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The role of community knowledge and participation for inspections of hydraulic structures: a citizen-science project

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Extended abstract

This paper examines stakeholder perspectives regarding the implementation of citizen-science projects, with particular focus in the Fella basin, a mountain basin in the Eastern Italian Alps, Friuli Venezia Giulia region. We used preliminary and final empirical work of the CHANGES[1] project via semi-structured interviews and data-collection exercises. Therefore, we present a framework for designing a citizen-science project for the inspection of hydraulic structures in the Fella basin. The findings of our case study highlights the importance of the existence of a culture of volunteer activities and the role of institutional frameworks to support citizens' involvement. However, challenges remain in terms of the need for tailor-made ICT tools and geo-information management systems to actually implement, manage, and maintain citizen-science projects. In addition, to develop this pilot into a perennial activity for training and feedback strategies for volunteers is essential. Attention is also needed for coordination and communication strategies between different actors. Such interaction may not only includes organizations that facilitate the implementation but also those that may benefit from the use of volunteers' data.

1. Introduction

The increasing complexity and frequency of hydro-meteorological events requires a shift towards adaptive management strategies. Such strategies aim at enhancing the adaptive capacity of a risk prone area to cope with changing and unforeseen environments (Merz et al., 2010). Moreover, adaptive capacity is comprised of four dimensions (Berkes, 2007; Folke et al., 2003.): 1) Learning to live with change and uncertainty while building a memory of past

[1] Marie Curie ITN CHANGES - Changing Hydro-meteorological Risks as Analyzed by a New Generation of European Scientists. The CHANGES project specifically focuses on hydro-meteorological hazards, in particular floods and landslides within four mountain basins. Those are catchment of the Targaniczanka stream (tributary of Wieprzówka River, Poland); Barcelonnette Basin in France; Nehoiu Valley in Buzău County in Romania and Fella Basin at Val Canale in the Friuli Venezia Giulia Region, Italy.

events; 2) Fostering diversity in management options; 3) Creating opportunities for self-organization in the face of crises and disaster; 4) Combining different types of knowledge for learning.

Adaptive capacity is represented by the set of available resources and the ability of a system and its parts, e.g. socio-institutional organizations, to design and implement effective adaptation strategies for coping with current or future events (Adger et al., 2011). In this sense, adaptive capacity can be related to the organizational capacity of socio-institutional organizations that have competences in a risk prone area. This connection becomes evident by considering the different dimensions of organizational capacity (Figure 1).

Therefore, links between institutional and community organizations become relevant for adaptations strategies, especially in the case that these links focus on complementary knowledge and resources (McFadden et al., 2009). However, unless knowledge leads to actions to reduce local hazards, exposure or vulnerability, it rarely results in effective adaptation strategies (Holcombe et al., 2013).

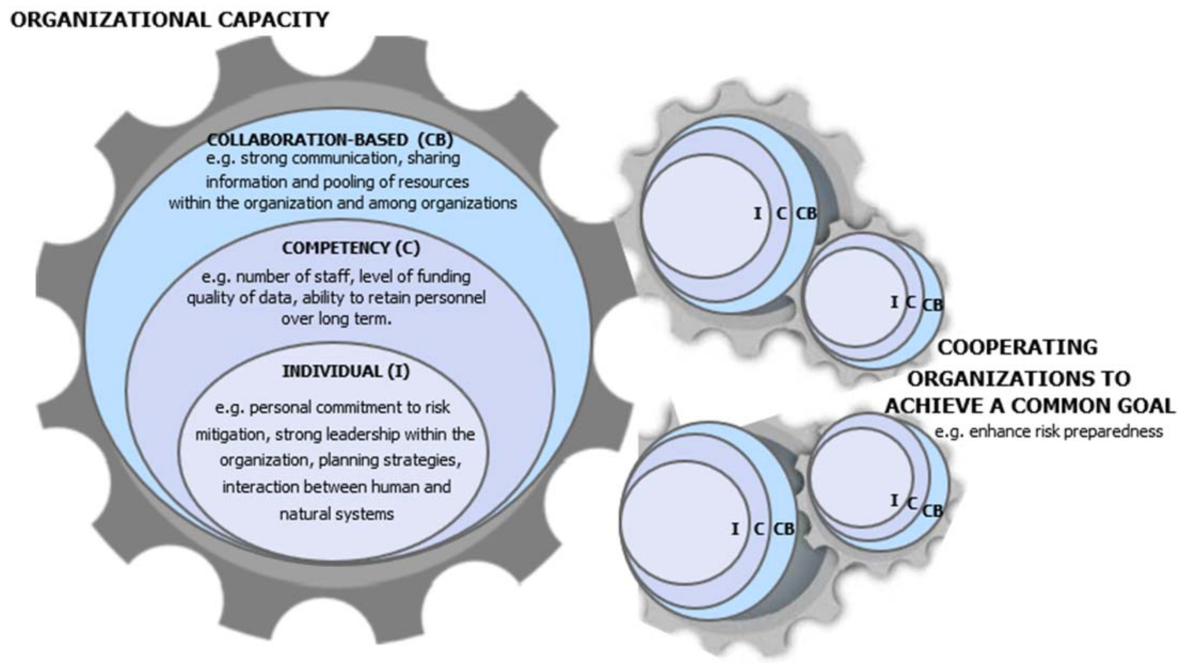

Figure 1. Dimensions of organizational capacity based on Brody et al. (2010)

