

# **Impacts of Natural Disasters in Brazilian Supply Chain: the case of São Paulo drought**

## Authors

Renata Peregrino de Brito, FHS St. Gallen U. of Applied Sciences, renatap.brito@gmail.com

Priscila Laczynski de Souza Miguel, Fundacao Getulio Vargas, plsmiguel@gmail.com

Susana C.F. Pereira, FGV-EAESP, Susana.Pereira@fgv.br

Submission #15676 accepted for the 2016 Academy of Management Annual Meeting

## **Impacts of Natural Disasters in Brazilian Supply Chain: the case of São Paulo drought**

### **ABSTRACT**

The present study aimed to study local food supply chains in the State of São Paulo, Brazil that were affected by 2014/2015's drought. The goal is to analyze how producers of these food chains experienced this natural disaster and reacted to manage the risks. Using qualitative interviews with different firms from three food supply chains, our findings suggested that although managers perceived the impacts from the water crisis, they did not perceive it as a potential risk to be considered in their risk management activities and do not plan to act to mitigate the risks in the future.

**KEY WORDS:** risk management, drought, qualitative interviews, risk perception

## INTRODUCTION

According to the annual statistical report of disasters in 2014 (ASDR, 2014), almost 330 natural disasters were registered worldwide. Despite a decline in the number of deaths (7823 deaths compared to annual average of 99,820), the natural hazards in 2014 still affected 140.8 million victims and caused a financial loss of US 99.2 billion. The most affected countries in the last decade were China, USA, Indonesia, the Philippines and India.

A disaster is considered "a disruption that physically affects a system as a whole and threatens their priorities and objectives" (Van Wassenhove, 2006, p. 476). Disasters can be classified as natural or manmade and can be sudden (such as earthquakes, tsunamis and terrorist attacks) or slow-onset (such as famine, drought, poverty or political crises and refugees) (Van Wassenhove, 2006).

In spite of the increase of natural disasters, few studies investigated their impacts at the country level. Research suggests that the impacts of natural disasters are higher in developing countries than in developed countries (Oh & Oetzel, 2011). The ADSR (2014) confirms that "among the top ten countries in terms of disaster mortality in 2014, seven countries are classified as low-income or lower-middle income economies". Therefore, it is important to investigate the phenomenon in a new context.

Brazil appears as the 2<sup>nd</sup> country in terms of victims in 2014 (27.62 millions) and as the 5<sup>th</sup> in terms of damages (US\$ 5.20 billions) (ASDR, 2014). The natural disasters in Brazil are not catastrophic events, but recurring phenomena such as drought and floods (gradual and sudden) also result in emergency situations. Despite that, the number of events in Brazil has been increasing since 2007 (ASDR, 2014, Miguel, Brito & Pereira, 2015). According to Brazilian reports, in 2013, there were officially 493 disasters reported and 18,557,223 people affected by them, with more than 70% municipalities suffering with drought or dry spell (Anuário de

Desastres Naturais, 2013). The country has faced severe droughts in several regions (Southeast in 2014, Northeast Semi-Arid in 2012 and 2013, North in 2010, and South in 2008). A recent study of the Brazilian government also highlighted that in 2040, Brazil will suffer with extreme temperatures and the water supply will be a scarce resource in many regions of the country (Brasil-2040).

Water crises alternating with periods of excessive rain result in major impacts to the population and also to supply chains. One of the most affected sectors is agribusiness as major climatic conditions directly affect food production and the availability of goods. In the long run, it results in increased product prices and stock outs in retail. In the case of drought, the food industry still suffers indirect consequences in power shortage function, resulting also in higher manufacturing costs (Miguel, Brito, & Pereira, 2015). Bearing that in mind, practitioners should consider natural disasters in their risk management activities. However, few studies investigate the impact of extreme weather conditions to organizations.

The analysis between business and the environment is traditionally seen by the inside-out perspective of how the activity of the company affects the environment, and there are relatively fewer studies that focus on outside-in perspective, how the environment impacts business (Winn, Kirchgeorg, Griffiths, Linnenluecke, & Gunther, 2011). Within the inside-out perspective companies are required to develop best practices for environmental management and reduce its contingent of negative externalities. In general, the corporate responsibility of literature and sustainability focuses on the analysis of how companies respond to environmental pressures (Darnall, Henriques, & Sadorsky, 2010; Delmas & Toffel, 2008) and how competitive are those strategies (Clarkson & Richardson, 2011).

Although the analysis of the environmental impacts on the business environment is still a subject little explored in the literature, the increasing impact of natural disasters such as droughts and storms have produced visible impact on society and business (Jennifer Howard-

Grenville, Buckle, Hoskins, & George, 2014). Study of reinsurer MunichRe (2014) showed that the average impact of major natural disasters is 0.3% of GDP. To Altay and Ramirez (2010), disasters affect the infrastructure and the flow of products, promoting disruptions in supply chains and affecting their profitability. Hence the need to evaluate the impact of disasters on supply chains and the ability of risk mitigation and resilience of the affected organizations, industries and value chains.

Therefore, there is an urgent need to better understand the impact of climate changes, represented here as natural disasters events, in productive supply chains and the actions plan to mitigate the risks(Altay & Ramirez, 2010). In the context of Brazil, the need of the present study is also imperative as organizations still consider environmental risks as marginal or negligible.

This research studied local food supply chains in the State of São Paulo, Brazil affected by 2014/2015's drought. The goal was to analyze how producers of these food chains perceived the effects of water scarcity on their operations, their perception of the likelihood of new events and their intention to act to mitigate future risks.

The relevance of this research is also justified by the chosen supply chains. São Paulo is the state with the highest GDP in Brazil which represented 32.1% of the Brazilian GDP in 2013 and the selected food chains plays an important role to this State's economy.

Therefore, our research question is: "How did the business affected by the 2014/2015 water crisis in São Paulo state perceived and managed the risks in their supply chains?"

