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Landslide risk perception in Mexico: a research gate into public awareness and knowledge

Abstract The purpose of this paper is to analyze landslide risk public awareness and knowledge in Mexico based on people's common understanding and perception of landsliding associated with previous events. The methodology involved the design and application of a risk perception questionnaire in the municipality of Teziutlán, Puebla, Mexico, an area that has been historically affected by mass movement processes, particularly during a rainfall induced landslide disaster event in October 1999. Sampling framework comprised two boroughs; Downtown Teziutlán (DTT, $N = 65$), and San Andrés neighborhood (SAN, $N = 72$). The former has no evidence of landslide risk, whereas the latter has been affected by landsliding. The questionnaire included the following items: (1) experience, (2) landslide risk awareness, (3) exposure, (4) preparedness, (5) responsibility, (6) response, and (7) trust. Results suggested that all the inhabitants of the sample are aware of risk of landsliding and consider the dwellings situated in the city center as the safest. The latter is consistent with a landslide susceptibility map on which hillslope material properties are reflected and lithological units of highest resistance are located beneath the city center. The need of undertaking different initiatives to achieve disaster risk reduction at community level was clearly expressed by the respondents in terms of ranking all the actions listed in the questionnaire as of high and moderate priority to improve the security of the residents. Highest accountability for actions in case of a landslide disaster was attached to the Mexican Army, as it is in charge of disaster response nationwide. Responses provided by the municipal government, health institutions and the Red Cross in DTT and by the state and municipal government along with civil protection in SAN were perceived as bad or just sufficient. High level of people's confidence to get information on landslide disaster preparedness and response from the Red Cross and scientists was also perceived in the two communities. From the outcome of the present investigation, it is possible to conclude and reinforce the argument that a better understanding on how landsliding is perceived is one of the most significant issues for enhancing landslide disaster risk awareness and knowledge and to guarantee the advance of resilient communities at individual and collective scales.

Keywords Landslides · Risk perception · Risk awareness and knowledge · Disaster risk reduction

Introduction

Disasters associated with the occurrence of natural hazards have increased dramatically (Fig. 1), not only in number and intensity, but especially in terms of impact; the latter is directly linked to unsustainable development practices (Alcántara-Ayala et al. 2015), in addition to climate change, globalization, urbanization, and instabilities of political and economic nature (Cutter et al. 2015).

In the last five decades, from 1965 to 2014, more than 10,000 disasters have been registered worldwide. Derived from the impact of droughts, earthquakes, floods, landslides, storms, and volcanic activity on vulnerable communities, circa 4.7 million casualties have taken place, and 6793 million people have been affected. Overall, climate-related disasters account for the majority of events. Floods were the most frequent type of disaster (42 %), followed by storms (34 %) and earthquakes (10 %). Notwithstanding that indirect drought-related deaths are extremely difficult to quantify, droughts alone account for 46 % of the total number of casualties globally, whereas earthquakes and storms were associated with 28 and 18 % of the human losses, respectively, during the same period of time (EM-DAT Database) (Figs. 2a, b).

When compared to other natural hazards, the impact of landslides does not seem to be that high. This is mainly because landsliding is usually not well documented as it is commonly triggered by rainfall and seismicity, and therefore, consequences have been to a major extent, accounted in terms of floods, storms, or earthquakes (Alcántara-Ayala, 2010). Nonetheless, it is evident that the number of disasters associated with landslides is increasing worldwide. Yet, even lacking of full documented landslide cases, at global scale, between 1965 and 2014, 644 landslide disaster events were registered and they involved 40,263 deaths and circa 9.5 million affected people (EM-DAT Database) (Fig. 3). It is interesting to note though, that within the same period of time, the largest number of landslide disasters, 112, was registered between 2000 and 2004, whereas casualties amounted 6497 (1970–1974), and the highest number of affected people (4,001,122), was recorded during the lustrum of 1965–1969 (see Fig. 3). The latest was mainly due to the impact of a series of rainfall triggered landslides in the city of Rio de Janeiro in 1966 (Barata 1969; Costa Nunes 1969; Jones 1973; Schuster et al. 2002).

Landslides are caused not only by the physical geodynamics of hillsides but also due to the modification of the Earth's surface by human activities. According to a global risk analysis, carried out by the World Bank, about 300 million people, that is to say, 5 % of the total population of the planet, live in an area of around 3.7 km^2, which is subjected to the occurrence of landslides; the areas of highest risk correspond to 820,000 km^2 with 66 million of inhabitants (Dilley et al. 2005).

Disaster risk reduction (DRR) points towards the anticipation of future disaster risk, decrease of exposure, vulnerability, or hazard, in addition to resilience strengthening (UNISDR 2015), and can be considered a significant challenge for the transformation of current societies into sustainable ones. To accomplish such an aspiration, landslide—and other hazards—disaster risk management becomes a high priority. Disaster risk management (DRM) therefore comprises the actions that aim to achieve DRR (UNISDR 2015), being risk awareness and knowledge the keystone required by all involved actors, especially by vulnerable communities exposed to landslides, and/or any other physical hazards, to reduce disaster risk. To this regard, in the international arena and in order to "pursue prevention, to provide practical solutions, education, communication, and public outreach to reduce

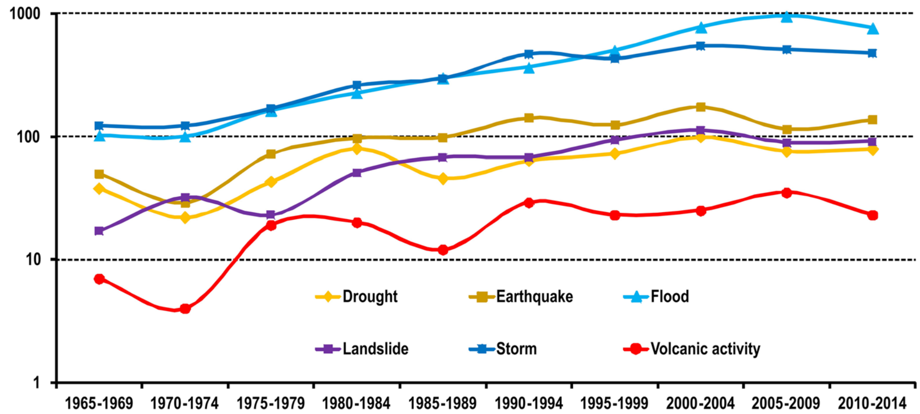


Fig. 1 Worldwide occurrence of disasters according to type of hazards, between 1965 and 2014 (source: EM-DAT Database)

landslide disaster risk," the United Nations International Strategy for Disaster Risk Reduction (UNISDR) and the International Consortium on Landslides (ICL) signed the Sendai Partnership 2015–2025 for global promotion of understanding and reducing landslide disaster risk (see Sassa 2015).

The ISDR-ICL Sendai partnership comprises a series of initial fields of cooperation in research and capacity building, coupled with social and financial investment, among which, in the case of Mexico, landslide risk public awareness and knowledge has been identified as a priority. Based on the definition provided by the UNISDR (2009), public awareness can be understood as the amount of common knowledge concerning disaster risks, the disaster driving factors, and the actions that can be carried out to reduce exposure and vulnerability to hazards at both, individual and collective dimensions. As public awareness and knowledge is directly linked to the way people perceive disaster risk, depending upon the experiences and the vulnerability spheres on which they have been historically embedded into, the first step for establishing a strategic scheme to strengthen awareness and knowledge, should take into account the analysis of risk perception. The latter can particularly be useful to develop risk communication among communities, scientists, and decision-makers (Slovic 1987).

This study is an attempt to address the issue of landslide risk public awareness and knowledge in Mexico by analyzing people's common understanding and perception derived from previous experience with landslide events. This will be undertaken by exploring landslide risk awareness (in terms of identifying main causes of landsliding), preparedness (as a mechanism for prioritising preventive measures), accountability (or perceived responsibility of actors in case of a landslide disaster), response (expressed through the evaluation of the response provided by different actors after a landslide disaster), and trust (regarded as level of people's confidence to be informed about disaster preparedness and response by different social actors) in the municipality of Teziutlán, Puebla, México, an area that has been affected historically by landslide events, specially of the type of slides, debris flows, and mudflows.

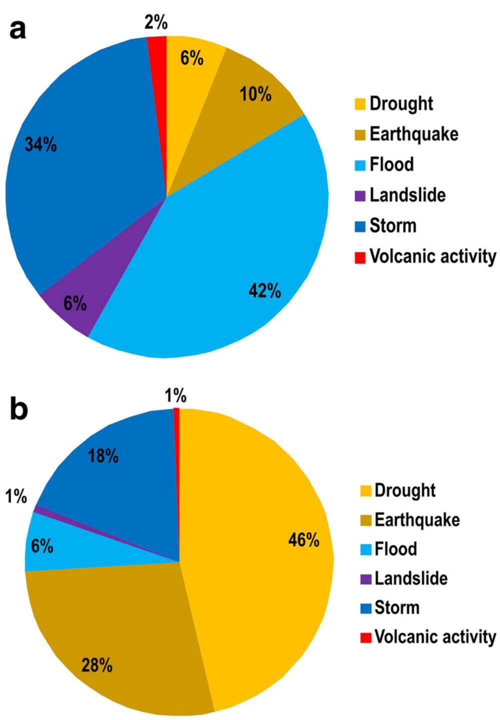


Fig. 2 Percentage of disasters occurred world-wide during 1965–2014 (**a**) and associated casualties (**b**), according to type of natural hazard (source: EM-DAT Database)

Risk perception of natural hazards

On the perception of risk

In general, the term risk has a dual character. On one hand, it involves probability, and on the other, effects. Within the context of the former, risk refers to the likelihood of some specific adverse event, which results from hazard exposure, whereas the dimension of effects is related to the detriment associated with the negative event (Breakwell 2013).

