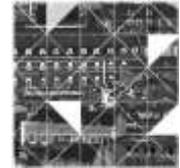

CIDADES, Comunidades e Territórios



Disaster Preparedness Indicators: an application in the state of Paraná, Brazil

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Abstract

The present project is part of a planning study for structuring resilience in disaster risk reduction in cities. The objective of the article is to evaluate the capacity of municipal managers in terms of preparation for the occurrence of disasters. The article opted for an exploratory study, with the application of 10 interviews with specialists in risk management and disaster protection and civil defense. Ten municipalities were adopted in Paraná, in the south of Brazil, which had critical occurrences recorded between August/2016 and August/2017: hailstorms, storm tides (floods), runoffs and gale. The article provides how different municipalities deal with disaster preparedness, with a clear need for greater social and cultural involvement in their activities. Each municipality has its own characteristics in risk and disaster management. Therefore, researchers are encouraged to apply the methodology in other cities in Paraná. The document includes implications for the development of indicators that allow public managers to monitor risk and disaster management in communities, minimizing the negative impacts suffered by the local population. The document includes implications for the development of indicators for the other risk and disaster management stages. This document addresses a need identified in Brazil to study how municipal managers deal with preparation for extreme events, which are increasingly common in their cities.

Keywords: Indicator, preparation, risk management, disaster management.

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1. Introduction

The uncertainty about the occurrence of disasters triggered by natural events is a constant in the lives of thousands of people around the world. Storms, floods, earthquakes, tidal waves, volcanoes, etc., are events known to take lives and cause calamity and chaos in society. Historically, there are several examples in which humanity was affected in an almost cataclysmic way, such as the cases of the eruption of Vesuvius, which caused the destruction of Pompeii, and the tsunami in the Indian Ocean (2004), which claimed about 225,000 lives (Hancock, 2015).

The disasters triggered by natural events have different types of magnitude, from small damages in restricted areas, to devastating occurrences that affect several countries simultaneously. Worldwide, about 75% of the population lives in regions that have already been hit by disasters (UNDP, 2004). These areas are found mainly in developing countries, such as Asia and the Americas for example. This proves the influence of socioeconomic conditions in relation to the concentration of the population in risk regions (CRED, 2014). In this scenario, Brazil is among the countries most affected by disasters in the world (Shi, & Kaspersen, 2015).

Furthermore, in Brazil, the increasingly frequent occurrence of disasters – be they natural or technological – in cities started to demand that public management turn their attention to the problem. In this context, and within the scope of federal legislation, a great advance was made from the promulgation of Federal Law n°. 12,608, of 2012, which instituted the National Policy for Civil Protection and Defense. That law brought a series of obligations to public entities regarding the management of cities and the occurrence of extreme events.

For the reduction of the impacts triggered by disasters to occur efficiently, it is of utmost importance to adopt strategies that contemplate all the dimensions of the damage and the needs of the affected populations (Fonseca, & Ferentz, 2020), such as the PPRR program (prevention, preparedness, response and recovery) of Australian emergency agency (Cronstedt, 2002). Preparation, for example, is configured as the adoption of measures listed during the prevention process, combined with the need to gather means so that society, in general, can act in order to reduce losses and damages as a result of critical events (Pinheiro, 2017).

The preparation is one of the main pillars for reducing the risk of natural disasters in vulnerable areas, as it allows the response mechanisms to function properly, preventing the destruction caused by these phenomena to be greater. Another factor that indicates the importance of preparation is the positive effect of raising the population's awareness in areas at risk (Kapucu, 2009; Fonseca, & Garcias, 2020).

Based on this circumstance, the application of an indicator can offer perspectives so that it is possible to measure not only the implementation of disaster preparedness actions, but also to know their dimension and peculiarities as a list of activities to be developed by municipal public managers. The development of indicator systems has the main objective of mapping the strengths and weaknesses of the physical and community complex of the municipalities, with the objective of outlining strategies and outlining decisions in order to achieve greater resilience and reversal of risks and vulnerabilities in infrastructures and communities.

Such knowledge creates conditions for the planning to take place in a more appropriate way and the National Policy for Civil Protection and Defense is effectively implemented in Brazilian municipalities. Thus, the object of study of this work is the evaluation, through the Preparation Indicator, in the Paraná municipalities affected by disasters in the period from August/2016 to August/2017, in order to assess the situation of disaster preparedness triggered by events and to understand and ascertain the positive points and the deficiencies that the structure presents in the municipalities.

2. Disaster Preparation

Disaster preparedness is often associated with other components that make up the so-called disaster cycle or global civil protection and defense actions. This set usually starts with disaster prevention and disaster risk mitigation prior to preparation, which is followed by response and recovery actions. This is how the United Nations

Development Program describes it by presenting risk and disaster management as the set of these components (Table 1).

Table 1. Comprehensive disaster risk management process

Risk and Disaster Management			
Risk management		Disaster Management	
Prevention/Mitigation	Preparedness	Response	Recovery
Reduce or limit vulnerabilities	Contingency plans, training, simulations, monitoring, alert, alarm	Relief and assistance to the affected population, rehabilitation of scenarios	Recovery of essential services, relocation of people, reconstruction

Source: UNDP, 2013.