To accomplish with this goal, a qualitative research design was adopted and carried out in two phases. First a documentary analysis using news from newspapers and digital media was conducted to identify supply chains impacted by the drought. In the second stage, qualitative interviews were conducted with respondents from three different supply chains in food sector.

Our findings show that there are positive and negative factors that influence the risk perception and preparedness of firms: access to information, direct experience, perception of the nature as a constant provider of good yield, lack of information and cost mitigation. The access to information about the severity of the event was a motivation for some firms to take precautionary measures. While the direct experience of the natural disaster (drought) with losses concerned most of the firms, but not enough to push them towards preparedness.

This research presents some contributions to the debate about natural disasters and supply chain risk management. A theoretical contribution by advancing the knowledge of natural disasters and supply chain from empirical evidences of the main impacts of a drought in the food supply chain in the condition of a slow-onset event. And a social and practical contribution by alerting to the need to start acting and educating all stakeholders to be prepared to face the climate change.

This article is divided in six sections. After this introduction comes a session with a literature review on supply chain risk management, risk perception and preparedness. The methodology section describes research procedures for data collection and analysis. Next, results are presented and the subsequent section discusses results. The paper concludes by presenting theoretical and managerial implications, describing limitations of the study and proposing ideas for future research.

## **LITERATURE REVIEW**

### **Supply chain risk management (SCRM)**

SCRM is an emergent area attracting the interest from both academics and practitioners (Sodhi, Son, Tang, 2012). There are several definitions of risk in the literature (March & Shapira, 1987; Markowitz, 1952; Mitchell, 1995). The most used operational risk definition divides risk according to three questions: what may happen, the probability of it happen and the

consequences (Kaplan & Garrick, 1981). Although the word risk usually means possible results for a particular event, in supply chain literature, the term is associated with a negative effect, such as disruption, damage or loss. The majority of studies associate risk to events, such as supply disruptions, demand volatility, capacity constraints, that may cause disruptions to the firm's operations and that affect negatively the company's results.

Risk management can then be defined as the process of assuming that the risk exists and taking action plans to avoid, reduce, transfer, share and even accept the impacts (Brindley, 2004, p. 22). According to Sodhi et al. (2011, p 5), there are four key elements in the SCRM: risk identification, risk assessment, risk mitigation and responsiveness to risk events (that can be either operational risks or catastrophic, such as disasters), as shown in figure 1. If a company can reduce its exposure to risk, it reduces the chances of disruption and increases its resilience, ie its ability to recover. Ghadge, Dani and Kalawsky (2012) also state that there are two approaches for risk management: proactive and reactive.

-----Insert Figure 1 about here-----

One of the risk sources identified in the literature is disasters, both naturally and man-made disasters (Wagner & Bode, 2006). Disasters are huge intractable problems that test the capacity of communities and nations to effectively protect their populations and infrastructure, in order to reduce human and property losses, and to recover quickly (Altay & Green, 2006, p. 475).

According to the EM-DAT, disasters can be classified into: (A) Natural hazards: Natural occurrences of physical phenomena caused by fast or slow events, which can be geophysical (earthquakes, landslides, tsunamis and volcanic activity), hydrological (avalanches and floods), climatological (extreme temperatures, drought and forest fires), weather (cyclones and storms / high the tides) or biological (epidemics of diseases and pest insects, animals) or (B) technological risks of human origin: events caused by humans and may include environmental

degradation, pollution and accidents technological risks (complex emergencies, conflicts, famine, displaced populations, work accidents and traffic accidents) (ASDR, 2014).

Because the impact of these events generate major disruptions in the flow of goods, people and financial resources, an impressive amount of attention is given to the future of disaster management (Drabek & McEntire, 2003), but collectively it corresponds to only 3% of the resources involved in response operations (Van Wassenhove, 2006).

The interest on the theme has risen in the last two decades. Nevertheless, a review of the recent studies on the topic indicated that major studies have been conducted by American researchers and were based on mathematical models. It also highlighted that studies about natural disasters are mainly focused on sudden events, despite the damage and number of affected resulting in a long-term situation. Among the key stakeholders identified in the studies, are non-governmental organizations (NGOs), government, local NGOs, United Nations, Military Organizations, and Private Sectors (Leiras, Peres, Bertazzo, Yoshizaki, 2014).

An agent that has been little explored in the context of operations in natural disasters is the commercial organization and its respective supply network (Altay & Ramirez, 2010). Beamon (2008) states that in the context of large climate changes and growth, management of the supply chain presents both new challenges and opportunities for managers, mainly for the food and humanitarian chains. Disasters result in damage to infrastructure and logistics disruptions in chains, affecting the performance of organizations (Altay & Ramirez, 2010). A proactive planning for this type of event should be a priority for managers and should be considered in their risk management activities (Knemeyer, Zinn, & Eroglu, 2009).

### **Risk Perception and Risk Preparedness in Natural Disasters**

Risk may vary from a technical perspective, with a more objective and measurable vision, until a socio-constructivist perspective, in which the risk is determined through social,

political and historical point of view (Lupton, 1999). Usually, the word perception is used in subjective definitions of risk, while the word probability is used in objective's one.

While experts have gradually adopted the objective risk approach to assess negative impact of natural hazards, a large number of researchers have focused their studies on the subjective aspects, what determines people's risk perceptions.. Moreover, researchers recognize that there is a shifting movement from an objective approach of flood-risk management towards a more integrated approach which includes social aspects as preparedness and response (Kellens et al., 2013).

The term risk perception is largely adopted within social sciences and “denotes the process of collecting, selecting and interpreting signals about uncertain impacts of events, activities, or technologies”(Wachinger, Renn, Begg, & Kuhlicke, 2013, p. 1049). The mental model and other mechanisms adopted by individual to assess risks are developed and influenced by social and cultural learning. And type of risk, risk context, individual personality and social context affect risk perceptions. These authors also claims that “perceptions play a major role for motivating individuals to take action to avoid, mitigate, adapt to, or even ignore risks”.

