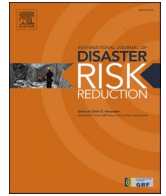




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Risk perceptions and management strategies in a post-disaster landscape of Guatemala: Social conflict as an opportunity to understand disaster[☆]

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ABSTRACT

This work analyses a post-disaster case study in Guatemala where a large landslide named “Los Chorros” affected several communities and one of the country’s main highways. Risk managers, starting from their own assessment, decided to respond in a way that did not coincide with the interests of the affected population. Local communities assessed the disaster risk situation from a different conception of risk and developed an alternative solution. Competition for priorities and solutions for risk management reveals that disaster risk is a complex and holistic concept, comprised of a large set of components. The first objective of this work was to identify the criteria and components chosen by each actor to define disaster risk and the approaches employed during risk assessment. The second objective concerned the study of strategies deployed by actors to legitimize both their assessment of disaster risk and its treatment. Using interviews and observation of practices it is possible to affirm that the actors consider very varied criteria when defining a risk situation. These criteria are material, symbolic, natural, economic, social and are linked to the types of vulnerabilities that actors face and recognize. Risk management measures depend on the specific arbitrations of each actor and their ability to be recognized as legitimate. The challenge for decision makers is to involve the various stakeholders, integrate the risk perceptions and assessments carried out by each actor and subsequently seek a compromise to determine which actions are the most appropriate in terms of social acceptance and technical validity.

1. Introduction

In developing countries, populations and territories are subject to multiple risks and vulnerabilities. Actors within such contexts manage risk at different scales and levels: authorities, technicians, administrators, territory planners, merchants, local communities, indigenous and non-indigenous groups. However, conflicts often arise because each actor has their own perception of the problem and particular interests, hindering the effectiveness of potential solutions. The challenge for decision makers is to involve various stakeholders, integrate risk perceptions and assessments carried out by each actor and seek a compromise to determine which actions are the most appropriate in terms of social acceptance and technical validity. To achieve this compromise, it is necessary to set aside the dichotomy between technical and vernacular knowledge in order to explore the complexity of risk perception. The conflict between actors over the characterization of disaster risk and its resolution is presented here as an opportunity for understanding the underlying aspects of a society related to disaster risk.

The way in which actors conceive and perceive risk reveals aspects that are not always considered in risk assessments and the designing of solutions but are nevertheless necessary.

Starting with the works of White [1]; successive authors have studied perceptions of risks and disasters [2–5]. Risk perception can be defined as “an assessment of the probability of hazard and the probability of the results (most often—the negative consequences) perceived by the society” Lechowska [6]:1342). Precisely, authors question how perceptions condition risk management [7–9]. According to Gaillard [10] two main fields of study on this topic can be identified. Firstly, a group which considers that the reaction of each actor is conditioned by their interpretation of a threat to which they are exposed [11,12]. The second group regards reactions as mainly limited by social, cultural, economic and political forces [13–18]. In addition, some authors consider that risks perceived by society can differ from those identified by risk specialists due to: i) the type of knowledge i.e. technical or vernacular [19–21], ii) institutional affiliation [22,23], or iii) being insiders or outsiders to disasters [24,25]. Nonetheless, other authors reject thinking

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in terms of a division between technical and vernacular knowledge since it is a reductive dichotomy [26,27]. Neither the point of view of the community nor that of external agents can claim possession of absolute truth or be considered as the only legitimate point of view. The dichotomies between institutional and non-institutional, technical-vernacular, internal-external are insufficient to account for the richness found in the interpretations of each actor. In turn, such a reductive viewpoint neglects the complexity of the interrelationships between actors, such as the common ground or rifts that may exist between them, which affects management and action itself.

Disasters are considered serious disruptions of the functioning of a system, community or society that cause deaths and material, economic and environmental losses, which exceed the capacities of the affected community to face the situation using its own resources [28]. While a disaster is closely linked to the *consequences* and unwanted impacts of a hazardous event due to a lack of management (or mismanagement), disaster risk (DR) is associated with the *probability* of a hazardous event and its negative consequences, in terms of lives, goods, services, livelihoods, etc, occurring as a function of vulnerability, exposure, hazards and capacity [28]. The specific interests and varied perceptions of actors can often give rise to conflicts during the elaboration of disaster risk reduction (DRR) strategies [29–31]. When solutions implemented to deal with a given risk are not adequate, not accepted or not used by all actors within the territory, the risk can increase and new risks can emerge [32–34]. Conflicts highlight social trends related to the acceptability of public policies and projects, the role of technical knowledge, aspiration, deliberation, and uncertainties [35]. A social conflict can arise from socio-psychological dynamics such as opposing values, interests and needs [36] and is most generally described as “a struggle over claims to scarce status, power and control of resources” [37]: 5) to which actors attribute a value [38]. The root causes of conflict can be linked to basic human needs and the availability of resources, as well as to structural conditions such as oppressive or unequal social relations and to exploitative economic and environmental systems and development models [36]. Since conflicts involve ethical and psychological dimensions, as well as political, economic and structural ones [36], it is accepted as a conceptual and analytical tool. In this work, conflicts are considered indicative of the factors that constitute disaster risk (e.g. roads in poor condition, lack of hospital infrastructure) and can reveal underlying aspects of a society. Using the social constructivism approach [39,40] and the PAR model [41], where disaster risk is considered to be the result of social, political, economic and historic processes, this work not only underlines the differentiated perceptions of risks but also the factors that structure vulnerabilities and disaster risk [42]. It is precisely these factors or root causes of disasters that can crystallize or manifest themselves in conflict situations.

