

CHALLENGES TO DEAL WITH CLIMATE CHANGE: ANALYSIS OF FLASH FLOOD RISK PERCEPTION

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El cambio climático requiere en la actualidad del diseño de estrategias que mitiguen los daños en la vida cotidiana de las personas. Una de sus consecuencias más visibles en la península ibérica son las inundaciones, cuya frecuencia e impacto social y económico han aumentado en las últimas décadas. Ello ha llevado a un cambio de paradigma en la gestión del riesgo de inundación en el que la dimensión social adquiere mayor relevancia. En este trabajo se revisan los desarrollos teóricos y empíricos sobre los principales procesos psicológicos relacionados con el riesgo de inundación, enfatizando las aportaciones realizadas desde la Psicología Ambiental, con un objetivo doble. Por un lado, construir un marco conceptual apropiado para el análisis de este riesgo y, por otro, dotar a los profesionales de los recursos prácticos necesarios para hacer frente a problemas que requieran de una intervención psicosocioambiental.

Palabras clave: Riesgo de inundación, Intervención psicosocioambiental, Percepción del riesgo, Adaptación, Comunicación del riesgo.

Climate change requires the designing of strategies that mitigate the damage to people's daily life. One of the most notable consequences of climate change in the Iberian Peninsula is flooding, the frequency and social and economic impact of which have increased in recent decades. As a result, a change of paradigm in flood risk management has been identified, with the social dimension of the disasters acquiring more importance. This paper presents a review of the theoretical and empirical approaches in relation to flood risk, emphasizing the contributions made in the field of environmental psychology. Two main objectives are pursued: to build an appropriate conceptual framework for the analysis of flood risk and to provide professionals in this field with the necessary practical resources to deal with problems that require psycho-socioenvironmental intervention.

Key words: Flood risk, Psycho-socioenvironmental intervention, Risk perception, Adaptation, Risk communication.

Global warming is a reality that will require changes in lifestyle to mitigate its disastrous consequences, posing a challenge for environmental psychologists. Although research on environmental and technological risks in the 20th century was dominated by the process of perception, centered on nuclear energy, the emergence of new types of hazards caused by climate change has gained ground generating greater specialization in risk analysis. Today, the interest of this research goes beyond the behavioral sciences and it has become an aspect of study that is multidisciplinary, multi-process, and focused on the analysis of specific dangers.

Among the dangers caused by climate change, flooding is the most frequent in the world and one of the most destructive and in the future it will be even more so (Bustillos-Ardaya, Evers, &

Ribbe, 2017, Intergovernmental Panel on Climate Change - IPCC, 2015). Of twelve natural disasters between 1998 and 2017, flooding was the most frequent and the one that affected the most people, the fourth most in deaths and the third in economic damage. Furthermore, some human activities have contributed to increase the frequency and severity of floods. Thus, the increasing urbanization of the "flood plains" of rivers and coasts exposes more people to this risk and, together with agriculture, reduces the natural capacity of these plains to retain water (IPCC, 2015). Between 1970 and 2010, the world population living in flood zones has doubled and their urbanization, between 2010-2050, will increase the value of material goods exposed from 46 to 158 trillion dollars (Jongman, Ward, & Aerts, 2012). In Spain, between 2000 and 2017, the flood was the second deadliest natural disaster after "high temperatures"; causing 800 million euros per year in damages (Ministry for the Ecological Transition, 2018). Spain is the most vulnerable country to climate change in Europe and will be one of the most affected in the world by this phenomenon (European Environment Agency, 2017). The phenomenon known as "cold drop" ["gota fría in Spanish] will cause heavy torrential rains and sudden floods in the Mediterranean (Garijo, Mediero, & Garrote, 2018); the rise in sea level will cause the flooding of many beaches and coastal areas, and flood damage on beaches and infrastructure will cause significant economic losses in tourism (Bujosa & Rosselló, 2011). In this regard, the

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World Bank (2010) identified as main factors that are increasing the costs derived from extreme events caused by water, the inadequate preparation towards the risks linked to climate change and the progressive increase of the dangers derived from it in areas prone to suffering its consequences.