It is important to differentiate between risk perception and preparedness and adaptation to an event. To reach preparedness and adaptation individuals consider both probability of an event and experience. The highest the direct experience with a disaster and perceived impacts, the higher will be risk management to future events (Wachinger et al., 2013). However risk perception is not enough, it is important that individuals take responsibility for adaptation. It is imperative that individuals are educated about risk, its impacts and ways of acting. The sooner individuals are involved and perceive their participation in the process the better the chances of adaptation (Wachinger et al., 2013).

There is empirical evidence of experience of past event (flood) acting as a motivation force to adaptive actions for future events (Zaalberg, Midden, Meijnders, & McCalley, 2009).

However, from a thorough literature review some authors identified a phenomenon called “risk paradox”. According to several studies reviewed, there are evidences that “even though individuals have experience and high risk perception, they seldom take appropriate preparedness actions” (Wachinger et al., 2013, p. 1054). There are three main reasons for the risk paradox: the first one is explained by expectation, when “individual perceive that benefits outweigh the potential negative impact”; the second is linked to trust, where more trust in structure or government, e.g, may influence risk perception by reducing the likelihood of acting; the third is a result of both confusion or ignorance about the adequate action to be taken and lack of capacity and resources.

## **METHODOLOGY**

The goal of the present research was to investigate the local supply chain in the state of São Paulo, affected by 2014/2015’s drought, and to analyze how the producers perceived the event and reacted to mitigate the risks. Therefore, a qualitative research design was adopted, allowing us to deeply investigate the phenomenon and the context (Eisenhardt, 1989; Yin, 1989). The unit of analysis of our research was the organizations, as we would like to understand their SCRM strategies.

### **The water crisis in Brazilian Southeast region**

Water crisis is listed as one of the top risks based on the perception of leaders and decision makers all around the world and this concern is related to the possibility of water being a scarce resource in the near future (WEF 2015). According to Brabeck-Letmathe and Ganter (WEF 2015), “Global water crises – from drought in the world’s most productive farmlands to the hundreds of millions of people without access to safe drinking water – are the biggest threat facing the planet over the next decade.”

Brazil suffered with recurrent droughts in the last 10 years (Miguel et al., 2015). The most affected region is the northeast region, especially the semi-arid region. However, the rain pattern in the southeast region (11% of the total Brazilian territory that encompasses the states of Rio de Janeiro, Minas Gerais, São Paulo and Espírito Santo) also varies: normally those states suffer with sudden and strong rains during summer time (December to March) and lack of rains from June to September. Long time of dry weather in the region has severe impact to Brazilian economy, mainly to agriculture (both intensive and familiar) and to energy supply as various hydroelectric power generation facilities are located in the region (Anuário de Desastres Naturais, 2013)

São Paulo water crisis was an unprecedented drought situation. It did not started in 2014, but was a consequence of the recurrent safety level reduction of large water reservoirs for more than ten years (MAPA, 2015). Besides that, the region was affected by an uncommon climate situation with no rain during summer time. Nevertheless, the first alerts about the severity of the event were issued only in the beginning of 2014.

The drought affected not only the population. Service activities mainly related to commercial point of sales, agriculture and manufacturing suffered with the reduction of water supply. The most reported impacts in the news articles analyzed were crop yield loss, livestock production losses, production reduction, energy and water supply shortages that affected most operations. Indirect effects reported were higher costs.

### **Data collection**

The research was conducted in two different stages. First, a documentary analysis was applied to identify facts in newspapers to ratify and validate information received by other sources and to distinguish case studies, major players and description of different impacts to the society and to supply chains that could be further investigated. Database used in this study consisted of

documents of the Brazilian Civil defense and news articles published in *Folha de São Paulo*, regarded as the newspaper of largest circulation in the country. Documents from the government and from independent organizations were analyzed to better understand the water crisis of 2014/2015 (length, causes and damages to both population and economic damages and most affected supply chain). The news articles were retrieved between 2013 and April 2015 to have a broader view of the communication of the drought to population. Table 1 brings a summary of the number of articles published in each year and the main topics addressed. According to this analysis, we can see that the drought was not considered severe until the year of 2014. A second outcome identified in this stage is related to information available to population. Although there were warnings about the low level of the reservoirs, Government was denying the possibility of a water crises. The consequence of that is that population did not have access to reliable information that jeopardize individuals' risk perception (Wachinger et al., 2013).

----- Insert Table 1 about here-----

A second phase consisted of 16 in-depth interviews with key contacts in the food supply chain. The food supply chain was identified in the first phase of the study as one sector most affected by water scarcity. The agriculture and livestock production are responsible for 70% of the freshwater consumption in the world (FAO, 2012), and is an important business sector to Brazilian economy. The food industry is responsible for almost 25% of Brazilian GDP and 40% of Brazilian exportation.

Three main supply chains were selected (orange, coffee and sugarcane). Brazil is the biggest producer and exporter of coffee in the world and São Paulo is the third producer of coffee in Brazil (Cecafé, 2015). In 2015, coffee represented 7% of total agribusiness exportation of the country (AGROSTAT, 2015). The supply chain is composed by farmers (normally small

farmers) who sell cherries to processors, cooperatives or traders. Traders are responsible for exporting products to retailers that sell in international markets (Costa, 2014).

Brazilian southeast region is also responsible for 60% of the worldwide orange juice supply and about 30% of the total fruit crop (CITRUS, 2015). São Paulo state concentrates almost 75% of orange production in Brazil (INVESTE SP). The orange juice supply chain is composed of small and large farmers and juice processors; these last are responsible for the storage and trade. Brazil is also a leader in terms of sugarcane production, used both for sugar and ethanol production. The estimated volume of exportation of sugar is 32.6 millions of tons in 2019 (MAPA, 2015) and 60% of Brazilian production is concentrated in São Paulo state. Additionally, there is a direct by product of sugarcane, the cachaça, popular liquor fermented and distilled.