The first objective of this work was to identify the criteria chosen by different groups of actors to define and perceive disaster risk, as well as the reference systems and approaches mobilized during the risk assessment process. Considering that multiple actors are involved in the implementation of solutions and risk management, this work seeks to understand how each actor forms their own definition of disaster risk. With this in mind, perceptions are analysed by means of risk approaches, which are generally divided in two conceptual points of view: the dominant paradigm and the radical paradigm [32,43]. Within the dominant paradigm we can find i) natural science approaches [44] or “pure determinism approaches” [45], where disasters are considered a result of natural hazard components and ii) applied science approaches [44] or “mechanistic engineering approaches” [45], which focus on hazard, exposition and physical vulnerability. Associated DRR strategies generally concentrate on structural [46] or technical [47] measures concerning human infrastructure, such as housing, public facilities, production units, and networks. Meanwhile, in the alternative radical paradigm we can find iii) social science approaches [44], oriented towards vulnerability studies and iv) an integrated approach [44], where disasters are treated within patterns of daily life and livelihoods, and

vulnerability is understood as a socially produced condition resulting from political, economic and social processes such as underdevelopment and marginalization [39,41,42,48]. The DRR associated with this second paradigm are based on non-structural measures [46] such as poverty and inequality reduction, promotion of both participation by the population and governance at the “grassroots level”, and community-based disaster risk management [49]. The second objective concerns the study of the strategies deployed by actors to legitimize both the assessment of disaster risk and its treatment. When resources are insufficient, all points of view are not included and actors are forced to argue their own interpretations of disaster risk. In a game of negotiation, compromise or confrontation, actors mobilize solid arguments to legitimize their implementation proposals. Finally, this work addresses the decision maker’s dilemma, which is to find a compromise between technically valid and socially acceptable (as well as economically viable) solutions. This article analyses a post-disaster case study in San Cristóbal Verapaz, Guatemala, where a landslide named “Los Chorros” affected several communities and one of the main highways West-East access to the country. The event had a strong impact on the population regarding their perception of landslides and their tragic consequences, blocking the movement of goods and people for months, destabilizing the local economy and causing conflicts over the adaptation strategies developed by risk managers. The study of conflict between actors can reveal the underlying causes of disaster risks and thus aid in characterizing and analyzing disaster risk in order to improve our understanding.

2. Material & methods

2.1. Study area

The study area is located close to the city of San Cristóbal Verapaz, Guatemala, along an active fault called Polochic. This fault is at the border between the Caribbean and North American tectonic plates. The area is mountainous, containing a series of river valleys and a corridor. The RN-7W route was built along this corridor to link the east and west of the country, causing significant urbanization and densification in the area. The majority of the population (85%) is indigenous, from the Mayan Pokomch’í ethnic group. Some 32% of the population live in urban areas and the remaining 68% in rural hamlets. Administratively, these communities are organized in COCODES (Communal Development Councils) and are mainly dedicated to the cultivation of corn, beans, sugar cane and fruits. There are also gypsum deposits in the area that belong to the COCODES and are exploited by a group that transports the mineral.

In accordance with the Road Development Plan, the RN-7W represents an opportunity for the economic, social and cultural development of the country. The RN-7W route is of vital importance for local residents and merchants, as it allows access to local markets, urban health centres and schools. In turn, the RN-7W is used by gypsum transporters since this road directly connects to the capital and the main gypsum company named Cementos Progreso via the CA-14 road (see Fig. 1).

On January 4, 2009, a large landslide called “Los Chorros” occurred in the area. A series of large blocks separated from the side of the mountain, moving between 8 and 10 million cubic meters of rock. The activation area was located at an altitude between 1300 and 2020 m above sea level. The collapsed material moved downstream at high speed in the form of an avalanche of stones and extended for 2 km, to an altitude of 950 m, halfway along the Agua Blanca valley [50]. The landslide destroyed 1.2 km of the RN-7W road [51]. Official reports recorded a total of 34 people dead, 30 missing, 20 wounded, 928 people evacuated and 1893 transferred to shelters [52,53]. The road’s destruction and subsequent closure to all crossing negatively impacted the population: blocking the movement of people and goods for months, interrupting activities and functions (commercial, school, health and community, among others), and destabilizing both the local and regional economy. Due to the impacts of the landslide hazard, the

