

# Impacts of social and environmental disasters in western Paraná between 2010 and 2020

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**Abstract:** The objectives of this research are to analyze: a) disaster records in the SISDC/PR system; b) the number of people affected and the inventory of financial damages, in the period from 2010 to 2020, in three of the main municipalities in the western mesoregion of Paraná. The research was carried out through data collection and documentary study, which identified 20 different types of disasters, between natural and technological. Of these, the most frequent were windstorms, floods, and hail. The economic losses were around BRL 372,046,631.73 and, concomitantly, 1,359,599 people suffered from the impacts of these disasters. From these records, risk and disaster management actions can be pointed out to increase the adaptive capacity of these municipalities to climate change and consequently reduce risks and disasters.

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## Introduction

The planet has been suffering from climate change for some time, and these changes have been presenting increasingly more consistently, as reported by citizens and studied by the international scientific community. One of the impacts of these changes are natural disasters, due to the increase in frequency and intensity of extreme events in the last decades (MARENGO, 2013).

According to Silva *et al.* (2016), natural disasters in Brazil are, for the most part, related to the climatic events that are enhanced by human action; these authors highlight a broad relationship between the worsening of environmental degradation, the intensity of the disasters, and the increase of human vulnerability. As indicated by the Atlas de Desastres Naturais do Brasil (Brazilian Atlas of Natural Disasters), the disasters that occur more frequently are: mass wasting, erosion, inundation, torrent, flood<sup>1</sup>, hurricane/whirlwind, hail, drought, tornado, frost, and forest fire (CEPED UFSC, 2013a).

Because they directly affect human beings' health, economy, society and culture, their impacts deserve widespread attention. Thus, the constant reflection on how our cities are being conceived and planned, and which paths can be taken in order to achieve fair and sustainable models become necessary, as well as diminishing the ongoing denial before the financial losses and material damages.

The relationship between Humanity and Nature influences the incidence of natural disasters. The farthest the relationship between humans and environment, in which human beings appropriate natural resources as their owners, as Bacon and Descartes have already traversed, the most quarrelsome is this social and environmental relationship (SAUVÉ, 2005). Researchers like Meira Cartea (2013) have pointed out that, often, human beings don't see themselves as an intrinsic part of the environment, making the change in behavior in order to soften the effects of the worldwide climate crisis harder to achieve.

Thus, the interventions promoted in the environment have been leading to an increase in the amount of natural phenomena, which trigger disasters in several sites on the planet, as shown by a variety of specialists (BECK, 2010; LESKENS *et al.* 2014; GONZALEZ GAUDIANO; MEIRA CARTEA; GUTIERREZ PEREZ, 2020; SUAZO; TORRES-VALLE, 2021). In Brazil, Pereira (2019) points out the lack of human beings' care in exposing extreme events like the disasters in Mariana and Brumadinho, the fires in the Amazon Forest, and floods and landslides in the mountainous region of the state of Rio de Janeiro.

In the state of Paraná, records of the disasters have also significantly increased in many of its districts (PINHEIRO; GARCIAS, 2014). The Coordenadoria Estadual de Defesa Civil do Paraná (CEDEC/PR) (Paraná's State Coordination of Civil Defense) in-

1 - Whilst in English *inundation* and *torrent* are most commonly referred to as *flood*, there are distinctions between these occurrences in Portuguese, with the words *inundação* referring to process where rivers' waters overflow due to rainfall, and *enxurrada* referring to the violent and destructive flow of water due to rainfall. In this translation, *inundation* will be used for *inundação*, *torrent* for *enxurrada*, and *flood* for regular flooding (*alagamento*), aiming to maintain the original work's precision when discussing these events.

licated an increase of 45.65% in the amount of registrations of natural disasters between 2016 and 2017 (PARANÁ, 2018). Moreover, Paraná's western region has been suffering with recurrent tornados, storms, windstorms, floods and torrents, according to the state's Defesa Civil's registers. These disasters' impacts include: illnesses; injuries; deaths; displacements; disappearances and other impacts on people, society, and the environment, as well as damage to property, destruction of goods, loss of services, and environmental, social, and economic degradation.

According to IBGE'S classification, it is observed in Figure 1 that the mesoregion of western Paraná, here analyzed, integrates the microregions of Cascavel, Foz do Iguaçu and Toledo, which have the rivers Piquiri, Paraná and Iguaçu as main divisions.

