Lessons learned about the importance of raising risk awareness in the Mediterranean region (North Morocco and West Sardinia, Italy)

Ante Ivčević[1,2], Hubert Mazurek[1], Lionel Siame[3], Raquel Bertoldo[4], Vania Statzu[5], Kamal Agharroud[6], Isabel Estrela Rego[7], Nibedita Mukherjee[8], Olivier Bellier[3,9]

5 [1]Aix Marseille Univ, IRD, LPED, Marseille, France
[2]Priority Actions Programme/Regional Activity Centre (PAP/RAC), UN Environment Programme/Mediterranean Action Plan (UNEP/MAP), Split, Croatia
[3]Aix Marseille Univ, CNRS, IRD, INRAE, Coll France, CEREGE, Aix-en-Provence, France
[4]Aix Marseille Univ, LPS, Aix-en-Provence, France
10 [5]Mediterranean Sea and Coast Foundation (MEDSEA), Cagliari, Italy
[6]Département de Géologie, Faculté des Sciences de Tétouan, Université Abdelmalek Essaâdi, Tétouan, Morocco
[7]Research Institute for Volcanology and Risk Assessment (IVAR), University of the Azores, Azores, Portugal
[8]CBASS, Brunel University London, Kingston Lane, Uxbridge UB8 3PH, United Kingdom
[9]Aix Marseille Univ, CNRS, ECCOREV, Aix-en-Provence, France

15 *Correspondence to*: Ante Ivčević (Aix-Marseille Université, St Charles, case 10, 3 place Victor Hugo, 13331 Marseille Cedex 3, France; email : aivcevic@gmail.com ; ante.ivcevic@paprac.org)

Abstract. In order to mitigate the potentially dramatic effects of natural hazards, risk management measures are critical. However, the lack of interdisciplinary indicators and adaptable governance frameworks highlight society's vulnerability in the particular context of global environmental and climate change. This interdisciplinary research aimed at identifying reliable
20 risk indicators and societal responses regarding natural hazards and climate change impacts, to provide a governance framework for disaster risk reduction. Different societies face diverse risks and do not necessarily have the same level of local awareness of these risk. To explore the diversity of risks, two sites were selected from the Mediterranean basin, one chosen from the South coast (North Morocco), the other from the North coast (the Italian island of Sardinia). North Morocco, a region of multi-risks, is characterized by high demographic and economic pressures; West Sardinia counts for remarkable biodiversity
25 of wetlands and is characterized by high environmental and agricultural pressures, which in both cases intensify the vulnerability of the coastal areas. Testing for the local population's preparedness for future financial protection allowed discussing the importance of risk awareness sessions or actions as an indicator of risk management. The significance of risk awareness sessions is shown in a quantitative part of the study, and its importance is also discussed with local stakeholders in North Morocco in a qualitative part of the study. It is shown that, although risk awareness sessions are recognized as important
30 in risk management, they are not necessarily implemented. Based on these findings, further ideas on a new series of less descriptive, more dynamic, and more user-friendly indicators are suggested. How can risk sessions be a dynamic indicator of a resilient society? The obtained results could serve in future governance frameworks for the mitigation of natural hazards in the Mediterranean region and wider. Finally, the urgent need for continuous work to overcome the communication gap between the scientific community, risk administrators, civil society and the general population is encouraged.

35 **1 Introduction**

Different societies living in a similar environment may face the same natural hazards, but do not necessarily have the same level of risk awareness, considered as a representation of risk knowledge uptake by the local population. They do not share a common conceptual understanding of that risk, which is reflected by risk perception (Slovic et al., 1976). Actually,

vulnerability of societies is a dynamic process, always relative to a certain situation and depends on local knowledge, practices, and cultural specificities. The importance of local knowledge for sustainable disaster risk reduction and management is largely recognised by international policy, such as the Sendai Framework for Disaster Risk Reduction (UN, 2015) and other international policies dealing with climate adaptation (Sakic-Trogrlic et al., 2021). The question of values (Zinn, 2009) and cultural and socio-economic background (Joffe, 1999; Joffe et al., 2013) are key societal problems when dealing with risks. Risk awareness and perception result in certain precautionary behaviours which show their relevance for risk management. However, the extent to which the local knowledge is translated into concrete, effective and practical measures is still open to debate.

A leading role in efficient risk management is played by risk perception, a concept that is already widely recognized in risk literature, but with remaining open questions. In one of the first contributions of cognitive psychology to decision-making under risk, the concept of risk perception depicted that non-expert people might perceive risks by resorting to different logics than experts do (Slovic et al., 1976), making the process of risk appropriation more complex. Likewise, Covello (1983) suggested that a better understanding of how experts and non-experts reflect on and decide about risks would be beneficial to both risk analysts and decision-makers. In the later article 'Perception of risk', Slovic (1987) proposed a strategy for studying perceived risk through a psychometric paradigm, which uses multivariate analysis techniques and scaling to produce a quantitative representation of risk perception. The main conclusion is that laypeople can be short of some information related to hazards, but have a rich perception of risk that has to be included in risk assessments by experts. Rohrmann (1998) defined risk perception as a concept that "refers to people's judgments and evaluations of hazards" which are the "interpretations of the world, based on experiences and/or beliefs". Since the images of risk are sometimes distorted, public perception is at least partly driven by biases, false assumptions and sensation, as argued by Renn (1998). He reasoned that risk perception studies help to collect different personal experiences with risks and to identify public concerns. However, they cannot state any normative legitimacy. Since scientific expertise and rational decision-making are necessary, but not sufficient, such a debate between experts and non-experts is needed. Another discipline that has a say in risk perception is applied social psychology. As argued by Langford (2002), social and cultural settings need to be studied to determine how anxieties relate to the ways people perceive risks. Among his case studies, one related to climate change captured a wide range of personal, social and environmental anxieties. This helped him to argue that the complexity and importance that risk perception has in forming identities demand people's recognition and involvement. People need to be persuaded in their need to act, and only by believing in change can risk managers develop significant and far-reaching risk strategies.

However, when determining indicators in risk management, risk awareness, perception and behaviour need to be distinguished. Although sometimes the concepts of risk awareness and risk perception are overlapping (AlQahtany and Abubakar, 2020), with awareness at times considered to be just one of the components to measure risk perception (Khan et al., 2020), the concepts in this paper draw from the distinction made by Papagiannaki et al. (2019a, 2019b). Risk awareness is, therefore, considered

as the measure of information and knowledge uptake. Risk perception is related to conceptual understanding of the threat, based on a personal interpretation of the knowledge arising from a cultural background, and risk precautionary behaviour is the result of awareness and perception based on the socio-economic context. Papagiannaki thus considers that risk awareness is a less technical concept than risk perception. A recent study on hydrogeological risk awareness and preparedness in Italy (Mondino et al., 2020) concluded that lack of big events and poor risk communication strategies can cause risk awareness to decrease. This shows that risk awareness is essential for adequate risk management policies and needs to be further explored. Moreover, since risk questions are always societal problems and relate to values (Zinn, 2009), the cultural context needs to be tested.

Inspired by a cultural approach that considers risk as a social and cultural construct (Bertoldo, 2021), this study will compare two different societies, with different socio-economic contexts. The focus will be on the indicator of risk awareness and its impact on precautionary behaviour, in order to understand the practical drives for measure-taking. The main questions we, therefore, ask in this paper are: Are locally organised actions dedicated to increasing risk awareness a predictor of societal resilience to face risks? More precisely, are the participants in risk sessions associated with higher risk awareness and do they opt more for precautionary behaviour? This comparative quantitative and qualitative study contributes to explaining risk preparedness by comparing the role that risk awareness sessions have to all stakeholders included in risk management processes. It describes relations between risk awareness and precautionary behaviour in two areas chosen from the Mediterranean basin. It also explores the role of risk awareness sessions in explaining the precautionary behaviour of investing money for protection measures. Finally, it discusses the additional benefits that risk awareness sessions can have when constructing dynamic indicators of risk management.

2 Methodology

2.1 The study sites

More than 500 million people are estimated to live currently in the countries bordering the Mediterranean Sea (Karadirek et al., 2019), with around 150 million people living along the Mediterranean coasts (Cramer et al., 2018). The Mediterranean basin is one of the cradles of civilisation and has always been an attractive migration hub, nowadays also the most visited tourist destination in the world with more than 330 million visitors in 2016 (Tovar-Sánchez et al., 2019). This region is prone to many natural hazards (Satta et al., 2016), and due to a very dense population, a vulnerability hotspot. The International Panel on Climate Change (IPCC) identified the region as one of the most vulnerable regions to global warming, forecasting a temperature rise of 2-3°C by 2050, which makes it a climate change 'hotspot' (Plan Bleu, 2019). The region is projected to experience the highest increase in the frequency of occurrence of extreme weather events due to climate and environmental

change (Vousdoukas et al., 2017), and the open question is whether the population is aware of those imminent risks. The chosen field cases from the Mediterranean basin are North Morocco and West Sardinia (Fig. 1).

