EXTREME WEATHER EVENTS AND THEIR CONSEQUENCES ON HEALTH: THE 2008 DISASTER IN SANTA CATARINA TAKING INTO ACCOUNT DIFFERENT INFORMATION SOURCES[1]

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Introduction

According to the International Strategy for Disaster Reduction (ISDR, 2012), disasters have two important characteristics. First, they are provoked by a natural event (such as heavy rains, a cyclone or an earthquake), termed a natural hazard. Second, these events alone do not constitute disasters. In order for them to be classified as disasters, the populations affected also have to be exposed to vulnerabilities which impact on their capacity to prevent and respond to these phenomena and on their living conditions (work, income, health and education, as well as aspects associated to infrastructure such as healthy and safe housing, roads, sanitation, land use and occupation). It is this combination of factors relating to vulnerability which results in disasters and their effects, leading to losses or material and economic damage, as well as impacting on the environment and the health of the population through immediate or subsequent diseases and deaths.

From this point of view, natural disasters are a result of a combination of both processes present in nature (despite the fact that these may have their cycles altered by social and economic processes, for example, climate change and carbon dioxide emissions), and in the structures and dynamics of societies, making it sometimes difficult to separate natural and social factors in a disaster situation.

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Two main academic areas are involved in the definition of disasters and in the academic and cultural production relating to this topic. First, the Earth Sciences, which focus on the physical threats that result in disasters, and an emphasis on the probability of the occurrence of a harmful physical event. Second, the Social Sciences, which focus on the social structures, processes and their impacts that produce vulnerabilities (Narvaez et al., 2009).

When analyzing debates on climate change, extreme events and disasters, we find that these academic fields are either in cooperation or in conflict with each other. Scientific evidence points to the likelihood of climate change at a global level, as well as an increase in the frequency of extreme events. This has resulted in greater interest on the part of the public and the scientific community in general (IPCC, 2012). Moreover, extreme events have contributed to an increase in the frequency and seriousness of natural events and their human and social impacts, thus there is also more interest in understanding these phenomena (Llasat et al., 2009). Although extreme events are known to cause immediate losses and damages, their medium and long-term effects have not been sufficiently assessed or understood. This is because most of the records produced by civil protection and civil defence authorities, as well as information from the press tend to be restricted to the first week after an event (period of search, rescue and immediate assistance).

The aim of this article is to capture and analyze information on the human impacts of disasters, in particular, relating to human health. In order to do so, we have recovered and analyzed information from different sources about the disaster which took place in November 2008 and affected a number of municipalities in the state of Santa Catarina, Brazil. As Castellanos (1997) - an important reference for those working on how social processes affect health - observes, health conditions relate to the way general processes, which characterize the structure and dynamics of a particular society in a given historical period, are manifested at the individual level. These processes may involve the degree to which production is developed, social relations, the economic development model and how it is internationally integrated, the organization of the state and political relations. Castellanos' work is a main reference for this article whose aim is to analyze some of the social processes which lie behind disasters and their human impacts, manifested as illnesses and health problems.

Natural disasters in Brazil and the world

According to World Bank data, in the last forty years, natural disasters have caused more than 3.3 million deaths, mainly concentrated in the poorer countries (WB &UN, 2010). Each year, approximately 226 million people are affected in total and 102 million by hydrological events alone. Based on the classification suggested by Kron and colleagues (2012) and data from the World Bank's report on disasters (WB & UN, 2010), it can be observed that, with regard to types of "natural" disasters which took place between 1970 and 2010 in Latin America, hydrological phenomena predominated, making up 45% of all events (in particular floods and landslides related to heavy rains), followed by meteorological events, 25% (such as storms and cyclones), while weather-related events made up 8% (for example, droughts and heat waves). Data from the Pan American Health Organization estimate that 73% of the populations and 67% of health centres and hospitals in the Americas are found in risk areas.

In Brazil, from a total of 31,909 natural disasters recorded between 1991 and 2010, 32.7% were hydrological events (flash or gradual floods) in which 60% of a total of 96 million people were affected. These events have led to 1,567 deaths, 309,529 people injured or ill, 1,812 missing and 3,566,087 people who had to leave their homes either temporarily or permanently. In addition 610,764 people had to migrate, leaving the region they previously lived in (CEPED/UFSC, 2012).

The southern region of Brazil has seen the greatest number of extreme weather events, in particular, the state of Santa Catarina. Prolonged droughts in the west of the state and torrential rains in the eastern region have become more frequent from the 1990s onward (Herrmann, 2006). In 1974, heavy rains left over 60,000 people homeless and caused 199 deaths. In July 1983, 78 municipalities declared state of public calamity due to floods which left 197,790 people homeless and 49 dead (Herrmann, 2001). Between 2000 and 2003, floods caused 13 deaths and left 4,935 people homeless (Marcelino et al., 2004). In 2004, the first hurricane was detected in the South Atlantic and it became known as Catarina and affected the northern coast of the state. The fact that it was unprecedented drew the attention of meteorologists from around the world. In November 2008, heavy rains resulted in flooding and landslides leading to the immediate death of 135 people; 5,835 injured or ill; 78,656 people were displaced and made homeless. In total, over half a million people were affected, 14 municipalities declared a state of public calamity and 63 were considered to be in a state of emergency (CEDEC-SC, 2009).

