Regional, Socio-Economic, and Demographic Vulnerability to Climate Change and Extreme Events in Baja California Sur, Mexico: Overview and Research Programme

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Abstract

This paper summarises the rationale and main research orientation of a proposed chapter on climate change vulnerability at the regional and local *social l*evels in the Mexican state of Baja California Sur's *Plan Estatal de Acción Contra el Cambio Climático*, PEACC (State Action Plan on Climate Change), now being drafted by researchers working at the state's main higher education institutions, in which we authors take part. The paper is structured in four sections. The first offers a brief review of previous assessments of climate-related vulnerability in Mexico. In the second section we argue that Mexico is especially vulnerable to climate-related extreme events, which tend to turn into disasters due to social inequality, the prevalence of poverty in over half of the population, fragile ecosystems and infrastructure, and a "development" model that fails to meet generally accepted sustainability criteria. The third part focuses on the characteristics of Baja California Sur (BCS), a peninsular state in north-western Mexico that suffers from the pervasive effects of both droughts and hurricanes, phenomena associated with climate change, with a large negative impact on tourism, agriculture and fisheries, as well as the well-being of the population. The fourth and final section outlines a research agenda for climate-related human/social vulnerability and its effects in the state of Baja California Sur, within the above mentioned PEACC.

Introduction

It is now widely accepted that climate change is not just a threat for the future, but that it is already with us (Sharma 2007; Australian Greenhouse Office 2005, Beratenes 2003). The *IV Evaluation Report* of the Intergovernmental Panel for Climate Change (IPCC) concludes "that the warming of the climate system is unequivocal, as evidenced by rises in global mean temperatures, the melting of Arctic ice, and the rise in the sea level; moreover, it expected that these trends will grow in intensity" (UNFFCC 2008). The effects of that phenomenon are undoubtedly being felt in Mexico as well, as witnessed by the greater intensity of hurricanes and cyclones on the Pacific, Gulf of Mexico and Caribbean coastlines, often penetrating hundreds of kilometres inland, leaving huge material losses. Further evidence points to more frequent and intense heat waves and drought in the Northern part of the country, cold fronts in the north and the centre, torrential rain in the Central, North-Eastern and Southern states, followed by vast areas of flooding that affect thousands, even millions of people, events that many attribute to global climate change, both of the cyclical kind and anthropogenic in origin As a recent paper on climate change in Mexico has put it: "Mexico, like many developing countries, is potentially quite vulnerable to economic changes caused by global climate change. It is located in a region that is fairly susceptible to significant variation in climate patterns and temperatures, and its lack of wealth could act as a barrier to funding effective climate change adaptation policies" (IPCC

2001, quoted in Boyd and Ibarraran 2008). Unfortunately, this comment is also an accurate description of conditions in the state of Baja California Sur.

1. Background: Vulnerability Assessments in Mexico

Mexico covers an area of just under 2 million sq. km. and has a wide diversity of climate zones. Northwards from the Mexico City region to the border with the United States, the weather is warm to hot, dry to very dry throughout most of the year (the hurricane season – the autumn- being the exception). The Central Western region is generally mild, subtropical, with a summer rainy season, as in Mexico City. Along the Gulf of Mexico and on the Yucatan peninsula the weather tends to be hot and humid, with frequent flooding during the summer rains and in the fall hurricane season. Most of the country's population live in the central, northern and North-Western regions, noted for the scarcity of water.

Several international institutions, such as the United States Country Studies Program (USCSP), the United Nations Environment Programme (UNDP), and the Canadian government have financed climate and environment-related studies in developing countries, including the vulnerability that arises from climate change, and the evaluation of mitigation and adaptation strategies; stress made by other studies as well (Heltberts et al. 2008).[1] In Mexico, the body entrusted with planning, coordinating and evaluating research on climate change and its effects is the National Ecology Institute (Instituto Nacional de Ecología, INE) and researchers at the Centre for Atmospheric Studies (CCA) at Mexico's National Autonomous University (UNAM) and elsewhere in the country have studied the impact of climate change on diverse sectors of Mexican society, economy, and environment. The results of some of these activities have been published by UNAM in a volume edited by Carlos Gay, Director of the CCA (Gay 2003, Conde et al. 2008).