With regard to research in the field of flood risk, some authors mention the emergence of a new field called "socio-hydrology", which requires the incorporation of the human dimension in water management and is based on interdependence between people and water. Its objective is to analyze the joint evolution of the interaction between human development and the management of the danger caused by water, including a combination of structural and non-structural measures to reduce the risk of flooding (Sivapalan, Savenije, & Blöschl, 2012). As noted by Fuchs et al. (2017), the analysis of a hydrological hazard and its adverse socioeconomic consequences requires methods and concepts based on both natural sciences (hazard assessment) and social sciences (exposure and vulnerability).

On the other hand, and as recognized by the various IPPC reports, climate change is generating a dynamic risk in that changes in the frequency of floods are becoming unpredictable, making a wide range of responses necessary to potential and diverse scenarios. In this context, risk management cannot be based, as it has been up to now, on static and rigid measures that create a false appearance of security for the people affected, but instead a holistic and integrated approach must be adopted, addressing research and practice of various topics (water resources, climate change, perception and communication, etc.) in an interdisciplinary manner. This approach includes the social dimension of risk, whose importance for the management of the risk of natural and technological disasters has been addressed, for decades, by sociologists, psychologists, and geographers (Lara, Saurí, Ribas, & Pavón, 2010; Slovic, 2000; Tierney, 2014). For example, it is important to consider the psychological processes of coping with the flood risk for residents in flood zones because these processes influence their decision as to whether or not to adopt preventive measures or to execute inappropriate behavior (González-Gaudiano, Maldonado-González, & Cruz-Sánchez, 2018).

This work describes, from the perspective of environmental psychology, some of the psychological and behavioral processes most analyzed by the recent literature in relation to risks in general and, specifically, flood risk. Processes such as risk perception, flood adaptation, and communication are essential to carrying out effective flood risk management. Also, a methodological proposal is presented for implementing interventions in this field that allow multidisciplinary collaboration among the agents involved.

RISK PERCEPTION IN ENVIRONMENTAL PSYCHOLOGY

From the point of view of environmental psychology, the perception of the risk of certain environmental events is of particular interest in that natural hazards such as earthquakes or floods and others derived directly from human behavior (e.g.

industrial pollution) have direct repercussions on individuals. In the late 1960s talk began about risk perception due to social opposition to nuclear energy. This concept began to gain popularity in the public sphere and within different disciplines of study, moving from a conception based on objective risk to one more related to social aspects. With regard to the social perception of risk, different theoretical approaches can be identified that are ascribed to three main approaches (Puy & Cortés, 2010):

- ✓ Individual-centered focus. This includes studies related to biases and heuristics (Kahneman, Slovic, & Tversky, 1982), such as the availability heuristic, which establishes that people consider risk according to their recent memory. Within this approach there are also theories about decision making and mental models. The former are linked to the proposal of Kahneman and Tversky (1979), according to which individuals value whether an event is a risk or not depending on the uncertainty and the gains/losses associated with it. Alhakami and Slovic (1994) and Finucane, Alhakami, Slovic, and Johnson (2000) add that the risk assessment is influenced by the affect heuristic, observing that, by manipulating the feeling with respect to a danger, the inference about the risk or benefit of the danger appears to be modified. On the other hand, this approach includes mental models, defined as intuitive theories that people build, maintain over time, and use in decision-making processes, which can lead, if they contain critical errors, to erroneous conclusions even in well-informed people (Fischhoff, Bostrom, & Quadrel, 1993). According to Binder and Schöll (2010), mental models are used mainly to know the differences between laymen and experts, identifying erroneous ideas when developing communication strategies. Finally, from this perspective, the psychometric model proposed by Fischhoff, Slovic, Lichtenstein, Read, and Combs (1978) is identified, which considers that the social perception of risk is a complex and multidimensional process and proposes a model composed of different factors. According to the psychometric approach, the perception of risk is linked to two aspects: the fear of impact (related to the control of the risk or the fatality of the consequences, among other aspects) and the knowledge of the risk (novelty and / or inexperience).
- ✓ Approach linked to the individual and society. This groups the values, beliefs and attitudes that people have. This perspective emphasizes the perception of risk as a process dependent on qualitative factors related to social priorities and/or attitudes towards technologies (Van der Pligt, Eiser, & Spears, 1986). Slimak and Dietz (2006) propose a causal model in which the perception of risk is influenced by values and general beliefs regarding the environment, as well as by religious and spiritual conceptions. The results show differences between lay people and experts, suggesting that the former are more concerned about less probable dangers that have more serious consequences (e.g. sewage or radiation); while experts are more concerned about risks with global consequences, such as global warming. These authors con-

