Analyzing Logistic Operations in Rain and Storm-related Disaster: a Case Study of Four Cities in Sao Paulo, Brazil.

Irineu de Brito Junior,

Environmental Engineering - Institute of Science and Technology -São Paulo State University and Graduate Program in Logistics Systems Engineering - São Paulo University – Brazil

Thomas Pinto Ribeiro, Hugo T. Y. Yoshizaki,

Graduate Program in Logistics Systems Engineering - São Paulo University – Brazil

Abstract

The cities of São Luiz do Paraitinga, in 2010; Cubatão, in 2013; Itaóca, in 2014; and Jarinu in 2016, all located in the State of São Paulo, suffered disasters caused by heavy rains and storms resulting in human and economic losses, as well as leaving dozens of people homeless or displaced. Immediately after the disaster, these localities began their recovery processes. This paper aims to evaluate the disaster phases of response and reconstruction in these locations through the following criteria: actors, donations, homelessness and housing, information and risk mitigation. Through case studies, in which field visits and interviews with the staff in charge of the response were carried out in order to verify the disaster context, this evaluation is complemented by an analysis of the literature on the subject. The results suggest that simple adherence to the Making Cities Resilient campaign does not ensure that municipalities are able to respond effectively to disasters, or that their recovery process reaches a better state than the previous one (Build Back Better). Hence, better monitoring of these cities is suggested, so that they may evolve from simple adherence to the campaign for implementing measures that, in fact, will increase their resilience to disasters.

Introduction

A natural hazard can be defined as the resulting impact of an extreme or intense natural process or phenomenon on a social system that causes serious damages, losses or health impacts that go beyond the ability of the victims to adapt (UNISDR, 2009);(Marcelino, 2008). Tomazini and Wassenhove (2004) add that the consequences of disasters are not only generated by their magnitude but also by the local vulnerability. Thus, low magnitude natural hazards can have catastrophic consequences in vulnerable communities.

Between 2008 and 2013, 40.9% of the Brazilian cities were affected by at least one disaster. Floods alone left around 1.4 million people homeless or displaced. In the same period, the State of São Paulo had the second largest number of landslides, followed by the state of Minas Gerais (IBGE, 2013). Some authors attribute this phenomenon not only to the intense and disorganized urbanization, especially in the South and Southeast regions, whose occupation of risk-prone areas is notably greater (Tominaga et al., 2009); but also to climate changes and the increase of the total precipitation along the years due to more frequent intense rains (Marengo *et al.*, 2013, Pinto Jr *et al.*, 2013).

In this context, the importance of a fast response to minimize both human and material losses is emphasized (Kawasaki *et al*., 2012). According to Van Wassenhove (2006), approximately 80% of immediate disaster response activities consist of logistical effort, which includes the costs of supplies, equipment, transport and warehousing for operations. Logistical aspects were formally presented in the Sendai Framework for Disaster Risk Reduction (SFDRR). While the Hyogo Framework for Action (HFA) only addressed the issue of relief supplies in disaster preparedness and response logistics (item 5.20. d) (UNISDR, 2005), the SFDRR addresses, in addition to preparedness and response already pointed in the HFA, strengthening logistical capacities in order to ensure better response in emergencies (item 33, f and h), availability of logistic resources (item 30. a), as well as the economic impact of the business supply chain disruption in societies (items 6 and 30.o) (UNISDR, 2015). Considering Disaster Risk Reduction (DRR) and from a humanitarian logistics operation perspective, this paper aims to analyze the disaster phases of response and reconstruction of water and meteorological disasters, especially floods and landslides, in the State of São Paulo. This research employs the case study methodology and is carried out from the analysis of the relevant literature, field visits and interviews with key actors such as the Civil Defense. The events studied occurred in the cities of São Luiz do Paraitinga, in 2010; Cubatão, in 2013; Itaóca, in 2014; and Jarinu, in 2016.

Methodology

The case study method was used for this analysis. Through field visits and semi-structured interviews, the researchers gathered stories about the experience of agencies, responders and authorities responsible for operations, characteristics of humanitarian logistics operations were identified in these disasters to create a pattern to identify the challenges and proposals for improvement in disaster response and reconstruction in the State of Sao Paulo. Prior to each field visit or interview, a checklist was developed addressing the logistical aspects to be verified, as well as the observed improvements based on the questionnaires applied in previous visits. In addition to the observations in previous reports, the questions were also based on the PDNA (Post-Disaster Needs Assessment) (The World Bank et al., 2013), (Jeggle & Boggero, 2018) and the Making Cities Resilient Guide (UNISDR, 2012). During the interviews, not only the checklist was applied but other questions were carried out according to the observations reported by the interviewees.

This work begins with a brief bibliographic review on disasters and humanitarian logistics, as well as national databases and available news on disasters. In order to carry out this research, the authors analyzed the situation of the affected areas according to the phases of response and reconstruction from the disaster cycle (FEMA, 2012) at three distinct moments: immediately after the disaster, one year after the disaster and five years after the disaster, when applicable. Field visits were carried out from 2013 to 2017, in the cities of São Luiz do Paraitinga, Cubatão, Itaoca and Jarinu for on-site verification of the scenario.

The analysis was conducted from the comparison of what is recommended in the literature and what was observed in reality. In agreement with the Making Cities Resilient Campaign (UNISDR, 2012) and a few points described from the Post-Disaster Needs Assessment (PDNA) methodology (De La Torre *et al.*, 2012), the disasters were evaluated through the following criteria: actors, donations, homelessness and housing, information and risk mitigation.

Literature Review

Disaster Management Operations

The disaster cycle involves actions to address emergencies that are or may be generated by disasters, focusing on preventing them from happening or, when not possible, reducing their effects. It comprises four phases: mitigation, preparation, response and reconstruction (FEMA, 2012; Wassenhove, 2006).

The mitigation phase includes activities that eliminate or at least reduce the probability and the effects of a disaster. This phase does not happen alone but alongside all the other phases. Actions such as hazard monitoring, risk mapping, as well as the enforcement of laws that reduce vulnerability, are good DRR initiatives (Costa *et al.*, 2012).