From a psychological perspective, risk has been defined in several ways, and to a major extent, it has been traditionally depicted as naturally subjective (Pidgeon et al. 1992; Slovic 1992; Wynne 1992), as it involves an assessment of probabilities of occurrence, in this case, of physical or natural hazards, and their potential consequences (Rayner and Cantor 1987). Risk is "subjectively defined by individuals, who may be influenced by a wide array of psychological, social, institutional, and cultural factors" (Slovic et al. 2000), but also can be "seen as a concept that

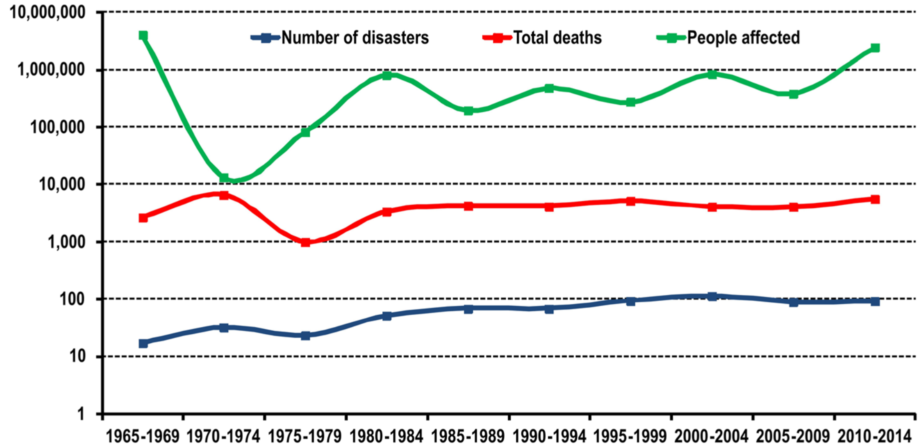


Fig. 3 Worldwide occurrence of landslide disasters, between 1965 and 2014 (source: EM-DAT Database)

human beings have invented to help them understand and cope with the dangers and uncertainties of life… risk does not exist out there" (Slovic and Weber 2002).

Within the framework of disaster risk, pioneering work developed in the last century had already envisaged the interactions between societies and the environment (Burton and Kates 1964; Burton et al. 1978; Hewitt and Burton 1971; White 1973). Since that time, several investigations have contributed extensively to identify and understand the multidimensions and significance of vulnerability as a key element for disaster risk (Cannon 1993, 1994; Cutter 1993; Maskrey 1993; Oliver-Smith 1999; Tobin and Montz 1997; Wilches-Chaux 1989). Nowadays, it has been recognized that the risk of disaster results from the combination of natural hazards and the vulnerable people, who is exposed to that particular hazard in space and time (Blaikie et al. 1994). Under such framework, and specially derived from the multidimensions of vulnerability, risk is understood as a socially constructed process.

Considering a disaster risk reduction approach, disaster risk has been defined by the UNISDR (2009), as "the potential disaster losses, in lives, health status, livelihoods, assets and services, which could occur to a particular community or a society over some specified future time period." Complementarily, for UNDP (2015), disaster risk is generated by the relations among hazards, exposure of societies, and conditions of vulnerability and is directly affected by patterns of social, economic, and political development.

There is also a vast amount of literature regarding the concept of risk perception, as it has been considered from psychological, anthropological-sociological, and interdisciplinary approaches. For instance, according to the psychometric paradigm risk perception can be characterized to a major extent by the newness of the risk and the degree of dread resulting from it (Fischhoff et al. 1978). The newness of risks entails factors that are not observable, unknown to the exposed people, and effect delayed. Dreaded risks are those involving potential adverse outcomes, fatal consequences, involuntary risk, and events that are beyond control (Slovic 1987).

Contrastingly to the psychometric paradigm, risk perception also has been explored by the cultural theory, which is focused on the links among perceived risks and the social aspects and the cultural adherence; individuals decide what to fear to protect their way or life or culture (Douglas 1978; Douglas and Wildavsky 1982).

Pidgeon defined risk perception as "people's beliefs, attitudes, judgments and feelings, as well as the wider social or cultural values and dispositions that people adopt, towards hazards and their benefits" (Pidgeon et al. 1992).

Based on an extensive literature review, the TACTIC report (Shreve et al. 2014; Oliver-Smith et al. 2016) suggested that there are three general conceptualizations of risk: "realist," "constructivist," and "critical." Within the realist view, the risk of an activity or event is objective, and can be measured (Rosa 1998; Rosa 2008), while for the constructivists, risk is not objective but subjective and socially constructed (Jasanoff 1998; Wachinger and Renn 2010), and critical risk is characterized by the need to identify and understand the underlying or root causes of risk (Shreve et al. 2014).

Moreover and derived from the need of both particular and wide-ranging views on how risk is perceived, different scientific approaches derived from specific disciplines, such as geography, political science, anthropology, and indeed psychology and sociology, have contributed to the understanding of risk perception (Slovic 1987) and its influencing factors (Table 1).

For several years, great effort has been devoted to the study of risk perception of natural hazards and the processes related to the balancing of risks and benefits, as alternative means of hazard adjustment (Slovic et al. 1974), and quite recently also on its role in disaster risk management. Derived from the large account of historical cases of disasters associated with natural hazards, there is a rapidly growing literature on perception of volcanic activity (Johnston et al. 1999; Paton et al. 2000; Eiser et al. 2015; Bachri et al. 2015), earthquakes (Jackson 1981; Mcguire 1995; Heller et al. 2005; McClure et al. 2015), hurricanes (Norris et al. 1999; Lindell and Hwang 2008), floods (Grothmann and Reusswig 2006; Whitmarsh 2008), tornados (Weinstein et al. 2000; Hoekstra et al. 2011), but there is insufficient research on landslide risk perception.

Landslide risk perception

One of the first studies concerning landslide risk perception was carried out in Australia and Hong Kong. Within a context of risk management from an engineering perspective, the investigation

Table 1 Main factors influencing risk perception

Risk perception influencing factors	References
Gender	Flynn et al. 1994; Gustafson 1998; Finucane et al. 2000; Weber et al. 2002
Culture	Weber and Hsee 1998, 1999; Jones et al. 2013
Individual perception	Slovic et al. 1982, 2000; Barnett and Breakwell 2001
	Sjöberg 2003; Chauvin et al. 2007; Lindell and Hwang 2008
Experience	Weinstein 1989; Barnett and Breakwell 2001; Grothmann and Reusswig 2006; Ho et al. 2008; McClure et al. 2015
Awareness	Armas 2006; Scolobig et al. 2012, Xie et al. 2014
Preparedness	Jackson 1981; Johnston et al. 1999; Norris et al. 1999; Paton et al., 2000; Heller et al. 2005; Zaleskiewicz et al. 2002; Basolo et al. 2009; Scolobig et al. 2012; Maidl and Buchecker, 2015
Exposure	Tobin et al. 2011; Van Manen 2014; Njome et al. 2010
Responsibility/ accountability	Damm et al. 2013; Wang et al. 2012
Response	Khan et al. 2012; Lawrence et al. 2014; Xie et al. 2014
Trust in official information sources	Cordasco et al. 2007; Haynes et al. 2008; Basolo et al. 2009; Kuhlicke et al. 2011; Terpstra 2011; Scolobig et al. 2012
Knowledge of measures	Peacock 2003; Peacock et al. 2005; Faupel et al. 1992

involved the analysis of novel aspects related to cognitive factors, levels of responsibility for mitigation measures, and contrasting mass movement processes to other hazards (Finlay and Fell 1997). Regarding attitudes and beliefs, the perception of landslide risk in areas of high exposure to rockfalls in Australia was explored by Aucote et al. (2010). Specific importance was given to the prediction of high-risk behavior according to beliefs, and results suggested that probability of high-risk behavior was higher in males and in people who believed that sign-posted high-risk areas were not dangerous.

Soon after a series of landslides induced by rainfall in Austria, a diachronic survey was applied to members of the affected community including local geologists and different stakeholders. Results suggested that risk perception was higher among people personally affected by the mass failures, with a higher level of knowledge on geology, which had been affected by other natural hazards or often spent time in outdoor activities. Moreover, natural causes for landslides were considered as the most important by nonexperts, while anthropogenic ones were of greater significance for the experts (Damm et al. 2013).

In an earlier study in Spain, risk perception provided information about the need of implementing landslide awareness programs since in areas affected by mass movement processes, communities did not perceived them as a potential risk, and consequently, also lacked of adequate response or emergency plans (Solana and Kilburn 2003). In the same order of ideas, more than a decade after, there is still a lack of public awareness and knowledge of communities in terms of landslide risk, as suggested by the work carried out by Salvati et al. (2014) at national level in Italy. Further evidence to emphasize the need of solid public programs on awareness and knowledge was revealed when analyzing, in a more detailed scale in Italy, the case of Sarno; 137 people died and the town was severely affected by the landslide disaster of 1998, and yet, people lack of knowledge concerning the prevailing classifications of areas of risk on which they are living in (Calvello et al. 2015).

Landsliding in Teziutlán, Puebla: background of the case study

Rainfall-induced landslides in Teziutlán

In October, 1999, thousands of landslides with volumes ranging from a few to hundreds of thousands of cubic meters were triggered by intense rainfall in the states of Veracruz, Tabasco, Puebla, and Hidalgo, Mexico (Lugo-Hubp et al. 2005). The heavy rains resulted from the interaction of the tropical depression number 11 and the cold front number 5. They caused widespread flooding in valleys and flat areas in addition to landslides, particularly in the zones formed by pyroclastic deposits (Alcántara-Ayala 2004a; Alcántara-Ayala et al. 2006). Major impact took place in the state of Puebla and particularly in the municipality of Teziutlán; in the former, the aftermath included 263 casualties, 1.5 million people affected, that is to say, about one third of the total population of the state, and economic damages in the order of US450 million (Bitrán and Reyes 2000).

The municipality of Teziutlán is situated in the northeast sector of the state of Puebla (Fig. 4), at 1940 m a.s.l. within the Sierra Norte (northern range), where the Sierra Madre Oriental and the Trans-Mexican Volcanic Belt (TMVB) intersect (Alcántara-Ayala 2004a). There are two main types of climate: humid temperate in the north, and to the south, warm humid with precipitation all year long, but particularly abundant in summer (INEGI 2015).

The local geological basement of this region consists of metamorphic rocks, including shales and andesitic metalaves from the Chililis formation, of Permian age, as well as an intrusive complex (Ferriz and Yañez 1981; Ferriz and Mahood 1984). The former, outcrops east of the municipality, underlaying the Huayacocotla, Tenexcate, and Cahuasas formations.