clude that individual values may have the power to explain how a person perceives risk.

- ✓ **Community-focused approach.** This places the emphasis on social groups and different institutional bodies, which focus and emphasize the estimation of certain risks through communication strategies. The cultural theory of risk, developed by Douglas (1985), explains the influence of values and cultural aspects on the perception of risk and proposes that individuals are immersed in a social structure that will form their values, attitudes, and way of seeing the world. Finally, from the social point of view, one can speak of “myths of nature” (Dake, 1992), or ideas constructed socially on nature and internalized by the members of society. Thus, it could be said that the perception of risk is a socially created construct to maintain the patterns of social relationships within each culture.

FRAMEWORKS OF ANALYSIS ON THE RISK OF FLOODING

Kellens, Terpstra, and De Maeyer, (2013) carried out an exhaustive review of the scientific literature on flood risk, concluding that the vast majority of the analyzed works are exploratory in nature, making it practically impossible to carry out a theoretical and methodological systematization of the research carried out in this field. These authors analyzed a total of 57 articles, in which they identified variables related to the perception of risk (causes, impact, knowledge, probability, etc.); behavioral variables (preparation, evacuation, mitigation, etc.) and other important variables, such as sociodemographic variables, previous experience, personality (locus of control), and situational variables (distance from the house to the river, elevation on the ground, etc.). Given the large number of variables and the few attempts at systematization in the literature, this section will attempt to shed some light on the main psychological processes associated with flood risk research.

Inspired by the reviews of Kellens et al. (2013) and Bubeck, Botzen, and Aerts (2012), Figure 1 shows graphically the main psychological processes involved in flood risk assessment, which feed back into each other.

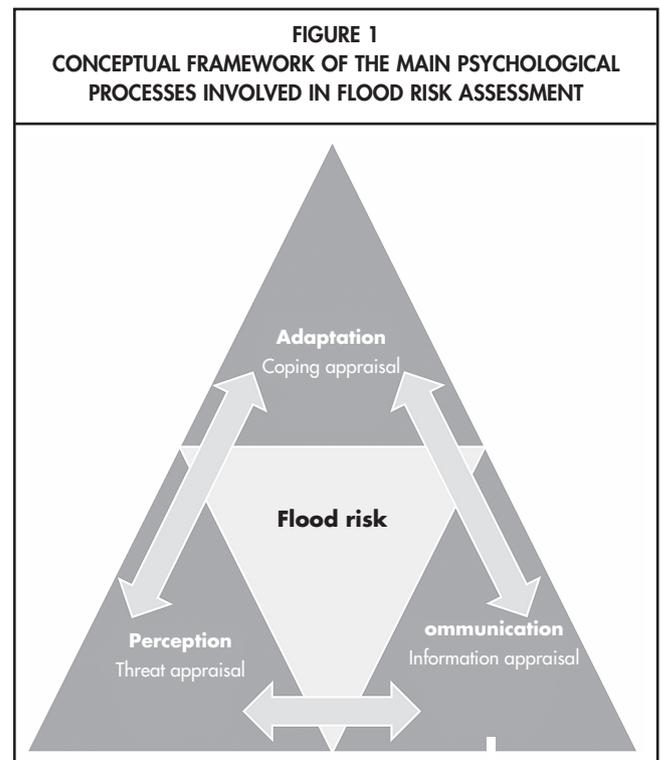
First, there are the processes related to the evaluation of a possible flood (threat appraisal), grouping variables related to the probability of suffering a flood (perceived vulnerability) and the evaluation of its possible consequences (perceived severity) (Bubeck et al., 2012), both encompassed under the label “perception of flood risk”. Secondly, the adaptive behaviors aimed at reducing the impact of the flood are included, which are determined by the coping appraisal that people make in relation to the danger of the flood and the resources they have to deal with it (Terpstra & Lindell, 2013). Finally, the risk communication process is analyzed, characterized by scarce empirical research.