November 2008 saw the biggest climate event ever recorded in the State of Santa Catarina. The centre-north coastal region of the state was subjected to intense precipitations which resulted in big material and human losses. The accumulated precipitation at the beginning of the month was above the historical average (calculation based in the last 30 years). This was further aggravated by heavy rains on the 22 and 24 of the month, leading to landslides and floods. Rain was triggered by a mass of humid air originating in the Atlantic Ocean, associated to a relatively shallow atmospheric system which transported humidity close to the surface. The accumulated rain in five days during November 2008 was approximately two times higher than the maximum for the historical series (Mitterstein & Severo, 2007).

During the 2008 event the 14 most affected municipalities were: Ascurra, Benedito Novo, Blumenau, Brusque, Florianópolis, Gaspar, Ilhota, Itajaí, Jaraguá do Sul, Luiz Alves, Rancho Queimado, Rodeio, São Pedro de Alcântara and Timbó. The events in Santa Catarina were extensively covered in the local and national press. Civil defence estimated the number of affected people which was used as a basis for most discussions and the direction of rescue activities in the first days after the rains started. Due to the repercussion of the disaster on public opinion, press organizations made efforts to collect and publish information on its impact both in print and on the internet. The health system became overloaded due to an increase of emergency activities, hospitalizations and outpatient care.

Method

It may be possible to assess the human impacts of disasters, in particular in terms of health, using sets of data from different information sources (media, civil defence, or routine data from the health services) which have different objectives, reach and structures. However, it is essential that this information is analyzed and compared in order to follow up impacts in the medium and long-term.

Health information systems record health events that may or may not be related to disasters, such as deaths, number of hospitalizations and the notification of diseases. The basic cause of a health event (death, illness, inpatient and outpatient care) provides, in this case, only an indication of the causality between a disaster and health problems. Generally, climate disasters may have a wide range of effects on health, depending on the type of weather event, local infrastructure and the exposure of the population to risk situations. Therefore, to capture the increase in health events related to disasters by separating data from routine occurrences recorded in health information systems is not an easy task. Data association depends on the quality of records and, therefore, on the capacity of care and diagnosis which are routinely performed within the health system.

By comparing all the data collected from this and other sources, it is possible to evaluate the quality of health records, and at the same time, validate the use of media information to issue warnings and monitoring disasters, as well as to provide a basis for drafting risk reduction policies (Llasat et al., 2009). Given the increase in the frequency and scale of situations involving natural disasters, it is essential to capture and understand available information, taking into account health system data, so as to give visibility to medium and long-term effects, and draft preventive and health care policies which go beyond the period of search, rescue and immediate care.

In this article we conduct a descriptive analysis of the impacts on health as a result of the rains of November 2008 which affected the municipalities on the northern coast of the state of Santa Catarina, in the Southern region of Brazil. Three data sources were used: health system data, civil defence data and information from the press.

Data on mortality and morbidity were gathered by using records from the Mortality Information System (SIM) and the Hospital Information System (SIH), as well as the System of Information and Notification of Health Events (SINAN) available from the Ministry of Health database (www.datasus.gov.br). Information was analyzed based on the latest revised version of the International Classification of Diseases (ICD-10), in particular chapter XX on external causes of accidental injuries (W00 to X59 and X-30 to X-39), chapter XIX on injuries, poisoning and certain other consequences of external causes (S00 to T98) and chapter I, relating to infectious and parasitic diseases (A27). Data was aggregated according to month and municipality and separated by causes of death or hospitalization which was used to develop a historical series, enabling the analysis of profile changes in the mortality and hospitalization in the municipalities affected. In order to assess the changes in epidemiological profile, the 2008 data was compared with that of the previous (2007) and the subsequent (2009) years. Values were interpolated by means of a moving average using three months (prior, present and subsequent) to smooth out the evolution line of long-term cases.

Data was also collected regarding the number of deaths and people seriously injured, according to the information provided by the national civil defence, via the National Civil Defence System (SINDEC) by means of the Form for Assessing Damages (Avadan), available at the Integrated Information System on Disasters (S21D) at the National Department for Civil Defence site (SEDEC). The Avadan database records the intrinsic characteristics of disasters, the area affected, harm to humans (deaths, injuries, illness, displaced, homeless and missing individuals), material and environmental damage, as well as economic and social losses caused by disasters. The form must be filled within a time-frame of 120 hours (five days) after the occurrence of a disaster and must be sent to the SINDEC coordination bodies (Decree n. 5.376, 17 February, 2005). Data collected were used to calculate the climate event impact indicators in the municipalities affected, such as the number of people affected in relation to the total population of the town and the number of deaths per population affected.

Finally, information from the media was collected via an internet search for 2008 using key words such as ‘floods’, ‘rain’ and ‘Santa Catarina’ by means of the search tool Google news. National and regional press articles were selected on internet sites containing data on the impact of floods on the health of the population, such as the number of people injured, missing and homeless, as well as the number of deaths.

