emBRACE

2015-03-31

Case study report:

Alpine Hazards in South Tyrol (Italy) and Grison (Switzerland)

Deliverable 5.4

Authors

Lydia Pedoth	EURAC
Sebastian Jülich	WSL
Richard Taylor	SEI-O
Christian Kofler	EURAC
Nilufar Matin	SEI-Y
John Forrester	SEI-Y
Stefan Schneiderbauer	EURAC

Contract Number: 283201 **Project Acronym**: emBRACE **Title**: Building Resilience Amongst Communities in Europe

Deliverable N°: 5.4
Due date: 31st March 2015
Delivery date: 31st March 2015

Short Description: Case study work was conducted autonomously in South Tyrolean (Italy) and in Grisons (Switzerland). Accordingly, this case study report is divided in a Tyrolean Part and a Grisons part.

Lead Beneficiary: WSL, EURAC
Partner/s contributed: SEI-O, SEI-Y
Made available to: public

Version Control		
Version	**Date**	**Name, Affiliation**
0.9	29th March 2015	Lydia Pedoth, EURAC
1.0	31st March 2015	Sebastian Jülich, WSL

Acknowledgements

Funding for this report was made available by the European Commission under the 7th Framework Programme – Grant Agreement No 283201.emBRACE

Contact:

Technical Coordination (Administration)

Centre for Research on the Epidemiology of Disasters (CRED)
Institute of Health and Society Université catholique de Louvain
30 Clos Chapelle-aux-Champs, Bte 30.15
1200 Brussels
Belgium
T: +32-2-764.33.27
E: info@cred.be
W: www.cred.be

Technical Coordination (Science)

School of the Built and Natural Environment,
University of Northumbria
Newcastle upon Tyne
NE1 8ST,
UK
T: + 44 (0)191 232 6002
E: hugh.deeming@northumbria.ac.uk
W: www.northumbria.ac.uk

About emBRACE

The primary aim of the emBRACE project is to build resilience to disasters amongst communities in Europe. To achieve this, it is vital to merge research knowledge, networking and practices as a prerequisite for more coherent scientific approaches. This we will do in the most collaborative way possible.

Specific Objectives

- ⇨ Identify the key dimensions of resilience across a range of disciplines and domains
- ⇨ Develop indicators and indicator systems to measure resilience concerning natural disaster events
- ⇨ Model societal resilience through simulation experiments
- ⇨ Provide a general conceptual framework of resilience, tested and grounded in cross-cultural contexts
- ⇨ Build networks and share knowledge across a range of stakeholders
- ⇨ Tailor communication products and project outputs and outcomes effectively to multiple collaborators, stakeholders and user groups

The emBRACE Methodology

The emBRACE project is methodologically rich and draws on partner expertise across the research methods spectrum. It will apply these methods across scales from the very local to the European.

emBRACE is structured around 9 Work Packages. WP1 will be a systematic evaluation of literature on resilience in the context of natural hazards and disasters. WP2 will develop a conceptual framework. WP3 comprises a disaster data review and needs assessment. WP4 will model societal resilience. WP5 will contextualise resilience using a series of Case studies (floods, heat waves, earthquakes and alpine hazards) across Europe (Czech Republic, Germany, Italy, Poland, Switzerland, Turkey and UK). WP6 will refine the framework: bridging theory, methods and practice. WP7 will exchange knowledge amongst a range of stakeholders. WP8 Policy and practice communication outputs to improve resilience-building in European societies.

Partners

- ⇨ Université catholique de Louvain (UCL) - **Belgium**
- ⇨ University of Northumbria at Newcastle (UoN) - **UK**
- ⇨ King's College London (KCL) - **UK**
- ⇨ United Nations University Institute for Environment and Human Security (UNU), **Bonn**
- ⇨ Accademia Europea per la Ricerca Applicata ed il Per-fezionamento Professionale Bolzano (EURAC) - **Italy**
- ⇨ Helmholtz-Zentrum Für Umweltforschung GMBH - UFZ (UFZ) - **Germany**
- ⇨ University of York (SEI-Y) - **UK**
- ⇨ Stockholm Environment Institute - Oxford Office Limited (SEI-O) - **UK**
- ⇨ Swiss Federal Institute for Forest, Snow and Landscape Research - WSL (WSL) - **Switzerland**
- ⇨ Middle East Technical University - Ankara (METU) – **Turkey**
- ⇨ University of Reading (UoR) - **UK**

Table of Contents

SOUTH TYROLEAN PART

1 Introduction South Tyrolean Part

In the Alps, natural hazards are part of everyday life and tied into local history and culture. They shape the livelihoods, identity and resilience of the community. Communities live with continuous risk and cope frequently with small, and sometimes major, impact events. Every year, different kinds of natural hazard events cause damages, losses and deaths. How to prepare for, cope with and recover from them are key questions for our society, particularly in mountain terrain.

Within this context the emBRACE case study offered a great opportunity to investigate on community resilience by working in close contact with the local community of Badia in South Tyrol. Moreover, it allowed to collect empirical data in order to get a better understanding of which key aspects influence resilience, how to assess, describe and possibly measure them. The work was inspired and supported by the Autonomous Province of Bolzano, particularly interested due to its focus on communities and the inclusion of social sciences perspectives and methods in the often technical and natural-science-dominated research on risk and natural hazards.

The small alpine community of Badia in December 2012 was hit by an exceptionally big landslide. The municipality lies in a very landslide-prone area and experienced several events in the past, one big landslide event in exactly the same area in 1821. Against this background we were particularly interested in people's risk perception and if risk perception increased after the recently experienced event, as described in other studies in different contexts and referred to different types of natural hazards (Perry and Lindell, 1990; Becker et al, 2001; Johnston et al, 1999). Furthermore, risk perception is a major factor that influences people's motivation to support or implement preparedness, prevention and adaptation measures in the context of natural hazards. Nevertheless, at the same time people tend to be less worried about risks they know and they are familiar with (Jurt, 2009). Besides risk knowledge and past experience, within our work we wanted to investigate which other factors such as values, attitudes and feelings as well as cultural determinants influence natural hazard perception and risk attitude (Kuhlicke et al, 2011). These aspects are of particular value for the case study community as it belongs to a linguistic and cultural minority within the region of South Tyrol.

One aim of our case study was to link the knowledge about risk perception to risk management, because it can contribute to shape a more effective community

response. It can also help the responsible authorities in disaster planning activities and the development and improvement of strategies for disaster risk reduction (Eiser et al, 2012; Davis et al 2005). Therefore, we wanted to work also with the community of supporters, with officers from public authorities dealing with risk management, looking at the different interactions and networks among them, but also between them and the population. We think that a fuller grasp of what community resilience might be involves both an understanding of the top-down policy network responsible for "the big picture" and also of the community network, which may have its own resilience but which is also often responsible for the plan implementation.

The research questions of the case study can be summarised into two groups. The first is focusing in risk perception and investigates the following questions:

- How did the population of Badia perceive the landslide event in 2012?
- Which aspects influence peoples' risk perception?
- How did the risk perception change due to the event in 2012?
- What is the role of local knowledge and past hazard experience for community resilience?
- How did people perceive the interventions carried out by authorities and organisation in response to the landslide event?

The second group of research questions looks at the role of social networks for community resilience and addresses the following questions:

- How are present responsibilities and relationships between authorities and between persons in charge for natural hazard management shaped?
- How do networks within the population interact with the network of organisational actors and the community of supporters?
- How do social and policy networks influence the resilience of communities?

2 Context of the case study

2.1 The Autonomous Province of South Tyrol

This case study focuses on the situation within the municipality of Badia in the Eastern part of the Italian Autonomous Province of Bolzano. This Province, also known as South Tyrol, lies at the geographic and cultural crossroads of northern and southern Europe. It is Italy's northernmost province and borders Switzerland and

Austria. The province covers an area of 7.400 square kilometres and is home for a total population of approximately 518.000 inhabitants (Astat, 2015). The area of South Tyrol, or in Italian language “Alto Adige”, is entirely located in the Alps. Its landscape is dominated by mountains of which the Ortler Mountain (3.905 m) represents the highest peak in the far west. However, the most famous mountain range are the craggy peaks of the Dolomites, partly lying in Eastern South Tyrol, which received the status of a UNESCO world heritage site in 2009.

Figure 1: The location of the Autonomous Province of Bolzano in Italy

The map highlights the location of South Tyrol in Italy in red. Source: Map created by EURAC based on data from the Autonomous Province of Bolzano/Bozen.

Until 1918 South Tyrol was part of the Austro-Hungarian Empire. At the end of the First World War this, until then almost completely German-speaking territory was occupied by Italy and was annexed to the Kingdom of Italy in 1919. Between the two World Wars the fascist regime led by Mussolini strongly fostered the migration of Italian speaking population from other parts of Italy to South Tyrol and activities linked to German culture and language (schools, newspapers, folk festival) were forbidden. After World War II (1946), an agreement was signed between Austria and Italy (Gruber-De-Gasperi-Agreement) that claimed an autonomous region of Alto Adige (South Tyrol) and Trentino and ensured the rights of cultural minorities, to

which belongs also the small language group of Ladin, based in some upper valleys in the Dolomites. As part of this agreement, Austria has been acknowledged as protection state for the German speaking population within Italy. However, the following years were drawn by increasing tensions and conflicts among the different population groups, due to a delayed implementation of the agreement, the German-speaking South Tyroleans being dissatisfied since the majority of this region was still Italian speaking and the state promoted migration of Italians from other regions towards Alto Adige-South Tyrol. The South Tyrolean question became an international issue and cause of friction between Austria and Italy. In 1960, “the South Tyrolean question” was taken up by the UN. This international attention triggered new negotiations for a “Second statutory order” containing a package of reforms that, in 1972, produced the “Autonomy Statute” for the Province of Bolzano with a considerable level of self-government.

The current institutional framework represents a model for settling interethnic disputes and for the successful protection of linguistic minorities. To these minorities belongs also the Ladin-speaking population, which represents the majority in the test case municipality of Badia.

The Autonomy Statute brought forward the development of South Tyrol as a wealthy European region and one of the most prosperous of Italy, with the lowest unemployment rate and the highest GDP per capita of the whole country (EUROSTAT, 2014). One reason for South Tyrol’s economic success even in times of crisis is its balanced economic structure between agriculture, artisans, industry, commerce, and services. Another one is its small and midsize company structure, many of which are family owned.

Predominantly due to the mountainous character of the area, the population and its activities are exposed to a number of natural hazards. Most importantly, there is a high potential of floods in the planes of the valley bottoms, of debris flows and overbank sedimentation on the alluvial fans, of landslides on the slopes and of rock falls and avalanches in the mountains and the higher valleys. Most natural hazard events are of small scale and do not have any or only a limited impact on the population, but some rare events affect infrastructures, settlements and the population. Historical documents prove a long history of damaging events and accordingly a vast knowledge of the local populations to deal with these events.

The responsibility to deal with the risk of natural hazards in South Tyrol has been in various hands. The status of autonomy of the Province encompasses the activities of civil protection and emergency response. That is, the authorities of South Tyrol have since 1972 the primary responsibility for managing the risks of potentially damaging events such as natural hazards and to carry out all activities in this respect, as long as the extent of the emergency event does not exceed the provincial capacities.

2.2 The municipality of Badia

The work of this case study was carried out within the municipality of Badia, where in December 2012 a landslide threatened the life of the inhabitants of several hamlets and destroyed four residential buildings. Badia – in German called “Abtei” - is located in the South-eastern part of the Autonomous Province of Bolzano, at the end of the Badia Valley, bordering the Province of Belluno in the South (see Figure 2).

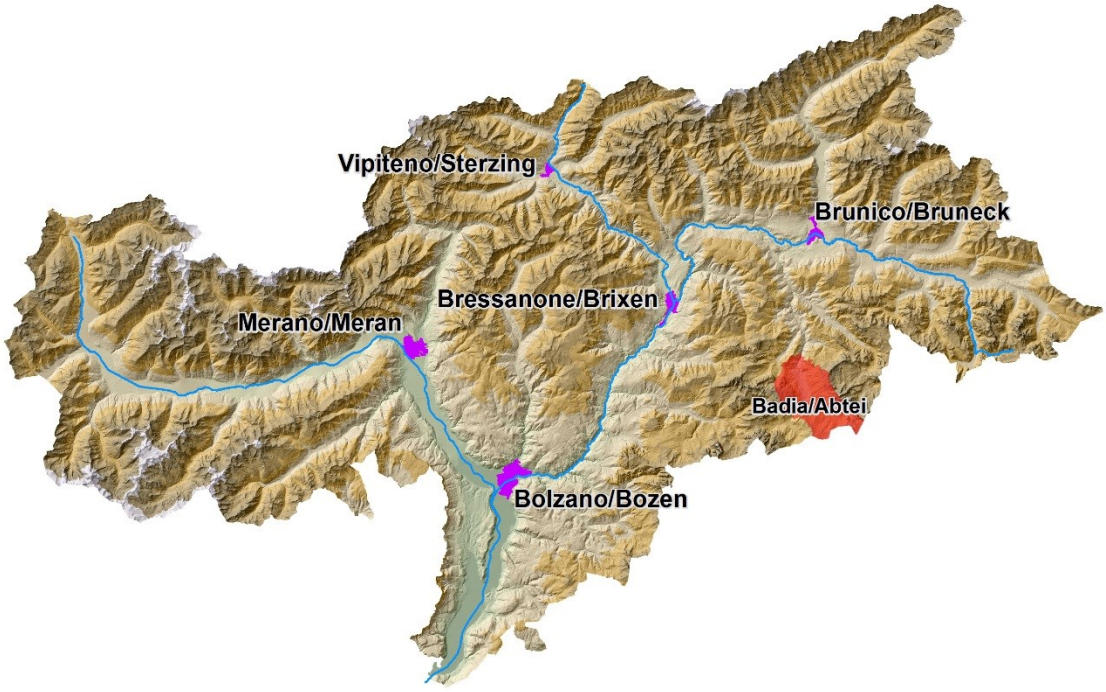


Figure 2: The location of the municipality of Badia (red area) in South Tyrol

Source: Map created by EURAC based on data from the Autonomous Province of Bolzano/Bozen.

The municipality of Badia comprises 3,458 inhabitants (as of 31.12.2014, source: ASTAT, 2015) and is divided into the districts Badia, San Cassiano and La Villa. It

covers an area of approximately 82 km² and ranges in altitude from about 1200 m in the valley bottoms up to slightly more than 3000 m on the surrounding peaks of the Dolomite Mountains (see Figure 3). Around 93 % of the population living in Badia belongs to the Ladin language group, while the mother tongue of the remaining persons is almost exclusively German or Italian. Ladin stems from a Latin dialect and is associated with Rhaeto-Romance languages.

Figure 3: Landscape in the upper Val Badia valley
Source: www.FotoST.eu, Photo taken by Gerda Hoffer

For a long time before industrialisation, the region of the dolomites were characterised by subsistence agriculture and poverty until it was discovered as a viable tourist destination in 1850 by British alpinists. Since then the region has developed rapidly as tourist destination, interrupted only - but strongly - by the two World wars. Nowadays the Badia valley - as many valleys in the Dolomites - benefits from a double tourist season: in summer representing an environment for hiking and numerous other activities, in winter providing numerous options for snow sports, principally downhill skiing (Franch et al, 2003). Tourism represents today the main source of income for the people in Badia. Around 69% of the population work in the service sector, around 21% work in production, and around 10% work in agriculture, however most of these hold other jobs as well and farm on the side (ASTAT, 2007).

2.3 General Hazard context

The landscape of the municipality of Badia is typical for its location in a geologically young mountain area such as the Alps and characterised by a high relief energy. Due to this mountainous setting, there are a number of geomorphological processes that threaten the Alpine populations through a variety of natural hazards. These hazards can roughly be divided into three groups:

- Water-related hazards such floods, overbank sedimentation and debris flows.
- Gravitational hazards such as rock falls, landslides and slope failures.
- Avalanches.

As a consequence, when compared to other European areas that are for example at risk of large river floods or earthquakes, alpine regions face a greater variety of natural hazards. In average these hazards occur at a higher frequency, but are mostly combined with a smaller damage potential. Figure 4 shows the amount and type of hazards that occurred in the area of the Badia municipality in the period from 1998 to 2012.

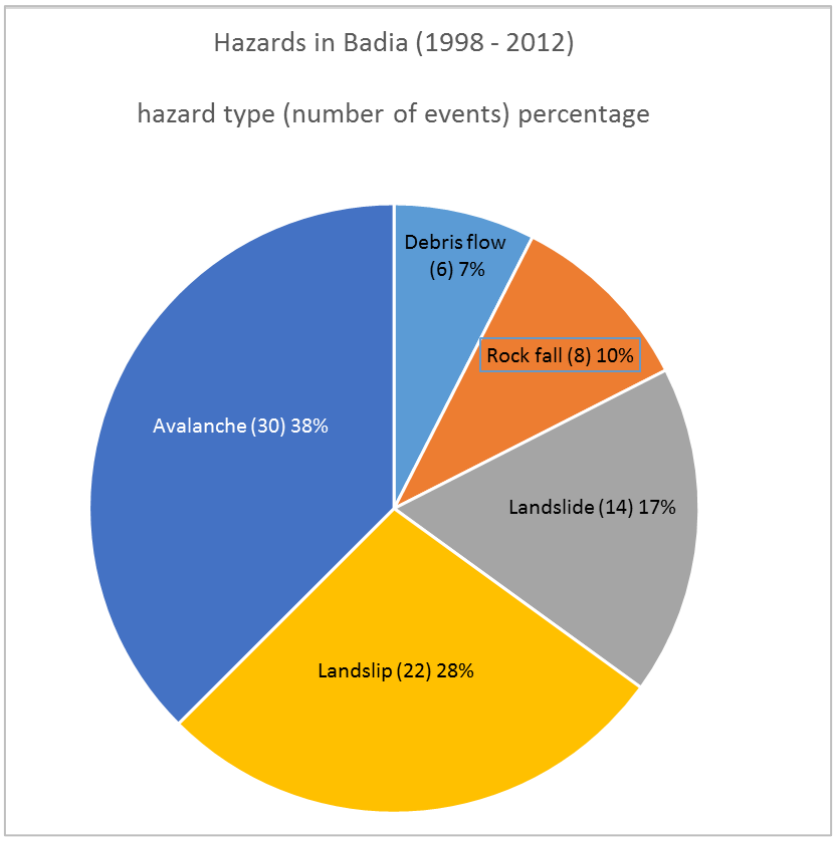


Figure 4: Hazards in Badia: Type and amount of events between 1998-2012

Sources: the event databases of the Autonomous Province of Bolzano for landslides (IFFI), for water related events (ED30) and for avalanches (LAKA)

Paying tribute to the fact that they are permanently exposed to hazardous events, the alpine populations have always tried to find and choose relatively safe areas for their settlements. In recent times the demand for such favourable and rather easily accessible areas in the valleys has augmented significantly, due to growing activities in tourism, industry and settlement extension. As a result, an increasing number of buildings as well as lifeline and traffic infrastructure have been constructed in hazard prone zones. This fact has led to a significant accumulation of assets in hazard prone areas and has increased the risk of losses, entirely independent from the frequency or magnitude of the hazardous events themselves.

In the test case area these assets are nowadays protected by state-of-the-art technical measures including a fine network of shielding structures (for example dikes, dams, avalanche barriers and rock fall nets) and warning systems. Thereby, the impacts caused by small or medium hazardous events, which in former times had frequently affected the population, could be significantly reduced.

Summarising, it can be stated that the life of the inhabitants of Alpine regions in general, and in the higher valley of the Dolomites such as the Val Badia in particular, is characterised by its very special topographic setting. The location of a mountain valley represents many disadvantages when looking from a modern economic perspective, with limitations in accessibility, costs for development as well as infrastructure construction and last but not least the risk of damages due to natural hazards. Bätzing (2003) elaborates on the historical changes of the perception of these characteristics by outsiders throughout the last centuries, ranging from purely menacing to peaceful idyll. At the same time, this special setting has led to a strong identification of the local populations with their environment, a territorial (or geographic) identification that incorporates natural as well as cultural and social aspects and that finally supports development processes (Pollice, 2003). Together with the beauty of the landscape this territorial identity has fostered the economic development of the Alpine valleys despite its unfavourable characteristics in a globalised world.

2.4 The landslide in Badia

In December 2012 a landslide occurred in the area of the municipality of Badia at the foot of the mountain Heiligkreuzkofel. This movement was mainly triggered by heavy precipitations and temperature variations in the weeks and months before the event. The landslide covered an area of overall 42.5 hectare with a maximum extend of 400 m width and 1500 m length. As a consequence, 4 residential buildings were entirely destroyed and 37 people of four Hamlets in immediate vicinity needed to be evacuated (Sotrù, Anvì, Martara and Larcenëi) (see Figure 5). In addition, the down sliding material threatened to create a lake by damming the riverbed of the Gader stream (Mair & Larcher, 2014).

Figure 5: Photo of the landslide event in Badia in December 2012

Destroyed residential buildings in the foreground. Source: Photo taken by Christian Iasio

The landslide within the municipality of Badia activated a number of response mechanisms, foreseen by the provincial government in case of natural hazards. The area was immediately visited after the population announced the first obvious cracks in the ground – though this movement of the slide was very slowly in the beginning. The situation with the related threats was analysed by the responsible authorities and

various experts. Thanks to the timely evacuation of potentially affected population no human damage was encountered. More severe damage, directly linked to the landslide itself, could be avoided thanks to continuous excavation and removal of down-slipping material with heavy machinery. In addition, potentially hazardous chemicals were removed from a down-stream located sewage plant. Immediately after the event aerial photos were taken and an in-situ monitoring system was installed in case that the slide would start to move again. A more detailed description of the development of the landslide and its geological context is provided by Mair & Larcher (2014) in German language.

In the light of the focus of this work, it is very important to mention that there had been a previous landslide at exactly the same position around 200 years before. In summer 1821 a movement with a similar geological process had taken place, also triggered by long during rainfall – most probably also combined with water stemming from snow melt. In addition to the destruction of an entire hamlet, this historical landslide blocked the water from the river Gader and created a lake that threatened the settlements downstream, due to the fact that the removal of material as emergency response was not possible in those times. A comparison of the extent of the two landslides shows Figure 6.

