Past disaster damages as drivers of coping and adaptive strategies in small and medium community businesses

Paola Hernández Montes de Oca*

University of Leeds

Centre for Climate Change Economics and Policy

Abstract

Small and medium enterprises are the most vulnerable group within the business sector to extreme climate hazards and, consequently, are the most threatened by climate change impacts. If these firms, as an integral and vital component of the economic and social system, are unable to acquire the ability to withstand future climate events and adapt, then development could be compromised in developing nations. The aim of this paper is to identify the coping and adapting mechanisms adopted by SMEs in a developing context, and examine which business characteristics and proactive attitudes constrain or facilitate the adoption of preparedness measures. Moreover, it investigates how the different types of damages experienced by businesses influence the nature of the measures implemented to protect them from tropical cyclones. Data was obtained by means of a face-to-face survey, which was carried out in two prone coastal areas in Mexico. Expanding on previous studies on businesses and natural disasters, this paper presents two quantitative models to derive its results. The findings suggest that direct damages (e.g. structural damage) increase as the events grow in magnitude. The enterprises that have experienced these types of damages are the ones that have adopted more adaptive measures (e.g. installed hurricane shutters). Meanwhile, indirect related damages (e.g. access in roads) drive the adoption of coping actions (e.g. store equipment). Proxies for strategic thinking and business environment prove to be good predictors in the adoption of both reactive and proactive measures. Overall, this work contributes to identify important elements that should be targeted in order to build the capacities that SMEs need to adopt in a developing context, so as to be in a better position to overcome an increase in the magnitude of tropical cyclones due to climate change.

Keywords: climate change, small and medium businesses, coping, adaptive measures

Introduction

Many people around the world are already experiencing stresses from changes in the climate, and each day more studies emerge that confirm the presence of these variations (Richardson *et al.,* 2009). The literature suggests that climate variability and climate change will affect the economy, the society and the environment (IPCC, 2007). Despite the enormous uncertainties that this phenomenon entails (Dessai *et al.*, 2007b), it is broadly accepted that vulnerable groups will be the most affected, and this could be further exacerbated if scientific projections are revealed to be true. Most of these groups are located in the developing world, which is also where climate variations and extremes are being felt more intensely. These can burden development paths, as they have the potential to weaken social assets (i.e. institutions) and destroy physical ones (GHF 2009). It is thus broadly accepted that developing nations will be the most affected, since the available measures needed to face this phenomenon depend on the access that individuals have to different forms of capital and resources (Smit *et al*. 2001).

In developing countries, small and medium enterprises (SMEs) form an essential basis of the economy (Pimenova and Van der Vorst, 2004). Although their individual impact may be considered small, SMEs represent approximately 95% of the whole private sector in almost every nation, which represents a major portion of all the economic activity (Schaper, 2002). SMEs perform crucial economic functions, such as providing employment, which can range between 60-70% of the total in most modern economies (Murphy, 2002), and account for around 55% of the gross domestic product of many nations (WBCSD, 2007). They produce goods and services to society, are a source of livelihood for communities, constitute local suppliers to large corporations (WBCSD, 2007), and are a source of innovation and agents of change in the business sector (Hillary, 2000). Hence, SMEs have been considered as important actors that promote growth, facilitate poverty reduction and enhance a more equitable development in the developing world (Jeppesen, 2005). However, within the private sector, they are the most vulnerable to natural disasters (Alesch *et al.,* 2001), and are considered to be the least able to cope with climate related impacts (Nelson, 2008).

There is a general consensus that disaster preparedness constitutes one way of reducing the negative disruptions caused by climate related events (Mitroff II *et al.,* 1987; Quarantelli, 1994; Dahlhamer and D'Souza, 1997; Howe, 2011). However, it has also been acknowledged that not all measures entail the same amount of effort, resources, expertise, etc. (Howe, 2011; Yoshida and Deyle, 2005; Webb *et al.,* 2000; Tierney, 1997; Alesch and Holly, 1996). In general, SMEs tend to take those measures that require less effort to implement and thus become "*ill prepared*" (Howe, 2011; Dahlhmer and Reshaur,

1996). On the other hand, preparedness measures can be conceptualised depending on different time scales. For instance, storing equipment and protecting inventories represent reactive measures that some businesses undertake, which protect them from a hazard in the short-term. Contrarily, installing hurricane shutters is a proactive action that conveys a higher level of preparedness, not only from a single upcoming event, but also from future impacts. In this sense, this paper argues that it is relevant to take into account these differences in time scales, so as to better understand the issue at hand and to provide sensible recommendations.

Even though there is a handful of empirical analysis that have addressed the types of preparedness activities that businesses are likely to engage in (Howe, 2011; Dahlhamer and D'Souza, 1997; Dahlhmer and Reshaur, 1996), there is a lack of studies focusing on small firms in a developing country context. Similarly, the majority of studies do not differentiate between types of preparedness measures. Moreover, the issue of what determines the adoption of these measures remains being an under-researched area in the literature. This paper aims to fill these gaps by examining which types of coping and adaptive mechanisms SMEs undertake in two coastal developing areas to protect themselves from tropical cyclones or flooding, as well as to identify which factors constrain or facilitate the adoption of different kinds of preparedness measures.

The next section provides a summary of the major and most common findings of the natural disasters literature, from which the explanatory variables of the models used in this paper were identified. Then, the survey design, variables and the techniques used to test the statistical models are presented. The following section discusses the results. Finally, the paper concludes with a discussion of the implications for the future of small and medium enterprises in the face of some expected climate change impacts.

Background

There are a number of studies in the literature that have analysed the situation of businesses related to natural disasters. This body is characterised for being more empirical than theoretical and the majority does not mention explicitly a specific analytic framework. They are mainly interested in looking at how businesses plan, prepare, respond and recover from natural disasters, and focus on what happens when firms face this type of events (Zhang *et al.,* 2007). Most of them have concentrated on earthquakes, and are carried out predominantly in developed countries.

The existing research suggests that natural disasters (e.g. hurricanes, floods, earthquakes, fires, etc.) have a great impact on the business sector, not only because of the direct physical effects, but also due to several indirect factors. For instance, Tierney (1997) found that after the 1993 flooding in the Midwest United States, several disruptions were registered in the public infrastructure (e.g. electric power, telecommunications, water and sewer, transportation, fuel, etc.). Organisations rely on those services to carry out their normal activities. Hence, these disruptions were among the main reasons for business closures during the aftermath of the disaster (ibid). Another important disruption that enterprises have experienced is related to their supply chains. Runyan (2006) undertook a study shortly after hurricane Katrina struck the coasts of New Orleans. His aim was to study the experiences of small firms after the disaster. He reported that even after 85 days of the impact, the supply of certain products was not available and, as a result, many businesses could not continue with their normal operations. In addition, it has been said that natural disasters can change the market structure of a certain region, since they can lead to a decline in customer traffic or to a destruction of the customer base (Zhang *et al.,* 2007). It has also been found that natural disasters can have a distributive effect. Some industries can thrive, while others can decline due to changes in consumer demand (Webb *et al.,* 2000). Furthermore, Webb and colleagues found that natural disasters can diminish worker productivity, as employees may have experienced disaster-related difficulties at home, and may be injured or ill —or even fatalities might have occurred. Several scholars have claimed that recovering from these "hidden" factors is at least as important as the physical losses (Chang and Falit-Baiamonte, 2002).

Having a previous disaster experience has shown mixed results in the literature. Academics such as Webb and colleagues (2000) report that those businesses that have experienced a disaster may be better prepared. Dahlhamer and D'Souza (1997) report a positive correlation between past experiences and strategies implemented to moderate harm. Further studies such as Howe (2011) report no predictive power of disaster experience on preparedness measures. Yoshida and Deyle (2005) also show that disaster experience did not have a significant effect on the preparedness measures. Although, both studies acknowledged the possibility that the respondents had little exposure to a major event at the time of the data collection. If the literature suggests that SMEs learn by experience, one would expect that those that suffered damages as a consequence of an extreme weather event and continue in the market are the ones who have taken some actions to prevent future impacts.