The region of North Morocco is a multi-risks zone, which is worth studying due to the increased complexity of social and natural processes. The region is prone to natural hazards particularly due to the seismic activity in the Gibraltar/Alboran region, between the Nubian and Iberian plates, that hosted disastrous earthquakes like 1755 Lisbon and 2004 Al Hoceima events (Neres et al., 2016). In addition, due to natural predispositions (lithology and slopes) and land use of the Rif Mountains, as well as the location on the transition between different climate types, the area frequently suffers from landslides, erosion, droughts, floods and flash floods (Ivčević et al., 2020a). The region's coasts are also characterized by a decreased resilience to climate change due to the heavy urbanisation of the coastline (Snoussi et al., 2010), that is highly exposed to sea-level rise (Satta et al., 2016) and possibly tsunamis (Benchekroun et al., 2015). During the last decades, the vulnerability of the region increased since it became an economic hub at the end of the 20th century, with a touristic infrastructure boom (Fig. 2) and the project of the Tanger-Med harbour. Nevertheless, Morocco maintains, in its modernity, very strong traditional components, with the traditional forms of use of space (El Abdellaoui et al., 2008). The population lives of land, and the agricultural sector is the backbone of the regional economy (Salhi et al., 2020). Besides, Morocco is a Muslim society, with religion playing a significant influence on opinions and perceptions of risk, particularly seismic one (Paradise, 2008).

The coasts of West Sardinia belong to the one third of the Mediterranean basin most exposed to natural hazards, mostly due to very high wave heights (Satta et al., 2017). The area of the Gulf of Oristano is frequently hit by extreme weather events, above all flash floods and coastal storms, predominantly during the cold season. Also, a maximum relative sea level for the Gulf of Oristano and the year 2100 is expected to reach up to 949 mm above sea level based on the IPCC AR5 8.5 scenario, which could leave some parts of the gulf partially flooded (Antonioli et al., 2017). Regarding flooding, wetlands in this area (Fig. 3) play a vital role in disaster risk reduction, but they also create a conflict between urban, fishing and farming activities, with the famous fishing town of Cabras, and the fertile area of Arborea, home to an extensive agricultural production. In addition, Sardinians have a long tradition of autonomous governance and environmental awareness, which even included wildfire regulations in the 14th century (Ivčević et al., 2020b).

In this study, North Morocco and West Sardinia are compared, in order to explore what could contribute to increased risk awareness and precautionary behaviour of the local population. These two studies provide the opportunity to compare how participating in risk awareness sessions is translated into practice. A face-to-face questionnaire-based survey was organised with respondents sampled among the general population using the same set of topics, but adapting to the regions' particularities. In addition, interviews were held with the main stakeholders in North Morocco, and policy documents analysed for the Sardinia case study, to confirm or reject the importance of risk awareness sessions in the actual risk management in the two regions. In the quantitative part of the study, a binary logistic regression model was used to model the willingness of respondents to invest money in protective measures. The qualitative part of the study represents an additional source of information to be crossed with the responses from the questionnaires. This is important to understand the advantages and flaws

of the present risk policy and to overcome a possible risk management gap. Analysing what these two different field studies teach us about the wider multicultural Mediterranean region sustain a deeper reflection about how these common challenges contribute to risk management strategy in other locations from the region. Potential policy advice related to multi-risks and risks related to climate change are formulated, which could contribute to disaster risk reduction in light of the UN Sendai's recommendations, preventing future human and financial loss.

2.2 Participants and fieldwork procedure

A flowchart explaining the steps of the methodology adopted is presented in Fig. 4. The fieldwork procedure was both quantitative and qualitative, organized around questionnaires and interviews. Firstly, to gain the answer on the usefulness of risk awareness sessions, the questionnaires and interviews were used for the Moroccan case study. The questionnaire for the general public resulted in responses of 391 inhabitants of the region North Morocco from eight different communes, responded in a public setting during November 2018. The chosen municipalities belong to areas with different historical hazards record and different geographical characteristics and are divided into three areas for the purpose of this study: Atlantic coast (Tangier, Larache), valley of river Martil (Tetouan, Martil, M'Diq) and Rif Mountain zones (Al Hoceima, Chefchaouen, Oued Laou) (Fig. 1). The obtained sample is composed of 44.2% female respondents and thus underestimates the female population (which is represented on the regional level with 49.27%, census 2014). The respondents are on average between 36 and 41 years old (which overestimates the fact that Morocco is a young nation with a median age of 29.5 years, census 2014).

In the Sardinian case study, the questionnaires were used for data collection, which was later crossed with the existing secondary literature on risk management on a national and regional level. Hundred and seventy-six inhabitants of the area of West Sardinia from three different municipalities, urban Oristano and rural Cabras and Arborea, responded to our questionnaire in a public setting. This questionnaire-based survey was conducted during May and June 2019. Data were collected face-to-face, by targeting the general population, and about 20 min were needed to complete each survey. The Sardinian sample is composed of 45% of male respondents (figures in the population are 49% from the 2011 census, so our sample underestimates the male population). The average participant is 46.4 years old (44 is the average age in population, census 2011).

Secondly, the use of interviews in the North Moroccan study was two-fold. They served to introduce the problem of risk management in the region and to construct the questionnaire. Regarding the Sardinian case study, the secondary literature on risk management at the regional and national level was analysed.

2.3 Quantitative part of the study: Survey content, variables and analysis

The Moroccan and Sardinian questionnaires consisted of 39 and 30 questions, respectively, and were divided into five sections. Not all questions from the questionnaires were used in this analysis. The common part of the questionnaire were the sections that dealt with risk awareness, personal experience, formal and informal education on risks; in addition to questions regarding

institutional trust, environmental identity and place attachment; and finally questions about the belief in climate change, adopting precautionary measures and investing money. It is to note that no risk awareness sessions were organised in the local community, only the previous experience of respondents regarding risk sessions was registered. Those questions were close-ended (dichotomous and Likert rating scale). The full questionnaires (in French and Italian) are available as supplementary material. The data were described in Excel and SPSS, the latter used for factor analysis and regression model. The used regression model was binary logistic which allows dividing variables into more blocks, tracking the model's progress. All the variables were nominal (Table 1).

The first set of variables used in the regression model consists of demographic ones: gender (value 1 for women), age (value 1 for those respondents older than the mean age of 36 years old), education (value 1 for those with bachelor's degree or higher), and zone of living (Morocco: Atlantic, Martil, Rif, Sardinia: urban and rural, five dummies for five zones). The second block includes variables related to risk awareness that are considered to describe better future willingness to invest money, as an indicator of precautionary behaviour. Risk awareness was described using questions related to the level of information about natural hazards, i.e. how much the respondents considered themselves informed about natural hazards in their region (each hazard listed and evaluated on the Likert 1-5 scale), rating their level of information about natural hazards (drought, flood, landslide, coastal storm, sea-level rise, heatwave, earthquake, coastal erosion and wildfire), and about climate change, and whether they participated or not in the awareness sessions or environmental education campaigns organized by the municipalities or associations), (e.g., Domingues et al., 2018; Ivčević et al., 2020a). The first study was the North Moroccan when the variables were explored and constructed, and the reliability was tested. Items were submitted to a factor analysis (Kaiser-Meyer-Olkin Measure of Sampling Adequacy = .897; Bartlett's test of sphericity: $\chi^2 = 1679$, df = 55, p < .001). One factor retained was 'risk informed' (α = .890), and the other 'risk sessions' (α = .381), used in the following analysis. Besides, the variable of personal experience of a natural hazard (yes/no) was added, whose importance in risk perception was showed in similar studies (e.g., Papagiannaki et al., 2019b). Next, respondent's belief in the existence of climate change was asked (yes/no). Moreover, the respondents were asked if they have previously taken any precautionary measures (yes/no). The final block of variables, related to trust, environmental identity and place attachment, was to test the supplementary variables about the impact on future precautionary behaviour. The place attachment was measured using items such as 'I think this municipality offers a good living environment' and represents a relationship of the resident with her municipality (Bonaiuto et al., 2016). These items were averaged to a single variable with a satisfactory consistency (α = .827). The environmental identity was measured using items such as 'I think of myself as someone engaged in environmental issues' and represents environmental concerns of residents (Bertoldo and Castro, 2016), averaged into a single variable with a good consistency (α = .846). The social trust, regarding science and institutions involved in risk management, is of importance especially when respondents cannot manage risks on their own (Achterberg et al., 2017). The items were submitted to a factor analysis (Kaiser-Meyer-Olkin Measure of Sampling Adequacy = .768; Bartlett's test of sphericity: $\chi^2 = 1230$, df = 21, p < .001) which split them in

two dimensions: trust in science ($\alpha = .887$) and trust in state ($\alpha = .804$). The variables were constructed based on the Moroccan case study, and were implemented in a similar way for the collection of the Sardinian dataset. Later, all those items were measured using a 5-point Likert scale, and then dichotomized: participants with responses above mean were considered to have a high value, those under mean to have low value, and are as such used in a binary logistic model, schematically presented in Fig. 5. For more details on variables chosen refer to publications by Ivčević et al. (2020a, 2020b).