The preparation phase can be defined as the use of mechanisms that counter the risk elements that society has not been able to mitigate (Tomasini and Wassenhove, 2009). Thus, even though planning an effective disaster response by providing the required resources do not eliminate the risk of disaster, they at least minimize the possible damage and prepares the population for an adequate response to an imminent emergency. Therefore, it is important to have an operational and contingency plan, training the population and assistance teams in case of emergencies (FEMA, 2012).

The response phase, in turn, is the very reaction that occurs during or shortly after the disaster, which involves rescue, victims assistance and damage reduction to the victims (Tominaga *et al.*, 2009). In this phase, a major difficulty faced by the actors is the phenomenon called material convergence, which is caused when a large amount of supplies and equipment is sent by numerous donors to the disaster-affected area in a short time interval. Donors are often unaware of the affected population real needs, resulting in inappropriate or unnecessary donations, which clogs the supply chain and slows down the flow of high-priority materials. Furthermore, there are consequences such as congestion of the affected site access point, lack of storage space, and especially the demand for scarce human resources, which are often already overloaded and could be assigned to more difficult or useful tasks (Holguín-Veras *et al.*, 2014).

Finally, the reconstruction, or post-disaster phase, focus on the complete restoration of the local public services, the regional economy and the well-being of the affected population (NOGUEIRA *et al.*, 2009). At the same time, it seeks to eliminate or reduce the local population vulnerability, preventing future disasters and providing greater security to the inhabitants of the affected area (Costa *et al.*, 2012). That is, not only concerned with local reconstruction, response actors should provide a better state than the one prior to the disaster, according to the "Build-Back-Better" principle (Klomp and Valckx, 2014).

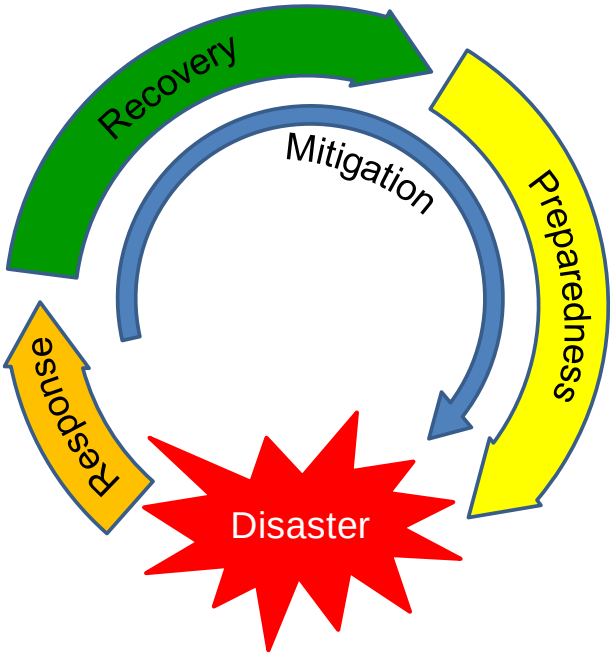
In disasters, the response is composed of different actors who may be public, private or civil organizations that must interact (Kawasaki *et al.*, 2012). In this context, the information dissemination during the response and recovery period is essential for the coordinating agencies so that they may act efficiently in their humanitarian operation, especially when there are numerous actors (Tomasini and Van Wassenhove, 2009; Holguín-Veras *et al.*,

2014). Activities registration not only facilitates information sharing during the response but also allows actors to prevent errors and to reinforce good practices (Gonçalves, 2011).

Figure 1 below illustrates each of these phases; however, even though the activities and stages of risk management are shown separately, there is an interdependence between them. This hinders the clear identification of an initial or final phase of the management process; thus, its structure can be characterized as cyclic (Araújo, 2012). The phases preceding the event must mainly happen in a continuous and integrated way (FEMA, 2012).

Figure 1: Disaster Management Cycle

Source: Cosenza (2015) (adapted)



According to the Figure 1, mitigation activities are conducted along other phases because every action done within these phases should apply disasters risk reduction principles and techniques in order to assure that the affected community is more resilient than its previous state (Build Back Better). According to the Sendai Framework for Disaster Risk Reduction (SFDRR), many organizations and public authorities have been switching their focus from disaster management to risk management, once disaster preparedness or even prevention allows a faster, safer and cheaper response.

Logistics in Humanitarian Operations

Logistics applied to humanitarian operations seeks to ensure the flow of people and materials in an appropriate and timely manner, that is, efficiently and effectively in the humanitarian relief chain, in order to bring aid to the largest number of people in need (Beamon and Kotleba, 2006). This is a logistical approach for the specific context of emergencies and, unlike the business environment, is still a little-explored concept in Brazil (Bertazzo *et al.*, 2013).

Humanitarian logistics takes place in a chaotic and unpredictable environment that, according to Thomas and Kopczak (2007), has many challenges, such as: (i) unpredictable demand, occurring in large quantities and in short lead times for a wide variety of supply items; (ii) deteriorated/damaged infrastructure, hindering the access and transport of resources and people; permanent and/or temporary facilities (e.g., warehouses and distribution points) along the supply lines; (iii) coordination of human resources, often lacking in training and capacity building; (iv) information is not always reliable; (v) high risks and insecurity associated with adequate and timely distribution.

In this context, operational improvements are left aside, once bringing aid to victims becomes a priority. As a result, there is little recognition of the importance of efficiency, cost, and optimization that compose the logistics of humanitarian operations (Wassenhove, 2006). Public authorities and aid organizations find difficult to recognize the relevance of humanitarian logistics when performing the response mechanisms previously prepared to reduce the high degree of improvisation and to maximize the effectiveness of emergency action (Nogueira and Gonçalves, 2009).

Regarding the disaster cycle, logistics efforts are better observed in the response and preparation phase (Cozzolino, 2010). Pedroso *et al* (2015) while evaluating the earthquake and tsunami response in Great Eastern Japan, in 2011, pointed out that logistics should not be underestimated when applied to catastrophic events once. The authors suggest partnerships between local authorities and the private sector in order to accelerate the material procurement and distribution in disaster-affected areas. In a DRR context logistics process as Storage and distribution of disaster relief supplies, Logistics management information systems and availability of teams of well-trained and suitably equipped personnel are an effective part of disaster preparedness planning which is a core part of disaster risk reduction (Sheppard, Tatham, Fisher, & Gapp, 2013).

