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Perception of and adaptability to the effects of climate change in a rural community of the State of Mexico

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ABSTRACT

Objective: To analyze the population's perception of recent changes in climate patterns and the actions they have taken to adapt to these changes in the El Saltillo community, Municipality of Jilotepec.

Design/methodology/approach: A survey was carried out between September and October 2022, answered online. Social networking and WhatsApp groups were used to disseminate the invitation to participate in the survey; 96 responses were received, of which 30 were answered on site together with the respondent. Aspects such as socioeconomic data, conceptualization and perception of climate change and adaptability actions were measured.

Results: All the survey respondents mentioned that they perceive strong changes in droughts and frosts in the last 10-15 years. Of them, 96% stated that they had heard the term climate change in different media; however, it is not a concept that is used to explain the changes that take place in the community. As a result of these changes, the population has chosen to build or enlarge rainwater container mounds for agricultural and livestock use, improve the physical condition of the stables, and begin to use precocious corn seed or more adapted varieties of improved corn.

Limitations on study/implications: The application of surveys online is a feasible and economical option that implies the need to implement data validation, control and verification mechanisms, as well as sampling of the results.

Findings/conclusions: Adaptation strategies to climate change were identified, showing that they are not spontaneous actions and that they have emerged empirically through daily contact with the phenomenon.

Keywords: Food security, agricultural vulnerability, online surveys.

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INTRODUCTION

Climate change is one of the most important themes both in the political agenda and in public opinion. The negative effects at the global level have become topics of analysis in global conferences to the degree that various groups of international experts have been established to understand the phenomenon, but mostly to attempt to give solutions to the quandary. In the United Nations (UN) Conference of the Parties on climate change (COP27,

Egypt, 2022), the Secretary-General of the organization pointed out that: “People and the planet are trapped by climate change, half of the global population lives in places that are very vulnerable to climate change, extreme climate events have surpassed the level of tolerance of animals and plants, the result has been an increase of insecurity in the access to foods and water, particularly in the most vulnerable regions like Africa, Asia, South America and Central America” (UN, 2022). Various studies such as those by Hallegatte *et al.* (2016) and the IPCC (2014) point out that by 2030, Climate Change (CC) will lead more than 100 million people in the world to poverty, because the increase in temperatures and in the availability of water increase the intensity and the frequency of natural disasters, and food crises increase the risk of diseases transmitted by water, among many other impacts. Hoffmann (2020) mentions that “CC and natural disasters exacerbate inequality in the population because, among other things, the poor (countries and communities) are often more exposed to CC, suffer greater losses in proportion with wealth, and are less resilient and more susceptible to increase their poverty”.

Studies such as those by Seaman *et al.* (2014) and Guajardo-Panes *et al.* (2018) describe that the effects of CC will be especially severe in rural communities of the least developed countries whose incomes depend on agriculture and become a risk in food security. In this sense, the IPCC (2014) points out that “agriculture is one of the activities that will be most affected by CC, because of the impacts that high temperatures, droughts and storms are expected to have on plant and animal production”. In studies such as those by Ortega-Gómez *et al.* (2019) and Ortiz-Paniagua *et al.* (2018) the authors assume that, in face of the evident decrease in agricultural yields and increase in presence of pests and diseases in the crops as a result of the increase in water stress, agricultural producers will face the challenge of remaining competitive in the commercial and productive scope, at the same time that threats increase, such as the unknown behavior of hydro-meteorological factors and the uncertainty in the market’s performance. In Pinilla-Herrera *et al.* (2012), the authors mention that “since the second half of the 20th century there have been reports at the global, regional and local level about the space-time alteration of the patterns of behavior of meteorological phenomena (storms, hailstorms and frosts, among others) and of climatological variables (temperature, humidity and precipitation). Around this, the scientific knowledge has specified and demonstrated that its main causes are the occurrence and intensity of phenomena of climatic variability by the ENOS (El Niño–Southern Oscillation) cycle and the widely spread climate change”.