2.4 Qualitative part of the study: Interviews and secondary literature

In North Morocco, the interviews were based on an interview guide, which consisted of five main parts. The general topic was the influence of the representation that associates, administrators and scientists have on the relationship between citizens and risk; and on the influence of memory and the territorial context in the development of management tools, particularly preventive communication. Firstly, the life in the region and the relationship and attachment the respondent has with the place of living was discussed. Then, the knowledge and history on risk phenomenon in the region were questioned, followed by the personal experience and risk memory. There the interlocutors were asked about the different types of knowledge (scientific and vernacular) that the institutional practices base their risk awareness activities on when talking about risks to the general population. Thirdly, the information, prevention and risk management in the region, as well as the importance of risk awareness sessions in risk management strategies were debated, followed by the consideration of the region within the context of national and international risk policies. Finally, the meaning and use of indicators in risk management were argued. There were twenty-five interviews conducted, and the interviewees were grouped into three: a) the elected or appointed administrators (eight), b) the scientists and technicians that work in the risk research or management (eight), and c) the members of civil society, i.e. associations (nine). All twenty-five narratives were recorded and transcribed and basic discourse analysis was carried out using the software Iramuteq (Ivčević, 2020c). The main parts of the interview guide and the groups interviewed are presented in Table 2. As far as the Sardinian case study is concerned, the secondary literature on risk management at the regional (Sardinia) and national (Italy) level was obtained as public documents free from the administrative web pages. These sources served to contrast the population's responses with the official directions in managing natural risks. Since this literature was easily accessible, the qualitative study in form of interviews with the local authorities was not considered to be essential for this research, conversely to the Moroccan case study.

3 Results

3.1 Quantitative: Explaining future willingness to invest money based on actual risk awareness

Willingness to invest money in order to protect from future natural hazards was examined through a binary logistic model. Willingness was regressed on three blocks of variables. The first block included demographic variables of gender, age,

education and zone of study. The second block included risk awareness variables that were considered to contribute more to explaining future willingness to invest: personal experience, precautions taken, risk informed and risk sessions. The last block included additional variables that hopefully could help clarify which profiles are up to risk investing: trust in science and state, environmental identity, place attachment, and belief in climate change. Presented in Table 3, results show that demographic

230 variables that significantly predict future willingness to invest money in protection are the age of the sample over 36 years old *(-.433, p < .05)*, and the education level of any university degree *(.459, p < .05)*. This result suggests that being under 36 years old and having a university education is positively associated with monetary investments for natural risk protection. The only additional indicator that predicts future willingness to invest is the awareness indicator of following risk sessions *(.539, p < .05)*. Personal experience is a marginally significant positive predictor *(.396, p < .1)*, as well as the fact of living in West

235 Sardinia – in both urban (*.780, p < .1*) or rural areas (*.743, p < .1*). None of the indicators introduced in the third block did significantly contribute to future willingness to invest money. The model overall describes over 11% of the social variability of the sampled population (Nagelkerke R^2 = .115).

3.2 Qualitative: The importance of the risk awareness sessions according to the stakeholders

The interviewees have been asked about natural hazards, their memory of catastrophic events and the risk management policy
240 in the region. Among the useful information given, some particular answers need to be discussed. During these interviews, among the main topics debated, risk awareness sessions were the hot subject argued. The verbatim extracts with these results are presented in Table 4.

As far as risk awareness and risk sessions are concerned, the administration in some cities (Male, 45, Rabat; Male, 40, Martil) claims that the sessions are present and organised and that the population is risk aware. However, those from smaller
245 municipalities do agree that the population is somewhat aware of risks, but they do not agree that there are risk awareness sessions (Male, 55, Oued Laou; Female, 60, Al Hoceima). The administration even admits that sometimes talking about risks is omitted on purpose (Male, 45, Rabat; Female, 60, Al Hoceima), but also thinks that the associations know better than themselves how to raise awareness (Male, 55, Tetouan).

The scientists are more critical. They agree that discourse on risks can be intentionally left aside (Female, 50, Tangier) and
250 they can agree that the population is aware of their local risks, but is more money-driven and decides economically (Male, 65, Tetouan; Male, 30, Al Hoceima; Male, 50, Tetouan). The scientists agree that more risk awareness is needed, but that the outreach campaigns need to be regulated (Male, 30, Tetouan). The scientist also admitted that, when undertaking risk awareness sessions in schools, they lack the expertise or means of what to do later with that data (Male, 50, Tetouan).

However, regarding risk awareness, the civil society expects more from the administration. Whether there is some awareness
255 at schools (Female, 30, Tangier) or not (Female, 35, Tetouan), more awareness and prevention are expected from the municipalities (Male, 55, Chefchaouen; Female, 30, Tangier). If the municipality does not raise the awareness, there are luckily

some associations that fill in that gap (Female, 50, Tetouan), but the question posed is how does the awareness translate into a behaviour and is the awareness sufficient to change attitudes regarding natural hazards (Male, 50, Al Hoceima)?

As far as the Sardinian case study is concerned, risk awareness sessions among the local society experiencing and managing risks seem to be taken into consideration in the official documents, but in a form of a theoretical wish list. In 'Elements for National Strategy of Adaptation to Climate Change' (Castellari et al., 2014), the authors recognised the importance of risk perception: "investments in innovative monitoring technologies, investments to improve communication and to raise awareness of perception and risk management by citizens (an informed population is more aware and safer), they are priority measures of 'non-structural' adaptation in the context of climate change" (p. 38) and "an effective communication, awareness and information activity to the interested parties for the purpose is, therefore, essential to ensure an adequate perception of these risks" (p. 216).

Similarly, in the Sardinian 'Regional Strategy of Adaptation to Climate Change' (adopted in 2019), among the general criteria in developing the objectives is the "awareness and education on climate change, to ensure full awareness of the future risks associated with expected climate pressures and to stimulate responses also oriented towards the development of bottom-up planning tailored to specific local needs" (p. 37). This document is followed by an extensive and detailed 'Methods and Tools for the Regional Strategy of Adaptation to Climate Change' (2018), where indicators useful for knowledge of the state of the environment in Sardinia are listed, among them the farmers' perception of the threats related to climate change is elaborated. In addition, a document 'Guidelines for Regional Adaptation Strategies', elaborates the role of the coordination group, and dedicates a place for questionnaires and workshops in the process of adaptation: "developing specific surveys with questionnaires or semi-structured interviews, focus groups, participatory workshops, laboratories managed with methodologies relating to participatory planning, etc" (Cocco et al., 2019). Finally, a document 'Guidelines, Standardized Principles and Procedures for Climate Analysis and the Assessment of Vulnerability at Regional Level', from the same MASTER ADAPT project (Giordano et al., 2019), calls for the quality of input data and states that "[a] deeper understanding of how a sector / system / territory behaves with respect to climate changes contributes, in fact, to establishing adaptation objectives and targets, to providing the necessary elements for planning adaptation measures, to raising community awareness and to monitoring and evaluating adaptation policies" (p. 31).

4 Discussion

4.1 All stakeholders underline the importance of risk awareness sessions, but do they remain only wishful thinking?

The results from quantitative case studies in North Morocco and Sardinia, targeting the general population, indicate that participation in risk sessions seems to have an impact on precautionary behaviour, related to future willingness to invest money in order to protect (Table 3). The importance of risk awareness sessions is also confirmed by interviews in the qualitative study in North Morocco. Although both scientists and members of associations call for more awareness campaigns, the majority of

administrators defend, however, the position that the population is already aware of risks and that the institutions are well-involved. Still, an administrator from a smaller municipality admitted the absence of sessions and learning processes on risk. The risk awareness sessions in risk management are elaborated by all three groups of interlocutors. As stated by the administrators in Rabat, Martil or Al Hoceima, the risk sessions exist and the population is aware of the risks, but in Oued Laou or Tetouan they do not agree, showing the local differences within the region.

On the national level, the Moroccan state is well-included in risk management and international policies, as confirmed by an administrator from Rabat. Besides, the Moroccan 'Référentiel de l'Urbanisme Durable'[1] (2017) elaborated the detailed commitment for which Morocco engaged by adopting the new urban agenda 'Quito Habitat III' from October 2016. The fifth issue, dedicated to 'Health and Citizens' Security', includes a special theme on 'Management of Natural and Technological Risks', with natural hazards like avalanches, wildfires, floods, landslides, cyclones, storms, earthquakes and volcanic eruptions. The listed objectives of prevention are: to suppress the extent of the hazard, to control its effects and to reduce the exposure of people and goods. The strategy of implementation is rather ambitious, with action, intervention, urgency and rescue plans, followed by the financial investments, to implement alerting systems, to develop risk cartography, to conform the constructions following the earthquake-resistant standards, to integrate risk management into local action plans and to realise infrastructure resilient to risks.

However, there is some void that is argued by the interlocutors, starting from the lack of legal respect, to lack of awareness and trust. Firstly, although the State's implication on a national level was appraised by the administrators, laws are there, but they are not respected, as stated by the scientists. The population seems to disobey the legislation, as well as the local leaders when it comes to financial matters, which creates distrust. Is the local population aware of risks or just decides based on an economic opportunity? It could be considered that awareness and financial means are actually intertwined. The financial resources are also likely to influence the risk management that is deficient at the municipal level. The smaller municipalities of Oued Laou and M'Diq do not use indicators of risk management therefore they do not manage risks on their own.

Secondly, a remarkable obstacle in advanced risk awareness campaigns is the reciprocal mistrust between administrators and scientists. Distrust regarding awareness and prevention sessions of local leaders towards scientists is confirmed by the researcher working in the national research institute CNRST[2] in Rabat. While conducting her research on tsunami hazard in Tangier she was refused to do the evacuation exercise on tsunamis and to place tsunami signs in the city.