The Making Cities Resilient Guide and the Post Disaster Needs Assessment (PDNA) Contribution

Since the majority of the world population is located in urban areas (UNDESA, 2014), greater attention is needed for risk management and for disasters response in these environments. To this end, the Making Cities Resilient Campaign was created by the United Nations Office for Disaster Risk Reduction (UNISDR) to raise awareness and to empower local managers with tools to better respond and mitigate disaster effects. These measures are summarized in ten key steps ranging from public-private partnerships to capacity building and popular awareness initiatives (UNISDR, 2012). The ten steps are summarized in Table 1:

Table 1: Making Cities Resilient Ten Steps

Source: UNISDR, 2012

Making Cities Resilient Ten Essentials	
1. Organize for Disaster Resilience	**6. Strengthen Institutional Capacity for Resilience**
2. Identify, Understand and Use Current and Future Risk Scenarios	**7. Understand and Strengthen Societal Capacity for Resilience**
3. Strengthen Financial Capacity for Resilience	**8. Increase Infrastructure Resilience**
4. Pursue Resilient Urban Development and Design	**9. Ensure Effective Preparedness and Disaster Response**
5. Safeguard Natural Buffers to Enhance the Protective Functions Offered by Natural Ecosystems	**10. Expedite Recovery and Build Back Better**

According to the UNISDR interactive website, 360 Brazilian municipalities are part of the campaign, most of them in the State of São Paulo (UNISDR, 2015). There are two levels of evaluation, the first one comprises a preliminary evaluation focusing on the main points of the SFDRR. The second level, in turn, presents a detailed risk

evaluation, involving different actors and exercises. While the first level is composed of 47 indicators, the second has 117.

As observed, the guide steps are multifocal, both regarding actors, targeting the public and private sectors, as well as the action fronts, ranging from popular education measures to monitoring and alert devices. The present research aimed to further emphasize the logistic actions of the Guide, highlighting possible improvements, mainly in the response and recovery phases.

The Post-Disaster Needs Assessment (PDNA), in turn, is a joint methodology of assessing disaster effects and impacts in order to support public authorities to determine priority recovery needs (Jeggle & Boggero, 2018). It collects information on economic loss and damage and sets the priority areas for recovery in a single, consolidated assessment report which can be used to develop a comprehensive recovery framework that will guide the design and implementation of short and long-term recovery programs (The World Bank *et al.*, 2013).

The PDNA primary objective is to assist governments in assessing the impact extent of a disaster on their country and, based on those findings, to produce an affordable recovery strategy for mobilizing technical and financial resources, including risk-reducing measures in the recovery plan while considering climate change (The World Bank *et al.*, 2013).

While the Making Cities Resilient Guide aims to implement medium- and long-term measures that enhance the community's response to disasters or even avoid them from happening, the PDNA is focused on the response phase, pointing out the priorities for an efficient and definitive recovery. These two methodologies, although from different creators and purposes contributes for this research as a starting point for establishing the criteria to analyze the presented disasters.

The Disasters

The following session describes the disasters that occurred in the cities of São Luiz do Paraitinga, Cubatão, Itaóca, and Jarinu. Based on the case studies previously published by Kawasaki *et al.* (2012), Carneiro *et al.* (2013, 2014), Costa *et al.* (2014), Sohn *et al.* (2015), Brito Junior *et al.* (2016) and Ribeiro *et al.* (2017), Figure 3 shows the geographical location of the cities.

Figure 3: Geographic location of the cities

São Luiz do Paraitinga

The city of São Luiz do Paraitinga is one out of 39 cities composing the mesoregion of Vale do Paraíba Paulista; it has 10,397 inhabitants (IBGE, 2010), and a GDP of BRL148,505 million (SEADE, 2014). In December 2009 and January 2010, the rainfall in the city region was higher than 1,000mm, causing an abnormal flood (Rosal and Medeiros, 2010). The Paraitinga River level reached 11 meters above normal, causing the waters to reach the city historical center (SINDEC, 2010). Due to the heavy rainfall, 4,000 people were homeless (accommodated in shelters) and 5,000 displaced (accommodated by family or friends) (CEDEC-SP, 2010).

The city was one of the most affected in the region. Regarding material losses, the economic deficit generated between December 31, 2009, and January 1, 2010, totaled BRL 87.3 million, as well as hundreds of kilometers of damaged roadways (SINDEC, 2010).

Cubatão

Located in the metropolitan region of Baixada Santista, the city of Cubatão stands out as one of the largest industrial centers in Latin America, especially in the chemical and petrochemical sectors. It has 118,720 inhabitants (IBGE, 2010) and a GDP of BRL 9.304 billion (SEADE, 2014).

On the 22nd of February, 2013, in about two hours, the rainfall index had already exceeded 175mm and, in the morning of the 23rd, it reached a limit not observed in the municipality since 1936 (DAEE, 2016): 238.4 mm within

10 hours (between 4 pm on the 22nd and 2 am on the 23rd), causing the floods. The water level of the Cubatão river reached almost 3 meters above the normal height in a neighborhood called Água Fria, the most affected one. The floods, along with landslides, destroyed houses and bridges, blocking the Imigrantes Highway, which connects Baixada Santista to São Paulo, the capital city, forcing the city mayor to declare State of Emergency (Hiar, 2013). According to the Military Office (São Paulo, 2013), 431 homeless and 1,200 displaced people were identified, as well as 27 slipping points.

The city water supply was compromised due to the partial destruction of a treatment plant, Pilões. In addition, agents of the Environmental Sanitation Technology Company (CETESB) and the Municipal Civil Defense Coordination (COMDEC) were required to stop an oil leak caused by the flooding of a Petrobrás oil collection facility (CEDEC-SP, 2013).

Itaóca

Located in the Vale do Ribeira region, the city of Itaóca has 3,228 inhabitants and a GDP of BRL 32,262 million (SEADE, 2014). Its economy is based on livestock and family farming.

