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Risk perception of local stakeholders on natural hazards: implications for theory and practice

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Abstract. In Romania, local stakeholders' knowledge plays a decisional role in emergencies, supporting rescue officers in natural hazard events, coordinating and assisting, both physically and psychologically, the affected populations. However, despite in Iași Metropolitan area (NE of Romania), the occurrence and severity of natural hazards are increasing there is a lack of knowledge of local stakeholders to address the population toward safety actions. For this reason, 118 local stakeholders were interviewed to determine their risk awareness and preparedness capacities over a set of natural hazards to understand where the lack of knowledge, action, and trust are exacerbated the most. Results reveal substantial distinctions among stakeholders and the different threats based on their cognitive and behavioral roles in the communities. The role of responsibility and trust has been seen as important driving factors shaping their perception and preparedness. Preparedness levels were low, and, not for all, learning and preparatory actions are needed to withstand the negative occurrences of natural hazards. As their role is to refer with direct interventions in affected areas managing communication initiatives with the entire population of the community, there is the need to create stakeholders' networks, empowering local actors that could serve as a bridge between authorities' decisions and local people in order to make effective risk management plans and secure more lives and economies.

1 Introduction

Increasing the level of preparedness of communities is an essential part of risk management, a complex process that challenges scientists and involves communities, authorities, but also some key stakeholders. Decisions and actions, included the speed of those, have an important role in reducing the vulnerability of communities for improving societal resilience. From global to local, communities are affected every year by disasters. Compared to the 1980-1999 period, the last 20 years are marked by an increase in the number of climate-related disasters with a significantly higher number of people affected and economic losses compared to other types of disasters (UNDRR, 2020, van Westen et al., 2020; excluded epidemiological disasters). Recent studies forecast an increase in climate hazard impacts in the future as a direct consequence of global warming (Dottori et al., 2018; Forzieri et al., 2018; Vousdoukas et al., 2018). Especially in Central and Eastern Europe, there is evidence of an increase in heat extremes, a decrease in summer precipitation, and an increased risk of river floods due to climate changes in

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the last two decades (Anders 2014; IPCC 2013, 2018). These events are able to threaten the wellbeing of communities, especially in Romania, since its population demonstrated to have a low copying capacity of natural hazards induced risks (Dunford et al. 2015; Vanneuville et al. 2017).

In many countries, besides the national government agencies which coordinate emergencies management (Strand et al. 2010) and have much more structural and financial resources, local stakeholders are often involved in disaster planning and risk reduction because of their knowledge of the community, norms, and habits and for their capacity to assist and control people during crises (Meltzer et al. 2018; ERCC, 2019; Scheuer and Haase, 2012; Horton et al. 2011). Local stakeholders are defined as individuals or groups (generally place-based) who demonstrated capacities to coordinate and cooperate before, during, and after emergencies (Hommels and Cleophas, 2013), as widely documented during the recent pandemic crisis (Alon, 2020; WHO, 2020). They are among the best communicators in their settlements (Slovic, 1993; Reed, 2008; Straja et al., 2008), stimulating proactive two-way communication and even run negotiations, being able to influence (positively) the community and acting as a bridge between national authorities' decisions and actions. For certain types of hazards, such as floods, there is already a separation of stakeholders' responsibilities: decisions regarding local flood defense improvements are devolved to local decision-makers, whereas decisions about river training are taken at national and international levels (Merz et al., 2010). A similar situation is encountered in the case of heavy snow, in which case a first assessment and intervention fall under the responsibility of local authorities.

Local stakeholders in Romania play an effective and decisional role in emergencies (Mărgărint and Niculiță, 2014; Meltzer et al., 2018), helping rescue officers in the onset of natural hazard events, and are able to coordinate and assist, both physically and psychologically, affected populations. People seemed to trust those key agents rather than county or governmental stakeholders (Beshi and Kaur, 2019). At the national level, in Romania, the management of the emergency is coordinated by General Inspectorate for Emergency Situations (IGSU) and at ATU3 (Administrative Territorial Unit) level by the Local Committee for Emerging Situations. According to the specific legislation (NSO - National Organization System, EO - Emergency Ordinance, 20/2004) these inter-institutional committees act as main social coordinators in the case of emergency situations triggered by natural or anthropic hazards (RG - Romanian Government - EO, 68/2020). Under the leadership of mayors, these committees act in synergy and work as consultants: vice-mayor, ATU 3 administrative secretary, representatives of public institutions, and local economy.

The current study focuses on five types of stakeholders, each having a specific role in the risk management process: mayors, police officers, school heads, priests, and farmers. Being largely a consequence of the centralization of social life during the communist period, but also due to current legislation, many of the public institutions in Romania are organized at the communal level (ATU 3): town halls, schools, police, and even the church. In this way, the leaders of these organizations are de facto stakeholders with clearly defined responsibilities, included the ones concerning disaster risk management (Ministerul Educației Naționale și Cercetării Științifice, 2016; Romanian Government, 2019, 2020; Romanian Parlament, 2020): (i) majors have a decisional role in administration and public services, including parts of local finances, emergency and disaster situations, local development and territorial planning; (ii) police officers are responsible with the investigation and monitoring of criminal

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65 phenomena, take care of public order and safety of people in the administrative unit concerning in situations of disasters; (iii) school heads exercises executive management of the educational unit, in accordance with the education legislation in force, including the organization of exercises to prevent the negative effects of disasters within the educational building; (iv) priests, in addition to current sermons and duties, care for the afflicted (the poor people, widows, and orphans) and assists the parishioners in their most difficult times, including in the aftermath of disaster, giving phycological support and assist with
70 primary care; and (v) local farmers who have a great power of influence in the Romanian community, because agriculture has a significant role in the country reported to people living in the countryside (almost 50%) and in terms of economic benefit (Burja, 2014). Farmers have labor and organizational skills able to coordinate with their peers in the countryside in case of emergencies. In addition, their knowledge of the territory can help track the changes of the weather and the land, being much more resilient than the urban society (Wilson, 1997; Heitz et al., 2009; Šūmane et al, 2018). For this reason, they are reference
75 actors within the community and a role model, especially in rural areas.

The assessment of local stakeholder's risk perception is an important issue in exploring possibilities for improving the management of emergencies, which implies individual and social preparedness, scenario-based risk assessment, process manifestation, the first evaluation of the impact, and the recovery phase (Merz et al., 2010; Zhou et al., 2018). A low level of risk perception of local stakeholders often associated with low knowledge of causal factors and the manifestation of natural
80 hazards (e.g., magnitude, timing, spatial distribution) have created conditions in the past for making wrong decisions that have led to increased casualties and economic losses (Kron, 2000; Oliver, 2010; Kaplan et al., 2010; Baker, 2011; Dykes and Bromhead, 2018). In Romania, the consequences of natural hazards are dramatic and are getting worse, according to model projections. In order to understand the level of preparedness of communities, there is the need to analyze stakeholders' risk perceptions.

85 The literature provides a wide spectrum of studies relating to the importance of risk perception research, analysing people's cognitive appraisal toward specific hazards (e.g., Salvati et al., 2014; Pereira et al., 2016; Fuchs et al., 2017), related to sensitive geographical settings and communities (e.g., Roder et al., 2016; Alcántara-Ayala and Moreno, 2016, Gao et al., 2020) or a combination of multiple interacting factors (e.g., Mondino et al. 2020). At the same time, several studies are referring to the importance of stakeholders' risk perception and their role in varied types of risk mitigation decisions and actions: the
90 management of contaminated sediment disposal (Sparrevik et al. 2011), safety management in construction (Zhao et al. 2016), environmental health risks (Kraaij-Dirkzwager et al., 2017), floods (Heitz et al. 2009; Hazarika et al., 2016) or multiple hazards (Mărgărint and Niculiță, 2014). However, while natural hazards are a particular threat to Romanian people, no studies attempted to understand stakeholders' role in the wake of natural hazards, nor their perceptions and preparedness. The attention devoted by scholars has concentrated only on people perceptions on a range of different natural and anthropic hazards (Grozavu
95 and Pleşcan, 2010; Comănescu and Nedelea, 2015), or specifically to earthquakes (Armaş, 2006; Creţu et al., 2010; Armaş et al., 2017) or floods (Armaş and Avram, 2009; Ceobanu and Grozavu, 2009; Armaş et al., 2015; Comănescu and Nedelea, 2016). In all these studies, remarkable low-risk perception and preparedness are underlined due to historical, social, and economic reasons.

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The current paper has been designed to investigate stakeholders' level of knowledge and cognitive appraisal of natural hazards in order to understand if they think and act differently from the lay public (that demonstrated a low perception and readiness) and understand their role during emergencies. For this reason, a set of questions has been developed and administrated face to face to selected stakeholders in the rural administrative units of Iaşi metropolitan area (NE Romania). Iaşi metropolitan area is one of the largest urban and rural areas in Romania (Iftimoaei and Baciu, 2019), and due to its geographic location, geomorphologic features, and climatic settings, made this area particular fragile to climate extremes and changes, threatening the economic sustainability and development of the region. For all these reasons, Iași area can be considered as a hotspot and can serve as a comparative study for similar realities in Europe.

2 Setting the scene: natural hazards in Iași Metropolitan Area (Romania)

2.1 Geographical settings

Iași Metropolitan area is located in North-Eastern Romania, in the proximity of the border with the Republic of Moldavia (Fig. 1) and accounts for 18 communes (ATU3) situated in its proximity.

In order to have a more unitary image from the point of view of floods and landslides, we decided to add another 5 ATU3 (Costuleni, Golăieşti, Horleşti, Ţigănaşi, and Voineşti) to the 18 communes of the metropolitan area (Fig.1). As part of the Moldavian Plateau, the study area is a monoclinic hilly region, with altitudes ranging from 30 to 400 m a.s.l. (Niculiță et al., 2018), developed in a Miocene mudstone-marlstone lithology, with sands, sandstones, and limestones intercalations, which favored a dense distribution of landslides (Mărgărint and Niculiță, 2017; Niculiță et al., 2019, Bălteanu et al., 2020). According to the Köppen-Geiger classification of the world climate (Kottek et al., 2006), the analyzed area is characteristic of the dry continental climate (Minea, 2013; Mărgărint and Niculiță, 2017). At Iaşi meteorological station (102 m a.s.l.) the mean annual temperature and the mean annual precipitation are 9.6°C and 559.7 mm, respectively, from 1950 to 2006 (Croitoru and Minea, 2015). Iaşi metropolitan area is particularly vulnerable to anthropogenic hazards (Dicu and Stângă, 2013), but also to natural ones, as a direct consequence of dramatic changes in population dynamic and build-up sprawl in the surrounding settlements of Iaşi city in the last decades. After the period of socio-political adjustments following the events of 1989, with ambiguous legislation, economic stagnation, and the lack of territorial planning, Iaşi became, again, after 2000, one of the main poles of urban and economic growth in Romania (Benedek and Cristea, 2014). In the last decades, there was recorded an obvious tendency of sprawling of the built-up spaces along the main roads, even the low level of construction favourability of the lands (Stoleriu, 2008). The old agricultural activities were gradually replaced by new constructions, industrial and storage spaces, by renting the lands. Individual dwellings appeared more and more on lands with erosive risk, without coherent territorial development plans, in neighborhoods with inadequate infrastructure: undersized lifeline network, the unmodernized road network that constantly generates traffic problems. Traditional occupations of the inhabitants (agriculture, vineyards, orchards, vegetable farming, and livestock) were gradually moving further and further away from the central urban pole, thus creating a permanent readjustment of the land cover and labor force (Cîmpianu and Corodescu, 2013). Interesting are the examples of

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communes that in only 11 years (between 2007 and 2017) had exceptional increased the number of inhabitants (Valea Lupului, 102.8%; Miroslava, 93,4%) or new constructions (Miroslava, 164,8%; Valea Lupului, 141.4%).