Data collection occurred between September and December 2015, to ensure that data from water crisis were still evident. An interview protocol was initially developed and, whenever it was possible, two researchers conducted data collection. Interviews were face-to-face or using skype. External validity was improved in trying to get respondents (more than two) in each point of the specific supply chains. The respondents were agro-industrial manager/director, sustainability manager/director and farmers. In most cases, farmers join cooperatives to become more competitive and provide logistic to other industries, retailers and restaurants.

### **Data Analysis**

We started by the within-case analysis for each case considering the firm as the units of analysis of this study. In this process, we codified the texts and identified the main categories that were then factored into new categories classes that better condensed the patterns (Miles, Huberman, & Saldaña, 2013). The final main categories of analysis are risk perception and climate change, risk management and other risk concerns. We consolidated findings within each unit of analysis

and classified each firm according to its attitude towards risk management. Finally, we performed the cross-case analysis, comparing firms' responses and attitudes towards risk management.

## **RESULTS**

From the 16 cases, 14 are distributed in the supply chain of agricultural products covering all positions from farming, food processor, food manufacturing and retailer. Two other cases are representative of the government department for rural assistance and one association of farmers. The sugarcane supply chain is integrated from the crop production to the manufacturing of sugarcane, ethanol and cachaça (liquor). The orange supply chain normally integrates farming and the juice extraction.

----- Insert Figure 2 about here-----

The sample was successful in capturing the impression of the farmers, the main players affected by the drought, as well as the players that influence the farming activity. That is the case of the government, the association of farmers, the consultant as well as the managers at cooperatives.

### **Cases analysis**

- **Retailer FF:** Operator of an international fast-food restaurant franchise network. The Brazilian HQ is located in the surroundings of São Paulo, where the Corporate Sustainability Director was interviewed. The most important restaurants are located in the city of São Paulo. Even though the restaurants had been affected by extreme weather events (such as floods), the Retailer FF had never considered environmental issues as a risk factor for its business, until been alerted of the gravity of the crisis. The firm adopted a contingent and mitigation plan mainly focused on their restaurants, which includes the elimination of redundancies in the cleaning process, installation of an extra water tank and the capture of

water condensed by the air conditioners. As result, the water consumption decreased 20%. Regarding the supply chain, as per Retailer FF analysis, 80% of suppliers were not in the area of drought and the remaining 20% reported having a contingency plan. The firm also started a series of workshops with suppliers to exchange experiences and best practices.

- **Coffee Manufacturer:** multinational manufacturer of coffee, paper coffee and coffee machines. The Supply Chain Director and the Sustainability Manager were interviewed in Brazilian HQ (São Paulo /SP). Coffee Manufacturer was indirectly impacted by the drought and noticed that the coffee supply was affected, however given the supply diversification; it was not heavily impacted. Supply diversification and the strategy of future contracts are measures already taken by the firm to manage supply risk, and are perceived as satisfactory. In terms of industrial production, the manufacturer also perceived the rise of energy costs and the risk of energy rationing, which could affect other products than coffee. To mitigate the energy risk, the manufacturer resorted to the future contracts with the power generator.
- **Sugar Mill:** One of the largest sugar mills in the northern region of São Paulo, it is a family owned business on its third generation. We interviewed the Agricultural Manager, who declared that the severe drought accounted for over 20% of decreased productivity. However, the respondent considers that the region is good in terms of natural resources and climate and extreme weather events have low probability. The interviewee considered several disadvantages of irrigation, as a mitigation project, that included obtaining environmental licenses (given the environmental liabilities of the firm) and the inappropriate conditions of the terrain. Additionally, he considered that the crop needed technological improvements that could overcome climate restrictions.
- **Liquor Scale:** Large producer of cachaça. Liquor Scale plant is located in the northern of São Paulo State, with sales nationwide and exports to several countries. The Sustainability Manager said that the drought decreased the productivity of the sugarcane, but because of

the diversification of supply, they could manage the crisis. Given its scale, the firm follows with weather forecasts to plan the production and has increased its own plantations to diminish the supply dependence. However, if a major drought happens to affect the entire region they would have no solution. The Sustainability Manager also recognized that competitiveness was a more important issue to the management in comparison to environmental risks.

- **Liquor Org:** Producer of organic cachaça, Liquor Org is located in the northern of São Paulo State. The founder, interviewee, demonstrated strong environmental awareness and demanded environmental education to farmers. The founder had experienced the effects of the drought and perceived broader impacts such as the expansion of the plantations to compensate for the low productivity. Even though, considering the likelihood of new extreme weather events, in his opinion, irrigation was not economically feasible.
- **Liquor I:** Producer of cachaça is a small firm is located in the northern of São Paulo State, where the founder was interviewed. According to him, the drought was vastly experienced in the region and halted the number of springs. Firm was also affected by the cost of energy. The interviewee considered that extreme weather events have increased and complained about the lack of information and action from the government. Other important concerns mentioned were appropriate work force and the rise of taxes that offer higher risks to the business.
- **Liquor II:** Small producer and distributor of cachaça, located in in the northern of São Paulo State. The founder perceived impacts of the drought more superficially, not affecting the firm production, he also considered that the region is abundant in natural resources and that natural disasters are not likely to happen. Moreover, irrigation and tank trucks were considered costly and insufficient solutions. On the other hand, the founder demonstrated strong concern with criminals that set fire to the plantation and the rise of the taxes.