There are several conditions that seem to constrain businesses' coping and adaptive capacities to climate hazards. Small firms usually do not possess enough financial resources, and are highly dependent to cash flows, so they do not have sufficient "slack" to recover (e.g. to purchase inventory or equipment that was lost in the disaster) (Alesch *et al*., 2001). As opposed to large firms, SMEs generally serve local markets, so they cannot diversify their risks in multiple locations (Webb *et al*., 2000). In addition, they usually have poor infrastructures and the characteristics of a firm's premises (location and whether they are owned or leased) can affect them negatively. For example, they may have to wait for the landlord —if they do not own their installations— to rebuild the premises after an impact (Runyan, 2006). Furthermore, they generally do not invest in structural and non-structural mitigation activities, such as planning or insurance purchases against natural disasters. Planning represents a highly time-consuming activity for them. Additionally, they do not have access to expertise, and the level of complexity to implement prevention measures (e.g. insurance policies may be difficult to understand) can be burdensome (Yoshida and Deyle, 2005). In this sense, many SMEs usually consider that the costs of implementing short and long term strategies (as has been said, due to a lack of time, funding and expertise) may outweigh the benefits derived from them.

Evidence suggests that among the strongest predictors of preparedness measures is the size of the firm, measured by the number of employees (Dahlhmer and Reshaur, 1996; Webb, *et al*. 2000, 2002; Chang and Falit-Baiamonte, 2002). There is a general agreement that large firms are more likely to recover in less time from a natural disaster, because many have insurance coverage or special funds for contingencies. They can also afford to have staff to deal with issues specifically related to the crisis. And, besides, big corporations are better positioned with their suppliers and their contractors —who can immediately begin to repair their premises—, or they might even have financial and political influence in their localities to attract funds to help them to recover (Zhang *et al*., 2007; Lindell and Perry, 1998; Whitney *et al.,* 2001). Nevertheless, some authors suggest that due to the amount of fixed assets, large businesses are more vulnerable to natural disasters than small firms, since they have much more things to lose (Tierney, 1997).

In relation to post-disaster aid, empirical studies have found that these measures often do not lead to positive outcomes. Aid usually comes in the form of loans, which bring additional pressures to businesses that are struggling to recover (Runyan, 2006; Danes *et al*., 2009). In addition, recovery has been studied from several perspectives. Alesch *et al*.'s (2001) work reports that weaker businesses that suffer from poor financial conditions prior to the disaster were more likely not to

recover from the event. In the disasters literature it has been argued that in the majority of cases a disaster caused behaviour is just a continuation of pre-disaster patterns (Quarantelli, 1994). Those businesses that were not doing well before the disaster (e.g. in their financial condition) and went out of business after that was not just because of the experience but an acceleration of its past condition.

There is a general consensus that in order to trigger adaptation, firms have to be conscious of the stimuli (Berkhout *et al.,* 2006). Even though natural disasters can be a cause of business failure, in general terms the perception among the business sector is that the risks related to these events are low, which results in poor future preparedness (Yoshida and Deyle, 2005). Businesses do not usually perceive their vulnerability and commonly adopt an "it-will-not-happen-to-me" attitude (Berkhout *et al.*, 2006). According to Spillan and Hough (2003), awareness arises and action takes place only when a business has experienced a past crisis. If perception about natural disasters can affect the outcomes of the experience, this issue has significant implications in the face of climate change. This phenomenon imposes the necessity to enhance awareness and identify the potential risks, in order to take proactive actions. It has been acknowledged that climate change involves different time scales. Thus, it is not only important to examine the capacities of SMEs to cope with a climatic event in the short term, but it is also vital to study their capacities to adapt in the long-run. Both attributes are complementary and necessary in order to face the different phases of this phenomenon. In this fashion, in this paper we make a differentiation between the short-term coping measures and medium-term adaptive strategies. On the one hand, coping measures refer of those reactive actions that seek to defend, protect and recover from the imminent probability of an event. These are taken prior the impact and are easy to implement. On the other hand, adaptive measures consist of proactive actions taken to change and to be better prepared to deal with future impacts. Generally, these require more resources (e.g. time, efforts, expertise, money) to implement.

The next section provides a brief examination of the research sites, then the methods utilised to conduct this research are presented, followed by the results, discussion and a conclusion.

Research sites

There are various studies that identify Mexico as a region prone to impacts derived from climate variations and extremes (Anderson *et al.*, 2008). Severe cyclone events and sea level rise are threatening some coastal regions, particularly in the Gulf Coast and the Caribbean (Warner *et al.*, 2009). Two sites of study were selected to carry out the research: Ciudad del Carmen and Chetumal.

Both are located in the Yucatan Peninsula. Their geographical location, weather conditions and hydrology, contribute to its physical vulnerability to extreme meteorological events. Carmen is one of the eleven municipalities in which the Mexican state of Campeche is divided. It is the second most important municipality after the state's capital. Its main city is Ciudad del Carmen, located at the Southwest of Carmen Island, which stands in the middle of the Terminos Lagoon ecosystem. Ciudad del Carmen has a crucial role in the economy of the state. According to the Department of Economic Studies of INEGI[1], this city contributes with 56.9% of Campeche's GDP, representing around 0.7% of the national output. Moreover, the region produces 70% of the total oil extracted in the country, 45% of the Gulf of Mexico shrimp production and 20% of the total national shrimp catch (Yañez-Arancibia *et al*., 1999). Around the 1950s, the main economic activity in Ciudad del Carmen was fishing. However, in the 1970s oil was discovered in this region, leading to a rapid change of its economic and social structures. Apart from the large scale exploitation and degradation of the natural resources in the area (Yañez-Arancibia *et al*., 1999), migration has brought an increasing pressure in the provision of public services (e.g. drinking water, security, rubbish collection). Ciudad del Carmen has an elevation of 2 meters above the sea level. Its low coastal profile makes it particularly vulnerable to storm surges and flooding. For instance, hurricane Dean left 70% of the city submerged under one meter of water. Vazquez (2009) has suggested that 50% of the population in the state is at risk from sea level rise, and this assertion is also supported by Caetano (2009). Hence, this locality is vulnerable to this kind of slow onset hazards. Ciudad del Carmen is also vulnerable to extreme weather events. Hurricanes Opal and Roxanne severely affected the area in 1995, impacting the shrimp infrastructure and fishing vessels, causing the industry to paralyze.

Chetumal is the capital of the state of Quintana Roo. It is situated on the Northern coast of Chetumal Bay. It is an important port and lies in the border with Belize. Its main economic activities are trade and related services. Before 1972, Chetumal was a tax-free zone and a relevant destination for trading. However, its appointment as a special designated zone was later abolished, but Chetumal's economy still remained dominated by commercial activities. It has been argued, nevertheless, that its key activities are related to the government. The majority of its active economic population is employed by governmental institutions or provide services for the local or federal governments (Secretaría Técnica del Gabinete, 2008). All of Quintana Roo central government offices reside in this city.

---

[1] Instituto Nacional de Estadística, Geografía e Informática (National Insitute of Statistics, Geography and Information Tecchnology).

Chetumal's geographical location makes it prone to climate variations and extreme weather events. According to CENAPRED[2] data, in the last 10 years the city has been declared a disaster-zone in six different occasions. The city has experienced hurricanes, heavy rains, and frequent flooding — almost on an annual basis—, which have sometimes levelled the entire town. Similarly to Ciudad del Carmen, Chetumal is also threatened by sea level rise. Studies carried out by the Geography Institute of the National University (UNAM) and the Department of Geosciences Environmental Studies Laboratory of the University of Arizona have identified that Chetumal lies in one of the five regions more susceptible in Mexico to be affected by this event. The INE (2010) has also designated this city, along with the Sian Ka'an bay, as the most vulnerable sites of Quintana Roo to suffer the effects of climate change. Their geophysical structures, as their individual elevations above the sea level, are the main factors that contribute to their vulnerability (Ortiz and Mendez, 2000).