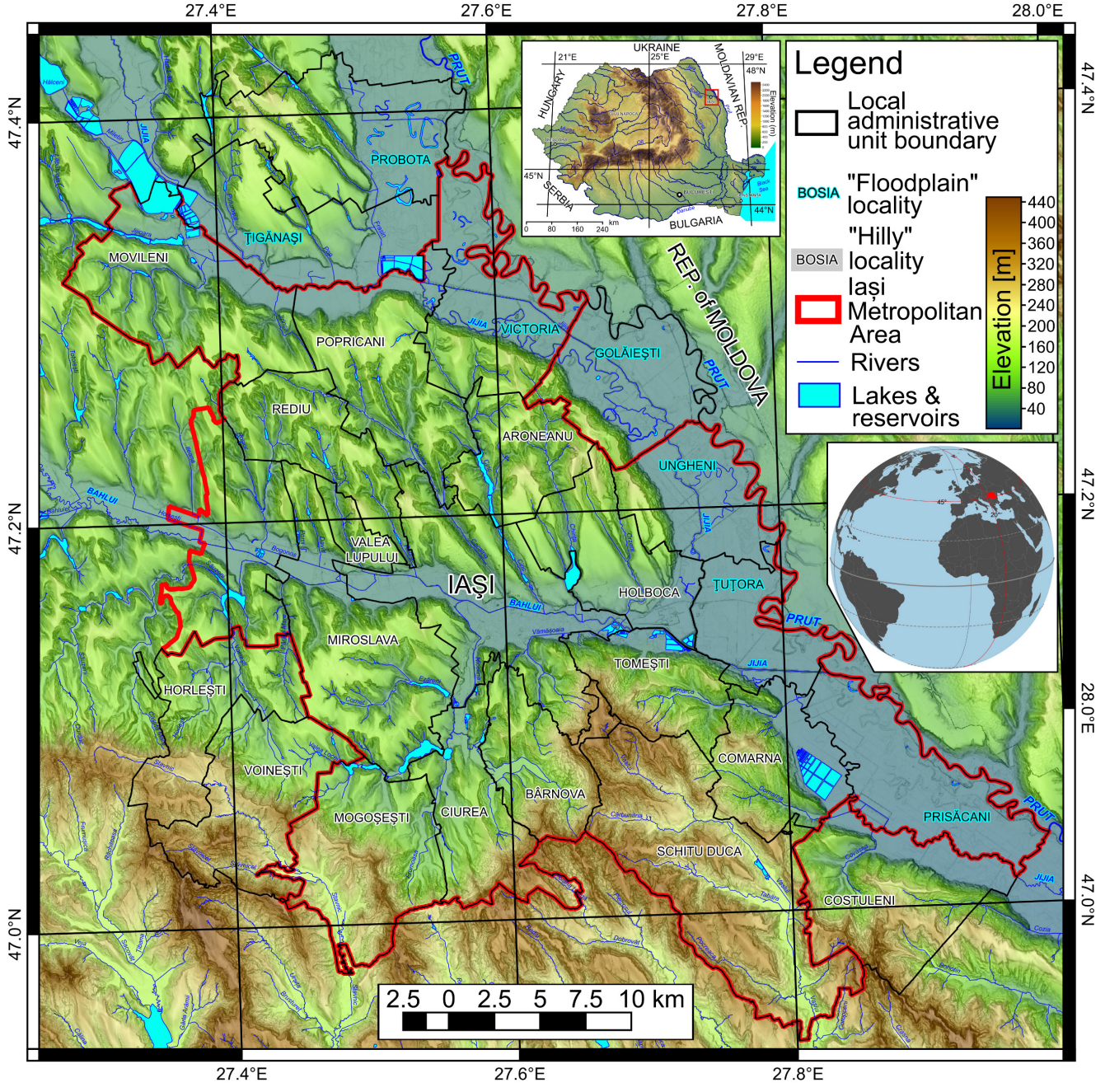

Figure 1: The geographical position of the study area.

135 The same trend is highlighted by the number of building permits issued in 2017, which in some cases (Miroslava and Valea Lupului) exceed that of the main urban center. A new peri-urban area is developing spontaneously around Iași City, which is

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growing rapidly but chaotically, generating severe problems related to the environment's quality and the future possibilities of landscape planning (Stoleriu, 2008). These complex changes in the recent past will create a greater degree of vulnerability of the population to natural hazards that have manifested in the study area in recent decades. A synthesis (Rotaru and Răileanu, 2009) of the damages caused in the 2000-2005 period by rains, hail, strong winds, and landslides in Iaşi County revealed losses estimated at 37 million RON (around 11.5 million Euro at that date). Also, a constant threat to the life of people and their dwelling stock is represented by earthquakes: Iaşi County was the most affected by the 7.1 MW subcrustal earthquake from 1997 in terms of total affected dwelling stock (Georgescu and Pomonis, 2008) and remain one of the most vulnerable to seismic hazard in Romania (Bunea and Atanasiu, 2014; Dutu et al., 2018)

In order to differentiate the administrative units and, as a consequence, different risk perception of the interviewees based on geographic location in the major landforms of the study area, the communes in which the present study was carried out have been split into two categories: (i) floodplain communes, located mainly on the major floodplains in the area (Prut, Jijia and Bahlui floodplains) and (ii) hilly communes, with a large development of slopes and associated geomorphological processes: landslides and soil erosion (Fig. 1).

2.2 Natural hazards characterization

Natural hazards considered in our study are droughts, rainstorms, heavy snowfall, floods, landslides, soil erosion, and earthquakes.

Droughts in NE Romania are associated with anticyclone conditions from summer and autumns, characterized by high temperature and low precipitation. The most frequent periods with drought appear in August, while the lengthiest appearing in October and the shortest in June (Mihăilă, 2006; Pelin, 2015). The impact of droughts on rural communities is high in NE Romania and can affect a wide range of activities (agriculture, forestry, livestock, water supply, industry), the quality of public health is considered as one of the main factors of rural poverty (Chiriac et al., 2005). Taking into account the intensity and multi-annual variability of droughts in the Moldavian Plateau, Cismaru et al. (2000) found that for the 1981-1998 period, the correlations between percentage losses of crops are logarithmically correlated with droughts intensity at the end of the vegetation period (usually October). In some parts of Moldavian Plateau, for the mentioned period, these losses reached up to 41-50%, in the case of corn crops, and 40-43% in the case of sugar beet or alfalfa.

Rainstorms are frequent in late spring, summer, and at the beginning of autumn, especially during the summer, the majority of the precipitations coming from these events (Mihăilă, 2006). In Iași the frequency of rainstorm is up to 40 times per year, the maximum 24-hour values were 136.7 mm (in June 1985 when in three days at Iași the rainstorm reached 193.8 mm), and the monthly cumulated values almost reached 300 mm (Mihăilă, 2006; Niculiță, 2020). In the proximity of Iași, toward the contact with the Central Moldavian Plateau, the 24-hour maximum value if even higher: at Sinești (30 km toward ESE) 185.3 mm in 12 hours, at Mogoșești (15 km toward SE) 154.4 mm and at Bârnova (10 km toward S) 167.9 mm (Minea 2013). Hail is a common phenomenon, associated with rainstorms, with an aleatory distribution in space and time, but with important events in 1950 and 1984, which produced important damages to agriculture (Mihăilă, 2006).

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The mean yearly number of snowfall days is 45 at Iași, but the yearly variation is between 16 and 70 days (Mihăilă, 2006). Heavy snowfall can have negative effects on agriculture and society when they happen very late, in April or even May, or when the intensity is very strong during winter (Mihăilă, 2006). Blizzards usually manifest from December to February (in February being the most frequent), but early (November) or late (April) events can appear (Mihăilă, 2006; Niacşu et al., 2019). At Iași there is a mean of 9 days per year, but the variation is between 0 and 22 days per year. During this phenomenon, the wind has a mean speed of 50-75 km/h, with a predominant direction from NW and N, the maximum speed registered being 200 km/h in 1966 (Mihăilă, 2006).

Floods are particularly frequent on Prut River, where the two remarkable ones occurred in 2008 and 2010 when thousands of hectares were covered by water and many settlements were threatened and partially evacuated (Romanescu et al., 2011a, 2011b; Romanescu, 2015). Much earlier, another event dated to 1991 has marked some great damages in Jijia River's floodplain (Romanescu et al., 2017). In Bahlui catchment, the hydro-technical infrastructure has diminished the frequency and the severity of floods (Minea, 2013), which were having important negative impacts on the populations from Iaşi city before 1960 (Tufescu, 1935). The impact of major floods in the last century on settlements from NE Romania was recently depicted using detailed topographic maps: dozens of villages have partially or totally displaced in the Moldavian Plateau (Văculișteanu et al., 2019).

Landslides and soil erosion are common natural hazards in the study area. In the last decades, landslides have been slow movement reactivations that generated household displacements and infrastructure destructions (Niculiță et al., 2017, 2018). One of the most destructive recent events that took place near our study area was the reactivation of Pârcovaci landslide in December 1996, triggered by heavy rains and snow melting: 97 households were destroyed or heavily damaged, affecting up to 400 inhabitants (Cioacă and Dinu 2002; Rotaru and Răileanu, 2009). In a recent study, Niculiţă et al. (2018) have identified and mapped a total number of 518 landslides that happened in the last century in Iaşi Metropolitan Area. They are usually reactivations of old landslides and present an obvious temporal pattern, in a strong relationship with the variability of precipitations. Their low magnitude and the fact that almost all the identified landslides happened outside populated areas show that landslides could be perceived not so dangerous by the inhabitants. But the situation could change in the future, considering permanent expansion of the built-up area (Cîmpianu and Corodescu, 2013; Iaţu and Eva, 2016) and future changes in climate evolution (Niculiţă, 2020). Soil erosion is favored by the increased tendency of extreme meteorological events, fragmented topography, and the land use of the study area. These characteristics frame our study area in the most important hotspots of soil erosion in Romania (Prăvălie et al., 2020).

Earthquakes are geological hazards that are quite present in Romania. Iaşi city is located about 200 km distance to Vrancea region, one of the European seismic hotspots. Since 1800, 7 earthquakes with moment magnitudes (MW) above 7 were registered, while the last 120 years were marked by four major events, measuring 7.1 MW (1908, 1986), 7.4 MW (1977), and 7.7 MW (1940) (Lungu et al. 2007; Mărmureanu et al., 2011). The last strong earthquake (March 4, 1977, 7.4 MW, 109 km hypocentre depth) was the cause of many socio-economic damages in Romania (exceeded 2 billion USD at that time), claiming the death of 1,578 people and injuring another 11,300 persons. At a national scale, the impact was huge: 32.897 collapsed or

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demolished dwellings, 34,582 homeless families, 763 industrial units affected, and many other damages in all sectors of the economy (Georgescu and Pomonis, 2008). Although located relatively far from the epicentral zone, Iaşi county was the most affected in Romania in terms of percentage of dwelling stock affected: 47% was affected, from which 11% destroyed, 13% of dwellings requiring strengthening, and 23% dwellings requiring repair (Georgescu and Pomonis, 2008). In the last decades, earthquakes of over 6Mw were those from 1986, 1990, and 2004 and minor damages were reported.

2.3 Climate trends in NE Romania

In the 1900-2005 period, mean annual temperature in Northeastern Romania has increased by around 0.2 and 0.3° C (Haylock et al., 2008; Kurnik et al., 2017), while for the 1961-2007 period, the trend of the increase is between 1 and 1.2° C (Busuioc et al., 2010). The current and future climate changes trends, and effects for Romania are not very well studied, and the existing results based on observational and modeling data are very often contradictory (Busuioc et al., 1997; Cuculeanu et al., 2002; Busuioc et al., 2010, 2013; Croitoru and Minea, 2015; Croitoru et al., 2016), this being the motive that the European level downscaled scenarios need to be taken into account. Currently, CORDEX (COordinated Regional climate Downscaling EXperiment) framework is used for European regional forecasting at a 12.5 km resolution and for the RCP4.5 and RCP8.5 emission scenarios (Moss et al., 2010; van Vuuren et al., 2011), through the EURO-CORDEX initiative (Jacob et al., 2014). The interpretation of modeling on a continental scale shows for the study area a change of 2071-2100 period temperature compared to 1971-2000 period, of 2 to 5° C for mean annual, summer, and winter values (Jacob et al., 2014; Kurnik et al., 2017). The historical climate data show for Northeastern Romania an increase of annual mean values with up to 20% and a decrease of summer precipitations with up to 5% (Haylock et al., 2008; Kurnik et al. 2017), although strong spatial variability is shown (Croitoru and Minea, 2015; Croitoru et al., 2016). The forecasts show a further continuation of these trends (Jacob et al., 2014; Kurnik et al., 2017). Climate change driven by anthropogenic emissions is expected to increase precipitation extremes in both wet and dry regions as it happened in the historical period, although the intensity cannot be predicted (Donat et al., 2016; Donat et al., 2017; Ingram, 2016). Anyway, the fact that the precipitation intensity will increase should be enough to alarm the authorities and the citizens (Ingram, 2016). In NE Romania, the forecasts are that precipitation extremes will increase (Jacob et al., 2014; Kurnik et al., 2017), continuing the trend of the historical data (Croitoru et al., 2016). Heatwaves are expected to be more frequent and more intense considering the increase in temperature (Velea and Bojariu, 2018). The historical trends of droughts in NE Romania are of increasing frequency but decreasing magnitude (Minea and Croitoru, 2015, 2017; Minea et al., 2016; Spinoni et al., 2015), while the forecast is of slight increase (Stagge et al., 2015). North Atlantic Circulation has a delayed effect on the spring flow (Bîrsan, 2017) in NE Romania, which will continue to remain a future trend, while the runoff should decrease (especially in summer), continuing the historical trends (Stahl et al., 2012; Croitoru and Minea, 2015). These assumptions are based on the upward trend of precipitation and evapotranspiration due to increasing temperatures (Cuculeanu and Bălteanu, 2004). The minimum discharge will decrease, and the water deficits will increase (Forzieri et al., 2014). The flood magnitude instead will increase in NE Romania (Alfieri et al., 2015; Reker et al., 2017), so probably the number of deaths in Romania will continue to be one of the biggest in Europe (Vanneuville et al., 2017).