From the evening of the 12th January 2014, until the morning of the 13th, within approximately 6 hours, it rained about 150mm in Itaóca, causing the Palmital River level to rise between 4 and 5 meters and overflow. The heavy rainfall happened in a region surrounded by rivers and mountains, resulting in a flood which, together with the landslides, caused the debris flow that invaded the city, its houses, and buildings (Gramani *et al.* 2014).

The deposition of thick layers of sediment affected 310 homes, about 100 of which were partially destroyed and 19 completely destroyed. 27 people died (about 1% of the population), bridges and vehicles were damaged, and part of the telephone, electricity and water treatment services became unavailable (IG, 2014).

Jarinu and Campinas

Jarinu is located in the same region as Campinas and Jundiaí. It has a population of 23,847 inhabitants (IBGE, 2010) and generates a GDP of BRL 1.556 billion annually (SEADE, 2014).

According to Candido (2012), this region is prone to the occurrence of storms, tornadoes, hail rains and micro-explosions. On the night of June 5, 2016, a tornado struck the region. In Jarinu, a tornado killed one person and wounded fifty others. In total, 45 families were displaced, which accounted for approximately 300 people, and more than 80 buildings, including shops, public buildings and homes were damaged. In addition, due to strong

winds, the municipality electricity network was damaged, leaving at least 8,000 buildings without electricity (Brito Junior et al, 2016). Campinas was also struck on the same day and a 74 mm rainfall in 45 minutes (Nunes *et al.*, 2017).

The Response Phase

In the four cities presented, the challenges reported by Thomas and Kopczak (2007) were observed. The unpredictability of demand and deterioration of infrastructure, for example, could be clearly identified in disaster descriptions. Other aspects observed are described in the following response operations.

São Luiz do Paraitinga

Regarding the response operation in São Luiz do Paraitinga, the São Paulo Civil Defense State Coordination (CEDEC-SP) coordinated a task force composed by the Brazilian Army, the Fire Brigade and volunteers (R7, 2010). Between the 6th and 24th of January, 2010, volunteers from the Brazilian Red Cross stayed in the city to help the reception, selection, and distribution of donations, as well as providing medical assistance to the victims. According to the State Civil Defense and the Brazilian Red Cross (Iskandarian, 2010a), the participation of the local community was extremely important for the humanitarian services, such as shelter and assistance to victims. According to the inhabitants, the first action, which rescued about 500 people, came out voluntarily from a group of rafting practitioners. One priest voluntarily set up a stock of supplies at his house and approximately 700 homeless people were welcomed by the owner of a farm to stay in her property for a period of 5 to 15 days (Iskandarian, 2010b). The homeless were also referred to three municipal schools.

At the beginning of the response operation, the fear of looting and theft was widespread. Many residents remained locked in their homes, opening their doors for social service and donation as long as police officers were present.

On the 4th of January, 2010, the State Civil Defense, supported by the Military Police and the Fire Brigade, began a campaign to assist the victims. However, on the 12th of January, the campaign was suspended once the deposits used to receive donations were full. Since there was no infrastructure in the city to set up collection and sorting stations, the operations were centralized in the neighboring city of Taubaté. On the 8th of January, the water

supply was almost normalized and 80% of the electricity network had already been reestablished (Kawasaki *et al.*, 2012).

Cubatão

In Cubatão, the immediate response was coordinated by four actors: the Municipal Civil Defense Coordination (COMDEC), the Municipal Social Assistance Department, the Brazilian Red Cross and the Social Solidarity Fund. The victims' rescue was also coordinated by the COMDEC, supported by the Military Police and the Fire Brigade. The Brazilian Red Cross and the Social Solidarity Fund were responsible for storing, sorting and distributing food. The Municipal Social Assistance Department took charge of the homeless by providing assistance, registration, and by transferring the need for relief supplies to the distribution centers (Carneiro *et al.*, 2014). Teams from the neighboring city of Santos were used to help mainly with the reception of donations and social assistance.

The homeless were sent to four shelters: (i) Castelão Gymnasium, (ii) The Church of Jesus Christ of Latter-day Saints, (iii) Júlio Conceição State School and (iv) Princesa Isabel Municipal School (CEDEC-SP, 2013). The main site, the Castelão Gymnasium, was also initially used as a donation reception and sorting center. However, due to its proximity to homeless people from the streets, conflicts started to arise, forcing the shelter to be relocated, as a matter of urgency, to a school that was yet to be inaugurated. This change not only improved the service but also made the materials administration more transparent, gave the handling area more workspace and allowed a better access control (Carneiro *et al.*, 2013). Carneiro et al (2013) also identified several improvements that could be implemented in accordance to the best practices in the matter, pointing out that there was no adequate training for the human resources involved in the disaster response.

Itaóca

Regarding the city of Itaóca, on the day the disaster occurred, the COMDEC was in charge of sheltering the homeless, removing residents from risk areas while finding a new place to relocate them. Later, the coordination of the response after the disaster was concentrated in two main actors: State Civil Defense Coordination (CEDEC-SP), which was contacted only the following day due to the lack of communication after the disaster; and the Fire Brigade. While the former was responsible for the search and rescue activities, the latter was responsible for

assistance activities, the organization of logistic resources and coordination. Besides, the CEDEC was using a Command Post to centralize these coordination efforts.

In addition to these two main entities and the city hall, more than 36 organizations were said to be acting on the response; most of them were not following a clear set of rules or did not have any specific training. Autonomous volunteers also went to the disaster site (Costa *et al.*, 2014). The neighboring city, Apiaí, hosted the relief teams and most of the actors present in the coordination network, composed of authorities, private organizations, and NGOs.

In Itaóca, the administration center was based at the Command Post, where the coordination of the actors and the centralization of information were carried out. The materials received were stored in the city hall building, which was in its final stage of construction, and inside a sports gymnasium next to the building. The victims, whose homes were damaged, were hosted in family houses or in public schools, established as shelters (Sohn *et al.*, 2015).

