The development of a natural disaster training program in Brazil by considering the previous victim profile

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Abstract
Disasters have increased in number and intensity which requires the study of previous disasters so that decisions can target the main vulnerabilities. This paper aims to assist policies for prevention and mitigation through training programs for disaster preparation in Brazil considering the previous victim profile and a methodology for data collection.

Keywords: Humanitarian logistics, disaster prevention, victim profile, natural disasters

Introduction

Each year, millions of people are affected by man-made and natural disasters that can trigger humanitarian crises. Humanitarian organizations, such as NGOs (non-governmental organizations), United Nation (UN) agencies or governments, work to help and support the communities affected, by delivering water, drugs, medical equipment, shelter, and food items, among others (Rottkemper *et al.* 2011). Such measures are due to the increasing number of disasters and people affected, in addition to estimated losses reported through databases of natural disasters (EM-DAT 2013).

From a national perspective, some disasters with worrisome dimensions (such as the tragedy of Rio de Janeiro mountainous region in January 2011, the landslide on Morro do Bumba in Niteroi in April 2010 and the Minas Gerais floods in January 2011), resulted in measures such as an investment of 18.8 billion reais in the National Plan for Risk Management and Disaster Response (PNGRD) until 2014 (Brasil, 2012) by the Federal Government. There are also legislative initiatives, such as the creation of Law No. 12,608 of April 10, 2012 (Brasil, 2012) which institutes the National Protection and Civil Defense

Policy (PNPDEC), the National Protection and Civil Defense System (SINPDEC) and the National Council for Protection and Civil Defense (CONPDEC), assigning obligations about disasters prevention and mitigation to federal agencies within the federation tripartite (Union, States and Municipalities).

This context increases the importance of monitoring and studying natural disasters, because reliable information can reduce the subjectivity of policies and operational decisions from Civil Defense and contribute to fight against vulnerabilities, to make resource allocation smarter, what fulfills the donor's demand of efficiency (Kopczak and Thomas 2005). Monitoring includes the accounting of human and structural damages from past disasters that can be useful as support for actions' planning and prevention for future events. Thus, international organizations such as the United Nations Office for Disaster Risk Reduction (UNSDIR) has encouraged the creation of databases about natural disasters as the EM-DAT.

Considering the Brazilian reality, this paper presents two studies based on the records of natural disaster victims provided by the State Coordination of Civil Defense (CEDEC): the first aims to identify risk factors in the profiles of victims of natural disasters in the states of São Paulo (SP), Minas Gerais (MG), Santa Catarina (SC) and Rio de Janeiro (RJ), highlighted in Figure 1, besides suggesting measures for prevention and training based on the results. The second study aims to measure the quality of data submitted by CEDEC by comparison with other database (BD) provided by the Institute for Technological Research (IPT), a leading scientific research and technological development institution of Brazil, in order to show discrepancies in findings, showing the actual reliability of the data collected. Finally, a more reliable methodology for collecting data is proposed.

Figure 1 -States of São Paulo (SP), Minas Gerais(MG), Santa Catarina (SC) and Rio de Janeiro(RJ)

Literature review

Profile of victim

O'Keefe *et al.* (1976), in the Nature Journal, was the first publication to detect the interface between natural disasters and the vulnerable human population segments. At that time, they explained that the increase of natural disasters victims was caused by population growth. 'As population continues to expand, and the resources continue to be controlled by a minority, the real standard of living drops for much of world population'. The more a population grows, the more vulnerable it becomes. To reduce this vulnerability, preventive planning should be established, considering geographical and geological aspects, socio-economic and cultural status.

According to Neumayer and Plümper (2007) and O'Keefe et al (1976), gender, biological, and physiological differences in capacity for disaster response can lead to different mortality rates because, among other reasons, men can be physiologically better equipped to survive a disaster physical impact. For instance, if a woman is weaker than a man, she will be more easily swept away by water, snow or land. On the other hand, under disaster scenarios, women are usually slower in crucial physical activities, such as running, climbing trees, and reaching rescue points.

Finally, Brito Jr. *et al.* (2011) use logistic regression to determine risk factors related to natural disasters in the state of São Paulo. This study identified the influence of factors such as gender, age and climatic effects such as El Niño and La Niña in the number of deaths caused by natural disasters, highlighting, for example, that La Niña is related to an increased number of deaths by lightning.

Databases

The EM-DAT is an international database created by the Centre for Research on the Epidemiology of Disasters (CRED) part of the School of Public Health of the Université Catholique de Louvain (UCL) in Brussels (EM-DAT 2014). It has free access and aims to analyze large disasters at national and international level, but without sufficient detail to evaluate them at the subnational level. EM-DAT DB records a single disaster event as human and material damages between the start and end dates in the same country and even in different regions.