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3 Data collection and methods

Local stakeholders have been selected representing different characteristics in terms of power, legitimacy, and urgency (Mitchell et al., 1997; Mainardes et al., 2012). Further, the dominant stakeholders (mayors, police officers), discretionary stakeholders (farmers), and dormant stakeholders (professors and priests) have been selected. Semi-structured in-depth interviews have been run from March 2017 until October 2018 involving 118 people: 23 mayors, 27 farmers, 25 priests, 21 police chiefs, and 22 school heads. (Fig. 1). As in many other countries, in Romania, public institutions are organized at administrative levels, village/town halls, schools, police headquarters. The leaders of these institutions (mayors, police chiefs and school heads, and in few cases, their deputies) were recruited directly to participate in the present study. Priests and local entrepreneurs (farmers) were randomly selected and interviewed on-site.

The questionnaire was organized into two parts: the first with pre-defined questions regarding the assessment of risk perception induced by natural hazards: level of threat, personal experience, level of knowledge, level of preparedness, risk management, communication, and trust (Table A1, Appendix) and a second part in which discussions have been focussed on environmental and hazardous phenomena that threaten the places where they live and work. Interviews were run from 30 to 50 minutes according to the desire of the participant to expand the open questions with his/her personal experience. In most of the cases, there were constructive discussions, some stakeholders inviting other members of the community (especially the mayors) into the dialogues considering it an enriching approach for the community.

There is a clear gender imbalance in the sample of stakeholders considered for the interviews (Fig. 2). This is due to the specificity of certain professions in Romania (priests are exclusively men, while police officers predominantly) or the perpetuation of older mentalities regarding the occupation of positions at the top of public administration (the case of mayors 100 % men). Only for school heads, we found a balanced situation: 63% were women. The majority of the stakeholders have a university degree, being a mandatory requirement for school heads, priests, and police officers. A large proportion of stakeholders (88%) live in the area where they work (same community or neighborhood communities), and this could suggest an amplification of perception of high-probability risks and reducing low-probability ones (Bernardo, 2013). The age distribution is skewed toward older persons, especially in the case of mayors (mean age 53.6 years) or school heads (49.2 years) in contrast with a younger age of policemen (39.4 years).

To test some assumptions, we formulated the following questions:

Q1: Is there a dependency relationship between the threats of different natural hazards?

Although the selected stakeholders have different roles within the communities and a different timing in the evolution and management of the events related to natural hazards, all of them bear extra responsibility (legislative, educational, communicational, and moral) compared to the lay public. In this sense, we stated the second hypothesis.

Q2: Do different stakeholders have different perceptions and preparedness level according to a set of natural hazards?

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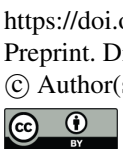

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Since Iaşi Metropolitan Area is situated in two main geomorphological settings (hilly areas and floodplains) and during the last decades, there have been registered localized hazards (such as landslides in hilly areas and floods in floodplains), this factor could influence the risk perception. As a consequence, another question was formulated.

Q3: Do geographical and topographical characteristics of locations affect stakeholder's risk perception of different natural hazards?

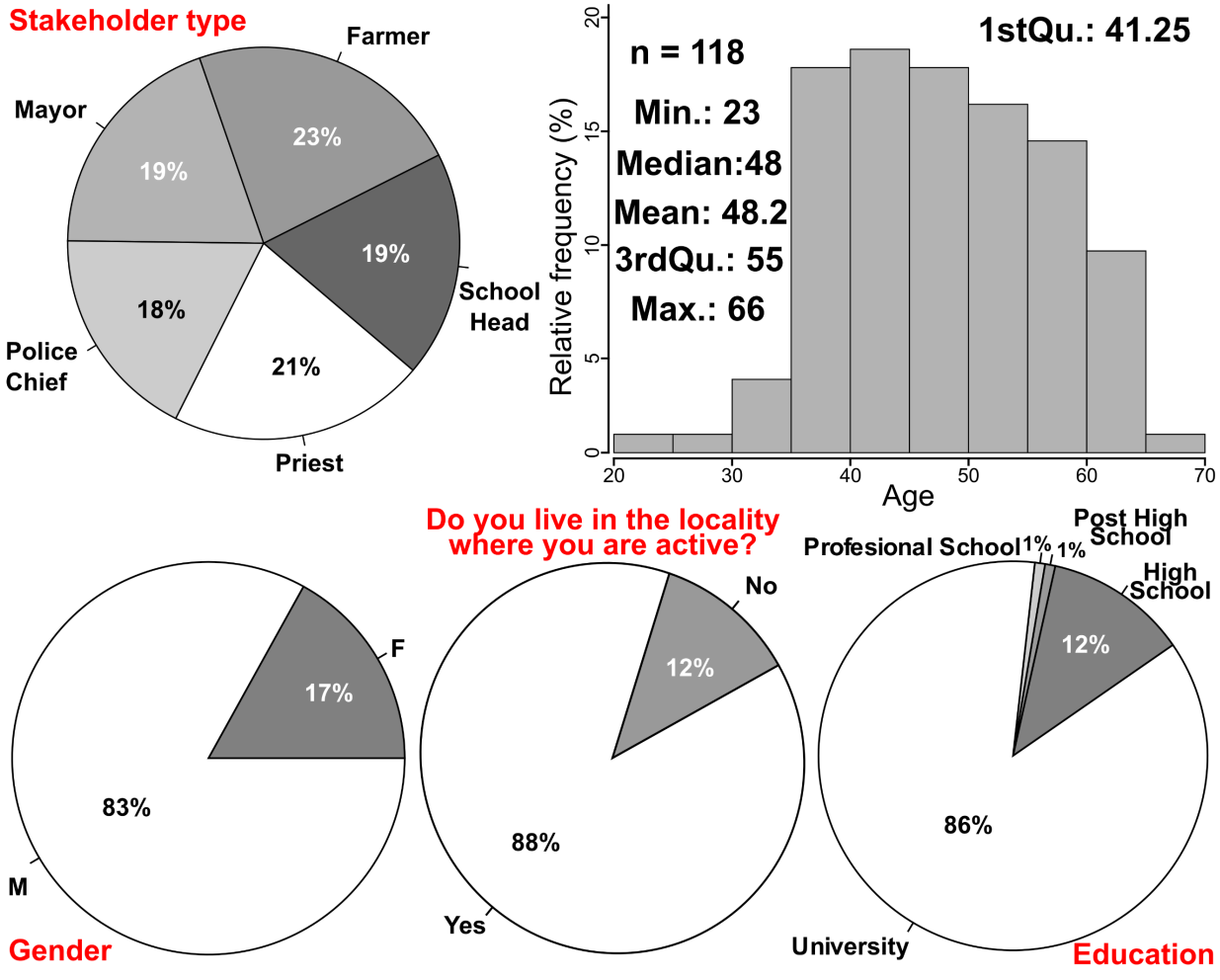

Figure 2: Descriptive statistics of interviewees.

3.1 Statistical analysis

Data coding was performed using a tabular data application (Open Office Calc) by assigning codes from 1 to 5 for the Likert scale data and from 0 to1 for dichotomous responses. The continuous variables were coded using numbers. After the coding, the raw data was exported to R stat (R Core Team, 2018), where the data was manipulated to obtain the format required by the specific functions used to analyze them. The statistical analysis was performed in three main steps (Openheim, 2000):

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(i) first, the univariate analysis was performed by plotting on the Likert or arithmetic scales the sample distributions in order to have a first overview (descriptive statistics) of the data. Also, we have chosen to comply with the standard statistical assumptions (especially regarding the failure of parametric statistics in the case of extreme values of ordinal data and unequal interval scales, Baker et al., 1966, Armstrong, 1981) and use both univariate and bivariate analysis with graphical analysis to provide a more in-depth analysis (Knapp, 1990; Mircioiu and Atkinson, 2017). Also, we avoided considering Likert data as nominal categories since the ordering will be lost (Agresti, 2010; Mangiafico, 2016).

(ii) secondly, the bivariate analysis consisted of computing the cross-tabulation and various independence and association measures between the variables. First of all, it has been tested the independence of the responses toward the risks involved in the study for the stakeholders' categories and, after that, association tests for the assessment of the significance of stakeholder type and other categorical variables. Kruskal-Wallis rank-sum test was used to assess if there are differences in the responses (Magnifiaco, 2016) for every category of risks and natural risks and decedent type, village, commune, flooded or non-flooded, age, gender, education. When the dependence exists (the null hypothesis is rejected), the statistic Freeman's epsilon-squared was used to assess the association's strength between one ordinal variable and one nominal variable (Mangiafico, 2016). This statistic ranges from 0 to 1, with 0 indicating no association and 1 indicating perfect association. Values bigger than 0.5 were regarded in our case as a measure of powerful association in the presence of dependence. This association measure was computed using the epsilonSquared() function from the rcompanion R package (Mangiafico, 2016).

(iii) finally, we applied a multivariate method, correspondence analysis for those questions and risks that were found conclusive in the bivariate analysis step.

Besides, CA (Correspondence Analysis) graphical methods have been applied for exploring the relationships between variables in contingency tables (Greenacre, 2007). The method's theory is straightforward, based on the singular value decomposition of the contingency table's matrix data structure. We have chosen this method because it describes our data graphically in terms of showing the differences between stakeholder types or other categorical variables, especially for those with big Freeman's epsilon-squared values. The Likert scale with the answer to the question is considered the dependent variable, and the variants of the response or the categories of stakeholders or other associated categorical data (flooded or non-flooded communes) are the independent data. The column variables (e.g., stakeholder type) are displayed as oriented vectors, while the Likert scale counts are displayed as dots. The orientation of the stakeholder type vector toward one of the axes shows its contribution to that axis's variance. If the angle between the vector and the lines is 45°, then the contributions to the two axes are the same, while if the angle is smaller toward a certain axis, the greater the contribution to the variance of that axis is. The length of the arrow vectors is proportional to their contribution to the two-dimensional solution. Since we have an ordered variable, and the distances between the categories are not the same, there is no logic to take into account the distances along the axes of the CA plot and to make comparisons (although this type of plot allow this, in the sense that the axes are scaled to a common scale).

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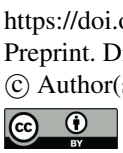

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4 Results

4.1 The level of threat

The first question addressed to the interviewees was designed to assess the main socio-economic and environmental factors which could affect the communities' quality of life. The majority of stakeholders (61%) consider that the level of development is the main factor that can threaten the quality of life in their territory (Fig. 3). It follows the risks induced by natural hazards (57% of responses), climate change (40%), criminality (37%), environmental pollution (27%), and technological risks (8%).

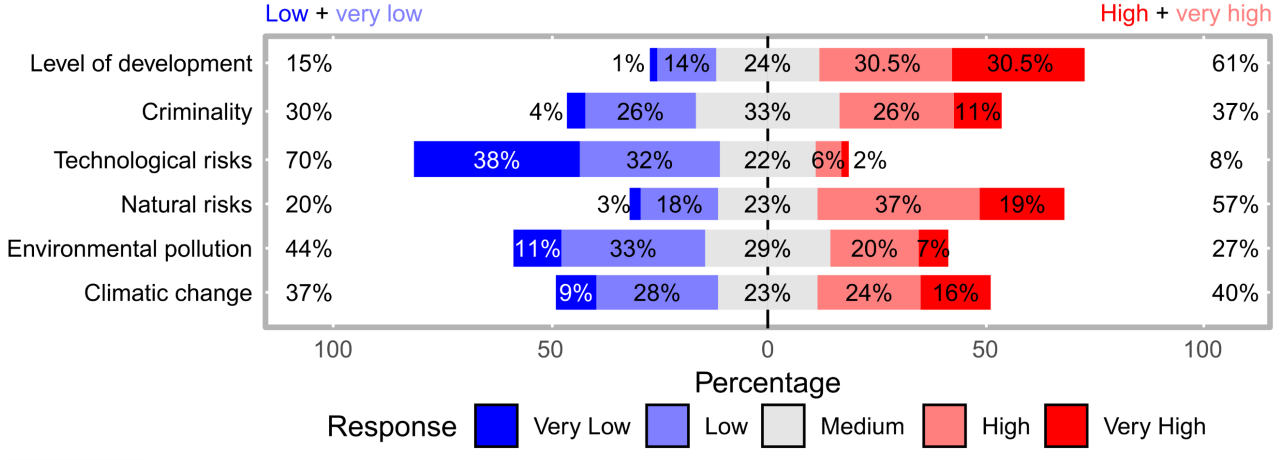

Figure 3: Likert plot of the responses regarding the perception of the factors that can threaten the local community.

Generally, the stakeholders that participated to the present survey consider droughts as the most threatening natural hazard both for their communities but also for them personally (Fig. 4).

Water scarcity is a direct consequence of the continental climate of the region that affected the agricultural economy of North-Eastern Romania for centuries (Mărgărint and Niculiță, 2016; Niculiță et al., 2020). Many stakeholders reported a drastic reduction in the number of cattle, which, in the driest years, can reach 80% of the total animals of the households in the villages. "There are ten years since I had serious problems every year. I achieved a special car-tanker to get water for livestock. And very little remains for vegetable crops. I get water from the reservoir (5 kilometers away), and I don't know what will happen when it disappears." (farmer, 35 years, managing 300 hectares of agricultural land and 35 cows. They also consider that this hazard will affect their communities for many years from now. Alongside the dramatic reduction of agricultural production, the most dangerous problems occur regarding livestock).