Perception of flood risk

As noted by Kellens et al. (2013), the application of the psychometric paradigm led to the obtaining of different results on the perception of flood risk in countries that suffer floods

periodically. For example, these authors point out a higher perceived risk among Chinese compared to Dutch citizens, concluding that personal experience is a relevant variable. Bubeck et al. (2012) also point to this variable as decisive in the recognition of risk and its explanatory power over the execution of some protective behaviors. Also, the research of Luís et al. (2016) on coastal risks, shows that a constant exposure to risk can lead to normalization processes, causing an excess of confidence in the protective measures to prevent it, reducing the perception of its occurrence, and creating citizens that are less adapted to cope with it.

The emergence of the analysis of cognitive processes in the evaluation of environmental problems has led to the identification of certain biases that affect the perception of risk, providing a greater development in research on the effect of heuristics in the processing of information. For example, due to the effect of “environmental hyperopia” (Uzzell, 2000), people assign more seriousness to an environmental problem the further away they are. Schultz et al. (2014) found, in 22 different countries, that the severity of environmental problems was greater when they were evaluated globally compared to the nearest local one. For these authors, this result is caused by the bias of psychological distance, explained by construal level theory (CLT, Liberman & Trope, 2008). According to CLT, the interpretation of the surrounding reality is more abstract (high-level construal) the further it is from the perceiver according to four dimensions: geographical or spatial, temporal, social, and hypothetical. As the reality becomes closer geographically or in time, it affects people we know, and deals with probable facts,



the interpretation of that reality becomes more concrete and detailed (low-level construal), reducing the space between subjective and objective reality. The results obtained by Bodoque, Díez-Herrero, Américo, García, and Olcina (2019) on the perception of flood risk by the residents of a Spanish town prone to floods, support the bias of psychological distance in its spatial and temporal dimensions. In addition, in a subsequent investigation (Guardiola-Albert et al., in review), it was obtained that the relationship between the geostatistical estimate of the distance from the home to the flood zone (objective reality) and the perception of flood risk of one's home (perceived vulnerability) followed a congruent pattern when the psychological distance of the flood risk was low in terms of time (low-level construal). However, this relationship congruent with the objective situation did not occur when the perception of long-term risk (high-level construal) was evaluated.

Responses to flood risk: Adaptation

A large number of works contemplate behaviors aimed at adapting to the life cycle of the flood (Kellens et al., 2013), that is, those carried out before (mitigation), during (preparation), and after (recovery). The first two are aimed at limiting the adverse impact of the flood; however, mitigation behaviors are carried out when there is no danger yet, while preparation behaviors are carried out just before the start of or during the flood. Thus, as Kellens et al. (2013) it is possible to distinguish between passive protective behaviors, mitigation behaviors (for example, getting hold of a first aid kit), and active protective behaviors, in preparation (for example, cutting off electricity, gas and/or water supplies). The execution of both behaviors, or the intention to carry them out, is determined by the knowledge that one has of them and the perceived efficacy of their ability to avoid (or mitigate) the adverse effects of the flood. Among the mitigation measures there is risk communication aimed at promoting the performance of these behaviors, which will be discussed later. In addition to communication, there are other behaviors that could be classified as "hard intervention measures" (infrastructure, technology) or "soft intervention measures", such as civil protection plans or communication strategies designed by public administrations (Bustillos-Ardaya et al., 2017).

With regard to recovery, adaptive measures can be taken to try to return to the situation prior to the flood as soon as possible, such as requesting financial compensation from public administrations, which helps the individual to manage the situation of properties affected after the flood (Kellens et al., 2013).