Guha-Sapir and Below (2002) aims to access the quality of global databases in disasters such as Sigma, NatCat and EM-DAT, by crossing and comparing their data and pointing out their weaknesses and strengths. Sigma is a limited access global natural (except for drought) and man-made disaster database maintained by the Swiss Reinsurance Company (Sigma 2013) and NatCat (NatCat, 2013) is a service that records approximately 1,000 events every year. The study finds that databases in general show a significant increase in events of natural disasters in recent decades, but there are major discrepancies among them depending on the variable analyzed. The EM-DAT, however, as a free access base, allows the discussion of the recorded data (Marcelino *et al.* 2006).

The database disaster DesInventar (DesIventar 2013) has open data detailing at subnational level, but still does not cover all the countries in the world (as is the Brazilian example). It considers small-scale disasters and is open to the possibility of collaboration with organizations willing to undertake the records.

All the databases mentioned focus on the historical records of disasters. However, Giuliani and Peduzzi(2011) discusses the proposal of designing a database of georeferenced disasters with global scale in order to support a study of natural disaster risk in each region and to be useful to government agencies. With a similar proposal, Blahut *et al.* (2012) advocate the establishment of a database to a region using the north of Italy data.

The Brazilian Atlas of Natural Disasters (CEPED UFSC 2011) provides information on records of disasters that occurred in Brazil between 1991 and 2010 with municipal detail and presents temporal and spatial analyses able to support the management and the reduction of disaster risk at the subnational level.

With an approach similar to this paper, many studies have proposed risk indicators of natural disasters that take into account natural aspects (frequency of earthquakes, floods, landslides, droughts and cyclones) and the social and economic order (per capita income, Human Development Index, relationship between total land and land facing agriculture, among others) in order to obtain an approximate estimation for a potential natural disaster of a given type and size (Peduzzi *et al.* 2009).

Study and methodology

Data collection and processing

The data considered in this study were provided by various institutions such as the Institute of Technological Research (IPT) and the State Civil Defense Coordination (CEDEC) of São Paulo, Rio de Janeiro, Santa Catarina and Minas Gerais. However, the data provided by each institution are disclosed in different conditions of format, quality and extent of covered item.

The data provided by the CEDECs of each state show relative homogeneity regarding deaths of victims of natural disasters. Their features are detailed in Table 1:

Table 1 - Description of CEDECs' databases

Database	CEDEC-MG	CEDEC-RJ	CEDEC-SC	CEDEC-SP
Spatial scope	State of Minas Gerais	State of Rio de Janeiro	State of Santa Catarina	State of São Paulo
Time span	Jan2006 - Jan2013	Jan2000 - Jan2011	Jan2008 - Aug2012	Jan2005 - Mar2013
Features	Age, sex of the victim, county, type of disaster and the disaster date.	Date of death, type of disaster, county, and age of the victim.	Age, sex of the victim, county, type of disaster and the disaster date.	Age, sex of the victim, county, type of disaster and the disaster date.
Data source	Official Reports	NOPREDs and AVADANs	Reports of the Legal Medical Institute (IML)	Official Reports
Disaster Classification	Deluge, flood, collapse, lightning, landslide	Flood, landslide	Flood, collapse / flood, slip, lightning, cold	Flood, collapse, lightning, landslide, other

The data collected have different formats and classifications, disallowing a proper comparison. This is mainly due to the difference in data sources, because while Minas Gerais and São Paulo are based on police incident reports (Official Reports), Santa Catarina uses data from IML (Brazilian federal institute responsible for surveys and examinations of corpus delicti) and Rio de Janeiro is based on official documents such as NOPREDs (Preliminary Notice of Disaster) and AVADANs (Damage Assessment Form). In addition, states use different terms to describe each event. Therefore, it was necessary to reclassify the data for a common nomenclature. For this purpose, the disaster classification was standardized as per the São Paulo Database (flood, collapse, lightning, landslide).

The criteria for reclassification were mainly semantics; however, some terms presented multiple possibilities of reclassification as the example of floods and collapses. In these cases, the EM-DAT (2009) classification was adopted which classifies both as subcategories of flooding. In the last quarter of 2008, the Civil Defense Coordination of Santa Catarina indistinctly labeled some events as floods and landslides. In the final classification, these events were placed as landslides, according to the classification adopted by the IPT database. The data provided by the IPT has spatial scope from January 1988 to August 2012, but there are problems with homogeneity, as the data are collected from media information. The items included are: municipality, state, date of the incident and a description of the event.