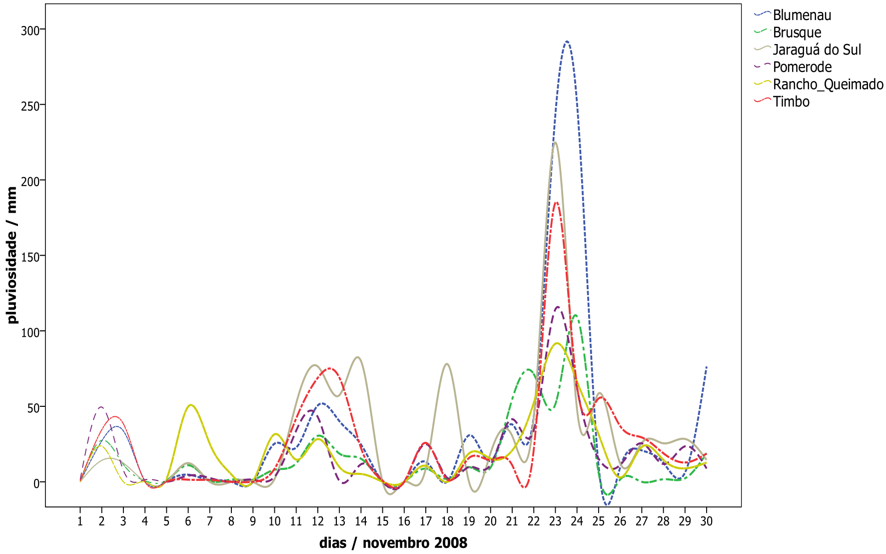
Daily data on precipitation for 2008, recorded by the State of Santa Catarina Agribusiness Research and Rural Education Company (EPAGRI) were collected via the Hidroweb system belonging to the National Water Agency (ANA), in order to describe the scale of this climate event.

Results

Figure 1 shows the precipitation for November 2008 (in mm), when there were incidences of extreme rainfall in the state of Santa Catarina. For the civil defence authorities, precipitations between 60 and 80 mm per day is considered to be at the alert level and above 80 mm, classified at a critical level. From the end of the first fortnight of November 2008 the pattern observed was atypical, with over 60 mm of rain per day between 11th and 14th of the month in the municipalities of Timbó and Jaraguá do Sul which displayed similar volumes of rain again on 18th. On 23rd November there was an increase in precipitation in all the municipalities in the region, reaching the critical level.

The accumulated precipitation for the month of November exceeded 1000 mm in Blumenau and 900 mm in Jaraguá do Sul. Almost 800 mm of rain was observed in Timbó, while Brusque, Pomerode and Rancho Queimado received approximately 500 mm of precipitation. All these weather stations, except for that at Rancho Queimado, are situated in the basin of the Itajaí River. It is thus possible to say that the rainfall converged to the Itajaí riverbed which was responsible for the floods that lasted approximately a week, even once the rains were over.

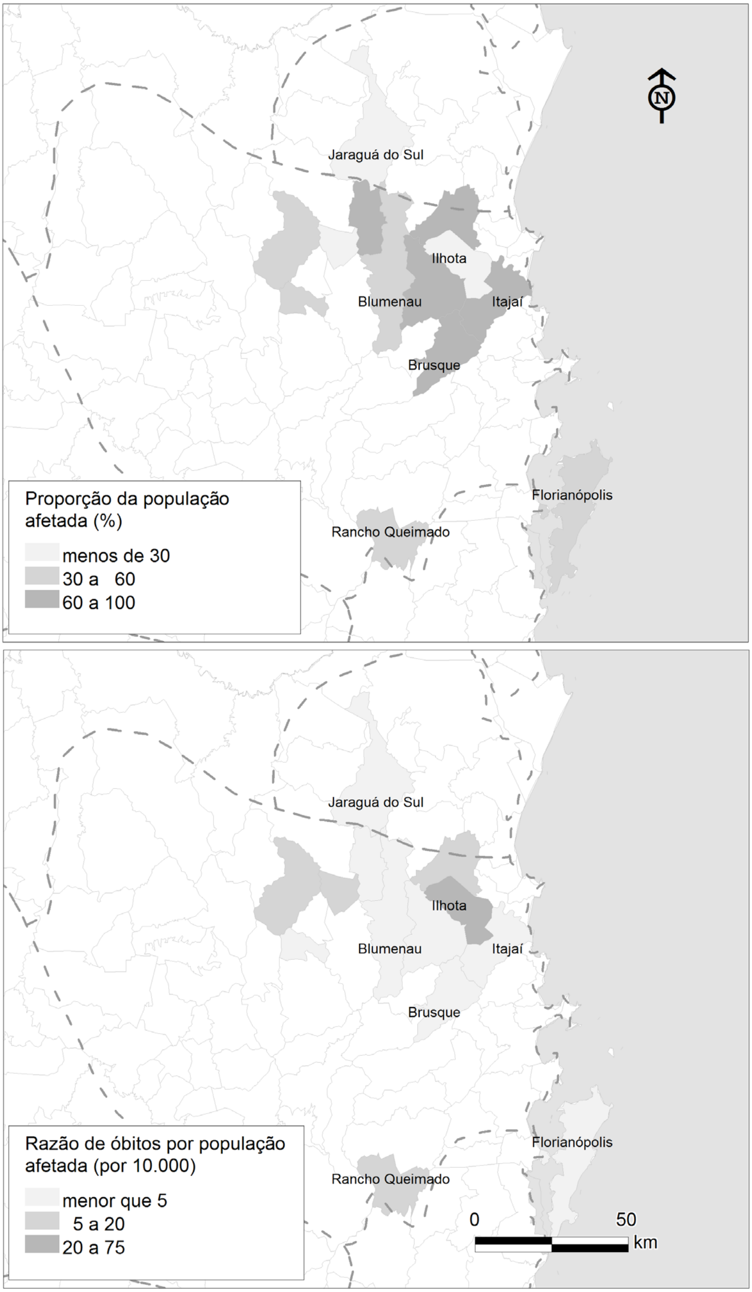
Figure 1: Daily precipitation (mm) during November 2008 in the main affected municipalities Source: ANA/EPAGRI.