**Figure 1 – Studied geographical highlighting the municipalities of the Microregion of Cascavel, Toledo and Foz do Iguaçu, in Paraná, Brazil**



Font: Adapted from IBGE's images.

Paraná's western region has an area of 22.851km<sup>2</sup>. Its three biggest cities are: Cascavel, with 332.333 inhabitants and 2.101km<sup>2</sup>; Foz do Iguaçu, with 258.248 inhabitants and 617.7 km<sup>2</sup>; and Toledo with 142.645 inhabitants and 1.197 km<sup>2</sup> (IBGE, 2020).

Still according to IBGE, the mesoregion is determined by social criteria, spatial characteristics and elements of economic origin, and aims to integrate the organization, planning and execution of public functions of common interest.

Among the several factors that influence the disasters' outbreak in urban areas, we can highlight soil sealing, construction densification, heat conservation and air pollution, and soil compaction, silting of rivers, deforestation and fires for rural areas (KOBİYAMA *et al.*, 2006).

As such, it is made clear how much human beings need to internalize the great environmental themes, many still in the construction stage. Even if they demand a certain effort to be understood, these themes reveal how much life is intrinsically reliant on them, which implies in awareness in order to acquire integrationist views on humanity and nature, so as to promote the most needed reflection regarding the construction of meaning in these relationships, as well as on the local and global environmental risks (JACOBI, 2007).

In order to change behavior patterns in such a way that is relevant in relation to the disasters, a culture of resilience and involvement is needed from all parts of social groups, besides the specialists, so as to prevent the occurrence of victims and losses (WARNER; ENGEL, 2014).

According to Sathler *et al.* (2019), in Brazil, the research focused on registering data on the incidences of disasters and the efforts in planning and managing fields are still relatively early, if compared to the volume of information developed abroad.

### **Concept and classification of natural disasters**

Climate events that occur where human beings live, accentuating their processes' causes, that is, when these events arrive at human occupation areas, bringing with them deaths and socioeconomic losses, are referred to as natural disasters. (MOURA; SILVA, 2008; GOERL; KOBİYAMA, 2013). Cardoso *et al.* (2012) add to this by stating that these are events that basically demand analysis dedicated to the prevention and prospection of situations and their aftermaths, given that these are usually sudden and unexpected episodes, and, in general, of significant severity and magnitude, with high impacts on society, as well as consisting of complex environmental events whose understanding and prevention rely on the contribution from several areas of scientific knowledge.

The disasters, according to the Secretaria Nacional de Defesa Civil (Brazilian National Office of Civil Defense), have their classifications, typologies and encodings in keeping with the Codificação Brasileira de Desastres (COBRADE) (Brazilian Disaster Encoding); the International Disaster Database (EM-DAT); and the Centre for Research on the Epidemiology of Disasters (CRED) from the World Health Organization (WHO/UN). The disasters are then classified according to criteria of evolution, intensity, frequency and origin. The types of disasters relating to evolution are: sudden- or of acute evolution- and gradual- or of chronic evolution. As for those relating to intensity are divided in: medium- intensity disasters- Level I- and high-intensity disasters- Level II; those relating to frequency are sporadic and cyclical or seasonal; and lastly, those related to origin are natural and technological, as depicted in Table 1 (CEPED UFSC, 2013b).

Table 1 – Classification of natural disaster

Classification	Types of disasters	Description
Evolution	Sudden Disasters or Disasters of Acute Evolution	Distinguished by the speed in which the process evolves and by the adverse events' violence, may occur in unexpected and surprising ways, or have cyclical or seasonal characteristics, such as landslides, torrents, windstorms, earthquakes, volcanic eruptions, hailstorms and others.
	Gradual Disasters or Disasters of Chronic Evolution	Distinguished by evolving in stages of progressive aggravation, like droughts, erosions or soil losses, such as the collapse of hillsides, environmental pollution, and others.
Intensity	Level 1- medium-intensity disasters	Damages and losses that are bearable and surmountable by the local governments. The situation of normality can be restored with resources mobilized locally or complemented with federal and state contribution. They represent emergency situations.
	Level 2- high-intensity disasters	Damages and losses on which the reestablishment of the situation of normality rely on the mobilization and coordinated action from all three levels of the Sistema Nacional de Proteção e Defesa Civil (SINPDEC) (Brazilian National System of Protection and Civil Defense) and, occasionally, on international help. These would be the states of public calamity.
Frequency	Sporadic	Those which rarely occur, with limited possibility of foreseeing.
	Cyclical or Seasonal	Those which occur periodically, being related to the seasons of the year and the phenomena associated with them.
Origin	Natural	Triggered by nature's phenomena and imbalances. May imply on human losses and other impacts on health, environmental damage, property damage, causing service interruption and social and economic disturbances.
	Technological	Triggered by technological or industrial conditions, including accidents, dangerous proceedings, infrastructure failures, or specific human activities, and may imply on human losses or other impacts on health, environmental damage, property damage, service interruption, social and economic disturbances.

