

# Natural Hazards and Disaster Risk Reduction Policies

**Loredana Antronico - Fausto Marincioni**  
**Editors**





# Geographies of the Anthropocene

OPEN  
ACCESS



PEER-REVIEWED  
SERIES

ISSN 2611-3171

## Geographies of the Anthropocene

Open Access and Peer-Reviewed series

**Editor-In-Chief:** Francesco De Pascale (CNR – Research Institute for Geo-Hydrological Protection, Italy).

**Co-Editors:** Marcello Bernardo (Department of Culture, Education and Society, University of Calabria, Italy); Charles Travis (School of Histories and Humanities, Trinity College Dublin; University of Texas, Arlington).

**Editorial Board:** Mohamed Abioui (Ibn Zohr University, Morocco), Andrea Cerase (INGV Tsunami Alert Center, Italy; Department of Social Sciences and Economics, Sapienza University of Rome, Italy), Valeria Dattilo (University of Calabria, Italy), *Chair*, Dante Di Matteo (“G. d’Annunzio” University of Chieti-Pescara, Italy); Jonathan Gómez Cantero (University of Alicante, Spain; Young Scientists Club, IAPG), Nguvulu Chris Kalenge (University School for Advanced Studies IUSS Pavia, Italy), Battista Liserre (Aix-Marseille University, Campus ESSCA, France), Alessandra Magagna (University of Turin, Italy), Carmine Vacca (CNR-ISMAR, Venice, Italy).

**International Scientific Board:** Marie-Theres Albert (UNESCO Chair in Heritage Studies, University of Cottbus-Senftenberg, Germany), David Alexander (University College London, England), Loredana Antronico (CNR – Research Institute for Geo-Hydrological Protection, Italy), Lina Maria Calandra (University of L’Aquila, Italy); Salvatore Cannizzaro (University of Catania, Italy), Fabio Carnelli (University of Milano-Bicocca, Italy); Carlo Colloca (University of Catania, Italy), Roberto Coscarelli (CNR – Research Institute for Geo-Hydrological Protection, Italy), Sebastiano D’Amico (University of Malta, Malta), Armida de La Garza (University College Cork, Ireland), Elena Dell’Agnese (University of Milano-Bicocca, Italy; Vice

President of IGU), Piero Farabollini (University of Camerino, Italy), Giuseppe Forino (University of Newcastle, Australia), Cristiano Giorda (University of Turin, Italy), Giovanni Gugg (University of Naples “Federico II”, Italy, University of Nice Sophia Antipolis, France), Luca Jourdan (University of Bologna, Italy), Francesca Romana Lugerì (ISPRA, University of Camerino, Italy), Fausto Marincioni (Marche Polytechnic University, Italy), Cary J. Mock (University of South Carolina, U.S.A.; Member of IGU Commission on Hazard and Risk), Francesco Muto (University of Calabria, Italy), Gilberto Pambianchi (University of Camerino, Italy; President of the Italian Association of Physical Geography and Geomorphology), Silvia Peppoloni (Istituto Nazionale di Geofisica e Vulcanologia, Italy; Secretary General of IAPG; Councillor of IUGS), Isabel Maria Cogumbreiro Estrela Rego (University of the Azores, Portugal), Andrea Riggio (University of Cassino and Southern Lazio, Italy; President of the Association of Italian Geographers), Bruno Vecchio (University of Florence, Italy), Masumi Zaiki (Seikei University, Japan; Secretary of IGU Commission on Hazard and Risk).

**Editorial Assistant, Graphic Project and Layout Design:** Franco A. Bilotta;

**Website:** [www.ilsileno.it/geographiesoftheanthropocene](http://www.ilsileno.it/geographiesoftheanthropocene);

The book series “Geographies of the Anthropocene” edited by Association for Scientific Promotion “Il Sileno” (Il Sileno Edizioni) will discuss the new processes of the Anthropocene epoch through the various worldviews of geoscientists and humanists, intersecting disciplines of Geosciences, Geography, Geoethics, Philosophy, Socio-Anthropology, Sociology of Environment and Territory, Psychology, Economics, Environmental Humanities and cognate disciplines.

Geoethics focuses on how scientists (natural and social), arts and humanities scholars working in tandem can become more aware of their ethical responsibilities to guide society on matters related to public safety in the face of natural hazards, sustainable use of resources, climate change and protection of the environment. Furthermore, the integrated and multiple perspectives of the Environmental Humanities, can help to more fully understand the cultures of, and the cultures which frame the Anthropocene. Indeed, the focus of Geoethics and Environmental Humanities research, that is, the analysis of the way humans think and act for the purpose of advising and suggesting

appropriate behaviors where human activities interact with the geosphere, is dialectically linked to the complex concept of Anthropocene.

The book series “Geographies of the Anthropocene” publishes online volumes, both collective volumes and monographs, which are set in the perspective of providing reflections, work materials and experimentation in the fields of research and education about the new geographies of the Anthropocene.

“Geographies of the Anthropocene” encourages proposals that address one or more themes, including case studies, but welcome all volumes related to the interdisciplinary context of the Anthropocene. Published volumes are subject to a review process (**double blind peer review**) to ensure their scientific rigor.

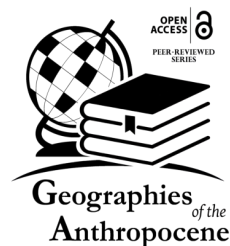
The volume proposals can be presented in English, Italian, French or Spanish.

The choice of digital Open Access format is coherent with the flexible structure of the series, in order to facilitate the direct accessibility and usability by both authors and readers.

# Natural Hazards and Disaster Risk Reduction Policies

Loredana Antronico  
Fausto Marincioni  
*Editors*

IL Sileno  
Edizioni



“Natural Hazards and Disaster Risk Reduction Policies”,  
Loredana Antronico, Fausto Marincioni (Eds.)  
is a volume of the Open Access and peer-reviewed series  
“Geographies of the Anthropocene”  
(Il Sileno Edizioni), ISSN 2611-3171.

