


## Influences of adverse climate events on the use of the management control system


Influências dos eventos climáticos adversos no uso do sistema de controle gerencial

Influencias de eventos climáticos adversos en el uso del sistema de control gerencial


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### Abstract

Adverse climate events (ACE) have both direct and indirect effects on companies. The use of information about these events is important to guide decisions as well as to seek reflections that are transformed into improvement of the Management Control Systems (MCS). Emphasis is given to the use of MCS, using Simons's (1995) *Levers of Control* (LOC) framework and the contingency theory. Thus, the study aimed to verify how ACE influence the use of the MCS. The research, characterized as qualitative and a multiple cases study: three of which being affected by Tornadoes and three cases by Flood. Indicate that the history with repetitions of occurrences causes the processes to the preventions to be perfected and formalized, alteration of organizational priorities, communications, understanding of risks that should be avoided or minimized; identification of the relevance of the monitoring and stimulation to research. ACE influences management techniques, use of inventory reports and logistic, with emphasis on the interactive use of LOC's. Six dynamic tensions related to the event were observed.

**Keywords:** Adverse Climate Events; Management Control Systems; Control Levers; Dynamic tension

### Resumo

Eventos climáticos adversos provocam efeitos diretos e indiretos e o uso de informações sobre eles orienta gestores a buscar reflexões que se transformem em aperfeiçoamento dos Sistemas de Controle Gerencial (SCG). Nesse estudo, enfatiza-se o uso dos SCGs por meio do *framework* das Alavancas de Controle (AC) de Simons e base teórica é contingencial. Objetiva-se verificar como eventos climáticos adversos influenciam o uso do SCG. Pesquisa qualitativa e múltiplos casos: três empresas afetadas por tornados e três por enchentes. Contatou-se que o histórico de ocorrências faz com que processos de prevenções sejam aperfeiçoados e formalizados. Houve alteração de prioridades organizacionais, comunicações, compreensão de riscos que devem ser evitados ou minimizados, identificação da relevância do monitoramento e estímulo à pesquisa e aprendizado. Os eventos influenciam o uso de técnicas gerenciais e relatórios de estoque, pessoal e logístico, com ênfase no uso interativo das ACs. Costataram-se seis tensões dinâmicas relacionadas aos eventos.

**Palavras chave:** Eventos Climáticos Adversos; Sistemas de Controle Gerencial; Alavancas de Controle; Tensão dinâmica

## Resumen

Eventos climáticos adversos (ECA) provocan efectos directos e indirectos en las empresas. El uso de información sobre estos eventos es importante para orientar decisiones de los gestores y buscar reflexiones que se transformen en perfeccionamiento de los Sistemas de Control Gerencial (SCG). Enfatiza el uso de los SCG a través del marco de las palancas de control (PC) de Simons (1995) y la teoría contingencial. Así, el estudio objetivó verificar cómo ECA influyen el uso del SCG. La investigación, caracterizada como cualitativa, fue realizada con base en estudio de caso múltiple: tres de ellos afectados por Tornados y tres por Inundaciones. Las principales consideraciones indican que el histórico con repeticiones de éxitos hace que los procesos relacionados con las prevenciones sean perfeccionados y formalizados, alteración de prioridades organizacionales, comunicaciones e interferencia en las demás palancas, comprensión de riesgos que deben ser evitados o minimizados, identificación de la relevancia del monitoreo, intensificación de uso y estímulo a la aprendizaje. Los ECA influyen los SCG. Los eventos influyen en las técnicas gerenciales, uso de informes de inventario, personal, y logístico, con énfasis en el uso interactivo de las PCs. Se constataron seis tensiones dinámicas relacionadas al evento.

**Palabras clave:** Eventos Climáticos Adversos; Sistemas de Control Gerencial; Palancas de Control; Tensión Dinámica

## 1 Introduction

Performance of the organizations involves a complex process that exposes them to various situations with different levels of predictability and controllability. Companies are increasingly subjected to interruptions in their operations, and it is almost impossible to preview their nature, time and extension (Sahebjamnia et al., 2015). Thus, as they are inserted into the natural environment, they need to adapt to any environmental interruption that may arise (Busch, 2011).

Natural disasters are the occurrence of a natural phenomenon that modifies Earth's surface and affects inhabited areas or regions, causing material and human harms (Amaral & Gutjahr, 2011). Major natural disasters, such as the East Japan Earthquake in 2011, landslides and flooding of the Itajaí-Açu River in Blumenau in 2008 and the flooding of the Chao Phraya River in Thailand in 2011, among many others, draw the attention to the business-related impacts.

This study focuses on Adverse Climate Events, according to the Intergovernmental Panel on Climate Change – IPCC (2012), as part of climate change. Climate change represents one of the most challenging risks of the natural environment and is a strategically relevant fact for organizations (Whiteman et al., 2013). The risk that a community or company is affected might exist; however, it does not always materialize as an adverse event. Therefore, the implementation of planning actions and adaptations can become more complex. The literature suggests that the subsequent impacts of climate change can negatively affect business volume or organizational profit, for example, due to higher operating costs (Mills, 2009), damage to buildings and change in asset values (Busch, 2011).

As climate change impacts become more visible, particularly those related to weather extremes, they need to be reflected in impact costing, reporting and disclosure (Linnenluecke et al., 2015). According to the authors, decision-makers will need relevant information to assess the economic implications of climate impacts and cost-benefit analyses to support adaptations, identify risks, vulnerabilities and liabilities, develop adaptation plans and derive information in the form of adaptation performance and benchmarking metrics.

Among the actions that can be carried out by the management is the use of Management Control Systems (MCSs) (Ferreira & Otley, 2006), in order to implement actions aimed at improving communications and monitoring, promoting diagnoses and simulations and developing continuity plans, among others. It therefore becomes necessary for them to further investigate if the use of MCSs may also minimize the effects of adverse climate events.

In this regard, it becomes important to use information related to adverse climatic events to guide decisions by managers and shareholders and seek reflections that turn into improvements in the MCSs, which, based on Chenhall (2005), is a broader term that encompasses Management Accounting System and includes other controls. It was in this sense that Souza et al. (2020) addressed usability of the managerial accounting practices through the investigation of the main attributes characterizing it.

This research emphasizes the use of the MCSs as a mechanism adopted by the companies to control operations and streamline performance. The “Use” dimension represents the different application purposes of the MCSs (Ferreira & Otley, 2006). The framework adopted to meet this dimension refers to the Levers of Control, by Simons (1995), and includes using the Dynamic Tension concept. According to Oyadomari (2008), Dynamic tensions are contradictory forces, such as the following: Freedom *versus* Restriction and Growth *versus* Risk, among others. It is the joint use of the Levers of Control that generates a dynamic tension (Simons, 1995), and the relationships between the different uses are important, as the increased use of a Lever of Control increases the benefits obtained from the increased use of others (Widener, 2007). This study explores the inter-relationships and uses of the MCSs and the creation of dynamic tensions in organizations affected by some adverse climate event.

This research resorts to the Contingency Theory to discuss the topic in the context of the use of MCSs by companies. According to the contingency approach, it is not possible to adopt a universal MCS model for all organizations (Gordon & Miller, 1976), as it is shaped by the interrelationships of contingency factors. The use of MCSs under the influence of Adverse Climate Events depends on specifications and contexts, so that there are interrelationships in these specificities, in the sense that each one can affect in a different way both the organizations and the ways used by them in management. According to the severity and frequency of the events and greater uncertainties (Linnenluecke et al., 2008; 2012), then different ways of adapting can be adopted. Depending on the company's location context regarding public infrastructure, different indirect effects might take place in the face of a same level of event severity.

In order to seek to understand how the effect of Adverse Climate Events takes place in the organizations, the research problem is to investigate the following: How do Adverse Climate Events influence the use of Management Control Systems? Therefore, the general objective of this study is to analyze how Adverse Climate Events influence the Management Control Systems based on the analysis of Levers of Control, by Simons. In this way, multiple cases were explored, in addition to how the context of the adverse climatic event that affects the companies influences the use of the MCS, which includes management techniques, adaptations, actions and planning.