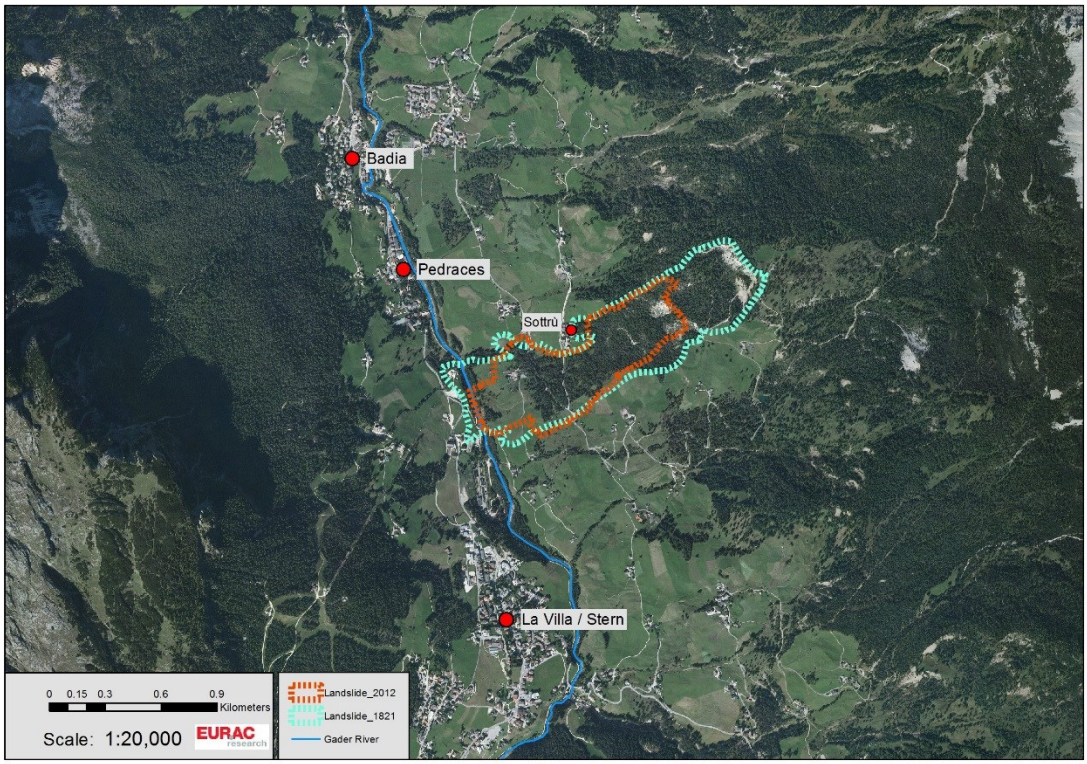


Figure 6: The two landslides: 1821 and 2012

The light blue dotted line shows the extent of the landslide event in 1821; the red dotted line shows the extent of the landslide from 2012

Source: Schneiderbauer et al, 2014. Data: Aerial Image: © Agea.gov.it provided by the Autonomous Province of Bolzano - South Tyrol

Against the background of the later analyses of this test case, it is worth to mention that the risk management situation in 2012 compared with 1821 was entirely different. In 1821 the available resources and organizational structures were very limited and one of the key actions was a call for donations to support the affected families. In 2012 however, the potentially and directly affected population was supported by a sophisticated emergency response mechanism, with modern technology and machinery to avoid more severe and potential further future damages and a well-organised institutional structure.

2.5 Risk management at local level

As mentioned above, the municipalities constitute an additional main player in risk governance in South Tyrol besides the provincial administration. There are two main processes with linked policies and legal instruments at local level:

1. the spatial planning process and the local hazard zone maps
2. the emergency planning and the local civil protection plans

The use of the hazard zone mapping as a sectorial spatial planning instrument is laid down by the Provincial Spatial Planning Act (PA, no. 13, 1997). The implementing regulation adopted through a Provincial Governor's Decree in 2008 (PGD, no. 42, 2008) obliges all municipalities to elaborate a hazard zone plan of all hydro-geological hazards and to document their particular risk level. It contains provisions to prevent or reduce the natural hazards identified in the hazard zone map, for instance through actions and protective measures in areas exposed to hydro-geological risk. For the implementation of the decree, guidelines have been developed for drawing up hazard zone maps and classifying specific risks. These plans have to be authorized by the Provincial Government. Currently the majority of municipalities in South Tyrol are working on the generation of such hazard maps. Also for the hazard zone of the municipality of Badia the plan is currently in elaboration. Once the plans have been approved, they become part of the legal binding and integrative part of the land use plan. The land use plan is the main

spatial planning instrument at municipal level and focuses predominantly on land use designation and building development (Hoffmann, 2010).

Looking at emergency planning and response, the Italian system of civil protection is based on the principle of subsidiarity. Figure 7 gives an overview on how responsibilities are distributed among the different institutional levels (from national to local) for different types of hazards.

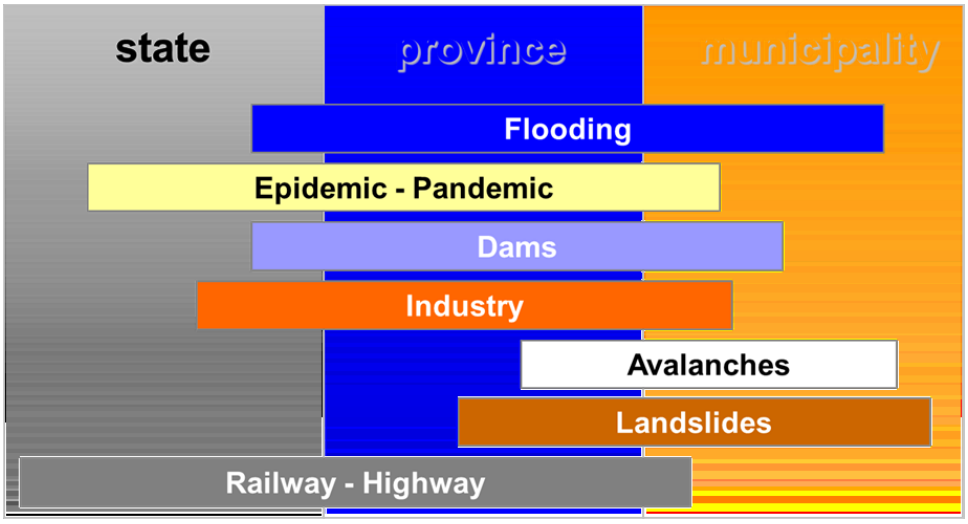


Figure 7: Responsibilities for Civil Protection- the principle of subsidiarity
Source: Autonomous Province of Bolzano

At local level, in each municipality the first person responsible for civil protection is the mayor, who organises municipal resources according to pre-established plans made, in order to cope with specific risks in the territory of the municipality. He has to implement and turn into action the strategies and plans of emergency interventions developed at regional level. In case of emergency he has to coordinate the rescue services and represents the interface between them and the population.

Additionally, in the Autonomous Province of Bolzano each Municipality has its *Communal Operative Centre* (Provincial Law n.15/2002 art. 3), which supports the mayor in the assessment, decision making and crisis management and consists of administrative officers of the Municipality and local experts. The same law foresees that each municipality should prepare and adopt a *Communal civil protection plan*. This standardised plan at municipality level has the objective to have a common tool for emergency planning and response and allows to collect and integrate the data at provincial level. The plan collects and organises available knowledge, resources and describes possible scenarios and response procedures. The above described hazard

zone map serves, among other data and documents, as an input for this local civil protection plan. The municipality of Badia developed and adopted its *Communal civil protection plan* in 2010 and is organising and carrying out regularly emergency drills in order to "test" the plan. The existence of a *Communal civil protection plan* as well as the regular emergency drills revealed to be very important for community resilience.

3 Methodological approaches

The case study was conducted using different methodologies and including both quantitative and qualitative approaches. For the assessment of community resilience, the following three methods were applied:

- survey among all adult population of the municipality of Badia through questionnaires
- social network analysis
- semi-structured interviews including qualitative social network mapping

After the development of the conceptual design of the case study, in autumn 2013 we carried out the first steps of the fieldwork, including meetings with the officer of the Geological department of the Autonomous Province of Bolzano and the mayor of the municipality of Badia. The fieldwork and data collection went on for about one year and were concluded with the last expert interviews in November 2014. The dissemination of the results is still in process and will be concluded with an information evening in the municipality, planned for early summer 2015.

3.1 Definition of community

The questions about characteristics of a community, how to define it and which different types of communities do exist have been addressed in previous works and deliverables of the emBRACE project. According to the types of communities described in the emBRACE deliverable 2.1 (Birkmann, 2012), in our case study we are looking at the following two types of communities:

> *Geographical communities* are those with identifiable geographical or administrative boundaries or arising from other forms of physical proximity (for example, a street or an apartment block). As described above, the geographical community is the boundary of

> choice for many disaster management functions although, while likely to be affected by the same type of natural hazard (such as flooding) the boundary can contain much variability (for example, in the context of flood risk, properties on raised ground within a flood envelope drawn on a map). Where there is strong identity with any level of community, it appears focused at the most local level […].
>
> *Communities of supporters* comprise, in this context, communities of people drawn from organizations (both statutory and voluntary) providing disaster-related services and support. The members of this community may also share a geographical location and may be affected in the same way as the communities they support.

In our case study, the geographical community is delimitated by the administrative borders of the municipality of Badia and includes all people with a residence in the area of the municipality.

The community of supporters comprises two levels:
1) The provincial level, including officers and experts from different departments within the Province of Bolzano involved in risk management (e.g. the Provincial Civil Protection, the Geological office, the professional Fire brigade) and
2) the local level, including the volunteer organizations, the officers and experts of the municipality, the local based divisions of the Province of Bolzano and the local division of the Carabinieri (the national military police of Italy).
As described in the definition of the communities of supporters, in Badia members of these communities (especially for supporters at local level) are also members of the geographical community they support.

In the case study work we looked at these communities separately (at the geographical community through a population survey and at the supporters community through single interviews) as well as at the interactions and linkages between them. We wanted to understand the existing networks within the communities as well as at the ways horizontal and vertical ties between members of social networks transmit information and provide access to resources at critical time (Aldrich, 2012).

3.2 Link to the emBRACE Framework

The emBRACE framework served as theoretical background for the case study and guided the conceptual development of the case study design. Its characteristic of being holistic and including the three dimensions (capacities & resources, actions, and learning) of community resilience as well as the institutional and political context gave the frame for applying different methods: working with two types of communities, assessing different aspects contributing to resilience and bringing together results and findings from different approaches to underpin the overarching theoretical framework with empirical data.

The framework was not directly applied in the fieldwork with the communities because of its complexity and theoretical character, but also due to linguistic difficulties in translating the terminology, e.g. Ladin as mainly spoken language has no term for resilience.

Within the case study work, we address all three dimensions of the framework. For the action dimension, we did not focus on one of the five elements being part of it, but we looked at the whole process from mitigation to reconstruction, from a risk management point of view as well as in terms of perceived responsibilities for mitigation, preparedness and response. Out of the Learning dimension, we focused on risk/loss perception and on critical reflection, whereas for the Capacities and Resources dimensions the work focuses on socio-political and human aspects.

Finally, the use of different methods and the assessment of different elements of the frameworks aims also at better understanding the interactions between them and how they are influenced by each other.

3.3 Questionnaires

The survey was conducted using questionnaires as it is a popular and fundamental tool for acquiring information on knowledge and perception within natural hazards research (Bird, 2009). Within our case study work, through the use of a questionnaire we aimed at assessing the following aspects and their influence on resilience: risk and loss perception, experience and knowledge about past hazardous events, the role of local knowledge, trust in authorities and information sources used before and

after the event. The purpose of the questionnaire was to assess these aspects and if and how they changed due to the recently experienced event.

In April 2014, the questionnaires were distributed personally by a trusted member of the community who shortly explained the purpose of the study to the recipients. The method of distribution was chosen because it covered the whole area and reached every member of the community. During the development phase of the questionnaire, stakeholders from the local geological authority as well as the mayor of the municipality, where involved in order to establish a relationship with the community and to integrate their expertise and their needs. The questionnaire consists of 29 questions divided into six parts. The first part contains questions about experience and knowledge about past events and in which way people were affected by the landslide event in 2012. The second part is dedicated to people's perception and satisfaction with the intervention activities carried out by the responsible authorities shortly after the event and within 16 months following the landslide, focusing on the recovery and reconstruction phase. The aim of introducing two different time slots is to include the temporal dimension and to try, by looking at changes over time, to capture the dynamic aspects linked to resilience. The third part focused on the knowledge about protection and mitigation measures, while the fourth part aimed at understanding the social networks of the community. By the mean of open questions, in the fifth part people expressed what, according to their opinion, could be improved immediately and within the first year after an event. Finally, in the last part respondents assessed their geographical distance to the landslide on a map and gave some demographic information. The questionnaire can be found in the Appendices, Annex 1.

The questions of the questionnaire were of different type: closed questions, semi-open questions, questions using a Likert scale and open questions. For the data entry we used the open source software CSPro5[1] and the analysis of the data was carried out with the software SPSS.

Univariate statistics were carried out for the whole dataset to understand the frequency distribution for the different variables. An important aspect of our case

[1] CSPro, short for the *Census and Survey Processing System*, is a public domain statistical package developed by the U.S. Census Bureau and ICF International. The software can be used for entering, editing, tabulating, mapping, and disseminating census and survey data. http://www.census.gov/population/international/software/cspro/

study work is to see if there are differences within the community, if there are sub groups that differ in their answers related to the main dimensions we looked at, such as risk/loss perception, knowledge and social capacities. Therefore, in a second step all questions were analyzed by:

- language group (Ladin, Italian, German)
- age classes
- gender

The size of these different subgroups varies significantly, reflecting the demographic and cultural composition of the population. By applying the chi-square test, we tested if the answers by subgroups are significant, meaning if the fact of being part of a certain subgroup has an influence on the answers or not (Dowdy, 1991).

As described in the emBRACE Deliverable 2.2 “Agreed Framework” (Birkmann, 2013), resilience is a dynamic process and changes over time. According to this concept, we wanted to address in our case study also the temporal perspective of community resilience. Besides studying peoples’ knowledge about past event and their perceived probability of an event happening before the landslide in 2012, through the questionnaire we also analyzed how people perceived the time shortly, in the first days and weeks after the event and 16 months later, in April 2014. Different aspects where assessed looking to these two time periods, such as frequency and amount of information, psychological support, satisfaction with intervention activities, e.g. coordination of involved action forces. The questions referring to this part were assessed using a Likert scale. This method allows to capture and measure qualitative data in a quantitative way. Applying different analysis we assessed the overall increase or decrease between the two time periods but also how big and in which directions the changes happened.

In order to detect groups of respondents that behave in a similar manner, we decided to carry out a cluster analysis. A cluster analysis groups a bunch of objects in a way that the objects within one group (= cluster) show a high similarity between them and differ from the ones grouped in another cluster (Brosius, 1998). Before performing the actual computation, it is important to have an idea of what kind of similarity one wants to measure. For our case study we wanted to group the respondents according to their perception and experience of landslides, if they got active or not and if they are feeling threatened by future events.

Since our data is stored mostly on a binary or ordinal scale, we decided to use the "Two Step" clustering method available in SPSS. The SPSS TwoStep Clustering Component is a scalable cluster analysis algorithm designed to handle very large datasets. It is capable of handling both, continuous and categorical variables or attributes. In the first step of the procedure, the algorithm pre-clusters the records into many small sub-clusters. Then, it clusters the sub-clusters from the pre-cluster step into the desired number of clusters. If the desired number of clusters is unknown, the SPSS TwoStep Cluster Component will find the proper number of clusters automatically (IBM, 2001).

3.4 Mixed methods for social network analysis

A social network consists of a set of actors and a set of relationships, simultaneously presenting structure and processes that are often multi-dimensional and multi-layered. Although social network analysis often uses quantitative methods to generate numerical measures of structural properties (Borgatti et al. 2002), there is a body of literature that generates visual data using participatory mapping techniques (Schiffer et al. 2008, Emmel and Clark 2009), archival narratives (Edwards 2010) and in-depth interviews (Heath et al. 2009). However, researchers are increasingly using methodologies that can capture both quantitative and qualitative dimensions of the networks under study. Crossley (2010) argues that quantitative and qualitative approaches have different strengths and weaknesses but they are broadly "complimentary". Quantitative data allows formal network analysis but it needs to be supplemented with methods of qualitative observations to deepen our understanding of what is "going on" within a network (p.21). Bishop and Waring (2012) in their study of interpersonal relationships in healthcare delivery networks find that, while mathematical properties of social networks utilising graph theory and statistical analysis present interesting data on the structure of ties, they sidestep other important elements of patterns of social relationships, i.e. their meaning and their implications for network members. This can be achieved using qualitative ethnographic data.

Edwards (2010) notes that social network analysis offers a particular opportunity for mixing methods because networks are *both* structure and process *at the same time*, and therefore evade simple categorisation as either quantitative or qualitative phenomena. "A mixed-method approach enables researchers to both map and

measure network properties and to explore issues relating to the construction, reproduction, variability and dynamics of network ties, and crucially in most cases, the meaning that ties have for those involved" (p.6). Edwards suggests a number of "added-value" that mixed-method approaches can generate. For example, quantitative methods and qualitative methods can be mutually informative in multiple stages of research; mixing methods can help in "triangulation", i.e. using different forms of data to explore the same phenomenon; mixing methods enables researchers to gain an *"outsider"* view of the network in terms of the structure of the network (which could not be seen by any individual actor), but also to gain data on the perception of the network from an *"insider's* view, including the content, quality and meaning of ties for those involved; combining methods allows mapping the evolution of the structure of networks over time using panel surveys, and exploring the reasons for change using qualitative methods. (p.18)

In this research we used the quantitative survey to gather attribute and relational information. This was then followed up with semi-structured interviews with selected key participants to gather in-depth qualitative data about type of link, quality of link, relations, trust. In this, we used the software programme R to assist with statistical computing and graphics (R core team, 2014). First, the survey data was used to produce social network maps that allowed visualisation of the entire network surveyed. The names that were thus generated were used to identify key actors. Second, these maps were used for interviews to explore the perceptions that these actors had of these structural patterns, for example to comment on any inaccuracies or missing data, and more importantly, the respondents' interpretations of the network view (Sloane and O'Reilly, 2013). Thus, the combination of survey and interviews provided triangulation or cross-referencing to test the reliability of network maps and therefore help in estimating the amount of "measurement error" involved in quantitative analysis (Lubbers et al. 2010). The maps were also used as a basis of participant narrative about how the relations had changed during the various phases of disaster planning, response and recovery. This design allowed both an "outsider" view on the network structure and an "insider" perception of the network (Edwards 2010) and helped to induce a critical reflection on how the network can be improved and become more resilient in the future.

3.4.1 Network analysis based on quantitative data

Two questions in the questionnaire addressed the existence of networks and collected data on relations of respondents. One question asked people to which institution or organization they go for help and support in case of an event and a second one to whom, out of their personal network, they contact for help or support in case of an event. For both questions respondents could give up to 6 answers, listing the most important first.

Taking the total number of answers, a frequency analysis was carried out and visualized in network diagram using the software R (R core team, 2014). In order to perform this analysis all answers had to be translated and checked for comprehensibleness as the original data were in three different languages and handwritten. In a second step the data were grouped and aggregated, and for each institution a frequency analysis was carried out.

In order to take into account the difference in importance according to the ranking of the institutions, we carried out an additional analysis for the institutions that were named first. In addition, we carried out an analysis to see whether an institution was named first without any other institutions named or whether it was named first among other institution. This analysis was based on the hypothesis that if an organization is named as first out of one it is considered more important than if it is named among others.

The network question was combined with the questions about whether or not respondents think there is a need of improvement shortly after the event and 16 months later. The need for improvement was assessed for a list of aspects given. Respondents were categorized as happy (few improvements needed) or unhappy (several improvements needed) and for the two groups a network analysis was carried out in order to see whether the group of “happy” people connected differently than the “not happy” group.

3.4.2 Network analysis based on qualitative data

In addition to the population survey we carried out single semi-structured interviews with persons working for the institutions that out of the results of the survey resulted to be the most important. In our case study, some of these persons have a double role, they are members of the community but at the same time actively involved in risk management because they are part of volunteer organizations involved in risk management such as the fire brigade or the first aid service or because they work for local based organizations and institutions with tasks in risk management such as the

municipality or the local civil protection unit while others are part of different department at provincial level, located in Bolzano, and responsible for risk management such as the Provincial civil protection, the professional fire brigade or the department for hydraulic engineering. During the interviews we applied a qualitative social network mapping in order to map and visualize their knowledge and experiences. The use of maps of all sorts have proved very useful at structuring the knowledge of a range of significant actors and re-presenting that knowledge in a way that is quickly and relatively easily usable and understandable by other actors in other positions in space and time (Taylor, 2014). Finally this method allows to understand the individual view of different kind of stakeholders with regard to responsibilities, power and weaknesses within the network and to work with actors from different scales, different backgrounds and sphere of influence and responsibilities.

The interviews focused on their role in risk management and in particular on their experiences during and after the event and aimed at assessing and visualizing patterns of responsibility, the relationship and the power of the different authorities and actors involved and responsible for natural hazard management, communication and coordination flows between them and the linkages between the organizational network and the community.

We applied the Net-Map approach that allows to look at situations where different kind of actors and institutions have to work together to reach a common goal (Schiffer, 2007). In the field of risk management and resilience building, different kind of experts, actors, organizations and authorities has to work together, share information and cooperate in case of a crises or disaster happening. During the single interviews stakeholders created qualitative network maps by writing in a first step all actors on post-it, putting them in a second step on a paper sheet according to the perceived closeness of collaboration and drawing, in a third step, links between them. The created “paper maps” where afterwards transcribed and imported into the software Gephi for further visualisation and analysis.

The so produced maps about existing networks are an important input for the discussion about “how resilient are existing networks” and “what are possible measures to increase resilience and improve existing risk management practices”.

This questions aimed at triggering critical reflection about existing networks and this is also why we choose to adopt single interviews instead of focus groups or

workshops in order to facilitate an open-speaking and avoid barriers due to institutional roles, hierarchy or the presence of other colleagues or officers. Furthermore, during the interviews the results of the survey network were discussed and validated to see if the institutions named by the population are “the right one”, the one people should contact as foreseen by the existing emergency plans.

4 Resilience in the context of capacities/resources, learning and actions: insights from South Tyrol

As mentioned above, in April 2014 we distributed the questionnaires to all adults living in the municipality of Badia (2523 questionnaires). 48,8% (1232) were returned of which 163 were not filled out. The response rate of 43% (N=1096) is very high and allows drawing a representative picture of the whole population of Badia. A comparison made with the official census data of Badia confirmed this showing a similar composition of the population and the respondents in terms of gender, age and language group.

The analysis of the first part of the questionnaire looking at risk perception shows that a large portion of the respondents (73,9%) is aware of the fact that the area is prone to landslides and mudflows. Nevertheless, for 50% the possibility of such an event happening was unimaginable. Only 20% of respondents anticipated that such an event is a possibility. A high risk awareness in terms of knowing to live in a high risky area does not mean that people expected an event happening. In terms of preparedness, these results show that people know about the risk in the area they live but this does not mean that they plan for an event and undertake measures.

Risk awareness is increasing with the age of the respondents, showing a statistical relevant correlation between the two variables. The answers for “perceived probability of a real event happening” behave differently, they are distributed in a similar way among all age groups, within all age groups the most common answers is that such an event was unimaginable/not expected.

Similar results can be observed also for the two gender groups. Gender has an influence on the risk awareness in terms of being aware to live in a landslide prone area. Risk awareness is higher for women than for men. This influence is not present for the “perceived probability of a real event happening”, where there is no difference between men and women.

As mentioned above all answers were also analyzed for the different linguistic subgroups within the population of Badia (Ladin, German and Italian). Findings show no differences in the answers for these subgroups, being part of a certain language group dos not influence the answers behavior and therefore has no significant influence on the aspects assessed through the questionnaire such as risk awareness, risk behavior or hazard knowledge.

The findings of the case study show an increased perception of risk after the landslide event, especially for people that have been affected by the impacts of the event. The answers show that most of the respondents (76%) were not affected by the landslide in any way. 23.1% were affected in some way (directly or indirectly) by the event. From the affected people 53.8% were limited in their mobility, 29.5% suffered building damages and 25.9% suffered material damages of another kind. 40.2% suffered financial losses and 21.1% were evacuated. Besides the experienced impact in 2012 respondents were also asked how probably they feel to be directly affected in the next 20 years by a landslide event and how probable on a scale from 1 (not probably) to 5 (very probably) they think they will suffer impacts such as evacuation, damages on their buildings or limited mobility. Looking at the correlation between the two (impact in 2012 and probability of future impacts) results show that for those not affected the mean level of probability of being affected by future landslides is 2.74 while for those affected by the landslide this mean is of 3.4. This clearly shows that having been affected by the landslide in 2012 increases the perceived probability of being affected again within the next years by damages and impacts due to a landslide event.