[www.ilsileno.it/geographiesoftheanthropocene](http://www.ilsileno.it/geographiesoftheanthropocene)

*Cover:* A woman shovels mud from her driveway in the aftermath of the October 2010 debris flow that affected the Province of Vibo Valentia (Calabria, southern Italy).

Copyright © 2018 by Il Sileno Edizioni  
Scientific and Cultural Association “Il Sileno”, C.F. 98064830783.  
Via Pietro Bucci, Università della Calabria, 87036 - Rende (CS), Italy.

This work is licensed under a Creative Commons Attribution-NonCommercial-NoDerivs  
3.0 Italy License.



The work, including all its parts, is protected by copyright law. The user at the time of downloading the work accepts all the conditions of the license to use the work, provided and communicated on the website  
<http://creativecommons.org/licenses/by-nc-nd/3.0/it/legalcode>

ISBN 978-88-943275-2-6

*Vol. 1, No. 2, December 2018*



# CONTENTS

<i>Preface</i>	8
<i>Introduction</i>	11

## Section I

### *Disaster Risk Perception*

1. Environmental perceptions: participatory methodologies for the assessment of social vulnerability to floods in two communities in Mexico  
*Gustavo Manuel Cruz-Bello, Miriam Alfie Cohen* 16
2. The urban political ecology of flood vulnerability in the core area of Ibadan Metropolis, Nigeria  
*Rafiu O. Salami, Jason von Meding, Helen Giggins* 36
3. People, places and volcanoes. A study on risk perception in the Azores (Portugal)  
*Isabel Estrela Rego, Sofia Morgado Pereira, Mariana Paim Pacheco* 51
4. Geographical and historical processes of human settlements in the Etna Region. A person-place relation approach  
*Salvatore Cannizzaro* 69
5. Humankind and Risk: a difficult history  
*Piero Farabollini, Francesca Romana Lugeri, Nicola Lugeri* 88

## Section II

### *Disaster Planning and Management*

6. Anthropology of the Vesuvius Emergency Plan: history, perspectives and limits of a dispositive for volcanic risk government  
*Giovanni Gugg* 105

7. Inclusive Disaster Planning. Evidences from municipal case studies in the Marche Region, Italy  
*Beatrice Gatto, Susanna Balducci, Fausto Marincioni* 124
8. Post-disaster dynamics in inner areas. An Italian hypothesis for transition management  
*Nora Annesi, Annalisa Rizzo, Matteo Scamporrino* 141
9. Increase social and physical resilience to disaster through post-disaster planning: The case of Cascia Municipality *Federica Appiotti, Mattia Bertin, Francesco Musco* 159

### **Section III**

#### ***Disaster Mitigation and Preparedness***

10. UNESCO Global Geoparks: living laboratories to mitigate natural induced disasters and strengthen communities' resilience  
*Charalampos Fassoulas, Mahito Watanabe, Irina Pavlova, Alessia Amorfini, Edoardo Dellarole, Florian Dierickx* 175
11. Information instead of fatalism: a proposal of a strategy to inform on disasters  
*Jon Cadierno Gutierrez, Justino Losada Gómez* 198
12. Re-assessing the role of communication in the aftermath of a disaster: case studies and lesson learned  
*Andrea Cerase* 213
13. Traditional flood mitigation measures in Mallorca *Miquel Grimalt, Joan Rossello* 243
14. Risk, hazard and disaster in India: a perspective from law and governance  
*Binod Kumar* 261

***The Authors*** 276



# **1. Environmental perceptions: participatory methodologies for the assessment of Social Vulnerability to floods in two communities in Mexico**

*Gustavo Manuel Cruz-Bello<sup>1</sup>, Miriam Alfie Cohen<sup>2</sup>*

## **Abstract**

This chapter introduces two participatory methodologies in order to obtain environmental perceptions and assess the vulnerability and adaptation strategies in two localities prone to floods due to cyclones and heavy storms in Mexico. The first methodology corresponds to a modification of the one proposed by the National Commission of Protected Areas in Mexico and the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) that helps to collect community perceptions about climate change. The second one is a participatory mapping approach that helped to collaboratively map out affected households, measures taken by the community to reduce disturbances and the proposed actions to be taken in the future to reduce their vulnerability. The case studies correspond to two communities, one located in the northwest of Mexico and the other located to the southeast of the country. Experts of “Protección Civil”, the agency in charge of disaster risk management, reviewed the results of both participatory methodologies implemented through workshops. All the results were given back to both communities. When combined, the products of the participatory methodologies enabled the population to discuss, propose activities and negotiate with the three levels of governmental authorities in charge of risk management and vulnerability reduction to be able to handle extreme hydro-meteorological events in a better fashion.

---

<sup>1</sup> *Corresponding author.* Department of Social Sciences, Universidad Autónoma Metropolitana Unidad Cuajimalpa. Avenida Vasco de Quiroga 4871, Col. Santa Fe, Cuajimalpa de Morelos, C.P. 05348, Mexico City, Mexico, e-mail: gcruz@correo.cua.uam.mx.

<sup>2</sup> Department of Social Sciences, Universidad Autónoma Metropolitana Unidad Cuajimalpa. Avenida Vasco de Quiroga 4871, Col. Santa Fe, Cuajimalpa de Morelos, C.P. 05348, Mexico City, Mexico, e-mail: miralfie@gmail.com.

**Keywords:** Environmental perception, climate change, semi-participatory GIS, floods, vulnerability reduction.

## 1. Introduction

The study of the relationship between society and nature has been approached from various disciplines and theoretical movements. This reciprocal relationship implies the way in which human beings have transformed nature, but also how the latter influences and determines humanity's way of life. The analysis can include points of view from disciplines like biology, ecology, physics, chemistry, and the social sciences. As a result of the failure to achieve agreements on emission reductions since the Copenhagen Climate Summit in 2009 (COP 15), social sciences have focused on the study of the environment, as a new approach to explain the influence of human actions on climate change, and understand the social dimensions of human responses to climate variability (Heyd, 2010). It is about studying the relationships between human society and the environment that surrounds it. Social sciences have tried to integrate an approach to understand the perception that individuals have in relation to their environment and the actions they take in consequence (Ramos *et al.*, 2011). As climate change has become a growing threat, efforts to understand more precisely how the climate is changing, as well as the impacts of these changes on natural and social systems have multiplied. The search for mitigation and adaptation solutions of a technological, social, economic and environmental nature has also increased. Therefore, from the social sciences perspective, individual and institutional responses have received special attention. The nodal point is to try to comprehend the processes of interaction between the society and their environment (Oltra *et al.*, 2009).