Climate change is expected to have large environmental and socio-economic impacts on Mexico. In order to evaluate theses impacts, Gay's team of researchers analysed the effects of doubling the concentration of carbon dioxide in the atmosphere.[2] By adapting two environmental forecasting models (the Canadian Climate Change model (CCC) and the Geophysical Fluid Dynamics Laboratory model (GPFDL-R30) to Mexican conditions, they found that there will be significant changes in overall precipitation patterns and hydrological catchments; there will be less aquifer recharging, more intense dry spells and greater desertification.

[1] In Mexico, the US–financed Country Study Program began in 1994 and ended a year later. Results were published in Magaña (et al. 1997, 2003). As mentioned in the text, Gay (2008) shows the results of a wider-ranging study.

[2] Magaña et al. (2003) underline the fact that Climate Change Models (CGM) are as yet limited in their ability to be integrated into regional or local studies, owing to their low resolution and too large scale. Still, these models can be usefully employed to simulate climate change by changing (e.g., doubling) the amounts of CO2 (2XCO2), given that the increase in the amount of this gas has been associated directly with human activity since the 19th century. Doubling the amount of CO2 (in the atmosphere, oceans, and plants) would result in significant increases in global warming by the mid-2000s or at the latest, by century's end.

These studies show Mexico to be a vulnerable country. As Gay (2003) reports, future climate scenarios predict increases in temperature but are not specific about rainfall, which in some models increases (because there are more hurricanes) but in others decreases (because of drought); both possibilities have been considered and both models employed. The trend in hurricanes is an increase in intensity, although not necessarily frequency, but their behaviour is by no means simple; many variables influence their inception, intensity and trajectory. As well, the impact of climate change in the different areas with cyclone activity will vary. Drought shows a tendency to increase in severity in several regions, and the competition for water, already intense, is to grow (Brabeck-Letmathe 2008). Moderate increases in temperature are expected in all regions of Mexico, as well as significant changes in rainfall. Magaña et al. (1997) warn that "the direction of these changes is extremely difficult to predict (but) they will have a significant impact on the Mexican rain season."

The Mexico country study also points to a 50 per cent reduction in forest cover due to the effects of climate change, and estimates that temperate-zone forests will be most affected. Coastal areas could be threatened by rising sea-levels, saline intrusion into the aquifer, and storms that affect regions farther from the coast. Floods and (paradoxically) lack of water could seriously hamper the industrial and energy sectors, whereas the yields of rain-dependent agriculture, in particular maize in the north, could decrease severely from already low levels. The study also underscores the direct implications of climate change for the population at large, such as water scarcity, the increase in certain types of diseases, internal migration, and population growth and its concentration in a handful of urban centres, often already under significant environmental stress: Tijuana, Ciudad Juarez, Cancun and Cabo San Lucas come to mind as does, of course, Mexico City.

2. Extreme weather events in Mexico

Around the world, extreme weather events are now on the rise and more likely to happen in the future. This is particularly true of both extremely dry and very wet periods. According to John Holmes, United Nations Undersecretary General and emergency fund coordinator, "any credible vision of the future must recognise that humanitarian needs are increasing. Climate change will be the main driver. Nine out of ten disasters are now climate-related. Recorded disasters have doubled in number from 200 a year to more than 400 a year in the past two decades…*so welcome to the "new normal" of extreme weather*" (Holmes 2008, emphasis ours.) [3] Holmes reminds us that neither poor nor rich are totally exempt from the effects of climate change (the richest few in most countries are, of course, only partially concerned over this warning). And he insists that nature is not the problem, *we* are: "be it through dangerously high emissions of green-house gases, depletion of natural resources or reckless urbanization, we are creating a house of cards that could mean humanitarian catastrophe for millions. Too often we do not take the simple precautions that can reduce