Font: Adapted from Secretaria Nacional de Defesa Civil (2014) (Brazilian National Office for Civil Defense).

The Secretaria Nacional de Defesa Civil (Brazilian National Office for Civil Defense) advise that substituting the Codificação de Desastres (CODAR) (Disaster Encoding) for the Classificação e Codificação Brasileira de Desastres (COBRADE) (Brazilian Disaster Classification and Encoding), fitting the Brazilian legislation onto international criteria - which are actually more simplified- levels the country to other bodies of disaster management on the world, and this standardization on the types of events makes it easier to identify and evaluate the disasters that are occurring in the country.

Thus, within the classification, there are five groups of possible causes for the disasters that are of natural order: geological, hydrological, meteorological, climatic and biological. Whereas the disasters of technological origin are those related to radioactive substances, dangerous products, urban fires, civil constructions and transport of passengers and non-dangerous loads, as depicted on Table 2.

**Table 2 – Disasters’ classification as related to Origin**

Origin	Causes	Examples
<b>Natural</b>	Geological	Earthquakes, tsunamis, earthly tremors, volcanic emanation, landslides, erosion.
	Hydrological	Inundations, floods, torrents.
	Meteorological	Cyclones, storms (tornados, intense rain, winstorms, hailstorms, lighting), heat waves and cold waves.
	Climatic	Dryness, drought, forest fire (parks, APA- areas of environmental protection- and APP- areas of permanent protection), fires on non-protected areas, low air humidity.
	Biological	Epidemics (viral, bacterial, parasitic or fungal infectious diseases) and pest infestation (animals and vegetables).
<b>Technological</b>	Disasters Related to Radioactive Substances	Satellite crashes, release of radioactive waste on the environment.
	Disasters Related to Dangerous Products	Release of chemical products on the atmosphere and on drinkable water systems, water contamination through the spillage of chemical products, transport of dangerous products.
	Disasters Related to Urban Fires	Fires on industrial plants and districts, parks and deposits, fires on residential clusters.
	Disasters Related to Civil Construction	Building collapses, dam breakage and collapse.
	Disasters related to transport of passengers and non-dangerous loads	Traffic accidents (road, air, rail or sea), work accidents).

Font: adapted from COBRADE’s Classification.

## Objective

As per the delimitations conducted previously, the main objective of this research is to analyze the main occurrences and their human and economic damages that happened, in a period of ten years, on the three main districts in the western Paraná mesoregion, represented by Cascavel, Toledo and Foz do Iguaçu, aiming to enable researchers on the Rede Internacional de Pesquisa Resiliência Climática (RIPERC) (International Network for Climatic Resilience Research) and the postgraduate programs in Sustainable Rural Development at the Universidade Estadual do Oeste do Paraná (Western Paraná State University), to which this study is attached, to have the possibility to contribute with establishing more effective public policies, and environmental education works as a measure of facing climatic emergency, mitigation and adaptation measures, and the improvement of society's behavior in the pursuit of making its territories intelligent and resilient.

## Material and Methods

This research is set as a quantitative documental research (GIL, 2008). It has been carried out through collecting data in the Sistema de Informações de Defesa Civil – SISDC PR (Civil Defense Information System) website, since this body is responsible for the actions that aim to prevent, mitigate, prepare and answer to the disastrous events' consequences and aid the affected populations, recovering the social well-being of the damages caused (MATO GROSSO, 2021). It must also be stressed that the choice for one single data bank, being the most local, is related to the fact that it is more detailed than banks of national and worldwide scopes, for the same region (LIXIN *et al.*, 2012).

Through a username and password, provided by Defesa Civil de Cascavel – PR (Cascavel- PR Civil Defense), the access to internal reports of three districts in western Paraná from SISDC/PR was made possible. Based on this data, it was sought to compile and measure the most recurrent extreme events, the amount of people affected by them, as well as the financial losses, within the period covering the years 2010 to 2020.