Earthquakes represent the second threatening hazard. The memory of the 1977 earthquake, when Iași County registered the highest number of buildings affected in Romania (Georgescu and Pomonis, 2008) is still vivid in the memory of many stakeholders. Although the norms in constructions were strongly upgraded after this event, after 1989, the discipline in buildings decreased suddenly due to the lack of legislation. How many dwellings have been built up in the last years is not far from the knowledge of the interviewees and, from this point of view, many raised serious questions regarding the resistance

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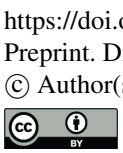

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of the new constructions. “Many who bought new homes think they are new and strong, but at the next big earthquake, they will find that they were built just to be sold.” (mayor, 58 years, personally affected by the 1977 earthquake). The population’s level of dissatisfaction is constantly increasing concerning public works, transportation, and the environment. Considering that any significant event did not trigger these permanent stressors, the real situation of risks associated with natural hazards can be much more profound, almost unknown to many of the inhabitants and their leaders.

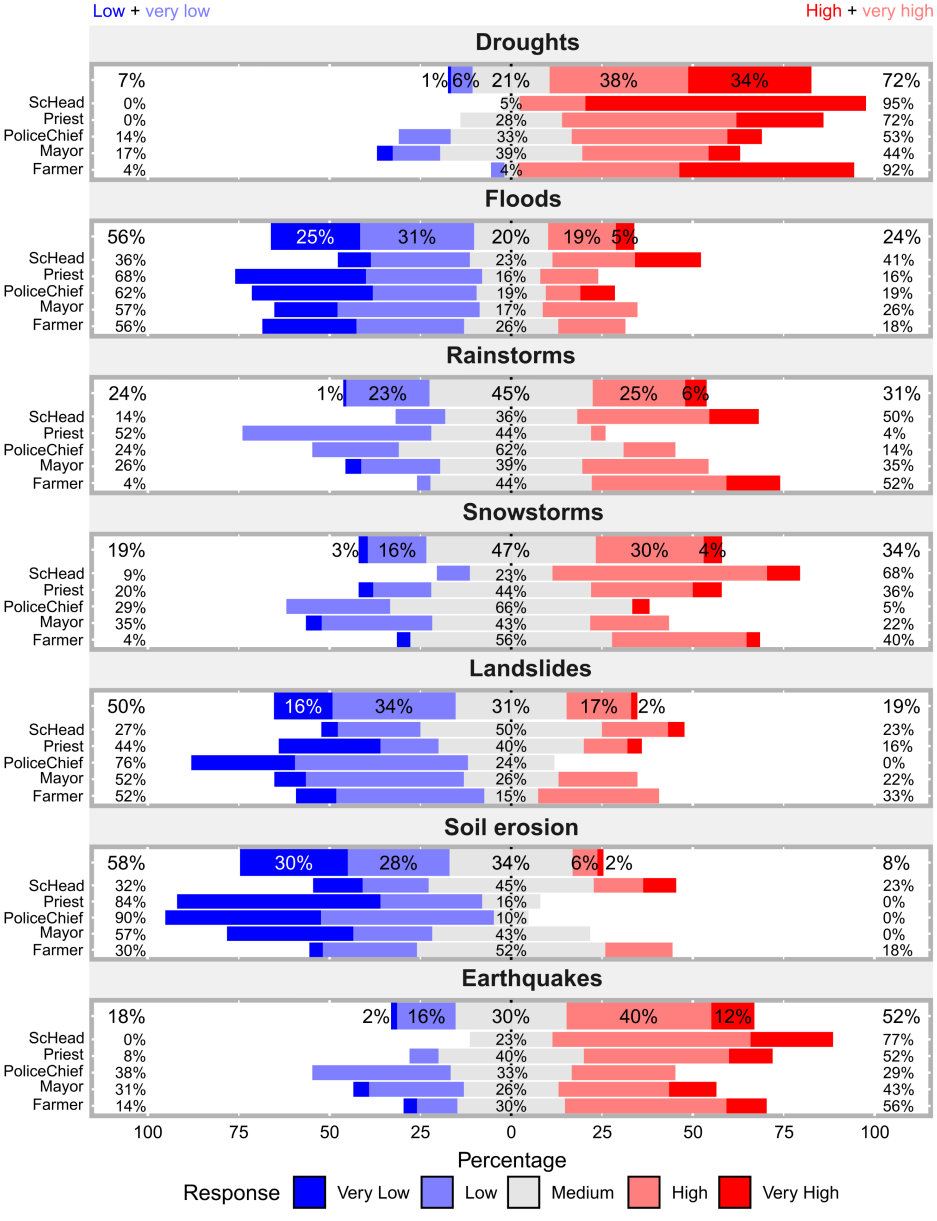

Figure 4: Likert plot of the responses regarding the perception of the natural hazards that can be a threat for the local community, for every natural hazard, and every stakeholder type.

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A middle position is occupied by the hazards which registered a higher frequency: rainstorms and snowstorms had a growing trend in the last decade in the study area and, as a consequence, their impact on communities is quite essential. During the year, the strongest storms occur in late spring and summer. In some cases accompanied by hail, the most significant damages are recorded in agriculture and in newly built areas that do not have an adequate drainage infrastructure. When they have a large area of development, they can affect the transports, trigger soil erosion, and lead to the increase of the lower order hydrographic network flows, leading to the destruction of the bridges, the siltation of the canals, etc. These issues were invoked as the most pressing by farmers and mayors, and police chiefs. "I am here for few years. In the center of the locality, there are no problems, there is asphalt on the street, but towards the valley, those who have moved to the house in the last four years live a nightmare every time it rains. The road is muddy and becomes impassable." (a police officer in a settlement with many new dwellings, 34 years).

Climate-related hazards that have a relatively low temporal frequency, like floods, landslides, and soil erosion, are perceived as imposing a low threat, in general. The landslide risk is high in hilly regions of NE Romania (Micu et al., 2017, Mărgărint and Niculiță, 2017). In the last century, one of the most significant events inside the settlements took place 50 years ago in a succession of years with high precipitations (Pujină, 2008). With few exceptions, the memory of those events seems to erase. But the risk is still high, and people will face again with landslide reactivations in the years with the same increased pattern of precipitations (Niculiță, 2020). There is a lack of prevention behavior in terms of recent expansions of built areas due to several factors: investors' desire to build and sell, lack of knowledge and awareness of the danger of those who buy, and those who should take decisions regarding the expansion of built-up areas. "In our commune, the landslide risk has been solved: we have the study regarding landslide hazard and risk in an updated form, so we are in line with the legislation." (mayor of a commune affected by landslides in 1969-1972, 66 years).

The outputs of The Kruskal-Wallis rank-sum test and Freeman's epsilon-squared statistics show correlations among every category of natural risks and a set of socio-economic and geographic variables (for further results, see Table A3 of the Appendix). The most significant differences are in stakeholder type (answering the second research question), gender, age, and spatial localization, and geomorphological context. At the same time, education does not influence the response. The results indicate that the risk perception is dependent on stakeholder types, which partially confirms the third research hypothesis. In addition, it has been found that the age of the respondents is an essential factor regarding certain risks (Table A2, Appendix) because some of them might be born after certain important hazard events such as the 1977 earthquake, 43 years ago, or the landslides events such as those between the '70 and the '80 (Niculiță et al., 2017, 2018). For floods, climatic hazards, and soil erosion, it seems that younger respondents are more aware.

The CA contribution biplot for Question 1 from Fig.5, is showing the correspondence between the perceived role of natural hazards as threats to the local community by different stakeholder type, considering the first two dimensions, that sum 96,8% of the variance. Police chiefs and priests who perceive natural hazards as low and medium threats, mayors and farmers perceive them as high threats, and school heads that perceive them as high threats. The explanation of the low perception of hazards as

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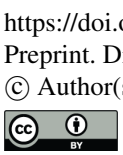

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threats to the community's quality of life in the case of priests and police chiefs is given by their relative low knowledge of natural hazards, given by their profession. School heads, mayors, and farmers have a high level of awareness associated with the threats for the quality of life of the following factors: level of development (91% of school heads), natural risks (82% of school heads and 81 % of farmers) and climatic change (78% of farmers, 55% of school heads). The exception is related to technological risks, given the predominant rural background of the communities. Priests and police chiefs, in general, expressed a low level of perception regarding the threats to local communities, with some exceptions: e.g., police chiefs regarding criminality, which is their duty (the same threat is seen by school heads, in association with their high level of childcare).

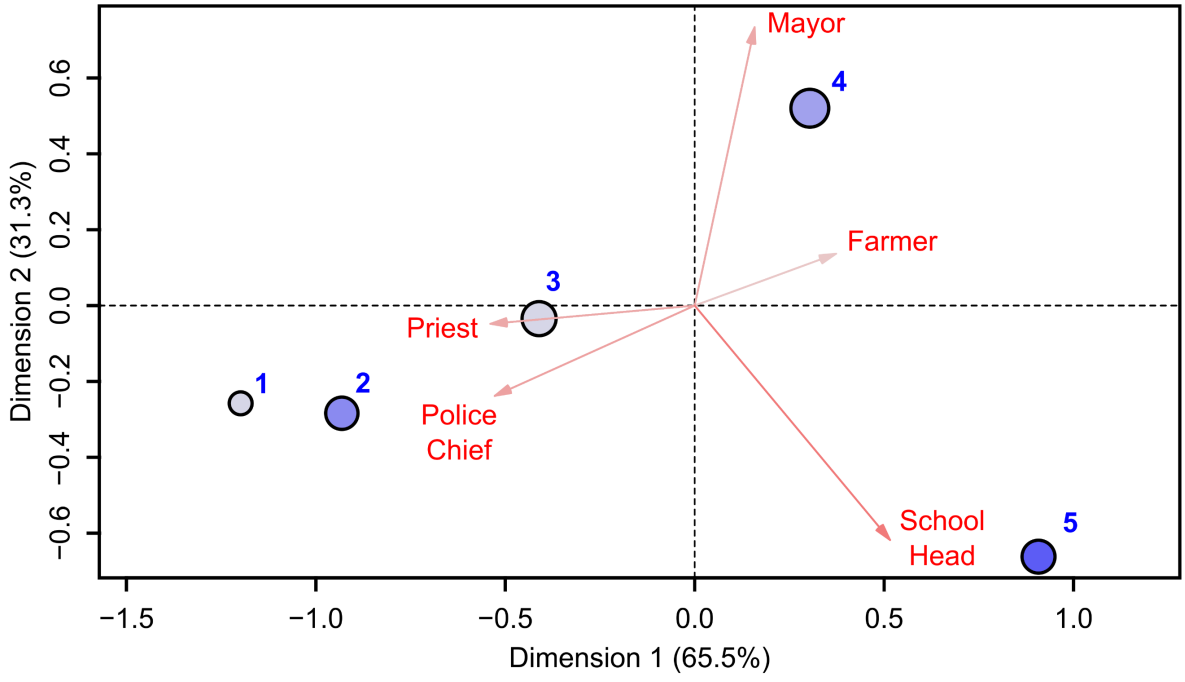

Figure 5: CA contribution biplot for the natural hazards' role as threats for the community's quality life as perceived by the stakeholders according to their type.

The highest values of the perceived threat associated with droughts have been registered in the case of school heads (95%) and farmers (93%) who expressed a great concern compared to the other stakeholders. Also, the earthquakes are seen as a significant threat by school heads (77%), farmers (56%), and priests (52%). By interpreting the enlarged discussions during the interview, this could be considered as a consequence of still lively memories of the 1977Vranceaearthquake (Armaş, 2006), a social trauma of Romanian people, but also to present-day other factors: (i) a high vulnerability characterizes the majority of institutional buildings (especially schools and churches) to earthquakes (Mosoarca and Gioncu, 2013; Albulescu et al., 2020) and (ii) the frequent exercises for the improvement of the earthquake preparedness (in schools usually these exercises take place annually). The problem of the vulnerability of old buildings in Romania represents a constant public and scientific debate

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(Armaş, 2012; Banica et al., 2017) and, in this sense, we also raise on this occasion an alarm signal regarding the need for essential investments in the modernization of public spaces in urban and rural areas in Romania.

From these general results, significant differences have been recorded among the two geomorphological types of the administrative units (Fig. 1 and Fig. 6): floodplain administrative units (FAU) and hilly administrative units (HAU).

The results highlight that stakeholders have different levels of perception related to different hazards, according to the main past events that have been recorded in the last decades: in the floodplain administrative units (FAU in Fig. 6) there is a significantly higher degree of awareness concerning flood risk and possible threats, while in the hilly administrative units (HAU) the level of threat associated to landslides and soil erosion is higher than in the FAU.