[3] Extreme events, of course, are not new, but they have received greater attention owing to their increasing frequency and intensity in many parts of the world (Cf. Watson et al., 1997).

loss of life and livelihoods" (Holmes 2008). On the same vein, Boyd and Ibarraran point out that extreme precipitation events have become more common, and tropical storms more devastating, "due to the underlying decadal cycle, to the fact that more densely populated areas have developed across the coastlines, and because of the higher strength and intensity" (Boyd and Ibarraran 2008, p. 4). The authors go on to stress that such extreme events can turn into disasters if they occur where there are *vulnerable populations, fragile ecosystems and infrastructure, and high levels of economic activity* (emphasis ours). Using data from the Centre for Research on Epidemiology of Diseases (CRED), Boyd and Ibarraran assert that already 10 per cent of the Mexican population (almost 11 million people) live in areas where the risk of mortality from environmental factors is high (Boyd and Ibarraran 2008, p. 4).

Mexico stands out as being especially vulnerable, owing to a host of reasons. First, its location: the country covers over 17 degrees of latitude (from 32 degrees north to 15 degrees south), and this encompasses, as said, a wide variety of sub-climates, as well as a large probability of being hit by hurricanes, cyclones and windstorms, often followed by flooding. Extremes of heat and cold are common, often in the same locality, as is seismic activity, especially in the central-western region. This situation is aggravated by Mexico's very high poverty levels (from 50 to 65 per cent of the population, depending on who does the reckoning), and its severely skewed income distribution (the Gini coefficient hovers round 0.50).

Boyd and Ibarraran (2008, table 1) offer data on natural disasters in Mexico from 1929 to 2005 with reference to droughts, earthquakes, epidemics (which include diarrhoea/enteric –cholera–, and dengue fever). Their Table 1 is reproduced below as our Table 1. Comments follow:

Table 1. Summary of Natural Disasters in Mexico, 1929–2005

Events	No. of Events	Persons killed	Person injured	People Homeless	Affected	Total Affected	Damage US dollars (000s)
Droughts	8	0	0	0	65,000	65,000	1,625,000
Average per event		0	0	0	8,125	8,125	203,125
Earthquakes	27	10,677	33,287	112,275	2,411,015	2,556,577	76,500
Average per event		395	1,233	4,158	89,297	94,688	2,833
Epidemics	2	68	0	0	11,525	11,525	0
Average per event		34	0	0	5,763	5,763	
Extreme temperatures	16	1,207	0	16,000	1,400	17,400	4,000
Average per		75	0	1,000	88	1,088	250

event							
Floods	44	4,080	659	165,990	1,333,695	1,500,344	138,400
Average per event		93	15	3,773	30,311	34,099	3,146
Slides	6	202	0	120	200	320	0
Average per event		34	0	20	33	53	0
Volcanoes	10	1,120	500	15,000	146,408	161,908	3,300
Average per event		112	50	1,500	14,641	16,191	330
Wild fires	3	83	0	0	0	0	0
Average per event		28	0	0	0	0	0
Wind storms	58	4,948	1,803	316,250	2,257,815	2,575,868	3,969,000
Average per event		85	31	5,453	38,928	44,412	68,431
Source: Boyd and Ibarraran 2008, table 1							

A rough total of the total population affected by these events comes to round 6.8 million over the period covered by the authors, an unbelievably low figure Although they focus on drought, it is clear from a look at the number of people affected that the main culprits are elsewhere: the numbers show that earthquakes affected more than 2.5 million (38% of the total), followed by windstorms (hurricanes), with 34%, and by floods, with 22%. The numbers of people affected by disasters in Mexico is much larger than those given here, and more research is certainly needed.