## Results and Discussion

### Disaster occurrences registered in western Paraná (2010-2020)

The occurrences are registered according to the technical analysis of the members of the Defesa Civil, that is, they are registered from the moment that the event is considered significant, according to the occurrence's severity or if there is even a single material or human damage, since, as stated by the referred institution, the frequency of the registered occurrences provides conditions to monitor the events' recurrences, supplying an indication of the alterations that are happening in the environment.

Thus, the analysis of the reports provided by the fourth and ninth Coordenadoria Regional de Proteção e Defesa Civil do Paraná – CORPDEC (Paraná's Regional Coordination of Civil Protection and Defense), agencies responsible for the studied districts,

resulted in 183 disasters (of those, 146 being of natural occurrence, and 37 technological) of 20 different types in the analyzed period.

Of those 20 types, 11 are natural disasters, namely: Local/Convective Storm-Windstorm; Local/Convective Storm- Hailstorm; Flood; Torrent; Drought; Infectious Viral Disease; Local/Convective Storm- Thunderstorm; Local/Convective Storm- Heavy Rainfall; Inundation; Local/Convective Storm- Tornado; Forest Fire- on Parks, Áreas de Proteção Ambiental (APAs) (Environmental Protection Areas); Áreas de Proteção Permanente (APPs) (National Permanent Preservation Areas), state or local.

Nine types are technological disasters: road transportation of dangerous products; spillage of chemical products in lacustrine, fluvial, marine and groundwater environments; road transportation of passengers and non-dangerous loads; building collapses; fires on residential clusters; release of chemical products in drinkable water systems; fires on industrial plants and districts, parks and deposits; release of chemical products onto the atmosphere caused by explosion or fire; and air transportation of passengers and non-dangerous loads.

It is worth noting that until the 1970s, the disasters were seen as extreme events of nature, and society as merely the spectators of what was happening. From the 1980s onward, another perception was acquired, that being that the disasters were consequences of a relationship between threat and social vulnerability, noting that the conditions for society's existence strongly imply on the level of destruction caused by the natural events (CEPED UFSC, 2013a).

Toward the end of the 1990s, the perception that society's growth's processes interfere with and modify the threat's patterns. Thus, natural disasters are seen today as products of the unsustainable social-environmental development that human beings have been establishing with the environment in recent years (CEPED UFSC, 2013a).

However, in the same way that society's behavior can generate new disaster risks, human development can also be reassessed and planned with the intention to contribute to their reduction. Thus, discussions and pursuits for strategies to tackle global challenges on climatic emergency and security and its impacts on the numerous life forms emerge, in order to avoid social damage and vulnerabilities, on risks and disaster management, as well as the idea of transforming the districts into safe and sustainable territories.

Table 3 displays the results collected on the natural disasters on the analyzed districts, throughout the considered time interval.

**Table 3 – Natural Disasters’ Frequency**

Position	EVENTS	Frequency		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
		Amount of times	%											
1st	Local/ Convective Storm-Windstorm (C*-F-T)	81	55.5	2	5	11	-	3	8	7	10	14	11	10
2nd	Flood (C*-F-T)	23	15.7	2	2	-	-	2	2	-	2	5	4	4
3rd	Local/ Convective Storm-Hailstorm (C*-F-T)	15	10.3	-	2	1	-	3	5	1	-	1	1	1
4th	Torrent (C*-F-T)	11	7.5	-	-	-	3	2	-	1	4	1	-	-
5th	Infectious Viral Diseases (C*-F-T)	6	4.1	-	-	-	1	-	-	-	-	-	-	5
6th	Drought (C*-F-T)	4	2.7	-	-	3	-	-	-	-	-	-	-	1
7th	Local/ Convective Storm-Heavy rainfall (C*-F)	2	1.4	-	-	-	-	2	-	-	-	-	-	-
8th	Local/ Convective Storm-Thunders-torm (C*)	1	0.7	-	-	-	-	-	-	-	-	-	1	-
9th	Forest Fires-on Parks, APA and APPs National, state or local (C*)	1	0.7	-	1	-	-	-	-	-	-	-	-	-
10th	Inundation (F*)	1	0.7	-	-	-	1	-	-	-	-	-	-	-
11th	Local/ Convective Storm-Tornados (T*)	1	0.7	-	-	-	-	-	-	-	-	1	-	-

Font: Adapted from SISDIC – PR.