In the context of the current trends in social sciences, it is essential and relevant to talk about the communities' perceptions about climate change, because attitudes towards climate variability, mitigation and adaptation might have a significant influence on the development and success of political programs, as well as on individual actions related to the preservation of the environment. Comprehend the public's engagement in climate change policy have become a subject of interest in social sciences, as well as within public authorities and private organizations (Oltra *et al.*, 2009). The main issue is understanding how the climate variability has permeated and transformed community lives, their economic activities, their social relationships and their interaction with the environment (Martinez-

Alier, 2006). A new environmental culture, values and behaviors can be addressed through a systematic study of the so-called social perceptions. As Lefebvre (1991) pointed out, the relationship between human beings and their environment is a reflection of their environmental perceptions.

In this chapter, we present two different, but complementary participatory methodologies applied in two communities of Mexico for the assessment of social vulnerability to climate change, understanding this as the people's potential for loss (Cutter, 2006). In this context, we tried to understand how communities use their knowledge about the climate variability and the implications in their territories and activities in the adaptation and vulnerability reduction processes.

First, the perceptions-based methodology focuses on individual and collective knowledge and is concerned about climate variability and climate change. We tried to understand the ways in which each community values its environment and the actions they have taken on the matter. Several authors, including Berkes *et al.* (2000), Heyd (2011) and Vander Molen (2011) state that perceptions attribute qualitative characteristics to environmental assets through references stemming from specific cultural and ideological systems, constructed and reconstructed by the social group; this in turn, allows to generate evidence about conservation practices in their territory.

The second one is a participatory mapping approach for knowledge co-production where environmental perceptions, in a spatial context, are obtained to engage the community in the decision-making process of risk management and vulnerability reduction.

The assessment of vulnerability at the local level allows for greater understanding of the impacts of climate change in specific contexts. At the community level, there is recognition that the planning and implementation of adaptation strategies are intimately linked with culture, social values, risk perception and local characteristics. That recognition can improve decision-making, socio-cultural contexts and community expectations. Local cultures would deal differently with climate change and this may have an influence in concrete practices (Soares and García, 2014).

Therefore, local and traditional knowledge systems, practices and perceptions are important sources of information to define improved adaptation strategies (IPCC, 2007). We appreciate community involvement towards self-management and adaptation as the key to reduce vulnerability to climate change. According to Van Aalst *et al.* (2008), the bottom-up approach has the advantage of using actual observation of current climate impacts and the way communities respond. In this research, the concept of "community-based adaptation" is core. It can be defined as "a guided

process by communities based on their priorities, needs, knowledge and ability to empower people to plan and cope with the impacts of climate change " (SEMARNAT, 2012: 34).

### *1.1. Environmental perception*

Perceptions are part of the process linked to environmental education where consciousness plays an important role (Borroto *et al.*, 2011). Therefore, perceptions are conditions, attitudes and sensitivities that influence the actions and regulations that human beings build on their environment. Perceptions reflect the consciousness of human beings about objects or phenomena of the environment that surrounds them, where sensations play a privileged role.

When a group is elicited to express their perceptions on environmental problems, it is essential to understand their environmental vision, their responsibility toward the surroundings, their attitude and the decisions they make when dealing with the various difficulties they face, as well as the opportunities of changing the environmental-cultural education that they may have. Perceptions are useful in exploring how people are exposed to climate change impacts and in what ways these affect their wellbeing. In this scenario, research on the various levels of knowledge and perceptions of climate dynamics and climate change, has been increasing in the last ten years around the world (specially in Latin America), as well as the acknowledgement of the knowledge base, beliefs and practices of the local communities. These factors contribute not only to fill the gaps in scientific information, but also to prepare the way in the design of mitigation and adaptation measures to the changing climate that are feasible from their cultural point of view (Correa, 2011).

In addition to the aforementioned, perceptions are measurements or estimates of the state the environment holds. It is an intersubjective evaluation of these conditions that includes a personal assessment of the quality of the environment, based on environmental factors to which human systems attribute certain significant values including economic, social, aesthetic and ethical aspects (Gallopín, 1986).

Perception are opinions, beliefs, values and norms to preserve lifestyles with the possibility of establishing agreements and commitments (Dietz *et al.*, 2003). Recreating environmental perceptions allows incorporating those ideas on the local planning, protected areas administration, risk management, vulnerability reduction and social empowerment (Adger, 2003; Berkhout *et al.*, 2004).

A balanced relationship between society and nature allows for the establishment of bonds of equity, justice and solidarity; as well as an increase to the quality of life of communities that require natural resources to ensure their material and cultural survival (Bertoni and López, 2010).

The sociocultural dimension is part of the qualitative change in the dynamic relationship between the society and nature (Guimaraes, 2001). It needs to be included in local environmental planning and management, since inhabitants know their territory and have adapted to the evolving climate conditions to prevent risks and mitigate vulnerability. Collecting local knowledge, (collective understanding rooted by generations on the cultural and territorial heritage -Martinez-Alier, 2006) can give light on the practices related to the cultural use of nature. In the words of Leff (2004), the practice of a new environmental rationality requires integrating the evaluation of ecological conditions of sustainability with the meanings of nature constructed from local knowledge and culture.

Moreover, sociologists such as Luhmann (1995) established how perceptions are able to build a space-time relationship based on linguistic signs. Perception acts as a filter between social systems and the external world. By means of perception, we can focus and understand time and space. Consciousness of spatiality is an impression of proximity with the world. "The perception is to put a foundation brick in the architecture upon which the construction of reality is built" (Lewkow, 2014: 36).