As mentioned above, the performance of mitigation and preparation behaviors will depend on their perceived efficacy. Studies focused on risk perception as a means of promoting these behaviors, which assume a positive relationship between the two variables, do not seem to be supported by a theoretical or empirical foundation (Bubeck et al., 2012). These authors point out other intervening factors such as the motivation towards self-protection. Protection motivation theory (PMT) has

been applied to analyze adaptive behaviors against natural risks. These are grouped under the label of "coping appraisal" (see Figure 1) and refer to the evaluation that affected individuals make of the costs of executing them and their beliefs about their efficacy and ability to execute them. Close to this approach would be the preventive action decision model (PADM). According to the PADM, people exposed to a risk seek, select, and adopt certain adaptive behaviors based on a series of beliefs about them (coping appraisal) that are classified into two groups: those referring to danger and those referring to resources. The first relate the danger to adaptation to it, with three types distinguishable: beliefs about the perceived efficacy of these behaviors to protect people, about their perceived efficacy to protect properties, and about their adaptive utility for other purposes. The second ones relate adaptation to danger with beliefs about the resources necessary to cope with it, such as costs, money, time, and effort derived from the execution of those behaviors; knowledge and skills concerning them; tools and equipment necessary to execute them, and the cooperation of other people to adapt to the danger. The PADM predicts that high levels of beliefs about the effectiveness of adaptive (preventive) behaviors to protect people and properties from danger will involve the adoption of protective behaviors or the intention to perform them; while high levels of beliefs regarding resources will reduce such behaviors (Terpstra & Lindell, 2013). The application of this model to analyze the decision to adopt preventive behaviors against flood risk in Dutch citizens (Terpstra & Lindell, 2013), confirmed the first of the predictions but not the second; no negative relationship was found between the beliefs related to the necessary resources (costs) and the intention to adopt preventive actions. The results of this work showed the importance of the variables related to the assessment of coping, since they were much more predictive of the intention to adopt preventive actions than the risk perception. Terpstra and Lindell (2013) note the consistency of this result with the theory of reasoned action (Fishbein & Ajzen, 1975), since the attitude towards an object (risk of flooding) is less predictive of behavior than the attitude towards an action (adaptation to flood risk).

Communication of flood risk

As mentioned by Kellens et al. (2013), the importance of risk communication when it comes to reinforcing awareness and motivating the affected people to carry out preventive actions is now widely recognized. Likewise, knowing how people cope with risks allows us to design more effective communication strategies. These authors summarize the various definitions of the communication process, considering them as an intentional exchange of information about environmental or health risks between interested agents (individuals, groups, or organizations). The authors note that during the last two decades there has been "a change in the emphasis of risk communication, from a pedagogical approach to deliberation, dialogue and public participation" (Kellens et al., 2013, p.26). However, empirical research on the influence of flood risk



communication is scarce, since of the total number of articles reviewed by these authors, only two dealt specifically with the communication process, although many of the reviewed works did make recommendations on this matter. Among the notable results, they highlight the “unexpected” scarce influence of communication on the perception of flood risk. These results were also obtained, although with nuances, in the study developed by Bodoque et al. (2019), since the execution of a communication strategy for flood risk did not increase the risk perception among citizens who evaluated it in the short term, but it did so when the probability of suffering a flood was evaluated throughout life, confirming the bias of the temporal distance. What was clearly shown was that the communication of risk increased the level of knowledge of the civil protection plan on sudden floods in the municipality, making citizens more competent to deal with them. These results, in line with what was mentioned in the previous section on the coping appraisal, allow us to conclude that a communication strategy should be based on information about the effectiveness of measures to mitigate the flood along with a practical guide on how to implement them (Bubeck et al., 2012), thus improving their perceived efficacy in the affected population. In any case, most studies do not provide practical recommendations on specific strategies for effective flood risk communication, and more research on this is necessary.

PSYCHOSOCIAL-ENVIRONMENTAL INTERVENTION WITH POPULATION AT RISK OF FLOODING: THE CASE OF NAVALUENGA

Following the conceptual framework described in Figure 1, the following is a methodological proposal whose objective is to serve as a guide for the design of psychosocial-environmental interventions in this area. It takes into account the processes of perception, adaptation, and communication of risk, integrated into three stages of intervention (see Figure 2).

