality takes a proactive approach in communicating with the press. While the press often calls directly via phone, if the phone lines are down, the plan is to use radio or the internet to disseminate information. Trondheim Municipality handles press communications to inform the public on how to behave and reduce the consequences of incidents. According to participants from the Municipality, in crisis situations, life and health are the top priorities, with a focus on evacuees and the Evacuation and Relatives Center (EPS). The police are responsible for deciding on evacuations, while Trondheim Municipality implements them. The decision on the EPS location is in the municipality's plan, but the police may decide the final location. Although there are agreements with hotels based on exercises and plans, these may not be available in this scenario. Face-to-face communication among crisis management, the country emergency council, and the local rescue management (LRS) is crucial. If necessary, the response can be always also managed from another location.

Communication is bidirectional, with alerts sent via SMS, voice messages, or based on phone agreements. In general, the Municipality is responsible for all city residents including students and commuters. In case of a crisis, it is the municipal crisis management teams' responsibility to evacuate and provide the necessary material. The municipalities' psychological teams are alerted as well to respond timely. The municipal crisis team is holding regular status meetings, where representative from all sectors, including education, health, and culture, participate. Liaison officers are established with necessary organisation, such as police, Red Cross and civil defence to ensure resources find each other. The approach mirrors the police staff's operation in this area. Due to the type of hazard, the NVE is to be included in the response and can come in through several channels - the emergency council or national resources. An email is sent to the County Governor with a situation report and resource needs.

When it comes to crisis coordination, the police are responsible staff by organizing what happens with the emergency services. It is not the municipality's task, but there is coordination with the police staff. As it becomes apparent how many different actors are

responding to this scenario, participants emphasize the importance of a situational plot, a real-time map or drawing that shows the current situation. They highlight that reports are outdated once written and that a visual representation would help everyone understand the significance of events like landslides.

Regarding digital solutions in place, Norway has transitioned from the national digital solution CIM to RAVEN, which is currently being tested by Trondheim Municipality. CIM was a comprehensive crisis management tool offering features like alert systems, mapping, report sharing, and logging. However, due to economic reasons, this well-functioning system has been replaced by RAVEN, which is seen as less robust and only provides basic logging capabilities.

The transition has resulted in a split management level, with ministries and directorates using different systems, complicating crisis management, especially during events like the pandemic. While CIM was sophisticated and evolved over ten years, RAVEN is still new and lacks user feedback for customization. The participant notes that RAVEN is a “50% solution” and expresses concern over moving from a sophisticated system to a simpler one.

With the new system RAVEN shared access to incident maps is supported. Users can plot their positions, making them visible to others and enabling collaborative marking of critical points.

As already experienced in the past where storms caused road closure impacting ambulance routes, the situation awareness through maps or models is perceived to be crucial for planning emergency responses, as it helps differentiate between temporary blockages and complete road destruction.

Further, it is pointed out that different stakeholders, like electricity providers, have proprietary systems that cannot communicate with others due to regulations. This is for example mandated by the specifications from the Norwegian Water Resources and Energy Directorate (NVE) so that no one can connect to or compromise the system. A separate system for actors to collaborate would therefore be helpful. In addition, an overlaying outage map from power providers with other layers to create a comprehensive situational picture was suggested. It would have to be clarified, who can draw on the map or if a central authority is only plotting. The power companies' data base (SCADA) is presented as a comprehensive example which can display the entire network showing which lines have gone down and based on these resources and durations can be estimated. However, only very few people have access to it as is highly proprietary.

Maps are considered to be extremely important, especially in scenarios involving landslides. The difference between a map and a situational plot lies in their detail and purpose. A map is incredibly detailed, containing many layers of information, whereas a situational plot is very simplified, resembling a weather forecast. According to the participants, these tools are used in different situations depending on the circumstances and the information that needs to be displayed. For instance, a geologist will use a detailed map, while someone in an emergency operations centre will rely on a situational plot to quickly understand and respond to the situation.

In addition, silo thinking has been reported as a frequent issue, with individuals prioritizing their own systems and interests, often overlooking collaboration’s potential. Recognizing that collective strength is greater is crucial. The Emergency House in

Bergen exemplifies this, serving as a civilian operations centre for the municipality and its partners, facilitating meetings and exercises, and fostering an understanding of collaboration's importance.

- **First responders**

In the following the alert procedures of different first responders in case of a crisis were identified by the participants.

In the event of an emergency, a triple alert is sent to the Fire, Ambulance, and Police services. Once the site is secured, search operations are activated. The police can issue warnings, and the municipality can request information.

For NKS, notifications are sent to emergency response team members via Spond, ensuring quick response times for large medical associations. Emergency response guards and NKS are trained in crisis management, psychological issues, and effective communication. To mobilize 100 volunteers, the group uses an app, although they may need to call each other to confirm availability for short and long-term commitments, relying heavily on phone and internet.

The Trondheim Red Cross action plan specifies that if all communication fails, members meet at the Red Cross House without any alert. Their emergency watch would support with resources, first responders rescue corps but also provide the centre for evacuees and relatives.

RVTS would also play a crucial role, particularly noted for their involvement in mental health services during the July 22 incident. If needed, the Akuttmedisinsk kommunikasjonssentral (AMK) is informed by the municipality via phone.

Within the Trondheim civil community there are also second line responders which are present in the landslide risk areas, and they are responding in agreement with the municipality.

Further, the Rescue Professional Forum for Voluntary Organizations (FORF) are always notified in a crisis via a phone alert. This Forum includes the Red Cross, Norwegian Rescue Dogs, Radio Relay League, and other voluntary organizations. The police have a button that opens a conference group for all voluntary organizations, allowing them to communicate with the police. The incident commander from the police is also involved. This system is new from last year.

The Trondheim Museums rely solely on phone communication. They are not contacted until after rescue operations, when the focus shifts to salvaging the value of houses and art. At this stage, the museums can contribute. They have their own network for internal alerts and crisis management and are not part of any other notification system by today. Whether this would be necessary did not become clear during the session. The municipality emphasized that there were discussions in the past with the Nidaros Cathedral Restoration Workshop which have their own plans because if a landslide goes down into the Nidelva River, the Nidaros Cathedral will be flooded. The landslide will block the river's flow, and it will only take hours before it happens. On the other hand, lessons were already learned from the fire in the Archbishop's Palace. A lot of valuable relics were lost there. These have now been moved to the Dora (warehouse) so that there is no longer a collection at the Archbishop's Palace.

- **Citizens**

Participants noted that traditional volunteering through organizations is declining over the years. However, they also highlighted that in Norway, a strong, trusted community culture exists where people help each other without expecting anything in return, which will be beneficial in case of a devastating event.

During the crisis a hotline staffed with trained professionals would be established to support citizens in need. Further, information would be provided during reoccurring press conferences sharing clear information and social media would be used in the meantime with rapid updates. In addition, the foreseen collaboration with the National Federation of the Blind and the National Association of Deaf will ensure accessibility, while interpreting services will help overcome language barriers.

The participants identified several key needs to improve emergency preparedness communication. One major concern is how to handle the vast amount of information shared during a crisis, distinguishing between fake and relevant information. Also, the importance of including people of different ages when planning communication strategies was emphasized. This ensures that the needs and preferences of all age groups are considered, making the communication more effective.

There is also a need to incorporate social media platforms, such as TikTok, as distribution tools to reach the younger generation. This approach leverages the popularity of these platforms among youth to disseminate critical information quickly and effectively. Additionally, diversifying communication channels might be essential to ensure that everyone, including the elderly and the young, receives the necessary information.

11.3. After the crisis

Introduction to the context

When it comes to after the crisis, participants of the focus group sessions highlighted the importance of investigating the past in more details, including the identification of best practices ("what went well") and challenges in communication, coordination as well as the practical evaluation of the feasibility of instructions and regulations. As it has been articulated, citizens of the area are often not entirely aware of the available resources after the crisis, which poses a further challenge on recovering from the crisis.

Identification of gaps, best practices, and needs

As this is a hypothetical scenario, little was said about the circumstances in terms of gaps and needs after the disaster. However, the following aspects were noted at the level of the local authorities, which also involves FRand Citizens.

- **Local authorities**

During the 2023 Emergency Preparedness Week, the Directorate for Civil Protection (DSB) highlighted the need for training and exercises. Focus group participants from Trondheim Municipality shared their perspectives on the campaign, which included interactive tasks such as tabletop exercises for households and family discussions on crisis management.

One participant noted, "The tabletop exercises and family discussions are a good start, but they feel like the lowest level of exercise I've seen. Not everyone gets the message, and it's not enough to ensure we're ready for a real crisis."

Another participant emphasised the importance of practical application: “Municipalities primarily rely on reports. During the last extreme weather event, the potential impact was similar to the storm Ivar, where 110,000 electricity customers lost power. We take into account the lessons from that report, but it’s still just a report. We need to translate these lessons into actionable plans and regular, practical exercises.”