According to the Boyd and Ibarraran data, drought affected only 68,000 people, but caused economic damages of 1.6 billion USD; whereas earthquakes, including that of 1985, which devastated Mexico City, had a cost of only 77 million USD. On the other hand, these authors report events, such as landslides, with large losses in terms of human lives, but zero effects on the monetary scale. To be fair, Boyd and Ibarraran's stated purpose is to apply a computable general equilibrium (CGE) model to measure the impacts of a climate-driven drought on Mexico's economy, not its overall human and social effects. Nonetheless, one cannot but feel that the excellent scientific data that are being generated in Mexico should put to more comprehensive analyses: CGE may have its uses as a modelling tool, but it is rather too restrictive.[4]

[4] The present authors have also used computable general equilibrium models in previous work (eg. Angeles, Ivanova, and Gamez 2008). At least one of them, however, is extremely wary (and weary) of the neo-classical assumptions (the effects of the price mechanism, the form that capital is to take -putty-clay, etc). One should of course be extremely cautious about modelling financial sectors in a CGE model (Downing 1992). For an alternative to neo-classical linear modelling see Duchin (1998), or the journal *Structural Economics and Dynamics.* Despite these comments, the Boyd and Ibarraran piece is a useful exercise although, in our view, their scenario 3 is unattainable. The problems lies with the assumed elasticities, as well as changes in government policy that one cannot take for granted.

Listed In terms of economic losses, Table 2 shows the ten most important extreme events of the last three decades:

Table 2. Recent extreme climate events in Mexico, 1985-2007		
Event	Year	Estimated cost (millions of USD)
Tabasco floods	2007	700
Hurricane Wilma	2005	1,752
Hurricane Emily	2005	302
Hurricane Stan	2005	228
Hurricane Isidore	2002	308
Hurricane Kenna	2002	176
Hurricane Juliette	2001	90
Hurricane Pauline	1997	62
Hurricane Gilbert	1988	567
Mexico City earthquake	1985	473
Source: Mexico's National Water Commission, (CNA), various years		

Clearly, hurricanes are the most recurrent events: there were three of them of great devastation in 2005 alone, and their economic impact has been on the increase. However, their effects in human terms surpass by far the immediate economic losses: production facilities tend to be repaired in fairly short order, but the loss of home and property (such as it is) tends to affect the bulk of the population (especially in rural areas) to a greater extent than it does industry, or the main urban centres. Generally the poorer social groups have tended to bear most of the costs, both human and economic, since they inhabit riskier areas and lack insurance or other resources to recover financially.

As stressed by Boyd and Ibarraran, moreover, it becomes clear that drought will be a very serious problem for Mexico, "more frequent, more profound, and will last longer than the worldwide average"; adding that drought and floods are the most damaging extreme weather events in Mexico, since they directly affect food production and their impacts are felt most pronouncedly by the poorer segments of society. The GDP data given in Figure 1 (in Boyd and Ibarraran) is instructive: By 2026, Mexican GDP would fall from 1,220 billion USD to 1,180 billion USD under the assumption of pronounced and prolonged drought, representing a drop of about 3 per cent; scenario 3 ("adaptation") would result in 0.33 per cent growth. The balance of payments surplus would fall by 26%. Interestingly, an already skewed distribution of income would become more unequal: under scenario 2 (long drought), the lowest income group ("welfare agent 1", in the neo-classical jargon), with an income of 4,193 USD for the base year, would suffer a decrease of 1.12 per cent,[5] but "welfare agent 4" (income: 32,465 USD, or 8 times larger than the first group

[5] Boyd and Ibarraran are not unaware of these findings. Indeed they stress that drought would imply serious losses of productivity for subsistence farmers (between 18 -24 percent of the total labour force). They also stress the need for "greater substitutability", a long-time neoclassical remedy, but point out the difficulty for subsistence farmers to obtain (eg.) water, seeds, or fertilisers. Still, that does not excuse their faith in "the

considered), is to lose 0.54 percent-of income.