Jarinu and Campinas

In Jarinu, the response operation was more intense in the first three days, coordinated by the State Civil Defense Coordination (CEDEC-SP), which supervised the work of several other agencies, including the Municipal Civil Defense (COMDEC), the Brazilian Red Cross (São Paulo branch), the Fire Brigade, the São Paulo Sanitation Company (Sabesp), Elektro (electricity supply company), the Scouts, as well as other municipal agencies, such as the Civil Guard, Traffic Control, and the Work and Social Service Department (Brito Junior *et al.*, 2016).

Although this type of disaster is hard to predict, the Center for Monitoring and Alert of Natural Disasters (CEMADEN) sent an alert 10 minutes before the occurrence of the tornado (BRITO JUNIOR *et al.*, 2016), yet municipal civil defense agents claim to have been warned by the citizens (Ribeiro *et al.*, 2018).

In Jarinu Regarding human damages, although 45 families were displaced, only one of them could not find shelter and had to receive rent assistance, the rest of the victims were housed in relatives' and friends' homes (Brito Junior *et al.*,).

As pointed out by Diedrichs *et al.* (2016), donation management is seen as the main problem derived from inefficient coordination in disaster response, being considered the "second disaster" (Balcik *et al.*, 2010, Holguín-Veras *et al.*, 2014). In the Jarinu case, although the operational coordination was held by CEDEC, which provided its safety-stock of relief items for the disaster, the donations sorting and distribution was largely carried

out by the Social Solidarity Fund. However, problems regarding the registration of beneficiaries, storage space and donations handling, and insufficient aid workers were reported (Ribeiro *et al.*, 2017).

In Campinas, 500 trees were taken down, demanding an effort of 200 people, 30 trucks and 15 bulldozers for debris removal. Three houses were interdicted, forcing the displaced victims to move to their relative's houses. The coordination was carried out by the Municipal Civil Defense and neither the State Civil Defense nor the neighboring municipalities were contacted.

The Reconstruction Phase

São Luiz do Paraitinga

In August 2010, the State and the City were called by the Public Defense Office with a public-interest civil action for lack of responsibility and efficiency in the protection of homeless families. On the 2nd of April, 2011, in agreement with the State of São Paulo government, a total of BRL 4.5 million was released for the city reconstruction. In the same year, some projects were analyzed, such as the construction of a two-meter wall for the Paraitinga River and the construction of a dam (Correa, 2011).

Two years later, approximately 80% of the area destroyed was rebuilt and the risk areas were being monitored (Bocchini, 2012). In April 2012, 20 telemetry stations with rain gauges and fluviometers were installed by the State Department of Water and Electric Power (DAEE) and another 10 pieces of equipment were planned to be installed.

After a visit to the city in 2015, during an interview with the Municipal Civil Defense coordinator (COMDEC), some measures of risk reduction and mitigation were verified to have been taken, such as the river silt and rock removal, the expansion of a canal downstream, where there is a curve and the protection of the banks by a low stone wall. Due to an alleged lack of resources for works of that magnitude, no walls, dams or tunnels were built, as previously promised.

Currently, there is a system of pluviometers and fluviometers whose measurements are sent via satellite to CEMADEN and DAEE. These measurements are recorded manually on a paper by the Municipal City Defense coordinator and his assistant. They are the only citizens with the expertise to predict the influence of measurements on the Paraitinga river tributaries. If necessary, the coordinator and his assistant drive through the city alerting the

residents orally. The city does not have cleaning and hygiene kits, basic food baskets or enough mattresses in case of a new disaster.

A Civil Defense Preventive Plan (PPDC) was established with the Social Assistance Department. The COMDEC coordinator has an evacuation plan that relies on the Brazilian Army to maintain the order. There are some high-altitude buildings that can be used as shelters, but they are not prepared for that purpose yet.

Slightly less than half of the homes destroyed were rebuilt and approximately 100 families were removed from risk areas and transferred to housing developments. The houses still located in high-risk areas are monitored. Storekeepers in these areas have stored their materials in safe places and kept their products in the stores only for display.

Evacuation simulations in case of disaster were carried out with the Army support and prevention and instruction booklets on how to act during disasters were (and still are) being distributed. Lectures are delivered by the coordinator, with the implementation of a pilot education project. In the cities of São Luiz do Paraitinga, Cunha and Ubatuba, teenagers can participate in an education program to carry out risk mapping, rule and rain gauge reading (CEMADEN, 2017).

Cubatão

On the visit, one year after the disaster, in 2014, the Castelão gymnasium and other schools, which could be used as shelters in cases of new disasters, were still closed or interdicted. The unfinished school, which had been used as a donation sorting and distribution center, was about to start its activities. Thus, in case of a new disaster, the city has no pre-defined places to serve as shelters or deposits for immediate use.

The city also does not hold emergency inventory for all relief items that are part of the ration in emergency situations. Some of the items owned by the Solidarity Social Fund, such as blankets and clothes, would not provide for more than 100 people, which would be insufficient to meet the population's basic needs for the 2013 disaster, for example.

The homeless were sent to housing neighborhoods or received rent assistance. In addition, the city is included in the Serra do Mar Socio-Environmental Recovery Program, which consists in the removal, resettlement, and promotion of socio-environmental sustainability issues for the inhabitants who live in the region. The Housing and Urban Development Company (CDHU) built houses for relocating families living in risk areas. By 2014, there were still 850 families to be relocated.

Training for Municipal Civil Defense teams is carried out regularly. Risk areas have a Civil Defense Community Center (NUDEC), providing different instructions according to the risk type to which it is exposed. However, a simulation or training for the population has not yet been recorded. The NUDEC in the Pilões neighborhood, after a campaign led by a local priest, received a warning siren for the neighborhood.

The COMDEC administration was also affected by political conflicts in the city caused by the replacement and return of the elected mayor in 2012, causing changes in municipal leadership posts. Only one breakthrough was observed regarding response planning and preparation: the elaboration of a management plan carried out by the Municipal Department of Social Assistance. However, this document is solely based on the knowledge acquired by the Department, that is, it does not include the experiences of other public departments and agencies that worked in the response coordination during the 2013disaster.