The consensus among participants was clear regarding the importance of receiving training: “To improve emergency preparedness, we need more comprehensive and frequent training that simulates real-life scenarios. This way, individuals and families are not only aware of potential risks but are also equipped with the skills and confidence to respond effectively during a crisis.”

To summarise, while reports and tabletop exercises are important components of emergency preparedness, they must be complemented by practical, hands-on training. As one participant succinctly put it, “By doing so, we can better prepare for and mitigate the impacts of extreme weather events and other emergencies.”

11.4. Overview of the needs identified for the key stakeholders under analysis

The stakeholders’ needs presented in the before/during/after phases are summarised as main outcomes of this analysis in Table 26.

Table 26 offers a comprehensive overview on the analysis of local authorities', FR and citizens’ gaps and needs, relevant to the analysed phase. The table shows the existing gaps that hinder the response capabilities of Local Authorities and presents best practices to address these issues. Best practices include possible implementation priorities that were addressed by participants during the Focus Group sessions, as well as successful strategies already put in place that represent success examples and/or inspiring approaches that could be considered in order to address the needs of the key stakeholders supporting in the enhancement of their preparedness. Should the circumstances also arise in more than one phase of the crisis, this is also indicated in the left-hand column.

Table 26: Overview of needs according to the phases before, during and after the crisis (Trondheim CORE lab)

PHASE	KEY STAKEHOLDERS	GAPS	BEST PRACTICES	NEED
LOCAL AUTHORITIES				
Before	Municipality Police	DSB data shows one of the most vulnerable groups is students. They live in cramped conditions, don't think about robustness, and don't have the same network or access to communication as we do.	• Every year, the municipality is challenged to work on a self-preparedness campaign. Targeting students can make a difference. Collaborations with the universities and the Women's Health Association were made to launch a direct campaign aimed at increasing self-preparedness in this most vulnerable group. • Maps of quick clay risk areas are online available • Self-preparedness brochures have been distributed via the post. Having a brochure ensures also having access to the information when no phone reception/internet connection is guaranteed • Warning is issued by the police and the geographical area can be decided upfront. It can be valid for several hours and the size of the area can be nationwide or only a certain district of a city. people entering the area are also receiving the message. • Additional warning issued by the municipality only reach the people who have been registered beforehand and have an address in that area. • Exercises can also identify unnecessary overlaps such as municipality and police	• Definition of meeting points for residents and emergency services to gather • There is a need to identify potential actors of support, and also know their resources (e.g. University NTNU, Refugee Services...) • Communication remains a recurring issue, particularly in crisis management and exercises. There is uncertainty about roles, responsibilities, and authority, which leads to confusion and inefficiencies. The difficulty in communication across sectors may stem from a combination of lacking skills, inadequate systems, and cultural barriers. This issue is frequently highlighted in evaluation reports and requires attention to ensure effective communication at all levels of responsibility. • Encouraging individual responsibility is crucial. While it's positive that Norwegians trust their authorities, it's equally important for people to take proactive steps.

			are obliged by law to register people in evacuation centres. • Stakeholders involved in vulnerability assessment and planning familiarize already for training or response scenarios.	
During		Shift in Norway's national digital solution: RAVEN replaced CIM but is not as well functioning anymore.	• The press is handled by Trondheim Municipality and is used to inform people on how to behave and reduce the consequences. • The emergency council is a consultative body. It ensures that all emergency actors have a common understanding of the situation and that resources find each other. The decision on the location of the EPS (Evacuation and Relatives Centre) is in the municipality's plan, but it may well be that the police decide where it should be. Based on exercises and plans, there are agreements with hotels and so on, but that will not be available in this scenario.	• It is our dependency on electricity and electronic communications (ECOM), meaning phone and data. This is an enormous vulnerability • Different stakeholders, like electricity providers, have proprietary systems that cannot communicate with others due to regulations. A separate system for actors to collaborate would be helpful. In addition, an overlaying outage map from power providers with other layers to create a comprehensive situational picture was suggested. • Maps are extremely important, especially in scenarios with landslides.

After	Municipality DSB		• Last year, DSB's main message during Emergency Preparedness Week was the need for training and exercises. Interactive tasks were created, such as tabletop exercises for the home. Discussion tasks with the family on how to manage ourselves in the event of a crisis. • Taking lessons learned from the reports of previous disruptive events such as heavy storms	
PHASE	**KEY STAKEHOLDERS**	**GAPS**	**BEST PRACTICES**	**NEED**
FIRST RESPONDERS (FRs)				
Before	Volunteers		• Crisis management often involves in-person meetings and courses to build personal relationships. This approach helps establish trust and collaboration	• The retirement of key individuals like incident leaders or police chiefs can disrupt these personal connections, affecting continuity. To address this, a system that focuses on roles and functions rather than personal relationships is needed. • Additionally, regular practice of roles, responsibilities, and authority is essential to make these processes more intuitive and effective. •

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During		High dependency on the phone without a backup communication line	• The emergency watch of the Trondheim Red Cross would support with resources, first responders rescue corps but also provide the centre for evacuees and relatives • The Red Cross action plan states that if everything is down, we meet at the Red Cross House without any alert. • Within the Trondheim civil community there are second line responders which are present in the landslide risk areas, and they are responding in agreement with the municipality. • The Rescue Professional Forum for Voluntary Organizations. They are always notified in a crisis. Alerts go out via phone. This includes the Red Cross, Norwegian Rescue Dogs, Radio Relay League, and other voluntary organizations. The police have a button that opens a conference group for all voluntary organizations, allowing them to communicate with the police. The incident commander from the police is also involved. • Lessons were already learned from the fire in the Archbishop's Palace. A lot of valuable relics were lost there. These have now been moved to the Dora (warehouse) so that there is no longer a collection at the Archbishop's Palace.	
After				

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PHASE	KEY STAKEHOLDERS	GAPS	BEST PRACTICES	NEED
CITIZENS				
Before	Residents	• The mudslides risk is communicated but the consequences are not communicated • Citizens do not know where to they have to go in case of a crisis. • The importance of insurance was highlighted as it is believed that many students do not have a home insurance. • Population registry list is not up to date as only a few residents registered. Not everyone is registering their move to Trondheim consequently not existing on the lists which are accessible and used by the Municipality. • High trust in authorities results in little or no responsibility taking. • Norwegians are very private and do not know their neighbours' potential resources	• A few years ago, the Norwegian Labour Inspection Authority ran information campaigns aimed at foreign drivers—primarily Eastern European truck drivers who may not read the local newspaper. Information campaigns were made for the mothers of the drivers coming to Norway, and they got the message across. Religious leaders in congregations have also been a communication channel. • DSB published an emergency list of what to have at home in case of a crisis, food and water for a week. • Bjornis mascot for educating children on fire related hazards, police and health issues. The mascot is present in kindergartens and elementary schools • Online national e-learning courses on first aid available. • For people with poor digital skills there is already a book available "in case of doomsday" providing information on how to prepare and to behave • For people with language barriers small cards were handed out with the relevant emergency numbers and	• Might be even in place but the information is missing on gathering points. People will be scattered around the city – information/visualisation where to meet • Quick clay campaign: where to meet, how to leave your house, what to bring, how not to be a burden, how to help, what is the structure of your neighbourhood • Especially important is the information on where to go within minus degrees during the winter month and the heating is not secured • Include vulnerable groups—refugees and immigrants. they often come from cultures where they are used to taking care of themselves. consider them as a resource and include them in planning. • Identify the target audience for risk communication and select the channels that are used the most e.g. among students • A checklist in paper format with the information what to do in case of the emergency • Facilitation of group session to avoid having people scared by the impersonal transmission of information • Other risks should also be considered, such as the risk of fire especially for the area "Moellenberg". As it is not as easy to

		• Tourist associations are not interested in communicating risks	also with text to show that they understand/not understand what is being said to them. this has been especially important as they were facing the hardest time making themselves understood. • Majority of residents do have trust in the police and authorities • Trusted community – helping each other without expecting anything in return. • Informal volunteering is strong in Norway	prevent quick clay, apart from not digging in the garden, for fires there are some things to do right e.g. not leaving candles burning when leaving the house. • Municipality sends out invoices monthly, idea would be to integrate information on risk • Targeting the people in the risk area and not to everyone. • Visualisation video: what can happen if the land slide happens - what are the consequences • Encouragement of getting to know people and forming networks to support each other on community level • Find solution on how to include the ones who cannot read or write Norwegian language • Encouragement of getting to know people and forming communities to support each other on the community level
During	Residents	• Volunteering is declining • High dependency on the phone without a backup communication line	• Trusted community - helping others without needing anything in return is a culture • Established Crisis Hotline •	• Ensure everyone can be reached and informed. • Include people of different ages in relation to thinking about communication. • Need to include social media (TikTok) as a distribution tool in order to reach the younger generation. • Diversifying the channels and considering to reach everyone (elderly, young, etc.)
After				

11.5. Overview of solutions and user requirements

As the final step of the analysis of the needs in Trondheim CORE Lab, a preliminary tentative matching has been created between a selection of needs and the solutions that RESILIAGE project has to offer, namely: soft solutions (Risk awareness campaigns, Preparedness toolkits, Communication guidelines), training and digital solutions (RAISE tool, Monitoring Dynamic Resilience Dashboard, Multihazard Early Warning Detection System, Multi-agent Social Network Modelling, CORE Digital Network, Decision Support System, ATLAS tool). At this stage, the table only contains a preliminary comparison of the selected needs that could potentially be addressed by RESILIAGE solutions and tools in order to discuss and prioritise them further with the research and CORE laboratory partners. In addition to mapping the needs, this table also contains generic, high-level user requirements that are results of the combined research process of T4.1. and should be taken into consideration when developing the solutions.