It should be noted that Holmes (2008, p. 110) concurs on the severity of this type of outlook for the poor: "If climate change is the most fundamental problem, the global food crisis is the most immediate problem. The knock-on effects extend far beyond hunger to include child malnutrition, lower primary-school attendance, and political instability….today`s food crisis is but an opening act in a larger drama in which swathes of the developing world will suffer acutely. How will we feed 50% more people using 59% less carbon, which is what the IPCC says it is imperative to avoid environmental chaos?".

Swathes of Mexico are already in the throes of the effects of climate change. Hernandez (2003) has found that doubling the amount of CO2 would bring about the result that almost 40 per cent of the country would face severe and prolonged droughts Available water would decrease, owing to aquifers being recharged less frequently and in smaller quantities. Scarce water would trigger chain reactions throughout the socio-economy: agriculture, cattle-raising, forestry, and ecosystems would be adversely affected, as well as some activities that depend on them, such as tourism. Although prolonged drought would more severely affect agriculture and forestry, urban centres would also suffer, mainly from lack of fresh water and water borne diseases. Food security, already below 50 per cent in some key products, would be hard-hit.

3. Conditions in Baja California Sur (BCS)

The Baja California peninsula, a 1,500 km long but rather thin (100 km, at most) stretch of land, is mostly arid, with winter rains in the Tijuana area just south of San Diego, California, hurricane activity and (recently) flooding in the southern part of the peninsula, which holds the state of Baja California Sur (BCS). The state, with an area of about 74 thousand sq. km., 2,000 km. of shoreline (one-fourth of Mexico's total), and population slightly under 600 thousand is evidently vulnerable to climate change and its effects. The vast majority of the state's population lives along the seashore, so that Sharma's (2007) caveats on coastal zones are a primary concern.[6] We take very seriously the recent warning by scholars meeting in Copenhagen, that long term sea-level rises may reach one metre or more, rather than the 18-50 cm. predicted by IPCC (2007).

Hurricanes and subsequent flooding are the most important climate-driven extreme events in BCS. The subtropical climate of the state, as well as the paths of Pacific hurricanes, ensure that the peninsula is more affected by tropical storms and cyclones than almost any other part of the country except the Caribbean and the Pacific Southwest. Table 3 lists tropical storms in BCS, including known or suspected fatalities:

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market", especially nowadays. Besides, no neo-classical theorist of note has seriously defended instantaneous responses in the markets of goods and services. The problem arises when practitioners are not imbued in theory.

[6] In an Annex, Sharma provides a wealth of examples of tools available for the management of climate-related risks in different communities.

Table 3. Extreme hurricane events in BCS, 1918-2007		
Name	Year	Number of deaths
Henriette	2007	1
John	2006	5
Paul	2006	2
Ignacio	2003	2
Marty	2003	5
Juliette	2001	2
Isis	1998	0 - 18
Nora	1997	2
Fausto	1996	1
Ismael	1995	0 – 57
Flossie	1995	2
Liza	1976	435-600+
Pauline	1968	4-5
Unnamed	1918	25
Source: List of Baja California hurricanes. Baja California hurricane tracks, Wikipedia (retrieved: 10-3-09).		

With time, provisions have been taken to reduce the toll of deaths, but in general no event has occurred without mortalities.

The effects of hurricanes, floods, and other phenomena associated with climate change on tourism, the state's main economic activity (about 40 per cent of GDP), are unequivocally negative. Population growth resulting from tourism growth (to about 2 million visitors per year, or four times the local population), and real estate speculation, has led to the creation of large "misery belts" and marginalisation, especially in the Los Cabos municipality. At the same time, the state's environment is clearly being affected by climate change and its attendant effects, be they natural or anthropogenic in origin. The identification of regions, groups, sectors and populations in conditions of vulnerability, and the recommendations arising there from, are of immense socioeconomic and environmental importance for BCS.

