



Designing and implementing more effective Integrated Early Warning Systems in mountain areas: a case study from Northern Italy

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NOTE DE L'AUTEUR

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Integrated Early Warning Systems (IEWs)

- 1 Early Warning Systems (EWSs) are not simple linear mechanisms limited to the emission of a timely warning. They are complex tools for disaster risk reduction and are only effective if they generate an appropriate response in the exposed population, i.e. a timely reaction that puts the people at-risk away from the danger. According to the United Nations (2006), for an EWS to generate an appropriate reaction it must be people-centred (i.e. more than just a technological intervention) and must include four inter-related elements: i) *risk knowledge*: assessment of the relevant hazards and vulnerabilities considering their dynamics and variability; ii) *monitoring and warning service*: capacity to monitor hazard precursors, forecast the hazard evolution, and issue timely and accurate warnings; iii) *dissemination and communication*: dissemination of

clear and understandable warnings with prior preparedness information; and iv) *response capability*: systematic education and preparedness programmes for people at risk and authorities.

- 2 EWSs have been traditionally conceived as hazard-focused. For this reason the element of “monitoring and warning service” is the aspect of EWSs that has usually received most attention. More recently, however, it has been broadly recognized that a precise forecast is insufficient by itself as disasters are the result of a complex combination of multiple factors, such as environmental, technical, economical and social issues (Wisner *et al.*, 2004). EWSs should be holistic, with a multi-hazard approach that considers relevant local vulnerability elements and the larger social context, reaction capacity, appropriate warning communication strategies and dynamics of the evacuation processes (Wisner *et al.*, 2004; Villagrán, 2007; Garcia and Fearnley, 2012). Furthermore, although scientists and technologists are core actors in EWSs, the roles of the government and population are fundamental in developing an efficient and sustainable EWS (Wisner *et al.*, 2004; Basher, 2006). An EWS that involves the previous aspects with an integrated approach is here called an Integrated Early Warning System (IEWS).
- 3 The importance of considering the larger social context of a particular community in order to plan effective and sustainable IEWSs was analyzed in the study area, where a methodology to implement an IEWS was developed within the framework of the European Mountain Risks project (Garcia, 2011). The methodology, applied in Valtellina di Tirano, northern Italy, resulted from combining traditional technical EWSs, Community Based EWSs and different risk management methodologies. An initial assessment phase of the proposed methodology evaluated the state of the components of the system, including the hazard assessment, the reaction capacity of the population at risk as well as the local root causes of vulnerability, including factors of marginalization among local communities. With this purpose, a comprehensive questionnaire was applied in the study area to ascertain the actual level of risk perception, preparation and knowledge needs, among other issues. In a second phase of implementation, these and other elements of the system were taken into account in order to develop the IEWS adapted to the local context. The initial assessment results are the main focus of this paper and specifically evaluate the relationships of reaction capacity, vulnerability and marginal conditions of the population and their key role in the effectiveness of an IEWS.

Vulnerability, marginality and reaction capacity

- 4 In the last decade the understanding of vulnerability has significantly improved. Comprehensive analyses of the various and complex ways in which social, economic and political systems interact to create conditions that make people vulnerable have been developed by many authors (*e.g.* Gaillard, 2010). Some of these conditions that increase vulnerability include poverty, lack of choice, lack of entitlement, poor governance, loss of traditions, lack of knowledge, low risk perception and apathy, amongst many others (Wisner *et al.*, 2004).
- 5 Marginalization, according to Wisner (2012), refers to the severe limitation of the participation of people in decisions which affect their lives as well as their access to resources and information. Marginalization can have multiple causes including: social