11.5.1. Soft solutions

The following table reports the preliminary match between key stakeholders' (local authorities, first responders, citizens) needs and requirements and the soft solutions to be developed within RESILIAGE project: risk awareness campaigns, preparedness toolkits and communication guidelines.

Table 27: Preliminary match of needs and requirements with soft solutions (LA= local authorities, FR= first responders, C= citizens)

Type of solution	*Stake-Holders*	*Needs*	*User Requirements*
Risk awareness campaigns	**LA**		
	FR		
	C	• Encouraging individual responsibility is crucial. While it's positive that Norwegians trust their authorities, it's equally important for people to take proactive steps. • Quick clay campaign: where to meet, how to leave your house, what to bring, how not to be a burden, how to help, what is the structure of your neighbourhood. • Other risks should also be considered, such as the risk of fire especially for the area "Moellenberg".	• Include people of different ages in relation to thinking about communication • Need to include social media (TikTok) as a distribution tool in order to reach the younger generation • Diversifying the channels and considering to reach everyone (elderly, young, etc.) • Find solution on how to include the ones who cannot read or write Norwegian language • Targeting the people in the risk area and not to everyone • Identify the target audience for risk communication and select the channels that are used the most e.g. among students
Preparedness toolkits *(infographics, safety plan checklist, safety plan templates)*	**LA**		
	FR		
	C	• Encouraging individual responsibility is crucial. While it's positive that Norwegians trust their authorities, it's equally important for people to take proactive steps. • Information is missing on gathering points. People will be scattered around the city – information/visualisation where to meet (especially when the temperature is below 0 Celsius degree).	• Find solution on how to include the ones who cannot read or write Norwegian language • Identify the target audience for risk communication and select the channels that are used the most e.g. among students

		• Quick clay campaign: where to meet, how to leave your house, what to bring, how not to be a burden, how to help, what is the structure of your neighbourhood. • A checklist in paper format with the information what to do in case of the emergency. • Other risks should also be considered, such as the risk of fire especially for the area "Moellenberg".	
Communication Guidelines	**LA**	• Communication remains a recurring issue, particularly in crisis management and exercises. There is uncertainty about roles, responsibilities, and authority, which leads to confusion and inefficiencies.	
	FR	• Communication remains a recurring issue, particularly in crisis management and exercises. There is uncertainty about roles, responsibilities, and authority, which leads to confusion and inefficiencies.	
	C		

11.5.2. Training

In Table 28 the preliminary match between key stakeholders' (local authorities, first responders, citizens) needs and requirements and the *trainings* to be developed within RESILIAGE project has been mapped. The table also marks which needs should be fulfilled with training, focusing on knowledge (K= bodies of information that are applied directly to the performance of work functions), skills (S= technical or manual proficiencies which are usually acquired through training) and/or abilities (A= proficiency to be innate or acquired without formal instructions).

Table 28: Preliminary match of needs and requirements with training (LA= local authorities, FR= first responders, C= citizens)

Stake-holders	***Needs***	***USER REQUIREMENTS***

LA	• Communication remains a recurring issue, particularly in crisis management and exercises. There is uncertainty about roles, responsibilities, and authority, which leads to confusion and inefficiencies. • A system that focuses on roles and functions rather than personal relationships is needed. This would ensure consistent and effective crisis management, even if specific individuals are unavailable or replaced. Additionally, regular practice of roles, responsibilities, and authority is essential to make these processes more intuitive and effective.	
FR	• Communication remains a recurring issue, particularly in crisis management and exercises. There is uncertainty about roles, responsibilities, and authority, which leads to confusion and inefficiencies. • A system that focuses on roles and functions rather than personal relationships is needed. This would ensure consistent and effective crisis management, even if specific individuals are unavailable or replaced. Additionally, regular practice of roles, responsibilities, and authority is essential to make these processes more intuitive and effective.	
C	• Encouraging individual responsibility is crucial. While it's positive that Norwegians trust their authorities, it's equally important for people to take proactive steps.	

11.5.3. Digital solutions

In Table 29 the preliminary match between key stakeholders' (local authorities, first responders, citizens) needs and requirements and the digital solutions to be developed within RESILIAGE project is reported. The digital tools taken into consideration for the mapping are the following: RAISE tool, Monitoring Dynamic Resilience Dashboard, Multihazard Early Warning Detection System, Multi-agent Social Network Modelling, CORE Digital Network, Decision Support System, ATLAS tool.

Table 29: Preliminary match of needs and requirements with digital solutions (LA= local authorities, FR= first responders, C= citizens)

Type of solution	*Stake-holders*	*Needs*	*USER REQUIREMENTS*

The Resilience Assessment Interactive Self-Enabler tool (RAISE)	LA		
	FR		
	C	• Quick clay campaign: where to meet, how to leave your house, what to bring, how not to be a burden, how to help, what is the structure of your neighborhood (general information can be included in feedback of RAISE) • A checklist in paper format with the information what to do in case of the emergency (maybe via a PDF document in RAISE)	
Monitoring Dynamic Resilience Dashboard	LA	• Definition of meeting points for residents and emergency services to gather	
	FR		
	C	• Might be even in place but the information is missing on gathering points. People will be scattered around the city – information/visualisation where to meet	
Multi-hazard early warning detection system	LA		
	FR		
	C	• Might be even in place but the information is missing on gathering points. People will be scattered around the city – information/visualisation where to meet • Targeting the people in the risk area and not everyone *(via filters in the system*)	

Multi-agent social network modelling for Resilient Behaviour	LA	• Communication remains a recurring issue, particularly in crisis management and exercises. There is uncertainty about roles, responsibilities, and authority, which leads to confusion and inefficiencies. tool, but inconsistencies between sectors can create doubt. The difficulty in communication across sectors may stem from a combination of lacking skills, inadequate systems, and cultural barriers. This issue is frequently highlighted in evaluation reports and requires attention to ensure effective communication at all levels of responsibility.	
	FR		
	C	• Need to find an approach/solution on how to handle vast amount of information/potential fake information	
CORE Digital Network	LA	• There are many potential actors within Trondheim that will be of support in case of an emergency. There is a need to identify them and also know their resources (e.g. University NTNU, Refugee Services...) (Dashboard can facilitate the communication)	
	FR		
	C	• Facilitation of group session to avoid having people scared by the impersonal transmission of information (hosting of digital group sessions) • Visualization video: what can happen if the land slide happens - what are the consequences (training package) • Encouragement of getting to know people and forming networks to support each other on community level • Find solution on how to include the ones who cannot read or write Norwegian language	
	LA	• There are many potential actors within Trondheim that will be of support in case of an emergency. There is a need to identify them	

Decision Support System (DSS)		and also know their resources (e.g. University NTNU, Refugee Services...) • The most important thing is getting information about what's going on and how to react.	
	FR		
	C		
The Multidimensional Atlas for Community Resilience	LA		
	FR		
	C	• Might be even in place but the information is missing on gathering points. People will be scattered around the city – information/visualization where to meet • Quick clay campaign: where to meet, how to leave your house, what to bring, how not to be a burden, how to help, what is the structure of your neighborhood • Other risks should also be considered, such as the risk of fire especially for the area “Moellenberg” As it is not as easy to prevent quick clay, apart from not digging in the garden, for fires there are some things to do right e.g. not leaving candles burning when leaving the house. (In ATLAS potential risk areas will be mapped)	

12. Conclusions

This deliverable presents the new data and knowledge relating to the individual dimension of resilience to natural disasters resulting from the four studies carried out as part of T2.3 and T2.4. These results should enable the project's subsequent activities to develop and improve digital tools, soft solutions and PP aimed at fostering community resilience.

These studies propose recommendations for risk communication that can contribute to any activity of the project aiming at communicate about disaster (digital tools, awareness campaigns, online trainings...). They show that visual communication of risk-preparedness behaviours using infographics is effective in promoting risk perception and emotional regulation (which can be a major mental health issue for people vulnerable to these risks). However, this risk perception does not appear to be sufficient to encourage individuals to become actively involved in their own protection. So this type of communication should therefore be accompanied by other, more engaging solutions such as training or any face-to-face interaction. This underlines the usefulness of developing various types of solutions for different audiences, which is what this project is proposing. The varying results from one CORE lab to another on the interactions between risk perception, feelings of control, emotions and preparedness also support the importance of a bottom-up approach that respects the specific characteristics of the different CORE labs.