Methods and data collection

A scoping study was conducted on October 2010, which allowed verifying the appropriateness and applicability of the hypothetic variables identified from the bodies of natural disasters and SME-related literature. In addition, other context-specific explicative variables were identified by means of a survey that was conducted in the study areas during March and April 2011. Paper-based structured questionnaires were administered to 345 SMEs, which included a total of 39 closed-ended questions of different types, such as dichotomous, multiple choice, likert scales, rating, etc. Twenty enumerators were recruited from the local universities[3] and received two days of training. Two field-supervisors were also hired in order to supervise the enumerators on a daily basis. The questionnaires were administered face-to-face to firm owners (70%) or top managers that had worked in the company for more than 5 years (30%). The National Directory of Economic Units (DENUE, 2010) was used[4] to draw a random sample. In order to avoid bias and ensure robustness of the results, stratified sampling was done based on the number of employees according to three strata: micro enterprises (0 to 10 employees) small firms (11 to 50) and medium organisations (51-250). The total sample size was calculated according to Cochran's (1977) formulas for discrete data. To avoid oversampling a particular firm size, a disproportionate allocation scheme, which is generally used in organisational studies, was applied. In this sense, the Neyman allocation procedure was used, which gives larger weights to those strata with higher variability, which in this case are small

---

[2] Centro Nacional de Prevención de Desastres (National Centre for Disaster Prevention)
[3] In Ciudad del Carmen was the *National Autonomous University of Carmen*, and in Chetumal was *Quintana Roo University*.
[4] This database was provided by the National Statistics Institute of Mexico (INEGI).

and medium enterprises (as opposed to micro). After correcting for finite populations, sample sizes were determined as 208 SMEs in Ciudad del Carmen and 165 in Chetumal.

Many studies acknowledge that working with SMEs is not an easy task. This was true during the fieldwork. The total sample size could not be covered due to several problems, mainly because firm owners were not always present in the premises and a lot of time was required to contact them. The response rate was around 7 to 1. Additionally, the objective of covering the whole sample of medium-sized firms could not be accomplished, since it was found that many of them were subsidiaries of big enterprises. Moreover, the DENUE database contains several errors related to the firm's addresses and the number of employees that each firm actually possesses. There were less existing medium firms in reality than the ones listed in the directory. Finally, 345 questionnaires were completed, but only 326 were utilized due to quality issues.

The database used in the analysis is thus comprised of 187 SMEs from Ciudad del Carmen and 139 from Chetumal. 80.4% of the firms are micro, 16.9% are small and 2.8% are medium. The highest proportion of the sample is concentrated in the retail and wholesale sector, as it is mostly formed by SMEs. 59.2% of the owners or top managers were male and 40.8% were female.

The majority of the respondents (95.1%) have experienced at least one type of tropical cyclone (e.g. hurricane, tropical storm, tropical depression, etc.). 45.7% reported that on average the experience had been damaging for their business, while 37.7% said that it had been beneficial and 16.6% expressed it had been neither damaging nor beneficial.

The preparedness measures that SMEs undertake in the study areas are listed in Table 1. The classification of each item was made according to this paper's definition of coping and adaptive measures. As can be seen in Table 1, around 40% to 85% of businesses (depending on the type of implemented measure) undertake several short-term coping strategies on a regular basis before weather related impacts. On the other hand, 3% to 30% of the firms undertake adaptive measures. The survey then shows that enterprises take more coping, short-term strategies to protect themselves against and recover from these events, than medium and long-term adaptive strategies. Four out of five of the surveyed businesses regularly store equipment, furniture and protect windows, monitor early warning systems, turn off gas, electricity and water lines, and inspect their premises before the strike of a tropical cyclone. In contrast, around one fifth of the firms have developed a risk or a business continuity plan, adopted communication strategies or bought insurance coverage. In terms of firm size, we found that medium enterprises take on average more

adaptive measures (5.3 out of 12) than small (3.1/12) and micro firms (1.2/12). Related to short-term reactive measures, the trend is similar. Medium firms take on a regular basis 9.6 coping measures out of 12, while small enterprises take 8.7/12 measures and micro take 7.3/12. A Kruskal-Wallis Test was performed to determine if these differences were statistically significant. The results show that at a 95% confidence interval the amount of the measures taken by micro, small and medium enterprises are statistically different. An inspection of the mean ranks for the groups confirmed that medium businesses undertake the highest number of coping and adaptive measures, while micro firms report the lowest.

Table 1. Coping and adaptive strategies undertaken by the surveyed businesses

	Percent of respondents N=323		Percent of respondents N=325
Coping measures		**Adaptive measures**	
Store equipment/furniture/windows	85.1	Developed a risk plan/business continuity plan?	32.0
Monitor early warning systems	84.8	Developed a communication strategy?	26.8
Turn off gas, electricity and water lines	83.6	Bought insurance coverage?	20.6
Inspection of premises *(N=321)*	80.4	Bought flood/hurricane insurance?	11.7
Store important information	78.6	Undertook emergency drills?	11.7
Store inventory *(N=322)*	70.8	Installed hurricane shutters? *(N=324)*	13.3
Debris and loose material cleanup *(N=321)*	61.9	Bought power generator?	16.0
Talk to employees about how you will communicate with them	60.1	Bought water generation?	4.0
Talk to suppliers about probable rearrangements in the supply	59.1	Bought /modified technology or equipment? [a]	13.3
Talk to customers about opening times	53.9	Moved your premises to a different location? [a]	3.3
Buy or rent equipment to clean up	40.2	Modified your product/service? [a]	6.8
Temporarily run your firm in a different location? *(N=325)*	3.1	Bought /rented other premises? [a]	3.8

[a] *Actions taken a*s a consequence of experiencing an extreme weather event.

Variables included in the analysis

For the regression models we used two dependent variables: coping and adaptive measures. Based on other studies (Howe, 2011; Web *et al.,* 2002), these variables were calculated as semi-continuous, composed of the elements presented in Table 1. Coping measures were grouped in an index that ranges from 0 to 12, whereas the adaptive-measures index has a scale of 0 to 12. As has been argued, the former refers to the short-term measures businesses take to protect themselves from the hazard. On the other hand, the latter indicates the proactive measures oriented towards preparedness for future impacts.

In order to be consistent with previous studies, the independent variables used in the statistical model were drawn from the natural hazards literature. They were classified according to the

following groups: disaster experience, business characteristics and proactive attitudes. The following section explains in detail how the variables were coded and describes the data.

Business characteristics

A number of studies have identified a series of business characteristics as consistent predictors of business preparedness (Dahlhmer and Souza, 1995). We include them in our analysis along with other firm traits[5]. *Business age* and *size* are two variables measured in ordinal scales. The first one goes from 1 to 7, where 1 denotes those businesses that are between 0 to 3 years old, and 7 indicate an age beyond 26 years. Around one quarter of the firms are less than 5 years old, 27.3% of the businesses have an age between 6 to 10 years, and almost half of the firms are more than 10 years old. Regarding the size, it is measured according to the number of employees. There are three categories: from 1 to 10 employees, 11 to 50 and 51 to 250. In this sense, the majority of the surveyed businesses (80.4%) have less than 10 employees.

Additionally, we explore if business growth has an effect on the type of preparedness measures that businesses adopt. Growth is measured by the increase/decrease in the number of employees since start-up and, hence, was coded in an ordinal scale. The statistics indicate that 70.5% of the firms have experienced changes in this respect. Specifically, more than half have experienced an expansion.

The next six variables are dichotomous: whether the business is *owned by a woman*; whether the *premises are leased* or owned; whether the *premises constitute a part of their homes*; whether the firm possesses *more premises*, whether it has *access to credit* or not; and whether it sells its products to *local or regional/international markets*. The results show that more than half (59.2%) of the surveyed SMEs are owned by men. Regarding their premises, 68.7% are self-owned and 29.4% of these form part of the homes. Only 18.2% of the businesses have other premises. The majority of the respondents (60.9%) do not have access to any kind of credit, and just 16.6% sell their products or services to other markets (regional or international).

The *sales* variable is measured in an ordinal scale, ranging from 0 to 6. Due to precautionary reasons, 10.7% of the respondents did not report their average monthly sales —so in this case the variable was coded with a zero. Finally, the last variable refers to the *business environment*, which was recognized as an influential factor during the scoping study and constitutes a significant element in a

---

[5] The list of these variables, coding scheme and their descriptive statistics can be found in the Annex.

developing context. With the purpose of incorporating this layer, we asked the respondents to assess if a range of elements have caused them monetary losses. 44.7% reported losses due to crime/theft and social disorders; 53.1% due to tax rates; 36.2% to business licensing and permits; 39% to lack of economic diversification in the locality, 29.4% to insufficient access to finance, 28.2% to the informal sector, 24.5% to corruption, 10.4% to inadequately educated labour force, and 4.9% to courts, custom and trade regulations. All the options answered affirmatively by the businesses were then added together and the aggregate index thus ranges from 1 to 10. On average, SMEs have experienced 2.93 monetary losses due to the business environment.