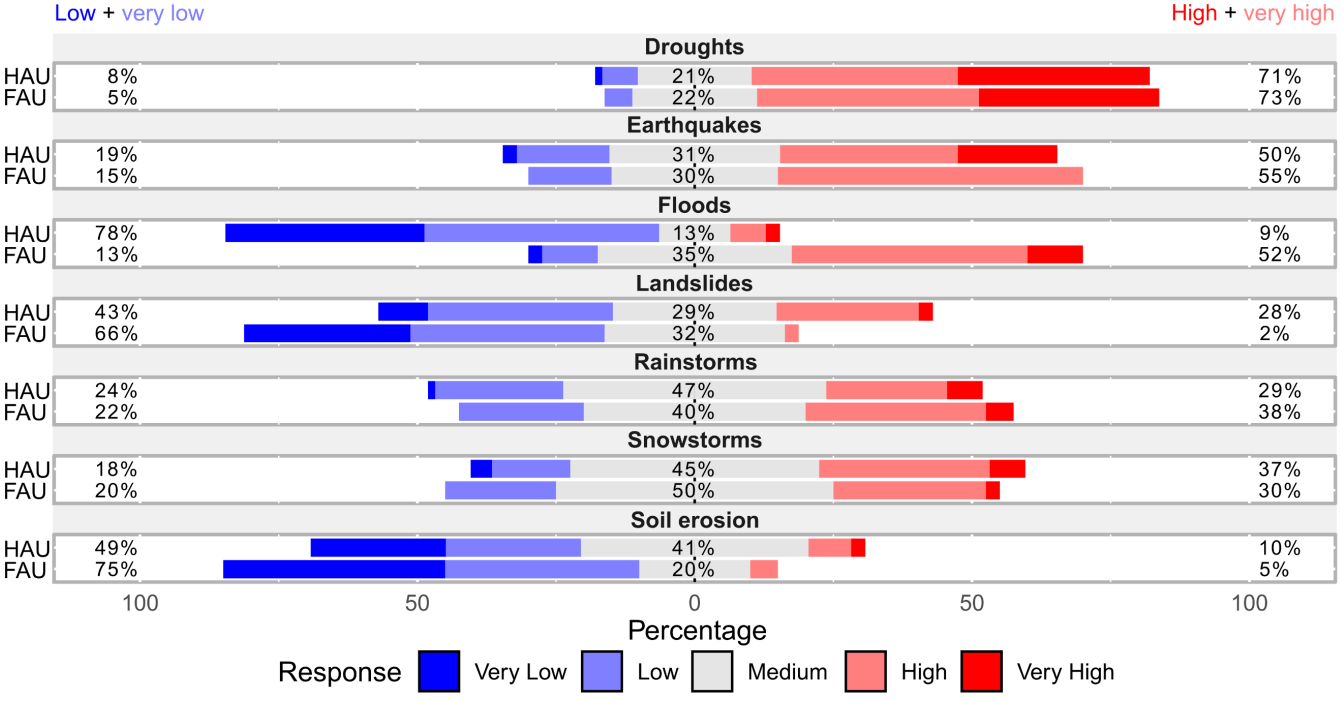

Figure 6: Stakeholders level of threat of natural hazard in relation to the dominant geomorphological landforms of administrative units (AU): floodplain (FAU) and hilly (HAU).

Again, droughts are the most life-changing natural hazards with the highest likelihood of occurrence. Rainstorms, snowstorms, and earthquakes follow them. A lower level of probability was assigned to soil erosion, landslides, and floods (Fig. 7). But here, there are important differences, depending on the geomorphological type of the locality. The stakeholders who come from floodplain settlements have indicated a higher probability for floods than the others (HAU stakeholders) and a lower probability for landslides and soil erosion.

The main geomorphological characteristics which can influence different hazardous processes and the distance to the potential risk areas constitute important factors of how different people perceive different risks (Bickerstaff and Walker, 2001; Heitz et al., 2009; Gao et al., 2020). Some natural hazards affect large areas (droughts, earthquakes, or snowstorms), while others (e.g., landslides, floods) are spatially concentrated in direct relation to topography characteristics at the local scale. From this point

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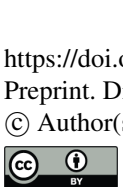

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of view, the settlements from the study area, as part of the Moldavian Plateau, have been constantly affected by landslides and floods (Văculişteanu et al., 2019), and their consequences are found in the answers given by the interviewees. Table A1 of the Appendix (Q2 and column 6) and Fig. 6 shows that the geomorphological context of the area where the stakeholder works is important in its perception regarding floods and landslide risk. These results are seen in the context of a social trauma of the inhabitants managed by the stakeholders during the evacuations of some settlements along Prut Valley in 2008 and 2010. Due to the risk of flooding of the inhabited areas, in July 2008, over 3000 inhabitants from Iaşi County, including Victoria, Ungheni, and Ţuţora ATU3 (Fig. 1), were evacuated (Ziarul de Iaşi, 2008).

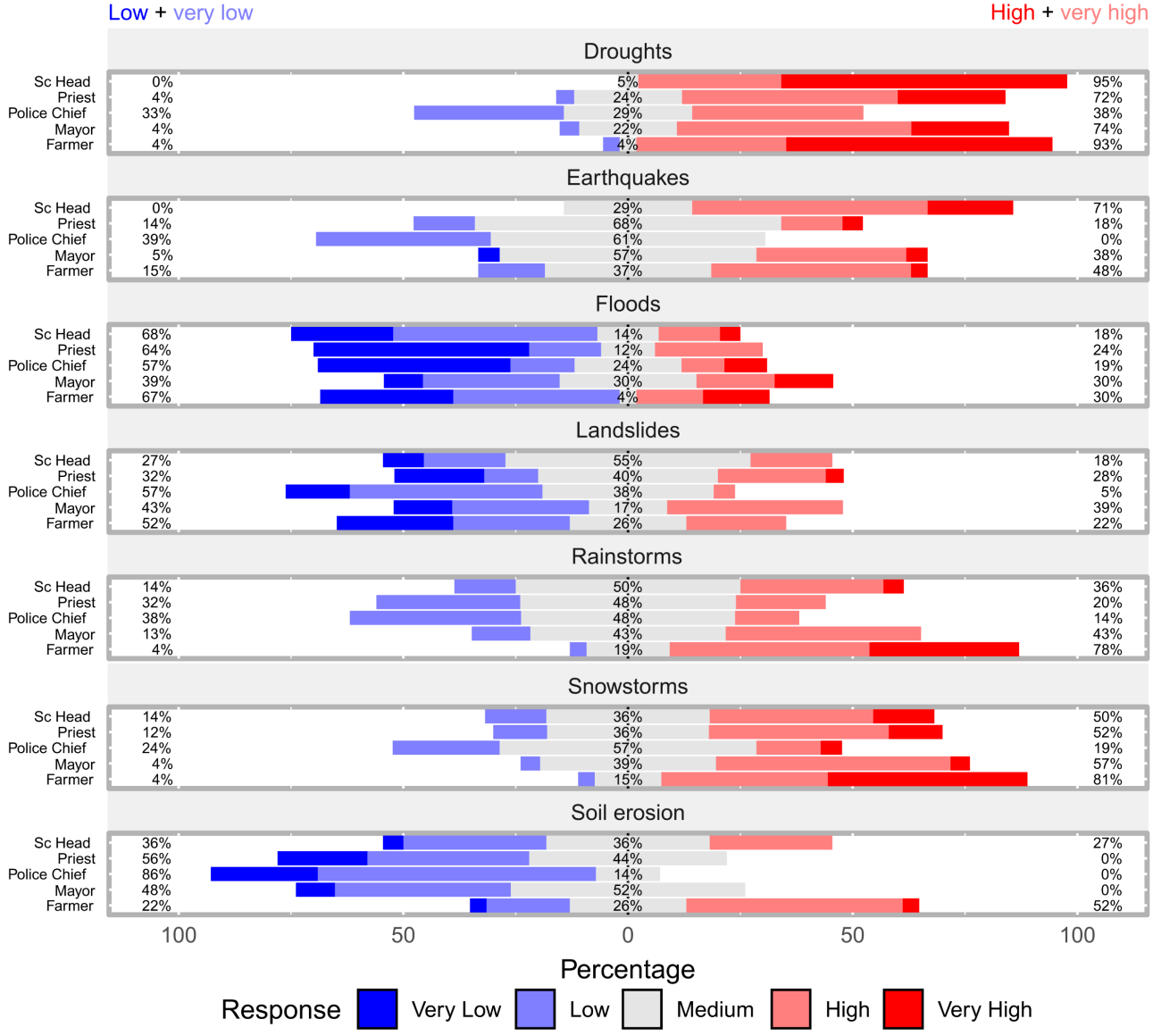

Figure 7: Likert plot of the responses regarding stakeholders' perceived likelihood of different natural hazards.

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Concerning the likelihood of occurrence of natural hazards (the fifth question), some types of natural hazards are perceived to increase in the near future, especially climatic induced hazards: droughts (86%), rainstorms (68%), and snowstorms (64%). Landslides and soil erosion are perceived as not increasing, while for earthquakes, the results are balanced.

4.2 Personal experience and knowledge

Personal experience is one of the most critical factors influencing risk perception (Weber, 2006; Van der Linden, 2014; Knuth et al., 2015; Öhman, 2017). The study participants indicated that they were affected mainly by droughts, rainstorms, and snowstorms, with farmers bearing the major costs (Fig. 8). A large proportion of them was affected by droughts (93%), rainstorms (78%), snowstorms, and soil erosion (48%). Stakeholders are affected by natural hazards according to their activities and responsibilities in their daily life, exposing them to different vulnerabilities.

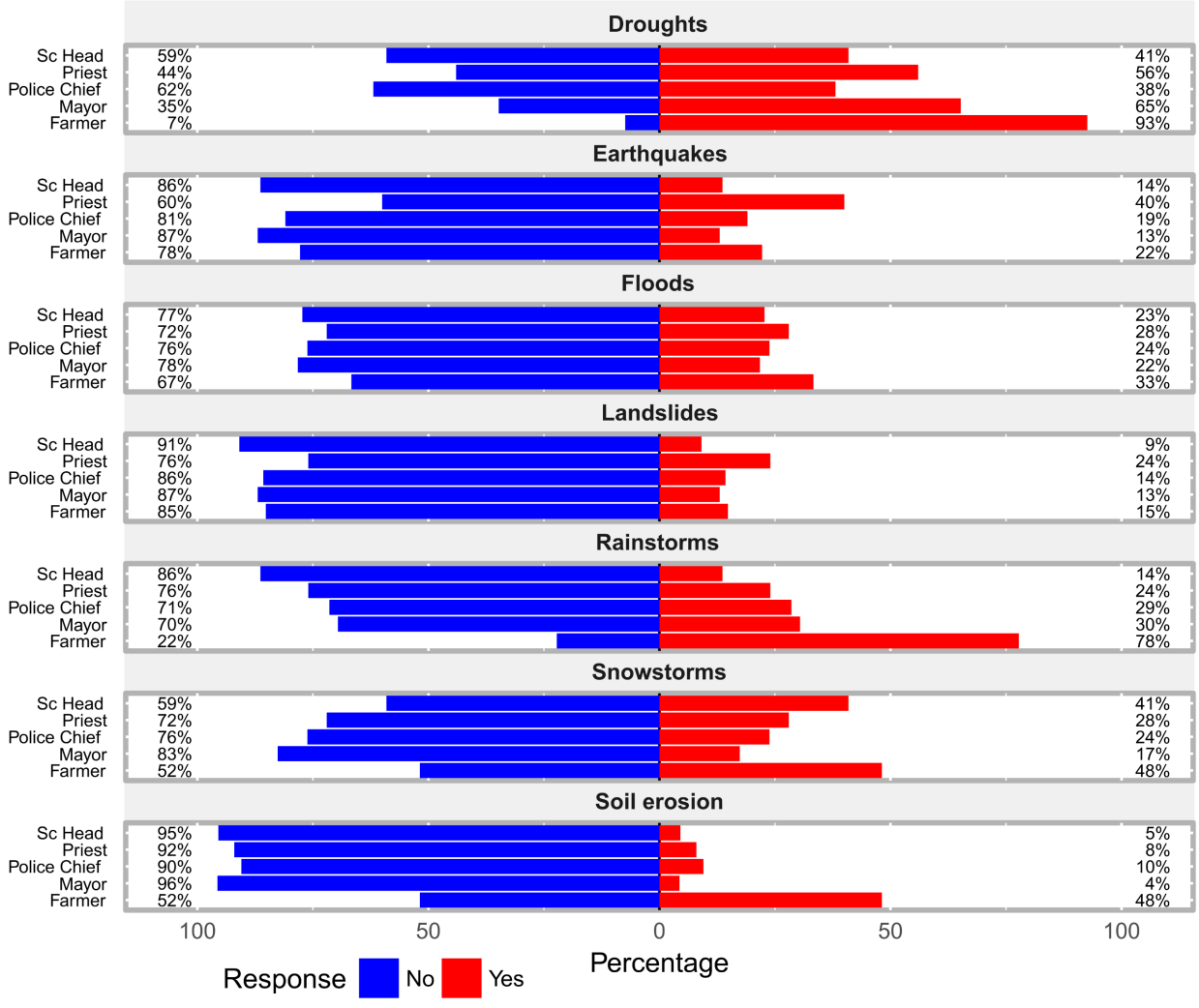

Figure 8: Stakeholders' past experiences of natural hazards.