Mexico’s geographic situation makes the country a highly vulnerable zone as a result of phenomena originated by CC. Zamora-Martínez (2015) mentions that “In Mexico the systematization of the information and the analysis of data referring to CC indicate, among other things, that meteorological drought will increase in some regions, forest ecosystems will present changes in 50% of the surface, rainfed agriculture will be severely reduced, and in the population, it will be evident in the quality of health”. According to the National Climate Change Strategy (*Estrategia Nacional de Cambio Climático*, ENCC, 2013), the government of Mexico fixed the adaptation to its effects as one of the pillars of the federal strategy against CC, and it includes reducing the vulnerability of the social sector as an action line. In this sense, understanding and defining the vulnerability, in addition to

having the ability to measure it, becomes an essential aspect to address the consequences through risk management.

In the State of Mexico, studies like those by Pérez *et al.* (2007) have documented that the thermal amplitude (difference between daily minimum and maximum temperature) has increased in region of Toluca in more than 30.0 °C due to the effect of urban growth and the change in land use, while inside the city of Toluca there have been “heat islands” which refer to the temperature within the city being warmer than in the periphery by approximately 2 °C at the same hour. Monterroso-Rivas *et al.* (2011), through the use of various climate change scenarios, evaluate the vulnerability of the agricultural sector at the municipal level in Mexico; the region of Jilotepec and its surroundings appear as with High vulnerability for corn farming, and these results agree with the publication by Espinosa-Rodríguez *et al.* (2020).

Climate change also has strong repercussions in the livelihood, traditions, culture and ways of thinking of the population, particularly in rural, poor and marginalized zones, due to migration towards urban centers of the country in search for better living conditions, primarily of the young generations. As mentioned by Landa *et al.* (2008), “Climate variability is not the main cause of the socio-environmental quandary that is experienced in several regions of the country, although it is a factor that favors the appearance of conflicts in the population. There are other factors such as the negative effects of farming policies, unemployment, deficiency in health services, social conflicts and poverty, which increase the vulnerability of the population in the presence of changing conditions in the availability of water and in climate”.

According to Retamal *et al.* (2011), “the framework of scientific approaches to climate change develops in three different research lines: (a) Physical sciences of climate change; (2) Impacts, adaptation and vulnerability; and (3) Mitigation. The last two approaches are the ways of responding to the potential impacts of CC and require behavioral changes from citizens and cultural changes from society. Therefore, behind these changes there should be a positive perception of the risk introduced by climate change, a level of information that backs this valuation and a degree of awareness to design and implement strategies for mitigation and adaptation, as well as to maintain them for some time”. Therefore, the study of climate change requires a line of study that approaches the perception of citizens, since the successful application of any strategy, both mitigation and adaptation, demands understanding the level of sensitivity, information and comprehension about climate change by those who will adopt such strategies, those who will evaluate their performance, and those who will benefit from their application.

When analyzing the perception of the population of the dangers from climate change, two aspects are considered: adaptation measures and mitigation measures. Adaptation, according to the definition by IPCC, is “the adjustment of natural and human systems in response to climate change to moderate its negative effects and exploit its benefits” (Pascual-Bellido, 2017). On the other hand, Libert-Amico *et al.* (2018) mention that “adaptation is equivalent to developing the abilities in different social sectors to adjust the variability to climatic extremes and to climate change, with the aim of taking advantage of positive effects and moderating potential damage”. The perception of changes in the climate of a

region, as well as the adaptation of daily activities that tend to reduce the negative effects and take advantage of the positive, are linked to the traditions of each society, and each strategy is a conscious and rational act by those who implement it, although influenced by the social context as a local strategy for subsistence. In Ávila-Flores *et al.* (2015) the authors argue that it is essential, in studies directed at understanding how the adult population accepts its responsibility in face of threats, to know whether they really perceive them as the institutions responsible for risk management expect them to; that is, to understand if society considers itself to be vulnerable, to what and to which extent, as well as knowing what is needed to reassess their modes of prevention and recovery.

MATERIALS AND METHODS

Study area

The research study was carried out in the locality of El Saltillo, belonging to the ejido Aldama, municipality of Jilotepec, State of Mexico. This is a rural community located 90 km to the NE of Mexico City (Figure 1). Agriculture produces mainly native corn with a rainfed regime. According to the General Population and Housing Census 2020 (INEGI), the population is approximately 870 inhabitants distributed in 220 households, and the territorial extension is 1,384 Ha. The type of climate of the community of El Saltillo is temperate sub-humid, C(w2)(w)b(i)g, sub-humid with long summer, winter rainfall under 5%, and the highest temperature manifests before the summer solstice (Casa, 1997).