Winn et al. (2011) mention that, irrespective of its *status* in management research, climate change is increasingly accepted as a fact of organizational life, so that its effects are felt across a wide range of industries, the financial sector, tourism, construction, agriculture and insurance, among others. With this perspective, what was mentioned by Winn et al. (2011) was confirmed by the surveys on this subject matter, as studies were found on climate change related to food security and natural hazards (Hanjra & Qureshi, 2010), tourism, immigration (Beine & Parsons, 2015), insurance (Dlugolecki, 2008; Mills, 2009; Botzen & Van Den Bergh, 2012a, 2012b), vulnerability (Adger, 1999), resilience and adaptation (Burton et al., 1993), environmental protocols and agreements and greenhouse gases (Kolk & Pinkse, 2005), carbon credits, government management (Warren, 2010; Turra, 2016) and quantitative or mathematical surveys on climate change impacts (Fankhauser et al., 1999; Mendelsohn & Neumann, 1999; Nordhaus, 2011).

However, the studies found in the accounting and administration area are few and recent: Linnenluecke and Griffiths (2010); Chartered Institute of Management Accountants – CIMA (2010); Busch (2011); Linnenluecke (2015); Linnenluecke et al. (2012, 2015); Silva et al. (2015), Sahebjamnia et al. (2015), Bui & Villiers (2017), Kumarasiri & Gunasekarage (2017), Silva et al. (2020) and Silva et al. (2021). These studies use climate change or adverse climate events in accounting and administration, with Bui & Villiers (2017) and Kumarasiri & Gunasekarage (2017) exploring carbon management accounting.

In this context, the research gap is in investigating Adverse Climate Events with the perspective of verifying how they affect the companies' use of the Management Control Systems, as there are many occurrences of adverse events, and managers can seek to make adaptations. Thus, it includes identifying and analyzing how this process occurs, what it involves, what type of interactions are provided between the agents or in relation to the uses of the Levers of Control, or even any occurrence of dynamic tensions, given the peculiarities of occurrence, predictability, controllability and intensity of the adverse events.

In this sense, more studies in the Accounting area regarding the use and benefits of leveraging information (Delone & Mclean, 2002) on adverse climatic events are necessary to understand the effects on practical management and to encourage managerial adaptations. Organizations are an important part of society and encompass many human resources, and adaptation to climate change represents a fundamental aspect from a social point of view.

## 2 Theoretical Foundations

### 2.1 Contingency Theory and the relationship with the management control system

Management control is the process of guiding the organization towards feasible activity standards in a change environment (Berry et al., 2005). Therefore, control depends on the type of organization structure, which in turn depends on technology and on the environment (Waterhouse & Tiessen, 1978). Thus, it is deduced that management control systems need to be projected to meet the specific demands.

It is the Contingency Theory that, according to Reid and Smith (2000), helps explain how the contingency factors (or variables) shape the Management Control Systems in the Management Accounting area. The organizational structure depends on contingency factors, such as environment, strategy and size (Gerdin & Greve, 2004). For an organization to have an effective structure, it needs to adapt to the contingency factors (Donaldson, 2001).

Almost all results in terms of the organization's structure and design, whether regarding the environment, technology or size, depend on the interpretation made by its main decision-makers in relation to problems or opportunities since, when interpretation occurs, the organization can formulate an answer (Daft & Weick, 1984).

Thus, many activities in organizations regarding structure, strategy formulation, organizational learning, goal setting, innovation and change, or other decision-making processes, can be linked to the way of interpreting the external environment. MCSs have the potential to assist managers in formulating strategies related to markets and products, required technologies and appropriate structures, and can even be applied in the implementation and monitoring of strategies, providing feedback and information (Chenhall, 2003).

## 2.2 Management control system

A Management Control System (MCS) comprises internal and external, financial and non-financial information that is obtained through formal or informal means, with predictive capacity, made available in a wide range of decision support mechanisms with effectiveness in the control ability (Chenhall, 2003). The definition adopted by Simons (1995) is the following: formal information-based routines and procedures managers use to maintain or alter patterns in organizational activities.

It can be seen that the MCS approach given by Chenhall (2003) includes informal information, unlike Simons (1995), who does so by presenting the Levers of Control as an MCS model. In this study, as used by Diehl (2006), the possible informal controls may come to be part of the research content. This criterion results from the fact that, in adverse situations, such as the one researched, it is possible that the managers have some informal action and this can be important for the research results.

Management Control Systems are mechanisms that facilitate the implementation of corporate strategies, and can be used from the perspective of two dimensions (Ferreira & Otley, 2006): (1) related to the design and (2) related to use. The contribution regarding use was offered by Simons (1995). The Levers of Control framework is explored below, a useful analytical tool to study the concepts of dynamic tension and balance.

### 2.2.1 Levers of control

Simons (1995) developed a framework that establishes a structured system of strategic control based on the establishment and implementation of four constructs: core values; risks to be avoided; strategic uncertainties and critical performance variables. These are operationalized through four systems called *Levers of Control* (LoC), namely: Belief Systems, Boundary Systems (Limits or Borders), Diagnostic Control Systems and Interactive Control Systems.

The Belief System is the explicit set of organizational definitions that the Chief Executive Officer formally communicates and systematically enforces to provide core values, purpose and direction for the organization (Simons, 1995). It encourages and guides the organizational agents in the search for opportunities; it is positive and affirmative in this sense.

Boundary (or Limits) Systems restrict the acceptable behaviors for the organizational agents; they are negative and prohibitive in this sense (Simons, 1995). According to Diehl (2006), these systems seek to establish borders in the search for opportunities, minimizing risks; they are used to protect organizational secrets, reputation and legal complications and can take the form of codes of conduct, codes of ethics, rules and sanctions.

Diagnostic Control Systems are the formal information systems that managers use to monitor organizational results and correct deviations from defined performance standards (Simons, 1995). They have a restrictive nature, with the objective of avoiding deviations. They are differentiated by three characteristics (Diehl, 2006): the possibility of assessing the results; the existence of previous standards; and the possibility of correcting the deviations. According to Façanha et al. (2020) risk management and internal controls are used to protect the company's assets. They also mention some other controls; budgets, cost-standard systems, management by objectives and business plans, among others. The diagnostic control evaluates the implementation of planned strategies and management of exceptions (Merchant & Van Der Stede, 2007).

The Interactive Control System encourages the search for opportunities and organizational learning, with the possibility of enhancing the emerging strategies. It aims at monitoring the strategic or environmental uncertainties, those assumptions that, in case they change, affect the fundamental premises of the strategy (Simons, 1995). Unlike the Diagnostic Control System, it is operated in a more subjective and informal way, through strategic experiences, meetings and discussions, monitoring of market signals and sharing of experiences and perceptions, among others (Diehl, 2006).

#### 2.2.1.1 Analyzing the levers of control: distinctions, combinations and balance

The Levers of Control have different concepts and uses, even if they are not static and totally independent divisions, and there is no way to delimit a boundary between when each use begins, as they are concomitant (Simons, 1995). According to diverse evidence verified in his research, Widener (2007)

suggests that the interdependence between the Levers is complementary. The uses of the Levers act in combination to produce dynamic tension.

As for the distinctions, therefore, it is inferred that the Belief System is used to inspire and direct the search for new opportunities; the Boundary System, to establish limits on the business behavior of the organizational agents; the Diagnostic Control System, to motivate, monitor and reward the achievement of specific objectives by the agents; and, finally, the Interactive Control System, to stimulate organizational learning, in order to apprehend and alert the organizational agents about the emergence of new ideas, strategies and opportunities. Simons (1995) states that the four Levers together create the control necessary to ensure congruent behaviors while still allowing for flexibility, innovation and creativity.

The main differences between the Interactive and Diagnostic Use of Controls (Simons, 1995, 2000) are the following: as for top management delegation, in diagnostic use it is little considered and in interactive use it is the opposite, a lever in which even the top management gets personally involved; in diagnostic use, the strategies are planned and, as for the result, there is correction of deviations and simple circuit learning, while in interactive use, the existing strategies are emerging, new action plans are formulated and learning is double-circuit; the scope of diagnostic use considers critical performance variables and, in interactive use, the strategic uncertainties; in diagnostic use, regarding the frequency of interactions with the subordinates, there is sporadic dialog and management by excess, while in interactive use, dialog is continuous and the agenda is recurrent.