The methodological proposal is accompanied and illustrated with a case applied to the municipality of Navaluenga (Ávila, Spain) that suffers sudden floods relatively frequently. The psychosocial-environmental intervention was carried out between February 2015 and January 2016. The results derived from it are presented in detail in the works of Amérigo et al., (2017) and Bodoque et al. (2016, 2019).

From the proposal shown in Figure 2, each of the three stages is specified in a series of: objectives, tasks to be carried out, relevant inputs, and expected outputs, which serve as a starting point for the following stages or allow us, ultimately, to evaluate the effectiveness of the intervention.

Stage 1. Pre-intervention evaluation

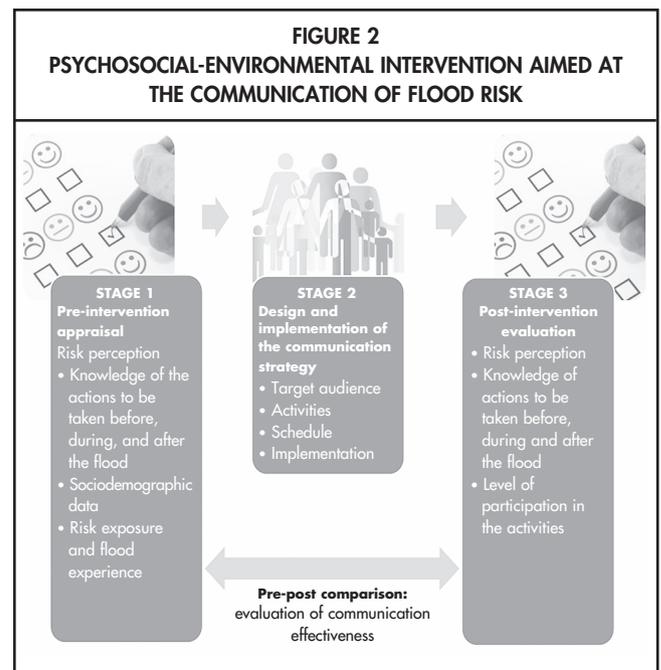
The main objective of this stage is to analyze the participants’ perception of flood risk, as well as their knowledge of the actions to be taken before, during, and after the flood (adaptation). In addition, it is essential to evaluate differences in these variables according to sociodemographic characteristics, exposure to the flood zone, and previous experience with floods. The main task

to develop in this stage is the designing of a questionnaire and its subsequent administration to a representative sample of the population under study. For this, one of the relevant inputs comes from secondary information available, among which it is worth mentioning the hydrographic studies and the municipal civil protection plan, if there is one.

In the case of Navaluenga, a questionnaire was designed and administered personally to a representative sample of 254 residents selected by means of a quota sampling according to sex and age. Four items were included to measure the perception of flood risk in the municipality/household in the short/long term (next 5 years/throughout life). To measure the knowledge of the appropriate actions to be taken in the three phases of disaster (before, during, and after the flood), the respondents were asked if they knew what (actions) they should implement in each phase and they were asked to mention them. Their answers were contrasted with the actions included in the civil protection plan (CPP). The percentage of correct mentions (coinciding with the CPP) indicated the level of knowledge of the respondent about the actions that should be carried out in each phase of the flood. The analyses carried out allowed us to identify which population groups had high, medium, and low risk perception and adaptation, respectively, as well as to characterize them according to the sociodemographic and exposure variables.

Stage 2. Design and implementation of the communication strategy

In this second stage, the psycho-socio-environmental communication strategy designed is implemented. Its main objective is to increase the participants’ knowledge about floods and about the flood risk in their municipality, as well as the



knowledge necessary to increase the resilience of the population in the event of possible flood events. The main tasks to be developed are: (1) to identify the priority population groups that will constitute the target public of the communication strategy; (2) to design a program of activities that adequately communicate the flood risk and increase knowledge of adaptation actions; (3) to establish a schedule to distribute these actions; and (4) to implement it, conveniently controlling the development of each of the proposed activities. The main input for this stage comes from the analysis of the information obtained in the previous stage, since it will be essential to know the general levels of perception and adaptation prior to the intervention, as well as the differences between the different segments or population groups.