Itaóca

Although the volume of donations after the disaster exceeded the actual needs of the victims, the municipality currently does not have previously defined places for storing relief items. There is not a hospital in Itaóca, just a health office that was flooded during the disaster and, by 2015, was already fully recovered. An old church is now used as a community center and can be a potential shelter in case of a new disaster, even though it has a rather limited capacity.

The victims who were able to return to their homes received donations of furniture and home appliances, and the ones who lost their property and houses received financial assistance for renting. Many were granted access to a social rent for a maximum period of one year and after that, some of them began to pay their own rent, while others still needed help from the town hall. The affected city commercial activities were regained after cleaning the flooded areas and were also supported by microcredit programs.

Two rain gauges were installed: one in the mountainous region near Itaóca and another in downtown. Both are controlled by CEMADEN (CEMADEN, 2015) and alerts are sent via mobile phone to COMDEC. There is no automatic system for residents' notification and alert. The old bridge that blocked the debris flow during the disaster was replaced by a new one, but it was higher and had no pillars in the middle of the river prevent any further blockage.

Simulations and training have not been conducted with the inhabitants of the areas with the greatest risk and there are no plans to do so. Although a report describing the actions taken in the response phase was written,

it was not shared with the other actors involved in the response, limiting the possibility of sharing knowledge. Furthermore, there was no record of the volunteers, whose responsibilities in the disaster were attributed according to their competencies. Such a record would facilitate the activation of trained volunteers in case of a new emergency.

Although the disaster of 2014 was not the only one to reach Itaóca, there are no records for disaster response provided by the city. Due to the lack of available resources, there is great human and technical difficulty when it comes to meeting the legal and bureaucratic requirements to obtain state and federal resources.

Jarinu and Campinas

In a visit to Jarinu one year after the disaster, in 2016, even though the city is part of the Campaign Making Cities Resilient, little was observed to have been implemented in terms of disaster risk mitigation. Furthermore, essential services such as COMDEC agents' shifts and the Civil Defense Card were cut due to insufficient municipal financial resources (Ribeiro *et al.*, 2017).

After a year, almost the entire commercial area of the city had already returned to normality, with the exception of a few public spaces once they relied on new public biddings. Agreements were made with construction materials stores so that the registered affected families could receive facilitated credit to purchase these materials, especially roof tiles. In addition, the Severance Indemnity Fund (FGTS, in Brazil), the Civil Defense Card, inoperative at that time, and a facilitated credit to storekeepers have also been released. The latter, however, was only obtained by four stores, the only ones that had the Negative Debit Certificate (CND), which confirms that the owner is out of debts to public authorities (Ribeiro *et al.*, 2017).

Regarding monitoring and warning measures, COMDEC has three rain gauges that had not been installed until the date of the visit, and the rainfall levels were still being manually measured. As previously mentioned, the Civil Defense agents' 24-hour shifts were also cut, making the city monitoring even harder (Ribeiro *et al.*, 2017).

Furthermore, no measures were identified regarding raising the inhabitants' awareness of disaster risk mitigation and preparedness. Ribeiro *et al.* (2017) perceived the lack of shared knowledge as the main obstacle for disaster awareness, once the replacement of public sectors coordinators, such as COMDEC and the Social Solidarity Fund, is not properly conducted. According to the authors, the coordinators take on their post without any previous training or briefing, which generates a loss of acquired knowledge regarding previous operations, as well as political disputes, as pointed out by some of the interviewees.

Finally, regarding donations management, the need for standardization and unification of family registers was pointed out, in order to prevent rework. By the time of the visit, the emergency stocks had not yet been replenished, making the city vulnerable to another disaster.

Campinas is also part of the Campaign Making Cities Resilient and has effectively implemented measures for disaster risk mitigation. The city evolved within the program, reaching the LG-SAT stage (3rd step).

Improvements Evaluation by Criteria

The following section discusses the analysis of the response and reconstruction operations phases according to the criteria listed before: actors, donations, housing and homelessness, information and risk mitigation. These dimensions were determined by observing the common characteristics within the case studies analyzed, the Making Cities Resilient Guide and the PDNA. The objective of this session is to identify the dimensions in which the disaster operations in São Paulo state are effective, that is, is efficient in minimizing the suffering of the largest number of disaster victims possible.

Actors

As the first step of the Making Cities Resilient Guide indicates, actors responsible for disaster risk reduction activities must organize their efforts, involving not only public authorities, but also civil society organizations, the private sector and, above all, the community. Among the actions needed are (i) establishing clear leadership for emergencies, (ii) updating the legislative framework to focus on resilience; (iii) defining stakeholder roles and creating action protocols; and (iv) establishing alliances and exchanges with neighboring cities.

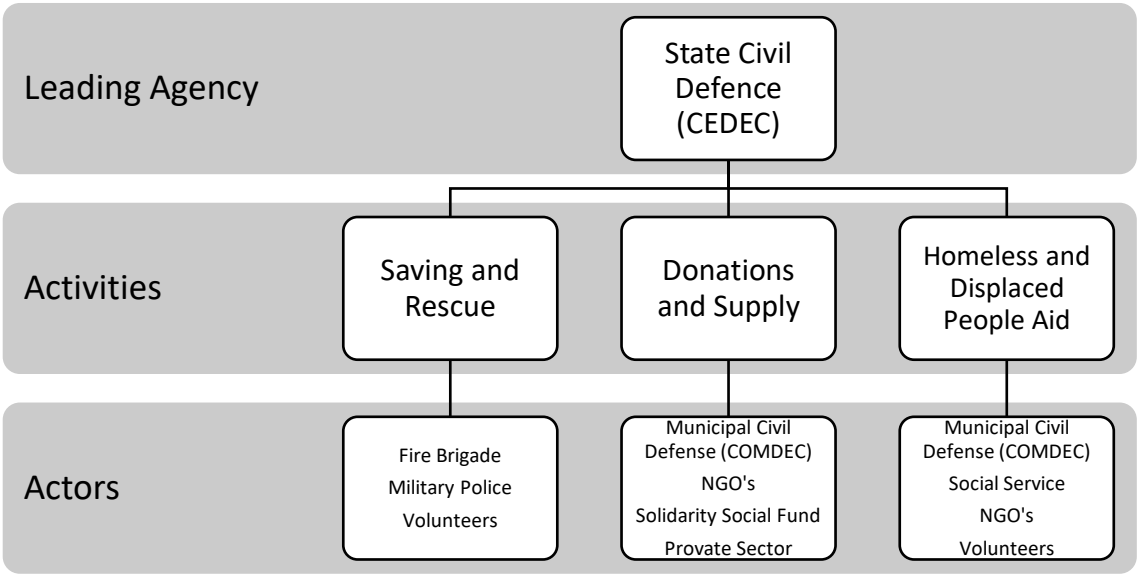
In the response phase, it was observed that in Cubatão, Itaóca, and Jarinu, there was a clear task division to deliver aid to the victims. In the first case, COMDEC, the Fire Brigade, and the Military Police were responsible for rescuing victims; the Solidarity Social Fund and NGOs, for the supplies and donations; and the Municipal Social Assistance, for the homeless and other sheltering issues. In the second case, the Fire Brigade was in charge of the rescue activities while the State Civil Defense Coordination was in charge of the other needs. Jarinu, in turn, had its response operation coordinated by the State Civil Defense Coordination (CEDEC), while the city Solidarity Social Fund handled the registration of victims and donations. In the four events, the community participation was