The interrelationships between the different uses of the MCS are important, as increasing the use of one Lever of Control enhances the benefits obtained from increasing the use of the others (Widener, 2007). Empirical studies on the management controls, such as those by Abernethy and Brownell (1999), Marginson (2002), Bisbe and Otley (2004), Tuomela (2005), Oyadomari et al. (2013) and Speklé et al. (2014), have used the framework to explain how organizations use their MCS to encourage innovation and learning while simultaneously exerting control over the goals to be achieved.

Thus, of the studies that used Levers of Control and Management Control Systems (MCSs), some are more related to the context studied in this research and, therefore, they are highlighted. Some of them include the following: Abernethy and Brownell (1999), for finding that interactive use of the budget places Accounting with the function of dialog, learning and creation of ideas; Henri (2006), for investigating the extent to which the diagnostic and interactive uses of the MCS specifically contribute to the creation and maintenance of capabilities that lead to strategic choices; and Mundy (2010), who researches how organizations strike a control balance allowing uses of MCS and how this balance facilitates the creation of dynamic tensions and unique organizational capabilities.

Similarly to the studies by Widener (2007) and Mundy (2010), this research explores the relationships and uses of Management Control Systems and the creation of Dynamic Tensions in organizations affected by adverse climate events. In this sense, the existence or nonexistence of emphasis in the use of some specific lever is identified, as well as how the interrelationship between them takes place.

### 2.2.1.2 Dynamic tension

Simons' framework (1995) presents contradictory forces that generate tensions: freedom and restriction, qualification and accountability, top-down direction and bottom-up creativity (Simons, 1995).

Tension is "dynamic" because there are continuous and varied strategic forces acting both internally and externally, which disturb the relative emphasis of the different levers (Henri, 2006). These forces are encapsulated in a set of organizational conflicts that affect the organizations' ability to balance control and allow for the use of Management Control Systems.

We shall now present some dynamic tensions studies by Oyadomari (2008): Flexibility *versus* Control (the companies need to respond to changes in the environment without losing control) and Competition *versus* Cooperation (competition between managers for better performance and cooperation in work development), among others.

Dynamic Tensions arising from the interrelationships between the Levers of Control facilitate the development of organizational capabilities, such as innovation, organizational learning, entrepreneurship and market orientation, which together contribute to organizational performance (Henri, 2006).

For Widener (2007), Mundy (2010) and Speklé et al. (2014), the research studies on balance in the scope of the Levers of Control provided empirical evidence that companies use them together. In addition to that, this combined use seems to be associated with desirable organizational results, including organizational learning and performance (Widener, 2007), organizational ability development (Mundy, 2010) and creativity (Speklé et al., 2014).

## 2.3 Management of adverse climate events in companies

As companies are inserted into the natural environment, they need to adapt to any environmental interruption that may arise (Busch, 2011). Companies increasingly, and unavoidably, have to address

adaptations to climate changes as an inherent aspect of the business and risk management strategy (West & Brereton, 2013).

Investors, rating agencies and lenders are increasingly demanding information about the impacts of climate change and the consequences for capital allocation decisions (West & Brereton, 2013). Companies can be affected by disasters through direct and/or indirect losses, broader impacts and macro-economic effects.

The companies' weakness is verified in the face of the possibilities of losses and effects caused by disasters. If there is no management, cost-benefit analysis of adaptation actions, continuity/contingency plans or strategies to face possible disasters, the losses and effects can be immeasurable, compromising the performance and even the life of organizations.

The ability of a risk-exposed system, community or society to resist, absorb, adapt and recover from the effects of a peril in a timely and efficient manner, even through the preservation and restoration of its essential basic structures and functions, is defined as resilience according to the United Nations International Strategy for Disaster Risk Reduction (UNISDR, 2009); while vulnerability is the characteristics and circumstances of a community, system or asset that make it susceptible to the harmful effects of a peril (UNISDR, 2009, 2017).

This research finds that observing the adaptations related to adverse climate events carried out in companies with the purpose of facing the crisis and reducing the effects of direct and indirect impacts on management, and doing this through the lens of the Contingency Theory, can contribute to the understanding of changes in the use of Management Control Systems.

### 2.3.1 Development of the study theoretical proposal

For the elaboration of the theoretical proposal of the study, it was considered that the surveys by Finan and Nelson (2001) and by Bahinipati and Patnaik (2015) show that decision-makers have learned from experiences of previous catastrophes, as well as other research studies (Kobiyama et al., 2004; Busch, 2011; Asano, 2012; West & Brereton, 2013) indicate the existence of some adaptation. In addition, a number of research studies on balance in the scope of the Levers of Control provided empirical evidence that companies use them together (Widener, 2007; Mundy, 2010; Speklé et al., 2014).

Thus, in the Levers of Control, the interactive system interferes in the diagnostic and boundary systems, and the belief system interferes in the other levers (Widener, 2007; Vasconcelos, 2012; Pletsch & Lavarda, 2016). Organizational learning is reinforced by emphasis on the Belief system, as well as the use of the Diagnostic system (Simons, 1995; Widener, 2007; Oyadomari, 2008). By stimulating research, learning and the emergence of new ideas and strategies, interactive systems produce opposite effects to diagnostic systems, which limit the search for opportunities (Simons, 1995).

Considering that, according to Henri (2006), dynamic tensions arising from the interrelationships between the Levers of Control facilitate the development of organizational abilities, this study explores the interrelationships and uses of Management Control Systems and the creation of dynamic tensions in organizations affected by adverse climate events. Thus, the theoretical proposal is as follows: Adverse climate events generate dynamic tensions in the Levers of Control.

## 3 Methodological Procedures

Given the nature of the problem, the approach is qualitative, with a research question that aims at describing "how" adverse climate events influence the use of MCSs. Due to the type of research problem and to the methodological design established, the multiple case studies is adopted as a research strategy, with a descriptive purpose.

For operationalization of the cases, preparation procedures for the study were conducted, an action referring to the study quality and criteria for selection of the cases. A pre-test was carried out and choice of the company to do the pre-test interview was for accessibility and for having been indicated by the Fire Department as a company that was greatly affected by an adverse climate event, namely a Tornado. The pre-test interview was carried out with two managers (together) during a visit on October 5<sup>th</sup>, 2013 to a building materials trading company with six employees in the affected store. The pre-test interview was recorded with the managers' consent, it lasted 41 minutes and was not part of data analysis so that, with it, the order of some questions was changed, as well as the way to ask them.

Two sets (analysis units) of three cases were selected, so that choice to use them was based on meeting recommendations by authors such as Eisenhardt (1989) and Yin (2015). According to Yin (2015), case studies can involve from one to multiple cases, as well as several analysis levels.

All the companies studied were affected by adverse climate events, either hydrological (in the study, resulting from rains) or meteorological (in the case of windstorms or tornadoes), according to the classification by Guha-Sapir, Hoyois and Below (2016) and EM-DAT (CRED, 2017). Similarly to one of the suggestions by Patton (2002) to select the cases, the climate events to be studied in this research are the extreme ones.

The first three cases refer to companies directly affected by the Tornado event. Subsequently, three additional cases were researched, belonging to another adverse climate event: Flood. Of those affected by the Flood event, the first two cases researched were directly affected and the last was indirectly affected. It was believed that, after these three cases of each event and 13 subjects, data confirmation was reached in relation to the selection of cases for each event.

Table 1 presents a summary of the event identification and of the characterization of the cases. Case 1, Case 2 and Case 3 are companies affected by the Tornado event, whereas Case A, Case B and Case C are organizations affected by Floods. The companies researched are located in different cities affected by the events.