Data compilation and survey

The survey titled “Perception and adaptability to Climate Change in the community of El Saltillo” was applied, which was answered online and with the aim of measuring

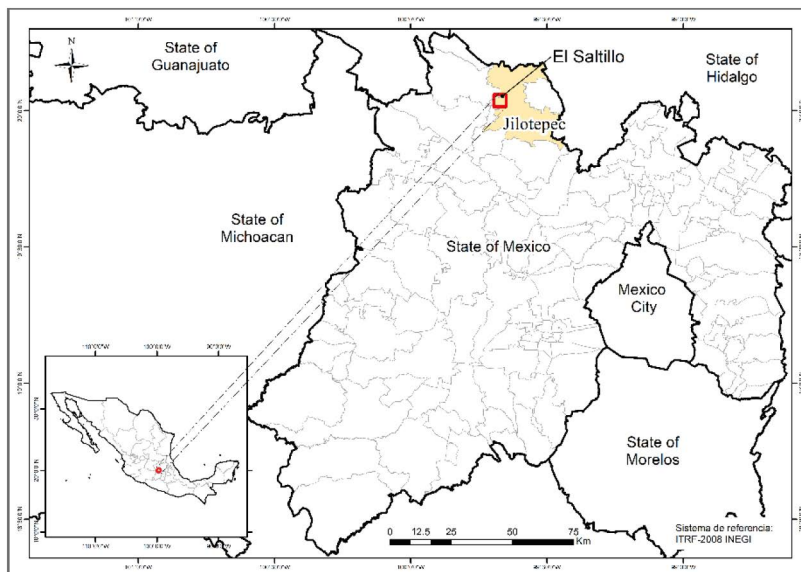


Figure 1. Location of the study zone.

Source of data: Prepared by the authors with cartographic data from INEGI.

the perception of change in climatic conditions in the zone, as well as understanding adaptation practices in the farming sector, in addition to the household or family itself. The method of dissemination and invitation to participate in the survey was through the ejido authorities who, when informed about the aim of the study, communicated the invitation to participate in the survey through the community's different WhatsApp groups. The control mechanisms of the survey were to request one person per family to respond, as well as the head of the household to ensure that, in addition to the confidentiality of their data, this would correspond only to the survey control and not to the body of the survey. Mandatory and control survey questions were asked. The period of application was from September 15 to October 30, 2022, and 96 surveys were answered in total, of which 30 were answered on site and directly with the survey respondent as a way of validation and sampling. The 96 surveys represent 43.6% of the households of the locality of study.

The survey was structured in six sections, the first and only as control mechanism, called A) general data (name and address of the survey respondent). The next sections were: B) socioeconomic data (to understand the characteristics of the survey respondents), C) conceptualization of climate change (to define what is understood as CC and how widespread the phenomenon is), D) perception of climate change (to know if such changes have been noticed in the community and how intense), and E) adaptability to climate change and vulnerability (to analyze the actions they have taken to face such changes).

RESULTS AND DISCUSSION

Of the survey respondents, 96% manifested having heard the term Climate Change (CC) mentioned in media like television, radio, internet, etc. However, CC is not a concept that is used to explain the changes observed in the precipitation and temperature patterns of the locality. All the people surveyed manifested they have perceived changes in the last 10-15 years, particularly in phenomena such as droughts (more severe and prolonged), delay and decrease in rainfall ("the rains come later and later and we do not get downpours as before"), as well as frosts (more severe and earlier than before), although only 5% of the survey respondents mentioned that it is a local phenomenon that only affects the community or the State of Mexico and this corresponds to people with scarce or no education (Table 1). When it comes to the origin of such changes in rainfall and precipitation patterns, 93% of the answers mentioned that they are caused by the activity of men or industrial activities and the other 7% said they ignore the cause or attribute it to divine matters or God.

Table 1 presents the main social characteristics of those who responded the survey, grouped by age range. The capacity of the population to act in the presence of emergencies is related to aspects such as level of preparation and age range, where older people and with lower academic preparation will understand the phenomenon to a lesser degree, they will be more vulnerable to the negative effects and will not be able to implement actions for adaptability; similarly with the young generations, particularly with university studies, who prefer to devote themselves to other activities and to abandon the farmland.