(due to caste, occupation, class status, religion, ethnicity, immigration status, disability, sexual orientation, gender and age); political (reflecting favouritism practiced by ruling parties); geographical (due to restricted physical access to the territory) or economical (due to land and resource allocations and market dynamics) (Wisner, 2012). In most cases, marginalization increases the vulnerability of the threatened population, which in turn decreases their reaction capacity by constraining the ability of individuals to react to, cope with and recover from extreme events (Wisner, 1998; Gaillard, 2010). Additionally, marginalized groups are often dependent on natural resources so they frequently interact with the environment causing its physical degradation for the benefit of economic survival or for settling. This interaction increases peoples' vulnerability to hazards and raises the probability of physical hazards and the severity of their impacts (Wisner *et al.*, 2004). Especially in poor and less empowered communities, the population is usually marginalized by imposition and is forced to live in high risk areas (Wisner *et al.*, 2004). However, this is not always the case. Some people, even from powerful sectors of the society, live in hazardous and marginalized areas by choice (Collins, 2010). This choice is often made with respect to a multitude of reasons including family and historic connections, insurance access or an environmentally attractive landscape.

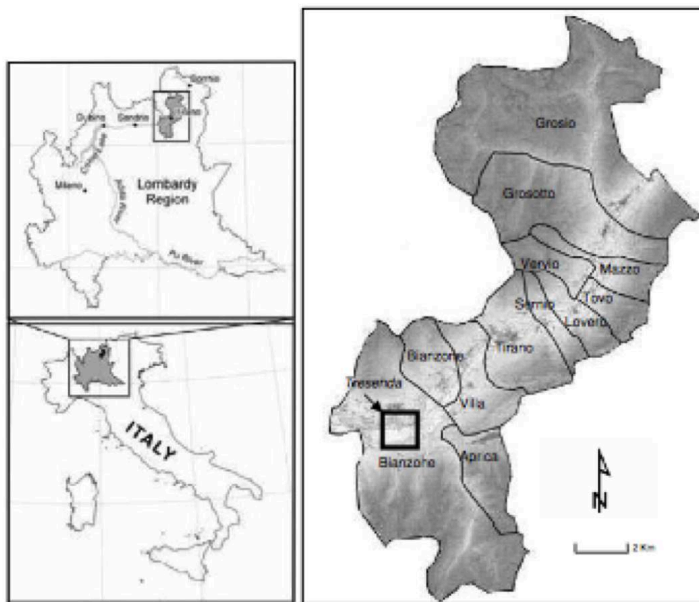
- 6 The reaction capacity of an individual is strongly influenced by marginalization and vulnerability factors (Wisner, 1998; Gaillard, 2010). Among these factors are the levels of risk perception and preparedness which can directly influence people's vulnerability and the way they might react in case of an emergency (Slovic, 1987; Heijmans, 2001).
- 7 Recently, there has been a change of approach as how best to deal with risk. The importance of public participation has been acknowledged by important governmental bodies, such as the European Union. This contrasts with the past when populations were regarded as passive subjects whose interests and needs were taken care of by experts and governmental agencies alone. More recently it has been shown that communities are not passive actors. People are active agents in their context and can influence their environments and change them. Moreover, as pointed by Gaillard (2010), local communities are usually the first line of defence to reduce vulnerability and build resilience. This reflects the importance of people centred and community-based disaster risk reduction initiatives which foster the participation of threatened communities in the evaluation and reduction of risk. As explained by Gaillard (2010), community based initiatives empower communities with self-developed and culturally, socially and economically acceptable ways of coping with and avoiding crises related to natural hazards (*e.g.* Lumbroso *et al.*, 2008). This strengthens peoples' livelihoods and favours the integration of disaster risk reduction into development policy, further promoting the sustainability of the disaster risk reduction efforts. However, it is difficult to put this new concept into practice and make public participation a real and effective strategy. Participatory activities are very demanding, mostly in terms of time and dedication, and they are labour-intensive – they require a shift of mentality, major changes in professional and institutional practices, and the design and implementation of new instruments and procedures.
- 8 Another aspect that affects both vulnerability and capacity reaction is the assumed responsibility for risk reduction. According to Collins (2010), particularly in capitalistic economies, individuals are typically reluctant to participate and invest in their development and prefer the collective investment by the state. In other words,

individuals pay taxes that the state invests into building environmental and social infrastructure, including those aimed at reducing risks (Collins, 2010). By doing this, citizens transfer the responsibility of disaster risk reduction to the government, neglecting their own responsibility. This practice is especially common in wealthy countries where unprepared populations transfer the responsibility to the local authorities by assuming that disaster risk reduction, and in particular preparedness, is predominantly the responsibility of the emergency personnel (Glantz, 2004; Garcia and Fearnley, 2012). Transferring safety responsibility and/or attributing the need for preparedness to others result in people decreasing their reaction capacity, underestimating risk, and increasing their vulnerability (Paton, 2005; Garcia and Fearnley, 2012). This also applies in northern Italy.