With regard to the psychological consequences of past disasters, the cross-sectional survey once again shows divergences between the CORE labs, but also sometimes worrying results in terms of the number of people suffering from PTSD. The study also highlights the psychological vulnerability of two groups within the population: women and volunteers.

In addition, trust in institutions appears to be a key factor in mental health among populations exposed to natural disasters. And the results of the cross-sectional survey also provide a guide on how to solicit interactions between the public and institutions based on the level of trust granted to them in each CORE lab.

Finally, the VR simulation highlights among TRC participants the need to continue working on the application of appropriate protective behaviourss in wildfire situations, given certain inappropriate reactions. On the other hand, the social dimension in this situation seems particularly important in individuals' decision-making and it is therefore important that PP integrate these elements. Finally, the importance of having an effective and rapid warning tool available is raised since it also significantly determines evacuation decision-making.

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14. Appendix

14.1. Methodological templates

14.1.1. Cross sectional survey questionnaire

Information identification

ID1. How you define yourself?
- □ Man
- □ Women
- □ Other/ Don't want to comment

ID2. What is your year of birth? ……

ID3. In which city do you live? ……

ID4. How long have you lived in your town? *Indicate your answer in years. If you have lived less than a year, enter 0.5* …….

Risk perception

RP1. How dangerous do you think the following natural disasters are **for you and your relatives?** *Please answer on a scale of 1 " The phenomenon isn't dangerous at all» to 5: "The phenomenon is completely dangerous". Intermediate scores can be used to qualify your answer.*

• Storm/ Rainstorm	1	2	3	4	5
• Tsunami	1	2	3	4	5
• Heatwaves	1	2	3	4	5
• Earthquakes	1	2	3	4	5
• Marine Submersion	1	2	3	4	5
• Drought	1	2	3	4	5
• Landslides	1	2	3	4	5
• Urban fire	1	2	3	4	5
• Wildfire	1	2	3	4	5
• Floods	1	2	3	4	5

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RP2. How dangerous do you think the following natural disasters are for **humans**? *Please answer on a scale of 1: "The phenomenon isn't dangerous at all" to 5: "The phenomenon is completely dangerous". Intermediate scores can be used to qualify your answer.*

- Storm/ Rainstorm 1 2 3 4 5
- Tsunami 1 2 3 4 5
- Heatwaves 1 2 3 4 5
- Earthquakes 1 2 3 4 5
- Marine Submersion 1 2 3 4 5
- Drought 1 2 3 4 5
- Landslides 1 2 3 4 5
- Urban fire 1 2 3 4 5
- Wildfire 1 2 3 4 5
- Floods 1 2 3 4 5

RP3. How dangerous do you think the following natural disasters are for **nature**? *Please answer on a scale of 1: "The phenomenon isn't dangerous at all" to 5 "The phenomenon is completely dangerous". Intermediate scores can be used to qualify your answer.*

- Storm/ Rainstorm 1 2 3 4 5
- Tsunami 1 2 3 4 5
- Heatwaves 1 2 3 4 5
- Earthquakes 1 2 3 4 5
- Marine Submersion 1 2 3 4 5
- Drought 1 2 3 4 5
- Landslides 1 2 3 4 5
- Urban fire 1 2 3 4 5
- Wildfire 1 2 3 4 5
- Floods 1 2 3 4 5

RP4. Have you been confronted with a natural disaster in the past few years?

- □ No, not personally.
- □ Yes, I've heard about and/or seen images of natural disasters.
- □ Yes, relatives (family, friend, colleagues) have suffered damage.
- □ Yes, I suffered damage.

RP5. Do you think that a new natural catastrophe will emerge **in the coming years**? 1 2 3 4

Please answer on a scale of 1: "No, certainly not" to 4: "Yest, most certainly". Intermediate scores allow you to qualify your answer

RP6. Are you or not **worried** that a new natural catastrophe will appear in the years to come? 1 2 3 4

Please answer on a scale of 1: "Not worried at all" to 4: "Highly worried."

RP7. Would you **feel in danger** if a natural catastrophe of the same type you've experienced were to occur in the years to come? 1 2 3 4

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Please answer on a scale of 1: "Not in danger at all" to 4: "Completely in danger."

RP8. Can you describe what kind of risk you're thinking of? .....

PTSD and PTG

*Only for participants who answered Yes (one of the three options) to question **RP4***

PT1. Below is a list of problems that people sometimes face following a natural disaster. In recent months, how have you been affected by: ***(Please answer the following statements on a scale from 0: "Not at all" to 4: "Extremely". The intermediate scores allow you to qualify your answer).***

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1. Repeated, disturbing, and unwanted memories of the natural disaster.	0	1	2	3	4
2. Repeated, disturbing dreams of the natural disaster.	0	1	2	3	4
3. Suddenly feeling or acting as if the natural disaster were actually happening again (as if you were actually back there reliving it.	0	1	2	3	4
4. Feeling very upset when something reminded you of the natural disaster.	0	1	2	3	4
5. Having strong physical reactions when something reminds you of the natural disaster (for example, heart pounding, trouble breathing, sweating).	0	1	2	3	4
6. Avoiding memories, thoughts, or feelings related to the natural disaster.	0	1	2	3	4
7. Avoiding external reminders of the natural disaster (for example, people, places, conversations, activities, objects, or situations).)	0	1	2	3	4
8. Trouble remembering important parts of natural events.	0	1	2	3	4
9. Having strong negative beliefs about yourself, other people, or the world (for example, having thoughts such as: I am bad, there is something seriously wrong with me, no one can be trusted, the world is completely dangerous).	0	1	2	3	4
10. Blaming yourself or someone else for the natural events or what happened after it.	0	1	2	3	4
11. Having strong negative feelings such as fear, horror, anger, guilt, or shame.	0	1	2	3	4
12. Loss of interest in activities that you used to enjoy.	0	1	2	3	4
13. Feeling distant or cut off from other people.	0	1	2	3	4
14. Trouble experiencing positive feelings (for example, being unable to feel happiness or having loving feelings for people close to you).	0	1	2	3	4
15. Irritable behavior, angry outbursts, or acting aggressively.	0	1	2	3	4
16. Taking too many risks or doing things that could cause you harm.	0	1	2	3	4
17. Being “super alert” or watchful or on guard.	0	1	2	3	4
18. Feeling jumpy or easily startled.	0	1	2	3	4
19. Having difficulty concentrating.	0	1	2	3	4
20. Trouble falling or staying asleep	0	1	2	3	4

PT2. To what extent have the following changes occurred in your life as a result of the natural disaster? *Please answer the following statements on a scale from 0: "I strongly disagree" to 5: "I strongly agree". Intermediate scores can be used to qualify your answer.*

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1. I changed my priorities about what is important in life.	0	1	2	3	4	5
2. I have a greater appreciation for the value of my own life	0	1	2	3	4	5
3. I developed new interests	0	1	2	3	4	5
4. I have a greater feeling of self-reliance	0	1.	2	3	4	5
5. I have a better understanding of spiritual matters	0	1	2	3	4	5
6. I more clearly see that I can count on people in times of troubles	0	1	2	3	4	5
7. I established a new path for my life	0	1	2	3	4	5
8. I have a greater sense of closeness with others	0	1	2	3	4	5
9. I am more willing to express my emotions	0	1	2	3	4	5
10. I know better that I can handle difficulties	0	1	2	3	4	5
11. I am able to do better things with my life	0	1	2	3	4	5
12. I am better able to accept the way things work out	0	1	2	3	4	5
13. I can better appreciate each day	0	1	2	3	4	5
14. New opportunities are available which wouldn't have been otherwise	0	1	2	3	4	5
15. I have more compassion for others	0	1	2	3	4	5
16. I put more effort into my relationships	0	1	2	3	4	5
17. I am more likely to try to change things which need changing	0	1	2	3	4	5
18. I have a stronger religious faith	0	1	2	3	4	5
19. I discovered that I'm stronger than I thought I was	0	1	2	3	4	5
20. I learned a great deal about how wonderful people are	0	1	2	3	4	5
21. I accept needing others	0	1	2	3	4	5

Trust in institutions and perception of management.

TI1. To what extent do you **trust** each of the following organizations and institutions to manage natural disasters? ***Please answer on a scale of 0: "Not at all confident" to 10: "Very confident".***

- European union 0 1 2 3 4 5 6 7 8 9 10
- National government 0 1 2 3 4 5 6 7 8 9 10
- Local government 0 1 2 3 4 5 6 7 8 9 10
- Police and law enforcement 0 1 2 3 4 5 6 7 8 9 10
- Civil defense, civil protection 0 1 2 3 4 5 6 7 8 9 10
- Religious organizations 0 1 2 3 4 5 6 7 8 9 10
- Scientific expert 0 1 2 3 4 5 6 7 8 9 10
- Health services 0 1 2 3 4 5 6 7 8 9 10
- Nongovernmental organizations 0 1 2 3 4 5 6 7 8 9 10
- Neighborhood 0 1 2 3 4 5 6 7 8 9 10
- Personal network (family, friends) 0 1 2 3 4 5 6 7 8 9 10

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TI2. Do you consider the following organizations and institutions to be **reliable** sources of information?