Legend: (hor) days/ November 2008; (ver) precipitation (mm)

Maps in **Figure 2** show the rainfall impact indicators for November 2008 in the municipalities of the northern coast of the state, according to information obtained from the Avadan form, made available by the civil defence. This data show estimates of the population directly affected, classified as displaced, homeless, relocated, missing, slightly injured, seriously injured, ill and dead, as well as the total number of people affected (the latter not only included people directly affected, but also all those affected by the disaster in some way, for example, by road blockages, the interruption of services and economic losses). Using as reference the total population of municipalities, obtained from the 2010 census, it was possible to calculate indicators showing the proportion of people affected (the number of people affected divided by the total population of a municipality) and the death ratio per population affected (number of deaths as a result of the disaster divided by the number of people affected, per 10,000).

Figure 2: Location of municipalities affected according to impact indicators: a- proportion of people affected according to the total population of the municipality and b- proportion of deaths per number of people affected. Data source: Civil Defence, 2008.



Legend: Mortality ratio per affected population; less than 5; 5 to 20; 20 to 75

The total number of people affected in the region was 691,857, where the municipalities of Pomerode, Luiz Alves, Gaspar, Itajaí and Brusque had the greatest number of people affected in relation to total population, as shown in figure 2a. The largest death ratio was found in Ilhota with a population of 12,355 in 2010. Blumenau had the largest number of deaths, with a total population of 309,214 in 2010 (figure 2b).

Table 1 shows the number of deaths during the extreme rainfall event in the state of Santa Catarina in 2008. It takes into account information collected by the state's civil defence, compared to the number of confirmed deaths in the Mortality Information System (SIM) associated to people's exposure to natural forces (Chapter XX, X30 to X39), and deaths reported by the press. The municipality presenting the largest number of deaths at the time of the event was Ilhota, with 26 deaths accounted for by the civil defence, 30 deaths recorded by SIM and 47 deaths as reported by the press. The municipality of Blumenau had 24 deaths, exactly the same count found in the three sources of information, a similar situation was reported in Jaraguá do Sul, 13 deaths; Ascurra, 1 death and Benedito Novo, Rancho Queimado and Timbó with 2 deaths each. As in Ilhota, the municipalities of Itajaí and Gaspar showed a considerable divergence between sources in terms of information. According to SIM, no deaths were identified in Florianópolis associated to the climate disaster. In Pomerode, civil defence registered 3 deaths, whereas other information sources recorded only 1. In São Pedro de Alcântara, SIM and the press recorded 1 death, not registered by the state's civil defence, which may have occurred after the period established by the decree.

Table 1: Mortality as a result of floods according to the civil defence, the health system's Mortality Information System and the press (Folha de São Paulo).

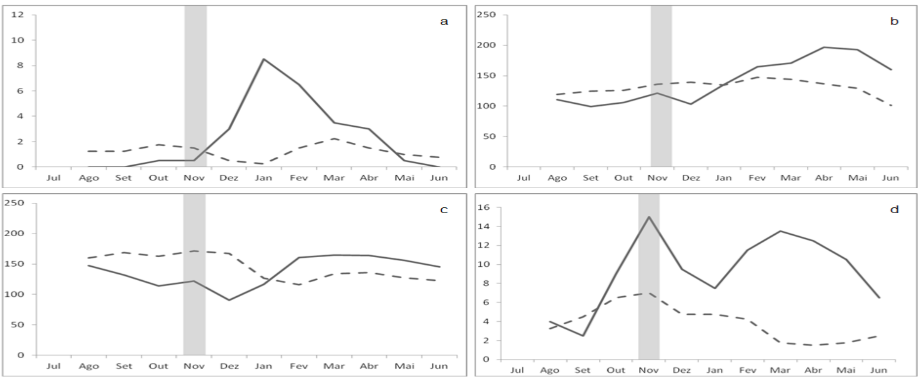
Municipality	Deaths (Civil Defence)	Deaths (SIM)	Deaths (Press - FSP)
Ascurra	1	1	1
Benedito Novo	2	2	2
Blumenau	24	24	24
Brusque	1	1	1
Florianópolis	1	-	1
Gaspar	16	17	20
Ilhota	26	30	47
Itajaí	5	8	2
Jaraguá do Sul	13	13	13
Luiz Alves	10	11	10
Pomerode	3	1	1
Rancho Queimado	2	2	2
São Pedro de Alcântara	-	1	1
Timbó	2	2	2
Total	106	113	127

The number of deaths in the municipalities affected seems to converge, but in general the press presents the highest figures. The greatest discrepancies were observed in Itajaí, Gaspar and Ilhota. These municipalities have very different populations (188,000; 57,000; and 12,000 respectively) and very different health and civil defence infrastructure.