Disaster experience

In order to investigate if different types of damages lead to the adoption of different kinds of preparedness measures, two individual variables were used: indirect and direct damages. Each of them represents an index calculated by adding the different items belonging to each type of experienced damage as described in Table 2. This table shows the damages that business experienced in relation to two kinds of events. Respondents were asked first to select from a list the type of damages suffered in relation to the most extreme weather event they had ever faced. Subsequently, they were asked to identify the damages they had suffered related to a less extreme weather event. Regarding the most extreme events, 82.6% of the respondents mentioned category 5 hurricanes (Dean in 2007 and Roxanne in 1995, among others). On the other hand, 72.3% of businesses reported a tropical storm as a less extreme weather event (72% mentioned TS Alex in 2010). Regardless of the magnitude, the three most common damages that SMEs experienced were energy power disruption (83.5% of firms experienced it in relation to the more extreme weather event /and 50.8% to the less extreme event), lack of customers (73.2%/54.7%) and inaccessibility to roads and highways (70%/46.1%). Moreover, the surveyed enterprises have experienced on average more indirect damages than direct damages. The Kruskal-Wallis test was performed to determine if there were significant differences in the amount of indirect and direct damages according to the number of employees. The mean rank shows that small businesses (11-100 employees) have experienced on average more direct and indirect damages in relation to a more extreme weather event. However, the Chi-square statistic reveals that this difference is not statistically significant.

As can be seen in Table 2, the percentage of firms that have experienced each of the items increases as the magnitude of the event augments. For instance, with a less extreme weather event, only 9.8% of businesses experienced non-structural damages in their premises. However, with a more extreme weather event, 35.2% of the surveyed businesses experienced this same type of damage. The

surveyed businesses reported that with a less extreme weather event (e.g. tropical cyclone) they had experienced around 2 indirect damages out of 7 possible items on average. And, with a more extreme weather event (e.g. hurricane), business experienced around 4 types of damages. Regarding direct damages, with a less extreme weather event, SMEs experienced 0.92 types of damages on average. Meanwhile, with the more extreme weather event, they experienced 2.52. By controlling the number of items in each damage category —and within each event— so as to make them comparable between them, the majority of the impacts were indirect. However, while the events grow in magnitude, direct damages increased in 175%, while indirect damages grew in 99%.

Table 2. Types of damages experienced by businesses according to the magnitude of the weather event

	Pecentage of respondents **More** extreme event *N=310*	Pecentage of respondents **Less** extreme event *N=254*
Indirect damages		
Energy power disruption	83.5	50.8
Access (roads, highways)	70.0	46.1
Communication	54.2	27.2
Water supply disruption	49.4	26.4
Sewage disruptions	45.2	28.3
Lack of customers	73.2	54.7
Disruptions in the supply chain	52.3	29.5
Direct damages		
Lack of cash-flow	57.4	32.7
Non-structural damage	35.2	9.8
Building construction	30.3	12.2
Inventory damage	25.5	9.8
Building maintenance	21.6	7.1
Office equipment	17.8	5.9
Specialised equipment	13.5	5.9
Injury to employees/customers	8.1	2.8
Disruptions in the product/service delivery	48.7	28.0
Changes in the firm's reputation	6.8	3.5

Four more explicative variables were used in the regression models. These reflect the businesses' experiences related to the most extreme weather event: *closure of premises, time to recover, decrease in sales* and *external support received to recover*[6]. The first variable is measured in an ordinal scale and ranges from 0 (did not close) to 4 (closed more than 15 days). The majority of respondents (73.3%) closed their businesses for less than 3 days; 21.8% of the respondents closed for less than 15 days; and just 4.9% closed for more than two weeks. The next variable is also ordinal and reflects the amount of time the surveyed businesses took to recover from the most extreme weather event. It ranges from 1 (sales returned to their monthly average within a month) to 4 (took more than one year for sales to recover). The results show that 96.7% of the businesses recovered in

---

[6] The descriptive statistics of each variable are found in the Annex

less than one year. Yet, the majority recuperated their normal levels in less than one month (69.6%); 21% of businesses reported 2 to 4 months to recover; and 6.1% required from 5 to 11 months. Only 3.2% stated that it took them more than 12 months to recover[7]. The following variable is dichotomous and indicates if the enterprises suffered a decrease in sales in the first month after the event. More than half of the businesses experienced a decline. The last variable, external support received to recover from the event, is an aggregated index that ranges from 0 to 10, depending on the different types of aid. Half of the SMEs in the sample declared they had received some kind of external support to recover. The main types of aid were loans from family (42.9%), credit from suppliers (37.9%), credit from a financial institution (30.4%), loans from friends (23%) and credit from government and chambers (13.7% and 1.3%, respectively). Other types of external support were advice from colleagues (22.7%), reduction/suspension of tax payments (9%), financial support to pay the employees (2.8%) and receiving building materials from the government (2.5%).

Proactive attitudes

Additionally, another block of eight independent variables[8] classified as proactive attitudes were included in the analysis. The literature suggests that those firms that show a more active behaviour are the ones who are more inclined to take precautionary actions (Howe, 2011; Yoshida and Deyle, 2005). In this sense, we hypothesise that these variables positively influence the adoption of coping and adaptive measures. The first variable is *planning time*, which is measured in an ordinal scale. It reveals how much time per year SMEs invest in planning for extreme weather events. 49.7% of the respondents stated that they usually do not plan; 27.9% reported that they invest around one to three days in planning; 9.2% spend around one week; and 13.2% said they spend more than 15 days. The next variable is the *perception of risk*. Owners/managers were asked to state their perception about the probability of going out of business as a consequence of an extreme weather event when compared to other businesses similar to theirs. Those who perceive having a much lower risk, somewhat lower, or the same risk were given a score of 0, while those whose perceive themselves as having a somewhat higher and a much higher risk were given a score of 1. Around four fifths of the surveyed companies perceived themselves as having low or the same level of risk when compared to other similar businesses.

Training and networking is a variable that reflects how often the owner/manager attends courses, workshops, fairs/expos or other business related events. It is measured in an ordinal scale. The attendance to this kind of events would indicate an interest in learning things that lie "outside" the

---

[7] Some of these businesses mentioned that event today they have not yet fully recovered.
[8] The list of these variable, coding scheme and descriptive statistics can be found in the Annex

scope of the business's daily activities. We expect that those businesses that attend those events take more precautionary actions. Our results show that half of the respondents never attend those events; 27.6% attend not very often; and only 22.1% attend regularly. The next two variables included in the study were coded as indices: *changes introduced since start-up* and *strategic thinking*. The first one is comprised of 5 possible changes that a company could have undertaken since its start-up: introduction of new products/services; changes in the main activity; modification of products/services; discontinuation of product/services; and other types of changes. On average, businesses reported having implemented around 1.98 changes since start-up. The latter variable has a scale from 0 to 7, and constitutes a proxy for strategic thinking. That is, it groups some elements that a business might possess and that reflect managerial abilities, such as logo, mission/vision, employee-training program, research program, marketing plans, and short term and long term objectives. On average, SMEs reported possessing 2.88 out of those 7 elements.

Three more variables were included in this block. *Perception of opportunities* is a dichotomous variable that measures if the owners/managers consider whether or not extreme weather events or changes in weather patters may bring business opportunities. 41.7% reported that they do perceive opportunities. The second variable is also dichotomous and indicates if the firm has *networks with big organisations*. Only 31% of the firms have business relations with big enterprises. The third variable shows if a firm possesses *networks with chambers and find them useful*. It thus seeks to identify the capacity that a firm has to use this network and take advantage of the relationship. It is coded in a four-point ordinal scale, ranging from not having networks with business chambers and finding them useless to having networks and finding them very useful. 63.2% of the firms fall in the first category, 12.6% of the firms reported having networks and finding them not that useful, 18.1% stated finding them somewhat useful, and just 6.1% find them very useful. In general, it was found that more than half of the firms (59.4%) are affiliated to a chamber or business organisation. However, 36.6% reported that it has been useless to be affiliated.

Results

Once the variables and data have been explained, this section provides the results derived from the two OLS regression models that predict the adoption of coping and adaptive measures taken by SMEs.