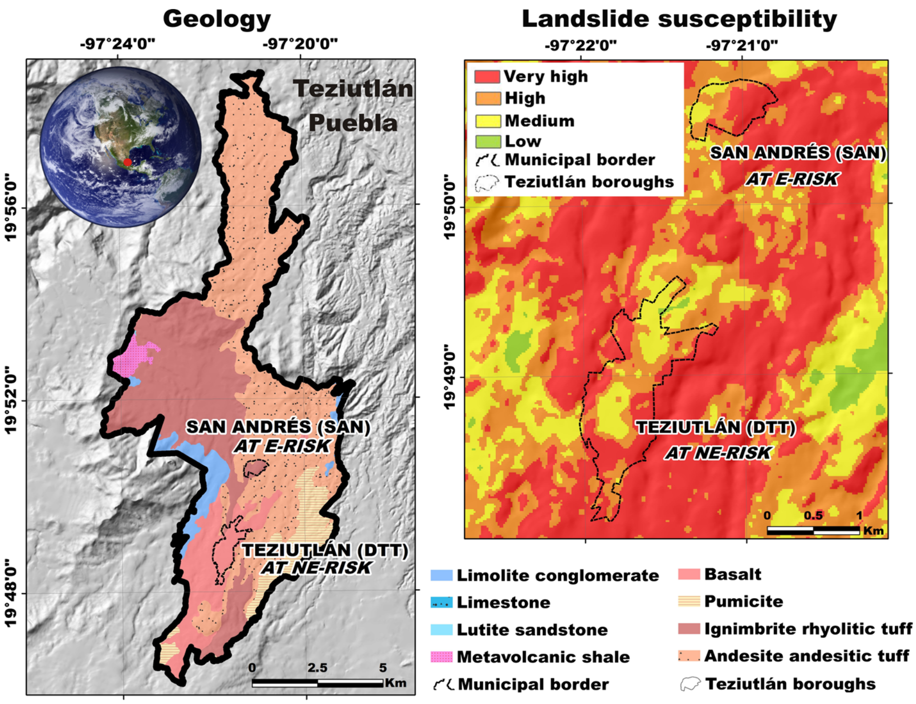


Fig. 4 Location and geology of the Teziutlán municipality (source: SGM 2011) and landslide susceptibility map of the studied area (source: extracted from Galindo-Serrano and Alcántara-Ayala 2016)

Sedimentary (shales and limestones) and igneous rocks comprised by the Huayacocotla formation, from the Jurassic and Cenozoic, outcrops only in a small portion east of the town (SGM 2011; Palma-Ramírez 2013). Overlying the sedimentary sequence of the Sierra Madre Oriental, volcanic deposits of the Trans-Mexican Volcanic Belt (TMVB) are found. They comprise andesite, basaltic andesite, and rarely basalt, along with some andesitic tuff horizons of Pliocene ages that belong to the Teziutlán andesite. The latter can be regarded as the basal unit of the volcanic products emitted by Los Humeros caldera (SGM 2011).

In the center of the town, and derived from the activity of Los Humeros caldera, volcanic materials comprised within the Xaltipán ignimbrite, such as rhyolitic tuff, rhyolite, rhyodacitic pumice, and andesitic scoria, can be found (Ferriz and Mahood 1986). This ignimbrite, of Pleistocene age, was originated by a Plinian eruption that induced the collapse of Los Humeros caldera and can be regarded as the major geological formation of Teziutlán (Ferriz and Mahood, 1986; Ferriz 1985; SGM 2011). The south and southeast sector of the town is mainly formed by pumicite deposits of Pleistocene age, while olivine basalt spreads out in the southern and southwestern part (SGM 2011).

In a general context, it can be said that the region is characterized by intense erosion and gully development, mainly on sedimentary rocks that are overlaid by volcanic deposits (Alcántara-Ayala 2004a), and on which the low resistance of these hillslope-forming materials plays a major role in the occurrence of mass movement processes (Fig. 4).

The impact of disaster events associated with landslides in Teziutlán is not new. Notwithstanding the lack of formal documentation on historical landslide affectations, several episodes of rainfall-induced landslides have been registered since the middle of the last century, including hurricanes (H) of different categories (Cat), tropical storms (TS), tropical perturbations (TP), and the combination of tropical depressions and cold fronts (TD&CF). Among them, the most significant have been the following: Florence (HCat1, 1954); two nameless events (TP, 1954, and TS, 1955); Hilda (HCat3, 1955); Janet (HCat5, 1955); Beulah (TS, 1959); Fifi (HCat2, 1974); Diana (HCat2, 1990); Gert (HCat2, 1993); TD&CF in 1999 (Flores-Lorenzo and Alcántara-Ayala 2002; Alcántara-Ayala 2004a), in addition to Stan (HCat, 2005); Dean (HCat2, 2007), and Ingrid (HCat1, 2013).

The scientific flow of contributions concerning landslide risk in the Sierra Norte de Puebla region has been expressed through two main perspectives. On one hand, on the hazard dynamics of hillslope instability (Lugo-Hubp et al. 2005; Borja-Baeza et al. 2006; Hernández-Madrigal et al. 2007; Murillo-García et al. 2015a), and on the other, on the social aspects linked to local knowledge (Alcántara-Ayala 2004b), indigenous risk communication (Alcántara-Ayala et al. 2004) and vulnerability analysis (Oliva-Aguilar et al. 2010; Murillo-García et al. 2015b).

The analysis presented in this paper is comprised within a larger research project (MISTLI: Monitoring, Instrumentation and Early Systematization of Unstable Slopes), devoted to the understanding of the different dimensions of landslide risk perception in the municipality of Teziutlán, Puebla, to be used as one of the major baselines for the design and implementation of a landslide disaster risk communication strategy and the establishment of a landslide early warning articulated system (Alcántara-Ayala and Oliver-Smith 2015).

Two boroughs of the city of Teziutlán were chosen to carry out the risk perception analysis presented here: Downtown

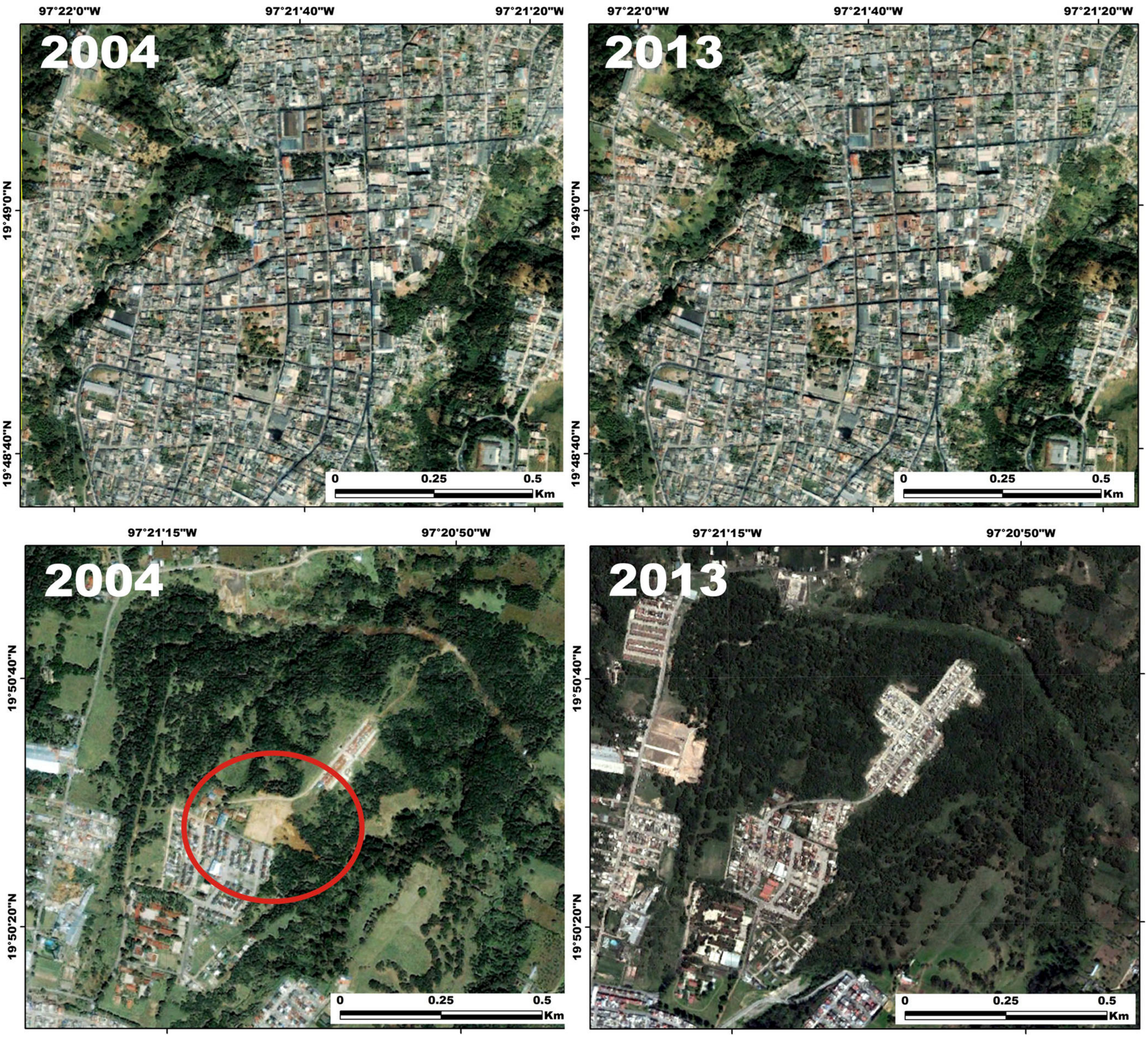


Fig. 5 Satellite images of Downtown Teziutlán (DTT) (*top*) and San Andrés neighbourhood (SAN) (*bottom*)

Teziutlán (DTT) and San Andrés Neighbourhood (SAN) (Figs. 4 and 5). The former was selected because it is considered by the inhabitants as the safest place regarding the occurrence of mass movement processes in the whole municipality, whereas in the latter, a shallow landslide episode (with no casualties) took place in 2003. In spite of being a hilly area, the sense of security in DTT is given by the lack of mass failure occurrence, which is influenced by the relative strength of the geological basement on which the city was built, since it is formed to a great extent by basalts (Figs. 4 and 6). Contrastingly, SAN was built also on a steep area but resistance of slope-forming materials is much lower given that it is situated on the ignimbrite-rhyolitic tuff deposits; resistance soil testing in seven field sites by means of a lightweight handheld dynamic cone penetrometer (PANDA) suggested mean values of soil strength in the order of 6 MPa for a maximum depth of 6 m that corresponds to the landslide failure surface of the October 2003 event (Figs. 4 and 7).