In the case presented, a one-month flood risk communication strategy was designed, aimed especially at those Navaluenga population groups that, although potentially exposed to a flood, did not perceive the risk as expected or they did not have the necessary knowledge to implement adaptation actions. Specifically, during the month of November 2015, four types of activities were carried out: (1) an informative talk about floods consisting of an oral presentation; (2) a question-and-answer competition on the different contents of the CPP that was publicized through the website of the town hall, informative posters, and email; (3) a contest of stories, photographs and videos about past floods, publicized through the website of the town hall and informative posters; and (4) intergenerational workshops in which the older population and young people exchanged their experiences related to the floods. For each activity, the priority target audience was defined, as well as the specific communication tools to be used, and the expected results. In addition, a follow-up was carried out by the research team as well as control of the development of the activity and assistance.

Stage 3 Post-intervention evaluation

The main objective of this stage is to evaluate the changes in the perception of risk and knowledge about flood adaptation behaviors, which allows us to quantify the effectiveness of the communication strategy, and to provide feedback on future interventions. This evaluation should be carried out repeatedly at different times after the intervention, in order to identify the effectiveness of the intervention strategy not only in the short term, but also in the medium and long term. These follow-up evaluations allow us to know if the short-term changes (in perception and knowledge) produced in the short term become structural in the medium and long term or dissipate with the passage of time. The tasks to be performed in this case are the design and administration of a new questionnaire to incorporate, in addition to the variables of the first questionnaire, questions that allow us to control the level of participation or exposure of each of the subjects surveyed to the different activities that make up the communication strategy. At this stage, it will be necessary to identify the subjects who participated in the pre-intervention evaluation (Stage 1) to re-

survey them and, in this way, to be able to make the pre-post comparisons.

A short-term post-intervention evaluation was carried out one month after the communication strategy, with a return to survey of almost 80% of the initial participants. To locate them, we used their residence address and the last numbers and the letter of their national identity document. Only two out of ten respondents did not know or participate in the communication strategy. The results obtained showed: (1) a significant increase in the perception of lifetime flood risk in Navaluenga; and (2) an increase in knowledge about the appropriate actions to be taken in a flood in those who participated in the communication strategy. These results show that adequately informing the population about the flood risk to which it is exposed contributes to making it more competent to deal with it. However, a priority area for future interventions is detected, since the perception of short-term risk has not increased for the municipality as a whole or for the household, perhaps as a consequence of the temporal distance bias.

CONCLUSIONS

This article has attempted to satisfy a current demand among flood risk managers about the need to include the human dimension, the processes for intervention in people before the arrival of a flood or its possible appearance, incorporating non-structural measures that improve its management. The traditional way of approaching the danger of flooding by seeking solutions of a structural nature, such as dredging and/or diversion of rivers and the construction of dams or retaining walls has proved ineffective in the face of the frequency and virulence that, as a result of climate change, increasingly characterizes this environmental danger. As noted by Kellens et al. (2013), the traditional approach in the evaluation of risk that differentiated between the scientific vision, based on probabilities and estimates of losses; and the legal vision, based on the "over/underestimation" of risk, has evolved in the last two decades towards a bidirectional communication necessary between managers and the public, demanding the need to take into account the public's values, preferences, and motivations to develop effective risk management (González-Gaudiano, et al., 2018).

These conclusions have been shown through the results that the Research Group of Environmental Psychology of the University of Castilla-La Mancha (UCLM) has obtained over the past 6 years through research developed jointly with the Geological and Mining Institute of Spain and the Faculty of Environmental Sciences of the UCLM. In them, in addition to advancing in basic research, it has been found that civil protection plans, developed unidirectionally by experts in flood risk management, could be greatly improved in efficacy if they took into account the recommendations of environmental psychologists and other social scientists based on their investigations.

CONFLICT OF INTERESTS

There is no conflict of interest.

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