Table 3. OLS regression models predicting the adoption of adaptive and coping measures

	Adaptive measures			Coping measures		
	Unstd.Coeff.	S.E.	Std.Coeff	Unstd.Coeff.	S.E.	Std.Coeff
Business Characteristics						
Size	0.78***	0.24	0.19	---	---	---
Women owned	-0.29**	0.17	-0.07			
More premises	0.51**	0.25	0.10	---	---	---
Market orientation	0.77***	0.24	0.15	---	---	---
<u>Business environment</u>	-0.08**	0.05	-0.08	0.16**	0.07	0.12
Disaster experience						
Closure of premises	-0.24***	0.83	-0.14	---	---	---
Decrease in sales	-0.33**	0.18	-0.08	---	---	---
External support to recover	0.25***	0.07	0.17	---	---	---
Direct damages	0.27***	0.05	0.30	---	---	---
Indirect damages	---	---	---	0.22**	0.08	0.19
Proactive attitudes						
<u>Strategic thinking</u>	0.18***	0.05	0.20	0.35***	0.09	0.29
Networks and useful	0.51**	0.21	0.11	---	---	---
N	326			326		
F-value	13.60***			5.27***		
R^2	.55			.32		

*p<.05, **p<.01, ***p<.001
 Variance inflation factors are less than 2.12 for each variable of adaptive measures and 1.99 for coping measures.

Model 1: adaptive measures

Table 3 presents eleven predictors that explain 55% of the variance of the current levels of adaptive measures. Preliminary analyses were conducted to ensure no violation of the assumptions of normality, linearity, multicolinearity and homoscedasticity. The variables that were statistically significant are business size, women-owned, ownership of more premises, market orientation, business environment, closure of premises, decreases in sales, external support to recover, direct damages, strategic thinking and networks and useful. By controlling for all other variables in the model, *direct damages* makes the strongest contribution to explaining the implementation of adaptive measures. This result indicates that the types of damages that lead to the implementation of adaptive measures are those that can directly destroy the physical and financial structure of the company. Similarly, the regression model shows that while external support to recover augments, so does the amount of adaptive measures. This suggests that receiving aid is an influential factor in the

adoption of protective actions. The regression model also indicates that businesses that had to close their premises for less time are the ones who take more adaptive measures. In the same way, those businesses that experienced less decreases in sales are more likely to implement them.

Business size, sex of the owner/manager, ownership of additional premises, orientation towards regional/international markets, and business environment demonstrate to be good predictors of adaptive measures. In this fashion, businesses with a larger number of employees, that are owned by men, that have more than one premise, those that sell their products or services not only to the local market, and those SMEs that have experienced less monetary damages due to the business environment are more likely to engage in proactive preparedness measures.

Finally, two more significant variables were found: the proxy for strategic thinking and networks and useful. In this manner, those firms that adopt a business vision and those that possess networks with business organisations and find them useful are more likely to adopt adaptive measures.

Model 2: coping measures

As can be seen in Table 3, the second model presents three predictors that moderately (32%) explain the variance[9] when coping measures were used as the dependent variable. The strongest predictor in this model is the proxy for strategic thinking. Interestingly, and not expected, this element proved to be significant in predicting the implementation of not only coping measures, but also of adaptive measures. Likewise, the business environment resulted to be a good predictor in the adoption of both types of measures. This relationship suggests that businesses that reported having monetary losses as a consequence of experimenting aspects such as crime, tax rates, lack of economic diversification, etc. are more likely to implement coping measures. It can be the case that these experiences trigger the need to protect the business from situations outside its control. This point relates to the next result. Regarding the block of disaster experience, the indirect damages index is a variable that strongly predicts coping measures. One interpretation is that these types of damages are outside the control of the company; therefore, they can only cope with them.

---

[9] Similar to the previous model, diagnostics were made to assess the degree of multicolinearity and homoscedasticity. The tolerance scores and variance inflation factors confirm no problems between the independent variables.

Discussion

The literature suggests that among the strongest predictors for taking preparedness measures is the number of employees (Dahlhamer and Reshaur, 1996; Dahlhmer and D'Souza, 1997; Quarantelli *et al.,* 1979; Webb *et al.,* 2000; Howe, 2011). Our results further elucidate this by adding that only certain type of preparedness measures can be explained by the size of the firm. The first model shows that larger businesses are more likely to undertake adaptive measures than their smaller counterparts. On the other hand, size was not a significant predictor for adopting short-term coping measures in the second model. A possible reason is that adaptive measures require more time and resources to execute. Small firms usually do not possess enough resources. Bigger businesses are then more likely to implement these adaptive measures. Contrarily, coping measures refer to those actions that require little planning time, efforts and resources. As a result, regardless of the size, businesses prefer to undertake actions that are technically easier or that require less efforts and resources to implement. This echoes other academic's work, such as Yoshida and Deyle's (2005) or Webb et al. (2000), who reported that costs, time required for implementation and lack of expertise were relevant constraints in the adoption of some preparedness measures.

Little work has been undertaken to investigate the influence of managerial and community/institutional characteristics on business preparedness (Dahlhmer and Reshaur, 1996). In this sense, a notable finding of this research is that both factors are relevant in the adoption of coping and adaptive measures. The proxy for strategic thinking demonstrated that possessing a business oriented mentality —expressed in the development of elements such as mission/vision, employee-training programs and marketing plans— contributes positively to a firm's level of preparedness. Directing efforts to develop strategic thinking in SMEs would be a way of preventing them from just being reactive to external stimuli. This attitude could additionally result in more profitable activities. Regarding the proxy of business environment, around half of the firms reported that they had been affected by existing tax rates, followed by crime, theft and disorder. In both models, this variable resulted significant, although the direction of the estimated coefficient showed an opposite behaviour in each case. On the one hand, the first model shows that those businesses that experienced lower monetary losses associated to the business environment were more likely to undertake a higher level of adaptive measures. On the other hand, the second model reports that those businesses that have experienced more monetary damages from the business environment are the ones who take more short-term coping measures. One possible explanation for this divergent behaviour could be that those firms that perceive a negative business environment are not

willing to invest on medium and long-term projects and strategies. However, these experiences trigger a sense of self-protection, and businesses tend to become more reactive and just cope with these effects in the short-term. Further work needs to be done in this respect, so as to examine the influence of the business environment on the adoption of preparedness measures.

The implementation of adaptive measures is also determined by other factors. Whether the business is owned by a male or female is one of them. The model shows that male owners are more likely to have in place more adaptive measures. It might be their female counterparts face more constraints in terms of time and lack of resources. On the other hand, and in light of previous research (Howe, 2011; Webb *et al.,* 2002), we found that those businesses that do not depend solely on local markets are more likely to implement more adaptive measures. Possessing a wide market diversification involves higher levels of resources and planning. Thus, it is possible that these firms are more worried of being protected from future impacts. Important is to mention that in our sample the majority of businesses that have a wider market diversification are larger firms. In contrast to previous analysis (Dahlhamer and D'Souza, 1995; Alesch *et al, 2001*; Chang and Falit-Baiamonte, 2002), the characteristics of the premises (i.e. whether they are owned, leased or home-based) were not found to be significant in our models. However, in this regard the only good predictor for adaptive measures was ownership of additional premises. Businesses that have more premises are thus more likely to embark in medium and long-term actions. It is obvious to think that the smaller the firm, the less likely it is for it to have more premises. These findings reinforce the argument that size is a significant driver in the adoption of adaptive preparedness measures. In this sense, smaller firms are less likely to adopt complicated or costly measures to protect themselves from future events.

When SMEs experience an extreme weather event such as a tropical cyclone, there are factors involved that can exert an influence in preparedness levels. We found that those businesses that were obliged to close their premises for a less period of time, that showed a lower decrease in sales, that received external support to recover and that have networks and find them useful, implement more adaptive measures. Throughout the literature it has been acknowledged that amongst the most damaging elements for businesses is the temporary closure of their premises. That is closely related with experiencing decreases in sales. Our survey shows that the majority of SMEs were forced to close for less than 3 days in relation to the more extreme weather event. And even though half of the surveyed SMEs experienced a decrease in sales, the majority recovered within a month. Runyan (2006) reported that those businesses which were able to resume operations faster after

hurricane Katrina struck the US experienced a large increase in their sales. Therefore, those businesses that closed their premises for a less period of time and that showed a lower fall in their sales were in a better position to survive and adjust their strategies for future events by implementing adaptive measures. On the other hand, several studies have reported that receiving external support after a disaster has worsened the situation of businesses because it contributes to further indebtedness (Runyan, 2006; Dahlhmer and Tierney, 1996). Our survey reports that half of the sampled SMEs have received some kind of external support to recover. Interestingly, our model shows that those businesses that received more external support to recover are the ones who undertook more adaptive measures. There are several reasons that might explain these contradictory results with respect to the literature. The most common sources of support that the businesses mentioned in this study are family and suppliers. It might be that as a result of close relationships, these sources do not impose stringent conditions (i.e. high interest rates) that can further damage the financial situation of the firms. This suggests that for SMEs kinship plays a relevant role. And, on the whole, receiving aid represents an influential factor in the adoption of adaptive measures. Parallel to this, the model shows that having useful networks with chambers or business organisations can influence the implementation of the proactive adaptive measures. Further studies can be undertaken to thoroughly investigate to what extent social capital influence the preparedness measures of SMEs.