- Orange Farm I: The firm has production, orange and concentrated orange juice. It has units in the west of São Paulo State, the operations manager and Agro industrial Director were interviewed. According to them, there has been considerable temperature rise in last years, and the recent drought reduced the production of orange in about 25 to 30%. The drought also affected the quality of the orange and increased production costs. The interviewees consider possibility of new droughts, however they ponder that the region has great natural resources, including rivers and climate regime, that did not posed great risk. Moreover, there were other concerns such as the competition in the sector that has been consolidated into few players. In terms of mitigation, the firm has slowly invested in irrigation, with good results, but the project is still very restricted, because of the investment costs and the dependence of water sources. The company resents the lack of information from governmental authorities.
- Orange Farm II: A family business, the farm produces orange and other fruits in the state of São Paulo. The farmer reported that the recent drought led to 20 to 30% of decrease in production, more intense in the areas without irrigation, and reduced the quality of the products. He acknowledges that they were not prepared for the extreme drought and that the irrigation is not feasible for the entire planted area. The farmer also reported great concern with the orange market concentration, reason why they have started the diversification of crop. The farmer also resents the lack of information and advisory from governmental entities.
- Orange Coop I: Farmers' Cooperative in the State of São Paulo that congregates 22 thousand producers of orange and other crops. We interviewed the Manager of the Agriculture Department, who said that the recent drought caused average losses of 20% of the production and that some farmers have already reduced the plantation of orange and diversified the production. In terms of mitigation, the Cooperative gives support to the

implementation of irrigation process, however not all farmers know how to operate it and there are discouraging bureaucracies in the access to water reservoirs. Also, that, the irrigation is expensive and might not be affordable by smaller producers. The interviewed sees the volatility of the climate conditions as cyclical, and do not believe that extreme events will become more frequent.

- Orange Coop II: The cooperative congregates 320 family farmers in the northern frontier of São Paulo. The Director of the cooperative, interviewed, estimated that the recent drought reduced the production in between 20 and 30%. The family farmers had low mechanization and no preparedness for the event. According to the Director there is a finance program for investment in irrigation, however, he sees the access to water as another obstacle. Even though the cooperative director perceive an abnormal rise of temperatures, he does not believe in climate change or that deforestation is a problem.
- Orange Coop III: Cooperative of small citrus producers (orange, lemon, and other tropical fruits) in the north of São Paulo State. According to the cooperative Agronomist, interviewed, the drought caused losses up to 40% of the production and that most of farmers were not prepared. Since then, the cooperative have focused in the capacitation of the producers about irrigation technologies, but there is still a lot to be implemented. Additionally, the producers do not perceive that severe droughts will happen soon.
- Farmers' Association: The President of Association of Orange producers of north of São Paulo State was interviewed. He acknowledged that the drought provoked losses in production and decreased the quality of the fruits and that few areas have irrigation, which is expensive for small and medium producers. However, his major concern regarded the control of diseases such as the "greening" that have endangered the production in the region.
- Coffee Farm: The farmer in the west of São Paulo State was interviewed. The farmer recalled that the temperatures raised above the forecast and surprised producers. As result,

coffee production decayed 30%. As per mitigation, irrigation is considered too expensive and not feasible in the entire region. The farmer also mentioned a process of shadowing with the plantation of rubber tree in conjunction with the coffee tree, as long-term solution. For the future, the farmer is optimistic about the weather and expects a good harvest.

- **Coffee Consultant:** We interviewed an agronomist, consultant of 20 coffee producers in the northeastern region of São Paulo. The consultant recognizes that the recent drought reduced productivity and producers had to renegotiate trade contracts. Producers also called on insurance policies to cover the losses partially. Due to the geography of the region, there are not many rivers available for irrigation projects; moreover, producers are concerned with other challenges such as mechanization and competitiveness.
- **Governmental technical assistance:** The technical department of the State of São Paulo government has the mission of promoting the rural development, through the implementation of programs and projects. Three directors were interviewed. The interviewees were aware of the effects of the recent drought and the impacts to the rural production. However, they considered that mitigation measures, such as irrigation and access to water, were extremely bureaucratic and limited the capacity of adaptation and led producers to illegal procedures. With constant comparisons with other States, the interviewees perceive low risk of future extreme events, besides they also considered unlikely that human action and deforestation could not interfere in climate regimes.

----- Insert Figure 3 about here-----

### **Cross Case analysis**

We grouped the cases according to their attitude towards the climate risk perception and management, as result we had three groups: the influence group, the vulnerable and the risk managers (Figure 4).

----- Insert Figure 4 about here-----

The vulnerable group is the major cluster of farmers that compose our sample (Coffee farm, Sugar Mill, Liquor I, Liquor II, Liquor Org, Orange farm I, Orange farm II). This group was directly exposed to the effects of the drought and suffered with the decay of production. However among these farmers there is a perception that the nature is provider and that negative events (such as climate) are transient. Because of the historical of good climate there has been little investment in solutions such as irrigation or shadowing, which are expensive and long term solutions. The perception of abundance of natural resources prevented farmers from recognizing the increasing vulnerability of their agricultural activities in relation to extreme weather events. Moreover this group is concerned with the competitiveness and not well informed. Therefore, the perception of low risk and the non-preparedness for the past drought or future events. We consider that this group suffers the influence of two other groups in different measure.

The “risk managers” group is composed of three large firms (Retailer FF, Coffee Manufacturer, Liquor Scale), that have perceived the risk related to the drought events and managed it with concrete measures. These group have acknowledged the severity of the climate restrictions and the likelihood of losses for their business, and looked for measures of mitigation. Their solution was to reduce the need of water and or to diversify geographically the sources of supply, so to reduce the exposition to climate events. This group has already hedged their supply interests by diversification, and foster rivalry to the supply chain. Therefore their influence does not bring awareness to the farmers.

The third cluster is composed of the three cooperatives, the consultant, the association and the govern. We considered them influence group because of their role of advising and helping the farmers in the production and commercialization. These group was in direct contact with the farmers, some were also farmers themselves, and perceived the impacts of the drought. However, extreme weather events were considered cyclical and did not caused alarm. In turn,

they were concerned about denying the relation of climate change, deforestation and use of water resources, to the agricultural practices and irregular land use. With little understanding of the rising environmental restrictions, the influence group did not help providing alternative solutions or searching for sources of information to farmers.