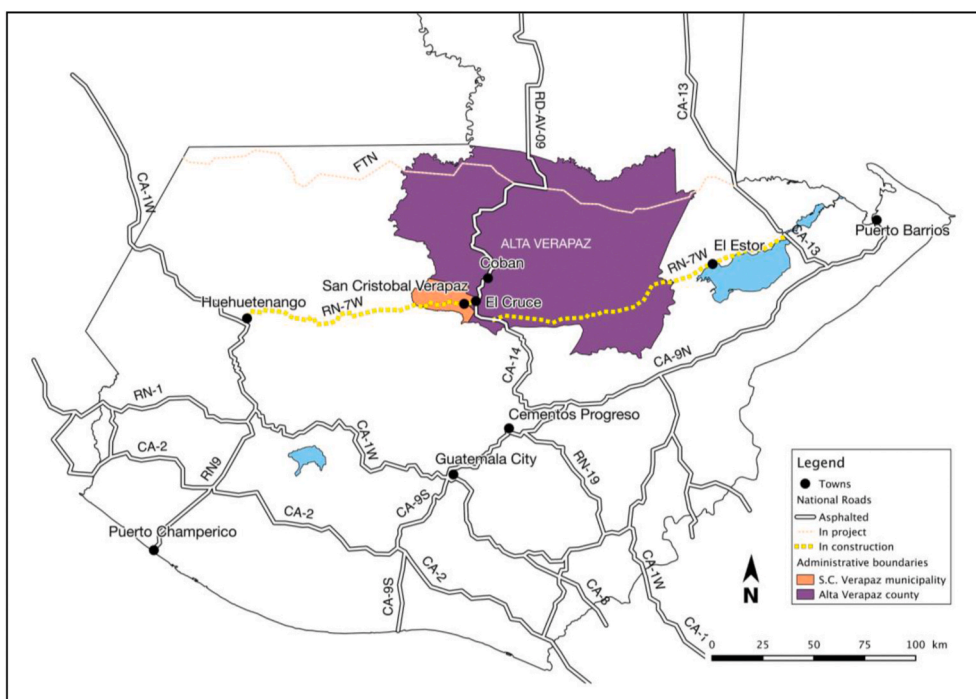


Fig. 1. Map of main routes of Guatemala and the study area.

vulnerability of the local population to such disruption and a lack of local capacity to mitigate the impacts, the situation in Los Chorros can be classified as a disaster. Due to the scale of the event, a special commission was formed under the responsibility of the country’s Vice-President to assess the situation and agree on measures. Three priorities were established: the emergency response, the construction of an emergency route and the search for a safe route for the RN-7W road [51].

3. Methods

An empirical case study approach was chosen for this work [54–56] with the aim of studying a contemporary phenomenon in-depth within its real-world context. Three instances of fieldwork were carried out in 2009, 2011 and 2013, producing a total of 11 months of observation. This was followed by verification and monitoring of the situation in 2017. The practices approach, known as Practical sciences [57,58], was used to study *modus operandi* (ways of doing things) in order to highlight how each actor defines what is at risk and the solution to deal with it. Practices are inserted in a context and cannot be understood as mere behaviour [59] because they refer on the one hand to the ways in which actors establish links between them, in a space structured by the institutions and organizations of society, and on the other hand to the subjectivity produced by each actor via their biographical trajectories, routines and practical knowledge. By observing each actors practices, the researcher is able to identify the main characteristics of a society: the structures and institutions into which individuals fit as well as the exchanges, information and games of power that are established through these practices. During fieldwork, participant observation [60], photography, and video capture were used to interpret the practices of the actors in their real-world contexts. This was made possible by the acceptance of the researcher by those people being observed. Practices were captured during engagement in shared activities and tasks with observed individuals as well as outside of direct interaction. In both cases, and when circumstances permitted, notes, photos and videos were taken as necessary for identifying aspects of observed activities that had not been grasped by the researcher in real time. In addition, these recordings were useful for identifying criteria that were of interest at the

time of observation but afterwards forgotten. A total of 64 interviews were conducted and transcribed, with the principal goal of asking “what the actors say” and “what they do” to face disaster risk. Interviewees were local actors either directly impacted by landslide or involved in its local management (28) and institutional managers (36) (Fig. 3 and Fig. 4). The interviews were carried out either individually, by family or by group. Secondary sources such as maps, GPS, sketches, aerial photographs and satellite images, census and official statistics, institutional reports and laws were also used in this investigation. Secondary data was associated with data collected through practice observation and semi-structured interviews (see Fig. 2), establishing a triangulation strategy [55] capable of relating data, theories and the observer’s role as a researcher. This case study is appropriate for such triangulation and integration of various data sources, given that it is essential for this research when considering the nature of the study object (risk) and the diversity of the criteria defining it. Finally, a table was constructed to encompass the strategies deployed by the actors during the conflict and the negotiation process. Data from a literature review was combined with that from fieldwork interviews and analysis to build a further table displaying the range of issues defended during the negotiation and

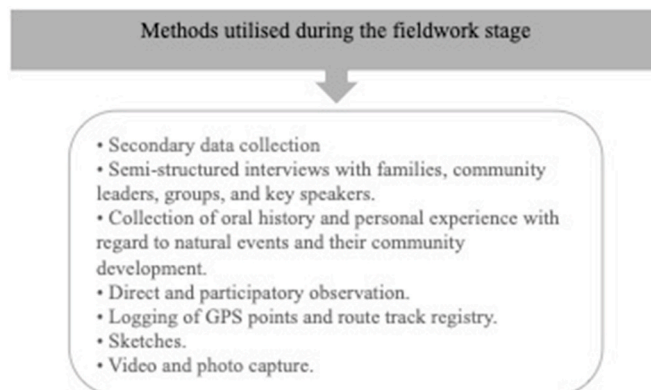


Fig. 2. Methods utilised during the fieldwork stage.

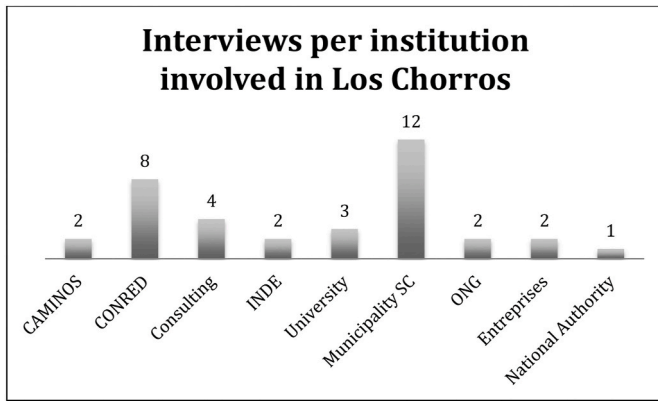


Fig. 3. Distribution of interviews carried out with individuals from the different institutions involved in the Los Chorros landslide.