Psychology has also tried to establish links between a high quality of life and a healthy environment. Thus, Baldi and García (2005) highlighted how the World Health Organization establishes that the quality of life is the result of the relationship of individuals and communities with the biotic and abiotic elements of the environment. Moreover, PAHO (2013) has declared that there is an intrinsic relationship between health and the environment and that more than 30% of diseases can be attributed to the latter.

Therefore, environmental perception is a relationship of construction or destruction with the environment, a novel, complex, surprising and, sometimes, incongruous individual and collective process. For authors like Cisneros (2010), the struggle is not against nature but rather for nature where environmental education becomes a key element to improve environmental behavior.

We can summarize that the environmental perceptions are understood as the way in which individuals appreciate and value their environment, and can drive important changes for its conservation and transformation. In Mexico, environmental perceptions have been mainly studied in communities in natural protected areas. These studies emphasize citizen participation as the central component to increase the adaptive capacity to

deal and recover from the impacts of severe climatic events. This capacity is explained by socioeconomic conditions at the household level, but it might be reduced by the lack of health facilities, communication, social networks or deficiency in institutional programs (CONANP-GIZ, 2014). However, as Fernández (2008) refers Mexican environmental policy mainly reflects the perceptions, visions and interests of decision-makers rather than those of the local population.

Given this situation, our interest was to study the environmental perceptions of two Mexican communities recurrently impacted by hydro-meteorological phenomena (cyclones, heavy storm and floods). We also wanted to study the degree of vulnerability of those societies related to climate variability and the processes of local adaptation they have achieved. We used two participatory methodologies where the population shared their visions, values, judgments and suggestions, to face environmental and climate change.

We were interested in distinguishing how environmental perceptions are different ways of seeing "reality", how distinct communities deal with diverse situations and in what way they use their local knowledge to face climate change and how they put together their adaptation forms; and develop spaces of dialogue with local authorities to generate public policies aware of climate change. In addition, we were interested in knowing direct experiences (information given by the participants), evaluations and explanations from the communities that would allow us to find timely answers against climate risks posed by hurricanes or floods (Heathcote, 1980; Whyte, 1985).

## **2. Case Studies**

The case studies correspond to two communities susceptible to floods caused by cyclones and storms. One located in the northwest of Mexico, Chametla, which is a suburb of La Paz city (the capital of Baja California Sur State). It is a costal settlement with an average altitude of 4 m, developed between 1990 and 2000. Its population comprises 2,178 inhabitants living in 696 households (INEGI, 2013). According to the Mexican National Centre on Disaster Prevention (Jiménez *et al.*, 2012) this community is under high flood risk due to the presence of streams. There have been reports that at least every two years a hydro-meteorological phenomenon affects the region (Martínez-Gutiérrez and Maye, 2004). The other case study, Progreso, is located in the southeast of Mexico, in the state of Yucatan. It is a coastal city with an average altitude of 2 m and it is an

old settlement created in 1856. It has a population of 37,369 inhabitants with 10,090 households (INEGI, 2013). It is under the constant occurrence of cyclones, strong winds, storms and floods.

### **3. Methodology**

To assess the social vulnerability to floods in Chametla and Progreso we decided to implement participatory methodologies, to gather the environmental perceptions of social actors that had been affected by floods and in some cases had experienced disaster situations. The participatory methodologies were conducted in two phases. The first one entailed establishing contact with the community through the local authorities in charge of the environment and risk management, as well as with academics of local higher education institutions. In the first visit, we got in touch with the community leaders, to know and analyze the locality and to talk about the project objectives and scope. Once the authorities and the community leaders agreed to support the project, we started the second phase and established a date to carry on the participatory workshop concerning environmental perception. A participatory workshop was done in each community; it included the environmental perceptions and the participatory mapping exercises. Results of these workshops were refined and delivered to the community and local authorities in a second workshop.

To have an adequate participation, our workshop attendees were volunteers. Since Chametla is a relatively small community, the invitation was opened to all its members through the placement of announcements in convenience stores and by direct invitation in some houses by a group of students of a local university (Universidad Autónoma de Baja California Sur) who helped with the project. Despite the ample invitation, we had the participation of only nine people who worked in a single group in the workshop (there were six women and three men; six were professional in different fields, one student and two housewives; their ages ranged between 21 and 60 years old; one of them was the neighborhood leader). In the case of Progreso, the research team and the personnel of the municipal risk management agency delimited the areas with most flood problems. Then the municipal personnel took the invitation to people who lived in different parts of the delimited working area to participate in the workshops. In this case, we had the participation of 15 people (eight women and seven men; four construction workers, three students; one fisherman, three housewives and four government employees; their ages ranged between 23 and 58 years old). People were divided in two groups; those who lived in the east side



and those who lived in the west, so two working groups were created of seven and eight people. Chametla workshops were carried on in November 2017 and January 2018 while the Progreso workshops took place in February and May 2018.

### *3.1. Community perceptions*

The second visit consisted in putting into practice a four-hour workshop and conducting semi-structured interviews with key players. We used a reduced and modified version of the approach used by the National Commission of Protected Natural Areas based on the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), which was used to analyze social vulnerability to climate impacts in protected natural areas of Mexico (CONANP-GIZ, 2014).

The methodological approach applied in this research was based and adapted from the vulnerability analysis used in the “Tool for the Analysis of Social Vulnerability to Climate Impacts at a Local Scale in Natural Protected Areas”, which is based on the theory of complex systems, ecosystem-based adaptation and vulnerability analysis founded on response margins (sensitivity analysis). This tool identifies five dimensions of vulnerability (DiV) defined from the interrelationships between life strategies of communities and terrestrial ecosystems in a context of climatic change (life strategies, wellness, adaptive capacity of people and households, adaptive community capacity and governance).