Data Analysis

Preliminary Analysis

This initial analysis aims to determine risk groups comparing the percentage of a particular group of victims in a given state and the percentage of that group in the population Chou *et al.* (2004), allowing an estimation of the characteristics of the population at risk and highlighting a possible abnormal incidence on age and gender. Population data were obtained from the Brazilian Institute of Geography and Statistics (IBGE), which publishes data collected through census and estimation (IBGE 2010). Table 2 shows the factors taken into consideration for each state, highlighting the limited data of Rio de Janeiro:

Table 2- Factors considered

State	MG, SC e SP	RJ
Gender	Male and Female	No distinction
Age	Child(0 to 14) Youth (15 to 24) Adult (de 25 a 60) Elder (more than 60);	Child (0 to 14) Adult (15 to 60) Elder (more than 60)
Climatic events	El Niño, La Ninã, Neutral	El Niño, La Ninã, Neutral

This preliminary study aims to identify risk factors related to natural disasters, being similar to the study conducted by Brito Jr. *et al.* (2011), which indicated the effects of El Niño e La Niña (which respectively cause anomalous heating and cooling of surface waters of the Equatorial Eastern Pacific, greatly influencing the climate in Latin America) combined with factors such as age and gender.

Logistic regression

Logistic regression models are used with data without a clear mathematical system. In this case, after the preliminary statistical analysis studies were performed using this type of regression. In studies of logistic regression, the reference category is chosen arbitrarily (Brito *et al.* 2011). The logits for the other categories are:

$$\text{logit}\,\pi_1 = \log\left(\frac{\pi_j}{\pi_1}\right) = x_i^T \beta_j, \text{for } j = 2, \ldots, J \qquad (1)$$

This type of model is widely used to analyze events with binary or binomial results from a set of factors (Dobson and Barnett, 2008) and is therefore suitable for this type of study as previously done by Brito Jr. *et al.* (2011).

The factors effects are interpreted in terms of odds ratios (OR). Considering a binary variable x, the OR for j (j = 2, ..., J) relative to the reference category j = 1 would be:

$$\log OR_j = \log\left(\frac{\pi_{jp}}{\pi_{1p}}\right) - \log\left(\frac{\pi_{ja}}{\pi_{1a}}\right) = \beta_{1j} \qquad (2)$$

Where πjp, πja are the probabilities of category j if the exposure is present or absent.

To study the data, a logistic regression model similar to that used in epidemiological studies was chosen. In a logistic model, the values of an independent variable are used to predict the occurrence of death (dependent variable). When there is more than one independent variable, the problem may be called multivariate. Thus, all the variables considered in the model are controlled simultaneously and the factors can be crossed.

The membership of the variables calculated from the logistic regression model is the OR. The adjusted ORs are obtained by comparing elements that differ in only one feature of interest, with other constant values (Dobson and Barnett 2008).

Analysis of Trends

Based on the analysis used by Marcelino *et al.* (2006) to identify trends in the number of natural disasters in the state of Santa Catarina over time based on EM-DAT data, this study replicates the same analysis for the number of deaths recorded in each state CEDEC.

The analysis consists in: (1) order the number of deaths due to natural disasters on a yearly basis; (2) draw a straight line interpolating the points previously found and then determine the trend and; (3) compare the number of deaths registered annually with the average for the whole period, indicating the possible presence of anomalies.

Cross-checks with IPT

This step aims to observe risk factors from crossing data among multiple databases, climate and population information as done by Marcelino *et al.* (2006) and given the differences in the time scope of each database, this analysis only compares data included in common periods both I the IPT and the CEDECs data.

The death registrations variables analyzed were: name, gender, age, date and municipality. As for the number of deaths, the largest among the two databases was chosen.

To eliminate duplicate records, the unification of databases (IPT and CEDEC) was held in each state, preferably checking names of the victims and, in their absence, using the other variables mentioned. This method detects the records that are not common between the two databases, being an indirect measure of its accuracy and reliability.

Results

Results of the preliminary analysis and logistic regression

This study seeks to observe climatic characteristics that make certain regions more prone to certain disasters and socioeconomic profiles that increase the vulnerability of any age group to each disaster. Given the need for consistency, the study required at least ten deaths by disaster in each location and then, only floods and landslides were analyzed in all the states. Events related to lightning were analyzed only for the state of São Paulo and the records of collapse had no detailing or appropriate amount in any of the four regions studied.

Landslides

Table 3 summarizes the relative risks of landslides for each state. The relative risk is the ratio between the percentage of a given age group in the number of deaths and its proportion within the state population. For example, if 20% of dead in the disaster are children and they represent 10% of the state population, their relative risk in this case is 2. This calculation eliminates the numerical differences between the populations of each state.