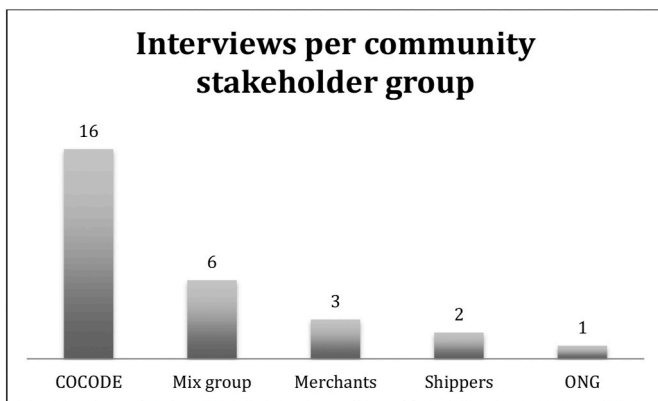


Fig. 4. Distribution of interviews carried out with actors of the different community groups.

conflict phases, along with approaches, risk definitions and measures as selected by the actors at Los Chorros.

4. Results

4.1. Description of actors

Successive institutions and actors appeared immediately after the landslide in response to the event. The actors present in the territory are (Fig. 5):

- Representatives of political power at local, regional and national levels. Their means and resources come largely from their institutional and formal legitimacy that is associated with their political function.
- Representatives of the professional body involved in danger and risk management: the National Coordinator for Disaster Reduction (CONRED). Their means and resources come from their legitimacy in an expert role with membership in a recognized professional body.
- Representatives of the state institution CAMINOS, responsible for the country's road development. Since the Los Chorros landslide destroyed one of the country's main routes (RN7W) the institution holds a fundamental role in the search for solutions.
- The National Electrification Institute (INDE) installed one of the most important hydroelectric plants in the country in the city of San Cristóbal Verapaz, where the landslide took place.
- Representatives of the Mayan indigenous communities. Their means and resources are derived from their social legitimacy associated with the organization of the community itself and from their political legitimacy, recognized in the National Constitution after the signing of the Peace Accords in 1996 and the successive law reforms.
- Economic and/or civil society representatives (transporters, gypsum operators, and merchants) are not formally organized. However, these actors are capable of mobilizing at all times and of imposing themselves as key actors when their interests are affected. They also have economic resources and social capital that allow them to intervene and carry out specific actions.
- Other actors were contacted for their technical knowledge or financial capacity: researchers and university professors, and

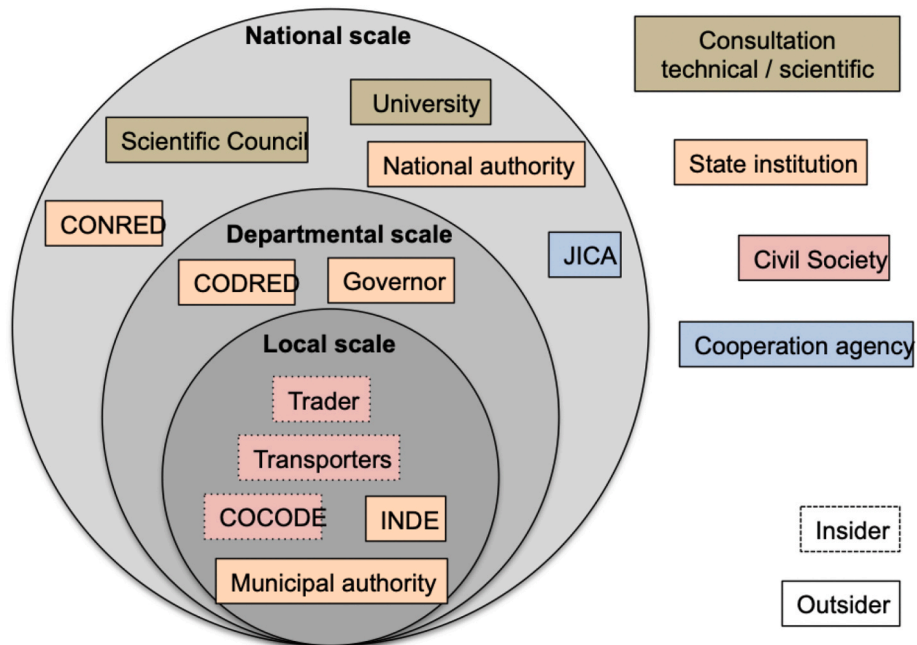


Fig. 5. Organization chart of the actors involved in risk management in Los Chorros and the scales of intervention Fernandez [61]:142.

representatives of international cooperation agencies such as JICA (Japan International Cooperation agency) and non-governmental organizations.

4.2. Risk definitions & actions

Actions are launched by different stakeholders to respond to the emergency, build an emergency route and find a safe place for the RN-7W (Fig. 6), in accordance with their own disaster risk definitions and risk analysis situation.

4.2.1. CONRED's definition of risk

Geological studies were carried out to define the area at risk, involving the analysis of geological maps, identification of faults and lithology, visual inspection to identify sinks and type of material removed (quantity, grain size and composition) and measurement of the slope. CONRED declared a "high risk area" inside which any and all activity, either state or private in nature, was prohibited. This area took into account exposed elements such as families living in areas deemed as at-risk (using polygons classified from higher to lower risk), land and houses built on secondary faults, the emergency road, communities located west of the Los Chorros landslide, the possible new design of the road and the supply tunnel for the INDE hydroelectric plant.