#### *DiV 1: Life Strategies*

- Social and ecological characteristics of the community
- Life strategies for different social groups within the community (gender, age, socioeconomic status, ethnicity)
  - Important climatic impacts for the community
  - Changes on life strategies due to climatic impacts or climatic change trends

#### *DiV 2: Wellness*

- Local criteria and welfare categories
- Households that correspond to these categories
- Vulnerable households or households with less capacity to adapt

#### *DiV 3: Adaptive capability of people and households*

- Access to resources to adapt, according to the social groups of the community
  - Level of control of social groups over resources and livelihoods

#### *DiV 4: Adaptive community capability*

- Norms, practices and institutions of the community having an influence in vulnerability and collective adaptation capability

#### *DiV 5: Governance*

- Capabilities and responsibilities of the political actors and organizations linked to processes of vulnerability and adaptive capacity

The information was systematized and synthesized by the members of the research team, maintaining criteria on gender, age and spatial location of the families. The analysis took into consideration local climate impacts, risks and vulnerabilities based on the DiV approach. The research team complemented the synthesis on the environmental community perception and their adaptation needs. The analysis of social vulnerability and the adaptation process was performed under the concepts of interdisciplinary and complex systems.

We applied the methodological proposal of (Ulrichs *et al.*, 2015) to gather the adaptation measures from the perceptions, experiences and needs of the inhabitants and their families, through the environmental perception workshops. We were interested in the family and community knowledge regarding ecosystems and biodiversity, and the adaptation measures they use to reduce their vulnerability.

In this identification, the DiV provide information about the causes of vulnerability and strategies for adaptation, considering: 1) the sensitivity of community groups to climate impacts or food security, and 2) adaptive capability or local barriers to adaptation (social, political or environmental), as the basis to define an adaptation measure. Finally, adaptation measures were discussed within the research team and the community to define those that are appropriate, defining their advantages and consequences.

One of the key points of the analysis was to adapt this methodology to our case studies that can be considered peri-urban areas (understood as multifunctional transition zones around the cities with a mixture of land uses and high and rapid transformations (Avila, 2001; Duran, 2005), and that have had an emergency due to cyclones, heavy rains and floods. Thus, the analysis of vulnerability to climate change of the communities was performed considering these five dimensions of vulnerability: life strategies; wellness; adaptive capability of people and households; community and collective adaptive capability; governance. With the information obtained it was possible to describe the social, cultural and environmental perception about the climate change of the inhabitants; the way they conceive the risks associated with this phenomenon, their vulnerability and the means to face it, as well as their adaptation strategies and practices.

The participatory perceptions workshops were conducted through four phases:

*Phase 1: Identification of risks and threats (meeting facilitation)*

- Identification of risks and threats (cause and effect) due to frequent climate effects on the community
- List of hazards and their impacts to understand their seasonality (January to December)

*Phase 2: Identification of areas and populations at risk*

- Identification of areas with degraded forest lands, rivers, flood zones, mudslides or landslides
- Location of social groups that inhabit risk areas

*Phase 3: Productive activities and risks*

- Identification of impacts on productive activities in the community (season, gender, place)
- Identification of the level of impact in a specific month, percentage of change and persistence, limits of tolerance

*Phase 4: Adaptation mechanisms*

- Enumeration of the mechanisms of adaptation to situations of risk that affect families or the community, their relationship with productive activity and limits of tolerance
- Enumeration of the support mechanisms that families and the community receive (institutions, programs, social and family networks).

### *3.2. Participatory mapping*

In order to gather information to support vulnerability reduction and risk management to face extreme hydro-meteorological events exacerbated by climate changes and to involve the community in the decision-making processes, we implemented a participatory mapping exercise in Chametla and Progreso. This exercise complements the information collected in the social perception workshops.

The participatory mapping exercises allowed collecting of firsthand-community information about major impact zones, refuges and evacuation routes in case of emergency. Additionally, we obtained a list of steps already taken and those that need to be carried out, individually or collectively by the community inhabitants to reduce their vulnerability (Canevari-Luzardo *et al.*, 2015; Arapostathis *et al.*, 2018).

In the end, the information was given back to the community through a workshop. This information would empower the population, providing elements for discussion and negotiation with the authorities or non-

governmental agencies that support risk management and vulnerability reduction actions to face extreme hydro-meteorological events. Besides, the map generation process represents a mechanism that allows society engagement in the decision-making process since it is an easily understood approach that facilitates the coordination with the authorities through the communication of local knowledge (Hung and Chen, 2013).

This is of utmost importance since it is a way to close the gap between society and risk management authorities. In addition, it facilitates community appropriation of measures proposed by the authorities since they are taking into account their perceptions. Additionally, this exercise allowed the workshops participants to be conscious of their spatial knowledge about their community, their exposure and vulnerability and the damage of hydro-meteorological hazards.

After the perception workshops, the participatory mapping approach was conducted through a pair of workshops in each community. In the first workshop, local knowledge was gathered and in the second one, the results were presented and validated. For the first one we used a satellite image, printed in a poster size, from Google Earth (Google Earth©, Image© 2017 Digital Globe). In addition, we employed some tools including photographs of emblematic sites from each study area to which we assigned an identifier linked to a location. In addition, we prepared markers and labels of various colors to identify different territory elements to be located by the workshops participants. These elements were previously included in a list and comprised refuges, evacuation routes, households of participants, hospitals, meeting points as well as places where adaptation activities have been carried out and those proposed to be done to reduce the vulnerability to floods. We started the first workshops for both case studies with the presentation of the projects' objective and scope; the request for consent to use the information in scientific products, and emphasizing the commitment of the research team to conduct a second workshop to present the results.

The first mapping activity was to create a confidence map. In Chametla, all participants showed deep knowledge about their community and its flood problems. In Progreso, people in the two groups agreed that they knew very well the East and West zones respectively, and almost all knew the whole study area. Spatial knowledge of their localities was gathered in both communities in the following exercise. Participants were asked to locate emblematic sites (depicted in photographs) and their houses in the printed satellite images. Discussion in this exercise among the participants was very enriching to the spatial knowledge since they not only locate their houses and the places in the photographs, but also other reference sites such as schools, churches, streets, parks, etc.