Method

Sampling procedure

As mentioned before, this study is part of a larger research project aiming at analysing the different dimensions of landslide risk perception in the municipality of Teziutlán, Puebla. Therefore, the sampling procedure included in this section corresponds to the methodological approach applied for the whole project.

The selection of the factors influencing risk perception used in the analysis was related to four questions derived

Fig. 6 Downtown Teziutlán (DTT)

from the interaction with the community during field research in Teziutlán:

1. Why do people live in areas exposed to landslides, on which at least a significant disaster has taken place?
2. What is the role of personal vs. general landslide risk?
3. Derived from the disaster of 1999, were there any lessons learnt in terms of response, awareness, and preparedness?
4. What is the perception of people regarding responsibility of the different actors to reduce landslide disaster risk?

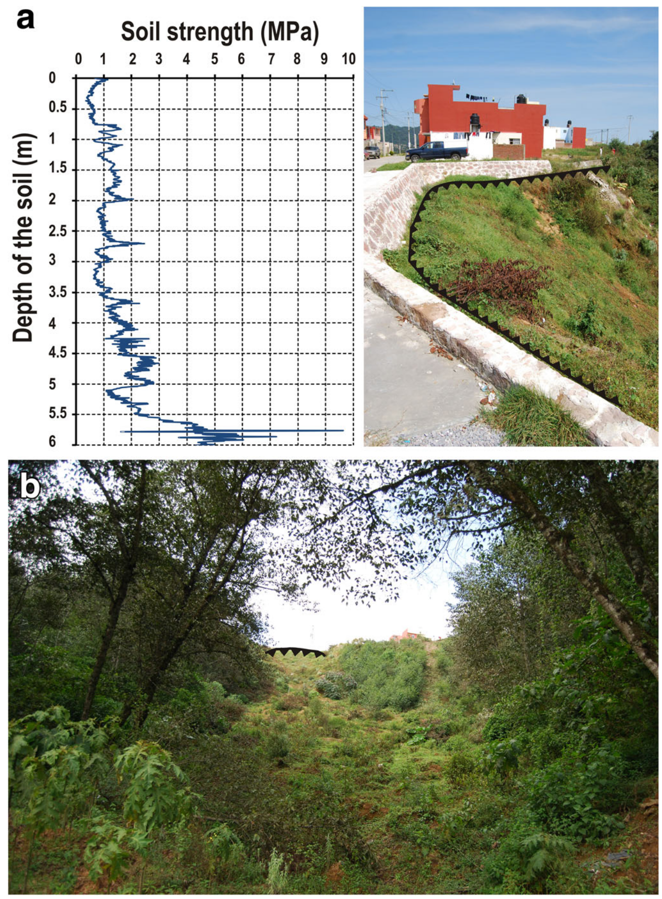


Fig. 7 Slope instability in San Andrés neighborhood (SAN)

A risk perception questionnaire was developed by using the information provided by in-depth interviews and a pilot study applied to the community of Teziutlán. In-depth

Table 2 General attributes of the people surveyed during in-depth interviews

	La Aurora		Juárez		Lomas de Ayotzingo		San Andrés		Downtown Teziutlán	
Gender	F	M	F	M	F	M	F	M	F	F
Age (years old)	62	40	47	62	61	30	55	39	56	53
Time since moving into current residence (years)	43	40	47	39	14	12	9	5	26	28
Experienced the 1999 disaster	Yes	Yes	Yes	Yes	No	Yes	No	No	Yes	Yes
Affected during the 1999 disaster	Yes	Yes	No	No	Yes	Yes	No	No	No	No
Level of education	a	c	c	e	a	c	b	d	d	d
Employment status	1	2	3	4	1	5	5	6	7	5
Homeownership	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of people living in the house	8	4	2	5	12	3	3	3	3	4

Level of education: (a) basic education; (b) secondary education; (c) higher education; (d) university education; (e) commercial education. Employment status: (1) housewife; (2) mechanic; (3) administration officer; (4) pensioner; (5) owner of small business; (6) assistant of public works; (7) teacher

Table 3 Overview of the questions and topics included in the in-depth interviews

Concept	Have you ever heard of landslides, mudslides, or debris flows?
	Please tell me about landslides, slides, mudslides, or debris flows, i.e., tell me everything that comes to your mind. When the materials of a slope move down, they are called landslides, can you tell me about it?
	When a landslide (slide, mudslide, or debris flow) takes place, it may cause harm to the population living in the surrounding area. Have you heard about this? What can you tell me about this?
Causes and landslide identification	Why a slope falls down? What may be the role of any of the following factors?
	• Natural factors: climate, vegetation, soil, rainfall
	• Anthropogenic causes: road construction, land-use changes, deforestation, mining
	Why a landslide would take place in Teziutlán? Would it take place near your community? In your neighborhood?
	What type of hillslopes "fall-down"? Why some hillslopes fall-down while others do not?
	How is the slope on which your house is built?
Consequences	What happens after a landslide take place?
	What type of damage can cause? In Teziutlán? In your community? To your home? To your family? To you?
	If a landslide takes place who would be affected most? What would happen in your community?
	From the type of damages you just mentioned, which one do you think would be the worst?
	Do you think that government authorities know what would it happen if a landslide take place in your community? How about the experts, researchers or scientists?
	Do you trust what the government knows about landslides and their consequences? Experts, researchers, scientists?
Risk assessment	Is it possible to know when a landslide would take place? How come? Which means would be used? Through a monitoring system? Observing changes in the terrain?
	What would be the best way to know if a landslide can take place?
	Under which circumstances a landslide can take place?
	Who can do the monitoring and observation? Who should do it? Who could be in charge of communicating this situation to you, to your family, to your neighbors?
Risk management	If a landslide is going to take place, what should it be done? When? By whom?
	What should be done during and after the landslide occurs?
	Do you think that the authorities can deal with the effects of landslides?
Risk communication	Have you heard about landslides (slides, mudslides, debris flows)? Why a landslide can take place? From who have you heard it? Where?
	Have you heard, seen or read or know of something that has been made in terms of landslide mitigation (slides, mudslides, debris flows)? Is something being done? Is something being planned? Where have you heard that? From who?
	Do you know if there is any program in your community to prevent or avoid landslides? What does it consist of? Who did/does/will do it? (Government, private sector, educational institution, international organization, NGOs, etc.)
	Do you trust the program(s) or plan (s) you mentioned?
	If you have not mentioned any,
	• Who do you think should develop a program or a plan to prevent landslides?
	• Who should inform (give information) about programs or plans that exist or will be made to prevent the impact of landslides?
	Who do you trust most?
Landslide significance	Do you get concern about the likely occurrence of landslides? Are landslides important risks for you? Your family? Your community?
	Are there any other important risks in your community? Are they more important than landslides?
	Have you are anybody you know been affected by landslides? What did you do? What happened afterwards?

semistructured interviews were conducted to ten key people from five neighborhoods of the municipality in order to explore the local context of the area of interest, and to identify the key components linked to the psychosocial elements of landslide risk perception. Neighborhoods were selected by considering exposure and previous experience with landslide events (Landeros-Mugica et al. in press) (see Table 2).

Table 4 General attributions of samples

Surveyed locations	Downtown Teziutlán (DTT) ($N = 65$)		San Andrés neighborhood (SAN) ($N = 72$)	
	Frequency	%	Frequency	%
Gender				
Female	43	66.2	42	58.3
Male	22	33.8	30	41.7
Age (years old)				
18 to 20	8	12.3	3	4.2
21 to 30	14	21.5	15	20.8
31 to 40	14	21.5	22	30.6
41 to 50	11	16.9	15	20.8
51 to 60	10	15.4	8	11.1
>61	8	12.3	9	12.5
Level of education				
With no education	0	0	4	5.6
Basic education	7	10.8	13	18.1
Secondary education	12	18.5	13	18.1
Higher education	20	30.7	14	19.5
University education	20	30.8	24	33.4
Commercial or technical education	6	9.2	4	5.6
Employment status				
Employed in the public sector or government	4	6.2	9	12.5
	5	7.7	14	19.4
Employed in private sector	10	15.4	3	4.2
Business owners	9	13.8	9	12.5
Working by their own (taxi driver, labourer, peasant)	4	6.2	3	4.2
	2	3.1	4	5.6
Sole practitioners (dentist, accountant, lawyer, etc.)	1	1.5	1	1.4
	21	32.3	22	30.6
Professor or teacher	8	12.3	6	8.3
Retiree or pensioner	1	1.5	1	1.4
Housewife				
Student				
Unemployed				
Years living in the community				
0 to 5	11	16.9	25	34.7
6 to 10	15	23.1	40	55.6
11 to 20	8	12.3	1	1.4
21 to 30	9	13.8	5	6.9
31 to 45	17	26.2	1	1.4
>46	5	7.7	0	0

Table 5 Description of the questionnaire sections

Section	Concept	No. of items	Responses	Observations
General information	Sex	1	Dichotomy: male or female	N/A
	Age	1	Open: years old	N/A
	Education	1	Multiple choice: from elementary to postgraduate	N/A
	Employment status	1	Multiple choice	N/A
	Years living in the community	1	Open: years	N/A
	Neighborhood they live in	1	Open: Downtown Teziutlán (DTT) or San Andrés neighborhood (SAN)	N/A
Experience	Previous experience with landslide disasters	1	Multiple choice (personal experience with landslides)	N/A
Landslide risk awareness	Main causes of landslides	1	Multiple choice (select the three main causes)	Natural and anthropogenic induced
Exposure	Levels of landslide risk perception of exposure, based on location of dwellings and nature of properties	11	Four-point scale: 1 = very low risk (VLR) to 4 = high risk (HR)	Final scale for graphic representation low, moderate, and high exposure
Preparedness	Prioritizing preventive measures to be undertaken to cope with landslide disaster events	11	Six-point scale: 5 = nothing necessary to 10 = very necessary	Final scale for graphic representation low, moderate, and high priority
Responsibility	Perceived accountability of actors in case of a landslide disaster	11	Four-point scale: 1 = nothing responsible (NR) to 4 = very responsible (VR)	Final scale for graphic representation low and high accountability
Response	Evaluation of the response of different actors after a landslide disaster	10	Four-point scale: 1 = bad (B) to 4 = very good (VG)	N/A
Trust	Level of people's confidence to be informed about disaster preparedness and response by different social actors	11	Four-point scale: 1 = never trust (NT) to 4 = always trust (AT)	Final scale for graphic representation no trust, some trust, and trust

N/A not applicable

The language used in the in-depth interview was free and depended on the vocabulary used by the respondent. Questions or topics included served only as a guide to explore the issues of interest related to landslide risk perception to be further addressed. The order and structure of the questions were adapted to the needs of the interviewee and the way the interview was conducted. Contact with "key informants" was established by municipal or state authorities, as well as by the participants of the research project that had previous interactions with them. Appointments were arranged in homes or in places where the respondents felt confident.