Contrary to previous studies (Howe, 2011; Yoshida and Deyle, 2005), but in line with others (Dahlhmer and D'Souza, 1995; Dahlhmer and Reshaur, 1996; Webb *et al.,* 2000), we found that past experiences contribute to increase preparedness measures. The present study offers useful insights in this respect, by undertaking a deeper examination and providing evidence that the nature of the damages experienced by firms influence the type of measures that they undertake in order to protect themselves, recover from and prepare for future impacts. Those enterprises that implement more short-term coping measures are those that have experienced more indirect damages. The reason might be that these damages, similar to the ones caused by the business environment, are usually originated outside the firm, such as energy power, water supply and sewer disruptions, or inaccessibility to roads and communication channels. Thus, firms do not have control over them. This is especially emphasised when it comes to micro-enterprises, which often do not have the necessary ability, resources and influence to avoid disruptions in their supply chains or in the delivery of their own products due to external causes. All these enterprises can do in the short-term is to cope with this type of impacts. However, the model was not able to show why enterprises do not implement other kind of strategies in the medium and long-term in order to face these specific

damages, especially when these habitually occur in both sites of study. An answer could be that these damages impose them relatively smaller costs than direct ones, which compromise their physical and financial assets. Consequently, firms may believe that the costs of implementing more complex measures outweigh the benefits. Another possible explanation could be that a significant part of the sampled firms have already been in the market for nearly ten years and are already adapted to these conditions, so the coping measures identified in the survey just represent their routine practices. Important is to highlight that the coping model left a large amount of variance unexplained. Therefore, there are other factors that may explain the implementation of coping measures, which this study failed to identify. Future analyses could include more variables, apart from indirect damages and business environment, which were found to be good predictors of coping measures.

On the other hand, it is interesting to notice that experiencing direct damages (e.g. structural damages, lack of cash-flow, lost of office equipment, etc.) has the contrary effect. Businesses that have suffered direct damages tend to implement more adaptive measures. In contrast to indirect damages, business owners/managers do have control over some of these factors. They can develop risk and business continuity plans, or receive credit in order to install hurricane shutters or move the premises to other locations. These damages exert a more direct harm to businesses and imply higher costs. Consequently, firms invest and adopt measures to lessen those risks. But once more, the model does not convey a complete explanation about why businesses do not apply additional short-term measures in this respect. It might be that the firms that were included in the sample are the ones that actually survived this kind of damages, while less fortunate ones have not survived nor reached a phase where they started applying these measures. On the whole, this does not imply that firms just implement one of these two types of measures. Actually, the majority implement both at the same time and only a few of them implement more adaptive measures. It is important to highlight, in this sense, that coping and adaptive capacities are positively correlated (Pearson correlation of 0.4).

SMEs usually do not plan in their everyday activities (Hilary, 2000), and they also do not undertake planning activities to prevent impacts from an extreme weather event (Yoshida and Deyle, 2005; Webb, 2000; Howe, 2011). However, it has been recognised that their size makes them flexible and thus have the ability of reacting to immediate situations (Gibb and Scott, 1985; Murphy, 2002). From our results, it can be seen that this reactive trait persist when they face a tropical cyclone. On average, the surveyed firms undertake 7.6 out of 12 coping measures in the short term, while they

only take 1.63 out of 12 proactive adaptive measures. It could be argued that these reactive coping strategies could be enough for SMEs to withstand climate related impacts. After all, the statistics derived from this study show that many of them have been in the market for at least ten years. There is a tendency in disaster planning to look at the past instead of looking at the future (Quarantelli, 1976). However, the past is not equal to the future. Climate change will bring an increase in hurricane magnitude, and thus represents a threat to SMEs. A relevant finding is that when the magnitude of the event increased, firms experienced on average almost twice the amount of indirect damages and three times the number of direct damages. In this sense, if the magnitude of extreme weather events increases in the future, as climate projections suggest (IPCC, 2007), direct damages will increase significantly. Hence, it might be that just implementing short-term coping measures will not be sufficient. This is disturbing, since low levels of adaptive measures were found in the area, while climate projections for the region suggest an increase in tropical cyclone damages.

Conclusions

This study provides evidence about the factors that constrain or facilitate the adoption of coping and adaptive preparedness measures among small and medium sized businesses located in a developing context. These organisations provide goods and services to the communities in which they are located. In developing countries, SMEs represent a source of economic growth and are the only economic support for many families. Therefore, they have been considered crucial for development. Nevertheless, small businesses are considered to be the most vulnerable to climate variations and extremes within the private sector. Despite this, few studies have been undertaken from a developing-country perspective. This study addresses this gap. Here we provide evidence that contextual problems common in the developing world, such as corruption or the existence of a large informal sector, are important factors that explain the adoption of both coping and adaptive measures.

A number of studies have concluded that smaller businesses are less likely to take preparedness measures. This study supports that conclusion, and we make a further contribution by pinpointing that the size of the business is a good predictor for the adoption of medium and long-term preparedness measures. Additionally, our models suggest that those businesses that take more adaptive measures are the ones who have experienced more direct damages. On the other hand, those businesses that take more adaptive measures are the ones that have been obliged to close

their premises for less time after an impact, as well as those who have experienced a lower decrease in sales and received external support to recover. Our findings also stress the need to promote market diversification among SMEs. It was found that those businesses that sell their products to other markets have in place more adaptive measures. In addition, we provide evidence that a useful relationship with business chambers can have a positive influence in the adoption of adaptive measures. Therefore, based on this study, we recommend a revision of the objectives and performance of business chambers, since the majority of firms do not find them useful. Overall, risk managers, local governments and business chambers should take measures that take into account all these elements.

This study shows that small businesses usually do not plan in advance to prevent the impacts of weather related events. It could be hard to modify these traits. However, the government and business chambers could target programs to encourage small businesses to develop managerial abilities. They could provide assistance to develop risk and business plans, as well as to encourage the implementation of adaptive measures that prevent SMES from being just reactive to external stimuli. Some additional support can take the form of loans to buy hurricane shutters or insurance coverage with low interest rates. Assuming a proactive stance can determine the survival or failure of an organization (Alesch *et al.,* 2001; Runyan, 2006). This is further stressed in the face of climate change, which will bring an increase in the frequency and intensity of sudden weather events (e.g. hurricanes), as well as slow onset periodic hazards (e.g. droughts) and creeping changes (e.g. sea level rise) (IPCC, 2007). In this fashion, it is essential that SMEs, considered the backbone of the economy, acquire not only the ability to cope in the short term, but also the capacity to manage long-term uncertainties.

References

Aldrich, H., Auster, E.R., 1986. Even dwarfs started small:liabilities of age and size and their strategic implications. In:Staw, B.M., Cummings, L.L. (Eds.), Research in Organizational Behavior, Vol. 8. JAI Press, Greenwich, CT, pp. 165–198.

Alesch, DJ , Holly, J.N. Mittler, E., and Nagy, R. (2001). Organizations at Risk: What Happens When Small Businesses and Not-for-Profits Encounter Natural Disasters. Small Organizations Natural Hazards Project First Year Technical Report University of Wisconsin-Green Bay Center for Organizational studies. Published by the Public Entity Risk Institute. Fairfax, VA. On the Web at: www.riskinstitute.org

Alexander, D. (1997). The study of natural disasters, 1977–1997: some reflections on a changing field of knowledge. Disasters 21 (4), 284–304.

Anderson, E.R., Cherrington, E.A., Flores, A.I., Perez, J.B., Carrillo R., and E. Sempris. (2008). Potential Impacts of Climate Change on Biodiversity in Central America, Mexico, and the Dominican Republic. CATHALAC / USAID. Panama City, Panama.