Please answer on a scale from 0: "Not at all reliable" to 10: "Completely reliable".

- European union 0 1 2 3 4 5 6 7 8 9 10
- National government 0 1 2 3 4 5 6 7 8 9 10
- Local government 0 1 2 3 4 5 6 7 8 9 10
- Police and law enforcement 0 1 2 3 4 5 6 7 8 9 10
- Civil defense, civil protection 0 1 2 3 4 5 6 7 8 9 10
- Religious organizations 0 1 2 3 4 5 6 7 8 9 10
- Scientific expert 0 1 2 3 4 5 6 7 8 9 10
- Health services 0 1 2 3 4 5 6 7 8 9 10
- Nongovernmental organizations 0 1 2 3 4 5 6 7 8 9 10
- Neighborhood 0 1 2 3 4 5 6 7 8 9 10
- Personal network (family, friends) 0 1 2 3 4 5 6 7 8 9 10

14.1.2. Eye-tracking experiment survey

Eye-tracking experiment - pre-observation

Socio-demographic data

Q1. What year were you born? ……

Q2. What type are you?
- □ Woman
- □ Man
- □ Other/Does not wish to comment

Q3. What is your nationality?
- □ Portuguese or Nowegian, Greek, Turkish or Belge
- □ Other (specify) ……

Q4. What city do you live in? ……

Q5. Do you play an official role in disaster management (member of the local administration, NGO, medical institution, scientific community, etc.)?
- □ Yes (Specifiy) ……
- □ No
- □ I don't know

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Q6. What is your socio-professional category?

- □ Self-employed farmer
- □ Craftsperson, Shopkeeper, Manager of a small business
- □ Company director, civil service executive, higher intellectual and artistic profession
- □ Intermediate profession
- □ Clerk
- □ Manual worker
- □ Liberal profession or similar
- □ Retired
- □ Homemaker
- □ Student
- □ Unemployed
- □ Other (please specify)

Q7. What is your highest level of education?

- □ No diploma
- □ Secondary education diploma (1st cycle)
- □ Secondary education diploma (2nd cycle)
- □ Post-secondary non-tertiary education (law degree, DAEU, etc.)
- □ Short-cycle higher education (BTS, etc.)
- □ Higher education at licence level or equivalent
- □ Higher education at master's level or equivalent (including doctorate in health)
- □ Higher education at doctorate level or equivalent (excluding health doctorate)

Risk perception

Q8. Regarding the risk of [...], for each of the propositions above, indicate your degree of agreement or disagreement by choosing the case that corresponds best to your opinion.

- Future generations exposed to a growing risk of [...].
- In the future, my community (town/village) will be exposed to an increasing risk of [...].
- Due to climate change, [...] will increase significantly.
- People living in [...]-prone areas will be exposed to an increasing risk of fire.
- I experience living near a [...] risk area as a threat to my safety.
- I'm worried about the [...] risk I'm exposed to.
- When I think about [...], I feel anxious.
- Buildings need to be adapted to the risk of [...].
- First and foremost, we need to strengthen [...] protection infrastructures.
- To reduce the risk of [...], you have to apply the regulations.
- The experts know exactly when [...] protection infrastructures are no longer effective.
- For people like me, the risk of [...] is well known.
- I can assess the possibility of a [...] very well.
- For experts, the risk of [...] is well known.

Affect

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Q9. The following list includes a number of words that describe different feelings or emotions. Read each word carefully and say how strongly you feel about that emotion at the moment on a scale ***from 0 (Not at all) to 10 (Very strongly).***

- Tranquillity
- Nervous
- Moody
- Surprise
- Calm
- Enervated
- Sadness
- Joy
- Serenity
- Anger
- Weariness
- Excitement
- Balance
- Annoyance
- Worry
- Cheerfulness

Eye-tracking experiment - post-observation

Risk perception

Same scale as pre-observation

Affects

Same scale as pre-observation

Coping

Q3. Answer each of the following statements by ticking the box that best describes how you would react to the risk of [...]. Answer honestly, without worrying about what people would do if they were in your shoes, on a scale from ***Not at all (1) to Completely (4).***

- I'd turn to work or other activities to take my mind off things.
- I would decide on a course of action and follow it.
- I'd tell myself it wasn't real.
- I'd use alcohol or other substances to make myself feel better.
- I would seek emotional support from others.
- I would give up trying to resolve the situation.
- I would try to find comfort in my religion or spiritual beliefs.
- I would accept the reality of my new situation.
- I would vent my unpleasant feelings by talking about them.
- I would seek help and advice from others.
- I would try to see the situation in a more positive light.
- I would criticise myself.
- I would try to strategise about what to do.
- I would seek support and understanding.
- I would give up hope of coping.
- I'd take it with a sense of humour.
- I would do something to take my mind off it (like going to the cinema, watching TV, reading, daydreaming, sleeping or shopping).
- I would try to get advice or help from other people about what to do.
- I would express my negative feelings.
- I would concentrate my efforts on resolving the situation.
- I would refuse to believe it was happening to me.
- I would use alcohol or other substances to help me get through the situation.
- I would learn to live in the new situation.
- I would plan the next steps.
- I would blame myself for the things that happen to me.
- I would look for the positive aspects in what is happening to me.
- I would pray or meditate.
- I would enjoy the situation.

Evaluating the material

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You are going to look at certain parts of the document you observed earlier, one by one.

Picture
Q1. Which image have you just seen?
Picture
Q2. Which image have you just seen?
Q3. ….

Relevance

Q4. Regarding the document as a whole, on ***a scale of 1 to 10 (1 Not at all, 10 Absolutely)...***

- ... How well did you understand the message conveyed by the document?
- ... How relevant the content was?
- ... How useful the content was?

Q5. Choose one of the 3 possible answers for each sign.

1. I didn't understand the message, nor do I have the basic knowledge needed to act on it.
2. I understood the message, but I don't have the necessary knowledge to act accordingly.
3. I have understood the message and I have the necessary knowledge to act accordingly.

Amelioration

Q6. In your opinion, which instructional images could be improved, and how? **……**

Colours

Q7. With regard to the document as a whole, please indicate ***on a scale of 1 to 10 (1 Not at all, 10 Very much so)...***

- ... how easy to read the colours used to display the images were.
- ... how well the colours in the document attracted your attention.
- ... how well the colours in the document conveyed the message.

Vulnerable populations

Q8. Are there any other accessibility features or parameters that you would like to see implemented for users with disabilities? **……**

Q9. ***On a scale of 1 to 10 (1 Not at all understandable, 10 Perfectly understandable)*** ... how comprehensible do you think the document is for non-English speakers?

14.1.3. Longitudinal survey

Phase 1

STAGE 1 – WHO ARE YOU ?

- **Who do you identify as within the community:**
  - First responder
  - Knowledge organisation
  - Decision policy maker
  - Citizen and civil society
  - Other (Specify.....)
- **What's your age range:**

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- Under 18 yo
- 18-24 yo
- 25-34 yo
- 35-44 yo
- 55-64 yo
- 65 yo

- **Please select the option that best describes your gender identity**
  - Woman
  - Man
  - Other
  - Prefer no to say
- **Regarding your current residence status in this region, which of the following best describes you ?**
  - Resident
  - Temporary visitor (e.g. tourist, student, temporary work assignment)
  - Frequent visitor (e.g. second home, worh-related visits)

STAGE 2 – POSITIVE AND NEGATIVE EMOTIONS

This questionnaire contains adjectives that describe feelings and emotions. For each of these adjectives, you must indicate to what extent it describes how you feel at that particular moment. To do this, you must use the following choice of answers: (1) Very little, (2) Little, (3) Moderately, (4) A lot, (5) Extremely.

	Very little (1)	*Little (2)*	*Moderately (3)*	*A lot (4)*	*Extremely (5)*
Anxious					
Strong					
Guilty					
Enthusiastic					
Irritated					
Inspired					
Nervous					
Determined					
Active					
Fearful					

STAGE 3 - RISK PERCEPTION

With regard to the risk of natural hazard, for each of the proposals below, indicate your degree of agreement or disagreement by ticking the box that best corresponds to your opinion.

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	strongly disagree	*disagree*	*somewhat agree*	*agree*	*strongly agree*
Future generations will be exposed to an increasing risk of natural hazard.					
In the future, my area will be exposed to an increasing risk of natural hazard.					
As a result of climate change, natural hazard will increase significantly.					
People living in areas at risk of natural hazard will be exposed to an increasing risk of natural hazard.					
I experience living near a natural hazard zone as a threat to my safety.					
I'm worried about the risk of natural hazard.					
When I think about natural hazard, I feel anxious.					
Buildings need to be adapted to the risk of natural hazard.					
Above all, we need to strengthen natural hazard protection infrastructures.					
To reduce the risk of natural hazard, we need to apply the regulations.					
The experts know exactly when natural hazard defences are no longer effective.					
For people like me, the risk of natural hazard is well known.					
I can assess the possibility of natural hazard very well.					
For experts, the risk of natural hazard is well known.					