General topics of the in-depth interviews included the landslide concept (in terms of the local terminology used for landsliding), causes (natural and anthropogenic) and landslide identification, consequences (which ones, where, to whom, etc.), risk assessment and management (evident symptoms of landsliding in the landscape, accountability and trust), risk communication (type of media, actors, content), and landslide significance (exposure, experience) (Table 3).

Based on the results provided by the in-depth interviews, a specific questionnaire was prepared. Major elements included risk perception, vulnerability, responsibility, preparedness and prevention, risk communication, and social and psychological aspects. A pilot study, consisted of a survey applied to 206 inhabitants, was performed for validation of the questionnaire. Statistical analyses for psychometric validation of content, scales, and reliability of queries were used (Landeros-Mugica et al. in press). Questions were revised, and the final version of the questionnaire was prepared. The final sample consisted of 600 respondents, adults over 18 years of age, from eight neighborhoods of Teziutlán, who were interviewed, voluntary and anonymously, in April 2014. Questionnaires were conducted in Spanish by experienced interviewers by using a mobile tablet computer.

Sampling framework

For the purposes of this paper, a subsample of two boroughs was considered: Downtown Teziutlán (DTT), the city center of the

Table 6 Detailed overview of questionnaire structure

Experience. Previous experience with landslide disasters	
Q. From the following sentences tell me please, what is the one that indicates best your experience with landslides?	
• You have experienced landslides in this neighborhood	
• You have experienced landslides in another neighborhood	
• You have not personally experienced landslides, but a relative or close friend has	
• You have never suffered from the impact of landslides, neither a relative or a close friend	
• You have just heard, read or seen information related to landslides on the news	
Landslide risk awareness. Main causes of landslides	
Q. I'm going to read a series of situations that are on this card. What are the three that in your view are the main causes of landslides?	
• Drought	• Presence of drainage channels
• The existence of a river close to slopes	• Terracing
• Moderate rains for several days	• Negligence of the authorities
• Presence of loose or soft soil	• Tree removal
• Earthquakes	• Houses built on slopes
• Heavy rains	
Exposure. Levels of landslide risk perception of exposure, based on location and nature of dwellings	
Q. Could you please indicate to me the degree of risk the following properties have to be affected by a landslide? Response options are: very low risk (VLR), low risk (LR) moderate risk (MR) and high risk (HR).	
• Houses built on areas affected by landslides	• Houses built by the government for relocation of affected settlements
• Houses built at the top of a slope	
• Houses built at the foot of a slope	• Houses built of precarious materials
• Houses built on the edge of a slope	• Houses built on the side of a road
• Houses built very close to a river	• Houses built by the government (social interest housing)
	• Houses built on reinforced slopes
	• Houses located in the City Centre
Preparedness. Prioritizing preventive measures to be undertaken to cope with landslide disaster events	
Q. From the following situations please let me know how necessary do you think they are for improving the safety of the inhabitants of Teziutlán.	
• Guaranteeing equality for the attention of affected people	• Prohibiting the construction of dwellings in areas at risk
• Promoting programs for community preparedness	• Implementing a warning system for communities at risk
• Providing health programs for people affected by disasters	• Relocating people that live in areas at risk
	• Establishment of shelters
• Providing information on the best practices for protecting belongings during an emergency	• Promoting evacuation drills in areas at risk
• Getting people involved in landslide risk communication programs	• Landslide instrumentation and monitoring
Responsibility. Perceived accountability of actors in case of a landslide disaster	
Q. To what extent do you consider that it is responsibility of the following actors to take steps when a landslide is likely to occur, or when it already happened? Was it nothing responsible (NR), little responsible (LR), responsible (R), or very responsible (VR).	
• Federal Government	• Health Institutions
• State Government	• The Red Cross
• Municipal Government	• Lions Clubs International
• Civil Protection	• The Community
• Local Police	• Scientists
• The Mexican Army	

Table 6 (continued)

Experience. Previous experience with landslide disasters	
Response. Evaluation of the response of different actors after a landslide disaster	
Q. How was the response of these actors during or after a landslide? Was it bad (B), sufficient (S), good (G), or very good (VG).	
• Federal Government	• Health Institutions
• State Government	• The Red Cross
• Municipal Government	• Lions Clubs International
• Civil Protection	• The Community
• Local Police	
• The Mexican Army	
Trust. Level of people's confidence to be informed about disaster preparedness and response by different social actors	
Q. To get information on how to prevent or respond to a landslide, how much do you trust the following actors? No trust (NT), some trust (ST), regular trust (RT) always trust (AT).	
• Federal Government	• Health Institutions
• State Government	• The Red Cross
• Municipal Government	• The chieftain of the neighborhood
• Civil Protection	• Lions Clubs International
• Local Police	• Scientists
• People from other communities	

municipality, situated in an area with "no evident" landslide risk (AT NE-RISK), and San Andrés (SAN), a neighborhood with "evident" landslide risk (AT E-RISK). With a population of 18,039 (SCINCE 2012), the former is considered as the safest area of the municipality in terms of landslide events, whereas the latter, composed by 1624 inhabitants (SCINCE 2012), has been directly affected by landsliding during recent years (Figs. 5, 6, and 7). The sample consisted of 65 respondents from Downtown Teziutlán (DTT) and 72 participants from San Andrés neighborhood (SAN). General attributes of the samples are provided in Table 4.

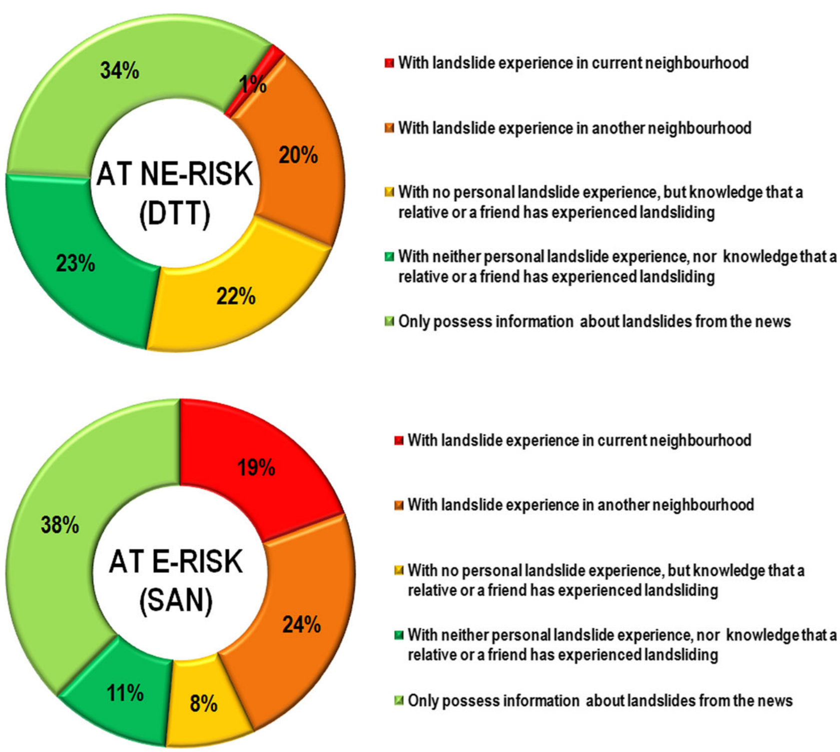


Fig. 8 Landslide experience: Downtown Teziutlán (DTT, AT NE-RISK) (*top*) and San Andrés neighborhood (SAN, AT E-RISK) (*bottom*)

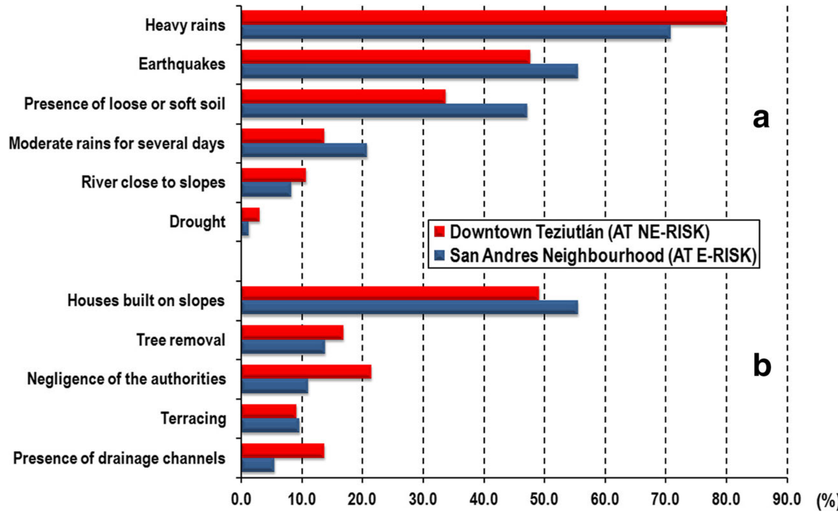


Fig. 9 Landslide risk awareness: natural causes of landslides (**a**) and human-related causes of slope instability (**b**)

Measures

Seven aspects related to landslide risk perception were considered to prepare the survey (Tables 5 and 6): (1) experience (previous direct or indirect experience with landslide disaster events); (2) landslide risk awareness (main causes of landslides); (3) exposure (levels of landslide risk perception of exposure, based on location and nature of dwellings); (4) preparedness (preventive measures to be undertaken to cope with landslide disaster events); (5) responsibility (perceived accountability of actors in case of a landslide disaster); (6) response (evaluation of the response of different actors after a landslide disaster); and (7) trust (level of people's confidence to be informed about disaster preparedness and response by different social actors).

Results

General findings

Landslide experience

Based on the fact that the municipality of Teziutlán had faced significant landslide events in the past, especially the disaster of October 1999, one of the starting points of the study was to address previous landslide experience. The latter was assessed by introducing 5 types of possibilities in terms of direct, indirect or lack of experience (Table 6). Results indicated that people living in San Andrés neighborhood (SAN, AT E-RISK) acknowledged higher levels of landslide experience, than those interviewees from Teziutlán downtown (DTT, AT NE-RISK) (Fig. 8).