Note\*: The letters C, F and T refer to the cities of Cascavel’s, Foz do Iguaçú’s and Toledo’s initials. Whenever they are present, they indicate the occurrence in that district.

It can be observed, according to Table 3, that the most recurrent event on the three districts was the local convective storm. This climatic event's character is related to the humidity and high temperatures on local scales. In this category, some associated events may occur, such as convective storm - windstorm, convective storm - hailstorm, convective storm - thunderstorm, convective storm - heavy rainfall, and convective storm - tornados, as described at COBRADE.

The research showed that all of the events in table 3 were registered at least once through the ten years analyzed, with convective storm-windstorm having 81 registers (55.5%). Of these, 38 occurred in Cascavel, 32 in Foz do Iguacu and 11 on Toledo.

This result confirms the study done by Fonseca and Ferentz (2017), which also presents windstorm as the event with the most occurrences on the western mesoregion of the state between 2013 and 2017, being an intense movement of air on the earth's surface due to instabilities on the atmospheric pressure's gradient (CASTRO, 2003).

The event convective storm - hailstorm obtained 15 registers (10.3%), with the district of Cascavel being the most affected, with 7 registers, Foz do Iguacu, 6, and Toledo, 2 registers.

Regarding the thunderstorms, only one register was found (0.7%), in the district of Cascavel. Heavy rainfall, twice (1.4%), on Cascavel and Foz do Iguacu, and tornado, only once (0.7%), on Toledo.

Although a tornado was only verified on the district of Toledo, it is worth mentioning that, on Marechal Cândido Rondon, a city also belonging to western Paraná, while not a part of the research in question, was affected by a tornado in 2015, which brought damages to the residences, grain storage silos and poultry farm roofs, in addition to damages on industries, which arose the urgency on finding mechanisms for resilience on the district, since the damages amount to 91 million Brazilian reals (HORNES; BALICKI 2018). These data have contributed to Balicki *et al.* (2020) pointing out that the storms on western Paraná promote windstorms, tornados and hailstorms.

Hailstorm was the third most occurring phenomenon in the studied area (10.3%) and it is characterized by the precipitation of water on its solid state, which can cause several damages. The records occurred in the three districts between the months of July to November, with prevalence in the month of October. However, the event that occurred on the 7th of September of 2015 on Foz do Iguacu was studied by Riquetti *et al.* (2018), who verified falling trees, several damages on properties and structures of schools and nurseries, with 95% of the roofs of the houses on a southern area neighborhood falling, and school closure, leading the city to declare state of emergency. As per agriculture, the damages happened on all vegetable structures (leaves, flowers and fruit), which can lead to plant lodging, bearing with it major financial loss (AGOVINO *et al.*, 2018).

According to Caldana *et al.* (2020), in the period between 1986 and 2016, the weather stations in the region also registered a high frequency of hail on western Paraná, presenting the city of Cascavel as the most affected, registering 7,704 damaged houses. The great constant of this event is justified not only by the meeting of the polar air masses with the hot continental masses of high humidity air, but also and mostly, to the region's

altitude, with 100m of Paraná River's (Foz do Iguaçu) channels rising to 800m on the Cascavel region in few kilometers, influencing the formation of this kind of storm.

Flood was the second most identified in the region, with 23 occurrences (16%). On Cascavel, there were 5 registers between 2015 and 2020, 13 registers on Foz do Iguaçu, and only 1 on Toledo in 2011, appearing on essentially all of the years, except in 2013 and 2016. In correlation to these events, there is also inundation, registered only on Foz do Iguaçu, and torrents, which appear on fourth place (7.5%) among the most frequent events in the region, happening more times on Foz do Iguaçu as well.

The intense urbanization process makes it so problems on urban drainage appear, especially through soil sealing and maintenance and obstruction of galleries, bringing these events' incidence as a consequence. That is the case of Foz do Iguaçu: even with a vast green area in its territory, it is a district that suffered with heavy rainfall, having the Juscelino Kubitschek avenue as the most affected area of the city, which is located on a lower point of the land, acting as a natural passageway for rainwater (SILVA, 2015).