observed; however, in São Luiz do Paraitinga, the volunteers' actions were fundamental to the operation. In Itaóca and Jarinu, companies in the region donated or lent equipment and labor.

Particularly, in Itaóca, the city infrastructure and size increased its dependence on the state government. The second step of the Making Cities Resilient Guide indicates that cities should define a budget for disaster risk management activities in their government plan while encouraging partnerships with the city private sector and with international development agencies.

During the response phase, the network of actors was quickly built allowing them to work together. In all the cases, even though COMDEC and local agencies acted directly in the disaster, the effective activities coordination was carried out by CEDEC. This type of arrangement and performance can be considered a Leading Agency, according to Gillmann's typology (2010). Figure 4 illustrates this type of coordination.

Figure 4: Actors and response phase coordination according to Gillmann (2010).



In the reconstruction phase in São Luiz do Paraitinga and Cubatão, the municipal bodies were the main actors, especially due to the management of bureaucratic and legal procedures necessary for social benefits and due to the activities prioritization, seeking and obtaining financial resources for the work. In Itaóca, the dependence on the state administration persisted, especially for bureaucratic procedures. In Jarinu, while commercial establishments had returned to normal operation five days after the tornado, many public areas, due to the public biddings, were still to be rebuilt after a year of disaster (Ribeiro *et al.*, 2017).

Donations

In all the cases presented, donation showed to be one of the most difficult activities, mainly due to the large volume, which made processes such as sorting and classification even more difficult. In the four cases, the volume of donations exceeded the need of the victims and was passed on to other cities. In Jarinu, for example, the reception of donations had to be stopped once they had reached so great a volume that could harm the operation. Note that most of these donations consist of low priority products which, despite the possibility of being used for a later phase of the response stage, are not immediately needed.

In all the cities, it was necessary to set up a place for collection, sorting, inventory, and distribution for donations. In Cubatão, the proximity of the donations handling area with the homeless victims caused turmoil in the place and had to be relocated to another place. In Jarinu, once the Solidarity Social Fund building was full, the donations had to be transferred to other assistance agencies, such as the Center for the Coexistence of the Elderly (CCI) and the Reference Center for Social Assistance (CRAS), as well as churches, nurseries and health posts (Ribeiro *et al.*, 2017).

Homeless and Sheltering

The Making Cities Resilient Guide advocates land regulation and planning as a key step for disaster risk reduction (step 6). In the case of São Luiz do Paraitinga, about 100 families living in high-risk areas were relocated to a neighborhood where popular houses were built and approximately half of the affected houses were rebuilt or repaired. Families that still live in risk areas have their residences monitored by COMDEC.

In the city of Cubatão, public places, such as gymnasiums, schools, and churches, were used as shelters for disaster victims. Some problems involving hygiene and food wastage were observed in the largest shelter, besides coexistence and safety problems, especially regarding the risk of rape. Also noticed was the importance of involving the victims left homeless in integration, leisure or work activities. In one of the schools, a kennel was improvised to accommodate the animals taken by the victims during the evacuation. During the reconstruction phase, the homeless were relocated to houses of the Housing and Urban Development Company (CDHU) or received rent assistance.

In Itaóca, the victims were housed by relatives or relocated in schools adapted as shelters. Those who could not return to their homes received rent assistance; however, due to problems with public administration, the delay of the processes resulted in the closure of the temporary benefits before the establishment of definitive solutions.

Finally, regarding the sheltering activities in Jarinu, only one family was left homeless and the others received help to repair their houses through an agreement between the town hall and a few construction material stores. The shelters in all the four cases were established in a quick and improvised manner once there was no previous definition or preparation of appropriate places.

Information

Regarding the registration and dissemination of information, the application of these concepts appears to be a great challenge to the analyzed cities, especially during the response phase. In São Luiz do Paraitinga, it was pointed out that several activities of the humanitarian relief chain needed more information, for example, the quantity and location of supplies. In Cubatão, it's communication failures were observed between public authorities in the city, causing an overlapping management of donations.

In Itaóca, despite the establishment of an information flow system, there was no record of the activities and procedures. Finally, in Jarinu, the Solidarity Social Fund had difficulties in centralizing the management of the donations, deriving from voluntary initiatives for donation collection in several places. In addition, the victim's registration, which was to be carried out by social workers, was also being conducted by other community agents, generating duplicated registrations and rework. Not exclusively in the four studied cases, problems with information management are reported in papers from the literature on humanitarian operation logistics (Kovács and Spens, 2009).