Comunità Montana Valtellina di Tirano, Italy (CMVT) and its hazardous environment

- 9 The Comunità Montana Valtellina di Tirano – CMVT (Mountain Consortium Valtellina of Tirano) is located in the central part of Valtellina Valley, between the Orobic and Rhaetian Alps, Northern Italy. The Adda River flows in the bottom of the valley at an elevation of about 350 m a.s.l. while surrounding peaks rise to over 3000 m above sea level. The climate is heavily influenced by the drastic differences in altitude. The precipitation is variable from less than 700 mm/year in the valley bottom to more than 2000 mm/year on the upper part (Ceriani and Carelli, 1991).
- 10 The CMVT, with an area of about 450 km², is composed of 12 municipalities with around 29,000 inhabitants mostly settled in the bottom of the valley. Access to the area is limited to a main road and some secondary routes. The main economic activities are industry followed by tourism and agriculture which is focused on the production of high quality grapes and apples. Vineyards are widespread on the north Rhaetic flank, especially on the terraced slopes with dry stone walls between the municipalities of Toglio and Tirano.

Figure 1. Location of the CM Valtellina di Tirano (Garcia, 2011)



- 11 The valley follows a regional fault line, with the lower valley covered by glacial, fluvio-glacial and colluvial deposits, and the valley bottom covered by alluvial material of the Adda River and alluvial fans of the tributary valleys. The tectonic and post-glacial conditions of the valley, in combination with poor environmental management (deforestation, mismanagement of water resources and overdevelopment of settlements and roads), has given rise to frequent floods and mass movements which have historically caused considerable damage and losses (Alexander, 1988). Among the main damaging events is that of 1987, which affected most of the lower valley impeding the access to the region for several days and causing 53 deaths (Alexander, 1988). This event included a combination of flooding, landslides and debris flows that developed during a heavy rainy season. Another important event occurred in May 1983 in the small locality of Tresenda, Teglio Municipality, when a series of sudden debris flows resulted in 18 deaths. According to the local population, the cause of these debris flows was the combination of high precipitation with lack of maintenance of the vineyard's channels and dry walls.

Results of IEWS assessment: vulnerability and participation

Levels of awareness, risk perception and trust

- 12 In the CMVT, a first survey was developed involving the general population of the whole region. The survey consisted of a comprehensive questionnaire with close-ended questions and was completed by 648 people from three population groups: students from local schools (from 14 to 20 years old), students' relatives (from 30 to 75) and

some general population not related to the schools. The sampling methodology and results of the questionnaire are presented in detail in Garcia (2011). The questionnaire results show that even if nearly 90% of the population has been directly affected or is aware of the existence of large events in the past, the population exhibits low levels of preparedness (2.5 in a Likert Scale from 1 to 5), low risk perception (2.2/5), and a lack of knowledge about risks related to natural hazards (2.3/5). Additionally, the population has medium levels of trust (3/5) towards the local authorities and the entities responsible for hazard monitoring and emergency management at local level. Furthermore, the population feels that the current warning system will provide them with sufficient time to escape personal harm, regardless of the dimension or characteristics of a future event. This corresponds to a transfer of responsibility to the authorities, who are expected to manage the emergency without involvement of the population. However, respondents are aware of their lack of preparedness and show a strong interest not only in increasing their risk knowledge and preparedness, but also in participating more actively in disaster risk reduction efforts.