STAGE 4 - FEELING OF CONTROL

Please indicate your level of agreement with the following statements (from 1 to 7).

	1 (strongly disagree)	2	3	4	5	6	7 (strongly agree)
I can learn almost anything if I condition myself to do so.							
It's not up to me to protect myself against natural hazard.							
Natural hazards are a phenomenon that I can't predict.							
If one day I have to suffer a natural hazard, it will be due to fate.							
When I make plans, I'm almost certain to carry them out.							

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Natural hazards are powerful phenomena against which I cannot fight.							
I am responsible for the consequences of natural hazard in my home.							
I can generally achieve what I want when I work hard at it.							
Generally speaking, I know what to do when natural hazard strikes.							
Natural hazards are events that I can control.							
I am not responsible for natural hazards.							
I can predict the arrival of a natural hazard.							
I can use my abilities to avoid natural hazard.							
My greatest achievements are entirely due to my hard work and abilities.							
Anything is possible for me if I really want it.							
I feel powerless against natural hazard.							

STAGE 5 – DISASTER EXPERIENCE AND IMPACT

- **What types of natural disasters are common in your city ?** *(multiple choices)*
  - Heatwaves
  - Earthquakes
  - Landslides
  - Floods
  - Wildfires
  - Other (specify.....)
- **How many disasters have you witnessed in your life?**
  - Scale from 0 to 10+
- **Now think of the most damaging disaster in your area, what type was it ?**
  - Heatwaves
  - Earthquakes
  - Landslides
  - Natural hazards
  - Wildfires
  - Other (specify.....)
- **When do you recall this disaster?**
  - In the last 6 months
  - In the last year
  - Between 1 and 2 years ago

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- More than 2 years ago
- A precise date (specify.....)

- **Did you or someone you know experience personal damages ?** *(multiple choices)*
  - Myself
  - My family
  - My friends
  - Other (Specify.....)
- **What kind of damage was experienced as the testimony of the mentioned disaster?** *(multiple choices)*
  - Health
  - House
  - Work building
  - Work activity
  - School (education)
  - General well-being
  - Other (specify.....)
- **Did you live in extraordinary conditions as a result of the disaster ?**
  - **Yes / No**
- **If yes, for how long did you live in extraordinary conditions ?**
  - Within 1 week (or less)
  - Between 1 week and 1 month
  - Between 1 month and 6 months
  - More than 6 months

STAGE 6 – RESPONSE CAPABILITIES

Please indicate your level of agreement with the following statements (from 1 to 5).

Prevention behavior					
I have an emergency kit ready.	*I don't and won't (1)*	*I would like to, but I can't (2)*	*I may prepare it (3)*	*I plan to (4)*	*I already have it (5)*
I participate in disaster preparedness training or drills.	*Never (1)*	*(2)*	*Sometimes (3)*	*(4)*	*Regularly (5)*
I identify the areas at risk in my city/region.	*Not at all (1)*	*(2)*	*(3)*	*(4)*	*Yes in general (5)*
I identify the safest areas in my community in situation of disaster.	*Not at all (1)*	*(2)*	*(3)*	*(4)*	*Yes in general (5)*
I know how to access local emergency services.	*Not at all (1)*	*(2)*	*(3)*	*(4)*	*Yes in general (5)*

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I know how to access disaster information.	*Not at all (1)*	*(2)*	*(3)*	*(4)*	*Yes in general (5)*
I keep myself regularly informed about disaster risks in my region.	*Never (1)*	*(2)*	*Sometimes (3)*	*(4)*	*Regularly (5)*
I have downloaded a risk prevention/preparedness app.	*I don't and won't (1)*	*I would like to, but I can't (2)*	*I may (3)*	*I plan to (4)*	*I already do it (5)*
I share my past experiences and knowledge of disasters with other people.	*Never (1)*	*(2)*	*Sometimes (3)*	*(4)*	*Regularly (5)*
CNH as driver for preparedness					
I feel more motivated to engage in preparedness behaviors when cultural or historical sites are at risk	*Not at all (1)*	*(2)*	*(3)*	*(4)*	*Yes in general (5)*
The potential loss of cultural heritage in a disaster motivates me to be more prepared	*Not at all (1)*	*(2)*	*(3)*	*(4)*	*Yes in general (5)*
I am motivated to prepare for disasters to ensure that our traditions, rituals, and cultural events can continue uninterrupted	*Not at all (1)*	*(2)*	*(3)*	*(4)*	*Yes in general (5)*
Maintaining cultural heritage, traditions or events in my community, motivates me to better prepare for natural disasters	*Not at all (1)*	*(2)*	*(3)*	*(4)*	*Yes in general (5)*
Preparedness behavior					
I turn off the electricity and gas supply in situation of potential disaster.	*Never (1)*	*(2)*	*Sometimes (3)*	*(4)*	*Regularly (5)*
I have a safe place to stay in case of emergency.	*Not at all (1)*	*(2)*	*(3)*	*(4)*	*Yes in general (5)*
I have drinking water and food for emergency use in the event of natural hazard.	*I don't and won't (1)*	*I would like to, but I can't (2)*	*I may (3)*	*I plan to (4)*	*I already have it (5)*

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I have a suitcase ready with clothes and other items (radio, torch, batteries, first aid kit etc.) in case of natural hazard emergency.	*I don't and won't (1)*	*I would like to, but I can't (2)*	*I may (3)*	*I plan to (4)*	*I already have it (5)*
I have an accessible list of emergency phone numbers	*I don't and won't (1)*	*I would like to, but I can't (2)*	*I may (3)*	*I plan to (4)*	*I already have it (5)*
I have identified the most vulnerable people in my environment (home, neighbourhood, etc.)	*Not at all (1)*	*(2)*	*(3)*	*(4)*	*Yes in general (5)*

STAGE 7 – MEMORIES

- **How do you define the damage for each of these cultural heritages?**

	Not damaged at all (1)	*(2)*	*Moderately damaged (3)*	*(4)*	*Extremely damaged (5)*
Public Commemorative Structures (monument, statue, celebrative artefact…)					
Representative building for the community (town hall, community centre, library…)					
Religious building					
Historical building					
Cultural building (archive, theatre, cinema…)					
Natural sites (park, forest, garden, landscape…)					
Traditions and/or events of the community					
Other (Specify...)					

- **To what extent does this damage negatively affect your community?**
  - Not at all (1) ----- Extremely (5)

Phase 2

Reuse of Phase 1 STAGE 2, 3, 4, 6

STAGE 8 – DOCUMENT FEATURES

Please indicate your answer to each of these questions between 1 (not at all) and 10 (very much).

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To what extent did you understood the document you saw ?	Not at all (1) ---------- Very much (10)
To what extent the document was relevant ?	Not at all (1) ---------- Very much (10)
To what extent this document was useful ?	Not at all (1) ---------- Very much (10)
Does this document make you want to find out more about disaster preparedness?	Not at all (1) ---------- Very much (10)

- **Is there any information missing from this document?**
  - Yes / No
- **If so, which ones?**
  - .....
- **Do you have any suggestions regarding the document you have just seen?**
  - .....

Phase 3

Reuse of Phase 1 STAGE 2, 3, 4, 6

14.1.4. Virtual reality associated survey

Pre-simulation questionnaire

Stait anxiety

Below are a number of phrases we use to describe ourselves.

Read each one and then respond in the most appropriate way to indicate how you feel NOW, AT THIS PRECISE MOMENT.

There is no right or wrong answer. Don't spend too much time on each sentence but give the answer that seems to best describe your current state.

Please answer on a scale of 1 ("Not at all") to 4 ("Very much")

1. I feel calm.
2. I feel tense.
3. I feel upset.
4. I feel relaxed.
5. I feel satisfied.
6. I am worried.

Post-simulation questionnaire

Reuse of the stait anxiety scale from pre-simulation questionnaire

PRESENCE

Here are several suggestions that might apply to the experience you've just had.

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Please indicate whether or not each of these applies to your experience.
You can use any scale you like. There is no right or wrong answer, only your opinion.
You will notice that some questions are similar. This is necessary for statistical reasons.

Remember that you must answer these questions with reference only to the virtual reality experience you have just had.

1. How aware were you of the surrounding real world while you were navigating in the virtual world (e.g. sounds, room temperature, presence of other people, etc.)?
Extremely aware / Moderately aware / Not at all aware
2. How did the virtual world seem to you?
Completely real / Not at all real
3. I had the sensation of acting within the virtual space rather than acting on some mechanism outside of it.
Totally disagree / Totally agree
4. How consistent did your experience in the virtual environment feel with your experience in the real world?
Not consistent / Moderately consistent / Very consistent
5. How real did the virtual world seem to you?
About as real as an imagined world / Indistinguishable from the real world
6. I didn't feel present in the virtual space.
Didn't feel present / Felt present
7. I was not aware of my real environment.
Totally disagree / Totally agree
8. In the world generated by the computer, I had the feeling of "being there".
Totally disagree / Totally agree
9. In a way, I had the impression that the virtual world surrounded me.
Totally disagree / Totally agree
10. I felt present in the virtual space.
Totally disagree / Totally agree
11. I always paid attention to the real environment.
Totally disagree / Totally agree
12. The virtual world seemed more realistic than the real world.
Totally disagree / Totally agree
13. I had the impression that I was just perceiving images.
Totally disagree / Totally agree
14. I was completely captivated by the virtual world.
Totally disagree / Totally agree

EXPERIENCE

The following questions are designed to help us better understand your virtual reality experience.