Table 1

**Identification of the events and characterization of the cases**

Company	Case 1	Case 2	Case 3	Case A	Case B	Case C
	Tornado			Flood		
Effect	Direct					Indirect
Type	Commerce	Industry	Industry	Industry	Commerce	Industry
Sector	Supermarket	Agribusiness	Agribusiness	Textile	Supermarket	Health
Invoicing (annual)	Not reported	1 billion reais	Not reported	Not reported	Not reported	700 million reais
Activity (years)	17	46	60	36	60	82

Source: Research data.

To conduct the research in the companies, the indications provided by the cities' Fire and Civil Defense departments were also followed. Patton (2002) asserts that, for the selection of critical cases, the targets are those in which the experiences or processes to be studied are especially clear in the opinion of SMEs.

The research protocol was developed to guide the researcher at the data collection moment, with the database registered and stored in the Field Report. Semi-structured interviews were used in this study, as well as document analysis, field notes and observations as sources of evidence. In addition to that, the interview transcriptions were reviewed and approved by the participants.

Regarding external validity, the tactics to meet it in multiple case studies "resorts to replication logic" (Yin, 2015, p. 48), based on the study theoretical proposal. External validity was increased with the result of the investigation of several companies and of the full analysis of the comparative findings. The analysis included verifications that proved to be useful to test data interpretation credibility.

The interviews took place between 11/18/2016 and 02/23/2017, were recorded and transcribed, and are included in the Field Report (2017, DOC-14), with 144 pages. Each interview lasted a mean of one hour, totaling approximately eleven hours of telephone interviews and conversations, with a total of thirteen Participants.

The respondents are not identified and their characterizations are generic: "Participant 1", "Participant 2", and so on. The participants have worked in the company for between 5 and 28 years. The mean is over 16 years, showing that the respondents know the company's processes and were working in it at the time of the adverse climate event. As for the training of the 13 participants, eight have at least some graduate degree; one of the respondents has a technical course in Mechanics and Electricity (Participant 10) and the others have some undergraduate degree. The details are shown in Table 2 below.

Table 2

**Characteristics of the respondents**

Case	Participant	Gender	Age	Role in the company	Time in the company (years)	Time in the role (years)	Academic training
1	1	M	40	Commercial manager	11	9	Undergraduate degree in Business Administration and graduate degree in Business Management
	2	M	48	Financial manager	16	16	Accounting technician
2	3	M	53	Planning, quality and cooperativism counselor	28	5	MSc student in Cooperative Management
	4	M	49	Maintenance manager	18	18	Undergraduate degree in Business Administration and graduate degree in Business Management

Case	Participant	Gender	Age	Role in the company	Time in the company (years)	Time in the role (years)	Academic training
3	5	M	65	Industrial manager	25	25	Undergraduate degree in Business Administration
	6	F	39	Production engineer	20	8	Undergraduate degree in Production Engineering and MBA in Industrial Management
	7	F	35	Accountant	10	4	Undergraduate degree in Economy and Accounting and graduate degree in Financial Management
	8	M	36	Member of the Internal Accident Prevention Commission (CIPA)	3	3	Civil Firefighter by IBRAV, Occupational Safety technician, Property Security technician
A	9	M	41	Supervisor of the Legal and Asset Security area	18	4	Undergraduate degree in Accounting Sciences and Law and graduate degree in Cost Strategic Management
	10	M	-	Asset management coordinator	5	3	Mechanics and Electricity technician
B	11	M	30	Unit's general manager	11	6	Undergraduate degree in Business Administration and graduate degree in Supermarket Management
	12	M	39	Controllership manager	20	13	Undergraduate degree in Accounting Sciences and MBA in Controllership
A	13	M	32	Work and Environmental Safety	14	8	Graduate degree in Work Safety

Source: Research data.

A software program (AtlasTi) for qualitative analysis was used to code the data and ensure that there was no selective choice of data in the study conclusions (Abernethy et al., 1999; Richards & Richards, 2000). The interview transcriptions were transferred to the software and provided data for the categorization process.

The research constructs (Table 3) guides elaboration of the script for structured interviews. Operationalization takes place by triangulation with other techniques, such as observation (field notes) and document analysis. Similarly, external sources were consulted to check if the diverse information provided by the managers was precise. These external sources were news items linked in the media referring to the adverse climate event, such as dates, technical details and other news items, municipal decrees, photographs and videos about the direct and indirect effects for the companies depicted in the cases.

Table 3

**Research constructs referring to the Management Control System and to the Levers of Control**

Dimension	Analysis category	Operationalization	Related studies
Adverse Climate Event	<ul style="list-style-type: none"> <li>✓ Affected</li> <li>✓ Classification of the event</li> <li>✓ Estimated damages</li> <li>✓ Decrees</li> </ul>	Semi-structured interview (Appendix A) Documents Observation	(Ewusi-Mensah, 1981); (Castro, 1996, 1998, 1999a); (BRAZIL, 2012); (UNISDR, 2013); (CEMADEN, 2017); (Guha-Sapir; Hoyois; Below, 2016); (CRED, 2017)
Levers of Control	<ul style="list-style-type: none"> <li>✓ Belief systems</li> <li>✓ Boundary systems</li> <li>✓ Interactive Control systems</li> <li>✓ Diagnostic Control systems</li> </ul>	Semi-structured interview (Appendix B) Observations and Documents	(Simons, 1995, 2000); (Widener, 2007); (Oyadomari, 2008); (Mundy, 2010); (Tessier; Otle, 2012).

Source: Prepared by the authors.

Semi-structured interviews were used in this study, as well as document analysis, field notes and observations as sources of evidence. The content analysis material is the transcripts of the interviews, carried out based on the script prepared from the research construct (dimensions, categories) and with the participants defined according to certain criteria, these being the circumstances of origin, addressed by Mayring (2014).



The analysis was carried out following the stages mentioned by Mayring (2014), the way of attributing the categories, which came from the theoretical grounds and the research construct, which was deductive and followed the nominal analysis of the text. According to the author, the systems of nominal, or qualitative, categories consist of a list of independent categories, and the result is a list of categories related to text passages, eventually frequencies of their occurrence.

Table 4 presents a scheme referring to the elements of the research instrument and the expected results related to the pre- and post-event, and some authors as a basis, which assists in the search for comparisons of the findings with previous studies.

Table 4

**Levers of control, elements of the research instrument and expected results related to the adverse climate events**

Levers of control/Sources	Elements of the research instrument (Appendix B)	Expected results related to the Adverse Climate Events
<b>Beliefs</b> (Simons, 1995; Widener, 2007; Mundy, 2010; Vasconcelos, 2012; Pletsch; Lavarda, 2016)	Organizational vision/mission/values/beliefs/priorities (question 1) Communication of the organizational values between the main managers and the other employees (question 2)	Adverse climate events change the organizational priorities, vision/mission/values and beliefs. Change in communication of the organizational values. Interference in the other levers.
<b>Boundary</b> (Simons, 1995; Widener, 2007; Mundy, 2010)	Risk map (question 3) Restriction referring to the business/investment/activity (question 4) Influences from the public authority's rules/legislation/guidelines (question 5) Create, review or undo organizational limits (question 6) Existence and enforcement of penalties due to business behavior (question 7) Existence and enforcement of strategic limits (question 8)	Understanding of risks that must be avoided or minimized. Operation within specific limitations
<b>Diagnostic</b> (Simons, 1995; Widener, 2007; Oyadomari, 2008)	Monitoring of plans and goals (question 9) Business continuity plan (question 10) Management report (before, during and after the event) (questions 11 and 12) Main preventive actions (questions 13)	Identification of the relevance of monitoring. Identification of use. Interference in the interactive system and in organizational learning.
<b>Interactive</b> (Simons, 1995; Widener, 2007; Alves, 2010; Vasconcelos, 2012; Pletsch; Lavarda, 2016; Linnenluecke et al., 2015)	Correction of deviations, new action plans (question 14) Participation of top management (question 15) Benchmarking, group of studies/information management (question 16) Something positive: organizational learning (questions 17 and 18) Understanding, know-how, techniques and practice learned (question 19)	It interferes in the diagnostic and boundary systems. It encourages research, learning, emergence of new ideas and strategies.