Arrocha, Fernando (2008). El impacto de la población flotante en el gasto municipal de Ciudad del Carmen en el 2006. Industria extractiva. Instituto Municipal de Planeación. Marzo, 2008

Barron, D.N., West, E., Hannan, M.T., 1994. A time to grow and a time to die:growth and mortality of credit unions in New York City, 1914–1990. American Journal of Sociology 100 (2),381–421.

Berkhout, F. Hertin, J. & Arnell, N. (2004) Business and climate change: measuring and enhancing adaptive capacity, Technical Report 11, Tyndall Centre for Climate Research.

Berkhout, F., Hertin, J., Gann, D.M. (2006). Learning to adapt: organisational adaptation to climate change impacts. Climatic Change 78(1): 135-156.

Blackman, A. (2006). Small firms and the environment in developing countries: collective impacts, collective action, Resources for the Future, Washington, DC. Pp.1-19

Brooks N. (2003). Vulnerability, risk and adaptation: a conceptual framework. Working Paper 38, Tyndall Centre for climate change research, and Centre for Social and Economic Research on the Global Environment (CSERGE), University of East Anglia, Norwich, UK. http://www.tyndall.ac.uk/publications /working papers /workingpapers.shtml

Burnett, J.J. (1998). A Strategic Approach to Managing Crisis. Public Relations Review, Vol. 24, No. 4, pp 475-484

Caetano, E. (2009). Las costas en un clima cambiante. Conference procedings. Instituto de Ciencias de la Atmósfera de la UNAM

CENAPRED, Centro Nacional de Prevención de desastres. Área de estudios económicos y sociales del CENAPRED. [Accessed 13 May, 2010]. Available from World Wide Web: < http://www.cenapred.unam.mx/es/>

Chang, SE., and Falit-Baiamonte, A. (2002). Disaster vulnerability of businesses in the 2001 Nisqually earthquake. Environmental Hazards 4 (2002) 59–71

Dahlhamer, J. M. & K. J. Tierney. (1996). Winners and losers: predicting business disaster recovery outcomes following the Northridge earthquake. Preliminary paper no. 243. Department of Sociology and Criminal Justice, Disaster Research Center, University of Delaware.

Dahlhamer, J. M. & L. Reshaur. (1996) Businesses and the 1994 Northridge earthquake: An analysis of pre-and post-disaster preparedness. Preliminary paper no. 240. Department of Sociology and Criminal Justice, Disaster Research Center, University of Delaware.

Dahlhamer, J. M. & M. J. J. D'Souza. (1997). Determinants of business disaster preparedness in two US metropolitan areas. International Journal of Mass Emergencies and Disasters. August 1997, 15(2) pp. 265-281

Dahlhamer, J. M. & K. J. Tierney. (1998) Rebounding from disruptive events: Business recovery following the Northridge earthquake. Sociological Spectrum, 18 (2), pp.121-141.

Danes, S.M., Lee, J., Amarapukar, S. Stafford, K., Haynes, G. (2009). Determinants of Family Business Resilience after Natural Disaster. Conference Procedings USASBE, Page1275. National Science Foundation

Dessai, S., K. O'Brien & M. Hulme. (2007b). Editorial: On uncertainty and climate change. Global Environmental Change, 17 (1), pp.1-3.

GHF, Global Humanitarian Fund. (2009). Human Impact Report Climate Change:The anatomy of a Silent Crisis. Geneva: Global Humanitarian Forum http://www.ghf-ge.org/ (accessed 12 June 2009)

Gibb, A. and M. Scott (1985). Strategic Awareness, Personal Commitment and the Process of Planning in the Small Business. Journal of Management Studies, Blackwell Publishing Limited. 22: 597-631.

Hayward, Mathew (2001) When do firms learn from their acquisition experience? Evidence from 1990 to 1995. Strategic Management Journal 23(1) 21-29, January 2002

Hillary, R. (2000). Small and medium-sized enterprises and the environment: business imperatives, Greenleaf Publishing.

Howe, P.D. (2001) Hurricane preparedness as anticipatory adaptation: A case study of community businesses. Global Environmental Change 21 (2011) 711–720. doi:10.1016/j.gloenvcha.2011.02.001

INE, Instituto Nacional de Ecología, SEMARNAT and CCA-UNAM (2010). [Accessed 15 May]. Available from World Wide Web: <http://www2.ine.gob.mx/cclimatico/edo_sector/index.html>

INEGI, Instituto Nacional de Estadística, Geografía e Informática. (2006) Micro, Pequeña, Mediana y Gran Empresa, Estratificación de los establecimientos, Censos Económicos 2004.

INEGI Instituto Nacional de Estadística, Geografía e Informática. (2005) Censos de población 2005.

IPCC. (2007). Summary for Policymakers. In: Climate Change 2007: impacts, adaptation and vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. In: M. PARRY, O. CANZIANI, J. PALUTIKOF, P. VAN DER LINDEN & C. HANSON, eds.: Cambridge University Press, Cambridge, UK.

Jeppesen, S. (2005). Enhancing Competitiveness and Securing Equitable Development: Can Small, Micro, and Medium-Sized Enterprises (SMEs) do the Trick? Development in Practice, Vol. 15, No. 3/4 (Jun., 2005), pp. 463-474

Lindell, M.K., Perry, R.W., 2000. Household adjustment to earthquake hazard: a review of research. Environment and Behavior 32 (4), 461–501.

Mitroff, II., Shirivastava, P., Udwadia, FE. (1987). Effective Crisis Management. The Academy of Management Executive (1987), Vol. 1, No. 4 (Nov., 1987), pp. 283-292

Murphy, M. (2002). The OECD small and medium enterprise outlook, Organization for Economic.

Nelson, J. (2008). Corporate Action on Climate Adaptation and Development: Mobilizing New Business Partnerships to Build Climate Change Resilience in Developing Countries and Communities. Paper prepared for Brookings Blum Roundtable: Development in

the Balance: How Will the World's Poor Cope with Climate Change? Aspen, Colorado, USA, Aug.3. Online at http://www.brookings.edu/events/2008/0801_development.aspx

O'Brien, K., Eriksen, S., Schjolden, A., Nygaard, L. (2004a). What's in a word? Conflicting interpretations of vulnerability in climate change research. Center for International Climate and Environmental Research. Working Paper 2004:04; March 2004

Ortiz Pérez, MA, Méndez Linares, AP. (2000). Repercusiones por Ascenso del Nivel del Mar en El Litoral del Golfo De Mexico. Instituto de Geografía de la Universidad Nacional Autónoma de México. In Gay García Carlos (Ed.) (2000). México: una visión hacia el siglo XXI. El cambio climático en México. Instituto Nacional de Ecología, Universidad Nacional Autónoma de México, US Country Studies Program. México, 220 p. ISBN 968-36-7562-X pp.73-85

Othon P. Blanco (2008). Programa Sectorial Factores De Competitividad Y Desarrollo Económico: H. Ayuntamiento De Othón P. Blanco 2008-2011. [Accessed 10, April]. Available from World Wide Web: <http://comunicacionopb.org/images/stories/pdf/programa_sectorial_factores_de_competitividad_y_desarrollo_economico.pdf >

Pearson, CM., and Mitroff, II.(1993). From Crisis Prone to Crisis Prepared: A Framework for Crisis Management. Published by: Academy of Management. The Executive, Vol. 7, No. 1 (Feb., 1993), pp. 48-76

Penrose, J.M. (2000) The Role of Perception in Crisis Planning. Public Relations Review, Vol. 26, No. 2, pp 155-171

Pimenova, P. and Van der Vorst, R. (2004). The role of support programmes and policies in improving SMEs environmental performance in developed and transition economies. Journal of Cleaner Production 12 (2004) 549–559

PMD-Carmen (2009). Plan Municipal de Desarrollo 2009-2012. Ayuntamiento del Municipio de Carmen, Campeche. [Accessed 10, May 2010]. Available from World Wide Web: <http://www.carmen.gob.mx/W_Principal/PMD.pdf >

Quarantelli, E. L. (1994). Preparedness and Disasters: A Very Complex Relationship. Disaster Research Center, Preliminary Papers;209. retrieved 1st August 2011 [http://dspace.udel.edu:8080/dspace/handle/19716/594?show=full]

Richardson, K., W. Steffen, H. J. Schellnhuber, J. Alcamo, T. Barker, D. M. Kammen, R. Leemans, D. Liverman, M. Munasinghe, B. Osman-Elasha, N. Stern & O. Wæver. (2009). Synthesis Report from Climate Change. Global Risks, Challenges & Decisions, Copenhagen 2009, 10-12 March. University of Copenhagen, Australian National University, ETH Zürich, National University of Singapore, Peking University, University of California - Berkeley, University of Cambridge, University of Copenhagen, University of Oxford, The University of Tokyo, Yale University.