The distrust between the administration and the broad population is mutual, as well. A female member of the association from Tetouan judged the administrative, repetitive discourse of taking commitment before each election, but not fulfilling any later on, and a female administrator admitted not even communicating the risk to the inhabitants of the cliff in Al Hoceima.

---

[1] Sustainable Urbanism Reference System
[2] Centre National pour la Recherche Scientifique et Technique = National Centre for Scientific and Technical Research

As far as the Sardinian case study is concerned, all official documents look professional and well-elaborated, nevertheless without concrete measures of a broad assessment of risk awareness. Based on the results from the quantitative case study, the indicator of risk awareness sessions seems to be significant in deciding whether or not the local population invests in future protection. Besides, the lack of risk awareness sessions was often brought out by the respondents on the margins of the quantitative study. However, actual actions might in fact exist. The impression is that these strategic documents do recognise the need for awareness and education sessions, yet without specific training activities. It is as if there is no follow-up of these wishes in concrete monitoring, which therefore does not provide a useful indicator of climate change adaptation. This calls for the administration to promote more risk awareness sessions among the general population. As argued, among other criteria that contribute to taking precautionary behaviour is the economic criteria. However, risk awareness sessions will certainly contribute to some future risk decisions the inhabitants make. To sum up this discussion, a point stated by a male member of the association from Al Hoceima can be used to depict the awareness situation: *"Natural hazards, yes, people are aware and informed that this region is seismic. Much the same as with garbage, people know that it's not good. But what do we do? Is this awareness sufficient to change behaviour, attitudes?"*

4.2 Future perspectives of the results as an input for risk policy: the importance of dynamic indicators

Another recommendation of this study regards dynamic indicators in risk management. Although the content of the past risk awareness sessions was not analysed within this study, risk awareness sessions seem to be considered useful in preparedness and risk management strategy by the participants of these research activities. As such, they could be imagined as an effective risk management tool and their true utility should be tested to confirm the effectiveness of risk awareness sessions in adopting precautionary behaviour. In efficient risk management, indicators should be used to collect information on every phase of the disaster management cycle, building a less vulnerable society. For example, in economics, cost-benefit analysis of the actual and new risk policy, before and after the investment, could be coupled. Also in education, for instance, the number of middle- or high-school pupils educated on risk and climate change could be coupled with the number of resilient pupils in an affected area and those that consequently developed a belief in climate change processes, which showed to have an impact on the Sardinian population in adopting precautionary behaviour. Raising awareness in schools was already done in Tetouan, as brought out by our interlocutor, but so far without the success rate estimate. (Male Scientist, 50, Tetouan)

The information on hazard history, recurrence time of earthquakes or return interval of floods can be used as input data for risk awareness sessions, that would boost both awareness and perception, and provoke changes in attitudes towards precautionary behaviour, as was shown in North Morocco. Risk awareness sessions could be followed up on a time scale, and that can further contribute to the interdisciplinarity of risk science with policy, psychology, and economics. Furthermore, the North Moroccan example showed the need for integrating risk awareness sessions with religious institutions. The hazard history of great earthquakes and floods could be used as input risk information during religious discussions with an outcome

of an ethical maxim of adopting precautionary behaviour to save human lives. Moreover, the participatory approach is always important for a successful information flux between all stakeholders included in risk management processes. It can also be assessed dynamically, by initially identifying the individual positions of the risk management stakeholders, and consequently reaching consensual priorities of all stakeholders after participatory focus groups.

355   This way of approaching indicators is a suitable consideration for different hazard types. If we consider flood hazard, and the number of people living in the area exposed to flood, that would be an example of a vulnerability indicator. Since it could be assumed that we have the information about flood frequency and maximum or average intensity, the educational campaign in that area could be organized. The number of people that moved out from that flooded area based on the input of the educational campaign, in some limited time frame, could be measured and be considered as a resilience indicator. These pieces of

360   information could notify about the success of the flood awareness campaign, but also about the local readiness to cope with the ongoing change. Last but not least, if we consider the sea-level rise and coastal storm effects as a consequence of climate change, the community can be informed about the annual cost of beach nourishment and possible control structures. If the coastal storm damage is registered, and the benefits of nature-based solutions to mitigate the impact of climate change are divulged to the population, it could be that the community would see the utility and financial benefit of nature-based solutions,

365   as it is promoted in the case of wetlands from the Sardinian case study. A similar idea can be used for the example from geomorphology. These ideas are presented in Table 5 and are some of the possible changes that dynamic indicators could bring to the community. Finally, organizing a series of risk awareness sessions in the local community, opened and destined to all stakeholders, would certainly represent an instructive research activity that would contribute to clarifying the existing learning processes between the local stakeholders and improving risk management.

370   **4.3 Limits of this study**

The contribution of two Mediterranean case studies analysed is the region's North-South coupling and comparison, where Morocco and Italy could easily serve as pilot studies to other countries, sharing the methodology and adapting to local physical and social particularities. Likewise, undertaking risk perception case studies in the lower-income countries could help us to get out from the mindset of the higher-income country, when financial obstacle can play a role in different forms of

375   precautionary behaviour. The variety of case studies should increase the efficiency of risk management strategies. Still, comparing two areas of study is not always a simple task: risks are complex phenomena and those acceptable in one cultural context are not necessarily acceptable in another (Dauphiné, 2003). In this case, the first to keep in mind while trying to compare these two Mediterranean territories was their size proportion. North Morocco is a region of more than 17,000 km² and with more than 3,5 million inhabitants. The Sardinian surface is a bit over 24,000 km² with 1,6 million inhabitants.

380   However, the Gulf of Oristano municipalities included in our Sardinian case study are of surface that is seventeen times smaller than those of the Moroccan case study, and with forty times fewer dwellers (1000 km², 85,000 people). This is, therefore, the biggest limit of this comparative study. Another important remark regards the difference in hazard history that those areas

experienced. Inhabitants of the Rif have in memory a recent series of earthquakes, with a notorious and deadly event in 2004. Conversely, Sardinians seem to be less impacted by what they experienced and learned regarding their territory. These differences in risk experience may lead to differences in main hazards perceived between the two studied regions (Fig. 6). To continue, additional comparative studies from the Mediterranean basin should be organised, from both North and South coasts. Those studies would generate new knowledge that has to be constantly shared in form of risk awareness sessions, improving the information transfer between different interlocutors and local dwellers, that are, although diverse, not so different in the end.

4.4 Conclusions

Hazards occur regardless of the situation, whereas vulnerability is a dynamic process, always relative to a certain situation. Local knowledge, practices and cultural particularities between countries should be acknowledged, respecting local scale for every unique case and questioning risk perception. The theory of common sense helps to clarify the importance of local knowledge, keeping it from oblivion. The results from two Mediterranean case studies, North Morocco and West Sardinia, confirm the importance of interdisciplinarity in risk management, since hazard history and environmental conditions, as well as societal and cultural characteristics, contribute to increased risk awareness and precautionary behaviour of the local population. Those two case studies showed the importance of risk awareness sessions in financial precautionary behaviour. The general population seems to reveal that 'risk awareness sessions' are an adequate indicator of local resilience. This information should be useful for policymakers at regional and national levels. Unfortunately, the policy literature and interviews held with the administrators and scientists indicate that although recognised, the importance of risk awareness sessions is not necessarily put into practice. As a consequence, this could lead to a failure of risk management policy. Although there is a constant improvement in risk management policy, with the Sendai Framework and the increase of participatory approach and local perception studies, the question is how to make a step forward. The communication gap is one of the problems, where the language used is not suitable for different groups of society included in risk management. To overcome this gap, more dialogue between different stakeholders included in the risk management process is needed. The dire need for continuous transdisciplinary work to overcome the communication gap between the scientific community, risk administrators, and the general population is encouraged. The technical documents can be well done, but the information should be transmitted clearly, popularized, even vulgarized, to the general population, from door to door in risk areas, if needed. Last but not least, risk awareness sessions have a crucial position in learning processes and in the usage of dynamic indicators. They can be followed on a time scale, and that can further accompany the transdisciplinarity of risk management.

Acknowledgements

These research activities have received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No713750. Also, they have been carried out with the financial support of the Regional Council of Provence- Alpes- Côte d'Azur and with the financial support of the A*MIDEX (n◦ ANR- 11- IDEX-
415 0001-02). This work has also been funded by the RiskMED project, Labex OT-Med (ANR-11-LABE-0061) supported by the Investissements d'Avenir, French Government project of the French Agence National pour la Recherche (ANR) through the A*MIDEX project (ANR-1-1E-0001-02). The authors are grateful to the local population and other local stakeholders that provided useful information for this study. Also, the authors are thankful to two reviewers whose comments helped to improve the manuscript. Finally, the first author is particularly thankful to Prof. Matthieu Kervyn from Vrije Universiteit Brussel and
420 to Marta Banožić from the University of Vienna for their advice, reading, editing and commenting on the manuscript.

Data availability: The data presented in this study are openly available online in OSF repository, Ivcevic, A. (2021, October 9). Risk Awareness Morocco-Sardinia. Retrieved from osf.io/gmkyq ; under the DOI 10.17605/OSF.IO/GMKYQ .