As is the case for the nation as a whole, there is no doubt that BCS already faces the effects of climate change, which will just as likely intensify in the future, regardless of global, regional, or local efforts to reduce green-house gas emissions. The scale of such changes, their manifestations, and the way in which they will affect the state's regions and micro-regions, communities, residents and visitors, are as yet unknown. However, the application of more precise climate change models may help to measure them. Although precise estimates are lacking, one can expect for BCS the following possibilities, based on the findings of the Fourth IIPCC report, as well as preliminary results obtained by academics working in universities and research institutions in BCS.

- An annual increase in temperature of between 0.4 y 2.0 degrees C until 2030, and between 1.0 to 6.0 C to 2070,

- More frequent an intense heat waves,

- Greater frequency of El Niño events, with a more pronounced cycle of drought alternating with flooding

- Reductions in precipitation in the southern part of the state, and a corresponding increase in rainfall in the northern municipalities,

- Despite the above, more frequent hurricanes, of greater intensity,

- Greater risk of flooding, both in urban and rural zones,

- Greater damage to buildings, homes, and electricity, water, and drainage systems,

- Changes in coastal zones, rising sea levels, changes in currents and water flows,

- Severe changes in the amounts of oceanic basic matter, leading to a decrease native and migrating species, leading to reduced bio-diversity,

- Strong negative impacts on the state`s main economic activities; tourism, agriculture, mining and fisheries,

- Impacts on population flows, both into the state, and within it.

The last point merits further emphasis. In the last 15 years or so, BCS has fallen from 4th to 9th place in the national ranking of states in terms of income per person. Although GDP growth (up to 2007, last figures available) grew at a faster pace than the national average, population growth was even faster: the Los Cabos municipality went from 20,000 people in 1980, to 164,000 in 2005, mostly through migration. Other indicators of human well-being, such as life expectancy and education, have remained fairly strong in comparison with (rather low) national standards, but even by these measures are showing a downward trend, again especially in Los Cabos.

4. Towards a research agenda for human vulnerability related to climate change and its effects

It is now a commonplace that climate change cannot be discussed in isolation, but rather in conjunction with matters such as those just listed, among others. At the same time, the climate change literature insists that rich world populations must change their lifestyles if the planet is to survive. According to the Human Ecological Print measurements, we would require from 7 to 9 planets Earth, if we were to follow the consumption patterns of the high and middles classes of the USA. This recognition implies limits on our future extractions

from a finite place (our planet), which faces inexorable laws: population and thermodynamics.

Even if long-term solutions, with particular regard to the greenhouse effect, are still an "on-going situation,", continuously re-evaluated and revised but not, yet, seriously undertaken, it is imperative that we act at the regional and local level, to look into the impacts of socio-economic and demographic change at those scales. The socio-economic environment can influence and condition (or not) the resiliency (or lack thereof) of affected groups, regions, and populations, and their answers and strategies of prevention, mitigation, and adaptation to climate change (University for Peace 2007).

As suggested earlier, little research has been done on *human* vulnerability rather than its environmental or economic counterparts. In order partially to fill this void the present document is orientated towards the relevance of analysing: (a) the effects of climate change- driven extreme weather events on the ability of the affected population groups of BCS, to continue to carry out their normal productive and social activities, (b) the interactions between climate-change, extreme events risks, adaptability and vulnerability. We deem this task to be essential, for even though environmental disasters are generally thought of as "acts of nature," the fact is that social and human vulnerabilities can turn a calamitous event into a disaster. Poverty is a factor of overwhelming significance, which greatly increases vulnerability and reduces the scope for action by local populations: estimates are that: 94.25 per cent of disaster-caused deaths between 1975 and 2000, involved low or low middle income people. Thus, these groups are to receive special attention in the research project that is outlined below, even though, as will be seen in the project's general objectives, its reach is wider. While it is certainly true that vulnerability is highest where marginalisation is crudest, it is by no means absent in the rest of our territory.