Among the three groups farmers held the higher risk exposure to weather events and were poorly informed by the influence group, whereas the manufacturers and retailers are themselves hedged against the effects of extreme weather events. The great gap of information that make farmers vulnerable is not attenuated by any governmental communication. As recognized by the farmer Liquor Organic, there is a need for environmental education in the field.

We did not find distinction among the crops of coffee, sugarcane and orange in terms of risk perception and risk management. Irrigation, more specifically drip irrigation, is the main known solution, while other solutions were also mentioned such as shadowing (coffee), contour plowing (sugar cane), preventing bare ground, and biotechnology. However, the extensive plantations of orange, sugarcane and coffee crops and the implementation costs did not encourage the investments.

## **DISCUSSION**

Our study brings some contributions to the debate about natural disasters and risk management. First contribution regards the investigation, within the business context, of the interplay between the experience of extreme events and the continuous non-preparedness. This risk perception paradox is a phenomena broadly investigated in the literature, however, much of the existing studies refer to individuals and households attitude and not to business decisions (Wachinger et al., 2013). Our study brings the vision of business men faced with the experience of a natural disaster and deciding about future precautions.

Our findings demonstrate that there are positive and negative factors that influence the risk perception and preparedness of firms (Figure 5), where decision making has some specificities

in compassion to individuals (Wachinger et al., 2013). The access to information about the severity of the event was a motivation for some firms to take precautionary measures. While the direct experience of the natural disaster (drought) with losses concerned most of the firms, but not enough to push them towards preparedness.

----- Insert Figure 5 about here-----

On the other direction, we found a perception of the nature as a constant provider of good yield (natural resources and climate conditions), this image, nurtured in time, seemed to give security to the interviewees. The lack of appropriate information, coming from government and opinion makers, also helped the farmers to undervalue the risks of new occurrences. Finally, in business context of competition, other concerns than climate risks were priority to the firms and competed with the costs of mitigation.

The second contribution regards the examination of business decision in the condition of a slow-onset event (Van Wassenhove, 2006) rather than the commonly studied sudden events such as floods (Kellens et al., 2013). The characteristic of the drought that resulted in the hydric crisis, is that the role of warning and information is crucial to foster preventive measures. Without that, the drought was perceived as a transitory event that could be alleviated at any time, and the level of water reservoirs and rivers were neglected.

This aspect is even more relevant in face of the escalation of extreme weather events such as drought and intense rain, coastal flooding, as predicted by climate change studies. The climate change scenario involves complex interactions and changes in the probability of climate regime. In that scenario, businesses need to reevaluate their vulnerability and draw a risk management strategy to mitigate the impacts and promote adaptation. Climate change will impact the supply chain and the supply network (Jennifer Howard-Grenville et al., 2014). The firms that are able to diversify or reallocate supply sources have higher adaptation capability. Whereas business that are attached to a location suffer higher losses.

The third contribution of our article is towards the improvement of public policies. The results of data collection in the present research demonstrated that the lack of information can have strong impact in management. Our study demonstrated that the information and the awareness were not equally distributed in all the supply chain. Upstream, farmers were less informed about weather events and influenced by a group of climate change deniers. The lack of information and the obscure mindset environment led farmers to perceive low risk in an imminent subject.

## CONCLUSIONS

The present research investigated the impact of the hydric crisis of São Paulo in three food supply chains and concluded that although respondents recognized the impacts of the drought to their results, organizations were not willing to act to mitigate future losses.

The main contributions of the study are twofold: First, using a qualitative interview, we found empirical evidences of the main impacts of a drought in the food supply chain, especially for farmers, advancing the knowledge of natural disasters and supply chain. Secondly, the results suggest that although the respondents of the investigated supply chains perceived the risk, they did not intend to act, because they do not know what to do and do not feel responsible for acting. As there is a forecast of extreme temperatures in Brazil in 2040 (Brasil, 2040), we need to start acting and educating all stakeholders from now on so that we are prepared to face the climate change (Wachinger et al., 2013).

Our study has some limitations. The first limitation refers to the sample. The present study was focused on respondents of the food supply chain located in São Paulo state and did not investigated regions that suffer constantly with droughts such as the North-east region. Moreover, we could not interview respondents of all echelons of the studied supply chains. This research must continue to increase the number of interviews and also collect data from more steps of the supply chain.

Future researchers also should investigate the indirect impacts of the disaster to the final consumer and also to global supply chains. Another opportunity is to investigate this impact to other industrial and services supply chain than the food supply chain.

## REFERENCES

- AGROSTAT, 2015 Indicadores de agricultura – Available at:  
<http://indicadores.agricultura.gov.br/agrostat/index.htm> Accessed in 12/28/2015.
- Altay, N., & Green, W. G. (2006). OR/MS research in disaster operations management. *European Journal of Operational Research*, 175(1), 475–493.
- Altay, N., & Ramirez, A. (2010). Impact of disasters on firms in different sectors: Implications for supply chains. *Journal of Supply Chain Management*, 46(4), 59–80.  
<http://doi.org/10.1111/j.1745-493X.2010.03206.x>
- Anuário de Desastres Naturais (2013)– Available at  
[http://www.mi.gov.br/c/document\\_library/get\\_file?uuid=fee4007a-ab0b-403e-bb1a-8aa00385630b&groupId=10157](http://www.mi.gov.br/c/document_library/get_file?uuid=fee4007a-ab0b-403e-bb1a-8aa00385630b&groupId=10157). Access in 22/12/2015.
- ASDR - Annual Disaster Statistical Review 2014 – Available at  
[cred.be/sites/default/files/ADSR\\_2014.pdf](http://cred.be/sites/default/files/ADSR_2014.pdf). Access in 04/22/2016
- Beamon, B. (2008). Sustainability and the Future of Supply Chain Management. *Operations and Supply Chain Management*, 1, No. 1(1), 4–18.
- Brindley, C. (2004). *Supply chain risk*. Ashgate Aldershot.
- Brasil 2040. Alternativas de adaptação às mudanças climáticas – Available at:  
<http://www.sae.gov.br/imprensa/noticia/o-que-e-o-brasil-2040/>.Access in 14/11/2015
- Cecafé, 2015 Conselho dos exportadores de café do Brasil. Available at:  
<http://www.cecafe.com.br/> Accessed in 12/28/2015.
- CITRUS, 2015. Available at: <http://www.agricultura.gov.br/vegetal/culturas/citrus>. Accessed in 12/28/2015.
- Clarkson, P. M., & Richardson, G. D. (2011). Does it really pay to be green ? Determinants and Consequences of Proactive Environmental Strategies. *Journal of Accounting and Public Policy*.