Source: Prepared by the authors.

As for the limitations of this study, we must mention the fact that there may be other factors that were not considered and that can influence the relationships built in the data analysis regarding the interactions, grounded on the contingency perspective, between the dynamic tensions and the adverse climate events.

In addition, it may have the researcher's and the interviewees' biases, minimized with data triangulation, or even regarding the research subjects, which refers to the fact that the interviews took place with people who knew about the adverse climate event that affected the company, but perhaps they were not fully aware of all aspects related to the company's MCS. The limitations were minimized by case preparation, case quality, and by the criteria to select the case and the interviewees, conducted as indicated by Yin (2015).

## 4 Data Presentation and Analysis

### 4.1 Cases referring to the Tornado and Flood adverse climate events

The Tornado adverse climate event hit a strip of the city of Marechal Cândido Rondon (PR), had a brief duration but destruction was devastating, according to data from the Field Report (2017, DOC-7). Case 1 refers to a supermarket, which was open at the time of the Tornado event. The manager's report (Participant 1) regarding the damages indicated that the total was approximately 600,000 reais. Not much of the inventories was lost and the suppliers soon made the reimbursement, but there was damage to the structural part of the market and also to the vehicles in the parking lot.

In relation to Case 2, the Tornado affected one of the industrial units. As for the harms, there was damage to the roof of the garage for light vehicles and to the staff access walkway. There was a commitment of financial resources to make the repairs. Production was not interrupted. One person was injured because he/she was crossing the walkway at the time of the event.

The occurrence of the Tornado in Case 3 was devastating in the factory structure. At the time of the incident, the feed factory was not operating, so that may be the reason why there were no injuries. The silo, machinery, roof and production elevators were destroyed.

In general, the effects of the Tornado were of high severity, reaching the structure of companies with no history of a similar event. As for the characteristics of the event, what stands out is its uncontrollability, difficulty monitoring, direct effects on buildings and indirect effects on the communication and energy networks, in addition to obstructing roads and accesses, brief duration and need to devote some time after the occurrence to reform the structure of the affected buildings. It was a severe event, difficult to predict in terms of its occurrence and predetermination of the places affected, its strength and duration. Even with technologies capable of predicting weather conditions that may be favorable for its occurrence, or places that could be affected, unpredictability prevails.

The floods in the city of Blumenau (SC) in 2008 and 2011 occurred due to rainfall concentrations (Field Report, 2017, DOC-7). In Guaramirim (SC), in 2014, according to the city's Civil Defense department, 15,000 people were left out of their homes, and practically the entire city was flooded (Field Report, 2017, DOC-6).

The company in Case A had its yard covered by water due to the flood, harming the shipping sector, although without reaching the inside of the factory. However, the company had to interrupt its activities for a day. Thus, it stopped invoicing and production in this period. As the geographically closest cities were also affected, some suppliers also had problems and temporarily interrupted provision of materials.

The company in Case B was closed for one day. According to Participant 11, there is an increase in invoicing before the flood, due to the publicity through the media about its possible occurrence, and this increase is also accompanied by a loss of revenue during the flood, as the store is closed. One ends up overlapping the other.

In Case C, there was no activity for two days during the 2008 flood. In 2011, production did not stop. The company was indirectly affected as many employees did not have access to the workplace and, therefore, did not show up for work.

It is verified that the effects of the Flood were of high severity and, even though the water level might drop quickly, it is also necessary to wait for the water level of roads and accesses to go down so that activities can be normalized. Regarding the occurrence history, each of the companies under study (Cases A, B and C), referring to the Flood event, were affected at least twice. As for the characteristics of the event, its direct effects on the company's structure stand out, as well as the indirect effects on the affected employees and on the accesses to the company. There is the possibility of predicting the event, but what stands out the most are the monitoring means that have been improved by the public bodies (City Hall, Civil Defense, Fire Department, Cemaden) and started to be used by the managers, mainly due to forecasting controls and technologies used by public bodies, in addition to the use of communication technologies, even by the managers. Greater controllability of the negative effects caused by the event can depend on public structures for monitoring, containment and water drainage, among other factors, as well as on preventive actions carried out by the companies.

Observing all the Cases referring to both events, it was found that there were employees who were affected, although they were not fired or had reductions in their salary for the days they were absent. As for the possible positive effects, all the participants stated that they had somehow learned how to proceed.

Some of the effects that affected the Cases were also found in previous studies referring to events other than those that were the object of this research. Case A suffered damage in terms of non-invoicing, similarly to the effects found by Asano (2012) when studying the effects of the earthquake in Japan. Difficulties accessing the roads by customers, employees and suppliers were evidenced in Cases 1, A, B and C, also pointed out by UNISDR (2009).

Thus, in the contingency perspective, Adverse Climate Events present specificities and occurrence context as other elements that support them in the theory foundations. The context in which the events are inserted is related to the each company's environment, as it involves how to be internally prepared, with its

products/services, raw materials and human resources, among others, to manage the event and how the regulatory environment, actions of competitors and public bodies, suppliers, among others, exert an influence on the direct and indirect effects.

One of the broader and more complex contexts referring to both events investigated (Tornado and Flood) and in all locations of the companies surveyed refers to the public bodies, as it is related to infrastructure and support actions, which mainly influence the indirect effects of an event.

Regarding the context of public bodies, these actions include research studies, lectures, training sessions, monitoring, services, information disclosure, assistance, referring to bodies such as Civil Defense, Fire Department, City Hall, Universities, Water and sewage supply companies, power distribution and communications, among others. Possible support from these bodies is often not targeted at the specific company, but at communities, individuals or other related parties. Thus, in general, the companies researched mentioned that the direct actions received from public bodies are focused on the reimbursement of amounts related to electricity due to a period without supply (Case 1), cleaning and clearance of roads and accesses (Cases 1, A, B and C) and disclosure of monitoring information (Cases A, B and C).

Regarding the internal environment, it was verified that Human resources exerts direct effects on the companies when related to adverse climate events. When the employees' access to their homes is affected by the adverse climate event, some of them will not go to work, and the effect is that companies have to make adjustments and internal relocation of personnel. The situations reported by the managers that have greater effects in this category permeate the company's productivity, which occurred in Cases A and C, as they had to stop production for some period due to lack of human resources.

## 4.2 Management control system by the levers of control and the dynamic tensions

This subsection develops an analysis of the evidence, collected through open questions, and aims at characterizing changes in the use of the Management Control Systems after an adverse climate event. Table 5 presents the quantification of the diverse evidence found regarding the analysis categories.

Table 5

### Diverse evidence: Levers of Control and Dynamic Tensions

Analysis categories	Coded interviews	Total of text sentences			
		Tornado		Flood	
Belief System	9	18	Cases 1, 2 and 3	20	Cases A, B and C
Boundary System	5	4	Cases 2 and 3	6	Cases A, B and C
Diagnostic Control System	7	10	Cases 1, 2 and 3	20	Cases A, B and C
Interactive Control System	8	11	Cases 1, 2 and 3	17	Cases A, B and C
Dynamic tension	5	1	Case 2	12	Cases A, B and C

Source: Research data.

Table 5 shows the scope of the Levers for all Cases, and, in relation to the dynamic tensions, the diverse evidence is presented in all cases referring to the Flood event and, in Case 2, referring to the Tornado event. The category that provided the most evidence was the Belief System, as the historical accounts of the occurrence of each event in the Cases referred to issues such as mobilizing teams to carry out actions, solidarity actions regarding affected employees, communication means and other aspects related to the organizational values.

Subsequently, the main and more detailed evidence is presented and discussed and this is done by addressing the Belief and Boundary Systems, and then about the two Control Systems, which focus on diagnostic and interactive uses. In addition, it is sought to present the evidence most related to the adverse climate event.

### 4.2.1 Belief and boundary systems

When researching the Belief Systems in the Cases, the expected results related to the adverse climate events and based on authors Simons (1995), Widener (2007), Mundy (2010) and Vasconcelos (2012) are as follows: adverse climate events change organizational priorities, vision/mission/values and creeds, communication of organizational values and interfere in the other Levers.