- 13 Results of the questionnaire indicate that most of the surveyed population have not received information about natural hazards, there is a general lack of knowledge regarding the emergency management plans and non-structural mitigation and protective measures that individuals can take to protect themselves. This reflects a general lack of self-responsibility with regard to risk reduction. It is also related to the general lack of participation of the population in the decision making process. These results are similar to those obtained by De Marchi *et al.* (2007) in the region of Trentino-Alto Adige, north of Italy. Trentino is an area with a significant history of flooding where, despite the official warning system, only a minor portion of the population knows how to respond when an impending hazard warning is received.
- 14 Particularly in Tresenda, the local population believes that the main cause of the 1983 debris flow that caused 18 deaths was the collapse of a dry wall into a water channel from an uphill vineyard. The water channel was blocked for several days, causing water to accumulate in a naturally unstable area, triggering the mass movement. Some key respondents think that if the vineyard owner had notified the authorities and cleared the water channel, the mass movement could have been avoided or the population at risk could have been evacuated in timely fashion.
- 15 Historically, most of the population of Valtellina lived on the slopes of the valley. As a consequence of the event of 1987, however, the number of people living in the flood-prone alluvial plain has increased significantly. This is a result of the construction of large structural mitigation works following the 1987 event, upon which residents rely heavily for protection from future floods and debris flows. As described by Etkin (1999), this reliance on structural flood defences generates a false sense of security and therefore increases vulnerability over the long-term. People feel that the structures will protect them, no matter the magnitude of the event, and for this reason they do not take any self-protection measures. This constitutes another means of “responsibility risk transference”, not towards the authorities but towards the structural works.

Root causes of vulnerability

- 16 To understand the root causes of people's vulnerability, a second survey, developed in collaboration with Dr. Graciela Peters-Guarin, was applied exclusively in the small locality of Tresenda, Toglio Municipality. The survey consisted of a series of open-ended face to face interviews and had 25 respondents from the local population. Tresenda, a locality of 1,200 inhabitants, has been affected by several disasters in the past. In Tresenda, as well as in most parts of Valtellina Valley, viticulture has been a strong traditional activity of the local population. Since the year 1400 AD the presence of steep slopes has led to the creation of artificial terraces supported by dry stone walls. This system of artificial terraces, water channels and roads caused changes in the natural slopes' conditions and also a high dependency on man-made structures for slope stability, as the terraces and walls demand constant maintenance. According to the population, in the past, farming ensured maintenance not only of the vineyards but also the terraces and water channels. Currently, there are few economic benefits from cultivating vineyards and this has led to the abandonment of cultivated land, as people do not have the resources to invest in maintenance. Forests that grow in abandoned vineyards help to stabilize the terrain. However, there is a period of high risk between the moment in which the vineyards are abandoned and when a forest is adequately established. According to a key respondent, the presence of farmers decreased since around 1975, resulting in a decline of maintenance of terraces and channels. This in turn led to the instability of the slopes. This may have been related to the Third Industrial Revolution (Giannetti and Vasta, 2006), a major change in the industrial economic system towards a more technological structure in the 70s.
- 17 Currently, small vineyards are no longer a lucrative business. Consequently, small farmers lack the resources to clean the channels and to fix deteriorating dry walls as they have been economically marginalized due to the expansion of the wine industry. The wine industry demands production standards and a degree of sophisticated technology that cannot be achieved by small producers. Additionally, in Italy, the big wine companies receive subsidies from the government, whereas the small farmers lack government support.
- 18 Respondents stated that the abandonment of local agriculture has generated a strong rural exodus. This occurs especially within younger populations, generating a high percentage of elderly people in Tresenda. In contrast, an increased number of national and foreign immigrants have arrived who are usually not well informed about local hazards and have problems integrating into the local community.

Participation

- 19 The assessment phase of the IEWS indicated that significant efforts have been made in Italy to enhance civil protection leading to important improvements to the current risk management framework. Furthermore, scientific understanding of risk factors has increased remarkably in the last several decades at the global level, and the importance of public participation in increasing the effectiveness of disaster risk reduction strategies has been acknowledged by important governmental bodies, as previously stated. Unfortunately, the divide between scientific research, risk legislation and risk management still exists. Moreover, little is done to involve the at-risk population. The

scientific community and government authorities make most decisions and tend to assume that the general population is not interested in participating in disaster risk reduction and that by paying high taxes to the state, people transfer the responsibility of disaster risk reduction to the authorities (Garcia, 2011).