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The other stakeholders were affected in a smaller measure by soil erosion. This process can generally pose problems only to those who directly connect with the land, which affects lesser the build-up areas. It is shown that experience is higher with age, especially for the analysis with the earthquake occurrence. These are disasters that, for their high magnitude, can be impressed vividly in people's memory. Their role in disaster risk management and coordination allows them to remember the most significant events they served the community. In contrast, slow onset events (e.g., droughts or soil erosion) can disappear quickly.

The knowledge of participants about natural hazards has been asked through several sub-questions. Stakeholders get information differently about the probability of occurrence and the severity of these events. The majority get information from the TV/radio (82%), friends/family and community peers (60%), and social networks on the internet (53%). The more official channels are the least represented with national information initiatives (47%), school (44%), local administration (41%), and volunteer associations (40%). Looking at the triggering factors of those events, stakeholders mentioned all sub-sections from the questionnaire (Table A1, Appendix) that they consider having an important influence on the negative impact of natural hazards. Some exceptions have been registered for 57% of mayors who responded that uncontrolled urbanization and unmanaged land use planning are not influencing the occurrence of any hazard. Local administration is controlling the land use planning, and, in any case, this might be the cause of negative consequences derived by climate extremes and geological movements.

The majority of priests and mayors do not consider that climate change can exacerbate the negative consequences of natural hazards (56% and 22% of them indicated "low" and "very low" respectively. Among the solutions to avoid the negative consequences of natural hazards, results indicated a uniform answer among all stakeholders, except the compensation scheme for the victims especially marked from mayors. Financial compensation schemes represent a particularly neuralgic issue in the post-communist society of Romania. Many interviewees highlighted that these compensations could be an encouragement of non-compliance with the law, especially regarding unauthorized constructions on lands at risk of floods and landslides.

4.3 The level of preparedness

The level of preparedness was investigated individually, and regarding the community, they belong. Overall, the results indicate a low level of preparedness in the case of all the natural hazards discussed. The lowest ranks were given to soil erosion (64%), droughts (58%), earthquakes and landslides (55%), floods (52%), rainstorms (50%), and snowstorms (35%). It seems that, despite a low level of readiness, stakeholders feel a bit more prepared to withstand the consequences of storms and floods. Snowstorms affect the communities in winter (and exceptionally in spring, the case of April 2018), and agriculture do not suffer. Life in rural areas can be more comfortable compared with urban areas. In Romania, after the recent intense snowstorms such as those from January 2008 (Georgescu et al., 2009) or January-February 2012 (Bălteanu et al., 2013), rural settlements have been endowed with specialized equipment in rapid intervention, especially in the case of roads, and these endowments seem to improve the respondents' concerns.

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Similarly, the existing embankments along rivers (Prut, Jijia, and Bahlui) have often been invoked during discussions as ensuring a relatively good level of protection, especially of built-up areas. The lower level of preparedness is associated with soil erosion and landslides, for which many stakeholders declared their lack of knowledge concerning the processes themselves and related protective measures. The results of the survey made us accept the second hypothesis, which states that the level of preparedness depends on the risk type.

The same pattern of the answers has been registered in the case of the assessment of the preparedness level of the communities. However, preparedness was low, and stakeholders affirmed strongly that by good training and knowledge of natural hazards occurrence and mitigation practices, their and community preparedness could increase. Question 11 (How much do you think that your personal knowledge might increase the level of preparedness of your community? Table A1 of the Appendix) reveal significant differences among stakeholders; while in the case of school heads, "high" and "very high" responses reached 95%, for police chiefs the percentage of the same responses dropped to 14%. Intermediate values have been recorded for the other stakeholders: "high" and "very high" answers were given by 67% of farmers, 56% of priests, and 39% of mayors. Police chiefs and mayors are responsible for risk management during an emergency, and for them, preparedness is at the base of the training. For this reason, they might think that their role is the management of situations and, in any case, is the responsibility of individuals. School heads who have the obligation of small infants feel that individual preparedness is the key to successful disaster management, evacuation, and recovery. In this regard, participation in simulation evacuations is a crucial step for a positive disaster outcome. Most of the stakeholders declared that they had participated, especially in the simulations concerning earthquakes, and few of them indicated other specific hazards (e.g., fires). Seventy-two of stakeholders (61%) declared that they participated in simulations in the last years, most of them to earthquake simulations (especially school heads and mayors). Stakeholders from floodplains communes stated participation in flood simulations. In a particular case (Aroneanu settlement, located close to Iași International Airport), stakeholders participated in a technological disaster exercise (aircraft crash). The period elapsed since the last simulation varies from few months to over ten years, the most recent being mostly declared by the school heads.

Some of the most representative CA biplots represent the position of stakeholder types in the case of preparedness to cope with different types of natural hazards (Fig. 9 and 10).

The same differentiated pattern of the stakeholder responses was recorded in the case of the level of their communities' preparedness.

4.4 Risk management, trust, and communication

Several factors have been listed (Fig. 11) and discussed as representing long term solutions to improve current risk management plans.

Most of the participants agreed with all the items proposed. On the other side, priests seemed to be the most pessimistic, especially in terms of predictability, people's preparedness, intervention, and recovery capacity. Again, the role of trust in depicting a negative situation in which stakeholders evidenced low trust on mitigation and management measures (Fig. 12).

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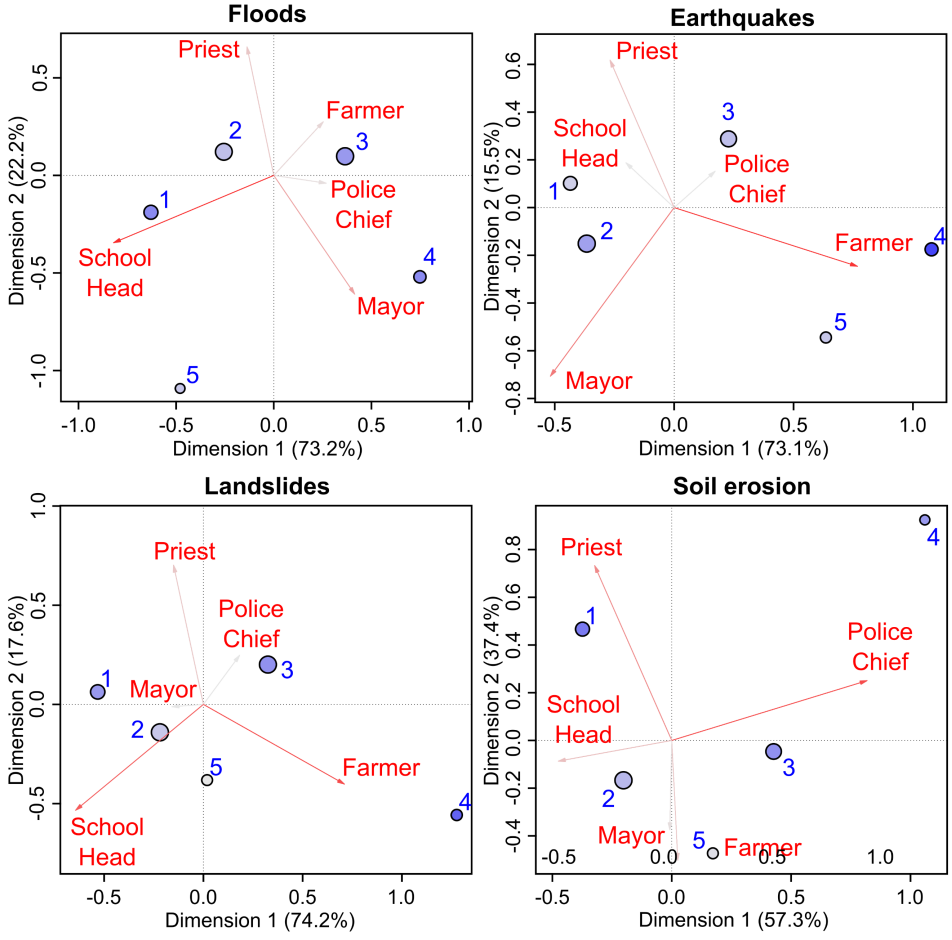

Figure 9: CA contribution biplots for perceived personal preparedness of different stakeholders for floods, earthquakes, landslides, and soil erosion.

As mayors followed the same trend, it is plausible to think that they delegate the responsibility during emergencies to other institutions, imputing ineffective planning and organization.

Question 16 ("In your judgment, how much are the opinions of the following actors taken into account in the decisions about measures to adopt for preventing or reducing damage from natural hazards phenomena?") presents a grouping of "high" and "very high" responses around 70% for followings sub-sections: local communities, technicians/engineers, elective representatives at local and national levels. A lower percentage (34% of "high" and "very high" responses) has been registered for the sub-section "environmental organizations." Among stakeholder types, we should highlight the higher percentages of "low" and "very low" responses in the following cases: priests for "elective representatives at the local level" (16%) and "technicians/engineers" (16%), school heads (50%) and mayors (43%) for "environmental organizations," farmers for "local communities" (16%), and "state elective representatives" (26%).

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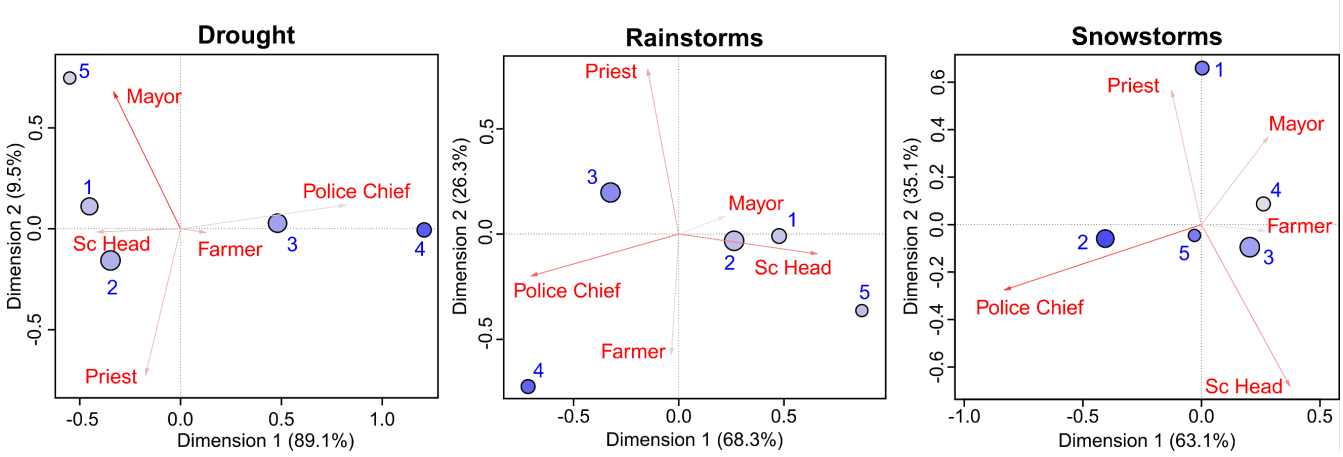

Figure 10: CA contribution biplots for different stakeholders' perceived personal preparedness for droughts, snowstorms, and rainstorms.

The stakeholders' role as leaders of their institution during the events generated by natural hazards is critical. They refer to direct intervention in the affected areas and the management and communication with the entire population of the community. These issues were addressed in the following question. The gathered answers are generally in line with the level of social responsibility of the institutions that stakeholders represent according to the legislation but also to the moral leadership in the community. "high" and "very high" responses were acquired as follows: priests (88%), police chiefs (86%), mayors (74%), school heads (64%), and farmers (52%). There are interesting absences of "low" and "very low" responses in the case of mayors, school heads, and priests, and the low proportion of these responses in the case of police chiefs (5%) and farmers (7%).