4.2.2. Government definition

In mid-January 2009, the government inaugurated the emergency road at the bottom of the Agua Blanca valley (in red, Fig. 6), at an altitude lower than the landslide, but within the limits of the risk area determined by CONRED. Construction of the road was possible because the authorities considered it a mitigation measure, and therefore in compliance with the standard of high-risk declarations. According to the government, this alternative route prevented RN-7W users from using the destroyed and high-exposure section. The decision was governed by the need for an immediate (political) response. In this sense, it was the result of a political decision rather than a technical one.

4.2.3. CAMINOS definition and the definitive route

CAMINOS aimed to complete the East-West connection of the country through its Northern region. CAMINOS sought a suitable final route for the RN-7W taking into account political requests and expert opinion. For them, the original location of the RN-7W (through the landslide) would have been the best option, considering national and local interests, but this was no longer an option after CONRED's risk assessment. CAMINOS hired companies to carry out geological studies and social surveys with the aim of understanding the complexity of the situation and the real impacts on the territory. Using this information they finally proposed a route outside of the risk polygon (in black, Fig. 6).

4.2.4. Community definition (indigenous communities, carriers, shippers, merchants)

The usefulness of the emergency road was not satisfactory for a large number of local users. It was too narrow for trucks and involved travelling more kilometers than the RN-7W. Its steep slope presented both a risk to the lives of drivers and "cuadrillas" (groups of daily workers) and a possibility of loss of transported products. Furthermore, the group of gypsum carriers did not use this road because it was unsuitable for trucks with heavy loads. Minibuses responsible for passenger transport were the only appropriate vehicles (in terms of size) for the institutional emergency route. Minibus owners took advantage of this situation to increase the price of the trip and as a consequence many people could no longer afford it. Only occasional travelers with private vehicles took this official route. Without the RN7W, the local and regional economy was quickly affected. In fear that the final route would be built far from their territories (according to the CAMINOS proposal), and thus leave them geographically, culturally and socially isolated, representatives of the COCODES, city merchants and a group of shippers organized a meeting to discuss their needs. They asked the government to rebuild the RN-7W, but their proposal was denied out of respect for norms, laws, and the CONRED risk declaration.

Facing a refusal from the government, they formed a Route Committee and started to rebuild the RN-7W themselves, a few meters south of the original route (green route, Fig. 6). Each group of actors

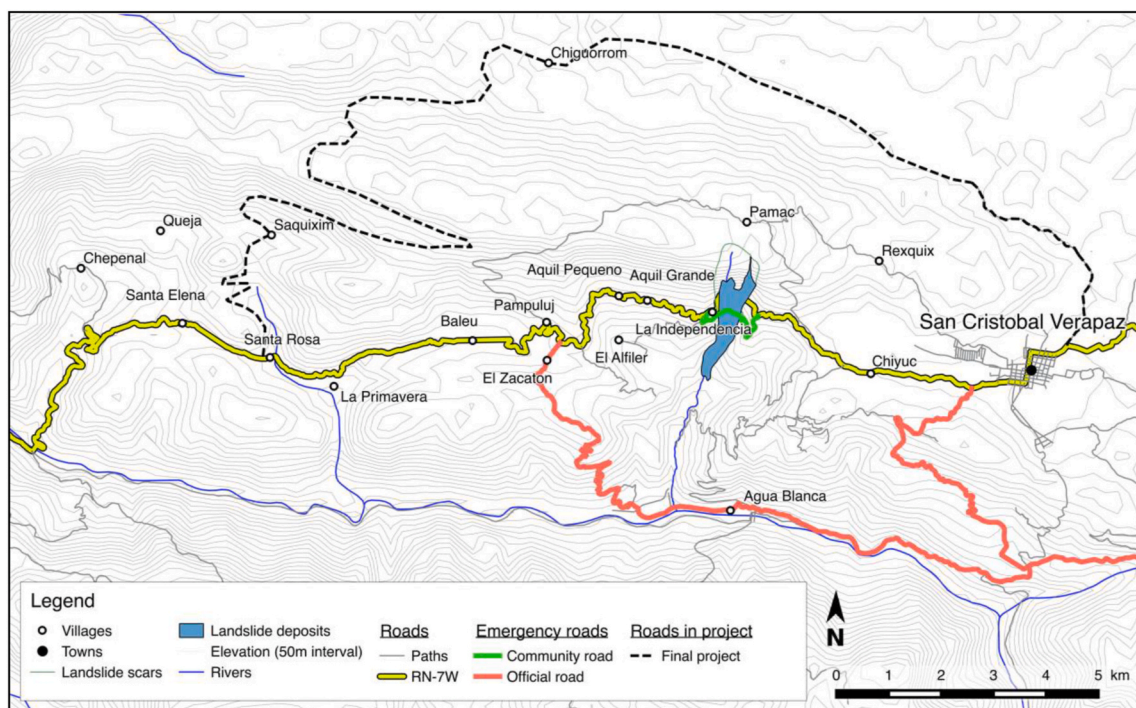


Fig. 6. Road map and solutions to Los Chorros, Fernandez [33]: 164.

collaborated voluntarily and performed various tasks. Men and women from the 19 affected indigenous communities offered unpaid workdays. They organized themselves into teams that took turns. Carriers lent their trucks to transport villagers to their workplace and merchants ran donation drives and gave meals to laborers. The machinery necessary for construction was supplied by one of the carriers. The road construction took 40 days. Before its inauguration, the communities performed Mayan rituals called “*quema*” (“burnings”), through which they asked the mountain spirits to protect their route and avoid movements on the slopes. Although the ritual is part of their traditions and customs, asking for protection for the path and stability of the mountain is a sign that they implicitly recognized the danger and considered it in their evaluation. Once opened, a toll was installed to recover the money invested and control the security of the route, prohibiting the passage at night (from 6 p.m. to 6 a.m.) and in case of rain. They also installed warning signs on each side of the landslide announcing that the crossing was dangerous. This was how these groups became increasingly active on the risk management scene, taking over not only construction but also the road monitoring and maintenance system.