Costa, B.R. When does coffee's voluntary certification pay? The case of production in Brazil, São Paulo, 2014 (Dissertation MPGI)

Darnall, N., Henriques, I., & Sadorsky, P. (2010). Adopting Proactive Environmental Strategy: The Influence of Stakeholders and Firm Size. *Journal of Management Studies*, 47(6), 1072–1094. Delmas, M. A., & Toffel, M. W. (2008). Organizational responses to environmental demands: Opening the black box. *Strategic Management Journal*, 29(10), 1027–1055. <http://doi.org/10.1002/smj>

Drabek, T. E., & McEntire, D. A. (2003). Emergent phenomena and the sociology of disaster: lessons, trends and opportunities from the research literature. *Disaster Prevention and Management*, 12(2), 97–112. 4

Eisenhardt, K. M. (1989). Agency Theory: An Assessment and Review. *Academy of Management Review*, 14(1), 57–74.

FAO, F. and A. O. of the U. N. (2012). No Title. Retrieved from [www.fao.org](http://www.fao.org)  
INVEST SP. Available at: <http://www.investe.sp.gov.br/setores-de-negocios/agronegocios/laranja/> Accessed in 12/28/2015.

Jennifer Howard-Grenville, Buckle, S. J., Hoskins, B. J., & George, G. (2014). Climate change and management. *Academy of Management Journal*, 57 (3), 615–623.

Kaplan, S., & Garrick, B. J. (1981). On the quantitative definition of risk. *Risk Analysis*, 1(1), 11–27.

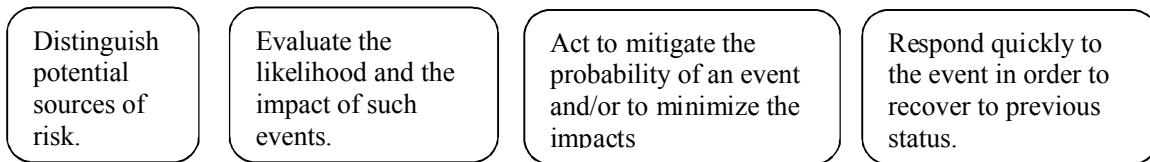
Kellens, W., Terpstra, T., & De Maeyer, P. (2013). Perception and Communication of Flood Risks: A Systematic Review of Empirical Research. *Risk Analysis*, 33(1), 24–49.

Kleindorfer, P., & Saad, G. (2005). Managing disruption risks in supply chains. ... and *Operations Management*, 14(1), 53–68. Knemeyer, a. M., Zinn, W., & Eroglu, C. (2009). Proactive planning for catastrophic events in supply chains. *Journal of Operations Management*, 27(2), 141–153.

- Leiras, A., Jr, I. D. B., Peres, E. Q., Bertazzo, T. R., & Yoshizaki, H. T. Y. (2014). Literature review of humanitarian logistics research: trends and challenges. *Journal of Humanitarian Logistics and Supply Chain Management*, 4(1), 95–130.
- Lupton, D. (1999). *Risk and sociocultural theory: New directions and perspectives*. Cambridge University Press.
- MAPA, 2015 Ministério da Agricultura, Pecuária e Abastecimento. Available at <http://www.agricultura.gov.br/vegetal/culturas/cana-de-acucar> Accessed in 12/28/2015.
- March, J. G., & Shapira, Z. (1987). Managerial Perspectives on Risk and Risk Taking. *Management Science*, 33(11), 1404–1418.
- Markowitz, H. (1952). Portfolio selection. *The Journal of Finance*, 7(1), 77–91.
- Miguel, P. L. S., Brito, R. P. de, & Pereira, S. C. F. (2015). Radiografia dos desastres no Brasil. *RAE Executivo*, 14(2), 60–63.
- Miles, M. B., Huberman, A. M., & Saldaña, J. (2013). *Qualitative data analysis: A methods sourcebook*. Sage Newbury Park,, CA.
- Mitchell, V.-W. (1995). Organizational Risk Perception and Reduction: A Literature Review. *British Journal of Management*.
- Oh, C. H., & Oetzel, J. (2011). Multinationals ' Response to Major Disasters : How Does Subsidiary Investment Vary in Response to the Type of Disaster and the Quality of Country Governance ? *Strategic Management Journal*, 32(6), 658–681.
- Sodhi, M.M.S.; Son, BG; Tang, C.S. (2012) Researchers' Perspective on Supply Chain Risk Management. *Production and Operations Management*, 21 (1), 1-13.
- Van Wassenhove, L. N. (2006). Humanitarian aid logistics: supply chain management in high gear†. *Journal of the Operational Research Society*, 57(5), 475–489.
- Wachinger, G., Renn, O., Begg, C., & Kuhlicke, C. (2013). The Risk Perception Paradox-