Table 3: Relative Risks - Landslides

State	**Minas Gerais**		**Rio de Janeiro**	**Santa Catarina**		**São Paulo**	
Gender	F	M	No distinction	F	M	F	M
Child	0.89	1.72	1.07	1.58	1.26	2.68	1.34
Youth	0.22	0.66	-	0.53	0.83	0.59	0.61
Adult	0.8	0.75	0.89	0.67	0.83	0.75	0.7
Elderly	2.12	2.22	1.65	1.61	2.17	0.61	1.08

The data show that children and the elderly are generally more vulnerable to landslides. This finding can be explained by physiological and socioeconomic factors (Neumayer and Plumper 2007), because these groups generally have less flexibility in case of an escape attempt and they usually stay in their homes longer. However, it is clear verified that the state of São Paulo female children appear more vulnerable than others. This result was confirmed by multivariate logit regression in status (OR = 2.29 for females and OR = 2.42 for child in São Paulo). In other states, the highlight was the elderly population. It is important to note that these data are subject to error, and certain inconsistencies can be noted, such as the relative risk of young males being three times higher than that of young females in Minas Gerais.

For climatic regimes, multivariate logit detected strong influence of El Nino in São Paulo (OR = 2.2), Minas Gerais (OR = 2.03) and an even greater influence of *La Niña* in Rio de Janeiro (OR = 6.4). For landslides, reference variables were: male (gender), elders(age range), neutral (climate regime).

Floods and lightnings

In the case of flooding, Table 4 shows the relative risk is greater for young and adult males. Only in Rio de Janeiro did children appear as a predominant risk group in the multivariate logit (OR = 2.37), and a very large influence of *La Niña* in the state (8.2) is also reinforced. For floods, the reference variables were: male (sex), elderly (age range), neutral (climate regime).

Table 4 – Relative Risks (floods)

State	**Minas Gerais**		**Rio de Janeiro**	**São Paulo**	
Gender	F	M	No distinction	F	M
Child	0.78	0.61	1.24	0.37	1.35
Youth	0.99	0.78	-	0.6	0.37
Adult	0.7	1.53	0.98	0.76	1.54
Elderly	0.53	2.28	0.61	1.22	1.4

The state of Santa Catarina could not be evaluated in this aspect, because in 2008 the CEDEC-SC indistinctly rated landslides and floods, and this study considered these cases as landslides, following the classification of IPT, so the state did not have sufficient case of floods for a reasonable study.

In the case of lightning, seen in Table 5, only the state of São Paulo had enough data (more than 10 cases) for the study, a fact that may be due to a higher probability of lightning in the state, or perhaps record errors of the other CEDECs. However, in all the cases, there was a very large predominance of male adults, reaching 8 out of 10 dead (80%) in Minas Gerais:

Table 5 - Relative Risks (lightnings)

State	**São Paulo**	
Gender	F	M
Child	0.31	0.63
Youth	0.59	1.8
Adult	0.48	2.0
Elderly	0.33	0.76

The multivariate logit confirmed these findings, with an OR of 1.8 for adults and 3.4 for youth. The influence of gender is verified because females had low OR (OR = 0.38). Under the climatic regimes, it highlights the strong influence of La Niña (OR = 2.93). For lightning reference, the variables were: Male (Gender), Elder (age range), Neutral (Climate Regime).

It was observed that the profile of victims of floods and lightning is quite similar. This fact can be explained by cultural and socioeconomic factors (Neumayer and Plumper 2007), as most men tend to underestimate the risks as compared to women, trying, for example, to save their belongings amid floods. In the case of lightning, it was observed that most cases occurred in rural areas, where generally men are exposed, venturing even during storms. In coastal cities, many youths deaths were registered, generally associated with sports such as surfing.

Results of trend analysis

This study is based on the analysis used by Marcelino *et al*.(2006) to identify trends in the number of natural disasters in the state of Santa Catarina over time based on data from EM-DAT, and replicates the same analysis for the number of deaths recorded by the CEDECs of each state. In this case, however, Santa Catarina is not included; due to its limited time scope (the oldest data datesback to 2008).