4.3. Strategies - legitimation & conflict situation

The Route Committee produced a document to convince the authorities that its initiative was founded on solid arguments. They did not focus attention at the local level, but rather provided a broader view of the risk situation at a multi-scale level. If CONRED established a risk area that strictly corresponded to the dimensions of the natural phenomenon, the community group delimited the impact areas at a regional level. The magnitude of risk was associated with exposed elements and vulnerabilities that go beyond the dimensions of natural hazards, such as everyday life and basic needs. The committee provided the following examples: “The considerable drop in the local employment linked to crafts; Absolute paralysis of all types of transportation; Paralysis of income sources in marketing, groceries, agricultural products, horticultural products and livestock products; Paralysis of mining (gypsum); Vital need to move from one place to another; People still risk their lives by crossing the landslide area, declared impassable and high risk. This is due to the fact that there is no nearby, cheap and viable route; Partial and total loss of the coffee and *pacaya* harvest; Total paralysis of all transactions between the departments and other places located west of the highway and the town of San Cristóbal Verapaz; Most of the communities and people who travel for tourist, commercial or business purposes would deviate from our municipality and we will therefore be isolated” (Comité de ruta [62]: 1–2; translated by the author). In addition, the committee was against CAMINOS’ newly proposed route in a region far from Los Chorros, mobilizing environmental criteria.

Almost all road users (merchants, farmers, transport groups, regular, casual and local travelers) preferred to take the route rebuilt by the community because it was faster and the toll was cheaper when compared to the cost of gasoline incurred on the longer trip using the state emergency road. CONRED experts prohibited the use of the community route, mainly for safety reasons, due to its high exposure to landslides. Both those responsible for the Los Chorros case (Vice President and Ministers) and CAMINOS were opposed to the community route, following the recommendations of CONRED. The Ministry of Communications and Infrastructure placed no-go signs. Despite this,

Table 1
Strategies mobilized by each actor in the Los Chorros case to legitimize their position and definition of risk.

Authorities	Community Group	CONRED	CAMINOS
Use of laws, riot control and compromises	Consensus, Memorandum, lobby, road block, body resistance, media pressure, recourse to laws	Recourse to laws, deterrence	Recourse to science, recourse to laws

people continued to use the community route. From that moment on, the political authorities came into conflict with the Route Committee and in an opposition game, each actor deployed strategies to convince and maintain their position (Table 1). The set of strategies is described below.

- Deterrence: CONRED met the Route Committee to convince them of the danger of their road. They explained the reasons for the prohibition of access to the route using physical vulnerability, the degree of exposure, respect for the laws and the declaration of risk. However, the community group did not accept this explanation and highlighted the shortcomings of the official emergency route. The group also opposed any final route outside of the original location and asked for its road to be maintained by the authorities (since the community road required very expensive maintenance) and for studies to be carried out to improve the conditions of the route.
- Recourse to laws: The Route Committee prepared a petition signed by thousands of people. They generated a memorandum specifying the deterioration of the economy and abandonment. To justify their request, they drew attention to questions of legality by mentioning certain social, political, and environmental laws and codes.
- Lobbying: Community leaders and initiators of the movement obtained hearings and sessions with legislative and executive agents at the national level through departmental and local deputies.
- Route blockade: During the meeting with the representatives of the Guatemalan Congress, the Route Committee mentioned the possibility of a national strike. The government, faced with this warning, found it necessary to respond quickly. A national strike was deemed too risky for the country’s economy. Furthermore, the reputation of the National Government would also be at stake due to the negative image that such a demonstration would generate. Consequently, the Vice President, under strong political pressure, travelled to Los Chorros to calm the population and find a compromise. When an agreement with the Vice President was not reached, the community group blocked the passage of the CA-14 highway at El Cruce level for half a day, cutting off the country’s northern connection with Guatemala City.
- The armed forces, riot police, and the physical resistance of the community: The government decided to use public force to prevent people passing through the community route. The army and police were sent to the area. This action was not well received by the community group and resulted in a strong reaction. Summoned by community leaders, the local population gathered in Los Chorros to prevent official security forces from removing maintenance machines from the road. The situation was complicated as children, women and men confronted the official forces with their own bodies, using machetes as weapons. The national government finally ordered the army and the police to withdraw from the area.
- Summon the press: The community group continued to request the maintenance of its highway and detailed studies of the area. The government, for its part, encouraged the use of the official road in Agua Blanca and, to appease the population, announced that CAMINOS would take over the maintenance of the community route. After this did not happen, the community group decided to put pressure on the media, publicizing their actions and demands in the press.