The results in the Cases only confirm the facts that adverse climate events change organizational priorities of the Cases in both events (Tornado and Flood), mainly during the occurrence and in a short period of time after the event; and that the Belief Systems interfere with the other Levers. The fact that all the Cases had the same stance on the decision not to deduct any amount from the salary referring to the day of absence of the employee affected by the event is a change in an organizational priority. The situations cited in relation to role changes and work division also deal with a change in priorities. As for communication, in all

the Cases surveyed, communication of the values between the main managers and the other employees takes place through interaction, conversations, meetings and training sessions.

As for the Boundary System, the expected results, based on Simons (1995), Widener (2007) and Mundy (2010), are the understanding of risks that must be avoided or minimized and operation within specific limitations. In this perspective, it is noticed that all the cases understand the risk better when experiencing them. Organizational limits were created due to the manpower restriction as a result of the climate event, due to the employees' not showing up to work or to their leave of absence because their homes or the homes of their family members were affected.

#### 4.2.2 Diagnostic and interactive control systems

In the exploration of the Diagnostic Control Systems, the expected results related to the adverse climate events and based on authors Simons (1995), Widener (2007) and Oyadomari (2008) are as follows: identification of the relevance of monitoring, intensification of use, interference in the interactive system and organizational learning.

The results found in the Cases reveal that there is intensification of the use of the Diagnostic Control System in relation to the Contingency Plan. The companies that stand out regarding the Contingency Plan are in Case A, with the elaboration of the Emergency Actions Manual for weather events, accidents and asset security. In this company, likely cases in which the employees will not show up to work is not covered in the contingency manual prepared by the company. The reason is that this situation depends on each context and on the extension or severity of the event. Case B has a folder with documents referring to the events that occurred, as it was found that most of the cases surveyed did not adopt a written form of elaboration of a plan regarding activities in the face of a new occurrence of the event.

Observing the Manual (Field Report, 2017, DOC-13) developed in Case A, it is noted that it is in agreement with what was addressed by PRICEWATERHOUSECOOPERS LLP - PWC (2012), regarding the need for a continuity plan to have emergency response procedures that help ensure the safety of the personnel and the protection of the company assets during and after the crisis event; as well as to keep the business running.

In Case A, when analyzing the Manual document (Field Report, 2017, DOC-13), what stood out in the part about the Flowchart of actions was that the content focuses on guidelines on who to contact, on who to notify and not exactly on details about the actions and how to proceed. Thus, exactly how to proceed depends on the procedures that will be carried out by each person and that are not described or indicated in the Manual.

Participant 9 (Case A) speaks about the importance of planning the actions at the time of a Flood event. Referring to Case B, the objective of formalizing this plan is to document knowledge about the events. According to Participant 11, “[...] *When we are faced with the event, we take the action plan and put it into practice*”.

It would be important that this plan in the form of a document goes through discussions and reviews prior to the occurrence of the event; however, regarding update of the contingency plan, interviewee 11 mentions that he has to “live the event” to perhaps make any changes. In other words, in this case the managers do not include formal planning actions in the report by means of simulations or other possible effects, but update the actions according to the event's occurrences.

According to PWC (2012), for the efficacy of a business continuity program and to ensure that the program is well understood by the constituents, periodic validation and testing processes are needed. In Case 2, there is a plan for fires, accidents with pesticides and others, all as required by the legislation; however, there is no plan for the Tornado event and no interest from the managers in this regard was noticed. The company's quality control also provides in a plan which actions to take regarding the receipt of agricultural products after droughts or frosts. Thus, there are some controls regarding adverse climate events such as droughts or frosts in this Case, but not for tornadoes.

Regarding the Interactive Control System, based on Simons (1995), Widener (2007) and Vasconcelos (2012), the expected results are interference in the diagnostic and boundary systems, stimulus to research, learning and emergence of new ideas and strategies. The results of the diverse evidence found in the Cases reveal outcomes regarding learning. In relation to Case B, according to Participant 13: “[...] *the improvement brought about is the possibility of being better prepared for another event. The flood brings about many teachings, in relation to our attitudes, what should be done, what shouldn't be done, how to await the event*”.

#### 4.2.3 Emphasis in the use of the levers of control and balance of the dynamic tensions

After characterizing the changes in the use of Management Control Systems after an adverse climate event according to each Lever of Control, a general analysis is made in this section, focusing on the emphasis given to the use of some lever.

As the context related to the adverse climate events presents itself as complex, the assumption is that it is necessary to emphasize the interactive use of controls in the search for emerging strategies. It is supposed that the objective of using diagnostic controls is to identify errors, regardless of having planning about the climate event or not.

Thus, Table 6 was prepared to present the list of evidence on the changes in the MCS by the Cases studied, relating them with the Levers of Control. Consequently, when analyzing Table 6 it is verified that, generally, more emphasis is given to Diagnostic use, although many interactive uses were observed. The use of the Diagnostic Control Lever in view of the adverse climate event mainly occurs with the use of reports. This situation is quite favorable for the company's operational activities.

Table 6

**Changes in the Management Control System with emphasis on the Levers of Control**

Management Control System		Levers of Control System			
		Beliefs	Restrictive	Diagnostic	Interactive
Formal	1) Systematic use of Benchmarking				Cases A and B
	2) Formalized strategic planning				Cases A and B
	3) Immobilized Control Reports			Case 3	
	4) Logistic Control Reports			Case B	Case B
	5) Stock Control Reports		Case C	Cases 3 and B	Case B
	6) Monitoring of weather information	Cases A and B		Cases A and B	
	7) Personnel report and flood levels			Case C	Case C
	8) Crisis or Contingency Committee	Case 2			Case C
	9) Contingency Manual, documentation of occurrences		Case A		Cases A and 5
Informal	10) Door lock control		Case 1		
	11) Climate change monitoring routine		Case 1		
	12) Labor and task division control			Cases 1, 3 and B	Cases 1, 3 and B
	13) Insurance management				Cases 2 and 3

Note: The numerical Cases (1, 2 and 3) refer to the Tornado adverse climate effect, and the alphabetic Cases (A, B and C) to the Flood adverse climate event.

Source: Research data

It is verified that the adverse climate event provided changes in formal and informal controls. Informal controls are understood as those that are not written or documented; however, they are implemented and can be important in the context of adverse climate events. Thus, for the cases researched, changes were verified in four informal controls.

The other controls, with formal characteristics, are mentioned below. The company in Case A started to carry out benchmarking systematically after the event took place to learn about the successful actions carried out by other companies referring to the event. The actions considering the possible occurrence of adverse climate events started to be considered in the plans of the company from Case A. In the strategic planning of Case B, there was the choice of investment in an area heavily affected by an adverse climate event after carrying out a cost-benefit analysis.

In Case B, the adaptations involved the logistics system and maintenance of the conveyor belts, elevators and entrance gates in the parking lot. In Case C, according to Participant 13: as the company is indirectly affected, the finished materials that are in the factory are distributed to the Distribution Centers in the first flood forecast, due to the known historical difficulty accessing the roads.

Monitoring of information about the events was indicated as controls that underwent changes in Cases A and B. Case B made use of many reports, mainly in merchandise distribution and stock control. Case C used a report from the Human Resources sector with the people's addresses and comparing them with the flood levels on the streets. In Case A, the managers assembled a contingency group comprised by seven to nine people, including security management, production management, administrative personnel and directors; and in Case C there is a Crisis Committee. Case 2 showed emphasis on the Belief System Lever by indicating that there is an intention on the part of the planning and quality advisory management to

create a Crisis Committee. In Case A, the Contingency Manual was a document prepared after an event and is reviewed annually; after updates, it is presented and approved at a board meeting.

In a general analysis, the diverse evidence considered to comprise Table 6 mostly consists of changes with emphasis on interactive use. This emphasis considers some characteristics: multiple management levels and high management attention. Seven controls are presented as resorting to more than one Level of Control. A similar situation was presented by Henri (2006) regarding performance measures both interactively and diagnostically, which showed a positive and significant impact on performance.