Author contribution: Conceptualization, A.I., H.M. and L.S.; methodology, A.I., H.M., R.B. and L.S.; software, A.I., R.B. and V.S.; validation, A.I., I.E.R., R.B. and V.S.; formal analysis, A.I.; investigation, A.I. and R.B.; resources, A.I., H.M., R.B.
425 and V.S.; data curation, A.I., I.E.R., R.B. and V.S.; writing—original draft preparation, A.I.; writing—review and editing, A.I., I.E.R., R.B., N.M. and L.S.; visualization, A.I., K.A., R.B. and V.S.; supervision, H.M., L.S., R.B. and O.B.; project administration, A.I.; funding acquisition, A.I. All authors have read and agreed to the published version of the manuscript.

Competing interests: The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, or in the decision to publish the results.

430 **References**

Achterberg, P., De Koster, W. and Van der Waal, J., 2017. A science confidence gap: Education, trust in scientific methods, and trust in scientific institutions in the United States, 2014. Public Understanding of Science, 26(6), pp.704-720.

AlQahtany, A.M. and Abubakar, I.R., 2020. Public perception and attitudes to disaster risks in a coastal metropolis of Saudi Arabia. International journal of disaster risk reduction, 44, p.101422.

435 Antonioli, F., Anzidei, M., Amorosi, A., Presti, V.L., Mastronuzzi, G., Deiana, G., De Falco, G., Fontana, A., Fontolan, G., Lisco, S. and Marsico, A., 2017. Sea-level rise and potential drowning of the Italian coastal plains: Flooding risk scenarios for 2100. Quaternary Science Reviews, 158, pp.29-43.

Benchekroun, S., Omira, R., Baptista, M.A., El Mouraouah, A., Brahim, A.I. and Toto, E.A., 2015. Tsunami impact and vulnerability in the harbour area of Tangier, Morocco. Geomatics, Natural Hazards and Risk, 6(8), pp.718-740.

440   Bertoldo, R., 2021. A comparative frame for a contextualised analysis of local natural risk management. International Journal of Disaster Risk Reduction, 52, p.101945.

Bertoldo, R. and Castro, P., 2016. The outer influence inside us: Exploring the relation between social and personal norms. Resources, Conservation and Recycling, 112, pp.45-53.

Bonaiuto, M., Alves, S., De Dominicis, S. and Petruccelli, I., 2016. Place attachment and natural hazard risk: Research review

445   and agenda. Journal of Environmental Psychology, 48, pp.33-53.

Castellari, S., Venturini, S., Giordano, F., Ballarin Denti, A., Bigano, A., Bindi, M., Bosello, F., Carrera, L., Chiriacò, M.V., Danovaro, R. and Desiato, F., 2014. Elementi per una Strategia Nazionale di Adattamento ai Cambiamenti Climatici. Ministero dell'Ambiente e della Tutela del Territorio e del Mare, Roma, 245 p.

Cocco, G., Arras, F., Congiu, A., Satta, G., 2019. Linee Guida per le Strategie Regionali di Adattamento ai Cambiamenti

450   Climatici, MASTER ADAPT, Roma, 97 p.

Covello, V.T., 1983. The perception of technological risks: A literature review. Technological forecasting and social change, 23(4), pp.285-297.

Cramer, W., Guiot, J., Fader, M., Garrabou, J., Gattuso, J.P., Iglesias, A., Lange, M.A., Lionello, P., Llasat, M.C., Paz, S. and Peñuelas, J., 2018. Climate change and interconnected risks to sustainable development in the Mediterranean. Nature Climate

455   Change, 8(11), pp.972-980.

Dauphiné, A., 2003. Risques et catastrophes. Observer, spatialiser, comprendre, gérer. Paris, Armand Colin, 288 p.

Domingues, R.B., Santos, M.C., de Jesus, S.N. and Ferreira, Ó., 2018. How a coastal community looks at coastal hazards and risks in a vulnerable barrier island system (Faro Beach, southern Portugal). Ocean & coastal management, 157, pp.248-256.

El Abdellaoui, M., Chikhi, N.E. and Boulifa, A., 2008. Agriculture et dynamiques territoriales dans la zone spéciale de

460   développement économique" Tanger-Méditerranée". Université Abdelmalek Essaâdi.

Giordano, F., Barbieri, L., et al., 2019. Linee Guida, Principi e Procedure Standardizzate per l'Analisi Climatica a la Valutazione della Vulnerabilità a Livello Regionale e Locale, MASTER ADAPT, Roma, 111 p.

Ivčević, A., Bertoldo, R., Mazurek, H., Siame, L., Guignard, S., Ben Moussa, A. and Bellier, O., 2020a. Local risk awareness and precautionary behaviour in a multi-hazard region of North Morocco. International Journal of Disaster Risk Reduction,

465   p.101724.

Ivčević, A., Statzu, V., Satta, A. and Bertoldo, R., 2020b. The future protection from the climate change-related hazards and the willingness to pay for home insurance in the coastal wetlands of West Sardinia, Italy. International Journal of Disaster Risk Reduction, p.101956.

Ivčević, A., 2020c. Indicators in risk management: a fresh perspective between hazard analyses and societies' responses (Ph.D.

470   Dissertation). Aix-Marseille University, Marseille, France.

Joffe, H., 1999. Risk and 'the Other'. Cambridge University Press., chapter 6 'Social representations of risks'

Joffe, H., Rossetto, T., Solberg, C. and O'Connor, C., 2013. Social representations of earthquakes: A study of people living in three highly seismic areas. Earthquake Spectra, 29(2), pp.367-397.

475 Karadirek, I.E., Aktas, K. and Topkaya, B., 2019. Environmental Pollution of the Mediterranean Sea: Evaluation of Research Activities in the Mediterranean Sea Countries. FEB-Fresenius Environmental Bulletin, Vol 28, No. 2, p.867-872.

Khan, A.A., Rana, I.A. and Nawaz, A., 2020. Gender-based approach for assessing risk perception in a multi-hazard environment: a study of high schools of Gilgit, Pakistan. International journal of disaster risk reduction, 44, p.101427.

Langford, I.H., 2002. An existential approach to risk perception. Risk analysis, 22(1), pp.101-120.

Metodi e Strumenti per la Strategia Regionale di Adattamento ai Cambiamenti Climatici, 2018. Regione Autonoma della
480 Sardegna, Assessorato della Difesa dell'Ambiente, Adottata con Deliberazione della Giunta Regionale n. 6/50 del 5 febbraio 2019, 662 p.

Mondino, E., Scolobig, A., Borga, M., Albrecht, F., Mård, J., Weyrich, P. and Di Baldassarre, G., 2020. Exploring changes in hydrogeological risk awareness and preparedness over time: a case study in northeastern Italy. Hydrological Sciences Journal, 65(7), pp.1049-1059.

485 Neres, M., Carafa, M.M.C., Fernandes, R.M.S., Matias, L., Duarte, J.C., Barba, S. and Terrinha, P., 2016. Lithospheric deformation in the Africa-Iberia plate boundary: Improved neotectonic modeling testing a basal-driven Alboran plate. Journal of Geophysical Research: Solid Earth, 121(9), pp.6566-6596.

Papagiannaki, K., Diakakis, M., Kotroni, V., Lagouvardos, K. and Andreadakis, E., 2019a. Hydrogeological and Climatological Risks Perception in a Multi-Hazard Environment: The Case of Greece. Water, 11(9), p.1770.

490 Papagiannaki, K., Kotroni, V., Lagouvardos, K. and Papagiannakis, G., 2019b. How awareness and confidence affect flood-risk precautionary behavior of Greek citizens: the role of perceptual and emotional mechanisms. Natural Hazards & Earth System Sciences, 19(7).

Paradise, T.R., 2008. Islam and earthquakes: seismic risk perception in a Muslim city. Journal of Islamic Law and Culture, 10(2), pp.216-233.

495 Plan Bleu Policy Paper, 2019. Outsmart climate change: work with nature! Enhancing the Mediterranean's climate resilience through Nature-based Solutions, 24 pp.

Référentiel de l'Urbanisme Durable, 2017. Groupement d'Expertises et d'Etudes Fquih Berrada Charaf-Eddine & Mikou Khalid, Royaume du Maroc, Ministère de l'Aménagement du Territoire National, de l'Urbanisme, de l'Habitat et de la Politique de la Ville, Direction de l'Urbanisme.

500 Renn, O., 1998. The role of risk perception for risk management. Reliability Engineering & System Safety, 59(1), pp.49-62.

Rohrmann, B., 1998. The risk notion: epistemological and empirical considerations. Integrative risk assessment, pp.39-46.

Salhi, A., Benabdelouahab, T., Martin-Vide, J., Okacha, A., El Hasnaoui, Y., El Mousaoui, M., El Morabit, A., Himi, M., Benabdelouahab, S., Lebrini, Y. and Boudhar, A., 2020. Bridging the gap of perception is the only way to align soil protection actions. Science of The Total Environment, 718, p.137421.

505 Satta, A., Puddu, M., Venturini, S. and Giupponi, C., 2017. Assessment of coastal risks to climate change related impacts at the regional scale: The case of the Mediterranean region. International journal of disaster risk reduction, 24, pp.284-296.