Once the confidence map was generated, we located elements related to flood vulnerability reduction. First, they were asked to identify sites that regularly get flooded even with minor rains, and then they located the zones that only get flooded with extreme hydro-meteorological events. As a next step, we asked the participants to list and spatially locate actions that they perform in an individual or collaborative way, as well as those carried on by the government to reduce the vulnerability and adapt to the floods. They were also asked to list and locate in the territory those activities they considered should be implemented to be less vulnerable to floods. Once they identified the activities they usually do and those they propose to be carried out, they were asked to locate the refuges, hospitals, meeting sites, evacuation routes established by them or by the local authorities.

At the end of the mapping activity, each group appointed a person to present their results; this presentation and the discussion that followed allowed for refinement of the final map of the first workshop. This was more significant in the case of Progreso, where the mapping work was made in two groups (east and west), since people working in one side of the city contributed to the other side and vice versa. This was possible since people in one side said they also know the other side. As a closing to the workshops, we asked the participants to describe for what purposes they could use the map and with whom they would use it. A technician then transferred the information collected in the printed satellite images during the workshops to a digital format using the geographical information system ArcGIS 10.1.

The resulting maps of the first workshops were presented to the municipal risk management experts to get their comments about the community perception; these comments were then presented back to the community in the second workshops. In these same workshops, we delivered the final map and the perception reports to the community.

#### **4. Results**

Combined, the two products of the participatory methodologies (community perceptions report and the participatory map) gave elements to the inhabitants for discussion purposes, proposal of activities and negotiation with governmental authorities of the three levels in charge of risk management and vulnerability reduction to face extreme hydro-meteorological events.

#### *4.1. Community perceptions workshop*

Participants' perceptions of our workshops in Chametla and Progreso exhibited the community's knowledge on climate variability and climate change. They mentioned an increase in temperatures and episodes of prolonged rains and increase in the presence of cyclones. People attending the workshops detailed the months of the year that are most affected by climate change. People have adapted to these new situations by using local knowhow, for example, raising the sidewalks or building walls to deviate the water flow, and reported that these actions have contributed to reduce catastrophes.

Climate change has affected their economic activities and adapting to these circumstances was one of the most important concerns in both communities. They reported changes on primary activities and consequently, they have switched to informal commerce or to the services sector to survive. Peri-urban areas are so relevant for the urban areas, because they provide climate regulation and food supplies, contributing substantially to their resilience.

Another perception reported had to do with the effects of climate change on health. Vector diseases have been increasing and today the risk in both communities is noteworthy. New diseases have developed because of changes in the ecosystems. Massive fumigations by municipalities, prevention campaigns and sanitation of streets and ponds are key actions to avoid diseases such as Zika or dengue.

Both communities perceive that the most vulnerable people are those living in poverty conditions, precarious housing and with jobs linked to climatic conditions. As several authors have shown, economic and social vulnerability plays a key role in a catastrophe. It is essential to mention that a robust social organization allows facing risk with more possibilities to prevent losses and to get better daily life conditions. In this sense, in both communities, people exhibited family and neighborhood solidarity in the face of disaster and adherence to traditional ways of making decisions. Strengthening environmental governance can generate a robust, constant and permanent organization that reduces social vulnerability to risk.

#### *4.2. Participatory mapping*

In Chametla the workshop participants identified those activities developed by the community to cope with floods, among them enabling areas for drainage and raking of streets to eliminate dragged material. This

last activity is conducted by the community inhabitants as well as by the municipal government. Among the activities proposed to reduce their vulnerability to floods, the most widely mentioned was street paving to allow for public transportation that could be used to escape flooded areas that are prone to remain under water for weeks. Another proposed activity was the installation of drainage pipes below the new road, which blocks the flow of the runoff water to the sea (Fig. 1).



Figure 1 – Edited participatory map for Chametla.

In this community, the inhabitants told that the generated map could have two main uses: first, as a tool to facilitate the cooperation to select and conduct activities to reduce the vulnerability in front of floods; second, to ask for help from the authorities to carry out the activities proposed in the workshops as reported by Cruz-Bello *et al.* (2018).

In the case of Progreso, the activities were mainly related to the cleaning of streets, the construction of drainage pipelines (mainly near the lagoon), an artificial reef for the protection of the beach and the construction of drain pits (the city lacks of a drainage system based on pipelines). Among the proposed activities are the maintenance of the drainage pits, better cleaning of the streets prone to flooding, the installation of cameras and the construction of a fence to the side of the lagoon to prevent and discourage



people from throwing garbage that causes the clogging of the water drainage pits. Additionally, they suggested the installation of a wire fence to prevent crocodiles from entering the city from the adjacent lagoon during flood season and building sidewalks to avoid stagnant water (Fig. 2).



Figure 2 – Edited participatory map for Progreso.

## 5. Final remarks

With the perception method, we created a framework in which the community becomes aware of the climatic variability and the changes produced by the global warming. It is important to highlight that for some participants in our workshops it was the first approach to identifying and defining climate change and its consequences. People were able to identify, throughout the year, the seasonal changes in the weather, and the variations in the climate. Furthermore, people were able to identify the main activities conducted in the community and relate them to the climatic variability and climate change. They were able to recognize which groups and activities were the most vulnerable to floods, which behaviors and activities make

them less vulnerable. In addition, they suggested actions to mitigate risk. As with many other human activities, actions to reduce vulnerability take place in a spatial context. Hence, it was pertinent to complement the communities' perception approach with the participatory mapping method. Here people mentioned who and where are the most vulnerable, those activities they have done to reduce their vulnerability, and the special conditions where they live. This activity made the participants aware about the spatial knowledge of their community and about their vulnerability and the means to reduce it.

In this exercise both methods were executed independently, but in a future research we might combine them in an integrating exercise.

Finally, we can say that the use of these participatory methodologies for the assessment of social vulnerability to floods facilitates the integration of the communities into the decision-making process conducted by the different government levels. Local authorities knew about the workshops, they received the results and they started working with the community to improve on their suggestions. In addition, the results will allow them to have a communication and negotiation instrument that will empower them to demand government actions to reduce their vulnerability. More importantly, they have now elements for the analysis and discussion to propose and implement individual or collective actions in a systematic way in a spatial context.