4.4. Post-flood concessions, INDE-defined risks and the community route as the only solution

Heavy precipitation carried a huge amount of sediment and rock from the landslide to the valley floor, forming a dam on the Chixoy River and leading to flooding of the government’s emergency route. Upstream of this natural dam, the water level continued to rise and endanger the pipeline of INDE’s Chixoy hydroelectric plant. Given that the power plant produces 30% of the country’s energy, the national authorities and

INDE focused all their attention on how to face this danger. INDE evaluated the danger of flooding, focusing its attention on the pipeline as an exposed element. They proposed to create a diversion channel and in the end the pipe was not damaged, though the emergency route remained impassable. The community route thus became the only alternative route.

One year after the event, without an emergency route and without a definitive route due to a lack of funds, the only option was that of the community. Throughout 2010, the national government began to concede. Several attempts were made to stabilize the slope and the government accepted responsibility for the maintenance of the route, despite the fact that the CONRED risk statement was still in force. Also, since funds from the toll implemented by the community could not cover maintenance costs, the government agreed to use public funds to reimburse the costs and debts incurred during route construction and maintenance.

Considering that this work was carried out over several years, it can be seen as a longitudinal study that enables an analysis of the evolution of risk perceptions. At Los Chorros, actors' perceptions remained the same over time, with the exception of the government that was made certain concessions and accepted the demands and points of view of the population. There was a change of presidential and municipal government in 2012, which the community group took advantage of to establish themselves as a legal group before the Municipal Development Council. Thus, the group known as the Road Committee obtained a vote and were able to formulate their requests within an institutional framework. Thanks to this new statute, the group had a "*libro de actas*" ("minute book"), through which it compiled a record of all actions and discussions related to the route. These minutes constitute official documents that serve as legally recognized evidence and formalize their definition of disaster risk. Since this recognition, the mayor and the newly legitimized community group defended the same interests. In 2013, at the request of both parties, CONRED visited Los Chorros to carry out a new study. Technicians confirmed that the landslide was still active and that material would most likely fall, leading them to maintain their disaster risk definition. However, they did not deny the possibility of modifying the risk area, provided that new studies were carried out that could show the landslide conditions had changed and the slope was stabilized. With regards to CAMINOS' proposed route, it was constrained by a lack of financial resources. The new government still did not grant a special budget for the completion of the RN-7W project. National authorities were pressured by social demands and did not dare free up resources for this work. Since then and until the time of writing, no decision has been made. In 2017, monitoring work was carried out and verified that the situation continued unchanged. At this time the community path was in poor condition and remained the only viable solution. Community residents and road users have adapted to this precarious situation by developing codes of behavior that make them safer, such as prohibiting traffic at night, monitoring of the landslide by neighbors, and forbidding passage in the event of earth movement, noise from falling rocks or heavy rains. These behaviors are important but not sufficient to safeguard the lives of people and road users. As stated by CONRED, the community route is highly exposed and consequently cannot be deemed acceptable without protection work.

5. Discussions

The first objective was to identify the criteria chosen by each group of actors and evaluate how they implemented a set of prioritization criteria for defining risk. From the interviews and observation of practices, it is possible to affirm that the actors in the Los Chorros case consider very varied criteria when defining a risk situation. These criteria are material, symbolic, natural, economic, social and cultural, and are linked to the types of vulnerabilities that actors face and recognize. For example, even if they do not name it in these terms, in their disaster risk definition the community group refers to unsafe

conditions, their everyday life and their different dimensions of vulnerability: social, organizational, ecological, economic, etc. Specifically, they refer to an educational vulnerability due to the interruption of school years, an economic vulnerability caused by a lack of employment and access to work, and an ecological vulnerability caused by deforestation should a new route be built. As for state actors, they speak directly of physical vulnerability and exposed elements. Each actor makes a cost-benefit trade off regarding post-disaster investment. If state actors favor the issues of energy (INDE, Government), protection (CONRED) and east-west communication (CAMINOS, Government), community actors prefer to preserve and defend aspects related to their basic needs, subsistence and the organization of their territory (Table 2).

Different disaster risk approaches [44] used by risk managers are highlighted (Table 2).

- CONRED used an applied science approach in which the explanatory factor of the disaster was the natural event. When CONRED delimited the at-risk polygon it considered the natural event (dimension, frequency, magnitude) as well as exposed elements such as houses, the RN-7W, human life and infrastructure. It proposed structural measures corresponding to the applied science approach, namely building a new route outside of the risk area, mitigation measures or technical studies.
- The Route Committee based its interpretation of risk on an approach close to the social sciences, prioritizing the population's living conditions which encompasses food security, housing, economic security, and social ties. For example, they highlighted the interruption of both communication between communities and of functional aspects within the territory. From their point of view, being isolated represented not only an economic loss but also a loss of relationships. In summary, the local population perceived risk in a broader sense than institutional actors, which used more restrictive criteria.
- CAMINOS wanted to put the country's East-West connection into service, carrying out socio-economic and geological studies to this end. It worked from an integrated approach that took into account danger, exposed elements and different vulnerabilities. It incorporated concerns raised by various actors into its analysis, including the technical arguments of CONRED, regional city mayors' needs, the Ministry of Communications and Infrastructure's plan, the needs of merchants, the points of view of the people directly affected by the landslide and the community group.
- INDE evaluated risk from an applied science approach as it identified the danger of flooding and the pipeline as an exposed element. It quantified the possible economic loss and proposed a structural measure (the diversion channel) to deal with the risk.