Satta, A., Snoussi, M., Puddu, M., Flayou, L. and Hout, R., 2016. An index-based method to assess risks of climate-related hazards in coastal zones: The case of Tetouan. Estuarine, Coastal and Shelf Science, 175, pp.93-105.

Slovic, P., 1987. Perception of risk. Science, 236(4799), pp.280-285.

510 Slovic, P., Fischhoff, B. and Lichtenstein, S., 1976. Cognitive processes and societal risk taking. In Decision making and change in human affairs (pp. 7-36). Springer, Dordrecht.

Snoussi, M., Niazi, S., Khouakhi, A. and Raji, O., 2010. Climate change and sea-level rise: a GIS-based vulnerability and impact assessment, the case of the Moroccan Coast. Geomatic Solutions for Coastal Environments. Hauppauge NY: Nova Science Publishers Inc, pp.275-310.

515 Strategia Regionale di Adattamento ai Cambiamenti Climatici, 2019. Regione Autonoma della Sardegna, Assessorato della Difesa dell'Ambiente, Adottata con Deliberazione della Giunta Regionale n. 6/50 del 5 febbraio 2019, 57 p.

Trogrlić, R.Š., Duncan, M., Wright, G., van den Homberg, M., Adeloye, A., Mwale, F. and McQuistan, C., 2021. External stakeholders' attitudes towards and engagement with local knowledge in disaster risk reduction: are we only paying lip service?. International Journal of Disaster Risk Reduction, p.102196.

520 Tovar-Sánchez, A., Sánchez-Quiles, D. and Rodríguez-Romero, A., 2019. Massive coastal tourism influx to the Mediterranean Sea: The environmental risk of sunscreens. Science of the Total Environment, 656, pp.316-321.

United Nations, 2015. Sendai framework for disaster risk reduction 2015–2030.

Vousdoukas, M.I., Mentaschi, L., Voukouvalas, E., Verlaan, M. and Feyen, L., 2017. Extreme sea levels on the rise along Europe's coasts. Earth's Future, 5(3), pp.304-323.

525 Zinn, J.O. ed., 2009. Social theories of risk and uncertainty: An introduction. John Wiley & Sons.
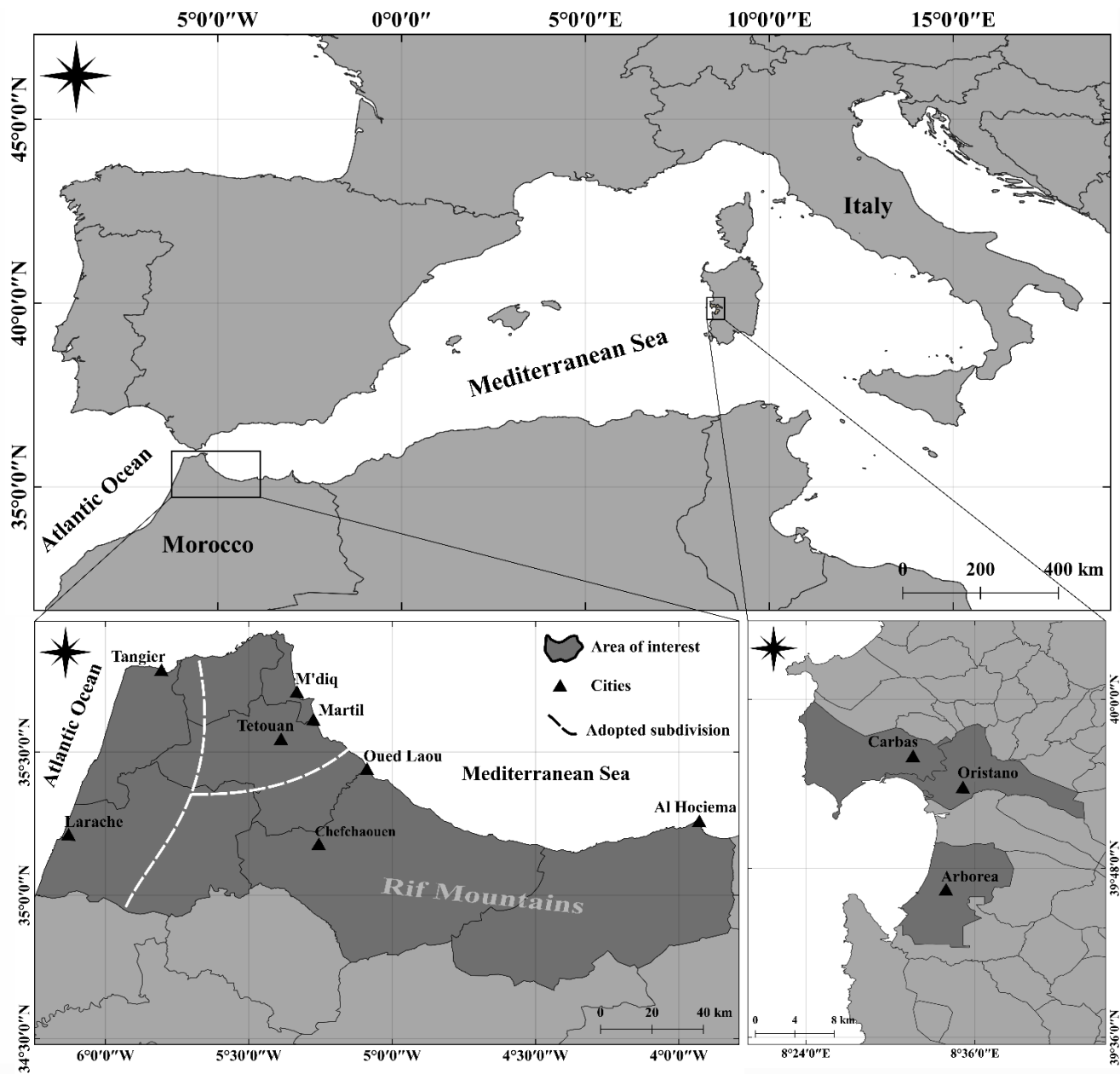
Figure 1: Study sites: North Morocco and West Sardinia, Italy.

530

Oued Laou, April 2018
© A. Ivcevic

Figure 2: The region of North Morocco has a high increase of touristic infrastructure.

535   **Figure 3: Wetlands of West Sardinia are famous for its fishing activities.**
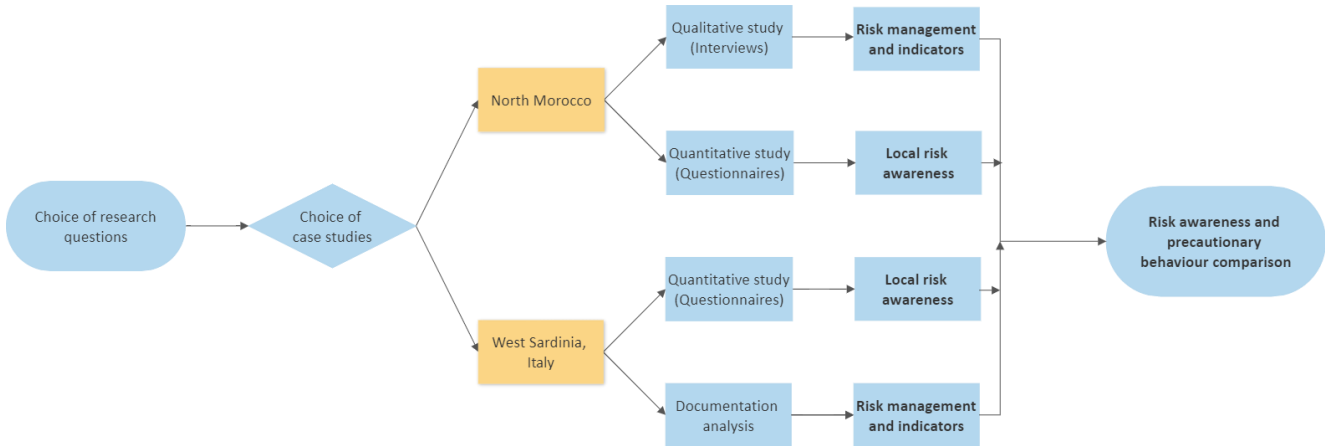
Figure 4: Flowchart (by SmartDraw) explaining the steps of methodology adopted.