Runyan, R. C. (2006). Small businesses in the face of crisis: Identifying barriers to recovery from a natural disaster. Journal of Contingencies and Crisis Management, Vol 14, No 1. pp 12-26.

Scarpetta, S., Hemmings, P., Tressel, T., Woo, J. (2002). The role of policy and institutions for productivity and firm dynamics: evidence from micro and industry data" OECD Economics Department, Working paper No. 329, OECD, Paris

Schaper, M. (2002). "The challenge of environmental responsibility and sustainable development: Implications for SME and entrepreneurship academics." Radical changes in the world: Will SMEs soar or crash: 525-34.

Secretaria del gabinete 2008. Presentación hecha en el Marco del congreso Uniendo al Estado de Quintana Roo

Smit, B., O. Pilifosova, I. Burton, B. Challenger, S. Huq, R. Klein, G. Yohe, W. N. Adger, T. Downing & E. Harvey. (2001). Adaptation to climate change in the context of sustainable development and equity. In: J. J. MCCARTHY, O. F. CANZIANI, N. A. LEARY, D. J. DOKKEN & K.S., eds. Climate Change 2001: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, UK.,

Tierney, K.J. (1997). Business impacts of the Northridge Earthquake. Journal of Contingencies and Crisis Management 5 (2), 87–97.

Vazquez, B. A. (2009). Vulnerabilidad de las costas mexicanas al cambio climático. Conference procedings. Instituto de Ciencias del Mar de la UNAM

Warner, K., C. Ehrhart, et al. (2009). In Search of Shelter: Mapping the Effects of Climate Change on Human Migration and Displacement. O. A. E. REFERENCIA, Cooperative for Assistance and Relief Everywhere, Inc. (CARE).

WBCSD (2007). Promoting SMEs for Sustainable Development . Atar Roto Presse SA, Switzerland, World Business Council for Sustainable Development.

Webb, G. R., Tierney, K. J., and Dahlhamer, J. M., (2000). "Business and disasters: Empirical patterns and unanswered questions." Natutal Hazards Review 1(2), 83–90.

Webb, G. R., Tierney, K. J., and Dahlhamer, J. M., (2002). Predicting long-term business recovery from disaster:a comparison of the Loma Prieta earthquake and Hurricane Andrew. Environmental Hazards 4 (2002) 45–58

Withey, L., K. Borgerson, et al. (2009). Making Climate Your Business Private Sector Adaptation in Southeast Asia, SIDA, WRI and CSR Asia.

Yañez-Arancibia, A., Lara-Dominguez, AL., Rojas-Galaviz, JL., Zárate, L., Villalobos Zapata, GJ., Sanchez-Gil, P. (1999). Integrating science and management on coastal marine protected areas in the Southern Gulf of Mexico. Ocean and Coastal Management 42 (1999) 319-344

Yoshida, K. and Deyle, R. E. (2005) 'Determinants of small business hazard mitigation', Natural hazards Review, ASCE, February 2005, pp1-12

Zhang, Y., Lindell, M.K., Prater, C.S. (2007). Vulnerability of Community Businesses to Environmental Disasters. Hazard Reduction & Recovery Center. Texas A&M University.

Zollo, M. and Winter, S. G.: (2002), 'Deliberate learning and the evolution of dynamic capabilities', Organization Science 13 (3), 339–351.

ANNEX: Supportive information

Descriptive statistics of the variables that portraits the disaster experience

Variable	Coding scheme		% of respondents[a]	Relevant literature
Indirect damages[b]	0-7	mean	4.07	Runyan, 2006
		std.dev.	2.22	
Direct damages[b]	0-10	mean	2.51	Drabek (1994);
		std.dev.	2.17	Dahlhamer and
				Souza (1995);
				Webb *et al.,*
				(2002)
Closure of premises (days)	0= close for hours or did not close		35.3%	Webb, et al. 2002
			38.0%	
	1= 1 to 3 days		13.2%	
	2= 4 to 7		8.6%	
	3= 8 to 15		4.9%	
	4= > 15 days		*N=310*	
Time to recover (months)	1= less than 1 month		69.6%	Webb, et al. 2002
	2= from 2 to 4		21.0%	
	3= from 5 to 11		6.1%	
	4= > 12 months		3.2%	
			N=309	
Decrease in sales in the 1st month after the event	0= no		39.1%	
	1= yes		60.9%	
			N=307	
External support received to recover from the event [c]	0-10	mean	1.13	
		std.dev.	1.32	

[a] If not stated otherwise N=326
[b] The list of these damages can be found in Table 2
[c] Ten types of support to recover: loan or credit from government; from financial institution; from business chambers; from suppliers; from friends; from family; reduction/suspension of tax payments; received building materials to reconstruct; financial support to pay employees; and advice from colleagues.

Descriptive statistics of the variables classified as business characteristics

Variable	Coding scheme	% of respondents[a]	Relevant literature
Business age (years)	1= 0 to 3	16.3%	Webb et al. (2002)
	2= 3 to 5	9.8%	
	3= 6 to 8	16.6%	
	4= 9 to 10	10.7%	
	5= 11 to 15	16.6%	
	6= 16 to 25	18.4%	
	7= > 26	11.7%	
Business size (number of employees)	1= 1 to 10	80.4%	Alesch, et al. (2001)
	2= 11 to 50	16.9%	
	3= 51 to 250	2.8%	
GrowthElasticity since start-up	-1= decreased	13.8%	
	0= remain the same	29.4%	
	1= increased from 1- 9	42.0%	
	2= increased > 10 empl.	14.7%	
Woman-owned	0 = no	59.2%	Tigges and Green (1994)
	1 = yes	40.8%	
Lease premise	0= own	68.7%	Dahlhamer and Souza (1995)
	1= lease	31.3%	
Premises home-based	0= no	70.6%	
	1= premises part of the house	29.4%	
More premises that are part of the firm	0 = no	81.8%	
	1 = yes	18.2%	
		N=325	
Access to credit	0 = no	60.9%	
	1 = yes	39.1%	
		N=325	
Primary market	0= local	83.4%	Dahlhamer and Tierney (1998)
	1= regional/international	16.6%	
Sales (Mexican pesos per month)	0= not answered	10.7%	
	1= $0 - $1,500	4.9%	
	2= $1,500 - $10,000	25.5%	
	3= $10,001 - $20,000	15.3%	
	4= $20,001 - $30,000	12.0%	
	5= $30,001 - $50,000	10.7%	
	6= > $50,000	20.9%	
Business environment [b]	0-10 mean	2.93	Dahlhamer (1998)
	std.dev.	2.00	

[a] If not stated otherwise N=326

[b] Ten items are revised: crime, theft or disorder; tax rates; business licensing and permits; lack of economic diversification in the locality; access to finance; corruption; courts; custom and trade regulations; informal sector; inadequately educated labour force.

Descriptive statistics of the variables classified as proactive attitudes

Variable	Coding scheme	% of respondents[a]
Planning time	0=do not plan	49.7%
	1=invest around 1 to 3 days	27.9%
	2= around one week	9.2%
	3= > 15 days	13.2%
Perception of risk	0 = very low to the same risk	81.0%
	1= high risk to much higher risk	19.0%
Attendance to courses, workshops, fairs/expos or other business events	0= never attend	50.3%
	1= not very often	27.6%
	2= attend regularly	22.1%
Changes introduced since start-up[b]	0-5 mean	1.98
	std.dev.	1.24
Strategic thinking[c]	0-7 mean	2.88
	std.dev.	2.18
Perception of opportunities	0= do not see any opportunity	58.3%
	1= see opportunities	41.7%
		N=324
Networks with big organizations	0 = no	69.0%
	1 = yes	31.0%
Networks and useful	0= no network or useless	63.2%
	1= not that useful	12.6%
	2= somewhat useful	18.1%
	3= very useful	6.1%

[a] If not stated otherwise N=326
[b] Five type of changes: introduction of new products/services; change the main activity; modified products/services; discontinued product/services; other type of change.
[c] Seven elements that try to capture if the business owner have strategic thinking: logo, mission/vision; employee training program; research program; marketing plans; short term objectives; long term objectives.