The second objective was to analyze the solution-building process and, more specifically, the strategies mobilized by actors to affirm their position and their proposed solution. Risk management measures depend on the specific arbitrations of each actor and their ability to be recognized as legitimate. The acceptable risk for the actors and, therefore, their solution and/or treatment are constituted as the product of their relations and social forces. The question of acceptability is closely linked to the ability to govern and refers to the processes of negotiation and arbitration, the consideration of decisions and the legitimacy of actors and actions. In the case of Los Chorros, each actor uses various intervention logics, ranging from consensus to integrating aspects revealed by other actors and, finally, closed oppositions. Technicians and authorities were able to cooperate and establish agreements by proposing an alternative route. Their interests were not exactly the same, but neither were they antagonistic. For this reason, they managed to negotiate and share the same solutions. As for the gypsum transporters and indigenous communities, they found common ground through prioritizing economic problems and access to resources. They made compromises and imposed their own representation of risk, rebuilding the road on the spot, and developing both a surveillance

Table 2

Summary of the actors present in the Los Chorros case, their approaches, definitions of risk, proposed measures, and topics to defend during the negotiation and conflict phases.

Name	Issue to defend	Approach	Risk definition	Measures
CONRED	Protection	Applied sciences	DR= $H \times \underline{V}$ (physical)	Relief activities, Assessment of the area and delimitation of the at-risk polygon, refusal of the community road; maintaining its position, follow-up and monitoring in the implementation of mitigation measures
National Authority	Energetic; Recovery	Integrated	DR= $\underline{H} \times \underline{V}$	Authorization of the emergency route / restore the situation Refusal of CAMINOS' proposals, sending of riot police to the area, refusal to receive protesting members of the road committee, encouraging the securing of INDE; authorization of blasting activity in landslide area; road maintenance
CAMINOS	East-West Passage, Subsistence	Integrated	DR= $\underline{H} \times \underline{V}$	Proposal of alternative routes; construction of the emergency road; engagement of consulting firms specializing in socio-economic studies and geology
INDE	Energetic	Applied sciences	DR= $H \times \underline{V}$ (physical)	Monitoring at Agua Blanca, structural measures (channel)
Gypsum carriers and transporters	Subsistence	Social sciences	DR= $H \times \underline{V}$	Refusal of the emergency route, initiation of the opposition movement; convocation of sessions to obtain membership; road committee organization, community road construction
Traders	Subsistence	Social sciences	DR= $H \times \underline{V}$	Refusal of the emergency road, organization of the road committee, construction of the community road
COCODE/farmers	Subsistence	Social sciences	DR= $H \times \underline{V}$	Refusal of the emergency road, crossing landslide area on foot, organization of road committee, construction of community road
Road Committee	Subsistence	Social sciences	DR= $H \times \underline{V}$	Road maintenance, New road construction, mitigation measure (berms, drainage), defence and vindication of its position (recourse to laws, lobbying, media pressure, strike, audiences with state institutions)

Legend: CONRED (the National Coordinator for Disaster Reduction), CAMINOS (the road development institution), INDE (the National Electrification Institute), COCODE (Communal Development Councils). DR = Disaster risk; H = hazard; V = vulnerability; when it is underlined it means that it has greater importance in the analysis according to the selected risk approach.

system and an *ad-hoc* alarm system. No compromise was made between the Route Committee and the rest of the risk managers regarding the characterization of disaster risk. It is for this reason that the actors entered into conflict and two distinct solutions were established in the territory: the official route and the community route. The second seemed more effective in terms of attendance and also addressed a large set of vulnerabilities. Regardless, it was unacceptable to technicians and authorities as it violated both their professional and deontological codes. They could not validate this alternative route, and therefore legitimize it, as it posed a serious problem in terms of liability. They could not bear the consequences if there were to be further destruction of the road in this particularly exposed sector. On the other hand, the official route has been disabled and the proposal for a definitive route outside of the danger area, while meeting the technical criteria, failed to satisfy the population as it directly and indirectly undermined their society from economic, social, health and educational points of view. The official solutions were the typical structural measures made from a hazard-related point of view and did not consider the factors, dynamics and processes which lead to local unsafe conditions.

6. Conclusions

Although this case study is different to situations in developed countries, lessons related to post-disaster decision-making processes can be applied worldwide. The importance of an inclusive approach to disaster management is highlighted when we accept that multiple vulnerabilities can exist and that every actor has specific knowledge, as is evident when examining the case of Los Chorros. The management proposal that emerges from the Guatemalan example invites another way of conceiving risk management through identifying and integrating the risk perceptions of the actors that are on the ground. This means abandoning the dichotomy between technical and vernacular knowledge to go in search of the complexity of risk perceptions. As seen in Los Chorros, neither individual solution is satisfactory in itself. When not all risk components are taken into consideration, solutions are incomplete and incapable of fully solving the problem. Sectoral approaches lead to segmented measures, omitting the diversity of factors that are at play in a risk situation and prompt decision makers to make conjectures and inadequate or insufficient decisions when faced with a risk situation. In light of the results presented here, this work encourages the

incorporation of community-based approaches as long as they are complemented with other perspectives and ways of interpreting disaster risk.

Finally, we studied the social conflict at Los Chorros in order to understand the underlying aspects of society and understand what constitutes disaster risk in a given context. The root causes of conflicts are related to the structural aspects of society such as economic models and production, distribution of power and participation, and can be closely intertwined with the root causes of disasters, in accordance with the PAR model. In this sense, by analyzing the causes of conflicts and listening to the voices of the actors, it is possible to identify the root causes of disasters and the elements that historically generate the vulnerabilities of a society. The comprehensive consideration of the perspectives of all actors that are involved in the problem is not the panacea for this challenge, but it can help decision makers to improve disaster risk management and to consider broader risk criteria and integrated solutions. This will allow decision makers to identify technically valid and socially acceptable risk measures.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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