In mountain areas, especially in the European Alps, hazard mitigation has been traditionally organized by implementing structural measures. However, the flow and sediment processes also affect the quality of hydraulic structures (so-called functional status), and vice versa (Holub and Fuchs, 2009). Under changing environments, frequent inspections of mitigation and hydraulic structures are important but also time consuming. A win-win situation can be created if institutional organizations dealing with the management of hydraulic structures involve community organizations.

One way for that engagement to be established is through the implementation of citizen-science projects for inspections. A citizen-science project, as understood within this research, is a project in which scientists and risk managers enlist and train citizen volunteers to better understand the environment and hazard related processes (Devictor et al., 2010). For example, changes on the functional status of hydraulic structures according to management needs.

Opportunities in promoting citizen-science projects in general stem from the increasing frequency, timeliness and coverage of surveillance activities (Flanaging and Metzger, 2008). Therefore, there is an increasing interest from risk managers such as municipal offices, civil protection, water authorities and geological surveys in adapting to the context of such citizen-based approaches. This approach (the design and implementation of a citizen-science project) enables in-practice strategies to potentially strengthen adaptive capacities through: 1) encouraging and training those who have the disaster memory to get involved and provide input into risk management practices; 2) introducing new management inputs including the local level organizations, volunteers groups; 3) fostering a knowledge base through trainings to encourage active involvement in management strategies; 4) and providing additional informational sources including the integration of local knowledge.

2. Methods

There are several potential areas or ways in which science and traditional knowledge can develop collaboration and communication. Community-based monitoring and by alternative types of citizen-observations become complementary information especially when they provide insights regarding local impacts and changes (Folke et al., 2003). However, integrating these two kinds of knowledge into decision-making is a difficult proposition that has come under discussion only relatively recently (Berkes, 2007). Furthermore, scientists and decision-makers have a general lack of confidence due to the limited accuracy, non-comparability and incompleteness of citizen-collected data (Conrad and Hilchey, 2011; Riesch and Potter, 2014).

Failing et al (2007), has emphasized the importance of a decision-focused approach to contribute towards the integration of both types of knowledge. Moreover, we present a framework for designing and implementing a pilot citizen-science project in the Fella basin (Figure 2). The need for such framework started from the requirement of local communities and authorities to enhance maintenance strategies of mitigation works.

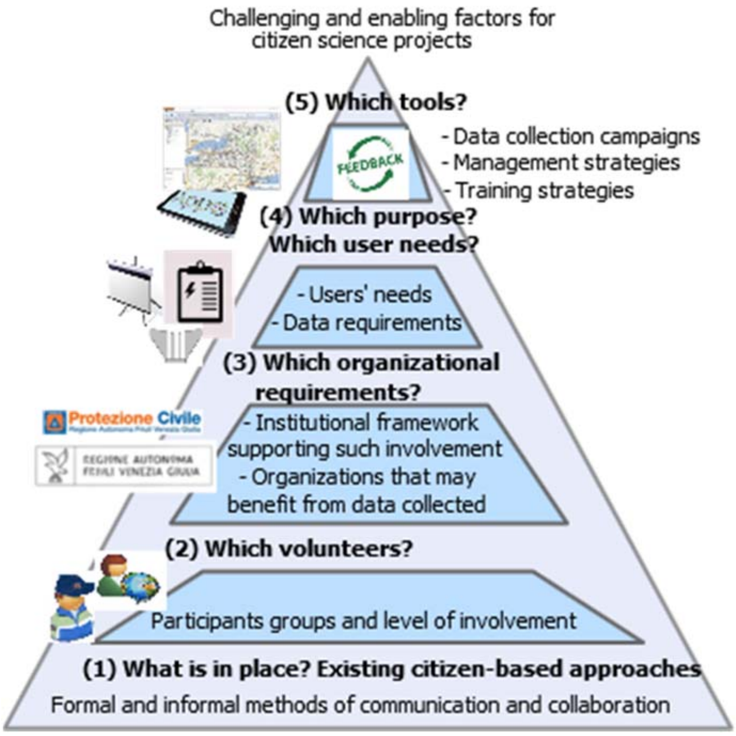

Figure 2. Framework for designing citizen-science projects for the inspections of hydraulic structures with citizens' volunteers.