Figure 2allows observing that the states of São Paulo and Minas Gerais show similar trends in the registration of disasters, with fluctuations between 2007 and 2011 due to climatic elements (*El Niño* and *La Niña*). However, in Minas Gerais, there was an increase in the number of records while a slight decrease was verified in São Paulo. This difference can mean a worsening in accounting results in São Paulo, thus making the decrease in the number of deaths not be a reliable conclusion:

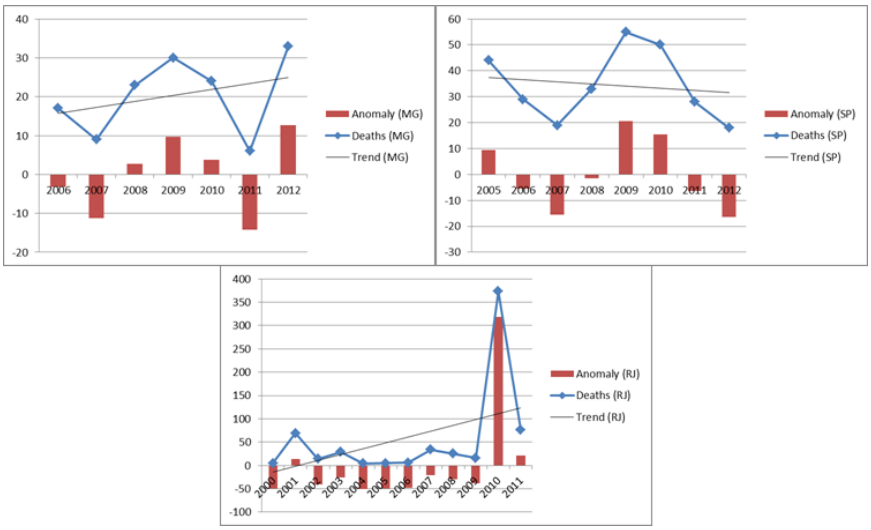

Figure 2 – Trend in the number of deaths

In Rio de Janeiro, the growth trend is poorly portrayed in the graph, since the disaster of major proportions in 2010 and 2011 indicates that the trend of growth may be even more expressive, while questioning the reliability of previous data whose proper accounting could significantly change the outcome.

Crossing the IPT x the CEDECs data

BDs were compared to information available on disasters related deaths for then quantifying the accuracy of the information. However, it should be noted that the IPT covers

only landslides and, due to classification errors, both by the media as by the CEDECs, some records of other disasters were also recorded in the IPT database.

The discrepancy is observed to be greater in the state of Rio de Janeiro where most data were recorded from disasters of major proportions (over 100 deaths) - tragedy of Rio de Janeiro sierra/ mountainous region, the landslide on Morro do Bumba. This result can be explained by the fact that the Civil Defense canvass ceases when the AVADAN and NOPRED reports are released in case of large disasters. The state of Santa Catarina, however, has good data correlation, as both the IPT as CEDEC use the same source of information: the reports of the Legal Medical Institute (IML).

Conclusions

In this study, we can reach several conclusions on the profile of victims of natural disasters in Brazil. The first statistical study delimits some risk groups within the population that should be targeted for public policy.

For the second study, a detailed analysis of the information indicates that there is great room for improvement in the data record of disaster victims. It is also noted that both CEDECs and the mass communication channels can, in each operational environment, significantly contribute to the maintenance of a unified and open database with information detailed by municipalities.

The study of victims of natural disasters profile allows verifying some characteristics of disasters in the states studied and to define risk factors within the population. These factors could be useful to government bodies for political awareness and prevention, because they identify and define target groups related with the most vulnerable part of the population. Thus, the preventive efforts of mobilization, communication and training would be much more effective, as they would be customized and focused on their respective targets. Landslides follow a similar trend for all the states, pointing risk groups considered more physically fragile, as pointed out by Neumayer and Plumper (2007), which indicate the demand for policies focused on these groups, for example the dissemination trough advertisement tools (leaflets and posters) or television info about home evacuation during the occurrence of heavy rains.

On the other hand, floods in Minas Gerais and São Paulo or lightnings in São Paulo affect mostly the adult male population (applicable to young and old, depending on the disaster). As pointed out by the fire department, this is due to greater exposure to risks of these groups arising from the underestimation of the danger. Thus, awareness programs would be necessary.

While crosschecking data from IPT and CEDECs, it was found that the reliability of the database of civil defense is not satisfactory since the number of occurrences identified exclusively by IPT is significant, reaching 64% of deaths in the case of Rio de Janeiro, getting close to 19% in the states of Santa Catarina and São Paulo and around 9% in Minas Gerais. These numbers represent an estimate of the errors committed by CEDECs to account for the deaths of victims in natural disasters; however, it does not consider the deaths that were not recorded by neither of the databases.

Based on the differences found between the databases, this study suggests the creation of a unified methodology for both data collection as natural disasters for classification in Brazil. An unified methodology for the whole country would give this study more reliability and allow the adoption of specific measures in response to disasters, according to the needs of each region and type of disaster.

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