With the exception of Florianópolis and Jaraguá do Sul, most of the municipalities affected are located in the lower course of the Itajaí River and are subject to flooding which may be caused by heavy rainfall occurring tens of kilometres away and which converges into the main riverbed. The rains which occurred between the 22nd and 25th November may have accumulated in this stretch of the basin and may have been the cause of the rise in river water levels for many days after the rains had stopped. The lack of data regarding the municipalities in the same stretch of river basin, which could have been affected, such as Navegantes, Penha and Camboriú, is striking.

Figure 3 shows the evolution in the number of hospital outpatients recorded in relation to the inhabitants of Itajaí, Blumenau and Ilhota, in terms of some causes for hospitalization, obtained from SIH-SUS. These municipalities were chosen for the next stage of the analysis because of the size of their population which can act both as a *proxy* for the assessment of existing governmental institutions and their capacity to acquire information, and because, to a large extent, these municipalities reflect the situation of Brazilian cities in general. Blumenau and Itajaí have 312,000 and 188,000 inhabitants, respectively. In population terms they represent approximately 4.5% of Brazilian municipalities with a population between 100,001 and 500,000 inhabitants, encompassing almost 25% of the Brazilian population. Ilhota is a small town with approximately 12,000 inhabitants. In population terms it represents approximately 25% of municipalities with a population between 10,001 and 20,000 inhabitants, where approximately 10% of the Brazilian population lives. The health services of Blumenau and Itajaí were most overloaded, considering these were the largest cities in the region affected. Ilhota, according to the indicators above, was the most heavily affected city in relation to the size of its population.

Figure 3: Evolution in the number of hospitalizations for Leptospirosis (a), Infectious Diseases (b) Fractures (c) and Stokes (d) in 2008 (continuous line) compared to the average for 2007 and 2009 (broken line) for the municipalities of Itajaí, Blumenau and Ilhota.



It can be observed from the graph lines relating to the number of hospital outpatients that there is an increase in the demand for hospital care with regard to some causes which may be either directly or indirectly related to the November 2008 floods. Leptospirosis is an infectious disease caused by contact with water and urine contaminated with the leptospira bacteria, outbreaks are often registered after flood episodes (Ko et al., 1999; Freitas e Ximenes, 2012). The volume of hospitalizations relating to leptospirosis was small before the November floods, increasing during the subsequent months, only returning to normal levels approximately 6 months after the event. The average for 2007 and 2009 was of one hospital outpatient per month, which can be considered the basal level for a region where the transmission of leptospirosis is endemic.

The total number of hospitalizations due to infectious diseases also saw considerable alteration after the floods. From a level of approximately 120 hospitalizations per month it reaches a maximum of 200, that is, it almost doubles in relation to the reference years (2007 and 2009). Many studies have shown an increase in the transmission of a wide range of communicable diseases (e.g. diarrhoea, respiratory infections, malaria, leptospirosis, measles, dengue, viral hepatitis, typhoid and meningitis) subsequent to disasters, be it due to exposure to contaminated foodstuff, contact with animals, or because the agglomeration of affected and displaced individuals favours the inter-personal transmission of infectious agents (Kouadio et al., 2012; Alderman et al., 2012; Freitas e Ximenes, 2012).

There is also a rise in the demand for hospitalization due to fractures (fracture of the femur and other bones, as well as trauma) of approximately 20% above the reference threshold (2007 and 2009). This increase may have been the consequence of immediate accidents due to collapses and falls during the flood period. However, in the two months immediately after the event, there is a drop in the number of hospitalizations due to fractures. This pattern may have been caused by a reduction in the supply of beds for the residents of the region, given the official limit for hospitalizations ("ceiling") and the temporary closure of some hospital sectors due to the floods. Limits in service provision were observed with regard to other causes of hospitalizations, including birth and perinatal events, areas which must be given due attention in the future planning of emergency actions. The number of hospitalizations due to fractures rose three months after the disaster and remained high, at a level considered above the reference standard, for the next five months, exceeding the number of hospitalizations and surgeries which could be considered selective.

From October onward, that is, a month prior to the floods, there was an above average increase in the number of hospitalizations due to strokes. Figures doubled in relation to the reference years of 2007 and 2009 during the month of November and remained high for the next six months. The response pattern of non-communicable diseases is rarely described in the literature, given that there is no direct relationship with floods and other disasters. However, disasters and the consequent disruption of the lives of those affected, such as the loss of family members, housing and material goods, may trigger stress mechanisms in the cardiovascular system (Dimsdale, 2008). In addition, the collapse of health services may have a negative impact on the diagnosis and treatment of high blood pressure, as well as the interruption of preventive care actions such as the distribution of medication.

Table 2 shows the historical series for leptospirosis in the municipalities of Blumenau, Itajaí and Ilhota during the extreme weather event of 2008 in the state of Santa Catarina.

Table 2 – Number of confirmed leptospirosis cases according to the System of Information and Notification of Health Events (SINAN) in Itajaí, Blumenau and Ilhota

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Blumenau	34	13	28	21	34	18	20	**163**	26	14	41
Ilhota	2	3	2	3	4	1	2	**16**	5	0	3
Itajaí	19	8	12	11	9	7	11	**137**	19	9	23

In 2008, 316 cases of leptospirosis were recorded in the three municipalities most affected, while the aggregated historical average for these municipalities was 40. The exceeding figure of 276 is very much higher than the 24 cases of hospitalization due to leptospirosis as a consequence of floods in 2008, as registered in the SIH. The ratio of one serious case of leptospirosis for a total of 10 cases is in line with results obtained from epidemiological studies (Ko et al., 1999).