5. Discussions and conclusions

The current study's importance lies in the intrinsic characteristics of Iaşi area, being exposed and vulnerable to major natural hazards and overlapped with recent and historical contradictory socio-economic dynamics of Romania (Ignat et al., 2014). In line with a competitive European economy with increasing educational level and income of the last 20 years, the Romanian society tried to follow the positive trends and numbers, with a rapid urban sprawl. The fast development was characterized by a lack of planning and infrastructural investments leading to an increased vulnerability to natural hazards. At the same time, the dissatisfaction and the feeling of the danger of people were felt even at the political level that, since 1989, has led to a constant decrease of trust in national institutions and their leaders. In this fragile socio-economic and political environment, local stakeholders were involved in national programs to help communities (primarily rural areas) to prevent, manage and recover from emergencies, including weather extremes or natural hazards, because, very often, media, politicians or other public actors demonstrated to discredit these phenomena and their potential negative impact. However, history showed that disaster communication was poorly managed, and local stakeholders lacked in coordinating people in all phases of risk

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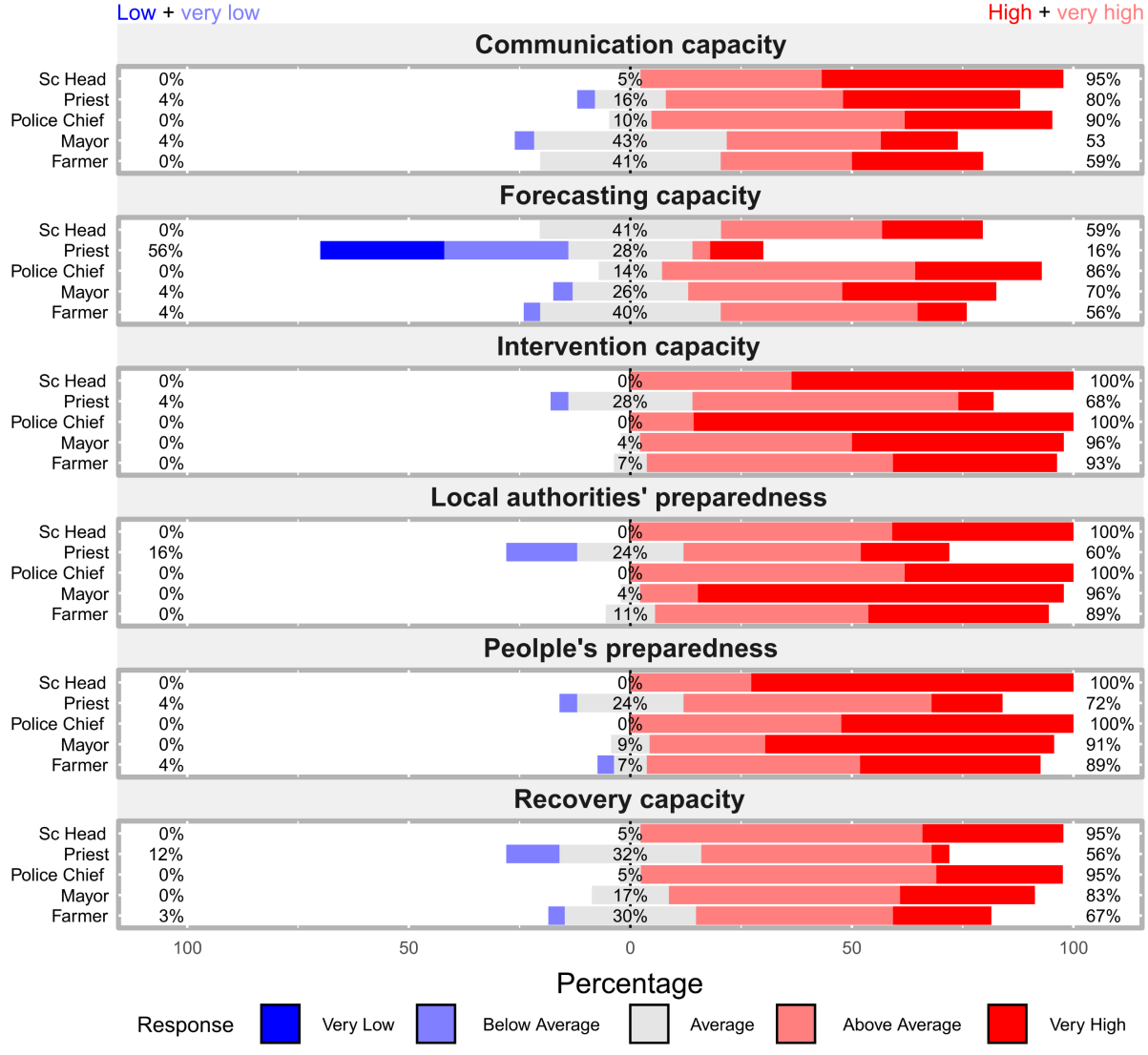

Figure 11: Likert plot of the responses regarding the factors which can increase the actual disaster risk management planning.

The results found with 118 interviews in Iaşi Metropolitan Area showed that, in general, there is a moderate level of threat toward the negative influence of climate-related hazards and earthquakes with different levels. The three main themes that are resumed in the questions posed (Q1, Q2, and Q3) reveals differences in risk perception concerning various stakeholders' types and risks, and an obvious specific behavior related to the local geomorphological settings which favor local scale hazards (e.g., landslides and floods). Farmers are more concerned, especially to climate-related hazards, that can directly affect their livelihood and source of income. The literature has found that they might already receive incentives to protect the economic

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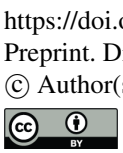

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sector from the threat of natural hazards and/or invest in insurance products to safeguard household income (Saldaña-Zorrilla, 2008).

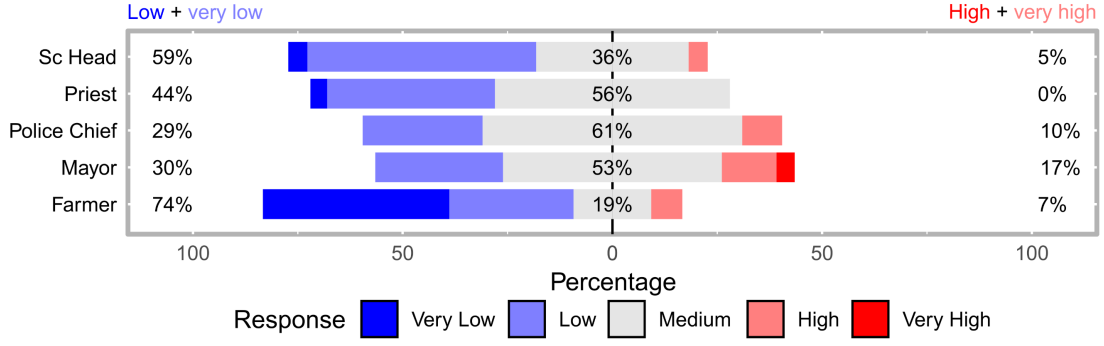

Figure 12: Likert plot of the responses regarding the trust in the actual measures for natural hazards.

Majors, school heads, and priests displayed a greater level of risk awareness on droughts and earthquakes, being on the major and long-lasting events for which planning, evacuation, and recovery is needed to manage the outcome of those events efficiently. Police officers were the only stakeholders recognizing the threat of floods because they were directly involved in recent flooding and rescue activities. Despite recognizing the probability of a wide set of natural hazards, the level of preparedness is perceived to be low. The poor vertical dialogue among stakeholders, the lay public, and higher authorities have scattered communication and proactive behaviors of citizens, rising low levels of trust, and on some occasions, discarding hazard warnings. Stakeholders highlighted great interest in information and education programs to reconstruct their network with the population and reduce the negative effects of natural hazards. The same results have been found in France, where a national concern needs to find solutions and economic investments at the local scale with poor transparency and trust, leading to unmanaged and inefficient solutions and actions (Heitz et al., 2009). Mayors in Iași County need to be involved in the discussions and negotiations at the national level, exposing different interests of the community's representativeness and the lay public to promote a horizontal dialogue that gradually would include people in the disaster risk planning. In this regard, stakeholders network needs to be established at the local level, share knowledge, how-how, enhance communication, and re-build a culture of trust. Networked governance is also highlighted by VanWell et al. (2018) that evidence the virtuous example of the Nordic Centre of Excellence on Resilience and Societal Security network, which includes Denmark, Finland, Iceland, Norway and Sweden and the synergy of communities, institutions, individuals and infrastructures for societal resilience and community development. Simultaneously, the political agenda can help those networks implementing monitoring systems of vulnerable buildings facilitating the knowledge of local stakeholders, their safety, and their relationship with the population moving from a self-centered approach to a community-based approach. Another important issue in disaster risk reduction and management is represented by the involvement of scientists in local committees for emergencies, with specific roles (Gill et al., 2020), such as identification and characterization of potential multi-hazard areas, prioritize effective, positive, long-term partnerships, sharing the experiences of others communities in best practices risk management through improved access to hazard information and embedding cultural understanding into local natural hazard environment.

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The perspectives of this study should be continued in the next years to assess the changes of the behavior of the stakeholders regarding the awareness of the threats posed by natural hazards induced risks in a dynamic perspective, taking into consideration the future events and their negative effects as well as the changes that the citizens will register at the level of increasing (or not) the inter-community cooperation and the compliance with legislation.

Author contribution

MCM, MN, GR and PT designed the conceptualization, MCM and GR the questionnaire and MCM and MN carried it out. MN carried the statistical analysis and the plotting. MCM prepared the manuscript with contributions from all co-authors.

Competing interests

The authors declare that they have no conflict of interest.

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Appendix A

Table A1. Questionnaire sample and variables' units of measurement.

Section	Question	Sub-sections items	Responses
The level of threat	Q1: On a scale from 1 to 5, how do you think these factors could be a threat for the quality of the life of your community?	Level of development; Criminality; Technological risks; Natural risks; Environmental pollution; Climatic changes	5-point Likert scale*
	Q2: Considering a set of natural hazards, how these events could be a threat/danger for your community?	Floods; Earthquakes; Landslides; Rainstorms; Snowstorms; Droughts; Soil erosion	5-point Likert scale

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	Q3: Considering a set of natural hazards, how these events could be a threat/danger for your personally?	Floods; Earthquakes; Landslides; Rainstorms; Snowstorms; Droughts; Soil erosion	5-point Likert scale
	Q4: Considering a set of natural hazards, what's the probability that these events could happen in the place where you live or nearby?	Floods; Earthquakes; Landslides; Rainstorms; Snowstorms; Droughts; Soil erosion	5-point Likert scale
	Q5: Do you think that these events could be more a frequent threat/danger for the next generations?	Floods; Earthquakes; Landslides; Rainstorms; Snowstorms; Droughts; Soil erosion	dichotomic
Past experiences	Q6: Do you ever experienced these events that have produced direct damage to you personally?	Floods; Earthquakes; Landslides; Rainstorms; Snowstorms; Droughts; Soil erosion	dichotomic
Knowledge about hazards	Q7: Which of the following have contributed to your personal knowledge about natural hazards?	National awareness campaign; Social networks on internet; Local administration campaigns; TV/radio; Personal interest; School; Participation to volunteerism activities; Friends/family members/neighbours	dichotomic
	Q8: It would be interesting for you to be more informed about natural hazards in order to be more prepared in the case they will happen here?	Floods; Earthquakes; Landslides; Rainstorms; Snowstorms; Droughts; Soil erosion	5-point Likert scale
	Q12: Which factors do you think might exacerbate the negative consequences of natural hazards?	Climate change; deforestation; Lack of protective structural device's; Lack of protective structural device's maintenance; Uncontrolled urbanization and unmanaged land use planning; Construction of buildings in areas at high risk; Unsafe infrastructure buildings	5-point Likert scale
	Q13: Which factors do you think might reduce the negative consequences of natural hazards and must be taken as a priority in the place where you live?	A proper legislation for land and urban planning; A proper compensation scheme for natural hazards victims; Build new protection works; Ensure more investments on controlling, monitoring and maintaining actual protection works; Increasing the level of awareness and	5-point Likert scale

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		preparedness of inhabitants□; Increasing communication with the community; Increase hazards education of children at school	
Preparedness	Q9: Considering a set of natural hazards, how much do you feel prepared to cope with these events?	Floods; Earthquakes; Landslides; Rainstorms; Snowstorms; Droughts; Soil erosion	5-point Likert scale
	Q10: Considering a set of natural hazards, how much your community is prepared to cope with these events?	Floods; Earthquakes; Landslides; Rainstorms; Snowstorms; Droughts; Soil erosion	5-point Likert scale
	Q11: How much do you think that your personal knowledge might increase the level of preparedness of your community?	Low - high	5-point Likert scale
	Q18: Do you participated to a simulation of a specific natural hazard, If you did, please specify the type of hazard and when (years ago)?		Multiple choice
Risk management, trust and communication	Q14: How much these factors can increase the actual disaster risk management planning?	Forecasting capacity; Communication capacity; Intervention capacity; recovery capacity; People's preparedness; Local authorities' preparedness	5-point Likert scale
	Q15: How much do you trust actual natural hazards mitigation and management measures?	Low - high	5-point Likert scale
	Q16: In your judgment, how much are the opinions of the following actors taken into account in the decisions about measures to adopt for preventing or reducing damage from natural hazards phenomena?	Local communities; Technicians/engineers; Environmental organizations; Elective representatives at the local level; State elective representatives	5-point Likert scale
	Q17: According to your position in the society, how much do you think that your institution could help in the communication/management of people during the events associated with natural hazards?	Low - high	5-point Likert scale
Place attachment	Q19: How much do you feel attached to the place where you live?	Low - high	5-point Likert scale

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Interviewee person settings	PS1: Age		Open
	PS2: Gender		Dichotomic
	PS3: Education		Multiple choice
	PS4: Profession	Mayor; School Head; Policeman; Priest; Farmer	
	PS5: Do you live in the locality where you are active?		Dichotomic
	PS6: The house you are living in is:	Your/your family property; Rented; Service house	Open
	PS7: Including yourself, how many people are there in your household? Number:		Open

Table A2. The most frequent responses and the Asymptotic Generalized Pearson Chi-Square dependence test results for stakeholder types (with bold are the questions tested for independence).