Bessa Junior (2011), when analyzing the occurrences of natural disasters on Paraná between 1980 and 2011, also pointed out the presence of torrents and inundations at 8% and 14% respectively, including in the city of Cascavel. This city, inserted on a region with many watersheds and micro watersheds on its territory, has several paths that take the places of tributaries, which causes the population to suffer when there's intense rain. This demonstrated the need for good planning for urban development, preferably before the growth and consolidation of new urban areas (CAMPOS; DIAS, 2020).

In the fifth position, viral diseases appear, with six registers (4.1%). Of those, one happening in Cascavel and one in Toledo in 2020, and four in Foz do Iguaçu, with three in 2020 and one in 2013. The reports do not distinguish the names of the diseases, but most likely, the events indicated in 2020 relate to Covid-19, since they were registered between March and April, precisely when this new disease began to be registered throughout the entirety of Brazil, becoming a worldwide pandemic. One of the possibilities for the Civil Defense not having made other registers throughout 2020 is the fact that the opening of the occurrence on SISDC as soon as it happens and its bolster until the end is necessary. However, this biological disaster is still on course, and without predictions to be over. On the other hand, Foz do Iguaçu was the only district that indicated viral diseases in the year of 2013, probably referring to the dengue epidemic that happened on the border region with Argentina and Paraguay in that year (MEIRA *et al.*, 2021).

Next, we have drought, with four registers (2.7%), occurring mostly in the year of 2012, and making a comeback in 2020. This event is related to the intense reduction of hydric precipitation, with loss of soil humidity being superior to its reposition. The alterations of the hydrological networks and rainfall regimes, as well as the alterations of vegetation cover, are determinants for this phenomenon's occurrence (KOBİYAMA *et al.*, 2006). In western Paraná, this event is quite worrisome, since this region makes high investments on animal and agricultural production, being strongly reliant upon these activities, thus suffering financial damages when struck by drought.

Lastly, just as with thunderstorms, inundations and tornados, we also had only one

register of forest fire (0.7%), in the city of Cascavel in August 2011. This data corroborates with those from Vosgerau *et al.* (2006) and Tetto *et al.* (2015), which allege that forest fires on Paraná are concentrated between July and September, and that is because of the combination of low precipitation and relative air humidity with the practices of cleaning and preparing of the soil for agricultural planting this time of the year.

The Corpo de Bombeiros do Paraná (2020) (Paraná's Fire Force) informs that the fact that this drought period exists along with a large area destined to the agriculture and a big part of Atlantic Forest preserved in the state, makes it easier to create fire spots. Thus, anthropic action should be handled with care, since many fires start with the disposal of cigarettes in improper places, poorly put out bonfires, cleaning burns of wasteland and release of Festa Junina<sup>2</sup> balloons.

### People affected and human damage

According to the collected data referring to the people affected by the disasters on the studied period, a total of 1,632,841 people was obtained by adding the three districts and all of the collected disasters (natural and technological). However, when analyzing each district separately and only the natural disasters, it is verified that there were 683,824 affected people on Cascavel, 555,723 on Foz do Iguaçu and 120,052 on Toledo, making up a total of 1,359,599 people that suffered with the impacts of these disasters.

It may also be observed that, according to the following Table 4, that the disaster that caused the most victims (630,840), obtaining a rate of 86,036 people per 100,000 inhabitants, was of the local/convective storm- windstorm type, which, apart from being an intense phenomenon, was also the most registered in the region. Fonseca and Ferentz (2017) registered 1,057,172 people affected due to the occurrence of windstorms on Paraná between 2013 and 2017. These data align with Castro (2003), who affirms that, apart from being the most recurrent disaster in the state of Paraná, it is also the one that brings the biggest consequences and damages, with falling roofs, destruction of buildings, falling trees and power poles, destruction of plantations, injured people, and even fatalities.

**Table 4 - Number of people affected on each modality of occurrence on the three districts**

Occurrence	Affected people			Total	Rate/100,000 inhabitants
	Cascavel	Foz do Iguaçu	Toledo		
Local/Convective Storm-Windstorm	192,549	437,913	378	630,840	86,036
Drought	334,573	10,000	119,353	463,926	63,271

2 - Festa Junina or Festa de São de João is a traditional Brazilian celebration occurring on late June. Among the many traditions of this holiday, there is the release of a specific kind of balloon that constitutes an environmental hazard due to being prone to catching fire.