Previous studies showed that the spatial distance to the natural hazard event has a direct impact on people's risk perception (Wachinger, 2004). Our results confirm this, also in Badia the geographical distance to the landslide has an influence on people risk perception. Those respondents who live in very close proximity to the landslide assessed the future risk of being affected from a landslide landslides as high (4.33 on the five point scale). When filling out the questionnaire people indicated the administrative district they live and, in addition, they were asked to draw a cross on a geographical map of Badia indicating where they live (the map is included in the questionnaire, see annex 1). Results show, that the correlation between geographical distance and risk perception is not linear, there is a strong correlation for people that live in close geographical proximity of the landslide and becoming less important for the area more distant from the landslide with no differences between people that live

in the district Stern (about 1.5 km linear distance from the landslide) and in the district St. Kassian (2 and more km linear distance from the landslide).

Looking at previous hazard experience, 25.5% of the respondents have already personally experienced at least one landslide event in the past and 73.7% have heard and/or read about such an event in the study area. The main source of information for past events was traditional knowledge and stories within the family (56.1%), secondly the media (51.7%) and thirdly everyday conversations with other villagers (36.4%). As expected there is a link between the type of media used and the age of respondents, young people use much more the internet as information source than elderly do. Surprisingly, there is no link between the information source “family and village members” and the age. Also for young people the traditional knowledge and the information coming from “real faces” (family and village members) has a very high importance.

The information channels more used to get information immediately after the event in 2012 were the media and the other village members, both used by 62% of the respondents. When looking at the type of media, people took information mostly from the television, followed by the radio and the internet. These results show the importance other village members and therefore the community itself has, it is as important as the media are in terms of information after an event happening.

Interestingly, after an event other community members are more important as information source than family members are, whereas for past hazard knowledge the family is more important as information source than the community is. Also for the use of media there is a difference, 51.7% stated that they got information about past hazard knowledge from it while after an event there are used by 62% of respondents.

Looking at the gender aspects, the data reveal that women learned more about past natural hazard events from the media from than men did. They also use more the media (firstly television followed by radio and internet) in case of an event than men do. In case of an event, they get their information more from family members than men do; men use more the village members as information source than women do.

Part of the study assessed how people perceived the time after the event, from short-term response during the first days and weeks after the event to mid and long-term recovery and reconstruction in the first 16 months following the event. The hypothesis behind is on one hand that peoples’ perception changes over time and on the other hand that during the response phase there are a lot more attention,

additional resources and emergency measures available than in the mid-and long term are. The question was structured in a way that people could express their satisfaction with different services offered by the public authorities on a scale from 1 (very satisfied) to 5 (very unsatisfied) shortly after the event and 16 months later (today). The aim was to find out peoples' perception and satisfaction for the following aspects:

- Information regarding the landslide in the media
- Information regarding the clean-up efforts
- Information-evenings
- Safety-works
- Participation and presence of politicians
- Coordination of the action forces
- Psychological aid

In order to receive a clear idea about how the opinion changed over time, we performed several analyses. In a first step we looked at the distribution a frequency for each aspect and for each of the time slots. From this first analysis and looking at the results in a qualitative way, we noticed a general trend of decrease in satisfaction from shortly after the event to today.

More in detail, findings show that people are satisfied with information about the landslide event received through the media, shortly after the event as well as 16 months later. When looking to the information about recovery and reconstruction activities there is a decrease in satisfaction over time. The number of very satisfied people halves between shortly after the event and the 16 months following the event. The highest degree of satisfaction was reached for the coordination of actions forces after the event with more than 600 persons stating to be very satisfied with this aspect. For the execution of cleaning up works and the organization of information evenings in the municipality results show a decrease in satisfaction over time. For the participation and presence of politicians there is a strong change towards satisfaction over time (from after the event to today meaning 16 months after the event).

Looking at the support provided by psychological services, there decrease in satisfaction is observable only for people that were satisfied with the services after the event, this group halved between the two time slots.

No significant differences in the satisfaction with the different aspects linked to the response and recovery phase between men and women were found. Regarding

possible improvements, women stated more often that they would like to have more frequent and more exhaustive information. This links well with the results described above that women use more often the media as information channel to get information. Women see also more need for improvement of the early warning system and evacuation plan than men do.

In order to receive a clearer idea about how the opinion changed over time and how big the changes were, we performed additional analyses.

We computed the difference, by which the satisfaction changed over the two time periods (e.g. If a person was very satisfied with a certain service shortly after the event (1) and moderately satisfied 16 months later (3), the satisfaction decreased by -2 points). A negative value indicated a decrease, a positive value an increase of satisfaction. The frequencies of these differences gave us an overview if the general satisfaction increased, decreased or remained stable, but did not explain migrations between different levels of satisfaction (e.g. a value of +1 could be an increase from unsatisfied (4) to moderately satisfied (3) but also an increase from satisfied (2) to very satisfied (1)).

Hence, we had to develop a method that computes these migrations. First, we reduced the five-level scale to three levels: satisfied (1, 2), neutral (3) and unsatisfied (4, 5). Then we computed for every questionnaire the change of satisfaction (e.g. from satisfied to unsatisfied; from neutral to satisfied) and counted the frequencies.

Figure 8 shows that the classes that indicate satisfaction with the public services (1 and 2) shrank over time while the neutral class (3) and the lower two classes (4 and 5) grew. This result confirmed our hypothesis that satisfaction decreases between the two examined time-periods.

Figure 8: Satisfaction with "the operation"- changes in time

Satisfaction with various aspects of the operation shortly after the event and 16 months later ("today"). The figure shows average values of satisfaction with seven different services within the operation.

This figure, however does not explain the migration of opinions between the two time periods. Therefore we analyzed, how often the satisfaction developed positively or negatively over time.

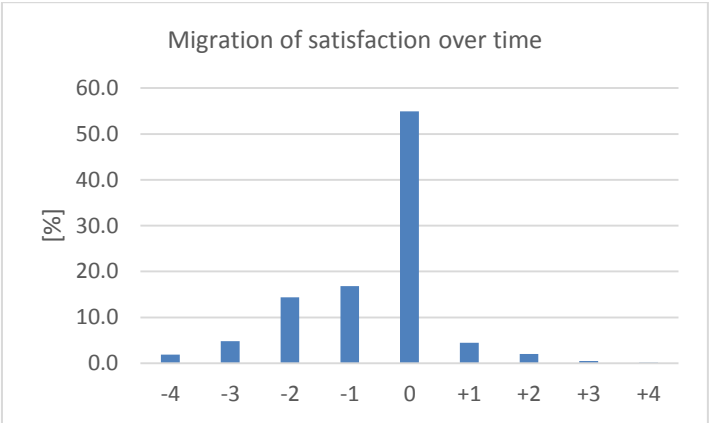


Figure 9: Migration (flow) of satisfaction over time

The figure shows average values of migration of satisfaction with seven different services within the operation.

Figure 9 shows that the satisfaction of more than 50% of the people did not change from shortly after the event to 16 months later. But it gets also visible, that very few people's satisfaction increased while a remarkable percentage of the respondent's satisfaction lowered.

Figure 9 however, does visualizes only the number (e.g.: +1,-2,…) by which the opinion of the respondents increases or decreases but does not explain the change of actual levels (e.g. from satisfied to unsatisfied,…) of satisfaction.

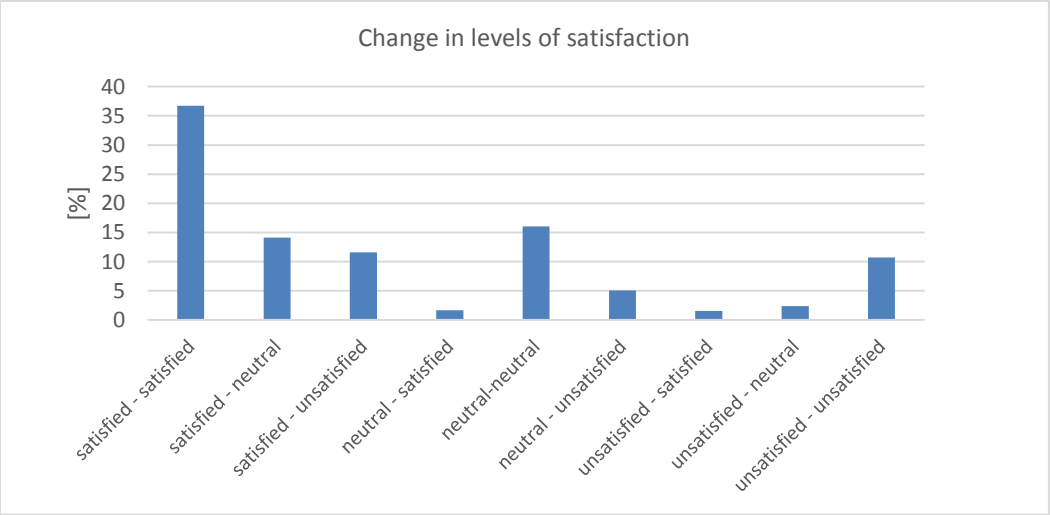


Figure 10: Change in levels of satisfaction

The first word always indicates the level of satisfaction shortly after the event, the second word 16 months later.

Figure 10 shows how actual satisfaction changed between the two time periods. This result fits with the previous figures since also here the level of satisfaction either tends to stay stable or to decrease. The percentages of increase in satisfaction over time (e.g. unsatisfied – satisfied) are very low.

As part of individuals' perception of resilience the study looked, with whom people see the responsibility for mitigation and protection against natural hazards (choice out of a proposed list with the possibility to name several actors). Results show that 88% of respondents do not consider the single persons, the citizens as responsible for natural hazard protection. The geological office, the municipality and the forest department result as the main responsible for natural hazard protection. These results do not differ for the different age groups but and no significant relation between age and felt responsibility could be found. In line with these results are also the findings linked to knowledge about already existing mitigation and preparedness measures such as protective infrastructure, local hazard maps or local civil protection emergency plans. More persons stated that they are not aware of existing measures than people that stated to know one or more of the existing measures. Among the

persons that know existing measures, the most named are infrastructural measures. Only 30% know the existing local civil protection emergency plan.

Confidence in protective measures and trust in experts and authorities are important factors of risk perception. The link between risk perception and social responses in terms of undertaking preparedness actions, is not clear. Some studies assume that individuals with low risk perception are less likely to undertake actions whereas others show that even people with high risk perception do not take actions (Wachniger, 2004). Findings from our case study show not only that people consider public authorities as the main responsible actors for the protection from natural hazards but also that they have a high level of confidence and trust in these authorities. The level of trust was assessed by looking at the mean value of three different questions: a) feeling of safety thanks to the existing protection measures, b) satisfaction with the effort and engagement of responsible actors and c) satisfaction with the work of the responsible actors. On a scale from 1 (low) to 5 (high), 43% of the respondents reported a medium to high level of trust (4 and 5), 42.7% a neutral level (3) and only 14.3% a low or very low level (1 and 2) of trust. Our results seems to confirm that high level of trust and risk awareness in terms of knowing about that they live in an area of landslide risk does not lead to social response in terms of feeling personally responsible to undertake preparedness actions.

After having performed the different analysis as described above (e.g. frequency distribution for the different answers, the influence of age and gender, changes over time) in a final step we wanted to identify groups of respondents that behave in a similar manner. In order to identify this groups we performed a cluster analysis. Out of the range of questions we decided to focus on risk awareness before the recent landslide event, feeling of being at risk after the landslide and on the active engagement in the response phase.

We choose the following questions as input for the cluster analysis:

- Question 1: “I always knew that Badia/Abtei is considered an area of high risk considering landslides/rock fall”
- Question 3.1: “I experienced one or more rock falls/landslides personally”
- Question 5: “I have felt at risk of being affected by a rock fall/landslide event since the landslide of 2012”
- Question 9:” Did you participate in any way in the operation?”

SPSS found four clusters to be the optimal amount. Figure 14 shows the size of the four clusters. The clusters' names are explained in the following paragraphs.

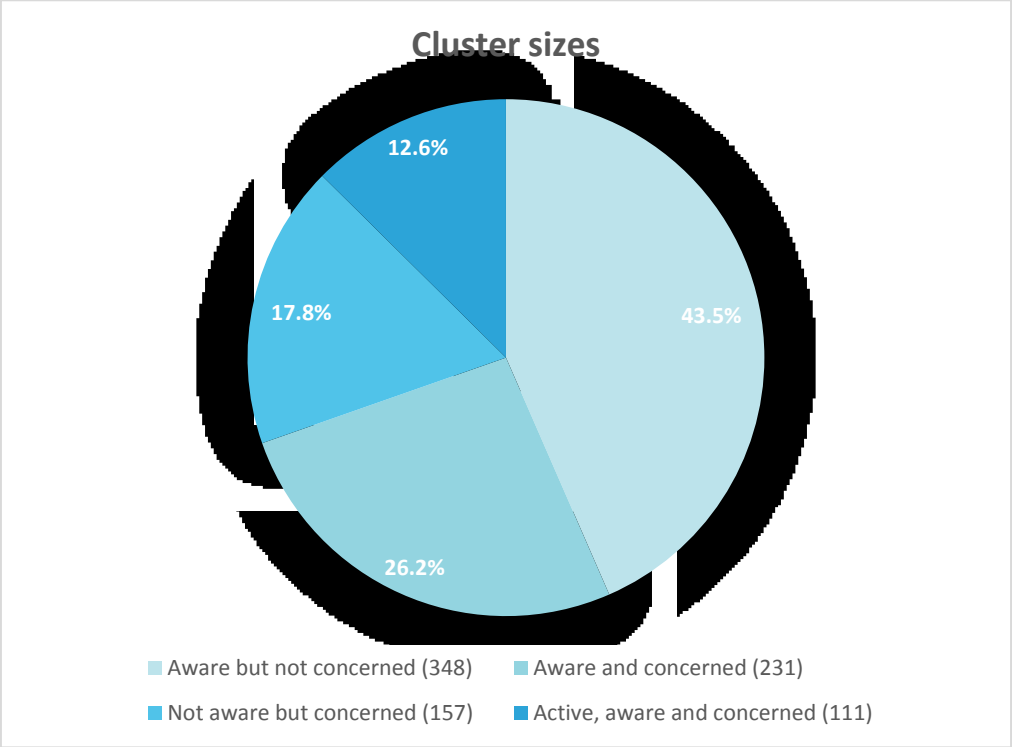


Figure 11: Size of the four computed clusters of respondents

The next step was to analyze the single clusters, where they differ among each other, give a key to the clustering results and name the groups accordingly.

The results are four types of respondents according to their risk perception and behavior. Figure 12 shows the four groups of respondents.

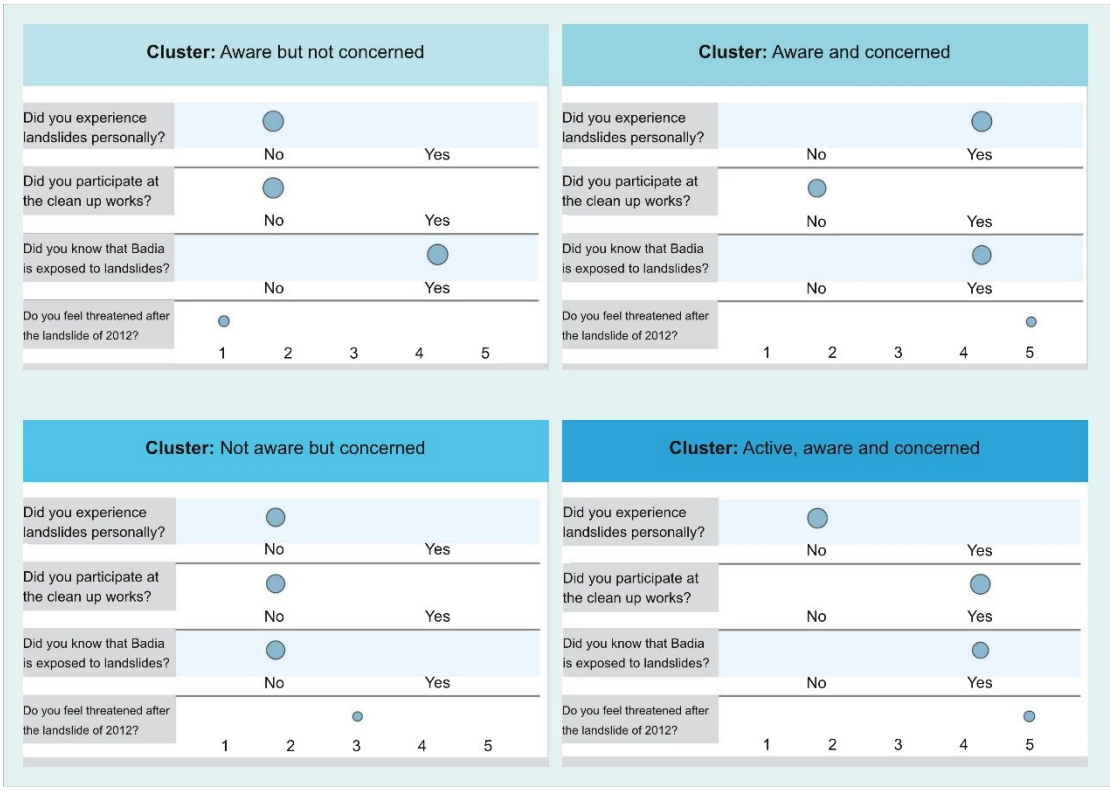


Figure 12: Aware, concerned, active: characteristics of the four clusters

The Cluster “Aware but not concerned” includes the most respondents (43.5%). Respondents of this groups knew that Badia is exposed to landslides but they did not experience a landslide personally nor they feel threatened by future landslides. They also were not involved in the cleanup works.

The Cluster “aware and concerned” is the second biggest one (26.2%) and shows a high awareness of natural hazards. The respondents had already personally experienced a landslide event in the past and hence they knew that their municipality is exposed to them. They are concerned about the future and feel threatened by future landslides.

The Cluster is named “not aware but concerned”. Respondents of this cluster were not aware that their municipality is exposed to landslides, they did not experience an event in the past and they were not involved in the response activities in 2012 but they feel at risk of being affected by a landslide in the future. The landslide event in

2012 changed the perception of people belonging to this group, they were not aware in the past, had no past hazard experience but they feel at risk for future landslide.

The smallest cluster (12.6%) is called “Active, aware and concerned”. People belonging to this group did not experience previous landslides but were aware that Badia is exposed to them. The interesting fact is, that although (or because) they were involved in the cleanup works they feel highly threatened by possible future landslides since 2012.

The results described up to this point focused mainly on the analysis on risk perceptions, hazard experience and satisfaction with the post event phases. The following sections are describing the findings of the network analysis. As stated in the introduction and in the methodology section, one aim of our case study work was to look at existing networks within the community and how the community of people living in Badia is connected to the community of supporters. Two questions of the questionnaires were dedicated explicitly to the connectivity of respondents. One question focused on the personal networks asking to which persons people go for help and support in case of an event (Question 19) and one to which institution and organization they connect to (Question 18).

In these two questions respondents entered text that was free-form, and therefore the first step was data cleaning by carrying out the standardizing of text in different languages, using different letter accents, and capitalization. The set of agreed standard labels/categories was decided by the research teams at EURAC and SEI. The process of replacing data with standardized labels did mean that occasionally duplicate entries were created. For example, one respondent had listed "118" and "fire brigade" separately. Since we consider both belonging to the same aggregate category (also named “fire brigade”), replacement would generate duplicate entries. Another example is where "first aid" and "ambulance", were aggregated. Across the survey dataset (around 1000 responses) there were very few (around fifteen) occurrences of duplicate entries. We checked each occurrence, as this could be a warning that categories are overly conflated (i.e. we are putting responses into the same category when respondents meant different things). However, given the size of the survey, we do not consider that this aggregation step this has affected our findings.

The next step was dealing with unusable entries which were coded “ignore”. Missing entries, where the respondent had not specified all 6 possible actors were also ignored.

Finally, and most importantly, in the statistical tests for differences in categorical data, categories that had too few responses were not included. We drew a cut-off of minimum ten responses for inclusion, because this is a reasonable sample size to compute statistically meaningful results. Whereas the full set of aggregated categories were included in the other analyses (the network mapping, the barcharts, the wordcloud).

Following this set of steps, we were able to aggregate responses and reduce the number of actor categories to 17, and 11 for statistical testing, in question 18 about institutional actors. Likewise for individual actors, the same set of steps was carried out for aggregation and descriptive statistics. In the case of question 19 no statistical test was carried out. The statistical tests of Q18 are described below.

Visualization of all responses for Q18 resulted in the “blue graph” depicted below. This forms a bipartite network showing all connections between respondents and institutional actors using the aggregated actor categories as described above.

A bipartite (or two-mode) network shows the structure of relations among two types of network nodes such as actors and events, where links connect actors and events only (i.e. there are no actor-actor or event-event links). This is a relatively large, sparse network consisting of 934 nodes and 2092 links.

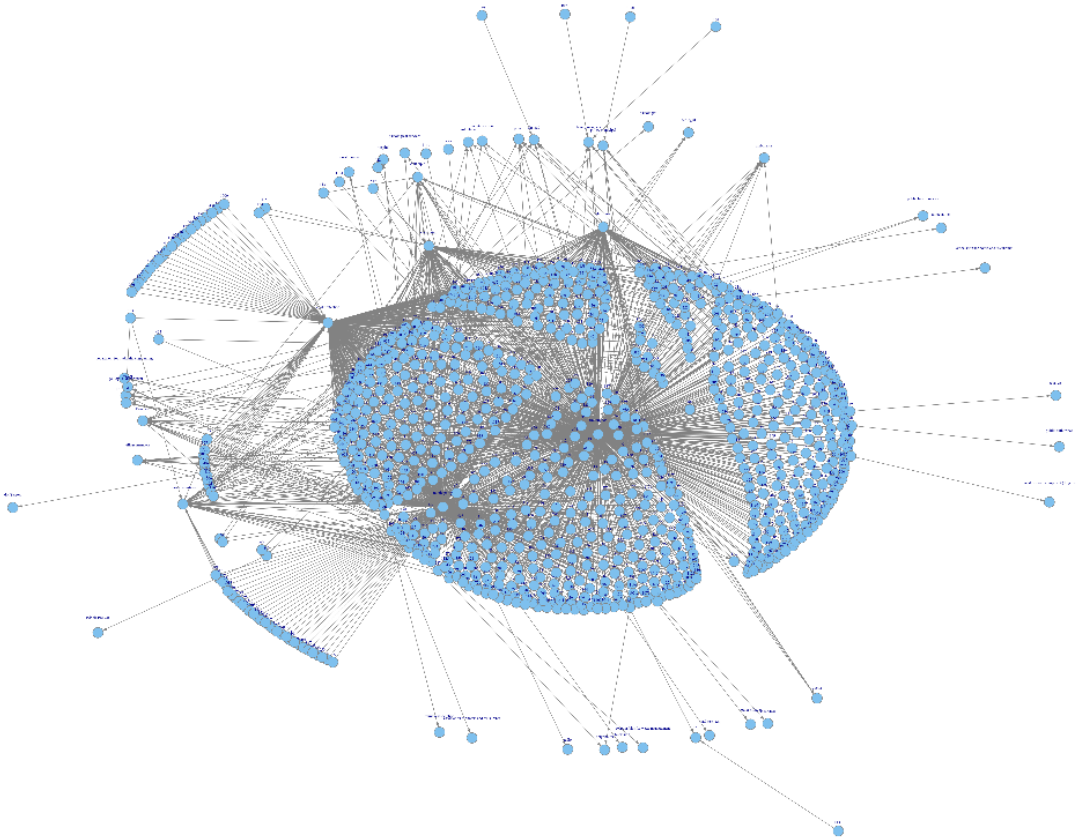


Figure 13: The "blue graph"

R statistical software's “sna” package does the layout according to a force-directed algorithm which tries to position nodes in clusters which avoid making many distant connecting edges and crossed edges. The graphical output can help to visualize proximity - if two institutions are placed close together it means that some individuals tend to link to both of them. It also puts the most central agents more towards the center. In this figure, the three most prominent actors - the fire brigade, the municipality, and civil protection can be seen in the center. (See figure 13.) At this printing resolution, the network is too large to see individual nodes, but the core and periphery structure can clearly be seen. A high resolution image can be supplied on request. Using this layout, on the other hand, several of the institutional actors with few mentions are displayed in the periphery (e.g. psychological services, major, tourism actors). A basic measure used in social network analysis is the node degree (or degree centrality) of an actor.