- Implications for Governance and Communication of Natural Hazards. *Risk Analysis*, 33(6), 1049–1065.
- Wagner, S. M., & Bode, C. (2006). An empirical investigation into supply chain vulnerability. *Journal of Purchasing and Supply Management*, 12(6), 301–312.
- Winn, M., Kirchgeorg, M., Griffiths, a., Linnenluecke, M. K., & Gunther, E. (2011). Impacts from climate change on organizations: A conceptual foundation. *Business Strategy and the Environment*, 20(3), 157–173.
- WEF (2015) World Economic Forum Global Risks 2015. Available at:  
<http://reports.weforum.org/global-risks-2015/> Accessed on 12/28/2015.
- Yin, R. K. (1989). *Case study research: Design and methods. Essential guide to qualitative methods in organizational research* (Vol. 5). Newbury Park, CA: Sage publications.  
<http://doi.org/10.1097/FCH.0b013e31822dda9e>
- Zaalberg, R., Midden, C., Meijnders, A., & McCalley, T. (2009). Prevention, Adaptation, and Threat Denial: Flooding Experiences in the Netherlands. *Risk Analysis*, 29(12), 1759–1778.

## Figures and Tables



**Figure 1 – The four stages of SCRM**  
 Source: Adapted from Sodhi et al (2011)

**Table 1: Documental analysis results**

Years	# of articles	Main themes
2013	8	Government communicated that there was no risk of energy supply due to drought in the Southeast region.
2014	494	Information about the levels of water reserves to population. São Paulo's government denies the severity of the water crises, but invites consumers to reduce their water consumption and apply penalties for those who increase their consumption. Discussion of alternatives for water supply to São Paulo.
2015 (From Jan to April)	187	Information about the levels of water reserves to population. Impacts to both population and economic sectors. Government, individuals and organizations actions to reduce the risks impacts.

**Figure 2: Distribution of the cases in the supply chain**

Supply chain	Farmer	Food Processor / Manufacturer	Retailer
Coffee	Coffee farm Coffee consultant	Coffee Manufacturer	Retailer FF
Sugarcane	Sugar Mill Liquor Scale Liquor I Liquor II Liquor Org		
Orange	Orange farm I Orange farm II Orange Coop I Orange Coop II Orange Coop III Farmers' Association		
Govern	Governmental Technical Assistance		

Figure3: Cases analysis resume

Firm	Previous Experience	Risk Perception	Other Risks/Concerns	Risk management
Retailer, fast-food chain				
Retailer FF	Indirect experience, no losses incurred	High likelihood	Competition	Planned and implemented mitigation measures
Food manufacturer, coffee				
Coffee Manufacturer	Indirect experience, incurred in losses	High likelihood	Competition	Emergency mitigation
Sugar and liquor producers				
Sugar Mill	Direct experience, incurred in losses	Low risk, diversification	Competition and technology	Non-prepared, disadvantages of mitigation
Liquor Scale	Direct experience, incurred in losses	High likelihood	Competition and taxes	Non-prepared, diversification of supply
Liquor Org	Direct experience, incurred in losses	High likelihood	Environmental awareness	Non-prepared, disadvantages of mitigation
Liquor I	Direct experience, perceived impacts in supply chain	High likelihood	Taxes and workforce	Non-prepared, other concerns (taxes)
Liquor II	Indirect experience, no losses incurred	Low risk, nature provider	Taxes and workforce	Non-prepared, disadvantages of mitigation
Orange farming				
Orange Farm I	Direct experience, incurred in losses	Low risk, nature provider	Competition	Non-prepared, disadvantages of mitigation
Orange Farm II	Direct experience, incurred in losses	High likelihood	Competition	Non-prepared, of lack of information
Orange Coop I	Direct experience, incurred in losses	Low risk, nature provider (climate change deny)	Competition, technology	Non-prepared, technological issues of mitigation
Orange Coop II	Direct experience, incurred in losses	Low risk, nature provider (climate change deny)	Competition	Non-prepared, disadvantages of mitigation
Orange Coop III	Direct experience, incurred in losses	Low risk, nature provider	Competition	Non-prepared, technological issues of mitigation
Farmers' Association	Direct experience	Low risk	Competition, technology	Non-prepared, disadvantages of mitigation
Coffee farming				
Coffee Farm	Direct experience, incurred in losses	Low risk, nature provider	Competition and technology	Non-prepared, perception of low risk
Coffee Consultant	Direct experience, incurred in losses	High likelihood	Competition and technology	Non-prepared, disadvantages of mitigation
Govern				
Governmental technical assistance	Indirect experience	Low risk, nature provider (climate change deny)	Technology, legislation	Non-prepared, disadvantages of mitigation

Figure 4: Identified Groups

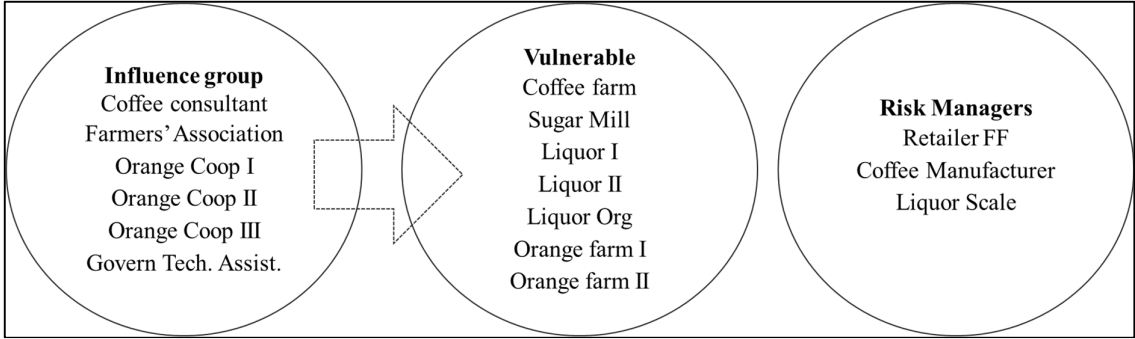


Figure 5. Influence factors towards risk perception and preparedness