Table 6 presents Cases that had some change in their controls or techniques. However, this does not mean that the Cases that had the most changes are necessarily more or less resilient. Either way, it was verified that, after being affected by an event, some control or management role started to be developed in relation to the climate events, in most of the Cases. As proposed by Linnenluecke et al. (2015), it is up to the Accounting department to support the organization in the adaptation to the climate changes, performing the following functions: (i) risk assessment (assessment of vulnerability and adaptive capacity), (ii) assessment of adaptation costs and benefits, and (iii) disclosure of the risk associated with the climate change impacts.

Similarly to previous studies by Widener (2007) and Mundy (2010), it was verified that there is emphasis on the use of the Interactive Control Lever. Oyadomari (2008) listed several forms of dynamic tensions and, based on these and relating the results of the interviews carried out, the following dynamic tensions found in the Cases are perceived, as shown in Table 7.

Table 7

**Dynamic tensions in the Cases**

Dynamic tension in the Cases	Cases that support the evidence	
	Tornado	Flood
Short-term <i>versus</i> Long-term	Case 3	Case A
Organizational limit of Labor <i>versus</i> Productivity	Case 1	Cases A, B and C
Changes in the environment <i>versus</i> Results		Case B
Prevention <i>versus</i> Work		Cases A and B
Internal relationships to create a Risk Committee <i>versus</i> Adaptation to devise new practices	Case 2	
Results <i>versus</i> Resources allocated		Case B

Source: Research data

The dynamic tensions listed are conflicts that were created before, during or after the event, but that occurred as a result of it. The companies surveyed sought to resolve the necessary situations after the event as quickly as possible, making operations return to normal as soon as possible, and most managers mentioned having implemented the necessary adaptations without leaving anything to be done in the Long Term.

It is verified that, regarding the Short Term versus Long Term conflict, the companies took positive actions due to something negative (the event), but which in the long term will bring about benefits to the company. The dynamic tension that refers to the Organizational Limit of Labor versus Productivity occurs when employees, their family members or friends are also affected and the employees do not go to work. This situation is also repeated in relation to the access and transportation means used by the employees to commute from their homes to their workplace. The companies seek to balance this tension by reorganizing task division.

The dynamic tension of Prevention versus Work was found in Cases A and B. In Case A, it is the result of the need to remove the stock so as not to be affected by the event, as the costs to carry out a packaging re-engineering were raised, but they were very high. In Case B, Participant 11: "*There are no mistakes... there is excess of precaution that brings a lot of work... it's that thing: you prepare for a flood and it doesn't happen*" (Field Report, 2017, p. 227) and in Case C, Participant 13's report refers to the dynamic tension of Results versus Allocated resources. "*In 2011, the company was kind, in the sense of providing the Association as a shelter here in the neighborhood... so people went there, they slept... [...], donations were made at the time too... products from the company to the corporation*" (Field Report, 2017, p. 249).

When addressing the topic of specific Committees to deal with the climate risks, it is noticed that most of the cases studied follows the findings by Busch (2011) and by Weinhofer and Busch (2013). Both these studies address the fact that the companies do not approach climate risks independently from general or broader risk management.

The dynamic tensions revealed by the diverse evidence were discovered in the Cases due to the interactions investigated; therefore, they constitute new elements, except for the one that refers to the results in the Short Term versus Long Term, as this has also been listed in other studies, such as Oyadomari (2008) and Lavarda & Pletsch (2016).

In Case A, the managers assembled a contingency group comprised by seven to nine people, including security management, production management, administrative personnel and directors; in Case B, there is a Crisis Committee.

### 4.3 Influence of the adverse climate event on the management control system

Through the multiple case study, the research in the first three Cases contributed diverse evidence that confirms the study theoretical proposal. Changing the context and, thus, researching another three cases, the last one being in the context of an indirectly affected company; even so, it was possible to find diverse evidence consistent with the proposals.

The evidence found is presented to assess the Proposal: *Adverse climate events generate dynamic tensions in the Levers of Control*.

Adverse Climate Events influence the management techniques (Benchmarking, Use of inventory reports, personnel, fixed assets, logistics and formalized strategic planning) and the use of Management Control Systems in all cases studied, through the Levers of Control. This influence informs that there are at least six dynamic tensions related to the event. The diverse evidence found on dynamic tensions involves five of the six cases studied, and only one of the dynamic tensions found in this study had already been mentioned in previous studies (Short Term *versus* Long Term), as the others are new elements.

In one of the cases studied, there was not enough evidence to mention the occurrence of dynamic tensions, which does not mean that there is a balance in this case, but that tensions in the context of the adverse climate event were not located. Given the above, the research proposal is confirmed.

## 5 Final Considerations

With the intention of identifying the effects of the Tornado and Flood events in the cases analyzed, brief occurrence histories of the events were described in each of the six cases. It was the narrative by the managers about the damage and adaptations, among others.

The results allow inferring that the history with repeated occurrences improves and formalizes the processes related to preventions. As for severity, the events surveyed (Tornado and Flood) are serious, meaning that actions taken by the company can minimize damage. In some situations, mainly related to the Tornado event, this severity causes unforeseen and uncontrollable damage, requiring efforts to focus on post-event actions as some preventions would not be enough to prevent harms to the company's physical structure, for example. In relation to controllability and predictability, what is verified is that the Flood event is more predictable; therefore, it presents more chances of being controllable. There was no forecast regarding the occurrence of the Tornado event.

Consequently, the companies were not prepared in relation to managing the event. Thus, due to the difficulty of forecasting, the Cases with the presence of Tornadoes do not carry out monitoring and, in the case of the companies affected by Flood, monitoring is possible, and it is done in the cases surveyed. As for the contexts to which the events are linked, the influences of an adverse climate event depend on each company's preparation, management and prevention. Thus, a more organized company may be more prepared to restructure after an event, or it could have an organizational structure that could allow for greater operational flexibility in the phase during the event.

It is verified that occurrence of the event contributes some learning to managers and employees, who, in some way, change their MCS. Intensity of the changes differs from company to company, in addition to appearing to be related to the effect degree of the event and with its occurrence history.

Referring to the research theoretical proposal - Adverse climate events generate dynamic tensions in the Levers of Control: the Events influence the management techniques and the use of the Management Control Systems of all the cases studied, through the Levers of Control, providing that there are at least six dynamic tensions.

Only one of the dynamic tensions found had already been mentioned in previous studies (Short Term *versus* Long Term), as the others deal with new elements: Organizational Limit of Labor *versus* Productivity; Changes in the Environment *versus* Results; Prevention *versus* Work; Internal relationship to create a Risk Committee *versus* Adaptation to create new practices; and Results *versus* Allocated resources.

In view of the above, it appears that Climate Events influence the use of the MCS through the generation of dynamic tensions in the Levers of Control, and this interaction occurs in all Cases, although it is different in each Case and does not always have all the contingent factors.

Adverse Climate Events and climate changes are subject matters that can be discussed from various perspectives. In the contingency perspective, as a result of the interactions found, it is inferred that there is an interaction between adverse climate events and the environment, structure and technology of the companies surveyed. From the perspective of accounting and management, as it is relevant to explore in order to assist in the understanding of the effects and reflexes on management through the use of an MCS, based on the evidence of this study, carried out through visits to the companies of the six Cases, it is possible to list and discuss practical contributions.

Thus, as some adverse climate events have greater predictability and controllability, it is important that managers check the company's geographic area of operation and prepare a contingency plan or risk map of adverse climate events, that is, an additional document to the map of risks of work-related accidents.

Therefore, it should be based on histories, data already raised and consultations to public or private entities that can convey more detailed, legitimate and reliable information.

In this collection of information on adverse climate events, the possible direct and indirect effects on the company must be considered, as the events do not choose which company will be affected; therefore, the most prepared companies in terms of physical structure, processes, adaptations and organizational culture related to motivation and engagement of employees and the community in their dedication to adaptation, monitoring or reconstruction actions are more successful. It is necessary to train all those involved, as well as to perform periodic simulations and tests, in addition to reviews (PWC, 2012).