Discussion

The 2008 Santa Catarina event revealed a number of important aspects that need consideration with regard to the interaction between the environment and society, in relation to this type of disaster.

With regard to the so-called threats, precipiation data - based on Earth Sciences conceptions and methods - show that an extreme weather event occurred at the end of 2008. This phenomenon enabled us to acknowledge the importance of establishing and strengthening both early warning systems for disasters and the National Centre for Natural Disasters Monitoring and Warning (CEMADEN), under the auspices of the Brazilian Ministry for Science, Technology and Innovation (MCTI). However, it is also essential that there is research and that proposals are made from a Social Sciences perspective so as to improve early warning systems, both with regard to organizational aspects and to enhance processes promoting the involvement and participation of local organizations and communities (Dolif et al., 2012). In the face of disasters such as these, we can no longer disregard hydro-meteorological and climate phenomena. They must be monitored and understood as part of strategic social responses to reduce the risk of disasters, for example by developing early warning systems. However, for these to be effective, it is essential to involve the communities living in vulnerable areas, as well as different sectors of the government and non-governmental organizations, as proposed by the Hyogo Framework for Action (HFA) (ISDR, 2005).

With regard to the development of vulnerable contexts, information on this disaster reveals that most of the municipalities affected were situated in the lower course of Itajaí River and in areas at risk of flooding. Although there was heavy rainfall, this would not have constituted a disaster had not vulnerability conditions been historically construed due to land occupation processes and environmental degradation, as can be observed from a passage of the **Plano Integrado de Prevenção e Mitigação de Riscos e Desastres Naturais na Bacia Hidrográfica do Rio Itajaí** [Integrated Plan for the Prevention and Mitigation of Risks and Natural Disasters in the Itajaí River Basin] (SEDES-SC, 2009):

"*... There is no doubt that the rain triggered the disaster, but it was the vulnerability of the municipalities in face of situations such as these that turned this event into a tragedy. The vulnerabilities observed can be explained by inadequate or inexistent municipal civil defence structures, the municipalities' environmental management practices and urban policies*" (p. 8).

As Rios (2009) observed when analyzing the expansion of urban areas into flood areas in Argentina, we cannot ignore the fact that in disaster situations, natural processes (heavy rains and floods) no longer happen in isolation, but are combined with social processes involving, among other factors, the occupation of environmentally vulnerable areas. Freitas and colleagues (2012) point to the same situation regarding the 2011 disaster in the mountain region of Rio de Janeiro State. Thus, if analysis of occupation and land use forms and environmental degradation, from an Earth Sciences point of view, are essential, it is also fundamental to show and understand, through the Social Sciences, the processes that underpin the dynamics of society in the use and exploration of natural resources and co-related forms of asset and wealth distribution.

Moreover, with regard to vulnerable contexts, data such as death ratios (the number of deaths per total number of inhabitants in a municipality) reveal that the scale of impacts is much greater in smaller municipalities, as in the case of Ilhota, a city the same size as 25% of Brazilian municipalities. Data available from the "2011 Profile of Brazilian Municipalities" (IBGE, 2012) show that in 2011 only 16.3% of Brazilian municipalities had either developed or were developing municipal plans for reducing risks. In municipalities with between 100,001 and 500,000 inhabitants, this figure rises to 49% and in smaller municipalities (up to 20,000 inhabitants), such as Ilhota, this figure was 10.4%. What took place at local level and in particular in Ilhota, (smaller municipality with a GDP per capita similar to the poorest Brazilian states) reveals that this dynamics is widespread. Research shows that countries or cities with reduced socio-economic conditions and little infrastructure are more vulnerable in terms of their institutional capacity to develop disaster risk reduction policies and actions, resulting in the greater impact of these events (ISDR, 2011).

With regard to information sources, despite their different objectives and rationales, analyzing the entire set of data may be useful in order to reveal factors that range from trigger events to prolonged consequences, such as effects on health.

The local and national press are very quick to produce a large volume of quantitative and qualitative data. This can provide a general picture of the health situation and assist in locating affected municipalities (Woodall, 1997). If on the one hand, the media helps in bringing visibility to the immediate effects of events, on the other, perhaps due to the media's market orientation, press articles are quickly substituted by other topics of interest to the readership, thus contributing to the general disregard for lasting effects. The media is not responsible for following up events in the medium and long-term. However, information investigated by the press and sometimes by citizens are posted on the internet and enable us to quickly obtain the population's statements and complaints regarding health problems (Madoff et al., 2011) not recorded on official information systems (Chunara et al., 2012). Similar to other countries (Llasat et al., 2009), it is likely that the fact that the disaster had a major human impact on the Brazilian state with the 2nd best HDI and the 4th largest GDP per capita in the country, may have contributed to the extensive repercussion on public opinion and the wide coverage it received in the local and national press. The press not only covered and published data on the disaster, but also provided estimates about this phenomenon, thus becoming an invaluable source of information, even after accounting for its limitations.