3. Results

The framework implemented followed a user-centered design. Such approach is an iterative process starting by users' requirements, definition of data-collection procedures and evaluation of data quality for the final design of required support tools. Table 1 summarizes the perspectives and feedback of stakeholders along the different design stages of the citizen-science project in Fella basin. The first stage in Figure 2 was carried out from the preliminary and final empirical work of the CHANGES project via semi-structured interviews.

These interviews were focused in analysing the institutional frameworks that are in place in the study areas of the CHANGES project. From these interviews, perspectives from the stakeholders indicated that targeting the monitoring of structural mitigation works was of vital importance and was indeed seen to be an issue within the Fella region as well as the other four case study sites of the CHANGES project (Nehoiu catchment in Romania, the Barcelonnette basin in France, and the Wieprzówka catchment in Poland).

Exploratory interviews were also carried out with focus on identifying citizen-based approaches in the Fella basin, FVG (Italy). Therefore, the main requirement as expressed by risk managers was to support decisions about obstructions of hydraulic structures and to pre-screen problems for more technical and detailed inspections in the Fella basin. Stage 2 continued with the selection of target groups for the citizen-science project. Citizens were involved in the form of civil-protection volunteers due to their strong and long history of involvement within Civil Protection activities and Fire brigades. The range of participants was widened to include university students in order to account for assumed differences in preliminary knowledge to carry out inspection procedures. Stage 3 was carried out by the design of an inspection form with four technicians from the region. Thereby, organizations facilitating the implementation (Civil Protection) were involved as well as organizations that may benefit from the data collected (e.g. Geological survey and Forestry Service). Stage 4 included a pilot data-collection exercise that involved 11 technicians and 25 volunteers. The exercise focused on evaluating data quality collected by volunteers (Cortes Arevalo et al., 2014). The pilot activities concluded with a discussion of procedures with technicians for later examination of volunteers' data and its use for decision-making. Thereby, we proposed a decision support methodology to evaluate data collected while establishing an indication of the functional status of the structure.

Overall, risk managers are willing to consider volunteers' inspections only to pre-screen potential problems that may require preventive maintenance. Findings highlight the importance of a culture of volunteer activities and the role of institutional frameworks in supporting volunteers' involvement.

Table 1. Perspectives and feedback of stakeholders along the different design stages

Challenging factors	**Enabling factors**
Step 1. What is in place existent citizen-based approaches?	
• Limited quality control of the data collected with volunteers' groups. • Requirement to support methodologies and tools to evaluate data collected.	• Promoting campaigns in the schools to raise awareness of the locals. • Mapping activities carried out with the University of Trieste in which volunteers geo-locate hydrants. • Scheduling of Inspection campaigns to identify damages on dikes.
Step 2. Which volunteers?	
• Engage volunteers on perennial activities and regular inspections	• Culture of volunteer activities that facilitate the engagement of participants.

besides emergency management activities.	• Institutional support to community groups in the form of civil protection and fire brigade groups.
Stage 3. Which organizational requirements?	
• Attention needed to clarify the responsibility for the maintenance of protection structures between the local (commune) and regional authorities.	• Interest to exchange information between technical organizations in local and regional level to support risk mitigation strategies. • Available platforms and mobile tools that support exchange of risk information between organizations and to the public.
Stage 4. Which purpose? Which user needs?	
• Need for innovative training strategies. • Short handout, which can be taken with them to the field to support their choices. • Iterative design and testing of survey procedures. • Exploit usability of mobile applications for form compiling, completeness checking, data transferring and photo recording.	• Initiative to instruct volunteers on the observation of the territory with a preventive scope. • Interest to understand and to prescreen the functionality of the structure. • Scheduling hydraulic-structure inspection campaigns.
Stage 5. Which tools? Initial focus was on the DSS methodology	
• Develop a more comprehensible and simple interface that guides technicians.	• Interest to test decision support methods,. i.e. index calculation that denotes the status of the structure as compared to limited conditions.

Results also account for the role of ICT tools and information management systems to collect, manage and evaluate volunteers' reports. However, challenges exist in making this pilot a perennial activity and stem from the importance of volunteers' training as well as coordination and communication strategies between actors involved. Therefore, inspection guidelines should support completeness and precision of volunteers' reports. Training strategies should also account for providing feedback to participants about the data-quality collected after every inspection campaign. Moreover, sustainable implementations of citizen-science projects require efforts to enhance coordination and communication with volunteers. Such requirements should also apply between the different risk managers that may benefit from volunteers' data.

4. Conclusions

Through the design and implementation of this framework, the research identifies that opportunities to enhance organizational capacity through citizen-science projects require a flexible design framework accounting for available actors and resources in the local context. Furthermore, despite some of the challenges, the potential strengthening of communication and coordination between those actors through such a framework is a vital element towards sustainable implementation on a long-term basis.

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