This has been calculated for institutional actors (see table 1, column: Citations).

Each respondent is also shown as a blue node on the graph. In terms of positioning of the respondents, they are grouped closely together based on similarity of their responses.

The degree of similarity can be shown using another network measure known as modularity. Modularity is a measure which targets the detection of community structure, by making partitions of the network into sub-networks that are more densely interconnected. The Gephi software was used to produce the following “modularity graph” by using the modularity algorithm to do the coloring of the network nodes.

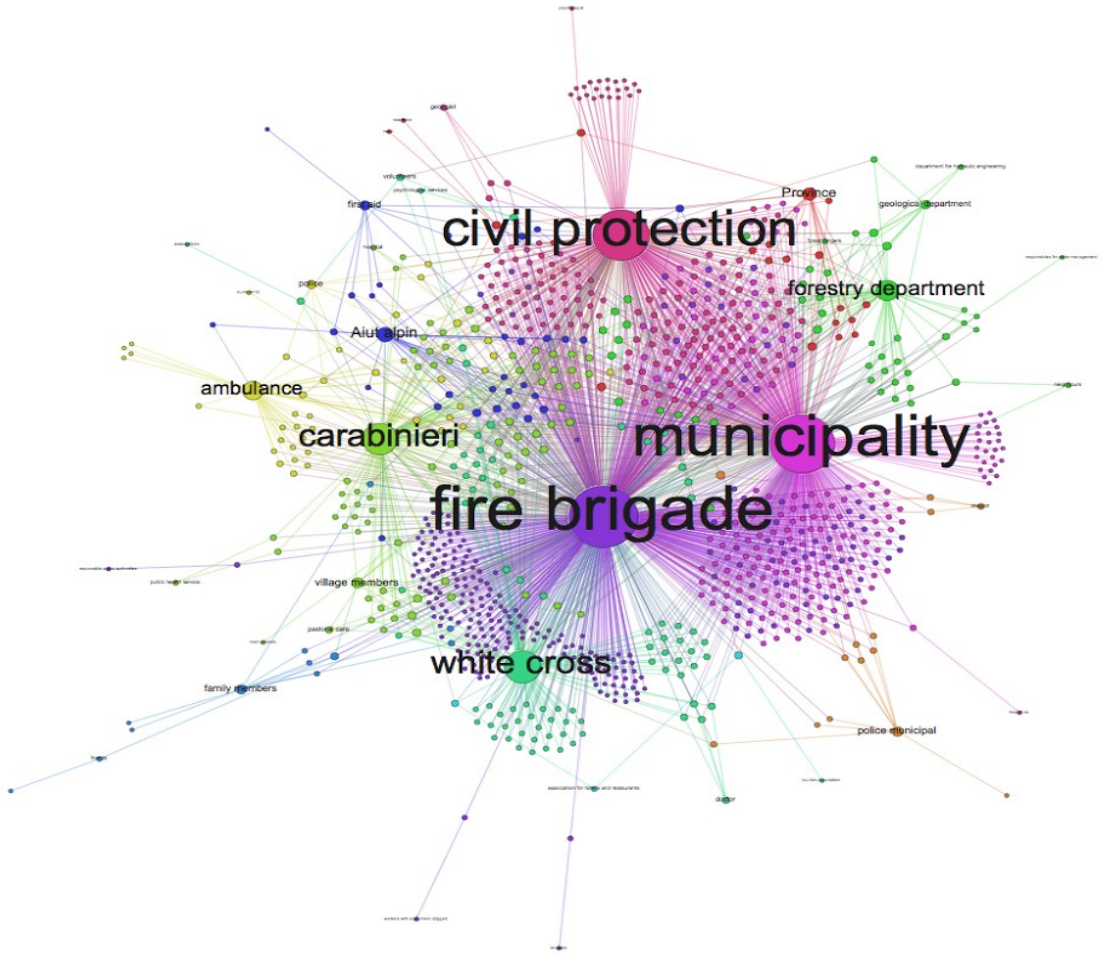


Figure 14: The Modularity graph

In this graph the nodes are also sized according to their node degree measure. What is very noticeable is that the different colors/shades highlight clusters of nodes having the same or similar connectivity; one can also easily compare the relative sizes of the clusters.

A further step was made by using Gephi software to transform the bipartite network into a one-mode network showing only the institutional actors. This network, based on the same data, shows potentially which actors may tend to be contacted together in case of an emergency, thus it would be very important that they would not provide conflicting information. It would be interesting to compare the resulting one-mode graph from the survey with the institutional actor networks constructed by stakeholders in the participatory mapping exercise. Further research could investigate this.

The blue graph and modularity graphs provide a way of examining the structure of the whole network. The Q18 responses can also be summarized in a frequency chart, i.e. a barchart showing frequency of responses. The data points for this chart are the same as the calculation of node degree mentioned above. Since there are some categories with very few responses (1 or 2) and some with very many (800) we used a logarithmic scale.

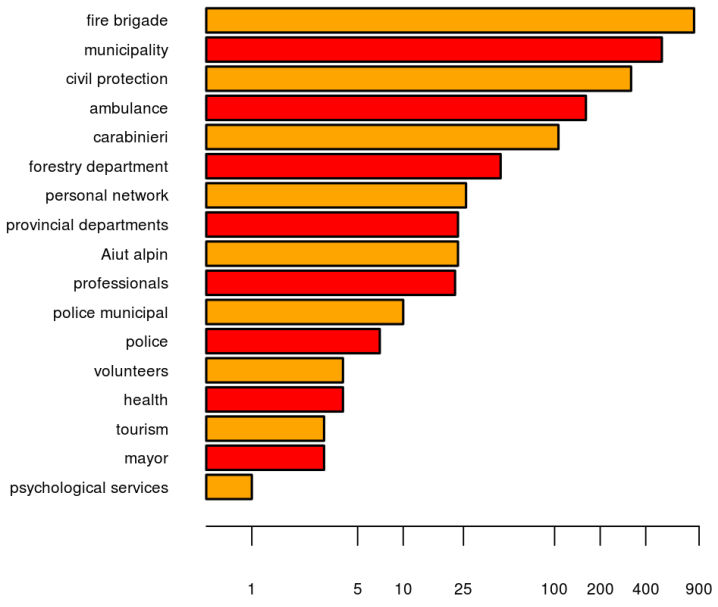


Figure 15: Frequency of responses for different institutional actors

For the network data, we were also interested in how often each actor was cited as a first contact (which was also termed “most important” in the survey form). We examined the data by calculating not only the frequency of “first contact” citations for each actor type, but also taking into account the total number of actors cited in each case. It would be important to know if an actor was cited as the “most important” actor and, simultaneously, the only actor that a respondent would look to in case of emergency. The result of this investigation is shown below in table 1.

Actor	Citations	%	First	First out of 1	First out of 2	First out of 3	First out of 4	First out of 5	First out of 6
Fire Brigade	834	40	659	191	221	171	45	22	9
Municipality	511	24	150	26	62	38	17	5	2
Civil Protection	320	15	57	21	16	17	1	2	0
Ambulance	161	8	29	5	13	5	4	1	1
Carabinieri	106	5	11	0	5	2	4	0	0
Forestry Dpt.	44	2	2	0	1	1	0	0	0
Personal Network	26	1	6	3	2	1	0	0	0
Aiut Alpin	23	1							
Provincial Departments	23	1	1	0	1	0	0	0	0
Professionals	22	1							
Police Municipal	10	0	2	1	1	0	0	0	0
Police	7	0							
Health	4	0							

Volunteers	4	0
Mayor	3	0
Tourism	3	0
Psychological Services	1	0

Table 1: Frequency of "First contacts" and their importance ranking

The list of actors is the result of the data cleaning and aggregation described above. The aggregation put similar actors together, this has been done by the researchers from SEI and EURAC that know the data in order to not loose content related information. The two actors police and police municipal for example has been kept separately because "police municipal" is locally based and does not belong to the armed forces while "police" is part of the Italian national armed forces.

Results in table 1 show that there is a significant difference between the first (Fire brigade), the second (Municipality) and the third (Civil protection) actor. The fire brigade is not only mentioned most often as first and therefore more important actor, but also mostly either out of one or out of two (with few difference between them, see columns 5 and 6). When looking at the municipality, it's named much more often first out of two than out of one, so more often together with a second actor. Finally, when summing up the answers of the first two actors they were cited 807 times first out of 917 answers. This shows that these two actors are the most important institutional actors people go for an event. Both of them are local based and people working for them are not only members of the community of supporters but also members of the community they support. In terms of resilience this confirms the importance of local presence on the territory and the interconnection between the geographical community and the community of supporters, knowing the people working in the organization leads to trust and being part of the community people support leads to a better understanding of their needs and perceptions. These two elements are crucial for crisis situation.

During the case study work we had continuously contact with the stakeholders. Part of this involvement was the discussion of first findings and feedback and input for further analysis. One result of this was the suggestions and interest in analyzing if people that were satisfied with the “operation” after the event connect differently than people that stated that there is a need of improvement. Therefore we analyzed question 17 on possible future improvements together with question 18 on how people connected to the community of supporters.

One approach to Question 17 (perceptions of where improvements are needed) has been to divide the responses into two groups, Happy and Not Happy. This section details how the two groups were constructed.

The "Happy" label means they are generally satisfied and do not think many improvements could be made. The “Not Happy” label signifies dissatisfaction, for example:

Those that ticked two or fewer “Yes” boxes are more or less satisfied – “Happy” group

Those that ticked more than two “Yes” boxes see room for improvements – “Not Happy” group

Note: many respondents who did not tick any “Yes” or “No” boxes were excluded.

Question 17 (perceptions of where improvements are needed), includes two parts: perceptions at the time/shortly after the event, and perceptions 16 months afterwards. Both parts were analyzed. First, we looked at the changes in group composition between the two time periods. Then, the question was analysed in terms of the differences in network connections of the respondents.

Statistics comparing perceptions after the event and today (=16 months after the event), in terms of changing group size is shown in table 2. In this table, the “gain” is the number of people moving in to the group, whereas the loss is the number of people moving out. The table shows a large number of people moving from Happy to Not Happy group as well as vice versa. In terms of overall group size, the gain and loss cancel out, and overall the Not Happy group increases in size during this interval. This survey finding substantiates what several experts suggested – an increasing public dissatisfaction with how the recovery operation has been handled in the long term.

DATE	HAPPY	NOT HAPPY
Shortly after the event	497	444
Today- 16 months after the event	438	503
Gain	83	142
Loss	142	83
+/-	-59	59

Table 2: Comparison of perceptions for improvement shortly and 16 months after the event

What is interesting - and perhaps surprising - is that the perceptions of many people have changed in the other direction as well. The picture of changing perceptions is quite mixed and a lot of people are at least somewhat happier today.

We then investigated Q17 (perception of future improvements) in terms of possible relationship to location of respondent – Question 23 and 24 of the questionnaire. Question 23 indicates the administrative district of Badia people live in, district 1 is the one closest to the landslide. Question 24 indicates “the neighbourhood” to the landslide, respondents had to indicate on a geographical map of Badia in which on the circled area they live. Figure 16 shows the map included in the questionnaire to assess the neighbourhood to the landslide.

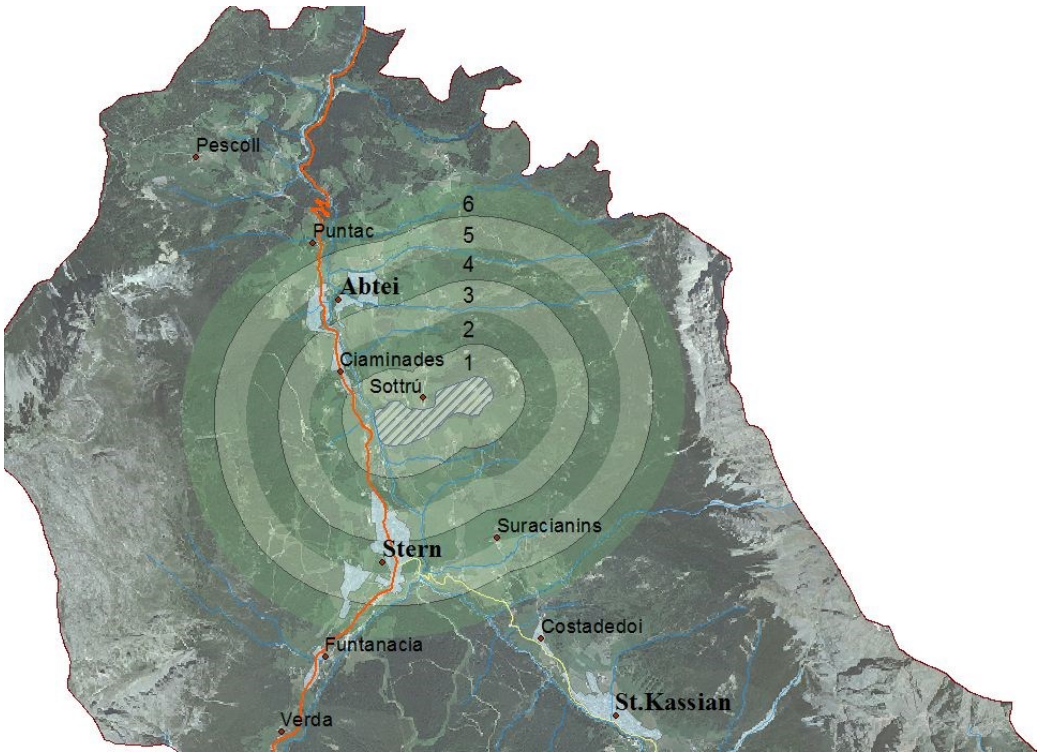


Figure 16: Map to asses "neighbourhood" to the landslide of respondents

We counted the number of respondents in each location, for district and for neighbourhood, according to their perceptions of improvements needed, and also using the time distinction “shortly after the event” and “today”(16 months after the event). In other words, we constructed three-dimensional contingency tables. Question 23 collected data about the district location, there were 5 possible categories of response, as reported in see table 3.

	Happy	
District	After the event	Today
1	20	18
2	170	164
3	159	134
4	103	79
5	14	9
Sum	466	404

	Not happy	
District	After the event	Today
1	30	32
2	200	206
3	117	142
4	75	99
5	0	5
Sum	422	484

Table 3: Happiness of respondents and the districts they live in

The left hand part of the table shows changes in the Happy group over time according to the District location. In all districts the number of people classified in this group had reduced during the time “shortly after the event” and “today”, however, relative to the group sizes groups 1 and 2 did not change much (around 10 percent change or less) whereas groups 3 and particularly groups 4 and 5 reduced substantially in size (>30 percent change in locations 4 and 5). The right hand part of the table shows the corresponding increase in the Not Happy groups.

Looking at the locations in terms of distance from the landslide site – termed “Neighbourhood” in the survey (Q24), one can see only small changes in the group sizes except for group 7 – those living in the most distant neighbourhood where there is a large increase in perceptions of the need for improvements, over the time period of interest. This finding seems to support that of Q23, that perceptions of residents in or near to Sotru or Abtei or Stern (in neighbourhoods 1-4) have not changed as much as residents in St Kassian and outside, but perhaps the effect of people belonging to the same district-based communities produces a stronger pattern of increasing discontent.

	Happy			**Not happy**	
Neighbourhood	After the event	Today	Neighbourhood	After the event	Today
1	27	26	1	38	39
2	27	23	2	31	35
3	39	34	3	38	43
4	147	135	4	140	152
5	40	34	5	34	40
6	28	25	6	27	30
7	114	89	7	85	110
Sum	422	366	Sum	393	449

Table 4: Happiness of respondents and their neighbourhood to the landslide

After having identified the two groups, we then looked for relationship between Q17 (perception of future improvements needed) and Q18 (connections to community of supporters).

Graphically, this was done using ego- networks, a type of network which is conventionally used to show the connections of a single, focal actor. In our case, ego-networks were produced to show the connectivity of groupings of respondents - Happy and Not Happy – to help visualize any possible differences in connectivity. We produced, in other words, “representative” ego networks - with one central network node representing the set of respondents and links (spokes) to the nodes representing each of the categories of alters – the alters in this case being the (aggregate categories of) institutional actors.

1) Happy

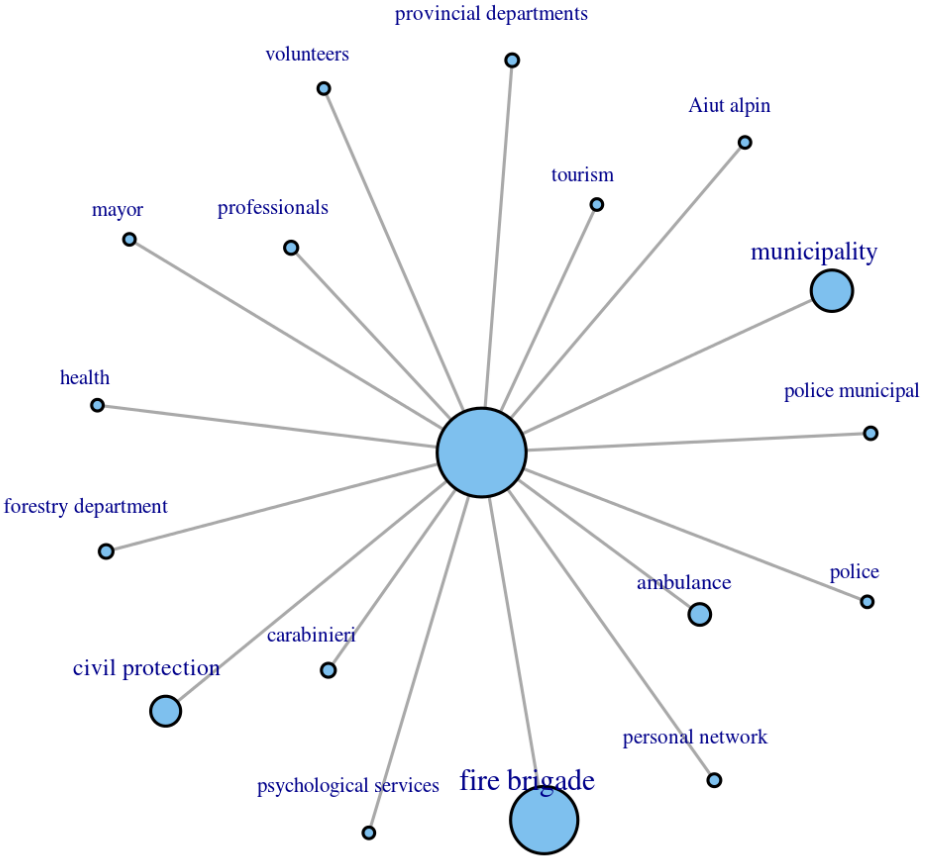


Figure 17: Connectivity of the respondent group "Happy"

2) Not Happy

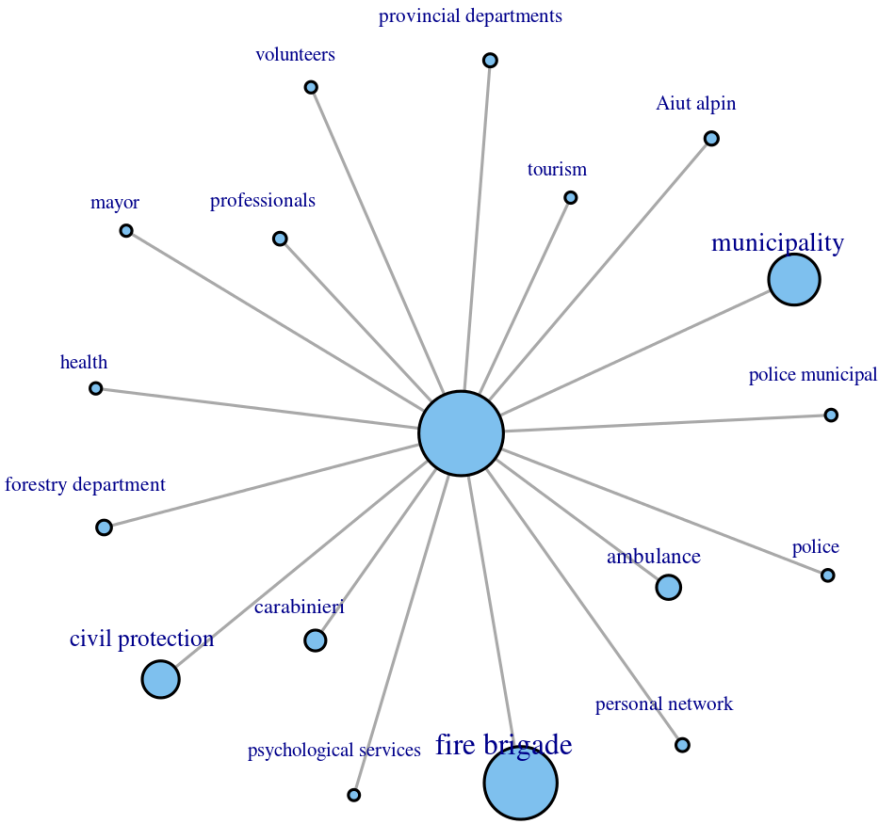


Figure 18: Connectivity of the respondent group "Not Happy"

In this graph, the size of the institutional actor node is scaled to the proportion of respondents from the group who said they would contact that actor. This graph helps to quickly visualize which actors were viewed as most important. Comparing the Happy and Not Happy group, we see that their connectivity is similar (e.g. the 3 most important actors) but there are apparent differences in some cases. However the sizes of the nodes as an indicator are quite difficult to gauge for making accurate comparisons.

Statistically, the differences were tested using the test for difference in proportion between the two groups, Happy and Not Happy, of respondents mentioned earlier.

The table below gives information about proportions of respondents from the 2 groups connecting to each kind of institutional actor

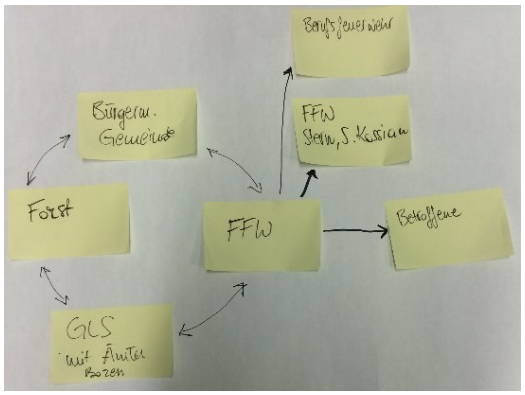
Actor	Happy	Not happy	p-val
Ambulance	0.130	0.178	0.090
Carabinieri	0.031	0.134	0.000
Civil protection	0.237	0.352	0.001
Fire brigade	0.721	0.841	0.000
Forestry Dpt.	0.027	0.050	0.163
Municipality	0.385	0.545	0.000
Personal network	0.015	0.027	0.434
Police municipal	0.011	0.010	1.000
Professionals	0.019	0.025	0.763
Provincial departments	0.015	0.028	0.370
Aiut alpin	0.000	0.031	0.008
Health	0.000	0.006	-
Mayor	0.000	0.004	-
Police	0.000	0.010	-
Psychological services	0.000	0.001	-
Tourism	0.000	0.004	-
Volunteers	0.000	0.006	-

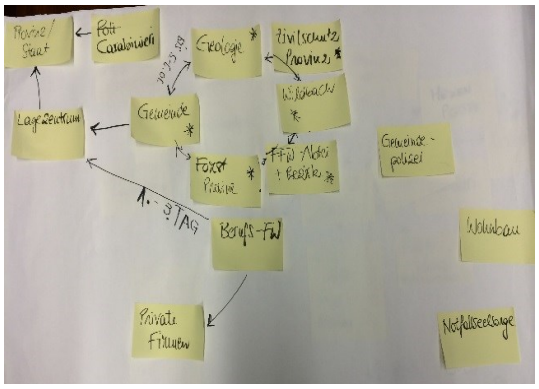
Table 5: Proportions of respondents groups and their connectivity to different actors

Firstly, it is interesting to note that generally people who were classified as Not Happy said they connected more. The statistical tests - Chi-squared test for difference in proportions in the 2 groups - revealed that Not Happy group connected more with Carabinieri, civil protection, fire brigade, municipality, and with the mountain rescue Aiut alpin (see table above), out of all 11 aggregate types for which we tested. For all other actor types, there were no significant differences.