Local/Convective Storm-Heavy Rainfall	150,050	710	0	150,760	20,561
Local/Convective Storm-Hailstorm	5,250	63,264	130	68,644	9,361
Floods	166	25,836	0	26,002	3,546
Torrents	80	16,795	120	16,995	2,317
Infectious Viral Diseases	1,048	471	69	1,588	216
Inundations	0	734	0	734	100
IForest Fires- on Parks, APA and APPs National, state or local	100	0	0	100	13
Local/Convective Storm-Thunderstorm	8	0	0	8	1
Local/Convective Storm-Tornados	0	0	2	2	0,25

Font: Adapted from SISDC- PR.

Drought and heavy rainfall were registered in second and third places (Table 4), affecting 463,926 people (63,271/100,000 inhabitants) and 150,760 people (20,561/100,000 inhabitants), respectively. Despite being two events with low verifications, it can be noticed that, when there's extreme excess or scarcity of water, there are also many damages originating from it. While heavy rainfall causes disorder in the city, material damage, collapses and landslides may leave behind injuries and fatalities (DERECZYNSKI *et al.*, 2017). Drought affects several activities that diminish the quality of people's lives, since it damages the water supplies, personal hygiene and irrigation (ESPÍNDOLA; NODARI, 2012).

Subsequently, there is local/convective storm- hailstorm, floods and torrents, with expressive amounts of affected people, demonstrating how rainfall truly causes damage where they appear. According to Marengo *et al.* (2011), the rise in temperature related to climate change causes enormous evaporation of the water supplies, triggering rainfall with intensities capable of affecting entire cities in a short period of time, even if not occurring frequently.

In regards to the infectious viral diseases- that, although were of little register on the reports, due to reasons already mention though this work, it is informed 1,588 affected people, complementing here that, according to the Secretaria de Saúde do Paraná (Paraná's Secretariat of Health), only Covid-19, in the period between March and December 2020, affected 413,412 people and lead to 7,912 mortalities on the state (PARANÁ, 2020).

Other occurrences such as inundations, forest fires, thunderstorms and tornadoes appeared much less in relation to the other disasters, and that is due to the fact that they occurred in small numbers.

It is valid to mention that, although the human and financial damages were not accounted in detail due to occurrences- according to the reports from the SISDC System from Paraná's Civil Defense, these incidents were only accounted for after early 2013, when they dropped the printed format and went digital-, these data are related generically and approximately, therefore being valid to add them here for a better understanding of the losses.

Thus, there was a record of 6,752 displaced people, 629 shelterless, 62 sick, 40 injured and 2 that passed away, due to the disasters registered during the studied period. To better understand the severity of this theme, in the last 40 years, more than 3.3 millions of deaths due to these disasters were registered in the world (MINERVINO; DUARTE, 2016). As per the economic damages, they will be presented in the following section.

### Financial damage

Data collected from the SISDC/PR reports on total financial losses (private and public) after the occurrence of extreme events on each district reveal amounts of: R\$321,106,812.70 on Cascavel, R\$49,756,285.83 on Foz do Iguaçu and R\$1,183,533.20 on Toledo, making up the sum of R\$ 372,046,631.73.

The event called local/convective storm- windstorm, besides causing several environmental, material and human damages, also leads to high financial losses where it occurs. Reinforcing this information, Fonseca e Ferentz (2017) registered a financial loss of R\$200,582,780.11 when studying the occurrence of windstorms on Paraná between 2013 and 2017.

According to Espíndola and Nodari (2012), drought affects several economic activities such as agriculture, livestock, industries and power generation. Considering losses around US\$ 6 billions on agricultural production on Brazil's northeast region between 2010 and 2015 due to drought (MARENGO *et al.*, 2017), this event draws a lot of attention, since western Paraná has the aggravating circumstance of being the region of state with the highest grain production.

The main financial damage caused by natural disasters lie, in general, on the losses or reduction of agricultural crops, losses of livestock or reduction of animal production, milk production, and delay of the slaughter season, besides damages on the agricultural industry, industrial activities, commerce and provision of services (MINISTÉRIO DA INTEGRAÇÃO NACIONAL, 1999).

According to the Global Assessment Report of 2015 (GAR, 2015), an investment of US\$6 billions on strategies for disaster risk management would bring benefits in terms of risk reduction of US\$360 billions. It is noted in this context that efforts employed on prevention and adaptation can reduce billionaire losses and losses of lives (BARCELLOS *et al.*, 2016).