There are no right or wrong answers. Please answer as honestly as possible.

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1. Can you describe what happened and what you did?

_____

2. Did you understand that it was a widlfire ?

Yes / No

3. If yes, when did you realise it was wildfire ?

_____

4. Did you see anything to indicate that there was wildfire ?

Smoke / Fire / Alert / Virtual agents behaviour / Other, please specify:

_____

5. Did you hear anything indicating that it was a wildfire ?

Yes / No

6. If yes, what did you here ?

_____

7. Did you see the virtual agents move ?

Yes / No

8. If yes, where did they go?

They followed the path in the direction of the parking lot (sign) / They followed the path in the opposite direction to the parking lot / They stayed in front of the fire / Other, please specify: _____

9. Where did you go?

I followed the path in the direction of the parking lot (sign) / I followed the path in the opposite direction to the parking lot / I stayed in front of the fire / Other, please specify: _____

10. Did you feel safe there ? (on a scale from 1 ("Not at all") to 5 ("Completely safe"):

12. Why did you go where you went?

_____

13. Have you followed any virtual agents?

14. If so, which one and why?

15. Have you ever experienced a wildfire ?

14.1.5. Semi-structured interview questions: T4.1

Trondheim

Semi-structured interview questions

3rd of July, 2024

When it comes to quick clay, we understood that citizens are not aware of this risk, they tend to think it will not happen just because it did not happen a long time ago. What kind of risk awareness campaign do you imagine to be effective for this purpose? What would be the channel(s) of this campaign? What would be the format? Who would be the target groups? What do you think the key message would be that would activate awareness in the community?

We learned from the focus group sessions, that there is a general lack of feeling empowered in case of a crisis due to the citizens high trust and reliance on the

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government – they believe the government will take care of them, them and the crisis. How do you think citizens would feel more empowered? What information do you think they should be provided to feel their own responsibility in crisis response?

When it comes to citizens supporting each other in crisis, there seems to be a high level of solidarity in the community, people gladly help each other, open their doors for the ones in need. How do citizens in this community become aware of the needs of others? Is there any guideline for citizens on how to support their community? If not, what do you think would be the key message to convey?

Do you have any ***practical*** ideas of how the following vulnerable groups could be better educated about what to do in case of a quick clay?

- Tourists and refugees (language barrier)
- Elderly
- Kindergarten and school kids
- Elderly, sick and/or disabled?

Awareness campaigns focusing on ensuring that citizens have self-supplies for 3-7 days are reported as rather generic, not containing specific information related to specific crisis scenarios. What do you think would be the crucial messages to convey to the public related to quick clay? How do you think this general campaign should be extended to cover citizens for the case of quick clay?

During the focus group session, we learned the importance of diversified communication including digital channels and solutions for the younger generation. What would be the most important features of a digital (smart) application developed specifically for Trondheim community? What would be the messages and information it would convey?

During the focus group sessions, first responders articulated a strong need for a digital application ("situation plot") that would provide them with up-to-date information of the crisis situation, and a shared platform to coordinate. What kind of information do you think this website should contain?

We learned during the focus group session that training addressing coordination and communication in crisis response would be very beneficial for certain actors to enhance smooth response mechanisms. Who do you think the target group(s) of this training could be? First responders? Authorities? Volunteers? Citizens? Educational institutions?

14.2. Ethical template

Eye-tracking experiment consent form

Impact of visual communication of natural disaster risk on risk perception and preparedness

RESILIAGE project

Grant Agreement No: 101121231

Dear Sir/Madam,

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The principal investigator, **Professor Oscar Navarro**, has asked you to take part in the research protocol entitled: " ***Impact of visual communication of natural disaster risk on risk perception and preparedness*** **"**.
Please read this information notice carefully, as it is intended to answer any questions you may have before deciding to take part.
During the trial, you can contact the investigator, **Oscar Navarro, or his colleagues Aude Naud, Margaux Fenard and Karine Weiss** to ask any further questions.

Objective of the research

The aim of this research is to understand how individuals process and understand the information provided by visual media communicating the risk of natural disasters, and how this affects their perception of risk and their preparedness for risk.

What is the methodology and how is the experiment being conducted ?

The study will take place in an enclosed area protected from view. You will be watching communication media on a computer screen and answering a number of questionnaires. The study will last around 30 minutes.

What are the constraints and inconveniences?

There should be no inconvenience in taking part in the study, apart from giving up your time.

What are your rights as a participant in this research?

You can refuse to take part in this research without having to justify your decision. You may also withdraw from the trial at any time without giving any reason, without any consequences for your treatment or the quality of care you will receive.

The principal investigator of this study is Professor Oscar Navarro.
The study is being conducted by the Chrome and APSY-V laboratories at the University of Nîmes, as part of the European RESILIAGE project.

- I read the summary explaining the above-mentioned study.
- I was able to ask all the questions I wanted and received clear and precise answers.
- I have noted that my data will be processed for the purposes of scientific communication, are intended for the principal investigator, and that they will be kept for a maximum of 5 years after the end of the project.
- I have noted that I may exercise my rights (access, rectification, opposition, deletion, limitation and portability) by contacting the principal investigator Oscar Navarro(oscar.navarro_carrascal@unimes.fr), or directly the University's Data Protection Officer: cil@unimes.fr.
- I understand that I can refuse to take part in this study without any consequences for me, and that I can withdraw my consent at any time (before and during the study) without having to justify myself and without any consequences.

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- In view of the information I have been given, I freely and voluntarily agree to take part in the RESILIAGE project's research project entitled " ***Impact of visual communication of natural disaster risk on risk perception and preparedness*** ".

Signed in....., on.....
In two original copies
Research participant
Last name: First name:
Signature

Cross-sectional survey consent form

TITLE OF PROJECT: RESILIAGE

Dear Ms/Mr,

We are inviting you to take part in a European research study. This information letter sets out all the details of the study.
Please take the time to read and understand this information so that you can consider your participation. You can ask the researcher in charge of the study to explain anything you do not understand.

RESEARCH GROUP:

University of Nimes (CHROME Laboratory)

AIM OF THE STUDY:

Investigating the temporal dimension of risk perception and adaptation.

PROCEDURE OF THE STUDY:

The survey takes the form of a questionnaire via a digital platform. The response time to the questionnaire can vary from 20 to 30 minutes.

INCONVENIENCES AND RISKS THAT MAY ARISE FROM PARTICIPATION:

Your participation in the research should not involve any inconvenience, apart from giving your time.

RIGHT OF WITHDRAWAL WITHOUT PREJUDICE TO PARTICIPATION:

It is understood that your participation in this research project is entirely voluntary and that you remain free, at any time, to cease participation without having to give reasons for your decision or suffer prejudice of any kind whatsoever.

CONFIDENTIALITY, SHARING, MONITORING AND PUBLICATIONS:

During your participation in this research project, the researcher in charge and his team will collect and record information about you in a research file. Only the information necessary for the proper conduct of the research project will be collected. This may include the following information: gender, date of birth, cultural background, etc. All information collected during the research project will remain strictly confidential to the extent permitted by law. In order to preserve your identity and the confidentiality of this information, you will only be identified by a number. Data from the research project may

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be published in scientific journals or shared with others in scientific discussions. No publication or scientific communication will contain information that could identify you. The data collected will be kept under lock and key for a period not exceeding 5 years. After this period, the data will be destroyed.
You are free to accept or refuse to take part in this study. Thank you for taking the time to read this newsletter. If you agree to take part in this research, please tick the consent box to start the survey.

- ○ Yes, I agree to take part in the survey (1)
- ○ No, I do not agree to take part in the survey (2)

Longitudinal survey consent form

PARTICIPATION AGREEMENT

1. By ticking this box, you agree to the RESILIAGE research team collecting and recording information about you in a research file. Only the information necessary for the research project to run smoothly will be collected. This may include the following information: gender, age, etc. All information collected will remain strictly confidential and anonymous. The results of the study may be published in scientific journals or shared with others in scientific discussions. No publication or scientific communication will contain any information that could identify you. The data collected will be kept under lock and key for a period not exceeding 5 years. After this period, the data will be destroyed. You are free to accept or refuse to take part in this study.
2. Would you agree to be contacted again (twice) to complete another shorter questionnaire, and to receive a short document about natural disasters preparedness?

- **Yes / No**

3. If yes, can you give us your e-mail address so that we can send you these items?

- .....