Further detail on the social network analysis will be reported in Deliverable D4.2.

The network results described up to this point took as input data the results from the population survey. The advantage of this data collection method is the possibility to collect is the huge amount of data coming from the whole population. The disadvantage is that as the questionnaires were filled out by people independently so the network questions had to be simple and easy understandable without additional explanation needed. Therefore it was not possible to collect additional information on the quality of links or to complement the data with additional qualitative information. This additional information is particularly important and interesting in terms of resilience research for the network of the community of supporters were quality and experiences of the functioning of the network are crucial to understand the network itself as well as being able to reflect whether on the resilience of the network. As the community of supporters is also much smaller than the geographical community of Badia and alternative, qualitative and more detailed approach was possible. We therefore choose a single qualitative mapping approach with the key members of the community of supporters (e.g. the Head of the Municipal Coordination Unit, the Commander of the Volunteer fire brigade of Badia, the officer from the Department of Hydraulic Engineering). During the about one hour lasting single interviews the interviewees were ask to specify the role of their organization within the process of risk management and their personal role within this organization. The starting point of the mapping exercise consisted in writing their organization on a post-it and put it on a blank paper and adding step by step all other actors involved. The second part consisted in drawing and explaining the connections among the actors in terms of coordination and information exchange. The results and the so drawn qualitative social network maps are shown in figure 19.





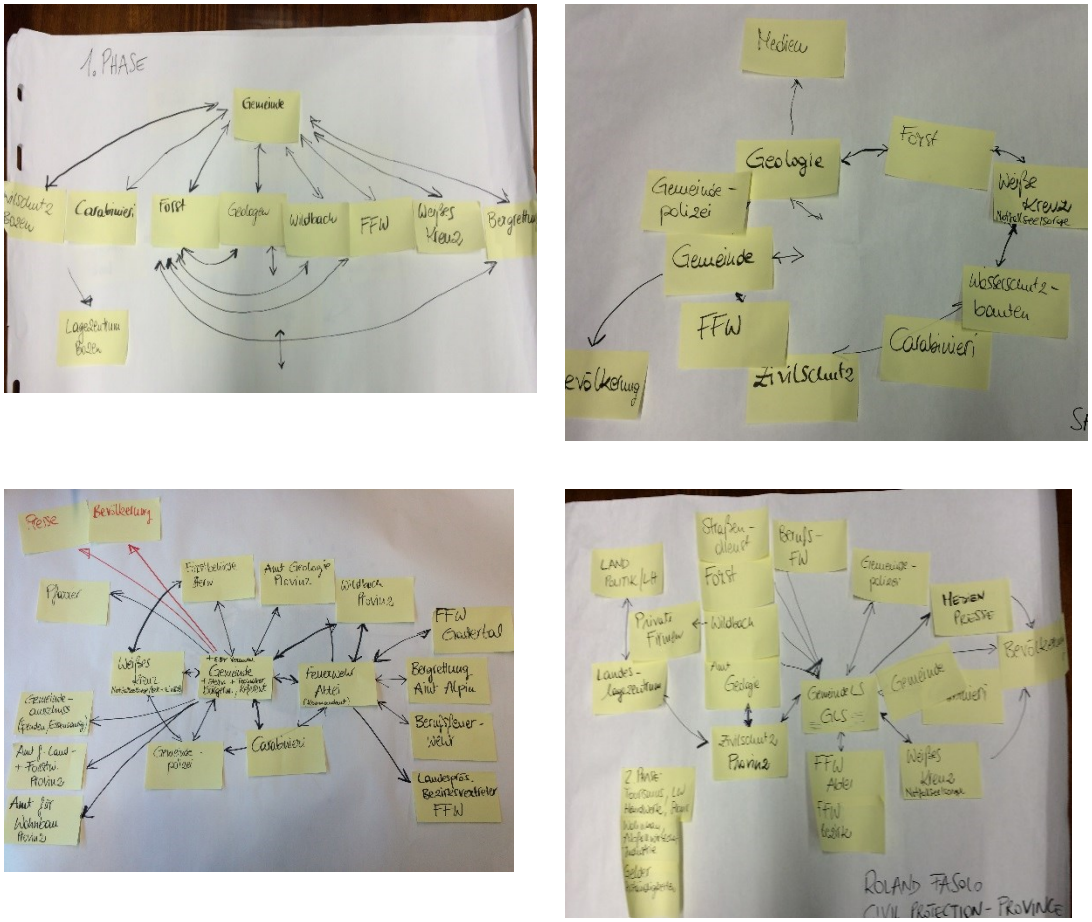
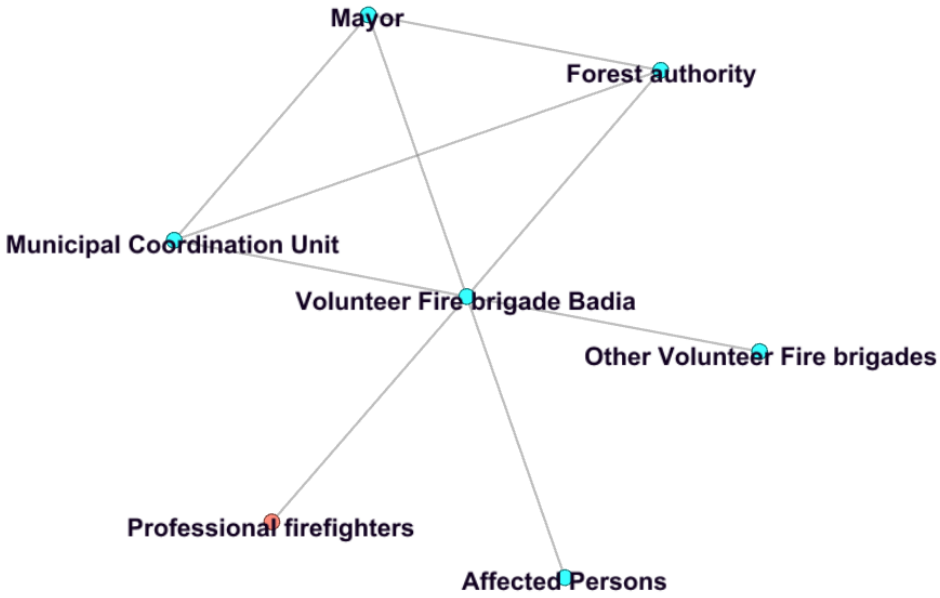
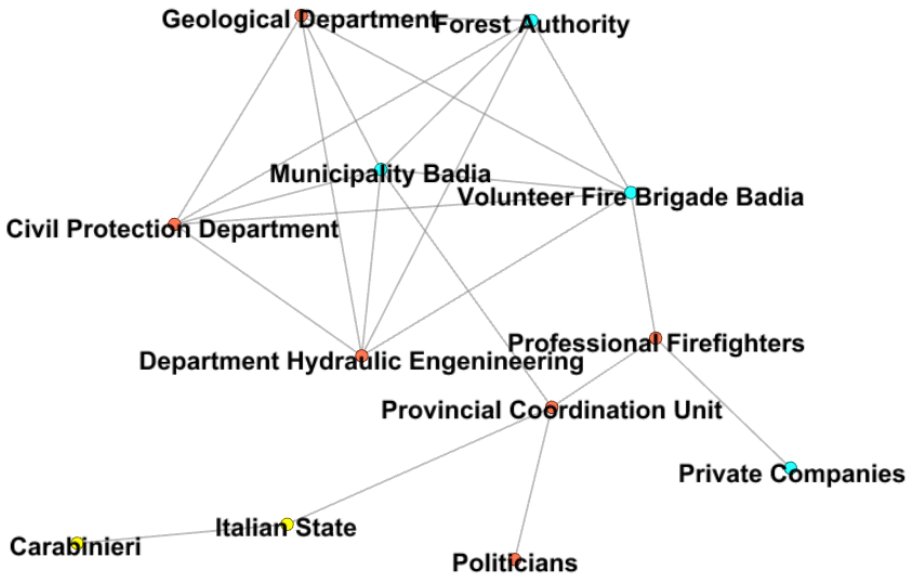
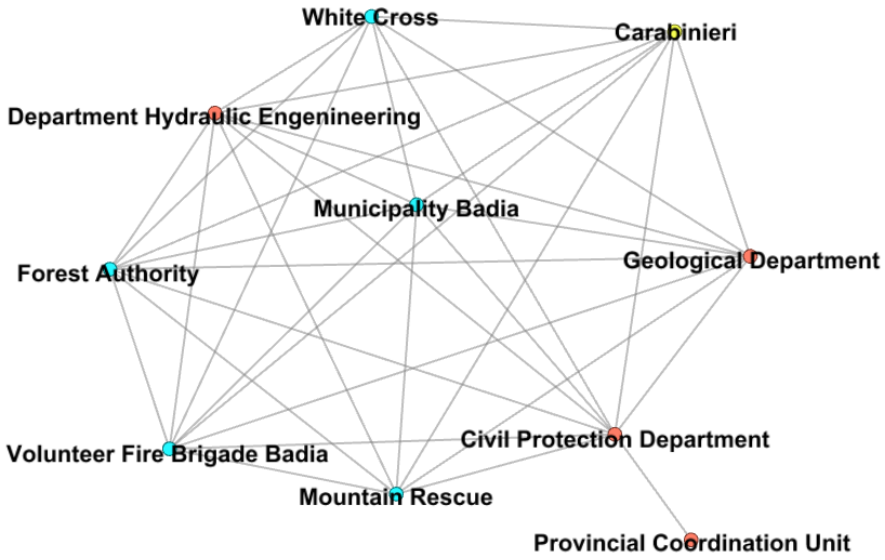


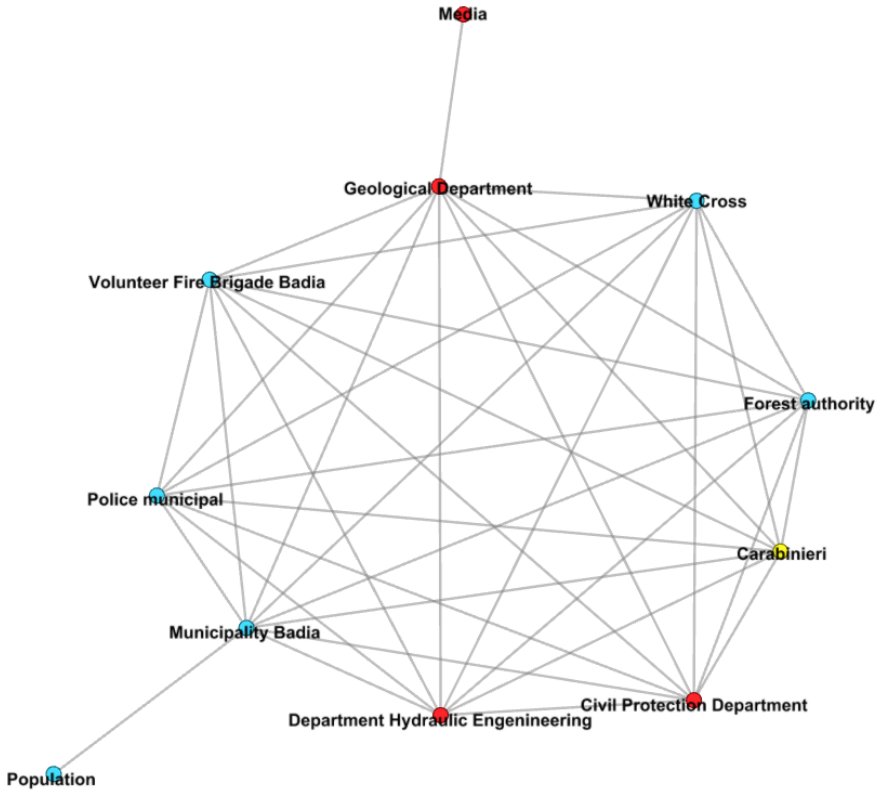
Figure 19: Social network maps from interviews

This “paper maps” were transcribed in order to put them in a format that could be imported into the software Gephi for further visualization and analysis. This process allowed also to include additional attributes such as scale (local, provincial and national) for each actor. The results are visualized in figure 20. Actors acting at local level are colored in blue, at provincial level in red and at national level in yellow.


Mayor
Forest authority
Municipal Coordination Unit
Volunteer Fire brigade Badia
Other Volunteer Fire brigades
Professional firefighters
Affected Persons


Geological Department
Forest Authority
Municipality Badia
Volunteer Fire Brigade Badia
Civil Protection Department
Professional Firefighters
Department Hydraulic Engenineering
Provincial Coordination Unit
Private Companies
Italian State
Carabinieri
Politicians


White Cross
Carabinieri
Department Hydraulic Engenineering
Municipality Badia
Forest Authority
Geological Department
Civil Protection Department
Volunteer Fire Brigade Badia
Mountain Rescue
Provincial Coordination Unit


Media
Geological Department
White Cross
Volunteer Fire Brigade Badia
Forest authority
Police municipal
Carabinieri
Municipality Badia
Civil Protection Department
Department Hydraulic Engenineering
Population

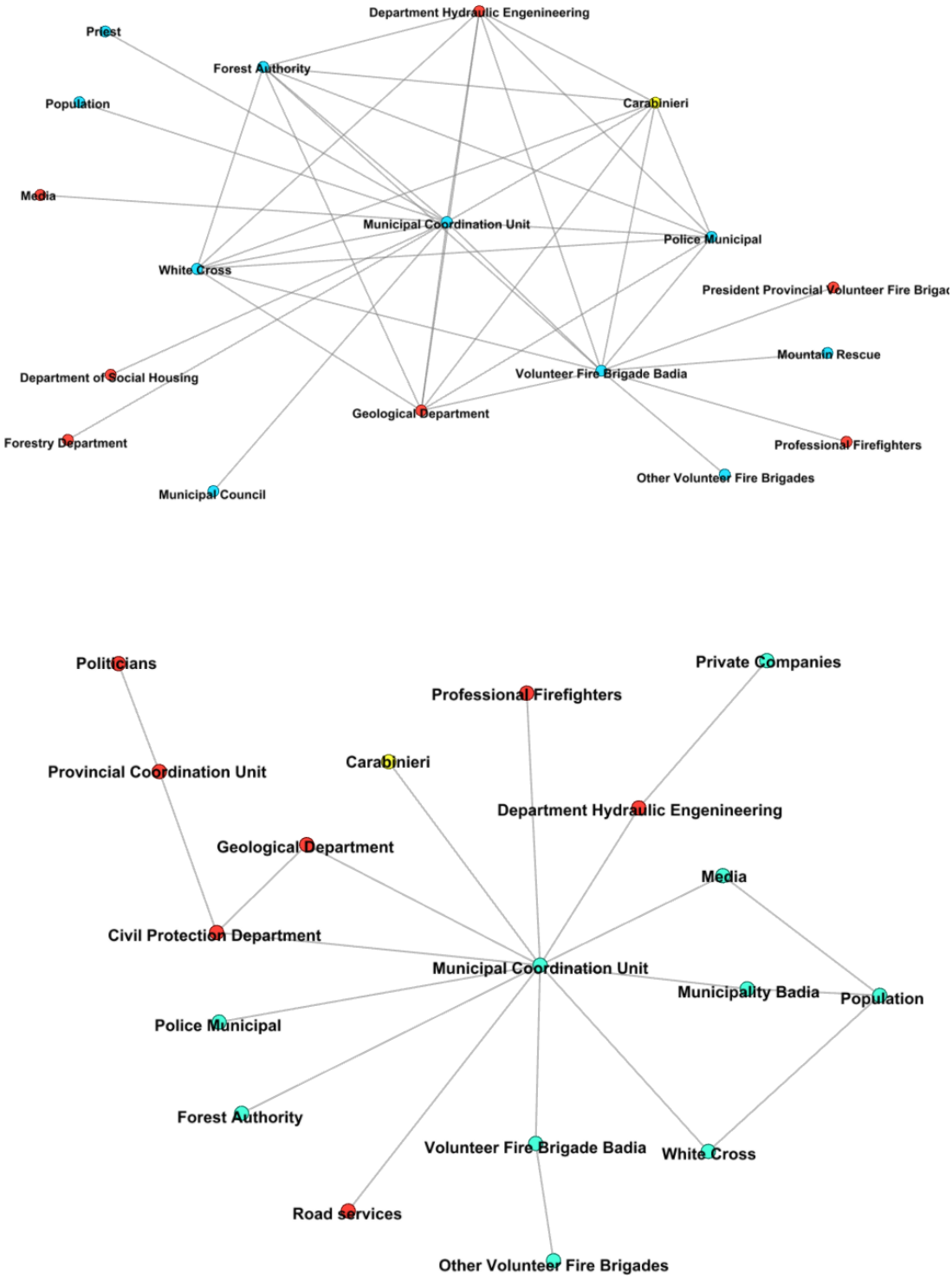


Figure 20: Visualisation of organizational networks

All maps show a highly interlinked core network involving key actors all connected to each other. There is a high level of coherence between the different maps. This shows that the actors have a similar view of the network which is very important in a crises or disaster situation. Further details and network analysis will be reported in Deliverable D4.2.

Qualitative data from the interviews reveal that after event in 2012 the network work very good. Main reasons for this were:

- the fact that there are regular emergency exercises

- the network needs little time to be activated (in case of the landslide event in Badia it needed only few hours to be fully operative)

- the actors from the network knew each other already before which facilitates the work, especially in a disaster situation and secures trust in information and the quality of work of the other network members

- the network is based a local level and has also a physical base with facilities for the network members

- there are few links to the outside: to the media, the population and the organizations at higher level.

Results show also that the network structures, who is part of it and where the responsibilities of each member lie are very clear for the response phase. For the medium and long term there the network structure and its functioning is not so clear, some members are not involved anymore due to their tasks clearly inked to the response phase (e.g. the fire brigade) while new members become part of the network (e.g. the department for social housing). Links and responsibilities are less defined and less clear, partly due to the fact that the network is no more operative day and night as it is in the first days after an event and activities are less defined and urgent in the long term (e.g. financing of rebuilding activities, future zoning and land use of the area) than in the short term after an event.

In terms of resilience of the network, all respondents agreed that the response network resulted to be resilient due to the above mentioned characteristics and that there were no missing links or marginalized actors. It could be argued that some of

the characteristics that resulted to be positive for resilience in this circumstance could also weaken the stability and the resilience of the network under other circumstances. The fact for example that the network is “highly personalized” meaning that actors are not only representatives of organizations but also “known persons”, the fact that actors know and trust each other and are a well-established and interacting team could become critical for the network if one or more of the actors is not available or has to change.

The study focused on the network and its functioning after the landslide event in 2012. Results are also valid for other kind of hazards because its structure and underlying regulations are the same and should guarantee more in general the protection of people and goods. The composition of its members can vary slightly according to the type of hazards and include additional experts. Although this wider validity of the network and its hazard independency, its experiences are strongly linked to alpine hazards and therefore linked to well-known hazards. It would be interesting for further research to understand if the network perform in the same way and results resilient also if confronted with unknown hazards.

5 Indicators for assessing community resilience

5.1 Development of indicators

The indicators applied in the case studies were developed using different methodologies. In particular, four different approaches were used, as outlined below.

Firstly, part of the indicators are the results of a literature review we carried out at the beginning of the case study. The focus was on indicators to assess risk perception and risk awareness at individual level, and this served as input for the development of our questionnaire.

Examples of indicators include: Experience with hazard events in the past, degree of being affected, area perceived as landslide prone, and number of years living in the community.

Secondly and in addition, during the first phase of the case study we had some meetings with stakeholders to discuss the general design of the case study work as well as to help us understand what their needs are, in terms of knowledge gaps and useful and applicable results. The aim of this involvement was to come up with

indicators that could support public authorities, for example in including social aspects in their practices and strategies.

Examples of indicators include: Information channels used by the population shortly after the event; indicators for the assessment of satisfaction with different aspects of the response and recovery phase (information provided, coordination of action forces) looking at two different time slots in order to be able to capture changes over time.

Thirdly, part of the indicators are the results of the single expert interviews we carried out as part of our case study. The development of these indicators is based on the qualitative data collected during the field work.

An example of such an indicator is: “regularity of emergency drills” as a test of the local emergency plan. This was identified as a complementary indicator to the indicator “existence of a local emergency plan”.

Finally, we used the combination of results coming from different methods in the case study, which led to the development of some additional indicators important for resilience.

Example here include: the “blue graph” (see figure 13) as results from the social network analysis: this graph visualizes to which institutions people go for help and support in case of an event, so it is giving a picture of community’s behavior. As part of the expert interviews we compared it to the existing local emergency plans in terms of to which institution people *should* go. So we came up with the emergent (and synthesis) indicator “coherence between emergency plan and community risk behavior”.

5.2 Data collection and types of indicators

The data collection for the assessment of the indicators was carried out using two methods.

Firstly, through the questionnaire that included various types of indicators or data that can be used as an indicator. Most of these are quantitative indicators about human subjects such as experience with their hazard events in the past, their years of stay in the community, their language group or else subjective or qualitative information that has been made quantitatively measurable through the use of a Likert scale (from

1 to 5). Indicators collected in this way include: feeling of being at risk: satisfaction with action forces: or trust in authorities.

Secondly, the data were collected through expert interviews which had a social network mapping component as part of it. Some indicators assessed through this method are quantitative: such as numbers of identified missing links in the response network; whereas others are qualitative, such as the perceived quality of coordination and information exchange among involved actors.

More details and insights and a discussion about the use of indicators for the assessment and measurement of resilience can be found in Deliverable 3.5. An overview of all indicators applied in the case study can be found in the Annex.

6 Summary and conclusions South Tyrolean Part

In this last section we want to summarise the main findings of the case study work in South Tyrol and draw some conclusions in terms of community resilience.

Findings show that in the case study community Badia people have a high risk awareness, they are aware of living in an area of high risk and they know about past hazard events, some of them experienced them personnally while the majority has heard or read about it. Nevertheless, results show that before 2012 they did not expect a real event happening and as a consequence did not actively prepare for it by undertaking preparedness measures. While risk awareness is positively correlated with the age of respondents, elderly people being more aware of living in a high risk area, the perceived risk for future landsildes event is not related to age and is distributed in a similar way among all age groups: the most common answer was that they did not expect such an event happening. In line with this results is also the fact that people do not perceive themselves, as individuals, responsible for the mitigation and protection against natural hazards and the knowledge about existing mitigation and protection measures is quite low. Indeed, people have a high trust in authorities and civil protection actors and perceive them as responsible for mitigation and protection measures. The event experienced in 2012 had a huge impact on peoples' risk perception, showing an increase especially for people that were affected directly by the landslide and for people that live in close proximity to the landslide area.