Results of each workshop allowed finding the environmental perceptions of each community to face different life strategies, their capability of adaptation and possible solutions based on the opinion and participation of the attendees. Environmental perception was one of the key components to understand the dynamics of each studied community. The socio-cultural characteristics, the economic elements, the environmental and physical situations were perceived individually and allowed the community to connect with their environment, visualize it, raise awareness and understand the complex relationship between nature and society. Our results show that community environmental perceptions promote changes and transformations in the habitat and build a new relationship with the environment that surrounds them. They used their local knowledge to adapt to new situations and they started to work with local authorities thus increasing policies to face climate change and strengthen resilience.

## Acknowledgements

This research was financed by the grant SEMARNAT-2015-01-263102 (Consejo Nacional de Ciencia y Tecnología / Secretaría de Medio Ambiente y Recursos Naturales), for the project entitled “Análisis de la Vulnerabilidad y Resiliencia al Cambio Climático en Sistemas Socio-ecológicos Periurbanos. We are extremely appreciative of the time and help given to us by the residents of Chametla, BCS, and Progreso, Yucatán.

Many thanks to Roberto Muñoz who conducted the perception workshops, Jose Luis Manzano and Marcelino García for their support and comments on the mapping process, Nora Morales and Javier Reyes who helped during the mapping exercises and to Yuma, and the LAST students who participated in the data collection.

## References

Adger, W.N., 2003, “Social Capital, Collective Action, and Adaptation to Climate Change”, *Economic Geography*, 79, 4, 387- 404.

Arapostathis, S.G., Spyrou N., Drakatos G., Kalabokidis K., Lekkas E., Xanthopoulos G., 2018, *Mapping information related to floods, extracted from VGI sources, for effective disaster management within the Greek territory; the floods of West Attica (November 2017 Greece) case study*, 11th International Conference of the Hellenic Geographical Society 2018, Lavrio, Greece.

Avila, H., 2001, “Ideas y planteamientos teóricos sobre los territorios periurbanos. Las relaciones campo-ciudad en algunos países de Europa y América”, *Investigaciones Geográficas Boletín del Instituto de Geografía*, 45, 108-127.

Baldi, G., García E., 2005, “Calidad de vida y medio ambiente. La psicología ambiental”, *Universidades*, 30, 9-16.

Berkes, F., Colding, J., Folke, C., 2000, “Rediscovery of traditional ecological knowledge as adaptive management”, *Ecological Applications*, 10, 1251- 1262.

Berkhout, F., Hertin, J., Gann, D.M., 2004, “Learning to adapt: Organisational adaptation to climate change impacts”, *Tyndall Centre for Climate Change Research Working Paper 47*.

Bertoni, M., López, M.J., 2010, Percepciones sociales ambientales valores y actitudes hacia la conservación de la reserva de biosfera “Parque Atlántico Mar Chiquita” – Argentina, *Estudios y Perspectivas en Turismo*,

19, 835- 849.

Borroto, M., Rodríguez, L., Reyes, A., López, B.A., 2011, “Percepción ambiental en dos comunidades cubanas”, *Revista Electrónica de Medio Ambiente*, 10, 13-29.

Canevari-Luzardo, L., Bastide, J., Choutet, I., Liverman, D., 2015, “Using partial participatory GIS in vulnerability and disaster risk reduction in Grenada”, *Climate and Development*, 9, 95-109.

Cisneros, Ma. P., 2010, *Percepción social y aspectos sociológicos del crecimiento sostenible*, Accessed: <http://www.encuentros-multidisciplinares.org/Revistan%C2%BA10/M%C2%AA%20Pilar%20Cisneros%20Britto.pdf>, (10 October 2018).

CONANP-GIZ, 2014, *Cambio Climático y Gestión de Áreas Naturales Protegidas*, Accessed: <https://www.giz.de/en/worldwide/33824.html>, (10 October 2018).

Correa, S., 2011, El clima: conocimientos, creencias, prácticas y percepciones de cambio en el Darién, Caribe Colombiano. In: Ulloa, A. (Ed.), *Perspectivas culturales del clima*, Bogota, Colombia, 367- 394.

Cruz-Bello, G.M., Alfie-Cohen. M., Morales-Zaragoza, N.A., Larralde-Corona, A. H., Reyes Pérez, J., 2018, Flood vulnerability reduction, using a partial participatory GIS approach. A study case in Baja California Sur, Mexico, *The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences*, XLII-3/W4, 185-190.

Cutter, S.L., Boruff, B.J., Shirley, W.L., 2006, Social Vulnerability to Environmental Hazards, In: Cutter, S.L. (Ed.), *Hazards Vulnerability and Environmental Justice*, London, UK.

Dietz, T., Ostrom, E., Stern, P., 2003, “The Struggle to Govern the Commons”, *Science*, 302, 5652, 1907-1912.

Durán, F., 2005, “Procesos de periurbanización y cambios en los modelos de ciudad. Un estudio europeo de casos sobre sus causas y consecuencias”, *Papers*, 78, 59 – 88.

Fernández, Y., 2008, “¿Por qué estudiar las percepciones ambientales? Una revisión de la literatura mexicana con énfasis en Áreas Naturales Protegidas”, *Espiral, Estudios sobre Estado y Sociedad*, XV, 43, 179-202.

Gallopín, G., 1986, Ecología y ambiente. In: Leff, E. (Coord.), *Los problemas del conocimiento y la perspectiva ambiental del desarrollo*, D.F., Mexico, 126- 172.

Guimaraes, R., 2001, *Fundamentos territoriales y biorregionales para la planificación*, CEPAL Serie Medio Ambiente y Desarrollo, 39.

Heathcote, R.L., 1980, The context of studies into the perception of desertification, In: Heathcote, R. L. (Ed.), *Perception of desertification*, Tokyo, Japan.

Heyd, T., 2010, "Climate Change, Individual Responsibilities and Cultural Frameworks", *Human Ecology Review*, 17, 2, 86- 95.