4. In order to be able to analyse participants' successive answers while preserving their anonymity, we need you to create an identifier that you will keep and mention before each questionnaire. Please use the following code: the last two letters of your first name in upper case (e.g. “ES” for Jules), followed by your month of birth (e.g. “07” for July, “12” for December...), followed by the first two letters of your municipality in lower case (e.g. “ro” for Rochefort), followed by the last digit of your telephone number (e.g. “6” for +32468123456). You will be asked for this identifier at the beginning of each questionnaire.
    a. *For T1 and T2: “Please indicate the same identifier as the first time you answered this questionnaire (the last two letters of your first name in upper case (e.g. “ES” for Jules), followed by your month of birth (e.g. “07” for July, “12” for December...), followed by the first two letters of your municipality in lower case (e.g. “ro” for Rochefort), followed by the last digit of your telephone number (e.g. “6” for +32468123456)).”*

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- **Identifier: .....**

Virtual reality consent form

Individuals' reactions to exposure to a natural disaster simulated in virtual reality

RESILIAGE Project

Grant Agreement No: 101121231

Dear Sir/Madam,
The principal investigator, **Pr. Navarro Oscar,** has invited you to participate in the research protocol entitled: **"Reactions of individuals in a situation of exposure to a natural disaster simulated in virtual reality".**

Please read this information leaflet carefully, as it is intended to answer any questions you may have before deciding to take part. During the research phase, you may contact the investigator, **Mr. Oscar Navarro, or his colleagues Aude Naud, Margaux Fenard, Eulalie Verhulst and Marie Le Duff,** to ask any further questions you may have.

What is the methodology and how is the experiment carried out?

The study will take place in a closed environment, protected from view. You will use a Virtual Reality device (headset) to observe a situation. You will also complete several questionnaires. The study will last around 35 minutes.

What are the constraints and inconveniences?

Your participation in the study should not entail any inconvenience, other than that of giving up your time, and possibly having a feeling of "head spinning", in which case we will terminate the experiment.

What are your rights as a research participant?

You can refuse to take part in this research without having to justify your decision. You may also withdraw from the trial at any time without justification, without any consequences for your treatment or the quality of care you will receive.

The principal investigator of this study is Prof. Oscar Navarro.

This study is being carried out by the Chrome and APSY-V laboratories of the University of Nîmes, as part of the European RESILIAGE project.

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- I read the summary explaining the above-mentioned study.
- I was able to ask all the questions I wanted and received clear and precise answers.
- I have noted that my data will be processed for the purposes of scientific communication, are intended for the principal investigator, and that they will be kept for a maximum of 5 years after the end of the project.
- I have noted that I may exercise my rights (access, rectification, opposition, deletion, limitation and portability) by contacting the principal investigator Oscar Navarro (oscar.navarro_carrascal@unimes.fr), or directly the University's Data Protection Officer: cil@unimes.fr.
- I understand that I may refuse to participate in this study without any consequences for me, and that I may withdraw my consent at any time (before and during the study) without having to justify myself and without any consequences.
- In view of the information I have been given, I freely and voluntarily agree to take part in the RESILIAGE research project entitled “Individuals' reactions to exposure to a natural disaster simulated in virtual reality”

Location ....., date .....

In two original copies

Research participant
Last name:
First name:
Signature:

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14.3. RESILIAGE Lessons Learned from the CORE lab field studies (T2.3 and T2.4)

Study	LL code	CORE lab(s)	LL
Eye-tracking experiment	LLET_001	All	Visual communication using posters on protective behaviours promotes risk perception and facilitate emotional regulation
Eye-tracking experiment	LLET_002	All	A more detailed poster promotes a feeling of risk knowledge, which in turn encourages positive emotions
Eye-tracking experiment	LLET_003	All	Visual communication about protective behaviours is a useful soft solution to enhance risk awareness but may not be enough on its own to promote behavioural changes
Eye-tracking experiment	LLET_004	All	The context and objective of the communication must be determined beforehand, because visual characteristics determine how the message is conveyed
Eye-tracking experiment	LLET_005	All	Communication in the risk of natural disasters must be accompanied by more engaging solutions to promote more active coping strategies by of individuals
Transversal survey	LLTS_001	All	Women have a higher overall perception of risk than men
Transversal survey	LLTS_002	Karsiyaka	The perception of risk is high for many risks in Karsiyaka, and the risk of earthquakes is by far the most worrying for respondent
Transversal survey	LLTS_003	TRC	Risk perception is relatively low for most risks in Trondheim (low awareness, high resilience, no PTSD)
Transversal survey	LLTS_004	All	Trust in institutions (more specifically scientific expert) is linked to higher PTG
Transversal survey	LLTS_005	All	Trust in institution varies greatly from one CORE lab another

Transversal survey	LLTS_006	Karsiyaka	Many people who developed PTSD in Karsiyaka
Transversal survey	LLTS_007	All	Women are significantly more prone to PTSD
Transversal survey	LLTS_008	All	People who develop PTSD also can develop PTG
Longitudinal survey	LLS_001	TRC	People from TRC are fairly well prepared for the risk of natural disasters
Longitudinal survey	LLS_002	F-A; Naturtejo Geopark	Natural sites are perceived as the most vulnerable kind of CNH by F-A and Naturtejo Geopark population
Longitudinal survey	LLS_003	All	Past experiences of natural disasters (number of disasters experienced) increase risk perception, feeling of personal control over risk, and negative affects
Longitudinal survey	LLS_004	TRC	Perceiving CNH vulnerability by natural disasters is linked to higher level of individual preparedness
Longitudinal survey	LLS_005	All	Emphasize collective dimension of the community's vulnerability to promote risk preparedness, by insisting on CNH as a pillar of community's identity and its vulnerability
Longitudinal survey	LLS_006	All	Communicate on the complementary nature of the individual and collective dimensions of risk preparedness after individuals and encourage perceived behavioural control.
Longitudinal survey	LLS_007	All	Communicating through short videos on individual behaviours to prepare for the risk of natural disasters tends to encourage people to seek information about the risk, but does not encourage them to adopt protective behaviours.

Longitudinal survey	LLS_008	F-A; Naturtejo Geopark	Raise awareness of the vulnerability of man-made heritage or emphasise the contribution of natural sites to the identity of the community to promote the perception of CNH vulnerability as a driver for individual risk preparedness
Longitudinal survey	LLS_009	All	Implement the means to facilitate access to digital technology for the least connected populations, or propose alternatives that are better adapted to their practices
Longitudinal survey	LLS_010	TRC	Communicate less on the serious and dangerous nature of natural disasters than on information on the risks themselves, and on the collective and individual resources that can be put in place to prepare for this type of event to encourage risk preparedness
Longitudinal survey	LLS_011	TRC	Communicate on the vulnerability of CNH to natural disasters, making it clear that this is representative of the community's collective vulnerability, in order to encourage risk preparedness
Longitudinal survey	LLS_012	F-A	Consider the potentially harmful role of fear of risk on preparedness when communicating about natural disasters
Longitudinal survey	LLS_013	Naturtejo Geopark	Emphasising the threatening nature of the risks and their increase over time but always insisting on the ways in which people can prepare and adapt to foster feeling of control and preparedness
VR	LLVR_001	TRC	People are alert to the first danger signals in forest fire situation
VR	LLVR_002	TRC, F-A	Train referents in crisis situations, capable of guiding the individuals present towards the right behaviour in an orderly and consistent manner, as social cues takes precedence over environmental cues when it comes to choosing the direction of evacuation

VR	LLVR_003	TRC	Prevent any altruistic behaviour that may be inconsiderate in view of the danger and urgency of certain situations
VR	LLVR_004	TRC	Communicate about secure preparedness behaviours in situation of wildfire, especially calling emergencies services and firefighters as soon as possible
VR	LLVR_005	TRC, F-A	Develop an early warning tool that is fast enough to evacuate people as soon as possible, as alert notification is often decisive in interpreting the situation, or even in individuals decision of evacuation
VR	LLVR_006	TRC	PP have to take into account that people most of the time do not panic in situation of disaster, even in more ambiguous situations

14.4. Glossary of terms

- **Coping:** "Cognitive and behavioral efforts to master, reduce, or tolerate the internal and/or external demands that are created by the stressful transaction" (Folkman, 1984, p. 843)
- **Risk awareness:** having and knowing information about a risk (Luís et al., 2015).
- **Risk perception:** risk assessment by non-experts based on risk characteristics (including perceived severity, perceived frequency and stated fear of the risk)(Slovic, 1992).
- **Perceived behavioural control:** feeling of ease/difficulty in implementing a behaviour, particularly in difficult circumstances (Wallston, 2001).
- **Post-traumatic stress disorder:** "a psychiatric disorder that may occur in people who have experienced or witnessed a traumatic event, series of events or set of circumstances. An individual may experience this as emotionally or physically harmful or life-threatening and may affect mental, physical, social, and/or spiritual well-being." (American Psychiatric Association, 2022).
- **Post-traumatic growth:** a metal transformation after a trauma, when "people who endure psychological struggle following adversity can often see positive growth afterward" (Collier et al., 2016).
- **Presence in virtual environment:** "The degree to which participants feel that they are somewhere other than where they physically are when they experience the effects of a computer-generated simulation" (Bystrom et al., 1999)

RESILIAGE
Revolutionising community resilience

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