540
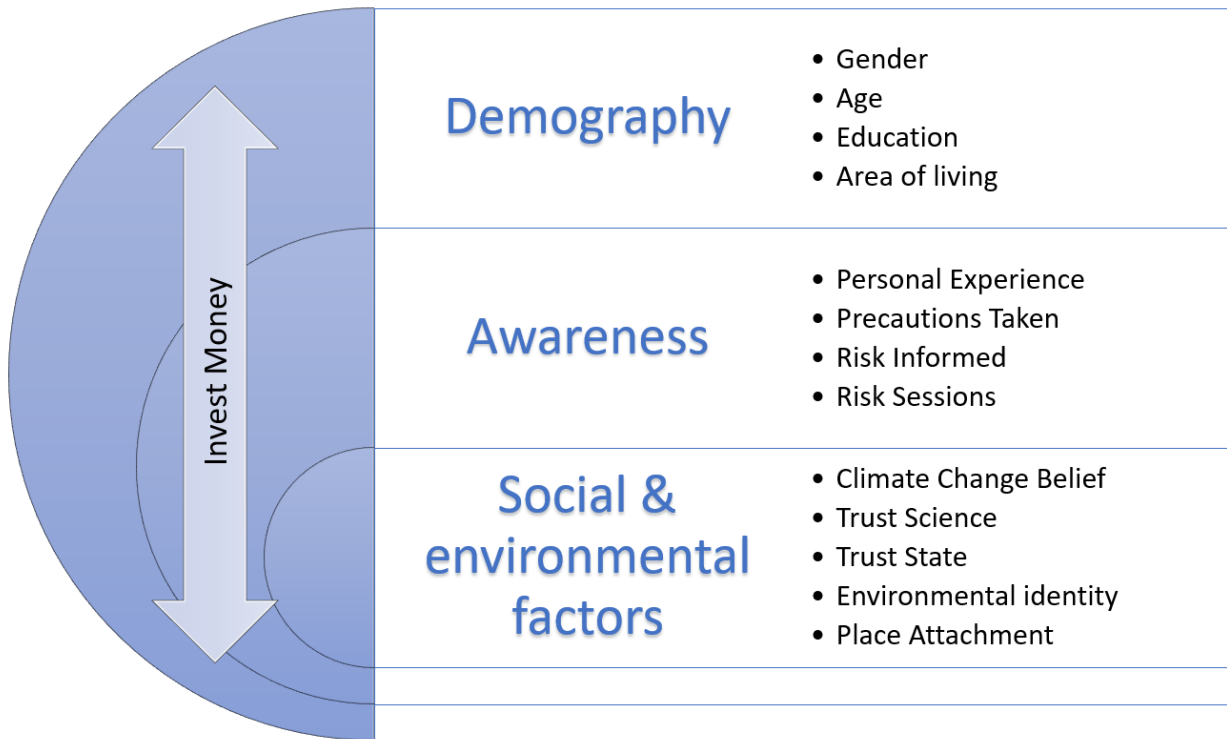
Figure 5: Schematical presentation of binary logistic model describing willingness to invest money in disaster risk reduction, with dependent variable of investing money.

545
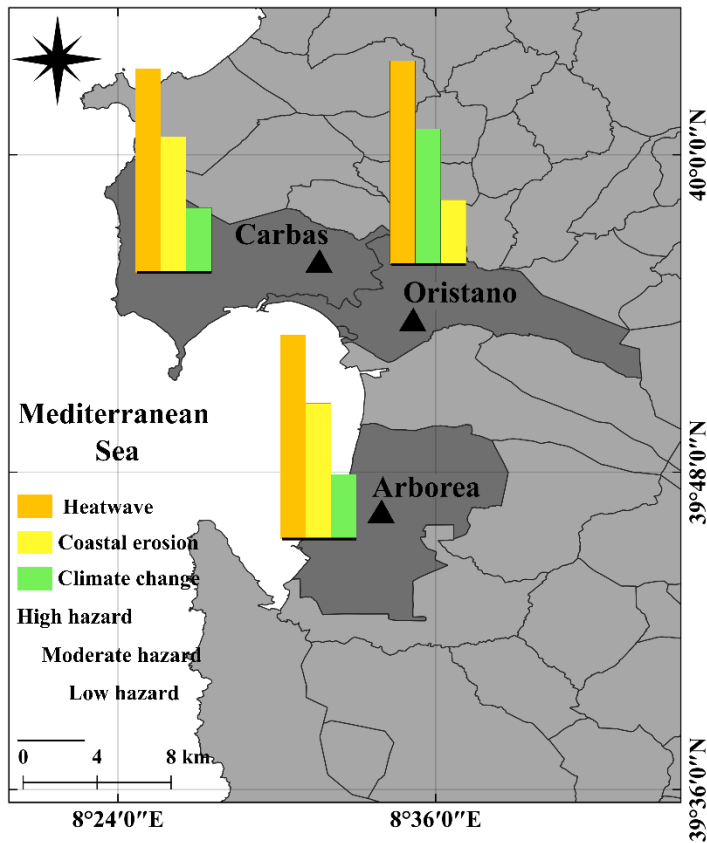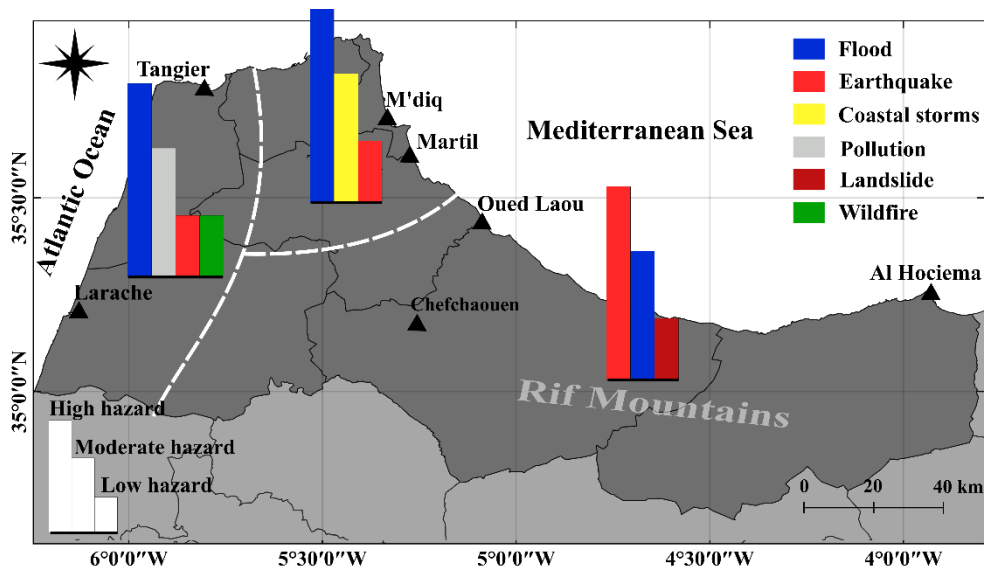
Figure 6: Differences of main hazards perceived in North Morocco and West Sardinia by the general population

Table 1: Variables used in regression model

Variable	Description	Questions	N obs.	Mean	St. Dev.	Min	Max
Gender (female = 1)	Demographic	Gender	567	.4762	.49987	0	1
Age > 36	Demographic	Age	565	.5894	.49238	0	1
Education	Demographic	What educational qualification do you have?/ number of years at school	539	.3581	.47988	0	1
Zone Rif	Demographic	Municipality of residence	567	.2328	.42299	0	1
Zone Atlantic	Demographic	Municipality of residence	567	.1464	.3538	0	1
Zone Med Martil	Demographic	Municipality of residence	567	.3104	.46307	0	1
Urban Sardinia	Demographic	Municipality of residence	567	.1411	.34843	0	1
Rural Sardinia	Demographic	Municipality of residence	567	.1693	.37536	0	1
Personal Experience	Constructed	Have you ever personally experienced a natural disaster in your life?	566	.5442	.49849	0	1
Precautions Taken	Constructed	Have you ever taken any precautions to avoid a potential natural disaster?	558	.1828	.38685	0	1
Climate Change Belief	Constructed	Do you believe that 'climate change' exists?	562	.9146	.27974	0	1
Risk Informed	Constructed	How well do you feel you are informed about each of the following natural phenomena?	508	.4606	.49894	0	1
Risk Sessions	Constructed	Have you ever participated in information and awareness-raising sessions on natural phenomena? (If yes, who organised the activity?)	516	.4438	.49731	0	1
Trust Science	Constructed	Regarding natural hazards, how much trust do you place in science/ scientists/ research institutions?	555	.5802	.49397	0	1
Trust State	Constructed	Regarding natural hazards, how much trust do you place in regional and national government/ media/ risk management institutes?	555	.227	.41929	0	1
Environmental Identity	Constructed	Concerning your municipality, would you say that you have ecological concerns/ that you are involved in environmental issues?	559	.4758	.49986	0	1
Place Attachment	Constructed	Concerning your municipality, would you say you are proud to live in it/ that it is a good place for living/ you identify with other inhabitants/ you would regret if you had to move out?	556	.4029	.49092	0	1
Invest Money	Dependent	Do you intend to protect yourself financially against natural risks in the future? How much are you ready to invest per year to insure yourself against potential natural risks?	556	.5827	.49355	0	1

Table 2: The main parts of the interview guide and the individual interviews with stakeholders representing different groups of actors in North Morocco

	Topic	Administration	Scientists	Associations
1	Life in the region and place attachment	Male, 55, Oued Laou	Male, 50, Martil	Male, 60, Tangier
2	Knowledge and history on risk, personal experience and risk memory	Male, 40, Martil	Male, 50, Tetouan	Male, 25, Tetouan
		Male, 60, M'Diq	Male, 30, Tetouan	Female, 35, Tetouan
3	Information, prevention, awareness sessions and risk management	Female, 60, Al Hoceima	Female, 50, Tangier	Male, 50, Al Hoceima
			Male, 35, Tangier	Female, 50, Tetouan
4	Region within the national and international risk policies	Male, 45, Rabat	Male, 30, Al Hoceima	Male, 55, Chefchaouen
		Male, 55, Tetouan	Male, 45, Tetouan	
5	Meaning and use of indicators in risk management	Female, 35, Al Hoceima	Male, 65, Tetouan	Male, 50, Larache
		Female, 40, Rabat		Female, 30, Tangier
				Male, 55, Tetouan