Table 2 shows how the inhabitants of the community conceive the changes in patterns of rainfall and temperature; the concept of rainfall is the one that all the survey respondents mention that has basically decreased since at least 10 years ago, similar to drought which

Table 1. Main characteristics of the population that answered the survey.

Question	Concept	Ages (years)					Total cases
		Less than 30	30 to 39	40 to 49	50 to 64	More than 65	
Educational level	Uneducated	0	0	0	0	6	6
	Primary level	0	0	3	17	4	24
	Secondary level	0	2	19	8	0	29
	Baccalaurate level	1	6	9	13	0	29
	University level	3	0	2	3	0	8
Have you heard about CC?	No	0	0	0	0	4	4
	Yes	4	8	33	41	6	92
Do you think CC occurs only in?	El Saltillo	0	0	0	0	1	1
	State of Mexico	0	0	3	1	0	4
	All Mexico	0	0	0	1	5	6
	The whole world	4	8	30	39	4	85
What do you think causes CC?	I do not know	0	0	0	1	4	5
	I have not noticed any changes	0	0	0	0	1	1
	All the changes are natural	0	0	0	4	1	5
	Because of divine reasons (God)	0	0	0	0	2	2
	Because of industrial activity	0	1	6	7	0	14
	Because of man's activity	4	7	27	29	2	69

Source of data: Prepared by the authors with field research work.

has practically increased in the same period. In these two concepts there was no response that they remain the same as always.

As Table 2 shows, the meteorological frosts have an increasing trend and the hailstorms seemingly do not have greater changes since there is no clear differentiation when it comes

Table 2. Perception of climate change.

Phenomenon / Numbers of cases		Change periods (years)				
		Since 5	Since 10	Since 15	For more than 15	It's always changed
Rainfall	Increase	0	0	0	0	0
	Decrease	21	39	21	9	6
Drought	Increase	21	36	21	8	6
	Decrease	0	3	0	1	0
Frost	Increase	13	20	12	6	3
	Decrease	4	3	4	0	0
	As always	4	16	5	3	3
Hailstorm	Increase	7	13	5	4	0
	Decrease	9	13	13	4	4
	As always	5	13	3	1	2

Source of data: Prepared by the authors with field research work.

to the change rate or period of influence. To measure which phenomena affect certain aspects of life in the community to a greater extent, they were asked which phenomena affect more the community, the crop, the livestock, and the family (Figure 2).

Figure 2 shows the level of affectation of some phenomena in percentage. For example, the decrease in rainfall (decrease in the amount of rain per event, or “there are no more downpours as before”, common comment among inhabitants of the community) affects the entire community equally; however, prolonged droughts seem to affect more the crops and the livestock. On the other hand, the increase in temperature has more effects on the family or on the people.

When it comes to adaptation to the negative effects of the changes in temperature and precipitation patterns, 82% answered yes to the question of: “As a result of the changes in climatic conditions that you mentioned, have you modified your daily activities in the field?” For the specific question about what actions they have implemented in the plot (it could be more than one action), 63.7% mentioned building or enlarging rain water container mounds; 28.3% said using more precocious corn seeds and better adapted to drought; 5.3% rationing water for irrigation, and here it is important to mention that a group of producers implemented drip irrigation systems with rain water; 2.6% manifested sowing a second agricultural product (such as oats or barley) in case that “the seasonal rainfall is not enough for corn to grow”. Regarding the actions to protect the livestock from