Landslide risk awareness

Main causes of landslides were described by using 11 different situations that were read to the interviewees (Table 6). Although they were not informed about it, causes were grouped into two major sets: natural and human related causes (Fig. 9). Heavy rains were ranked as the main natural causes of landslides (80 %-DTT and 70 %-SAN), whereas building houses on slopes was regarded as the most important anthropogenic cause of landslides (49 %-DTT and 56 %-SAN).

Exposure

In order to analyze landslide risk perception in terms of exposure, interviewees were asked about the degree of landslide risk, based on location and nature of properties, to which dwellings were subjected to. Response possibilities ranged from very low to high risk (Table 6). Based on location, for the people living in DTT ($N = 65$) and SAN ($N = 72$), houses built on the edge of a slope were considered to be the highest exposed. Additionally, in both neighborhoods, most participants strongly felt that the houses located at the city center are the less exposed to landslides (Fig. 10).

Preparedness

Aiming at understanding people's preparedness, a list of 11 items was constructed. Such items represented situations needed to improve the safety of the inhabitants of Teziutlán regarding landslide disasters. This question is intended to analyze the prioritization of preventive measures to be undertaken by the inhabitants to cope with landslide events (Table 6). The largest percentage of the respondents from DTT ($N = 65$) ranked prohibiting the construction of dwellings in areas at high risk ($F = 62$) at the top of the list of high priorities measures. In SAN ($N = 72$), guaranteeing equality for the attention of affected people was ranked as top action in the list of high priorities ($F = 69$). For both, DTT and SAN, in spite of being considered as of high and moderate priority, landslide instrumentation and monitoring was ranked the lowest of all preventive measures (Fig. 11).

Responsibility

Concerning perceived accountability, interviewees were asked to which extent they considered different community actors responsible for taking actions in case of landslide disasters. Answers were given in terms of "nothing responsible (NR)," "little responsible (LR)," "responsible (R)," and "very responsible (VR)" (Table 6), and then regrouped as high (R+VR) and low (NR+LR) accountability for analysis purposes. The Mexican Army was ranked the top one in terms of high accountability by the respondents of both communities. Around one third of the interviewees from DTT felt that Lions Club International had low accountability, while a quarter of the peopled interviewed in SAN considered the local police as of low accountability.

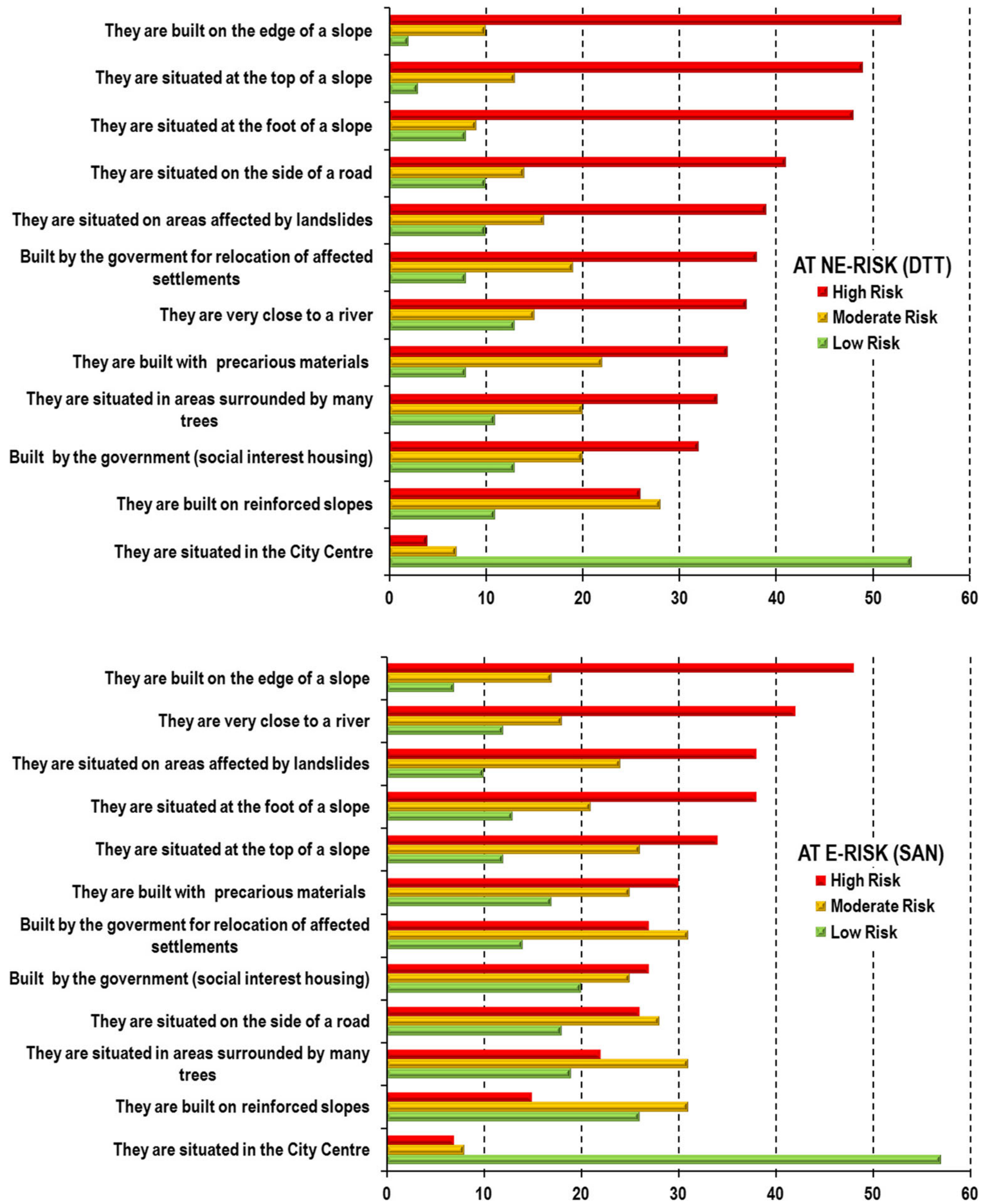


Fig. 10 Landslide exposure based on location of dwellings and nature of properties in DTT (*top*) and SAN (*bottom*)

Moreover, 75 and 89 % of the respondents from DTT and SAN, respectively, perceived a high accountability of scientists (Fig. 12).

Response

Aiming at evaluating the response of different actors after the occurrence of a landslide disaster, interviewees were asked about performance in terms of "bad," "sufficient," "good," and "very good" (Table 6). The prevalent feeling in DTT was that Lions Club International responded in the best way, while in SAN, it was the Mexican Army. Responses provided by the government at municipal and state level were considered as the worst by DTT and SAN, correspondingly (Fig. 13).

Trust

Level of people's confidence to be informed about landslide disaster preparedness and response by different social actors was assessed by posing the question of how much they trusted the actors to get information from on how to prevent and respond to a landslide. Possible answers were "no trust" (NT), "some trust" (ST), "regular trust" (RT), and "always trust" (AT) (Table 6). For graphic purposes, final grouping included RT and AT on a single category. In both study cases, the Red Cross was considered the most trusted actor as provider of information on disaster preparedness and response. In terms of lack of trust, local police ranked first in DTT and the State Government in SAN (Fig. 14).

Specific differences

This research indicates that concerning landslide exposure based on location and nature of properties, between the two groups (DTT, AT NE-RISK and SAN, AT E-RISK), the perception is significantly different at the 95 % confidence level ($P < 0.05$), in relation to houses that are built on the edge ($P = 0.033$) and at