The Health information systems (SIM, SINAN and SIH) are important elements in the analysis of the impact of disasters. However, the publication of this data is delayed by months (SIH and SINAN), at least two months after the disaster (SIM). As this information is part of the routine data of health services, methodological effort is required to sift out the health events which might have been caused by the disaster. Generally speaking, events are characterized by an increase in the volume of outpatient care and records of death above expected historical levels, as well as by some external causes which may be related to the disaster. Due to the way hospitalization records (SIH) are organized and disseminated, they do not reveal the causes for lesions and injuries, only identifying the type of injury which led a person to be hospitalized. It is therefore, impossible to obtain the number of people injured due to the disaster after its occurrence. The large number of people injured, in accordance to the civil defence information system, may have been processed within the health system either as outpatient or inpatient consultations which register the medical procedures adopted and not the causes of the injury. The only means of discerning the impact of disasters on the health system is by observing the higher levels in illnesses and health events taking place during the period of their occurrence and assessed through the analysis of historical series. The detection of an increase in the register of health events requires investing in information technology and quantitative methods which are currently unavailable to local health systems.

If on the one hand, health information systems provide important data, on the other they are restricted by the delay in their publication. Moreover, they do not register a direct link to disasters, even when these relate to immediate effects. Each health problem or disease has its own characteristics of incidence, seasonality and limit of care within the health provision services. The immediate consequences of disasters are a change of these dynamics, which can last a number of months. Furthermore, the disaster affects the performance of the health services themselves, limiting the service's care provision capacity, be these of a routine or emergency nature. These factors must be taken into account when analyzing health data, as they reveal positive aspects and limitations in terms of registering illnesses and injuries related to disasters.

In the specific case of this event, records produced by the Santa Catarina civil defence corroborate with the death records obtained from the health information system and those disseminated by the press. It is likely that civil defence provided information to newspapers. On the other hand, civil defence data have their own institutional validity, determined by this organization's rationale. Officially, according to the legislation in force at the time, estimates were conducted within a time-frame of 120 hours. It is not possible to gather information relating to the medium and long-term effect of disasters on health by using this information system, given that it is not the purpose of civil defence to follow up on the belated effects of disasters.

Some convergence was found between the three sources of information (press, health and Civil Defence) with regard to immediate deaths. However, other effects of disasters on health, such as injuries and lesions, outbreaks of communicable diseases and the worsening of non-communicable diseases are not depicted by all information systems and are difficult to compare.

Generally speaking, the longer the time since the disaster, the more difficult the assessment of health impacts. The medium and long-term effects of these events may be registered in health information systems, though they are not necessarily easy to extract. This is the case, for example, for the worsening of chronic diseases in people directly or indirectly affected by disasters. This may be so for cases such as the observed increase in hospitalizations due to strokes which may be related to the collapse of primary care provision and blood pressure preventive care actions, as well as to other phenomena, such as the negative impact on patients dependent on haemodialysis due to the lack of health resources near their homes. In addition, some communicable diseases have an incubation period of a number of weeks, for example, hepatitis, tuberculosis and leptospirosis, making it difficult to establish their association to climate events (Kouadio et al., 2012). It is also worth highlighting the lack of data on mental health, which although the data available in the information systems and the media is insufficient, it may be the result of stress and depression caused by human and material losses related to disasters. The evolution of these diseases can be gradual and occur within a longer time frame compared to others such as communicable diseases, fractures and traumas.

There are many challenges to overcome in order to further our understanding of the health, social and environmental impacts of disasters, when we consider that their human impacts (including death and diseases) are not limited to immediate after-effects recorded during or just after events. Taking as a reference the three stages of disaster impact, as suggested by Kron et al. (2012), we can argue that the press restricts itself to the immediate post-disaster phase (2 to 7 days), as the disaster affects more areas or becomes more severe, a period of greater activity in terms of response and rescue operations. It is during this phase when more acute effects, traumas and deaths are observed (Redmond, 2005). After the acute phase, investigations on human impact begin and government reports are produced, showing data on deaths and diseases. Most of the data from official agencies, such as the civil defence are restricted to this second phase, which does not usually last over a month. The aim of this article was to contribute to the understanding of human impacts, in particular, the effects on health after this first phase and during the first months after the floods, when the press and official bodies are no longer concerned with updating their records. Even when data on deaths, hospitalization and the notification of diseases, such as those available in health information systems, can be found, they are rarely classified and analyzed for these purposes.

Data on leptospirosis, a disease which is typically used to analyze the health effects of floods (Ko et al., 1999; Barcellos e Sabroza, 2001), together with other infectious diseases, as well as strokes and fractures show the different impacts on health, which may be present even prior to a disaster and continue for a few months, beyond immediate effects and fatalities. Infectious diseases can last longer either through the exposure to contaminated foodstuff, animal contact, or the agglomeration of affected and displaced individuals beyond the first 60 days. The fact that thousands of people remained in precarious shelters for over a year after the disaster, may have contributed to this situation. With regard to strokes, although further investigations are essential, data collected seems to point to an increase above the standard level of hospitalizations in comparison to the period prior to the disaster. This increase may indicate pressures experienced by the population before the event, due to years and decades of previous exposure to disaster risks. Similarly, living in temporary shelters for a prolonged period of time may also contribute to the fact that levels remained higher months after the disaster. Fractures show a slight increase during the recovery and reconstruction period, as people rebuilt their houses and lives. They may also be associated to post-disaster processes.

Data reveal that disaster effects tend to extend in time. It seems that effects can become more widespread and last longer, the slower and the more precarious are rehabilitation services, the recovery of infrastructure and the rebuilding of the lives of communities and affected populations. Thus, the greater and the more prolonged are the conditions of vulnerability, the greater and longer-lasting are the impacts of disasters.