Complementing these data, according to the World Bank (2020), between 2000 and 2010, the financial losses triggered by natural disasters have amounted to 1 trillion

dollars around the world.

These numbers lead to reflect on how much is lost or was stopped from being invested on other fundamental areas like health, education and infrastructure had the disasters not occurred or had they been minimized, thus contributing to the development of Paraná's western region. This also shows that disorderly population growth on the cities, as well as the economic development model that contemporary society has been adhering to, are unsustainable and bring with them an increase on environmental, economic, social and political risks insofar as climatic emergencies continue to be unstable on the planet.

### **Conclusion**

Bearing in mind the data and analysis present and discussed previously, and the spatio temporal scope, this study allowed us to scrutinize the range of the disasters occurred on western Paraná, specially those of natural origin, showcasing that the most registered occurrences in the analyzed period were those of windstorm, followed by flood and hailstorm, whilst those that affected the most people were windstorm, drought and intense rainfall. Besides that, the study enabled the reflection on the high financial value that is spent to recover the material damages caused by the disasters, besides the human damage that cannot be valued.

It was also sought to supply elements for debates on the theme, through the compilation of data and provision of information related to the disasters, as well as to assist managers and research groups in planning for social and environmental actions, allocating resources and preparation of teams with the purpose of making the districts, and especially the cities on the western mesorregion, more resilient.

The results come to highlight the need for the development of researches and actions that lessen the disaster's effects, seeking more sustainable answers for the coexistence between society and the environment, not only through structural measures, like infrastructure construction, but, also and mostly, with non structural measures like education, public policies and territorial planning, since the disasters tend to intensify with the climate crisis.

It is suggested that similar studies be carried out on other districts in the region with the aim to enhance the knowledge and identify more localized effects of natural and technological disasters, providing more support to the risk management capacity in western Paraná. It is understood that the assembly of these studies and information can diagnose the existing public policies' efficacy on their desirable effects, reinforcing the need for tools such as Environmental Education on the creation for educational agendas aiming to change the citizens, businessmen, farmers and public managers' stances in relation to their means of being and producing, as well as the respective impacts of their actions on the environment, seeking resilience on the field of natural disasters.

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# Impactos dos Desastres Socioambientais no Oeste do Paraná entre 2010 e 2020

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**Resumo:** Os objetivos dessa pesquisa são analisar: a) os registros de desastres no sistema da Defesa Civil SISDC/PR; b) o número de pessoas afetadas e inventário dos danos financeiros, no período de 2010 a 2020, em três dos principais municípios da mesorregião oeste paranaense. A pesquisa foi realizada por meio do levantamento de dados e estudo documental, que identificaram 20 tipos diferentes de desastres, entre naturais e tecnológicos. Desses, os mais frequentes foram vendaval, alagamentos e granizo. Os prejuízos econômicos foram da ordem de R\$ 372.046.631,73 e, concomitantemente, 1.359.599 pessoas sofreram com os impactos desses desastres. A partir desses registros podem-se apontar ações de gestão de riscos e de desastres para aumentar a capacidade de adaptação dos referidos municípios às mudanças climáticas e consequente redução dos riscos e dos desastres.

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**Palavras-chave:** Mudanças Climáticas; Prejuízo; Registros; Defesa Civil; CEPED Unioeste.

# Impactos de los desastres socioambientales en el Oeste de Paraná entre 2010 y 2020

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**Resumen:** Los objetivos de esta investigación son analizar: a) los registros de desastres en el sistema de Defensa Civil SISDC/PR; b) el número de personas afectadas y el inventario de daños financieros, de 2010 a 2020, en tres de los principales municipios de la mesorregión oeste de Paraná. La investigación se llevó a cabo a través de la recopilación de datos y el estudio documental, que identificó 20 tipos diferentes de desastres, tanto naturales como tecnológicos. De ellos, los más frecuentes fueron las tormentas de viento, las inundaciones y el granizo. Las pérdidas económicas ascendieron a 372.046.631,73 reales y, al mismo tiempo, 1.359.599 personas sufrieron los impactos de estos desastres. A partir de estos registros, se pueden identificar acciones de gestión de riesgos y desastres para aumentar la capacidad de adaptación de estos municipios al cambio climático y, en consecuencia, reducir los riesgos y desastres.

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**Palabras-clave:** Cambio Climático; Daños; Registros; Defensa Civil; CEPED Unioeste.