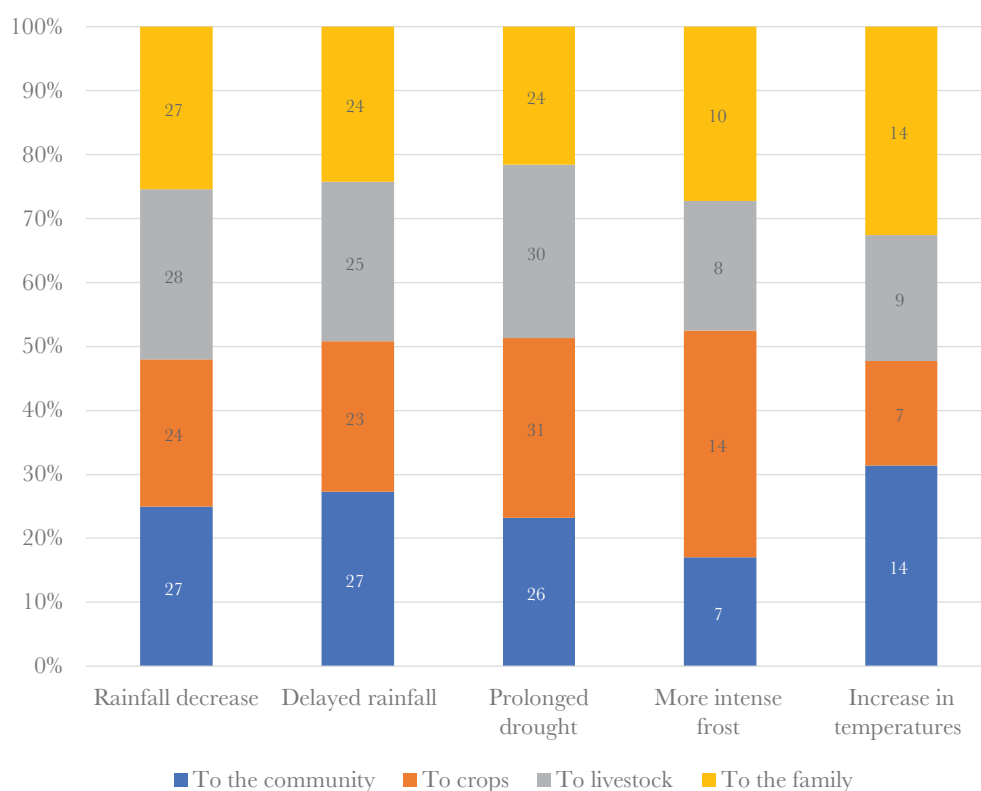


Figure 2. Level of affectation (%) of natural phenomena on some aspects of life of the inhabitants of the El Saltillo community.
Source of data: Prepared by the authors with research work.

drought, 49.5% of the people said they have built or enlarged the rain water container mounds both for irrigation and for the livestock, and 48.6% mentioned that they reduced the number of livestock, to feed fewer animals.

To protect the livestock from frosts, 75.4% mentioned that they have improved the stable with actions like placing a roof and/or a type of floor that allows keeping the livestock dry and warm; 15.6% said that during winter time, they add vitamins to the livestock feed to prevent illness. When it comes to actions to face the drought in the home or household, 74.4% mentioned that they have been forced to build cisterns or purchase water tanks to store water for exclusive use in the household; 15.3% have made home improvements in aspects like introducing piped water, placing a tile roof instead of metal sheets with the aim of keeping the house fresh. In this regard, 10.2% of the survey respondents answered that they have not taken any actions.

In the topic referring to the vulnerability from climate change in the agricultural sector, all the farmers mentioned that corn is their main crop. Figure 3 shows that 64.6% of the producers sow only corn (monocrop) and only 35.4% sow corn with another fodder product. This value could be less representative because in the year when the survey was applied, 2022, the drought forced several producers to sow oats, barley or another fodder instead of corn, with the aim of producing feed for the livestock.

Figure 3 shows that the number of producers who sow native corn varieties is 88.5%, which makes these varieties the main agricultural product of the region. Of the total surface sown, 95.7% is destined to producing corn. The average agricultural yields are 2.5 Ton/ha for native corn varieties and 6.6 Ton/ha for improved varieties.