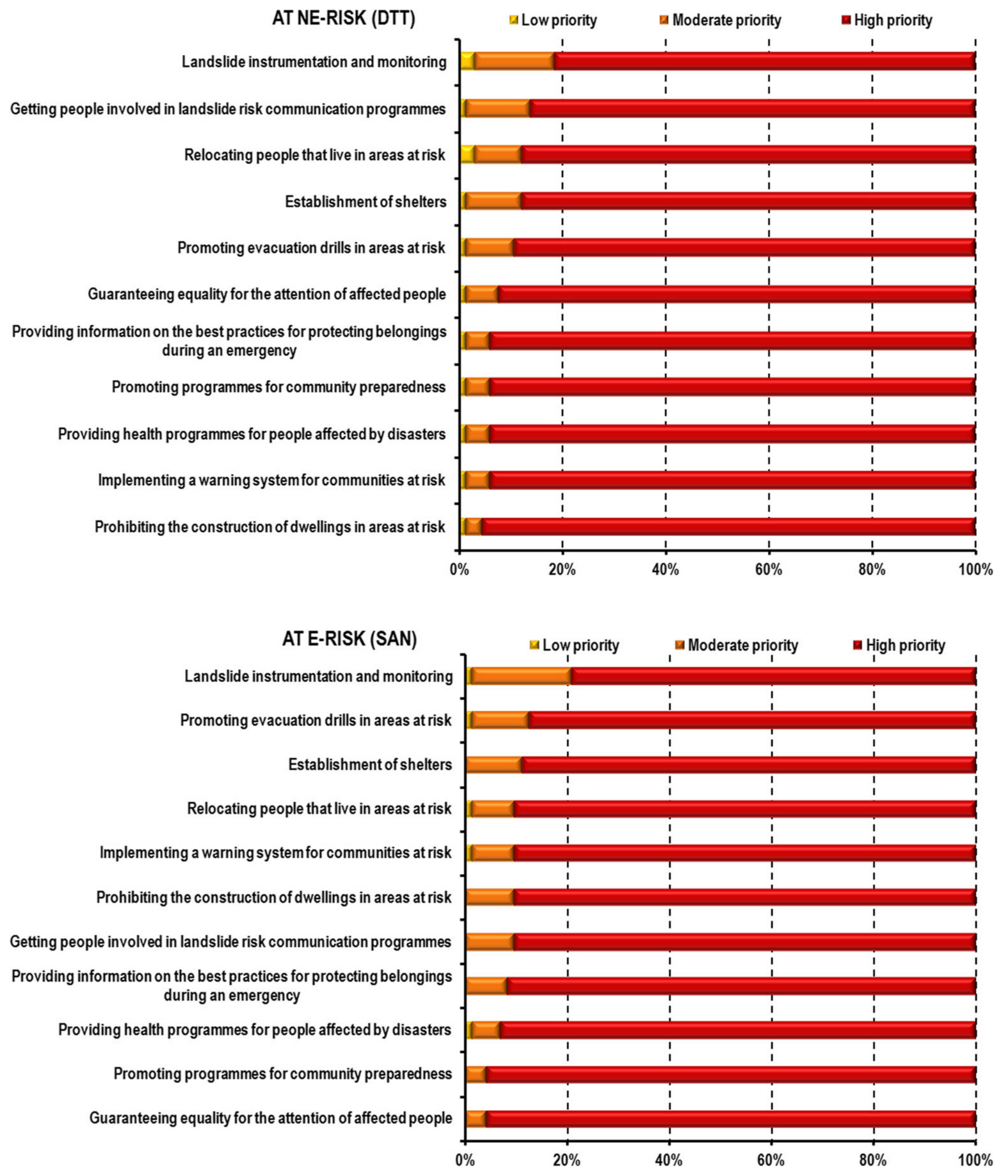
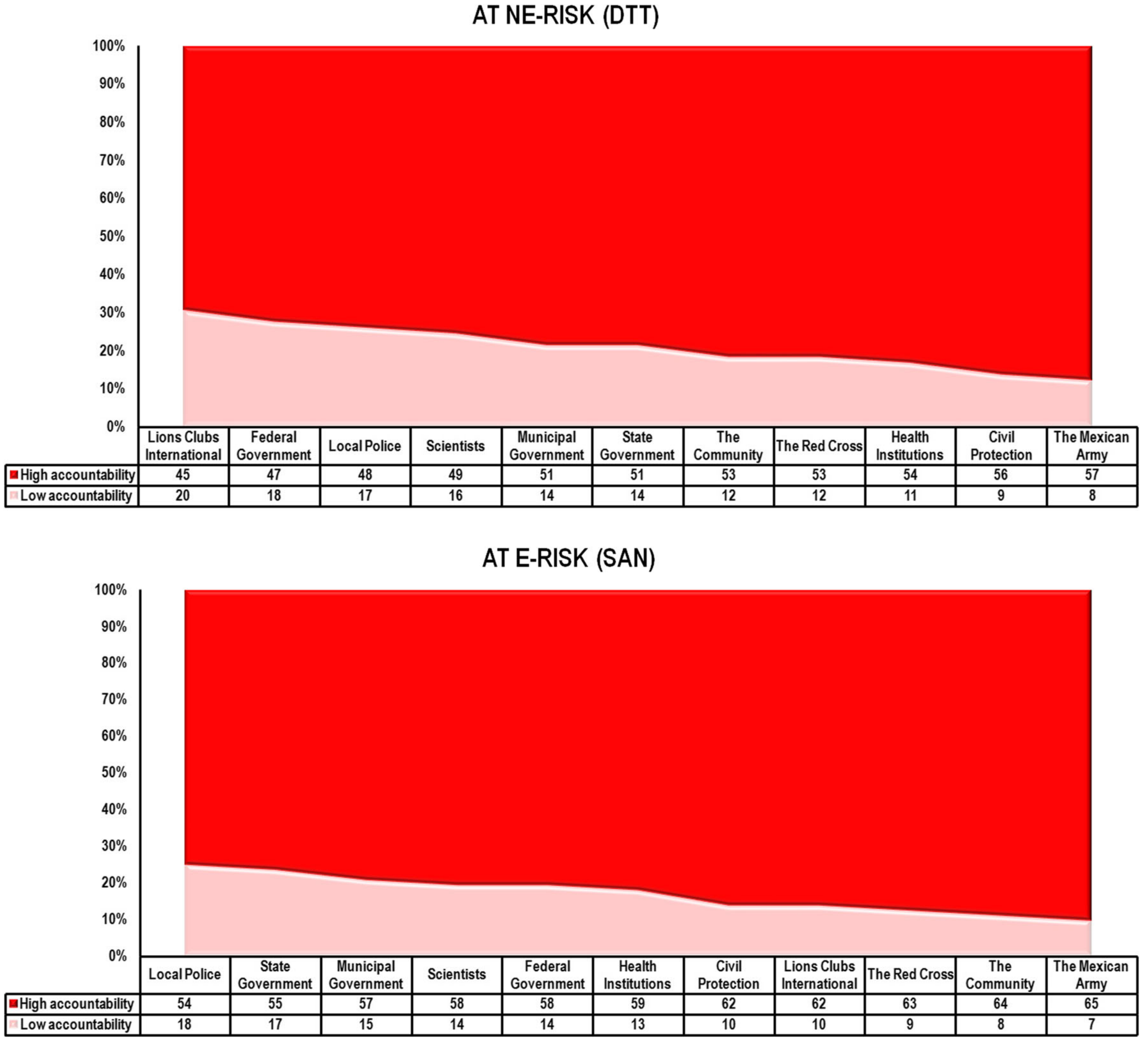


Fig. 11 Landslide preparedness as a function of prioritization of actions: Downtown Teziutlán (DTT) (*top*) and San Andrés neighborhood (SAN) (*bottom*)

the top of the slopes ($P = 0.002$), situated on the side of a road ($P = 0.005$), built on reinforced slopes ($P = 0.002$), or constructed by the government for relocation of affected settlements ($P = 0.019$). Nonetheless, people from DTT and SAN perceived the houses situated in the city center as the safest of all. The latter can be easily understood as the geological units on which the city was established is to a great extent comprised of basalts, rocks with higher resistance than those hillslope forming materials of the vicinity of SAN, and therefore, landslide susceptibility is lower than in the surrounding areas (see Fig. 4). That means that for the inhabitants of Teziutlán, it is clear now that material properties are more important than slope steepness in controlling mass failure. To this regard, it is important to mention that in the case of the October 1999 disaster, after being informed of a forecasted intensive period of rainfall, authorities decided to evacuate people living in the steepest slopes of the municipality, some of them located in the city center, that were settled on high resistance geology, whereas boroughs that suffered most were those whose houses were on less steep slopes, but situated on the volcanic deposits, in other words, on lower resistance materials.

As noted earlier, for the 11 items that were considered for analyzing the perception of the situations or actions needed to improve the security of the residents of Teziutlán, not significant differences were found ($P > 0.05$). All of them were given ranks of high and moderate priorities in a similar fashion, a situation that reflects the need of undertaking different initiatives to achieve disaster risk reduction at community level. What stands out however is that both, respondents from DTT and SAN, ranked landslide instrumentation and monitoring in the last place (still under high priority). Certainly, a lot of work has to be done in terms of linking science and society, based on knowledge transfer to strengthening resilient communities on which best practices and state of the art instrumentation, monitoring, and modeling would facilitate disaster risk reduction (Cutter et al. 2015).



	Lions Clubs International	Federal Government	Local Police	Scientists	Municipal Government	State Government	The Community	The Red Cross	Health Institutions	Civil Protection	The Mexican Army
High accountability	45	47	48	49	51	51	53	53	54	56	57
Low accountability	20	18	17	16	14	14	12	12	11	9	8

	Local Police	State Government	Municipal Government	Scientists	Federal Government	Health Institutions	Civil Protection	Lions Clubs International	The Red Cross	The Community	The Mexican Army
High accountability	54	55	57	58	58	59	62	62	63	64	65
Low accountability	18	17	15	14	14	13	10	10	9	8	7

Fig. 12 Accountability of actors in terms of responsibility for actions in case of landslide disasters: Downtown Teziutlán (DTT) (*top*) and San Andrés neighborhood (SAN) (*bottom*)

Concerning the responsibility for taking actions in case of landsliding, with the exception of the role of Lions Club International (a nonpolitical service organization), there were not significant differences for the perception of accountability between DTT and SAN ($P > 0.05$). Highest scores of accountability were given to the Mexican Army, as by presidential instruction, derived from the so-called Plan DN-III, the army is in charge of response in case of disasters nationwide. Values in the order of 70 % or higher suggested that in general, all actors were considered highly accountable in case of disasters. Federal and state government were placed at the lowest levels though, with 28 and 24 % of low accountability, by DTT and SAN, respectively.

Significant differences at the 95 % confidence level ($P < 0.05$) between DTT and SAN were found for the municipal government ($P = 0.008$) and the Mexican army ($P = 0.010$), regarding the evaluation of response as quality of performance after a landslide disaster event (which most probably was the disaster occurred in October 1999). Lowest ranks were given to the municipal government, health institutions and the Red Cross in DTT, whereas in SAN, the response provided by the state and municipal government along with civil protection was perceived as bad or sufficient.

When evaluating the level of people's confidence to get information on landslide disaster preparedness and response from different social actors, no significant differences at the 95 % confidence level ($P < 0.05$) between the two analyzed cases were found. The Red Cross was ranked as the most trusted actor, followed by scientist, municipal government, and health institutions by the interviewees of DTT, while the respondents of SAN considered also the Red Cross with the highest level of trust, seconded by scientists and Lions Club International. These results provide indeed a significant incentive for strengthening the role of science based disaster risk reduction policies, particularly in the view of implementing a landslide articulated warning system (Alcántara-Ayala and Oliver-Smith 2015), on which communities must play a cardinal role for success.