Risk Mitigation

Preparation and warning are cited in step 9 of the Making Cities Resilient Guide once time is a crucial factor in disaster response, reducing possible impacts. This includes institutional mechanisms, warning systems, escape routes and simulations (UNISDR, 2012). In Cubatão and Itaóca, fluviometers and rain gauges were introduced, but there is no automatic warning system. In São Luiz do Paraitinga, in addition to these pieces of equipment, other

mitigation and risk reduction measures were taken to improve the flow of the river, although further works were not carried out due to lack of funds. Jarinu received three rain gauges from the Military House; however, they had not yet been installed one year after the disaster.

In Itaóca, a new and safer bridge was built. Yet the city is verified to have problems to sponsor actions and projects, due to its small size and lack of human resources. Besides, it has difficulties in meeting the necessary legal and bureaucratic requirements to obtain federal and state resources.

At least two of the analyzed cities, Cubatão and São Luiz do Paraitinga respectively elaborated a disaster management and an evacuation plan. Neither the two mentioned cities, nor Jarinu, have sufficient stock of essential relief items to assist the victims, nor defined places to be used as shelters and storage of materials in case of a new disaster.

With regard to population training for risk reduction and response preparation, described in step 7 of the Making Cities Resilient Guide, only in São Luiz do Paraitinga was training and simulation carried out with the population. It should be noted that other training measures were taken in the city, such as the implementation of a pilot education project and the distribution of prevention booklets with instruction on how to act in case of disaster. In addition to these preparedness and awareness measures, the Guide also suggests integrating risk management into formal education programs and developing training with civil groups and priority groups, such as firefighters, police officers, doctors, etc. All these actions add to the empowerment of the population and, consequently, to the reduction of possible disaster damages.

Conclusion and Discussion

The combination of heavy rains, social vulnerability with lack of preparedness, and risk reduction measures by municipal authorities result in negative socioeconomic impacts. Based on four cases from different cities: São Luiz do Paraitinga, Cubatão, Itaóca and Jarinu, this article evaluated the response and reconstruction phases of disasters that occurred in São Paulo State, from 2010 to 2016. In addition, this research suggested improvements that may reduce the suffering of victims in case of new disasters. Brazilian legislation, through Law 12,608/2012, which establishes the National Policy for Civil Protection and Defense (Brasil, 2012), establishes many technical and public administration requirements for cities. Based on the analyzed response processes presented in this study, it is possible to conclude that small cities are not able to fully meet law requirements, especially regarding technical issues, without state or federal agencies support, due to the lack of skilled human resources or

operational difficulties. Apart from Campinas, in all presented cases, the inability of municipal authorities to respond to major disaster situations by itself was observed. In Itaóca especially, a city with a little more than 3,000 inhabitants, state government authorities had to coordinate the response process due to the shortage of human and material resources presented in the city.

Table 1 shows the city comparison according to size. Several analyzed aspects depend on the response and recovery phases prior preparation, which shows a greater need for actor management and coordination before a disaster occurs.

Table 1 – Cities characterized according to the criteria:

	São Luiz do Paraitinga 2010	Cubatão 2013	Itaoca 2014	Jarinu 2016
Actors	• Populations support during response phase • Leading Agency Coordination	• Clear task division • Population support during response phase • Leading Agency Coordination		
Donations	• Supplies > Needs • Great volume of nonpriority items • No previous local definition for warehousing and material separation			
Homeless and Housing	• Schools used as shelters • No previous local definition • Need for housing support • Delay for effective response			• Only one homeless family
Information	• No information flow	• Flaws within the information flow • No lessons learned register	• Effective information flow • No lessons learned register	• Victims registration duplication

Risk Mitigation	• Small works and constructions • Managerial plan elaboration • Training after the disaster	• Measurement system installation but no alert system • Managerial plan elaboration • No training after the disaster	• Small works and constructions • Measurement system installation but no alert system • No training after the disaster	• Rain gauges reception • No training after the disaster

The disaster magnitude in Campinas was similar to Jarinu's, but the response process was remarkably different. In Jarinu's case, although the city is part of the Making Cities Resilient Campaign, its stage within the program did not evolve, therefore, the city required the State Civil Defense assistance. Campinas, in turn, evolved within the program (LG-SAT stage) and did not need external assistance once the post-disaster stages occurred as planned within the program.

Regarding the actor's actions, the State Civil Defense (CEDEC-SP) support was essential for the post-disaster phases. The structure for task division, with activity responsibility given to each institution, which has been put into practice in some cases, may be a more efficient way to aid victims, emphasizing the importance of communication among the actors.

In addition, the population itself and the volunteers that emerged during the crisis were vital for the response success. These groups often do not have previous preparation for disasters operations, however many group leaders were prepared and led the others. In Cubatão and São Luiz do Paraitinga, the churches had an important role not only during the response process but also during the reconstruction phase, making a campaign in order to obtain alert equipment, for example.

Regarding the PDNA objectives, coordination among sectors involved in the recovery efforts was observed mainly between the Civil Defense and Social Assistance in the cities of São Luiz do Paratinga and Cubatão. In Itaóca, the main actions were taken by state (CEDEC-SP) and federal (CEMADEN) authorities. In all cases, projects for

mitigation and risk reduction were elaborated and recovery priorities occurred mainly thanks to federal and state authorities resources.

In all four cases, improvements to reduce and mitigate disasters risk could be made. Regarding housing policies, for example, measures were taken to reduce the number of families located in risk areas. No significant improvements have been made regarding disaster management, once difficulties are recurrent. Tools for knowledge management and Civil Defense career professionalization can reduce this gap.

Furthermore, the impact on neighboring cities is highlighted. In three of the four cases, cities close to the disaster site actively participated in the response process even though there was no prior preparation for a joint action. Therefore, there is a need for the establishment of inter-municipal consortia for disaster prevention and response, despite the absence of legal obligations for this to occur.

Only one municipal agency in Cubatão established a formal record of answers to questions such as: What went well or wrong? What could be done in the same way? What should be done differently? What was not known before the disaster and is known now? The lessons learned during the disaster form an important framework for prevention and response to eventual misfortunes (Uchoa and Monteiro, 2012). The construction of skills acquired from practical knowledge are important prevention and response tools.

As a suggestion for future works it is proposed to follow the studied municipalities over the next few years to observe their complete reconstruction process. Operations in other regions or countries can also be compared in order to develop a benchmarking study.

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