Results of the case study work show the importance of local and traditional knowledge for resilience building. The most important information sources for past

hazard knowledge are other village members and family, resulting more important than media. While media are more used by young people, surprisingly there is no difference by age groups for family and village members, being these the most important information sources also among young people. The family and the community show to be also an important information source after an event happening. In december 2012 people used them as much as the media to obtain information.

Being part of the community and having a strong family network, as well as with the other members of the community, and therefore having access to information coming from “real faces”, resulted to be very important for forming community identity. The feeling of community belonging and the strong presence of social networks proved to be very important as a crucial support to deal with the impacts of natural hazard events and to contribute positively to community resilience.

In the case study we looked at the interactions between the population and the community of supporters and how people perceived the period after the event. We also considered the activities carried out by authorities and supporters. Results show that people are satisfied with the way authorities and supporters dealt with the event, particularly with the coordination of action forces. Also results from the interviews with key actors of the community of supporters point in the same direction and confirm the well funtioning and good management of the response phase. This is partly due to the fact that in the first days and weeks after an event happening, the public and media attention is high and during this period additional resources and funds are available. This is true for financial and human resources, but also in terms of solidarity and sympathy. In fact, results show that 16 months after the event the satisfaction with provided information and recovery actions decreased. In terms of resilience, out of the findings we can say that it is important to look not only at the short term after a disaster, but also to the mid and long term. Moreover, it is essential to foresee and improve strategies for the mid and long term, especially concerning information, because the impacts on peoples’ risk perception, their feelings of danger and concern about future hazards last beyond the first weeks and months after an event happening.

Results from the social network mapping and analysis show that there is a high connectivity between the geographical community of Badia and the community of supporters. The results of the population network, showing to which organization people go for help and support in case of an event, reflect well and are coherent with

the actions foreseen inside the existing local emergency plans. All results from the different analysis carried out for the network, such as frequency, centrality and importance of actors, show that the two most important actors are the volunteer fire brigade and the municipality of Badia. Both of them are locally based and people working for them are not only members of the community of supporters but also members of the community they support. In terms of resilience, this confirms the importance of the local presence on the territory and the interconnection between the geographical community and the community of supporters: knowing people working in the organization increases trust, and being part of the community people support leads to a better understanding of their needs and perceptions. These two elements are crucial for crises situations.

The results of the mapping and analysis of the organizational network carried out with key actors of the community of supporters show a highly interlinked core network involving actors from different organizational scales (local, provincial and national). The individually drafted maps show a high level of coherence, revealing that the actors have a similar view of the network, which is very important in a crises or disaster situation. Additional key factors for resilience turned out to be the existence of a local civil protection plan and regular emergency exercises, the fact that the core network needs little time to become active and fully operative, as well as the personal knowledge and trust in the other members of the network. Thanks to these characteristics, the network resulted to be very resilient with no missing links or marginalized members.

One could argue, and it could be interesting for further research, that some of the characteristics that proved to be positive for resilience in this circumstance could also weaken the stability and the resilience of the network under other circumstances. The fact for example that the network is “highly personalized” and actors know and trust each other could become critical for the network if one or more of the actors is not available or has to change.

The study focused on the network and its functioning after the landslide event in 2012. Results are also valid for other kind of hazards, because its structure and underlying regulations are the same and should guarantee more in general the protection of people and goods. The composition of its members can vary slightly according to the type of hazards and include additional experts. Despite this wider validity of the network and its hazard independency, its experiences are strongly linked to alpine hazards and therefore linked to well-known hazards. It would be

interesting for further research to understand if the network performs in the same way and results resilient even if confronted with unknown hazards.

7 Acknowledgements South Tyrolean Part

This work would not have been possible without the support and input from the Autonomous Province of Bolzano and the municipality of Badia. A special thank goes to Volkmar Mair from the Geological department of the Autonomous Province of Bolzano and to Giacomo Frenademetz, the mayor of Badia.

We would also like to thank some colleagues at EURAC: Philipp Mitterhofer for the support in the development and data transcription of the questionnaires, Kathrin Renner for her support in GIS and Claudia Notarnicola for her advices on statistical methods.

GRISONS PART

8 Introduction Grisons Part

This part of the case study report draws on research conducted in the canton of Grisons in Switzerland.

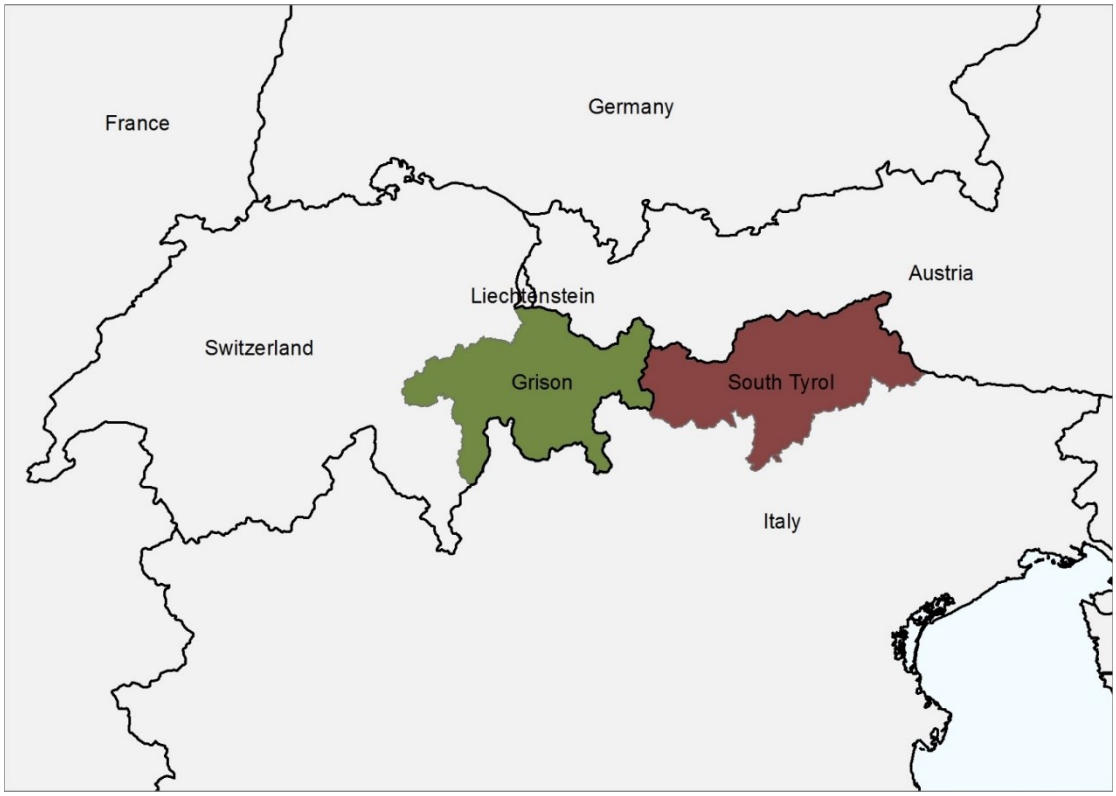


Figure 21: The location of the canton of Grisons in Switzerland

The map highlights the location of Grisons in Switzerland (green area) as well as South Tyrol in Italy (red area). Source: Map created by EURAC.

It is the main aim of the Grisons case study report part to investigate how resilience indicators at the local level can be developed. The emphasis here is on methodological issues.

9 Methodological Approaches

9.1 Link to the emBRACE Framework

The indicator development was guided by the emBRACE framework.

Figure 22: The emBRACE Framework

Source: The graphical representation was created by Valentin Rüegg (WSL) and is based on the main emBRACE framework as presented in Deliverable 6.6. It comprises post Deliverable 6.6 changes developed by Maureen Fordham, Hugh Deeming, Sylvia Kruse, John Forrester, Belinda Davis and Sebastian Jülich.

The emBRACE framework depicts the dynamic interactions of community resilience across three component domains: actions, learning and resources and capacities. Resilience is influenced by outside forces, comprising context, disturbance and change over time. With its disaster risk governance focus such external context is also acknowledged to encompass laws, policies and responsibilities, which enable and support civil protection practices. These influence community capacities and actions through all phases of the disaster risk management cycle of preparedness, response, recovery, mitigation.

9.2 Indicator

In disaster resilience research one research strand is the quantification of resilience by means of indicators. An indicator is a quantitative or a qualitative measure derived from a series of observed facts that reveal relative positions in a given area. Indicators are useful in identifying trends and drawing attention to particular issues. They can also be helpful in setting policy priorities and in benchmarking or monitoring performance. A composite index is formed when individual indicators are compiled into a single index based on an underlying model. The composite index should ideally measure multidimensional concepts that cannot be captured by a single indicator. In this way, composite indices can summarize complex, multi-dimensional realities with a view to supporting decision makers (OECD 2008, TATE 2012).

Resilience indicators facilitate identifying priority needs for resilience improvement. The measurement of resilience is essential for monitoring progress towards resilience reduction and to compare benefits of increasing resilience with the associated costs. Beyond that, resilience metrics are the basis to establish a baseline or reference point from which changes in resilience can be measured. First step in the process of indicator development is to clarify by means of qualitative research what measures to implement and to investigate on causal connections between observable characteristics and the resulting resilience. This is the basis for the development of quantitative metrics that are useful for decision makers to prioritize preventive actions.

Resilience indicators applicable at the national or regional level mostly employ existing statistical data (CUTTER ET AL. 2008, BURTON 2014). Indicators at the national level allow the comparison between nations, and regional level indicators allow comparison of sub national areas according to data availability. Resilience assessment at the local level faces the challenge that existing statistical data often is not available at the spatial resolution needed to generate comparative statements for various households or areas within a municipality. Hence at the local level it is mostly necessary to collect new data when conducting a resilience assessment. If individual disaster prevention is the focus of an indicator, household is probably the most suitable unit of analysis. A Household can be defined as the basic residential unit in which economic production, consumption, inheritance, child rearing, and shelter are organized and carried out, and it may or may not be synonymous with family

(HAVILAND 2003). If it comes to capturing organizational issues at the local level like disaster response, municipality is probably the most suitable unit of analysis. If resilience measuring is approached by a place based analysis, raster points on maps can be appropriate as unit of analysis.

9.3 Quantitative Indicator Development

The quantitative indicator development in the Grisons case study part in the canton of Grisons in Switzerland was guided by the general hypothesis: Resilience against natural hazards varies at the local level and can be characterized by measurable characteristics that indicate the degree of disaster resilience. From this hypothesis the central research question is derived: Are there measurable differences in resilience at the local level? In order to answer this main research question, the following secondary questions arose: Which socioeconomic or demographic characteristics can be employed to measure the disaster resilience at the local level? How can these characteristics be utilized to give an indication of disaster resilience? Since disaster resilience is a complex phenomenon with various dimensions, it cannot be captured by a single indicator. Several indicators are needed to reflect the multi-dimensional nature of disaster resilience.

9.4 Research Approach

To investigate on those dimensions of resilience, expert interviews with various stakeholders from the field of natural hazard prevention, disaster response and information platforms were conducted in the canton of Grison, Switzerland. For this, a matrix was developed, showing on one axis all natural disasters possible to occur in the study region (intense rainfall and snowfall, snow avalanches, storms, wind, hail, flooding, debris flows, rockslides, rockfalls, landslides, earthquake, drought), and showing on the other axis the following guiding questions: Who was affected in particular during past disasters and who was not affected? Which measures helped against the disaster? Who is very well informed, aware and prepared for the disaster and who is not? Who could recover best from a disaster and who would severely struggle in recovering? Who would even have positive externalities from a disaster? Who has more human, social or financial capital than others? Who is resilient and who is not?

Aim of those guiding questions was to track down measurable characteristics that can be employed as a measure for disaster resilience differences.

This formed a matrix and the disaster experts were enquired on each combination of possible disaster in the region and guiding question listed above.

Ziel: Naturgefahren-resilienzindikatoren	**Starkregen Sturm, Wind, Hagel**	**Flussüber-schwemmung**	**Murgang**	**Starker Schneefall, Schneedruck**	**Lawine**	**Steinschlag, Blockschlag, Felssturz**	**Erdbeben**	**Trockenheit, Dürre**	**Weitere?**
Wer ist besonders betroffen? Wer nicht?									
Welche Maßnahmen helfen gegen die Gefahr?									
Wer ist gut über die Gefahr informiert, sensibilisiert und vorbereitet? Wer nicht?									
Wer kann sich besonders gut erholen? Wer nicht?									
Wer kann noch Positives aus einem Naturgefahren-ereignis ziehen?									
Wer hat mehr Human-, Sozial- oder Finanzkapital als andere?									
Wer ist resilient und warum? Wer nicht?									
Wo könnte man diese Unterschiede gut empirisch ergründen?									

Figure 23: Matrix used for expert interviews (in German, translation in the text above)

The guiding questions were used as opening questions to identify thematic indicator complexes. Once such a thematic complex was identified, it was investigated in depth on all relevant aspects. This was the qualitative basis for the quantitative indicator development.

The following figure pictures all identified indicator complexes. Those are structured according to scale level from individual scale to cantonal scale on one axis and according to the type of hazard along the other axis.

Figure 24: Thematic indicator complexes matrix

Hazard / *Scale*	Storm, Wind, Hail	Flooding	Debris Flows	Intense Rainfall and Snowfall	Snow avalanches	Rockslides, Rockfalls, Landslides	Earthquake	Drought, Heat
Individual	***Awareness through past natural disasters:*** Once the impacts of a disaster are coped, the disaster starts acting positive in terms of awareness building and risk/loss perception. The manifestation of hazard in the form of a disaster increases in the aftermath the willingness to invest in mitigation measures, some planers of disaster mitigation building measures even have plans for new protection measures ready at hand and just wait for the next disaster to occur and the resulting positive political climate for allocation of money to preventive measures.							
	Residence time in the village or valley: Positive relation between the residence time of people and natural hazard awareness and risk/loss perception							
	Subscription to natural hazard warning services (e.g. MetoSwiss or public cantonal building insurance): A warning message received in time and interpreted properly can effect getting oneself or belongings to safety							
					Increased exposure: Due to high annual mileage in cars, for bus and train drivers, outdoor recreationists, mountain guides			
								Age: Elderly and sick people are more vulnerable to heat waves
	General independence and ability to deal with change and disturbances: Better coping with natural disasters and less stubbornness to rebuilt in the same place when better alternatives are present							
Household	***Insurance available for financial security and fast recovery after natural disaster:*** *Buildings:* Presence of building insurance also for sites of high risk Compulsory public Cantonal building insurance → Monopoly will consist only as long as Cantonal building insurance works cost-effective → To keep damages as low as possible is the core interest of the Cantonal building insurance → Active and engaged *Vehicles:* Comprehensive insurance *People:* Psychological effects uninsurable						***Principle of solidarity:*** National donations to pay for big events	
			Protection forest present to protect against gravitational natural hazards: Problematic if the protection forest is destroyed or weakened by tree diseases or forest fire or storm					
		Redundancy of critical infrastructure: Power lines, emergency power supply, water supply, roads, ...						
Company		***Spatial diversification:*** Multiple sites working independently increase the resilience						
								Access of farmers to civil defence pumps for irrigation: To maintain basic irrigation in case of severe drought
Municipality		***Municipality management command staff (Gemeindeführungsstab) present in the municipality and prepared for natural disasters:*** Increased coordination of management command staff with fire department and civil defence						
	Financial strength and reserves: Financially strong municipalities better cope with natural disasters than financially weak municipalities							
Canton	***Natural hazard research institutions and -warning institutes present in the Canton:*** Local presence (like SLF in Grisons) strengthens cooperation and often leads to increased research density in the canton							

The first three thematic indicator complexes resulting from the matrix interviews, “Awareness through past natural disasters”, “Residence time in the village or valley” and “Subscription to natural hazard warning services”, were taken exemplarily for the development of quantitative indicators. Those are portrayed and discussed in the subsequently.

10 Developed quantitative Indicators

10.1 Residence time as Example for a Risk/Loss Perception Indicator

This indicator aims at quantifying the first element (Risk/loss perception) of the Learning component domain of the emBRACE framework.

All questioned disaster experts confirmed a positive relation between the residence time of households and natural hazard awareness as well as risk/loss perception. For quantification unpublished empirical data collected for a study of BUCHECKER ET AL. (2015) was employed. The study explored factors which can positively influence local publics’ attitudes towards integrated risk management. They conducted a household survey in two Swiss Alpine valleys in which a disastrous flood event had taken place two years before (DERMITT ET AL. 2013). A total of 2100 standardised questionnaires were sent to all households in the Lötschen valley and to a random sample of the households in the larger Kander valley. The response rate was 30 percent. Table 2 displays the results for two questions on the residents’ disaster prevention knowledge, broken down to the respondents’ residence time in the village.

		Mean period of residence in **Lötschen** valley (years)	Mean period of residence in **Kander** valley (years)
I am well informed about natural disaster prevention measures	Disagree	43	27
	Rather disagree	40	38
	Rather agree	43	35
	Agree	45	42
I know which places are at risk in the village	Disagree	30	35
	Rather disagree	36	33
	Rather agree	42	35
	Agree	45	39

Table 6: Residents' assessment of their disaster prevention knowledge and their residence time in the valley

In general the residence time of all respondents in both valleys is relatively long. In the Kander valley there is a clear correlation between increasing residence time in the valley and how well the respondent assed her/his information level on disaster prevention. In the Lötschen valley there is a clear correlation between residence time in the valley and knowledge about places at risk in the village. This data suggests that prevention knowledge is increasing up to 40 years living in the same valley. The interviewed disaster experts confirmed a steep learning curve within the first 10 years of residence time at one place. In terms of quantification this led to a minimum goalpost of 0 years, a maximum goalpost of 40 years and a logarithmic run of the curve. Formula 1 captures all three characteristics. Unit of analysis is a household and the only input parameter is the time of residence of the household within the village.

Formula 1: $Resilience = min.\{log_{40}\, Residence\ years + 1\,;\, 1\}$

Formula 1 creates just values between (and including) 0 for lowest resilience and (including) 1 for highest resilience. Values above 1.0 are not allowed by this

minimising function. Hence, the concept of goalposts is employed (OECD 2008: 85, UNDP 2007: 356). Higher values than a residence time of 40 years have no further effect and would also result in an indicator value of 1.0. The following figure visualizes the run of the resulting curve. On the horizontal axis the input parameter is shown, and on the ordinate axis the resulting level of resilience according to the resilience indicator formula 1 is shown.

Figure 25: Residence time indicator curve

10.2 Awareness through past natural Disasters as Example for a Risk/Loss Perception Indicator

As the previously outlined indicator, this indicator likewise aims at quantifying the first element (Risk/loss perception) of the Learning component domain of the emBRACE framework.

The interviewed disaster experts pointed out that of course natural disasters are negative in the time of occurrence. But once direct impacts of a disaster are coped, the disaster starts to act positive in terms of awareness building. Hence, past disasters have positive effects on the risk/loss perception and awareness of people and hereby increase their resilience. The manifestation of hazard in the form of a disaster increases in the aftermath the willingness to invest in mitigation measures. Research even indicates that some planers of disaster mitigation building measures have plans for new protection measures ready at hand and just wait for the next disaster to occur and the resulting positive political climate for allocation of money to preventive measures.

For a quantitatively operationalised indicator, the dimension of time, the intensity of past disasters as well as the spatial dimension have to be defined.

Thus first is investigated on the issue of time. The memory of people concerning natural disasters is astonishingly short, confirmed by all interviewed experts. But to determine how fast people forget is difficult. The interviewed experts were not able to operationalize the curve of forgetting. Some indicate that after 5 years already quite an amount of memory is gone and after 10 or 15 years only very few do remember. WAGNER (2004: 84, 88) researched on the curve of forgetting at the example of river floods in Alpine areas. He found that the half-value time is around 14 years. Hence, after 14 years only half of the people are still aware of a certain flood in the area. At the example of flood risk perception in the United States LAVE ET AL. (1991: 265) employ the drop of flood insurance as indicator for the fading memories of the flood. They found that after flood events the demand for flood insurance rises sharply, but about 15 percent of policy-holders drop their flood insurance each year if there is no major flood event. This results in a half-value period of around 4 years only. It has to be distinguished between just remembering a disaster when asked by a researcher, as in case of WAGNER (2004), and actively recalling a disaster so that it still shapes the risk/loss perception and willingness to actually take or maintain mitigation measures, as in the case of LAVE ET AL. (1991). For indicator operationalization certainly the latter is desirable to capture. That is why a rather steep and exponential falling run of the curve of forgetting is suggested in terms of quantifying the factor of time for this awareness indicator.

Formula 2: $Single\ factor\ Time = max.\{2 - \sqrt[4]{Years + 1}; 0\}$

Maximum value for the single factor time is 1.0 when the disaster occurred less than one year ago, and minimum value is 0.0 when the disaster occurred 15 years ago. In case a disaster struck more than 15 years ago, the value would become negative. That is why a maximising function was chosen to eliminate negative values. The next figure demonstrates the transformation of the number of years since a disaster into the resulting single factor time.

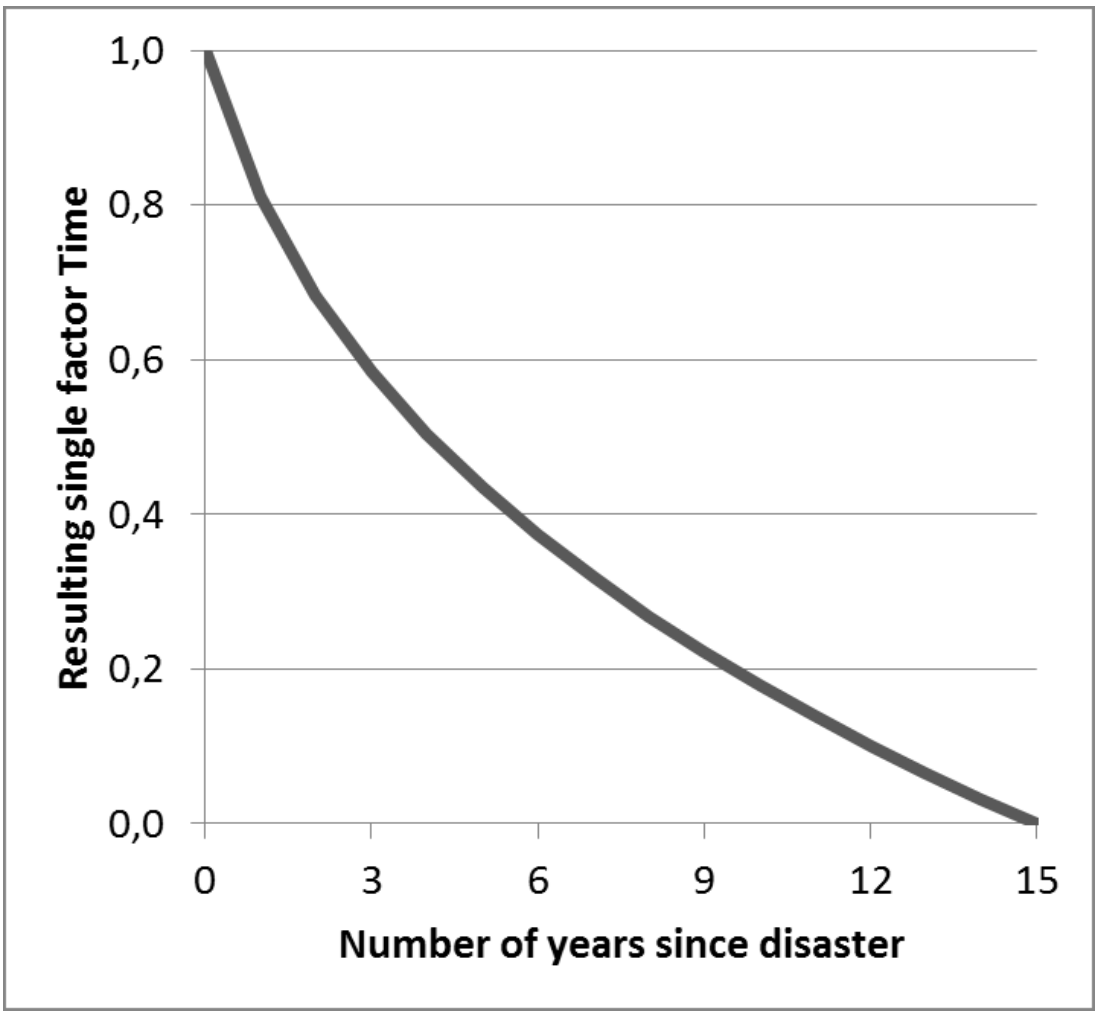


Figure 26: Risk/loss perception indicator single factor time curve

The research of WAGNER (2004) evidently reveals that the magnitude of a natural disaster highly influences the curve of forgetting. For quantification this aspect is captured by the second single factor. Discussion on measures with the interviewed experts point towards casualties as operationalization of the severeness of a past disaster. The number of deaths is captured in most disaster databases and the number of casualties can be employed for all types of natural disasters. Compared

with other countries the number of casualties of natural disasters in Switzerland is relatively low. That is why a maximum goalpost of 10 deaths is suggested. Especially this single factor has to be revised carefully when this indicator is employed in other countries. Evidence for a nonlinear run of the curve were too weak, this is why formula 3 is constructed straight forward in a linear way.