Concluding remarks

In this paper, an overview of the landslide risk perception of the inhabitants of two boroughs of Teziutlán municipality, in Puebla,

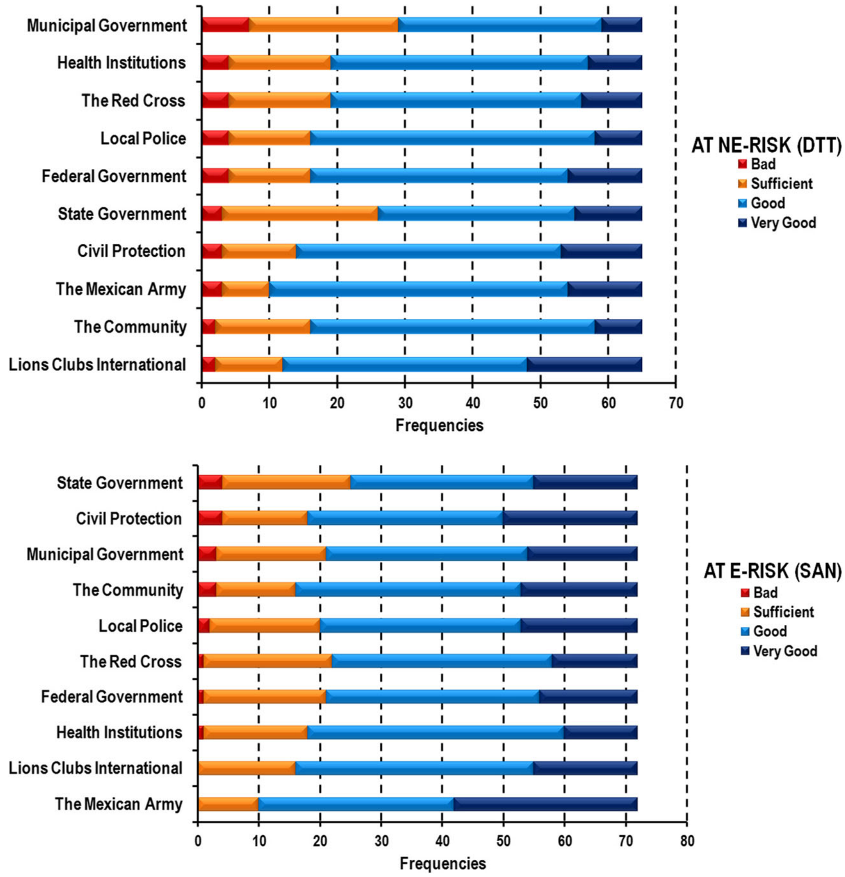


Fig. 13 Response of actors to landslide disasters: Downtown Teziutlán (DTT) (*top*) and San Andrés neighborhood (SAN) (*bottom*)

México, was presented. One of them is situated in an area with no noticeable landslide risk (DTT) and the other in a sector where landslide risk is clearly evident (SAN). DTT was regarded as such, bearing in mind that so far, landslides have not occurred there. However, it is important to take into account that given the steepness of the terrain, the lithological contact between materials of differential strength, and the possibility of being indirectly affected by the consequences of mass movement processes likely to be triggered by intense rainfall events in the adjacent hillslopes, this borough (DTT) cannot be strictly labeled as a place with no landslide risk.

DRR aims at reducing present exposure, vulnerability or hazard, anticipating potential disaster risk, and strengthening resilience; as such, DRM involves the actions to achieve those purposes (UNISDR 2015). One of the prime focuses of DRR is the reduction of vulnerability of individuals and communities, as in many cases, it determines the magnitude of the impact of disasters (Alcántara-Ayala and Oliver-Smith 2015).

Since the last century, authorities and residents of Teziutlán have dealt to some extent with landslide hazards. Nonetheless, the work that has been conducted so far regarding landslide disaster risk management not only in Puebla, but in the whole country, has been limited, and not adequate since this has been done rather in a response fashion. Within a DRM framework, the first step to decrease landslide disaster risk is with no doubt reducing people's vulnerability. This can be done in different manners including the improvement of living standards of people at risk. Likewise and of utterly importance, vulnerability can be also reduced by means of enhancing awareness and knowledge; to this regard, a good understanding on how landsliding is perceived is one of the most significant issues to do so.

Disaster risk perception is indeed a complex process resulted from a series of cognitive and social factors that influence conduct and actions at individual and collective level. Under such circumstances, possibilities, potential solutions, and answers are not simple. For instance, it is impossible to provide homogeneous responses or key activities towards capacity building in terms of awareness and knowledge that could be uniformly apply to every single case. Arising immediately from such considerations, the identification of the basic experience, familiarity, and the major concerns of people regarding landslides in Teziutlán turned out to be an important portrayal derived from the performed risk perception analysis that need to be taken into account to put forward a proposal regarding an effective risk communication strategy.

Our findings concur with those investigations on risk perception awareness, which have suggested that quite often interviewees are not very much concerned with natural hazards, and also lack of disaster risk preparedness (Wachinger et al. 2013; Wagner 2007). Public awareness and knowledge requires solid foundations of the processes and factors involved in the construction of disaster risk, not only on what to do during and after a disaster takes place.

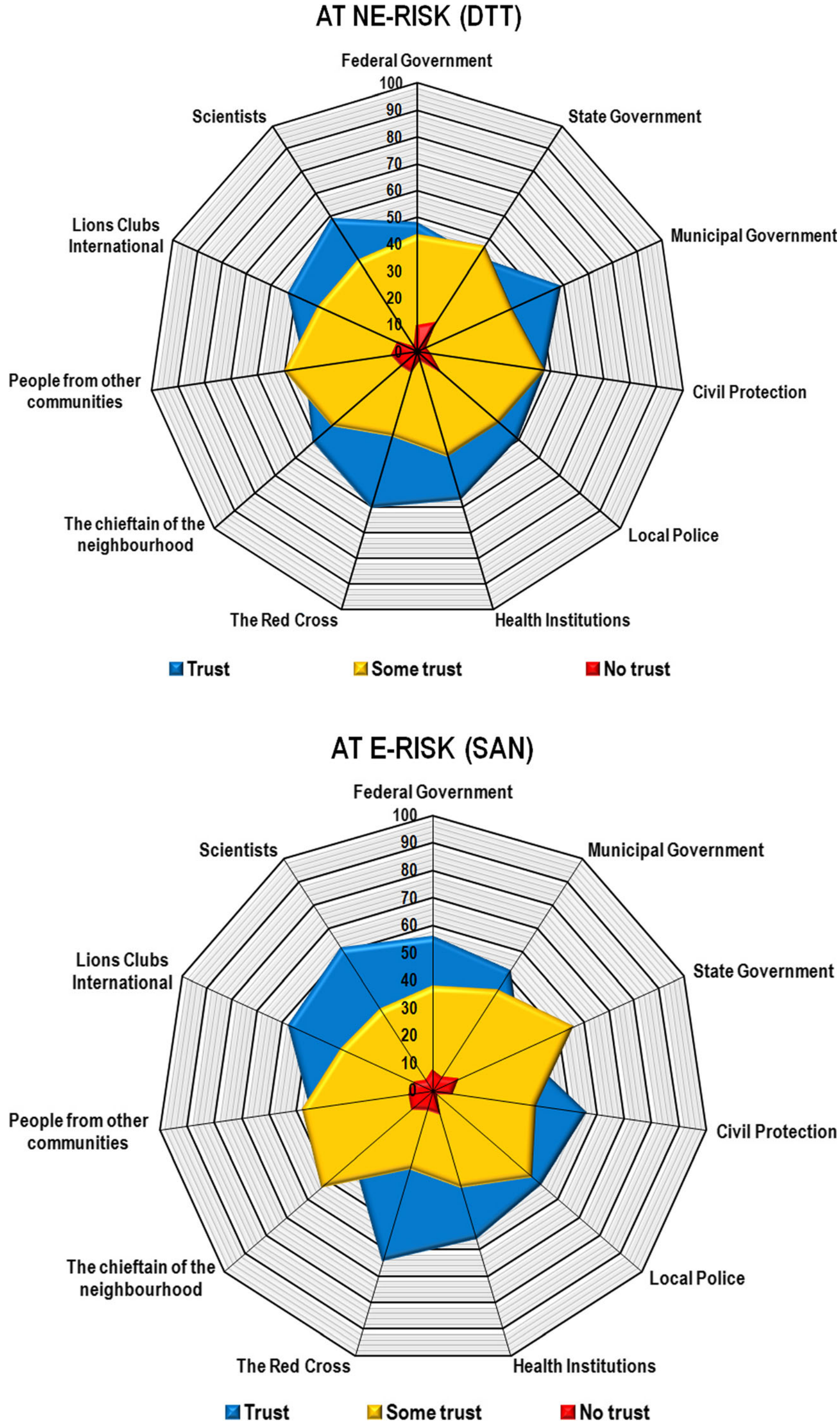


Fig. 14 People's trust in different actors as providers of information regarding landslide disaster preparedness and response: Downtown Teziutlán (DTT) (*top*) and San Andrés neighborhood (SAN) (*bottom*)

Likewise, strategies should not be focused merely on the significance of evident consequences such as death or missing people, but on the affected population in the short, medium, and even long terms; detriment of living conditions; coping capacity and environmental degradation, among others. Consequently, one of the greatest endeavors that remain is associated with the psychic numbing from which there must be a shift between responding to present or past disasters towards avoiding the creation of future ones.

In the case of Teziutlán, particularly, there appears to be insufficient transfer of information, and therefore knowledge regarding landslide instrumentation and monitoring as an essential mechanism for the establishing an early warning system. Therefore, as previously discussed, another point that needs to be comprehensively addressed is the generation of an articulated community-science based approach that includes people's perception of risk.

Considering the landslide risk perception analysis carried out in the community as a baseline, communication strategies on DRR and DRM should include five lines of intent: the first to guarantee the understanding of the hazard per se (causes, symptoms, natural, and human induced dynamics); a second one to provide a solid depiction of the significance of the multidimensions of vulnerability in controlling disaster impact (social, economic, cultural. and political factors); in the third, the social construction of landslide risk should be fully explained (emphasizing exposure, land use planning); the fourth line of intent should clearly exemplify the need of an integrated approach on which all actors are essential; and finally, the fifth one related to the urgent need of transiting from a disaster response approach to managing disaster risk, on which elements related to governance (trust, organizational structures and accountability, DRM mechanisms, capabilities, responsibilities, adaptive capacity, organization, coordination, and planning) are considered. By implementing these five central lines to communicate risk, the key message to get across would be that building resilience through landslide disaster risk management should be seen as an opportunity for development at both family and community scales.

In order to improve current policies on DRR and DRM, at municipal level, results from the risk perception analysis will be presented formally to all relevant authorities and indeed the members of the community. The development of the actual risk communication strategy, as previously delineated, will be carried out during a series of workshops that are planned to take place in the municipality and by incorporating key actors including authorities, the Director of Civil Protection (and all the members of his office), mass media representatives, chieftains and people from neighborhoods situated at risk, among other stakeholders. Avoiding top-down models and incorporating integrated approaches would be of major relevance; concepts and methodological views such as persuasiveness of messages, graphical risk information (Smerecnik et al. 2010), evidence maps (Wiedemann et al. 2011), mental models, and the expert influence diagram (Casman and Fischhoff 2008), would enrich with no doubt this significant task.

In essence, communities should become resilient entities, accordingly, landslide risk awareness and knowledge remains a challenge for the future disaster risk reduction agenda. The understanding of the ingredients of landslide disaster risk, but particularly of risk perception, evaluation, and interpretation, within the multidimensional context of vulnerability, certainly will provide valuable scientific assets to attempt, in an enhanced manner, reshaping our attitudes and rationale for decision making and actions.

Acknowledgments

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