- 20 In addition, the key role that volunteers play in the Civil Protection System in Italy is a positive example for many countries and has proven effective for the management of several emergencies. However, the fact that volunteers are seen as the representatives of the population leads to most preparedness activities involving only volunteers, while the preparedness of the general population is neglected. In the studied region, even though there have been some emergency exercises with the volunteers of the Civil Protection System, the emergency plans and procedures have never been communicated to the population, and drills involving the population at risk have not been performed despite this being mandatory by law. As a consequence, the actors involved in the decision making are almost exclusively government, some scientific advisers and the Civil Protection System. This shows that to some extent there is a strong disconnect between what is established by law and what is effectively carried out.
- 21 In Tresenda, the population generally has knowledge about structural preventive measures. The survey respondents recognised the importance of maintaining water channels and reinforcing terrace dry walls. Nonetheless, most of the population assumes that they are not responsible for these preventive measures. There is a strong transference of responsibility to the state and to the owners of the vineyards, whom the population considers responsible for construction and maintenance. However, a great majority of respondents in both surveys confirmed that they were willing to collaborate as volunteers in undertaking the construction and maintenance of prevention measures. Once again this establishes that the population is willing to participate in disaster risk reduction efforts as long as they receive guidance. Furthermore, technicians of the local government authority in charge of the prevention and mitigation stated that the economic and human resources were inadequate to attend the whole territory. This observation emphasizes the usefulness of involving the population.
- 22 Finally, the population of Tresenda, including several respondents, has been repeatedly evacuated as precautionary measure during particularly strong rain events that did not trigger mass movement. Even if this could be considered as “false alarms”, respondents clearly stated that they agree completely with the past evacuations and that they will evacuate again if the authorities consider it necessary. This shows that in this particular locality the population has high levels of trust towards the authorities and high levels of awareness of the population, in spite of their low levels of risk perception.

Discussion

- 23 Vulnerability and marginality vary significantly within a community over space and time. In both surveys, for the CMVT and Tresenda, most respondents have experienced an event or have knowledge of past events. In spite of this, most respondents are poorly prepared and have little knowledge about the hazards to which they are exposed. Furthermore, most respondents have low levels of risk perception as they consider

future events unlikely. In addition, the population of the CMVT, including Tresenda, is marginalized in several ways: geographically due to restricted road access to the region and their exposure to hazardous events; and socially, due to the lack of participation in the decision making process and their lack of access to information. Irrespective of the previous similarities, there are significant differences between Tresenda and the rest of the CMVT. Tresenda residents have a low socioeconomic status. Many are elderly and immigrants. In the rest of the CMVT, especially in the urban areas, the population usually has higher incomes, applies better land use practices, and there are lower immigration rates. Therefore, it appears that Tresenda residents are more vulnerable than the general CMVT population.

- 24 The lack of participation in decision making and preparedness activities is one of the main factors contributing to the vulnerability of the whole CMVT population. The volunteers of the Civil Protection System are seen by the government as representatives of the population, which leads to the exclusion of the rest of the common citizens. Furthermore, a large part of the population assumes a passive position, leaving the decision making to the state and limiting itself to paying taxes. Some people assume this tax payment as their main role in disaster risk reduction but what is actually doing with it is transferring the responsibility of disaster risk reduction to the state which could be seen as a self-marginalizing attitude. However, the population wants to reduce their vulnerability. They want to be involved in mitigation and preparedness activities so that they can be ready to react in case of hazardous events. Particularly in Tresenda, the population is willing to collaborate as volunteers in the maintenance of the channels, which are one of the main causes of instability. However, the population lacks self-initiative and waits for the state to provide means of participation and involvement. Until the present day, the state has failed to provide these means.
- 25 Finally, even if the existent disaster risk reduction activities in CMVT might be independently valuable, they are not linked and do not conform an IEWS. Therefore, a disaster might not be avoided in case of a large hazardous event. In addition to the integration of the already existent disaster risk reduction activities, to achieve an effective IEWS it is necessary to stop the transference of responsibilities among the different actors and to promote the active participation of the population in the decision making and other disaster risk reduction activities. To achieve this, local authorities and scientists should initially promote the development of participatory communication campaigns, to discuss the local risks and to analyze disaster risk reduction activities that can be performed by the different actors or stakeholders. These campaigns should be developed in public places and local schools.