555

560

565

570

Table 3: Binary Logistic model of future precautionary behaviour ('Invest Money' N = 447)

Block	Predictor	-2 Log-likelihood	Nagel kerke R²	χ²	Df	Sig	B	SE	Exp(B)	95% C.I. for Exp(B) Lower	Upper
1		581.371	.058	19.647	7	.006					
	Gender (female = 1)						.050	.202	1.052	.708	1.562
	Age						-.506*	.210	.603	.399	.910
	Education						.652**	.212	1.920	1.266	2.910
	Zone Rif						.245	.338	1.277	.659	2.478
	Zone Med Martil						.146	.317	1.157	.622	2.153
	Urban Sardinia						.486	.387	1.626	.762	3.471
	Rural Sardinia						.640	.367	1.897	.923	3.896
2		566.297	.101	34.720	11	.000					
	Gender						.122	.207	1.130	.752	1.696
	Age						-.447*	.215	.640	.420	.974
	Education						.528*	.219	1.696	1.104	2.605
	Zone Rif						.082	.349	1.085	.547	2.151
	Zone Med Martil						-.006	.329	.994	.521	1.895
	Urban Sardinia						.521	.394	1.683	.777	3.646
	Rural Sardinia						.705	.374	2.024	.972	4.215
	Personal Experience						.397	.219	1.487	.969	2.284
	Precautions Taken						.351	.272	1.420	.834	2.419
	Risk Informed						.170	.207	1.185	.790	1.777
	Risk Sessions						.555**	.212	1.743	1.150	2.642
3		561.319	.115	39.699	16	.001					
	Gender						.130	.210	1.139	.754	1.720
	Age						-.433*	.219	.649	.422	.997
	Education						.459*	.226	1.583	1.016	2.465
	Zone Rif						.068	.351	1.070	.538	2.130
	Zone Med Martil						.008	.333	1.008	.525	1.935
	Urban Sardinia						.780	.429	2.181	.940	5.058
	Rural Sardinia						.743	.390	2.102	.980	4.512
	Personal Experience						.396	.220	1.486	.965	2.290
	Precautions Taken						.374	.275	1.454	.848	2.494
	Risk Informed						.118	.212	1.125	.743	1.704
	Risk Sessions						.539*	.217	1.714	1.121	2.621
	Clim. Change Belief						.181	.496	1.199	.454	3.168
	Trust Science						.147	.222	1.159	.750	1.789
	Trust State						-.410	.270	.664	.391	1.127
	Environm. Identity						.347	.219	1.415	.921	2.173
	Place Attachment						.017	.223	1.017	.657	1.576

Table 4: Verbatim of stakeholders interviewed regarding risk awareness sessions

Administration	Scientists	Associations
"The population is aware of this problem, in any case, the municipalities are obliged according to the law, and municipal charter, and even according to the constitution to raise awareness of the population for the prevention of various risks." (Male, 40, Martil).	"The population is aware of the seismic risk when building, but in the poor area they think economically. Many times there are differences between the built construction and the authorized plan. There is a lack of control, workmanship and quality of the materials used. Everything works economically. [...] Awareness is there, but the illiteracy rate is still high, so we make a great effort to explain to everyone. [...] On the scientific side scientific side we did a lot, but on the outreach side nothing." (Male, 30, Al Hoceima)	"Even the administration does not raise awareness; they arrive after the event to remedy it, but not before to anticipate it. The administration must have the action and emergency plan." (Male, 55, Chefchaouen)
"This question of risk is not a regulatory, institutional or scientific problem, it's a problem of raising people's awareness. The population is not susceptible, it wants to build. Town planners have no experience in raising awareness. Neighbourhood associations have much more experience, and support at neighbourhood level would be more effective. And the fundamental issue is education in schools, it's a pedagogical problem. There is no awareness, so the population does not understand the need to relocate." (Male, 55, Tetouan)	"Unregulated awareness-raising among the population (schools, associations) is useless, it should be in the law. […] People are of course very aware of the risks [...] but when it comes to economic interests, everyone forgets about the risks. The [Martil] valley floods are very well known among the population, everyone knows and yet everyone forgets it when it comes to economic interest." (Male, 30, Tetouan)	"The city does not organise the awareness-raising sessions, but there are nature protection associations and they organise the seminars." (Female, 50, Tetouan)
"The State is well involved, the blue flags, the institutions, ... with specific awareness training, workshops organized, […] But we must not frustrate the people, the people who need special treatment. You don't have to be very direct, you don't even have to communicate the issues to them. So the awareness is there and it should not be overlooked, in addition with the installation of the Fund to fight against natural risks." (Male, 45, Rabat)	"In construction, the responsibility lies with the architect. But not everyone passes by the architect and not everyone meets the standards, even if the architect is there. On the other hand, yes, that poses problems. But this is not due to the wrongdoing, but due to the mentality of the inhabitant himself. I don't think there's awareness among the locals. What we see is that customers want the more space possible." (Male, 65, Tetouan)	"I had no notion of prevention in school. No education, no awareness campaign, nothing, it's useful for people to have this notion that there are risks, it must be in the national education curriculum. For management, the most important is to do a good job, to work. It's not to repeat with each election 'we'll do this, we'll do that', and after 4 years the results will be nothing and the loop will come again 'we'll do this, we'll do that'; it is not the continuation of

		the projects as it is elsewhere, they do not do their job" (Female, 35, Tetouan)
"After the 2004 disaster, half of the population sought help from a psychologist. I myself stayed with my family for 1 month in a tent. […] We work secretly because the population is not interested in public work related to risk, it is the task of the municipality. We did not even communicate the risks to the inhabitants of the cliff." (Female, 60, Al Hoceima)	"I retained by working with the managers in Tangier on the tsunami simulation is that initially […] they will follow up to the goal, that it is enough to make a request, and when D-Day comes they are reluctant and afraid to speak. Managers are afraid to scare tourists and the city's resident population. […] They are afraid that if the tourists look at the tsunami signs in the city that they will think that it is eminent that a tsunami is coming and therefore why bother with the tsunami?" (Female, 50, Tangier)	"I think there are associations that raise awareness about immigrants, but I doubt there are any for natural hazards. I am informed about floods because we had them here, not very big, but when we couldn't get out of our house. Here we don't have a lot of green spaces, only the construction of big buildings everywhere. Awareness is only raised in schools, never by the municipality. The weak points of the city are pollution, a lot of cars, few green spaces and no risk awareness." (Female, 30, Tangier)
"At school, there is no awareness. Even at the mosque, which is a showcase, in the speech of Friday, never a speech on the risks was mentioned. So there's nothing, total absence." (Male, 55, Oued Laou)	"The problem is that people forget, we need more awareness, we need to train people at the institutional level. Everything that worked in theory during the disaster on the spot falls. So the risk culture must be developed. […] Politicians want impact indicators and we cannot yet provide them since it is expensive and because we lack the expertise. For example, recently we have raised awareness in 40 schools, but after all, we do not know the success rate of schooling." (Male, 50, Tetouan)	"Natural hazards, yes, people are aware and informed that this region is seismic. Much the same as with garbage, people know that it's not good. But what do we do? Is this awareness sufficient to change behaviour, attitudes?" (Male, 50, Al Hoceima)

580

585

590

Table 5: Some examples and ideas of constructing dynamic indicators (adapted from Ivčević, 2020c)

Discipline	Hazard Indicators	Vulnerability (pre-disaster)	Impact (response, during disaster)	Resilience (recovery, post-disaster)
Climatology	flooding (frequency, maximum intensity, total rainfall, floodplain inundation)	number of people living in an area at risk (basic indicator of flood exposure), land use and cover	number of households affected	number of people moved out from the area after an educational campaign
Climate change	relative sea-level rise, storm waves effects, significant wave height	beach nourishment and control structures	coastal storm effect and damage on shoreline	nature-based solutions to mitigate the impact of climate change
Geomorphology	coastal erosion rate, sediment budget, coastal slope, distance from the sea	land use and cover as indicator of financial damage	marine erosion, economic valuation of land loss	added value of tourism and of new infrastructure, ecological restauration
Psychology-Sociology	hazard history, last disaster date, recurrence time of earthquake, return interval of floods	risk experience, risk awareness and perception	societal response, risk awareness sessions	changes in attitudes towards precautionary behaviour
Religion	hazard history	information on big earthquake and flood events	risk awareness discussions in the religious institutions	adopting precautionary behaviour in order to protect lives as ethical maxim
Economics-Policy	disaster probability, any	cost-benefit analysis of the actual policy, proportional tax and insurance for more exposed houses	investment or insurance	cost-benefit analysis of the new policy
Rupture of information	Any	individual positions of different risk management stakeholders identified	number of participants and stakeholders in focus group workshops	consensual priorities of all risk management stakeholders identified
Management	any	number of high-school pupils educated on risk, environment and climate change	number of affected pupils	number of resilient pupils (psychological recovery), developed belief in climate change

595