It is observed that the actions related to the contingency plan should be used as a diagnosis, but can also generate interactive use through conversations with the top management and employees, in addition to learning and innovations. When planning new priorities due to the adverse climate event, something that would involve the company's mission and vision, in addition to the involvement and mobilization of people in the actions, the Belief System is used.

Furthermore, this study is not trivial, as it makes the various explorations mentioned using the support of the complex Contingency Theory and also because the interrelationships are not simple, as they depend on environmental contexts and specifications as to severity and type of effects that each adverse climate event has.

Due to scope or opportunity, some recommendations for future research are made. Other types of events might be explored aiming to expand or further detail the aspects already studied on the Tornado and Flood events. Thus, it would also be possible to verify confirmation of the results found in this study or comparability of other similar events.

In agreement with Adger (1999), who suggests carrying out research studies on both short- and long-term interactions in the economy and, particularly, on Accounting for economic cycles in order to produce confident assessments of the impacts of climate change, we add the need to carry out studies on the economic impacts of adverse climate events for the affected regions. Another promising aspect for the development of studies refers to the behavioral approach, that is, the human aspect can contribute interesting results.

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## Appendix A – Interview script – Adverse Climate Event

### Identification of the respondent/interviewee and of the adverse climate event:

#### **Moment 1:**

Identification of the respondent/interview:

E-mail address:

Name:

Age:

Schooling/Training:

Role in the organization:

Time in the role:

Time in the company:

Identification of the company:

Sector of the company:

Number of employees:

Main products/services offered:

Working time:

#### **Moment 2:**

Identification of the event:

Number of times that the company was affected by a similar event:

When?

Affected:

Estimated damages:

#### **Moment 3:**

### Script for the semi-structured interview about the occurrence history of adverse climate events:

(Open questions)

Tell the story of an adverse climate event. Mainly regarding the following:

Possible losses/gains:

Company's infrastructure/structure/assets:

Resource allocation:

Possible difficulties/practicalities:

Actions taken:

Interruption of the activities/ Time to resume the activities:

Organization of work teams:

Did the event allow making adaptations? Explain.

1. Which is and which was the company's economic-financial situation at the time of the event? Did the event exert any influence? Explain.
2. If the employees did not go to work (for example, because they also had some contingency with their residence or family), would the company be able to organize/reorganize? Do you have any plan for that? Can you maintain productivity/customer services?
3. In the event of an electricity or water supply outage, does the company have a contingency plan for this? To what extent would this affect the company's activities? (water tank, reservoir, generator, alternative renewable energy...) Was anything implemented as a result of the adverse climate event?
4. In case of no Internet, does the company have a contingency plan for this? To what extent would this affect the company's activities?
5. In case there is no access to roads/streets, can the company deliver or receive its products/goods? Do you have any plan for that?
6. Was there a forecast in the last event? Any monitoring?

Others that were not asked and that the respondent wants to mention:

### Script for the semi-structured interview

(Open questions)

1. Write about the adverse climate event. Comment on the elements that **you consider significant to support the coping ability in the face of new events (resilience)**, regarding the following:

For each item below, at which moment(s): Before, during or after the event?

- a) Company's infrastructure/structure/assets (Short- and long-term):

- b) Resource allocation (Short- and long-term):
  - c) Possible difficulties/practicalities (Short- and long-term):
  - d) Actions taken (Short- and long-term):
  - e) Time to resume the activities:
  - f) Did the event allow making adaptations? Explain (Short- and long-term).
2. Which are the potential mistakes (that happened or not) in actions to support resilience (ability to recover)?
  3. In your opinion, which is the difference between before and after the event in terms of the organization's resilience (ability to recover)?

**Appendix B – Interview script – Levers of Control**

Script for the semi-structured interview – Management Control System – Levers of Control

(Open questions)

**Belief system:** formal and informal communication; coherence of the organizational behavior with the beliefs disclosed.

- 1) Did the adverse climate event generate any change in the organizational vision/mission/values/beliefs and priorities?
- 2) As a practice, in the organization, how does communication of organizational values occur between the main managers and the other employees? (see document) Was there any change in communication after the event?

**Boundary system:** Are there preventive restrictions through regulations (code of conduct, environmental rules, legal norms, financial risks)?

- 3) Is there any risk map? Comment on the risk map and on its use for management before and after the adverse climate event. (see document)
- 4) Did the company fail to carry out any business/investment/activity due to the possibility of an adverse climate event? Explain.
- 5) Which are the influences of regulations/legislation/guidelines of the public power referring to the adverse climate event?
- 6) Did the adverse climate event have any contribution to creating, reviewing or undoing organizational limits? Explain.
- 7) Comment on the existence and enforcement of penalties due to business behavior.
- 8) Comment on the existence and enforcement of strategic limits.

**Diagnostic control systems:** formal systems to monitor organizational results and correct deviations in relation to the performance standard defined.

- 9) How are the plans and goals related to the adverse climate event monitored?
- 10) Does the company have any business continuity plan? (see document) What was it like before the event? Was the event contemplated in the continuity plan?
- 11) Did any already existing management report contribute to managing the effect (before, during and after the event)? Comment.
- 12) Were new management reports created or used to manage occurrences (before, during or after the event) of adverse climate events?
- 13) Which were the main preventive actions that the organization took due to the next occurrence of an adverse climate event? Explain.

**Interactive control system:** example: iterative use of a budget. Iterative use of indicators or artifacts (for example: it was not reviewed). Identify emerging changes in the business activities and generate learning.

- 14) Are deviations corrected, are new action plans related to the adverse climate events formulated?
- 15) Comment on the participation + (delegations, frequency and form of interactions, or others) of the top management in actions related to adverse climate events.
- 16) Was there any inclusion of the organization regarding benchmarking, study group/information management?
- 17) In your opinion, did the event provide something positive for the company?
- 18) In your opinion, was there any organizational learning from the occurrence of the adverse climate event?
- 19) Were there any understanding, know-how, techniques and practices learned? Explain and exemplify.

Semi-structured interview – Management techniques

(Closed questions)

- 20) Was there any variation in the use of management techniques (managerial practices, artifacts) due to the adverse climate event? Comment.

Management techniques (Managerial practices, artifacts)	Description of use in the company/variation in use due to adverse climate events
1) ABC/ABM (Activity-Based Costing/Activity-Based Management)	
2) Analysis of the value chain	
3) Analysis of profitability of products, customers and markets	
4) Life cycle analysis	
5) Cost/Volume/Profit systematic analysis (routine and automatic)	
6) <i>Balanced Scorecard</i>	
7) Target costing	
8) Variable or absorption costing	
9) Monthly income statement	

Management techniques (Managerial practices, artifacts)	Description of use in the company/variation in use due to adverse climate events
10) EVA – Economic Value Added	
11) Non-financial indicators, such as: customer satisfaction index, number of new products launched, product processing time, % of defective products	
12) Budgets	
13) Formalized strategic planning	
14) Internal transfer price between business divisions	
15) Environmental reports	
16) Stock control reports	
17) Quality control reports	
18) Result reports by division or branch	
19) Systematic use of Benchmarking	
Others:	

21) Comments on the artifacts used by the company and their relationship with adverse climate events: BSC, Budget (analysis of variances), only diagnostic use of indicators or artifacts (are they financial or non-financial indicators?)

Semi-structured interview – Dynamic tensions

(Open question)

22) Did the adverse climate event cause any organizational conflict/contradiction (creation/closure/intensification)?

**NOTES**

**ACKNOWLEDGMENT**

Does not apply.

**AUTHORSHIP CONTRIBUTION**

Conception and preparation of the manuscript: F. Wrubel

Data collection: F. Wrubel.

Data analysis: F. Wrubel, M. Z. Silva; L. A. Toigo.

Discussion of results: F. Wrubel, M. Z. Silva

Review and approval: F. Wrubel

**DATASET**

The dataset that supports the results of this study is not publicly available.

**FINANCING**

Does not apply.

**CONSENT TO USE IMAGE**

Does not apply.

**APPROVAL OF THE RESEARCH ETHICS COMMITTEE**

Does not apply.

**CONFLICT OF INTERESTS**

Does not apply.

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