Conclusions

- 26 Vulnerability, marginality and reaction capacity are strongly related and understanding this relationship is fundamental to developing an efficient IEWS. Changing social and economic circumstances can increase vulnerability and at the same time modify the hazard. Therefore, changes in traditional livelihood activities, economic systems and population demographics must be considered in order to understand processes leading to vulnerability and disaster risk. In Tresenda, a small wine region of the study area, the changes are partially related to the withdrawal of

traditional agrarian practices due to a shift towards a more technological system during the Third Industrial Revolution of the 70s. This resulted in subsequent depopulation, land abandonment, environmental deterioration and higher slope instability. These combined factors reduced the population's ability to cope with environmental change generating an increase of vulnerability.

- 27 Furthermore, overestimating existing knowledge and the effectiveness of structural mitigation measures as well as transferring responsibility and/or attributing the need for preparedness to others, result in people decreasing their reaction capacity, increasing their vulnerability and underestimating risk.
- 28 The scientific community and government authorities in Italy tend to assume that the general population is not interested in becoming involved in disaster risk reduction because they do not spontaneously participate in any related activities. On the other hand, the communities assume that by paying higher taxes to the state, they transfer the responsibility to the authorities. However, it was found that most people actually want to be involved in disaster risk reduction and assume their own responsibility. Thus, in order to improve the state of disaster risk reduction and to develop an IEWS in the study area it is necessary to involve all stakeholders, including the population at risk, particularly the marginalized citizens such as the elderly and immigrants. This has the objective of building trust and confidence among all the actors through a process of public participation, acceptance of responsibility, mutual learning and collaboration and at the same time aims to decrease vulnerability by increasing risk awareness and improving public preparedness and reaction capacity of the targeted population. This increase of participation could be achieved through community based initiatives that empower communities in preparedness and decision making.
- 29 Finally, to achieve effective disaster risk reduction it is fundamental to improve the networking and communication among all stakeholders. An effective IEWS can only be achieved once stakeholders understand that they are all part of the IEWS and are therefore responsible of its efficiency and sustainability. However, IEWS alone are not enough – they must be combined with other equally important disaster risk reduction measures, such as spatial planning, education and loss compensation.

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RÉSUMÉS

It is essential to consider and to understand the social context in which an Early Warning System (EWS) is planned and to integrate all of its components, otherwise it is likely to fail. EWS are complex tools for disaster risk reduction which are only effective if they generate an appropriate response in the exposed population. Any effective EWS relies on the reaction capacity of all stakeholders. This reaction capacity is strongly dependent on how well EWS are integrated within their social context, especially with regards to potential marginalized and vulnerable communities. This dependence was confirmed in the study area in Valtellina di Tirano, northern Italy, which is recurrently affected by multiple mountain hazards. The local population is geographically marginalized due to restricted access to the region and exposure to hazardous events, and socially marginalized due to the lack of participation in decision making. Results of a survey show that the local population has low levels of perceived risk, a general lack of self-responsibility with regard to disaster risk reduction, and a tendency to transfer the responsibility to the authorities. However, respondents acknowledge and show interest in addressing their lack of preparedness and in participating actively in disaster risk reduction efforts. A follow-up survey demonstrates that significant variations in vulnerability within a given community over time, occur together with changes in traditional livelihood activities, economic systems and population demographics.

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Keywords : early warning systems, integration, marginalization, responsibility, vulnerability

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