Formula 3: $Single\ factor\ Casualties = min.\left\{\frac{Deaths}{10}; 1\right\}$

The subsequent figure displays the transformation of casualties caused by a disaster into the resulting single factor casualties.

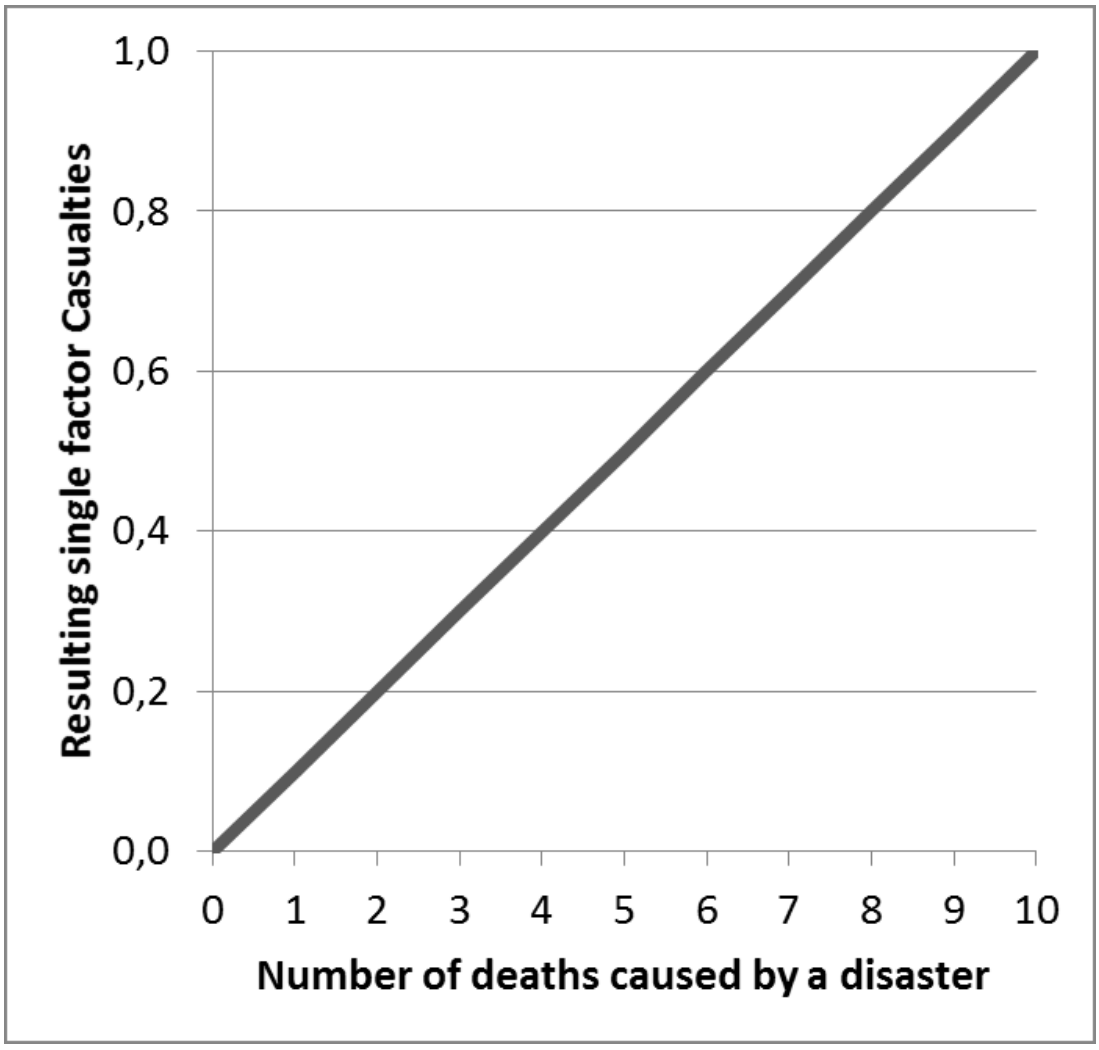


Figure 27: Risk/loss perception indicator single factor casualties curve

Last single factor is the spatial dimension of past disasters. Research indicate that the distance between the place of residence and the point of occurrence plays a crucial role. Just like with the previous single factors, also for the factor distance a line has to be drawn somewhere. Since topography, the range of media and individual ranges of activity influence the perception of disasters, it is in particular difficult to decide on the maximum goalpost and the run of the curve. After consultation with the previously interviewed disaster experts a straight forward linear run with a threshold of 50 kilometres bee-line distance is suggested. This enables an easier implementation within Geographical Information Systems (GIS).

Formula 4: $$Single\ factor\ Distance = max.\left\{1 - \frac{Kilometres}{50}; 0\right\}$$

The following figure exhibits the proposed transformation of disaster distance into the resulting single factor distance.

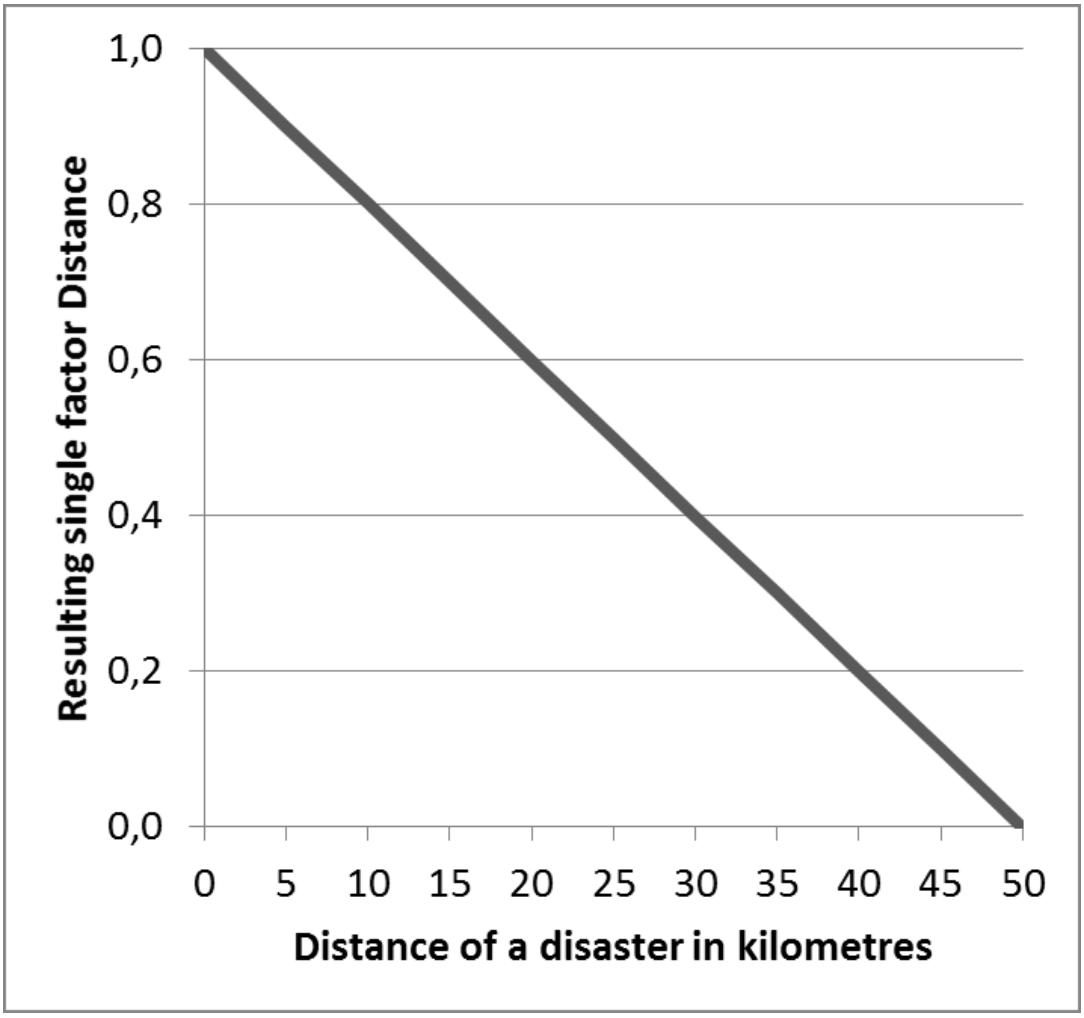


Figure 28: Risk/loss perception indicator single factor distance curve

All three single factors produce values between 0 and 1. These three single factors are combined in formula 5 in a way that likewise only indicator values between 0 (indicating low resilience) and 1 (indicating high resilience) are produced.

Formula 5: $Resilience = Casualties\left(\frac{Time+Distance}{2}\right)$

Inserting the three single factor formulas 2, 3 and 4 into formula 5 results in the following formula 6.

Formula 6: $Resilience = min.\left\{\frac{Deaths}{10};1\right\}\left(\frac{max.\left\{2-\sqrt[4]{Years+1};0\right\}+max.\left\{1-\frac{Kilometres}{50};0\right\}}{2}\right)$

The unit of analysis is a raster point on a map. The input parameters are all natural disasters of the past 15 years with casualties. The location of the disaster has to be geocoded. By inserting these input parameters by means of formula 6 into a GIS, a value for each raster point can be computed. If a raster point is influence by more than one disaster, the respective values are added together.

10.3 Warning services as Example for a Civil Protection Indicator

This indicator aims at quantifying one aspect of the first element (Civil Protection) of the Actions component domain of the emBRACE framework.

The two indicators portrayed above produce continuous resilience values between 0 and 1. The thematic complex of warning systems was chosen exemplarily to demonstrate how in terms of quantification binary indicators can be transferred into this numerical dimension.

Research clearly indicates that persons and households that are subscribed to one of the natural hazard warning services present in the study region (e.g. MetoSwiss and public cantonal building insurance) are more resilient than others. A warning message received in time and interpreted properly can effect getting oneself or belongings to safety, for instance proceeding to safe zones, bringing valuables upstairs in case of flooding, parking the car in the garage in case of hail, being on the right side when the only road of a closed off valley is liable to be blocked by avalanche or debris flows, and so on.

This indicator is constructed as an all or nothing indicator. As a result, the indicator allows only two values: 0.0 if the analysed household or person is not subscribed to a warning service or 1.0 if it is subscribed to at least one natural hazard warning service. Therefore, the value of formula 7 is defined by an indicator function.

Formula 7:

$$Resilience = 0 \; if \; not \; subscribed \; to \; warning \; service(s)$$

$$Resilience = 1 \; if \; subscribed \; to \; at \; least \; one \; natural \; hazard \; warning \; service$$

Most appropriate unit of analysis for this resilience indicator are single persons or households. If subparts of municipalities are supposed to be compared in terms of disaster resilience, all households in an area can be surveyed or a random sample can be taken and mean values can be calculated.

11 Summary and Conclusion Grisons Part

If several fully quantified single indicators are developed, it is crucial to transform the input parameters always to the same numerical dimension reflecting the level of resilience. Otherwise the single indicators cannot be combined in form of a composite index. In this study values between and 0 and 1 was chosen. It is not always possible to fully operationalize an indicator quantitatively, nor is it reasonable. A higher level of quantification not automatically goes with higher relevance to resilience assessment. But there is a certain demand by practitioners for concrete quantitative measures of resilience. This has to be addressed by science and the aim of a resilience assessment should determine the indicator operationalization.

However, quantification inevitably means determination und therewith contestability. This is the reason why all steps of decisions made during the quantification of indicators should be laid open. Quantitative indicators are to be seen as the best possible quantitative operationalization according to present qualitative knowledge about resilience in the study region. Quantified indicators are never all encompassing for all time and all regions. When indicators are transferred from one region or country to another, the indicators have to be revalidated carefully to ensure that the indicators actually measure the intended concept.

12 Acknowledgements Grisons Part

Thanks to Matthias Buchecker for access to his raw data, to Jonas Lichtenhahn for supporting the indicator development and to Marco Pütz and Hugh Deeming for their feedback.

13 References (both parts)

SOUTH TYROLEAN PART:

Aldrich, D. P. (2012). Building Resilience- Social capital in post-disaster recovery. The University of Chicago Press

ASTAT-Info 2/2015 (2015). Bevölkerungsentwicklung 4. Quartal 2014. Landesinstitut für Statistik, Autonome Provinz Bozen.

ASTAT (2007). South Tyrol in Figures 2008, Provincial Statistics Institute, Autonomous Province of Bolzano

Bätzing, W (2003). Die Alpen – Geschichte und Zukunft einer europäischen Kulturlandschaft, Verlag C.H. Beck, München 2003, 431 S., 2. unveränderte Auflage 2005

Becker, Julia; Smith, Richard; Johnston, David; Munro, Adam (2001). Effects of the 1995-1996 Ruapehu eruptions on communities in central North Island, New Zealand, and people's perceptions of volcanic hazards after the event. The Australasian Journal of Disaster and Trauma Studies. volume (2001-1).

Bird, Deanne K. (2009). The use of questionnaires for acquiring information on public perception of natural hazards and risk mitigation – a review of current knowledge and practice. Natural Hazards and Earth System Sciences, volume (9), 1307-1325.

Birkmann, J.; Abeling, T.; Huq N.; Wolfertz J. (2012). First Draft Theoretical Framework. Deliverable 2.1 emBRACE Consortium

Birkmann, J.; Abeling, T.; Huq N.; Wolfertz J. (2013). Agreed Framework. Deliverable 2.2 emBRACE Consortium

Bishop, S. and Waring J. (2012). Discovering healthcare professional- practice networks. Qualitative Research in Organizations and Management: An International Journal 7:308–322.

Borgatti, S., Everett M. and L. Freeman (2002). Ucinet for Windows: Software for Social Network Analysis. Analytic Technologies.

Brosius, F. (1998). SPSS 8. International Thomson Publishing. Stamford, USA

Crossley, N. (2010). The Social World of the Network. Combining Qualitative and Quantitative Elements in Social Network Analysis. Sociologica.

Davis, Matthew S.; Ricci, Tullio; Mitchell, Lara M. (2005). Perceptions of Risk for Volcanic Hazards at Vesuvio and Etna, Italy. The Australasian Journal of Disaster and Trauma Studies. volume (2005-1).

Dowdy S. & Wearden S. (1991). Statistics for research. 2nd Edition. Ed. Wiley & Sons, 1991

Edwards, G. (2010). Mixed-method approaches to social network analysis. Working Paper, NCRM.

Eiser, J. Richard; Bostrom, Ann; Burton, Ian; Jonston, David M.; Mc Clure, John; Paton, Douglas; van der Plight, Joop; White, P. Mathew (2012). Risk interpretation and action: A conceptual framework for responses to natural hazards. International Journal of Disaster Risk Reduction, volume (1), 5-16.

Emmel, N. and Clark A. (2009). The methods used in connected lives: Investigating networks, neighbourhoods and communities.

Franch, M.; Martini, U. & Tommasini, D. (2003). Mass-Ski tourism and environmental exploitation in the Dolomites: Some considerations regarding the tourist development model. In International Scientific Conference on Sustainable Tourism Development and the Environment, edited by E. Christou and M. Sigala. Chios Island, Greece.

Heath, S., Fuller A. and Johnston B. (2009). Chasing shadows: defining network boundaries in qualitative social network analysis. Qualitative Research 9:645–661.

Hoffmann C. & Streifeneder T. (2010). In-depth evaluation of the Hazard Zone Plan (HZP) in South Tyrol. Final Report of the project CLISP- Climate Change Adaptation by Spatial Planning in the Alpine Space. WP5.3. European Territorial Cooperation Alpine Space Programme

Johnston, David M.; Bebbington, Mark S.; Lai, Chin-Diew; Houghton, Bruce F.; Paton, Douglas (1999). Volcanic hazard perceptions: comparative shifts in knowledge and risk. Disaster Prevention and Management. Volume (8). No.2. pp 118 – 126.

Jurt, C. (2009). Perceptions of Natural Hazards in the Context of Social, Cultural, Economic and Political Risks: A Case Study in South Tyrol. PhD dissertation. University of Bern

Kuhlicke, Christian; Steinführer, Annett; Begg, Chloe; Bianchizzac, Chiara; Bründl, Michael; Buchecker, Matthias; De Marchi, Bruna; Di Masso Tarditti, Marina; Höppner, Corina; Komac, Blaž; Lemkow, Louis; Luther, Jochen; McCarthy, Simon; Pellizzoni, Luigi; Renn, Ortwin; Scolobig, Anna; Supramaniam, Meera; Tapsell, Sue; Wachinger, Gisela; Walkeri, Gordon; Whittle, Rebecca; Zorn, Matija; Faulkner, Hazel (2011). Perspectives on social capacity building for natural hazards: outlining an emerging field of research and practice in Europe. Environmental Science and Policy. volume (14). 804-814.

Legge provinciale 18 dicembre 2002, n. 15, Testo unico dell'ordinamento dei servizi antincendi e per la protezione civile. Pubblicata nel Suppl. n. 1 al B.U. 31 dicembre 2002, n. 54.

Lubbers, M. J., Molina J. L., Lerner J., Brandes U., Ávila J. and McCarty C. (2010). Longitudinal analysis of personal networks. The case of Argentinean migrants in Spain. Social Networks 32:91–104.

Mair, V. & Larcher, V. (2014). Der Hangrutsch „Gianëis“ in Abtei. In *Der Schlern*. Special Issue: Naturkatastrophen aus der Geschichte. H. 10, October 2014. pp. 109-125.

PA, no. 13, (1997): Landesgesetz vom 11. August 1997, Nr. 13., Landesraumordnungsgesetz.

Perry, Ronald W.; Lindell, Michael K. (1990). Living with Mt. St. Helens: Human adjustment to volcano hazards. Washington State University Press, Pullman (Washington).

PGD, no. 42, (2008): Dekret des Landeshauptmanns vom 5. August 2008, Nr. 42, Durchführungsverordnung betreffend die Gefahrenzonenpläne. Beschluss der Landesregierung Nr. 2740 vom 28.07.2008.

Pollice F. (2003). The role of territorial identity in local development processes. Proceedings of the Conference THE CULTURAL TURN IN GEOGRAPHY. 18-20th of September 2003. Gorizia Campus, Italy.

R Core Team. 2014. R: A Language and Environment for Statistical Computing. R Foundation for Statistical Computing. Vienna, Austria. http://www.R-project.org

Schiffer, E. (2007). Net-Map Toolbox: Influence Mapping of Social Networks. International Food Policy Research Institute. http://netmap.wordpress.com/

Schiffer, E., McCarthy N., Regina B., Waale D. and F. Asante (2008). Information Flow and Acquisition of Knowledge in Water Governance in the Upper East Region of Ghana. International Food Policy Research Institute.

Schneiderbauer, S.; Zebisch, M. & Chinellato, G. (2014). Fernerkundungsmethodik für Naturgefahren. Das Beispiel Abtei. In Der Schlern. Special Issue: Naturkatastrophen aus der Geschichte. H. 10. October 2014. pp. 126-134.

Sloane, A., and S. O'Reilly (2013). The emergence of supply network ecosystems: a social network analysis perspective. Production Planning & Control 24:621–639.

SPSS (2001). The SPSS Two Step Cluster Component. White Paper Technical Report. Available at: http://www.spss.ch/upload/1122644952_The%20SPSS%20TwoStep%20Cluster%20Component.pdf

Taylor, R.; Forrester, J.; Pedoth, L.; Matin N. (2014). Methods for integrative research on community resilience to multiple hazards, with examples from Italy and England. Procedia Economics and Finance. Volume 18, 2014, pp. 255–262

Wachinger G.; Renn O.; Begg C.; Kuhlicke C. (2004): The Risk Perception Paradox-Implications for Governance and Communication of Natural Hazards. Risk Analysis. Vol. 33, No.6

GRISONS PART:

Alexander, D. E. (2013): Resilience and disaster risk reduction. An etymological journey. In: Natural Hazards and Earth System Sciences, Vol. 13, pp. 2707-2716.

Birkmann, J. (Ed.) (2006): Measuring vulnerability to natural hazards. Towards disaster resilient societies, Tokyo.

Buchecker, M., Ogasa, D. and Maidl, E. (2015): To which extent has the wider public adopted the integrated flood risk management strategy? In: Environmental science and policy (submitted).

Burton, C.G. (2014): A Validation of Metrics for Community Resilience to Natural Hazards and Disaster Using the Recovery from Hurricane Katrina as a Case Study. In: Annals of the Association of American Geographers.

Cutter, S.L., Barnes, L., Berry, M., Burton, C.G., Evans, E., Tate, E.C., Webb, J. (2008) A place-based model for understanding community resilience to natural disasters. In: Global Environmental Change. Vol. 18, pp. 598-606.

Demeritt, D., Nobert, S., Buchecker, M., Kuhlicke, C., Ferri, M., Parkes, B. (2013): Assessing the roles and effectiveness of flood mapping and communication as a disaster risk reduction strategies. Public Report of the EU FP7 project KULTURisk Knowledge-based approach to develop a Culture of Risk prevention.

Haviland, W.A. (2003): Anthropology, Belmont.

IPCC (2014) Summary for policymakers. In: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Field, C.B., V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, L.L. White (Eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 1-32.

Jülich, S. (2015): Development of a Composite Index with Quantitative Indicators for Drought Disaster Risk Analysis at the Micro Level. In: Human and Ecological Risk Assessment, Vol. 21 No. 1, pp. 37-66.

Jülich, S. (2013): Drought. In: Penuel, K. B., Statler, M. und Hagen, R. (Hrsg.): Encyclopedia of crisis management, SAGE Publications, Thousand Oaks, pp. 300-301.

Lave, T.; Lave, L. (1991): Public perception of the risks of floods: Implications for communication. In: Risk analysis Vol. 11, No. 2, pp. 255-267.

OECD (ORGANIZATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT) (Ed.) (2008): Handbook on Constructing Composite Indicators. Methodology and User Guide, Paris.

Tate, E. (2012): Social vulnerability indices. A comparative assessment using uncertainty and sensitivity analysis. In: Natural Hazards No. 63, pp. 325-347.

UNDP (United Nations Development Programme) (Ed.) (2007): Human Development Report 2007/2008. Fighting climate change. Human solidarity in a divided world. New York, USA.