Research on vulnerability is, by and large, of fairly recent vintage in Mexican academic circles and (theoretically and methodologically) it has been-explored mainly with a view of applying it to restricted communities, whether the "restriction" is due to income, status, race, class, or gender. When the notion of vulnerability began to be employed, it referred mostly to such groups as were deemed a social priority, in particular children, women, older people, indigenous groups, and the ill. From there, public policies were designed to give specific attention to these sectors of the population.

The UN has mandated, specifically in its Millennium Objectives, that research such as we propose be gender-orientated. This type of research must deal with male-female differences in terms of (a) the ownership and disposition of physical, financial, human and social assets, (b) their different strategies for employing those assets, and (c) the set of possibilities to which men and women may have access, as conditioned by the market, the State, and "civil society." (United Nations 2007)- An analysis of gender-based inequalities and disadvantages is a key component in our research, especially when account is taken of the fact that in rural areas or in poverty stricken urban sectors, the vulnerability of women to extreme climate events is at its highest (United Nations 2008; UNFCCC 2008).

A look the problems at the level of regions, groups and populations (both resident and

visiting), including of course the gender approach, will enable us at the same time to obtain a general vision of our state's vulnerability, whilst providing more detailed views of the key groups involved in confronting the effects of climate change from the human perspective (cf. United Nations 2007, p. 1). Key words are: climate change, socio-economic and human vulnerability, regions, localities and population, Baja California Sur, Mexico.

A non exclusive list of general research priorities follows:

4.1 Objectives

- To identify the regions, groups, and populations vulnerable to climate-driven change in Baja California Sur, to assess their degree of vulnerability and risk, and to prepare the relevant diagnostic reports.

- To predict the effects of changes in climate on vulnerable regions, groups, and populations of BCS at the local level (both residents and visitors), in accordance with projections of regional natural sciences experts working on the State Action Plan, and to propose ways of managing risks[7]

- The gender approach is an integral part of both goals.

4.2 Methods

The statistical data required for this study will be drawn mainly from (a) INEGI (2000), the latest population census, (b) INEGI (2005), the mid-Census population simple, and the National Population Council marginalisation indices by locality (CONAPO 2005). Given that available official data are too aggregated for our purposes, we propose to conduct surveys in La Paz and Los Cabos and apply GIS (Geographical Information System) to the information. Based upon information from the natural science researchers' team, we will make forecasts about likely changes in the state of vulnerability and statistics will be used to make a diagnosis of the climate change-related vulnerability of the population (both residents and visitors) in BCS. Essential to this will be the use of Neuronal Networks and Diffuse Logics for the analysis and prediction of the regions and population's vulnerability to climate change and its effects

5. Concluding remarks

Studies about the negative effects of climate change on the economy have rendered important outcomes but there is still a vast array of fields and regions lacking assessment.

[7] See note 1 of this paper. In regard to proposals, we view the case studies reported in UNDP ISDR (2008) as fundamental, since our own research also centres on marginalised populations and communities,

In this paper we want to call attention to the importance of evaluating and forecasting the extent of human vulnerability in small regions, such as Baja California Sur (Mexico). Although intrinsically related to economic and environmental vulnerability, this type of research can give particular insight onto the policies that could be advanced to avoid human tragedies and help establish stronger basis for sustainable development. Therefore, the study will focus on the impact of climate change and its effects on the vulnerability of regions, social groups and communities in Baja California Sur. Although we deal with a wide array of issues (material goods, capabilities and economic activities, and the population's capacity of mitigation and adaptation), throughout the study the crucial element is human vulnerability.

Thinking economic growth by using the lenses of sustainability, as well as by raising awareness of the importance to take into account nature-related conditions, can lead to better ways for social organization and, to that extent, to the avoidance of human tragedies represented either by the loss of human lives and/or the weakening of productive capacities. We expect the study we are undertaking will help contribute to the design of more adequate public policies and to the private sector awareness about the need for planning and mitigation schemes related to climate change effects in a region which is highly vulnerable.

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