Question ID	Sub-sections items							
	a	b	c	d	e	f	g	h
Q1*	**5**	3	**1**	**4**	2	2	-	-
Q2*	**1**	3	3	3	**4**	**4**	2	-
Q3*	2	4	2	3	3	4	3	-
Q4*	**1**	3	1	2	**2**	**3**	1	-
Q5*	N	Y	N	Y	Y	Y	N	-
Q6*	Y	Y	Y	Y	Y	N	Y	-
Q7*	N	Y	N	Y	Y	N	N	Y
Q9*	3	2	2	2	3	2	2	-
Q10*	2	2	2	2	3	2	2	-
Q11*	4	-	-	-	-	-	-	-
Q12*	4	4	4	4	3	4	4	-
Q13*	4	2	4	4	4	4	5	-
Q14*	4	4	5	4	5	5	-	-
Q16*	4	4	3	4	4	-	-	-
Q8	5							
Q15	3	P8	N					
Q17	4	P9	4					
Q19	5	P10	4					

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P5	Y	P11	4	
P6	1	P12	5	

*No independence at 0.0001 level, Y – Yes, No – No, 1 – Very Low, 2 – Low, 3 – Medium, 4 – High, 5 – Very High

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Table A3. The Kruskal-Wallis rank-sum test (left part) and Freeman's epsilon-squared statistics (right part) for every category of risks and natural risks and stakeholder type, village, commune, flooded or non-flooded, age, gender, education

		TYPE	VILLAGE	COMMUNE	FLOOD/Y or N	AGE	GENDER	EDUCATION			TYPE	VILLAGE	COMMUNE	FLOOD/Y or N	AGE	GENDER	EDUCATION
Q1	a	D	D	D	D	D	D	D		a	**0.8**	0.1	0.2	**1.0**	**1.0**	**1.0**	0.6
	b	D	D	D	D	ND	0	ND		b	0.4	0.1	0.2	**1.0**	0.0	-	0.0
	c	D	D	D	0	D	D	D		c	0.1	0.2	0.1	-	**0.8**	1.0	**0.9**
	d	D	D	D	0	D	D	0	Q1	d	**0.9**	0.1	0.1	-	0.8	1.0	-
	e	ND	D	D	D	0	D	D		e	0.2	0.0	0.2	**1.0**		1.0	**0.9**
	f	D	D	D	D	D	D	D		f	0.5	0.1	0.2	**1.0**	1.0	1.0	**0.9**
Q2	a	ND	D	D	D	ND	D	ND		a	0.0	0.0	0.3	**1.0**	0.0	1.0	0.1
	b	ND	D	D	0	D	0	D		b	0.0	0.1	0.2	-	**0.8**	-	0.2
	c	D	D	D	D	D	0	D		c	**0.9**	0.1	0.3	**1.0**	**0.8**	-	**0.6**
	d	D	ND	D	0	D	D	D	Q2	d	0.5	0.0	0.0	-	**0.8**	**1.0**	**0.9**
	e	D	D	D	D	D	D	D		e	0.5	0.1	0.3	**1.0**	**1.0**	**1.0**	**0.6**
	f	ND	ND	ND	0	D	D	D		f	0.0	0.0	0.0	-	**0.8**	**1.0**	0.2
	g	D	D	D	D	D	D	D		g	0.5	0.1	0.3	**1.0**	**0.8**	**1.0**	**1.0**
Q3	a	ND	D	D	D	0	D	D		a	0.0	0.1	0.1	**1.0**	-	**1.0**	0.2
	b	ND	ND	ND	0	D	0	0		b	0.1	0.0	0.0	-	**0.8**	-	-
	c	D	D	D	0	D	D	D		c	**0.8**	0.1	0.1	-	**0.8**	**1.0**	0.2
	d	D	D	D	0	D	0	0	Q3	d	0.1	0.1	0.2	-	**0.8**	-	-
	e	D	D	D	0	0	D	D		e	0.5	0.1	0.1	-	-	**1.0**	**0.6**
	f	ND	D	D	0	D	D	ND		f	0.2	0.1	0.4	-	**0.8**	**1.0**	0.1
	g	ND	D	D	D	0	D	D		g	0.1	0.2	0.6	**1.0**	-	**1.0**	**0.8**
Q4	a	0	D	D	D	D	0	ND	Q4	a	-	0.1	0.2	**1.0**	**0.8**	-	0.1

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	b	D	D	D	D	D	D	ND			b	0.5	0.1	0.2	**1.0**	**0.8**	1.0	0.1
	c	D	D	D	0	D	0	ND			c	0.1	0.1	0.1	-	**0.8**	-	0.0
	d	D	D	ND	0	0	D	D			d	**0.8**	0.2	0.0	-	-	1.0	**0.6**
	e	ND	D	D	0	D	0	D			e	0.1	0.1	0.2	-	**0.8**	-	**0.6**
	f	D	D	D	0	D	0	D			f	0.5	0.1	0.3	-	**0.8**	-	**0.6**
	g	D	D	D	0	0	0	D			g	0.5	0.1	0.0	-	-	-	**0.9**
Q5	a	ND	D	D	D	ND	D	ND		Q5	a	0.1	0.0	0.1	**1.0**	0.0	**1.0**	0.1
	b	ND	D	D	D	ND	0	ND			b	0.1	0.0	0.1	**1.0**	0.0	-	0.1
	c	ND	D	D	D	0	D	D			c	0.0	0.1	0.2	**1.0**	-	**1.0**	**0.6**
	d	D	D	D	0	0	0	0			d	0.1	0.1	0.2	-	-	-	-
	e	D	D	D	0	0	0	0			e	0.1	0.0	0.4	-	-	-	-
	f	0	0	0	0	0	0	0			f	-	-	-	-	-	-	-
	g	D	D	D	D	0	0	D			g	0.8	0.0	0.2	**1.0**	-	-	**0.6**
Q6	a	0	D	D	D	0	0	0		Q6	a	-	0.1	0.1	**1.0**	-	-	-
	b	0	D	ND	0	0	0	0			b	-	0.2	0.0	-	-	-	-
	c	0	ND	D	0	0	0	ND			c	-	0.0	0.1	-	-	-	0.1
	d	D	D	ND	0	0	0	D			d	0.5	0.0	0.0	-	-	-	0.2
	e	0	D	ND	0	0	0	0			e		0.1	0.0				
	f	D	D	D	0	0	0	0			f	0.3	0.1	0.1				
	g	0	D	0	0	0	0	ND			g		0.1					0.1
Q7	a	ND	ND	ND	D	ND	D	ND		Q7	a	0.1	0.0	0.0	1.0	0.0	1.0	0.0
	b	ND	D	ND	D	ND	0	ND			b	0.0	0.0	0.0	1.0	0.0		0.0
	c	D	ND	D	D	0	0	0			c	0.1	0.0	0.0	**1.0**	-	-	-
	d	0	ND	ND	0	0	0	0			d	-	0.0	0.0	-	-	-	-
	e	0	D	D	0	0	0	0			e	-	0.1	0.0	-	-	-	-
	f	D	ND	D	0	0	0	0			f	0.3	0.0	0.1	-	-	-	-
	g	0	ND	D	D	0	D	0			g	-	0.0	0.0	**1.0**	-	**1.0**	-
	h	D	D	ND	0	0	0	ND			h	0.1	0.0	0.0	-	-	-	0.1
Q8		ND	D	ND	0	D	D	D		Q8		0.2	0.1	0.0	-	**0.8**	1.0	**0.9**
Q9	a	D	D	ND	D	D	D	D		Q9	a	0.8	0.1	0.0	1.0	**0.8**	1.0	**0.6**
	b	D	D	D	0	D	0	D			b	0.5	0.3	0.4	-	**0.8**	-	**0.9**
	c	ND	D	D	D	D	D	D			c	0.1	0.1	0.1	**1.0**	**1.0**	**1.0**	0.2

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	d	ND	D	D	D	ND	D	ND			d	0.1	0.1	0.3	**1.0**	0.0	**1.0**	0.1
	e	D	D	D	0	D	0	0			e	0.9	0.1	0.3	-	**0.8**	-	-
	f	ND	D	D	0	D	0	D			f	0.0	0.1	0.3	-	**0.8**	-	**0.6**
	g	ND	D	D	0	0	0	ND			g	0.0	0.1	0.3	-	-	-	0.1
Q10	a	D	D	D	D	D	0	ND		Q10	a	0.1	0.1	0.1	**1.0**	**0.8**	-	0.1
	b	D	ND	ND	0	D	0	D			b	0.5	0.0	0.0	-	**1.0**	-	**0.6**
	c	0	ND	D	0	0	D	ND			c	-	0.0	0.2	-	-	1.0	0.0
	d	D	ND	D	0	0	0	D			d	0.1	0.0	0.1	-	-	-	**0.6**
	e	ND	D	D	0	0	0	ND			e	0.0	0.0	0.1	-	-	-	0.1
	f	ND	D	D	0	D	0	ND			f	0.1	0.0	0.1	-	**0.8**	-	0.1
	g	0	D	D	0	D	0	ND			g		0.0	0.1	-	**0.8**	-	0.1
Q11		ND	D	D	0	D	D	D		Q11		0.1	0.0	0.1	-	**0.8**	**1.0**	**0.9**
Q12	NI	D	D	D	0	D	0	D		Q12	a	0.5	0.1	0.1	-	**0.8**	-	**0.6**
	b	D	D	D	0	0	0	ND			b	0.5	0.1	0.3	-	-	-	0.1
	c	0	D	D	0	0	0	0			c		0.1	0.1	-	-	-	-
	d	D	D	D	0	D	0	0			d	0.1	0.1	0.1	-	**0.8**	-	-
	e	D	D	D	0	D	D	D			e	**0.8**	0.0	0.1	-	**0.8**	**1.0**	**0.6**
	f	D	D	D	D	D	D	ND			f	0.5	0.0	0.1	**1.0**	**0.8**	**1.0**	0.1
	g	ND	ND	D	0	ND	D	D			g	0.0	0.1	0.0	-	0	**1.0**	**0.6**
Q13	a	ND	D	D	D	D	0	D		Q13	a	0.1	0.1	0.1	**1.0**	**1.0**		**0.6**
	b	D	D	D	D	D	D	ND			b	**0.9**	0.1	0.2	**1.0**	**0.8**	1.0	0.0
	c	D	D	ND	D	0	D	ND			c	0.1	0.1	0.0	**1.0**	-	1.0	0.0
	d	ND	ND	D	0	ND	D	ND			d	0.1	0.0	0.2	-	0.0	1.0	0.0
	e	D	D	D	0	D	D	D			e	**0.8**	0.0	0.2	-	**0.8**	1.0	**0.6**
	f	D	D	D	0	D	0	ND			f	0.1	0.0	0.1	-	**0.8**	-	0.0
	g	D	ND	ND	0	D	0	ND			g	0.1	0.0	0.0	-	**0.8**	-	0.0
Q14	a	D	D	D	0	D	D	ND		Q14	a	**0.8**	0.1	0.1	-	**0.75**	**1.0**	0.1
	b	D	D	D	0	D	D	D			b	**0.9**	0.0	0.5	-	**0.75**	**1.0**	**0.6**
	c	ND	D	ND	D	D	D	ND			c	0.1	0.1	0.0	1.0	**0.75**	**1.0**	0.0
	d	0	D	D	0	D	0	0			d		0.1	0.1	-	**0.75**	-	-
	e	ND	D	ND	0	D	D	D			e	0.1	0.1	0.0	-	**0.75**	**1.0**	**0.6**

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	f	D	D	D	D	D	0	D			f	0.1	0.0	0.2	1.0	**0.75**		**0.6**
Q15		D	D	D	0	D	D	D		Q15		**0.8**	0.0	0.0	-	**1.0**	**1.0**	**0.6**
Q16	a	D	D	ND	0	0	0	0		Q16	a	**0.8**	0.0	0.0	-	-	-	-
	b	D	D	D	D	D	D	ND			b	**0.8**	0.0	0.0	**1.0**	**1.0**	**1.0**	0.1
	c	D	D	D	0	D	D	ND			c	**0.8**	0.1	0.2	-	**0.8**	**1.0**	0.1
	d	D	D	D	0	D	D	ND			d	0.5	0.0	0.1	-	**0.8**	**1.0**	0.1
	e	D	D	D	D	D	D	D			e	**0.6**	0.0	0.1	**1.0**	**0.8**	**1.0**	**0.8**
Q17		0	D	ND	0	0	0	ND		Q17		-	0.0	0.0	-	-	-	0.1
Q19		D	D	ND	0	0	0	0		Q19		0.3	0.0	0.0	-	-	-	-
P9		D	D	D	0	D	0	D		P9		0.5	0.1	0.2	-	**0.8**	-	**0.6**

D – there is a difference between different groups responses, ND – there is no difference between different groups responses; bold values bigger than 0.5

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