Heyd, T., 2011, Pensar la relación entre cultura y cambio climático. In: *Perspectivas culturales del clima*, In: Ulloa, A. (Ed.), *Perspectivas culturales del clima*, Bogota, Colombia, 17- 32.

Hung, H.C., Chen, L.Y., 2013, "Incorporating stakeholders' knowledge into assessing vulnerability to climatic hazards: application to the river basin management in Taiwan", *Climatic Change* 120: 491- 507.

INEGI, 2013, *XIII Censo de Población y Vivienda 2010*. Accessed: <http://www.beta.inegi.org.mx/proyectos/ccpv/2010/>, (10 October 2018).

IPCC, 2007, Climate Change 2007: Synthesis Report Summary for Policymakers. Assessment of Working Groups I, II and III to the Third Assessment Report of the International Panel on Climate Change. Cambridge University Press, Cambridge, UK.

Jiménez, M., Baeza, C., Matías, L.G, and Eslava, H., 2012, *Mapas de índices de Riesgo a Escala Municipal por Fenómenos Hidrometeorológicos*, CENAPRED-SEGOB, Mexico. Available on the website: <http://www.atlasnacionalderiesgos.gob.mx/Descargas/Metodologias/Hidrometeorologico.pdf> (Last access: 10 October 2018).

Lefebvre, H., 1991, *The production of space*. Blackwell, Cambridge, UK.

Leff, E., 2004, *Racionalidad ambiental. La reapropiación social de la naturaleza*, Siglo Veintiuno Editores, Mexico.

Lewkow, L., 2014, "Aspectos sociológicos del concepto de percepción en la Teoría de las Ciencias Sociales, *Revista MAD*, 31, 29- 45.

Luhmann, N., 1995, *Teoría de la Sociedad y Pedagogía*, Paídos Ibérica, Spain.

Martínez-Alier, J., 2006, Los conflictos ecológico-distributivos y los indicadores de sustentabilidad, *Polis, Revista de la Universidad Bolivariana*, 5, 13.

Martínez-Gutiérrez, G., Maye, L., 2004, Huracanes en Baja California México y sus implicaciones en la sedimentación en el Golfo de California. *Geos*, 24, 57- 64.

Oltra, C., Rosario Solà, R., Sala, R., Prades, A., Gamero, N., 2009, Cambio climático: percepciones y discursos públicos, *Prisma Social Revista de Ciencias Sociales*, 2, 1- 23.

PAHO, 2013, *Health, Environment and Sustainable Development: Towards the Future We Want*, Pan American Health Organization (PAHO), Washington DC.

Ramos, C., Tenorio, A.D., Muñoz, F., 2011, Ciclos naturales, ciclos culturales, percepción y conocimientos tradicionales de los nasas frente al cambio climático. In: Ulloa, A. (Ed.), *Perspectivas culturales del clima*,

Bogotá, Colombia, 247- 274.

SEMARNAT, 2012, Adaptación al Cambio Climático en México: Visión, elementos y Criterios para la Toma de Decisiones, INECC-SEMARNAT, Mexico, Available on the website: <http://biblioteca.semarnat.gob.mx/janium/Documentos/Ciga/libros2009/CD001364.pdf>, (10 October 2018).

Soares, D., García, A., 2014, Percepciones campesinas indígenas acerca del cambio climático en la Cuenca de Jovel, Chiapas, México, *Cuadernos de Antropología Social*, 39, 63- 89.

Ulrichs, M., Cannon, T., Van Etten, J., Morimoto, Y., Yumbya, J., Kongola, E., Fadda, C., 2015, Assessing climate change vulnerability and its effects on food security: Testing a new toolkit in Tanzania, 91, Accessed: <https://cgspace.cgiar.org/rest/bitstreams/40382/retrieve> (10 October 2018).

Van Aalst, M. K., Cannon, T., Burton, I., 2008, Community level adaptation to climate change: the potential role of participatory community risk assessment, *Global environmental change*, 18, 1, 165- 179.

Vander Molen, K., 2011, Percepciones de cambio climático y estrategias de adaptación en las comunidades agrícolas de Cotacachi, *Ecuador Debate*, 82, 145- 158.

Whyte, A.V.T., 1985, Perception, In: Kates, R.W., Asusbel, J.H., Berberian (Eds.), *Climate Impact assessment: Studies of the Interaction of Climate and Society*, Scientific Committee on Problems of the Environment (SCOPE). Available on the website: <http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.123.6896&rep=rep1&type=pdf> (Last access: 10 October 2018).

*Natural Hazards and Disaster Risk Reduction Policies* collects 14 original essays, of authors from all around the World, exploring strategies and ability of local communities to adjust to natural hazard and disasters. The volume, fostering the current scientific debate on disaster ecology, muses about the need for Homo sapiens to define its rights and responsibilities in environmental dynamics, including extreme events and disasters. In the end, the reflections about how to deal with hazard, vulnerability and disasters, highlights the ethical nature of disaster risk reduction; control of nature or adaptation to its cycles?

PEER-REVIEWED  
SERIES

**Loredana Antronico** is a Researcher of the Research Institute for Geo-Hydrological Protection of the Italian National Research Council (CNR). She is author or coauthor of several papers published in international journals or presented at international conferences and workshops in the following issues: soil erosion, debris flow and flood hazard on alluvial fans, landslide incidence, landslide susceptibility and hazard assessment, landslide monitoring, and recently, geo-hydrological risk perception. Loredana Antronico is coordinator of research projects, on some of the cited issues, funded by National and Regional Administrations.

**Fausto Marincioni** is an Associate Professor at the Università Politecnica delle Marche at Ancona (Italy), where he teaches and carries out research on disaster risk reduction. He holds a Ph.D. in geography from the University of Massachusetts (USA) and is an editor of the International Journal of Disaster Risk Reduction. Previous to the Università Politecnica delle Marche Marincioni has worked with the US Geological Survey, in Woods Hole, Massachusetts, and taught human and environmental geography at Long Island University (LIU Post) in New York.

IL **Sileno**  
Edizioni



ISBN 978-88-943275-2-6