Final considerations

In order to understand the context in which disasters occur, it is important to combine data and information on hydro-meteorological, climate as well as geophysical phenomena (Mata-Lima et al., 2013). However, data, information and knowledge based on the Earth Sciences need to be integrated to other data, information and knowledge produced by the Social Sciences so as to allow important elements underpinning vulnerabilities to be identified and which must be tackled in processes for reducing the vulnerabilities and risks due to natural disasters (Rios, 2009; Freitas et al., 2012; Mata-Lima et al., 2013).

A combination of a myriad of elements which are simultaneously imbricated, ranging from the framework of early warning systems to rehabilitation, recovery and reconstruction policies and actions, to a multiplicity of natural and social processes have a large impact on health which is manifested as illnesses, injuries and even deaths. If we consider that health effects and the information available regarding these effects are an expression of vulnerable (socio-environmental and institutional) contexts which underpin disasters and their impacts, we are compelled to put forward broader conceptions to understand and face extreme weather events as possible generators of disasters.

This work points to a method to assess disaster impacts by focusing not only on immediate, but also on medium and long-term effects. In this way, recovering the health and the lives of the populations on a more secure basis than those observed prior to the disaster can be the result of a joined-up plan. Taking into account the fact that disasters are expressions of specific development models, the assessments and estimates regarding impacts presented in this article become an important tool, not only to increase investment and improve health care, but also to reduce the impacts of disasters, while at the same time develop policies to redirect social, economic and environmental development processes so as to reduce vulnerabilities.

Within this process, 2015 emerges as a promising year in the joined-up discussions and reflections on topics related to development, climate change and on disaster risk reduction. First, the Millennium Goals (MDG) will be substituted by the Sustainable Development Goals (SDG) through the post-2015 Development Agenda. Second, is the Post-Kyoto Climate Change Protocol, third, the new framework to substitute the global platform for disaster risk reduction, replacing the current Hyogo Framework for Action. These provide an opportunity not only for integrating policies, information and knowledge on topics individually addressed, but which are totally intertwined (sustainable development, climate change and disaster risk reduction), but also provide an opportunity for their integration at different levels, from the global to the local. Integrating these different topics and levels in an important step to reduce the impacts of disasters on health, which often transform extreme climate events into real tragedies for many families, through suffering, diseases and deaths.

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EXTREME WEATHER EVENTS AND THEIR CONSEQUENCES ON HEALTH: THE 2008 DISASTER IN SANTA CATARINA TAKING INTO ACCOUNT DIFFERENT INFORMATION SOURCES

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***Resumo*:** O objetivo deste artigo é analisar os impactos a saúde decorrentes do evento climático extremo ocorrido em novembro de 2008 em Santa Catarina. Também são considerados alguns dos processos sociais que se encontram subjacentes aos desastres e seus impactos humanos concretizados em doenças e agravos à saúde. O método consistiu na recuperação e análise de informações oriundas de diferentes fontes (saúde, defesa civil e imprensa), para os principais municípios atingidos pelo desastre. Os resultados demonstram que os efeitos imediatos constituem apenas a parte mais evidente dos impactos que se prolongam ao longo do tempo e expressam as vulnerabilidades sociais, ambientais e institucionais subjacentes aos desastres. Como conclusão aponta-se para as vulnerabilidades que devem ser enfrentadas nos processos de redução de riscos de desastres naturais envolvendo as agendas de desenvolvimento, do clima e da redução de riscos.

***Palavras-chave*:** Evento climático extremo; Desastre natural; Saúde ambiental; Vulnerabilidade.

***Abstract*:** There is trend of increasing the frequency and severity of extreme climate events and related disasters. The objective of this paper is to analyze the health impacts due to the flood occurred in November 2008 in Santa Catarina (southern Brazil) and the underlying social processes behind the disaster. The method consisted in the recovery and analysis of information from different sources (health services, civil protection and the newspapers), for the municipalities affected by the disaster. The results demonstrate that the immediate effects are just one part of health effects that extend over the medium and long term, expressing the underlying social, environmental and institutional vulnerabilities and lack of resilience to disasters. In conclusion we point to the various vulnerabilities that must be addressed to reduce the impact of natural disasters, involving the development agendas, and climate vulnerability reduction.

Key words: Climatic extreme event; Natural disaster; Environmental health; Vulnerability.

Resumen: Se observa una tendencia global de aumento en la frecuencia y intensidad de eventos climáticos extremos y desastres. El propósito de este artículo es contribuir para el análisis de los impactos en la salud resultantes de eventos climáticos extremos, tomando como caso la inundación del noviembre de 2008 en Santa Catarina (Brasil). Se consideran igualmente los procesos sociales subyacentes a los desastres y sus consecuencias en la salud de las poblaciones. Se buscó para este fin la recuperación y análisis de información desde diversas fuentes (salud, protección civil y la prensa) en los principales municipios afectados por el desastre. Los resultados han demostrado que los efectos inmediatos son sólo parte de los efectos, que se extienden a mediano y largo plazos, expresando las vulnerabilidades sociales, ambientales e institucionales por detrás de los desastres.

Palabras clave: Eventos climáticos extremos; Desastres naturales; Salud ambiental.