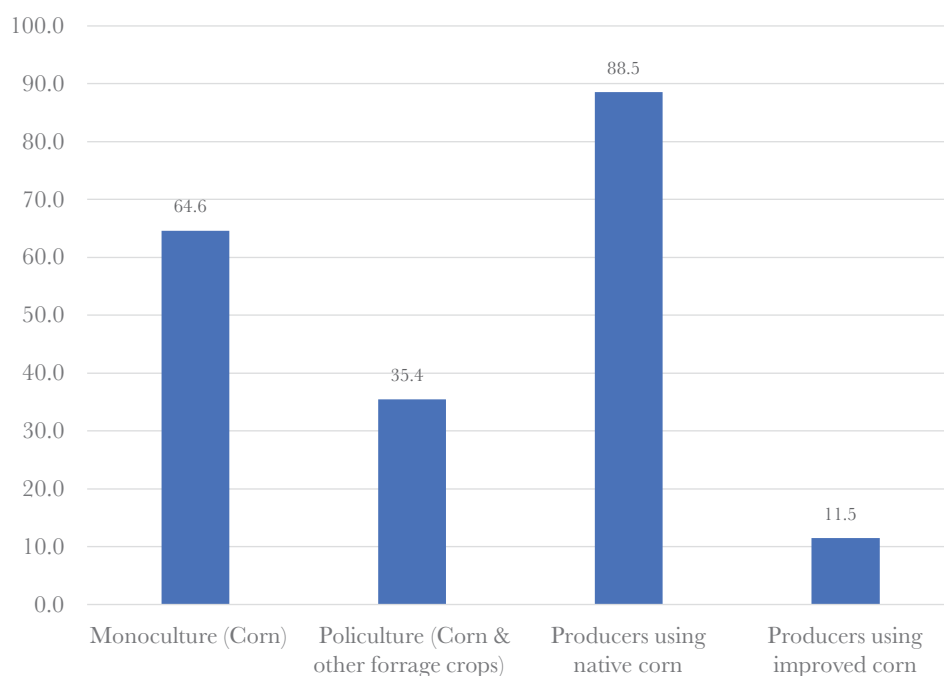


Figure 3. Comparison between producers who sow native and improved varieties of corn. Source of data: Prepared by the authors with field work.

Various studies such as those by Noriega-Navarrete *et al.* (2021), Monterroso-Rivas *et al.* (2011) and IPCC (2014) consider rainfed agriculture, including corn growing, as a highly vulnerable sector to the negative effects derived from CC. Despite the importance of the corn crop in the study zone, the negative effects of CC place the agricultural sector in a vulnerable situation, 98% of the survey respondents mentioned that the inhabitants are not organized to face the changes in climate conditions, it is only a topic that comes out in talks between neighbors or family members and that no government institution, research center or university, has approached them to inform them of the issue or to guide them in how to adapt better to these changes.

CONCLUSIONS

This study evidenced aspects such as how the population of the community has become aware and has empirical knowledge of changes in the natural patterns of temperature and precipitation, although without calling it Climate Change. These changes affect them in economic and social aspects. There is a generalized lack of knowledge about the causes for changes in climate and, therefore, it is an issue that does not go beyond the news, and which is not clearly relevant in the local reality. It is also true that producers have seen agricultural yields decrease, particularly in the native corn varieties, which has caused the adoption of improved varieties particularly among people whose main destination of production is to feed livestock. Unfortunately, it is a fact that this will worsen in the medium and long term according to scenarios of CC that point to an increase of temperature and decrease in rainfall in the region.

The study also allowed identifying strategies for adaptation to the negative effects of CC, evidencing that they are not spontaneous actions and that they have emerged empirically through daily contact with the phenomenon. As mentioned by Pinilla-Herrera *et al.* (2012), “In face of the technical documentation of the perceptions and the adaptability on alterations of climatic variables, it is important to conclude that from a scientific viewpoint, consistencies will continue to be found between the objective and the subjective, since the local knowledge—not measurable— establishes another form of knowledge that is justified in the experience, and therefore, they are valid, verifiable and credible understandings”. Therefore, the application of measures of prevention, mitigation or adaptation to CC is a long and varied process that depends not only on the ability to comprehend but also on the resources available, priorities of those involved, and society’s organization, in addition of course to the support from governments and research institutions.

The application of the online survey is an option in studies where data about one or many phenomena that are happening in a community need to be obtained, such as the perception and the adaptability of the population in face of changes in climatic patterns or Climate Change; therefore, the application of online surveys is a feasible option that is inexpensive, easy to obtain, easy to quantify, graph, interpret and analyze, although mechanisms for validation and sampling must be implemented.

Climate Change is one of the greatest challenges that humanity faces today since it affects each and all of society’s activities, although food security is perhaps one of the more critical issues and which forces authorities, politicians, scientists, decision makers and

the population at large to implement urgent measures to revert the problem. As a result of this, there is a need to elaborate detailed and local studies on the present and future affectations from climate change but also on how to involve society in general to generate action strategies.

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