Wagner, K. (2004): Naturgefahrenbewusstsein und -kommunikation am Beispiel von Sturzfluten und Rutschungen in vier Gemeinden des bayerischen Alpenraums. Dissertation at TU München. München.

Welsh, M. (2014): Resilience and responsibility. Governing uncertainty in a complex world. In: The Geographical Journal, Vol. 180, No. 1, pp. 15-26.

14 Appendices

Appendix 1: Questionnaire Risk perception in Badia- Abtei

Appendix 2: Table of indicators

ID ☐☐☐☐

AUTONOME PROVINZ BOZEN SÜDTIROL | PROVINCIA AUTONOMA DI BOLZANO ALTO ADIGE
PROVINZIA AUTONOMA DE BULSAN SÜDTIROL

EURAC research

Risk perception in Badia/Abtei

In December 2012, a huge landslide hit the municipality of Badia/Abtei. The European Academy (EURAC) in cooperation with the Geology Department of the Autonomous Province of Bolzano/Bozen wants to investigate how the population perceived the event and how this event affected the risk perception of the local population. Your opinion helps us to improve the way in which risks and future natural hazardous events can be dealt with in South Tyrol.
This questionnaire addresses all the residents of Badia/Abtei: we kindly ask you to devote 10 minutes of your time to fill it out. In order to help us in the evaluation of the questionnaire, we would like to ask you to answer the open questions in German or Italian. We want to thank you in advance for your participation. In accordance with the legislative decree 196/2003 your answers will be treated confidentially and the collected information will be used and evaluated for scientific purposes only.
In a few days, one of our collaborators will collect the filled out questionnaire. You can also bring it to the "Protokollamt" at the town hall or send it to: EURAC, Institute for Applied Remote Sensing, Drususallee 1, 39100 Bozen. For further information please contact EURAC via telephone: 0471 055377 or via Email at: info_franabadia@eurac.edu.
EURAC and the Geology Department of the Province of Bolzano thank you for your collaboration.

Section 1. : Risk perception

1. I always knew that "Badia/Abtei " is considered an area of high risk considering landslides/rock fall... ☐ Yes ☐ No

2. The possibility of an event of these proportions was completely unknown to me

...unimaginable ①②③④⑤ ...to eb expected ☐ Don't know

3. Have you ever experienced or heard/read about a similar event before 2012?

☐ Yes, I experienced one or more rockfalls/landslides personally. **How many?**: _____
☐ Yes, I heard/read about it but did not experience the event personally (please mark how you learned about it).

☐ Media/print media
☐ Conversational topic in town
☐ Conversational topic at work
☐ Traditional knowledge, family stories
☐ In the scope of voluntary work (fire brigade, mountain rescue)
☐ Other: _____

☐ No I'm not aware of any rockfall/landslide event.

4. Please indicate which of the following impacts of the landslide in 2012 affected you. (Multiple answers possible)

☐ Evacuation
☐ Material damage (house)
☐ Material damage (other than house)
☐ No implication
☐ Financial damage (no tourists/costumers)
☐ Impaired mobility
☐ Impaired provision of water/electricity
☐ Other: _____

5. I have felt at risk of being affected by arockfall/landslide since the landslide in 2012.

I do not agree ①②③④⑤ I fully agree

6. How high do you think is the risk that you will be affected by one of the following (because of a landslide)?

a.	Material damage (house)	Very unlikely ①②③④⑤ Very likely
b.	Material damage (other than house)	Very unlikely ①②③④⑤ Very likely
c.	Financial damage (no tourists/costumers)	Very unlikely ①②③④⑤ Very likely
d.	impaired mobility	Very unlikely ①②③④⑤ Very likely
e.	Evacuation	Very unlikely ①②③④⑤ Very likely
f.	Other: _____	Very unlikely ①②③④⑤ Very likely

Section 2: The operation/mission, intervention?

After the event evacuations, cleanup- safety and monitoring work had to be done; information and support services were arranged. In these activities many different stakeholders were involved (fire brigade, police etc.) In the following questions the term "operation" refers to all of these.

7. Where did you get your information about the operation from? (multiple answers possible)

□ TV □ informative evenings □ talking to other villagers
□ Radio □ Fire brigade □ municipal police
□ Internet □ from family members Other:_____

8. Please indicate how content you were with the following aspects of the Operation shortly after the event and today

a.	Information about the event through media	Shortly after the event	Very satisfied ①②③④⑤ Very dissatisfied
		Today	Very satisfied ①②③④⑤ Very dissatisfied
b.	Information about cleanup work	Shortly after the event	Very satisfied ①②③④⑤ Very dissatisfied
		Today	Very satisfied ①②③④⑤ Very dissatisfied
c.	Information evenings	Shortly after the event	Very satisfied ①②③④⑤ Very dissatisfied
		Today	Very satisfied ①②③④⑤ Very dissatisfied
d.	Execution of the cleanup work	Shortly after the event	Very satisfied ①②③④⑤ Very dissatisfied
		Today	Very satisfied ①②③④⑤ Very dissatisfied
e.	Safety work	Shortly after the event	Very satisfied ①②③④⑤ Very dissatisfied
		Today	Very satisfied ①②③④⑤ Very dissatisfied
f.	Participation and presence of politicians	Shortly after the event	Very satisfied ①②③④⑤ Very dissatisfied
		Today	Very satisfied ①②③④⑤ Very dissatisfied
g.	Coordination of the action force	Shortly after the event	Very satisfied ①②③④⑤ Very dissatisfied
		Today	Very satisfied ①②③④⑤ Very dissatisfied
h.	Psychological aid	Shortly after the event	Very satisfied ①②③④⑤ Very dissatisfied
		Today	Very satisfied ①②③④⑤ Very dissatisfied
i.	Financial aid	Shortly after the event	Very satisfied ①②③④⑤ Very dissatisfied
		Today	Very satisfied ①②③④⑤ Very dissatisfied

9. Did you participate in any way in the operation? □ Yes □ No

If "Yes" in what form?_____

10. The operation had different negative effects for the inhabitants. Did you feel constricted by these?

□ Yes I felt constricted □ No, I did not feel constricted

If "Yes" by what? _____

_____

11. Can you tell approximately when you felt constricted? Indicate one or more periods.

□ January-April 2013 □ Mai- August 2013 □ September- December 2013 □ Don't know □ Other: _____

Section 3: protective measures

12. Who is (in your opinion)responsible for the protection of the population against natural hazards. Please mark the two most important ones

□ Private citizens □ The municipality □ Office of Torrent and Avalanche Control of the province
□ The geology department □ Forestry officials □ Other: _____

13. How happy are you with the work of the responsible "players" to eliminate every trace of the event?

Very unhappy ①②③④⑤ very happy

14. The responsible "players" are doing everything to protect the village of future landslides.

I do not agree ①②③④⑤ I fully agree

15. Different protective measures exist in Badia/Abtei. Which of the following measures do you know?

□ Civil protection plan □ Danger-zone-plan

□ Monitoring □ Control structures (Slope stabilization, surface drainage, support walls, drainage…)

□ None □ Other_____

16. How safe do you feel (considering the measures you know about)?

not safe ①②③④⑤ completely safe

17. Where do you think that improvements are needed?	shortly after the event		today	
a. More frequent information via media	□ Yes	□ No	□ Yes	□ No
b. More exhaustive information via media	□ Yes	□ No	□ Yes	□ No
c. More information evenings organized by the municipality	□ Yes	□ No	□ Yes	□ No
d. Information via other channels (ex: Apps)	□ Yes	□ No	□ Yes	□ No
e. Warning system	□ Yes	□ No	□ Yes	□ No
f. Evacuation plan	□ Yes	□ No	□ Yes	□ No
g. Other_____	□ Yes	□ No	□ Yes	□ No

Section 4: Social networks

18. What institutions or public facility (fire brigade, municipality, civil protection…) would you contact first for help and support in case of an emergency? Please name the most important one first.

1._____ 4._____

2._____ 5._____

3._____ 6._____

19. What person (brother, neighbor…) would you contact first for help and support in case of an emergency? Please name the most important one first.

1._____ 4._____

2._____ 5._____

3._____ 6._____

Section 5: Wishes/Ideas

20. Which measures (immediately after the event) should be improved or are missing? _____

_____

_____

_____

21. Which measures (long term) are most important to you? Are there any measures missing or which one should be improved? _____

_____

_____

22. How would you manage/redesign the area that has been affected by the landslide? _____

_____

_____

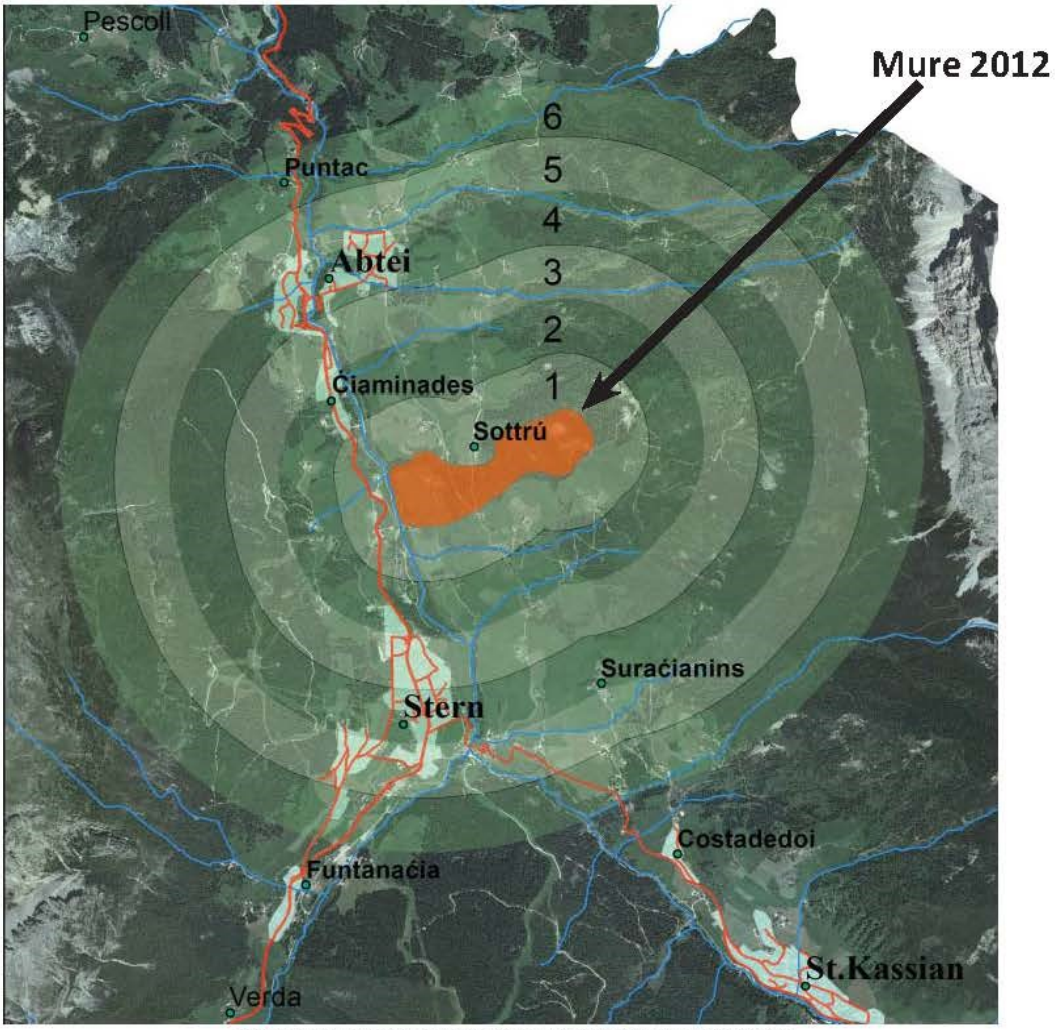
Part 6: Demographic questions

23. In which district do you live?

□ Sotrù / Oies / Anui / Larcnai □ Abtei □ Stern □ St. Kassian □ Other:_____

24. Neighborhood: Please tick the number that lies within the area you live in (see map)

①②③④⑤⑥ □ Outside of the shown area.



© Karte: EURAC, Daten: Autonome Provinz Bozen Südtirol

25. Geschlecht

□ Male
□ Female

26. Beruf

□ self-employed
□ employed
□ house wife/husband
□ student
□ pensioner
□ unemployed
□ worker
□ other _____

27. Age: ____ Years

28. How many children under the age of 12 do live in your home? ___children

29. 29) For how many years have you been living in Badia/Abtei? ____years

Thank you for your collaboration!

	Level 1	Level 2		Level 3							Feedback information on indicators			.... Other ways of categorising indicators	
emBRACE framework ***community resilience***	***emBRACE framework*** ***resources and capacities, actions, learning***	***emBRACE framework*** ***if resources and capacities then: physical, natural, human, financial, socio-political*** ***if actions then: preparedness, mitigation, response, recovery, reconstruction*** ***if learning then: experimentation and innovation, critical reflection, dissemination, risk/loss perception, problematization risk/loss***	***emBRACE framework*** ***change, disturbance, context***	***Indicator***		***Metric A - how will the indictor be quantified / parameterized?***	***Metric B - what is the value range of this indicator, what is the scale of measurement?***		***Matric C - description of evaluation - how will the available data/information be interpreted (operationalization/indicator formula), what is the correlation relation with resilience***	***Method - based on what approach has the indicator been selected***	***Positive or negative experience related to this indicator***			***IPCC / DFID Category of indicator (Adaptive Capacity, Exposure, Sensitivity)*** ***here: link to docs***	***Scale of application - the indicator might be feasible for certain scales but not for others (individual, household; organization; community of circumstance, administrative unit...)***
This is fixed	*Select one of the three Level 1 aspects*	*Select one of the Level 2 aspect considering the selection you have made under Level 1*	*Did you integrate 'change', 'disturbance' and 'context' in your test case assessment? If yes, how did you integrate it? Have you applied indicators?*	*General topic (if applicable)*	*short description*	*Describe as detailed as possible, indicate if not defined yet or not possible*	*Give a description to allow for reproducibility. This will provide the info if nominal, ordinal or metric*	*Define how the data were collected*	*Define the possible range of values and resulting resilience*	*Specify if selection was based on literature research, expert/stakeholder opinion, participatory methods etc.*	*Effort for applying the indicator - for data/inforamtion acquisistion, processing etc. [low, medium, high + explanation]*	*Importance for determining / explaining resilience [low, medium, high + explanation (based on what opinion / experience?)]*	*Generalisation possible? (is this indicator hazard / context specific or broadly / universally applicable? - please explain*	*please insert if possible*	*please insert if applicable*
Community Resilience	Capacities, learning	Human		Risk awareness	experience with hazard events in the past	Number of experienced events	nominal numbers	questionnaire	from 0 to X	literature	high	medium	universally applicable	Adaptive capacity	Community
Community Resilience	Capacities, learning	socio-political		Risk awareness	experience with hazard events in the past	Number of experienced events	nominal numbers	questionnaire	from 0 to X	literature	high	medium	universally applicable	Adaptive capacity	community
Community Resilience	Capacities, learning	Human		Risk awareness	knowledge about hazard events in the past	Yes/No, if yes what kind of information source (local knowledge, from media..)	number of ticks given a list of information sources	questionnaire	1 to 6	literature	high	medium	universally applicable	Adaptive capacity	community
Community Resilience	Capacities, learning	socio-political		Risk awareness	knowledge about hazard events in the past	Yes/No, if yes what kind of information source (local knowledge, from media..)	number of ticks given a list of information sources	questionnaire	1 to 6	literature	high	medium	universally applicable	Adaptive capacity	community
Community Resilience	Capacities, learning	Human		risk perception	area perceived as landslide prone/at high risk	yes/no	1 or 0	questionnaire	1 or 0		high	medium	universally applicable	Adaptive capacity	individual
Community Resilience	Capacities, learning	Human	disturbance is integrated. this indicator refers to a landslide event= disturbance	degree of being affected	not affected or directly/indirectly affected from the last landslide event	Yes/No, if yes what kind of impact	number of ticks given a list of possible impacts	questionnaire	number of ticks given a list of possible impacts		high	very low	yes, if there is a reference event	Adaptive capacity	individual
Community Resilience	Actions	Response	disturbance is integrated. this indicator refers to a landslide event= disturbance	risk management practises	satisfaction with response phase	assessment of different aspects during the response phase (information provided, coordination of involved actors, psycological support)- satisfaction linked to the reference event	Lickert scale	questionnaire	from 1 to 5	literature, participatory methods	high	low	yes, if there is a reference event	Adaptive capacity	community
Community Resilience	Actions	Recovery	disturbance is integrated. this indicator refers to a landslide event= disturbance	risk management practises	satisfaction with recovery phase	assessment of different aspects during the recovery phase (information provided, coordination of involved actors, psycological support)- satisfaction 16 months after the event	Lickert scale	questionnaire	from 1 to 5	literature, participatory methods	high	low	yes, if there is a reference event	Adaptive capacity	community

Community Resilience	Actions	Reconstruction	disturbance is integrated. this indicator refers to a landslide event= disturbance	risk management practises	satisfaction with reconstruction phase	assessment of different aspects during the reconstruction phase (information provided, coordination of involved actors, psycological support)- satisfaction 16 months after the event	Lickert scale	questionnaire	from 1 to 5	participatory methods	high	low	yes, if there is a reference event	Adaptive capacity	community
Community Resilience	Actions	Preparedness		risk management practises	trust in authorities		Lickert scale (mean value of 3 answers)	questionnaire	from 1 to 5		high	medium	yes, if there is a reference event	Adaptive capacity	community
Community Resilience	Actions	Preparedness			knowledge about existing protection measures	knowledge about existing protection measures	number of ticks given a list of existing protection measures, safety feeling from 1 to 5	questionnaire	number of ticks given a list of existing protection measures, safety feeling from 1 to 5	literature	high	medium	universally applicable	Adaptive capacity	community
Community Resilience	Resources_and_Capacities	Human, social		community identity	knowledge of the territory	number of years living in the community	number of years	questionnaire	from 1 to 98		high	medium	universally applicable	Adaptive capacity	community
Community Resilience	Resources_and_Capacities	Human, social	the context is integrated. We can use the language us a proxy for the knowledge of the territory because we are looking at a linguistic minortiy.	community identity	knowledge of the territory	language (ladin, german or italian)	1, 2 or 3	questionnaire	1, 2 or 3		high	high	context specific	Adaptive capacity	community
Community Resilience	Resources_and_Capacities	Human, social		social cohesion	integration in social networks	people they go for help and support in case of an event	list of 6 most important persons	questionnaire	up to 6		high	high	universally applicable	Adaptive capacity	community
Community Resilience	Resources_and_Capacities	Human, social			number of children living in the household	information if children above 12 are part of the family/living in the household	number of children above 12	questionnaire	from 0 to X	literature	high	zero	universally applicable	Adaptive capacity	Household
Community Resilience	Actions	Response	disturbance is integrated implicitly as this indicator refers to the response phase, so after an event happening	social networks	modularity of the community response network	the modularity of the community response network - balance between centrality and dispersiveness	number of nodes representing organizations	questionnaire	no predefined range of values	literature, field work	high	high (my opinion but supportd by expert=SEI peolple opinion :-))	yes (not hazard or context specific). The evaluation of the number of nodes is context specific (e.g. depending on the size of the community)	Adaptive capacity	community
Community Resilience	Resources_and_Capacities	Socio-political		risk management practises	trust in colleagues/officers from other department involved in risk management	personal knowledge of key persons involved in risk management/trust in information and activities among risk management actors	qualitative information	expert interview	qualitative	field work	medium	high	universally applicable	Adaptive capacity	community
Community Resilience	Actions	Preparedness	the context is integrated.the use of this indicator is linked to the existing legal framework	local emergency plan	existenceof a local emergency plan	existence of a local emergency plan	yes, no, in preparation	expert interview	0, 1 or 2	field work	medium	high	universally applicable	Adaptive capacity	community
Community Resilience	Actions	Response	the context is integrated.the use of this indicator is linked to the existing legal framework	local emergency plan	existenceof a local emergency plan	existence of a local emergency plan	yes, no, in preparation	expert interview	0, 1 or 2	field work	medium	high	universally applicable	Adaptive capacity	community
Community Resilience	Actions	Recovery	the context is integrated.the use of this indicator is linked to the existing legal framework	local emergency plan	existenceof a local emergency plan	existence of a local emergency plan	yes, no, in preparation	expert interview	0, 1 or 2	field work	medium	high	universally applicable	Adaptive capacity	community

Community Resilience	Actions	Preparedness		local emergency plan	existence and regularity of emergency drills	existence and regularity of emergency drills	yes/no, number per year	expert interview	from 0 to X	field work	medium	high	universally applicable	Adaptive capacity	community
Community Resilience	Actions	Response		local emergency plan	existence and regularity of emergency drills	existence and regularity of emergency drills	yes/no, number per year	expert interview	from 0 to X	field work	medium	high	universally applicable	Adaptive capacity	community
Community Resilience	Actions	Preparedness		risk management practises	collaboration and information exchange among involved actors	frequency of coordination actions and information exchange among involved actors	social network map	expert interview	0, 1 or 2	field work	medium	high	universally applicable	Adaptive capacity	community
Community Resilience	Actions	Response		risk management practises	collaboration and information exchange among involved actors	frequency of coordination actions and information exchange among involved actors	social network map	expert interview	0, 1 or 2	field work	medium	high	universally applicable	Adaptive capacity	community
Community Resilience	Actions	Response		risk management practises	collaboration and information exchange among involved actors	quality of coordination and information exchange among involved actors	social network map	expert interview	qualitative data (visualisation in the map)	field work	medium	high	universally applicable	Adaptive capacity	community
Community Resilience	Actions	Recovery		risk management practises	collaboration and information exchange among involved actors	frequency of coordination actions and information exchange among involved actors	social network map	expert interview	0, 1 or 2	field work	medium	high	universally applicable	Adaptive capacity	community
Community Resilience	Learning	Critical Reflection		risk management practises	identification of gaps and missing links in the network in order to improve it	number of missing links	number of identified missing links	expert interview	from 0 to X	me (I decided to put this question in the social network mapping)	medium	high	universally applicable	Adaptive capacity	community
Community Resilience	Actions	Response		response networks	Local response network	time needed to activate the local response network	minutes to several hours or days	expert interview	minutes to several hours or days	field work	medium	high	universally applicable	Adaptive capacity	community of circumstance
Community Resilience	Actions	Preparedness		risk culture	knowledge of institutions and organization people should go to in case of an event	coherence between emergency plan and community risk behaviour	no scale of measurement. Interpretation of 2 networks.	interpretation and validation with stakeholders	qualitativ	case study design and field work	high	high	universally applicable. Questions, data collection and validation might need to be adapted to the context.	Adaptive capacity	community
Community Resilience	Actions	Response	disturbance is integrated. this indicator refers to a landslide event= disturbance	risk behaviour	institutions and organization people go to in case of an event for help and support	coherence between emergency plan and community risk behaviour	no scale of measurement. Interpretation of 2 networks.	interpretation and validation with stakeholders	qualitativ	case study design and field work	high	high	universally applicable. Questions, data collection and validation might need to be adapted to the context.	Adaptive capacity	community

emBRACE

This study has been funded by the

European Commission on the 7th Framework Programme

Centre for Research on the Epidemiology of Disasters (CRED)

Catholic University of Louvain School of Public Health

30.94 Clos Chapelle-aux-Champs

1200 Brussels, Belgium

T: +32 (0)2 7643327

F: +32 (0)2 7643441

E: info@cred.be

W: http://www.cred.be

Northumbria University

School of the Built and Natural Environment,

Newcastle upon Tyne

NE1 8ST,

UK

T: + 44 (0)191 232 6002

W: www.northumbria.ac.uk