In the legislation in force in Brazil, the National Civil Protection and Defense Policy (PNPDEC) covers prevention, mitigation, preparation, response, and recovery actions aimed at civil protection and defense (Brazil, 2012). In risk management, prevention represents the identification of risks and the ways necessary to reduce or prevent them from occurring; mitigation is the step of reducing the negative effects found in relation to natural, technological threats and environmental degradation; and preparation consists of activities and measures to be taken in order to provide means for people and organizations to reduce losses and damages during events. In disaster management, the answer is based on the directions, mobilizations, and strategic action that must be carried out quickly, in order to intercept and reduce the damage that disasters can reach; while recovery consists of decisions and actions taken immediately after the disaster, to improve and restore the conditions of the affected community (EIRD/UN, 2004).

The country has some essential tools to assist in community preparedness and the effectiveness of response actions. The Disaster Information Form (FIDE) is an instrument available in the Civil Defense System (SISDC), which assists in monitoring disasters. The forms contain information about the type of disaster, the affected area, and the damages. The Contingency Plan has instructions on the actions to be taken during the events. According to Law 12,983 of 2014, the plan must inform the responsibilities regarding response, emergency, and simulates; the registration of technicians and volunteers; the provision of warning systems; and the location of logistics centers for receiving and distributing resources (Brazil, 2014).

The need for planning in civil protection and defense in the municipalities, made Pinheiro (2015) organized part of the knowledge contained in the Civil Defense Planning Manual (Castro, 1999), subdividing disaster preparedness in: institutional development; human resource development; scientific and technological development; culture change; business motivation and articulation; epidemiological information and studies on disasters; monitoring, alert and alarm; operational and contingency planning; planning to protect populations against focal risks; mobilization; equipment and logistical support.

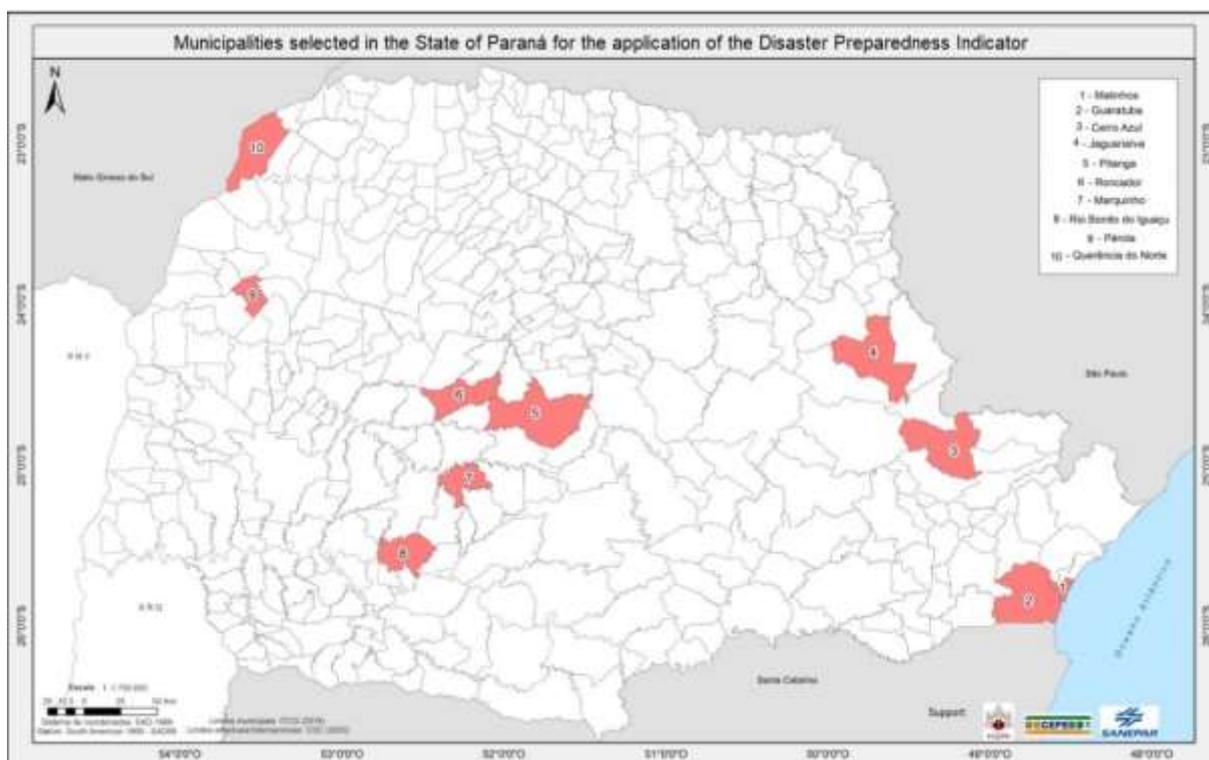
Currently, more and more methods and practices of preparation are being discussed to face natural disasters arising from climate changes that affect the entire planet. Recurring events cause serious damage to people, cities and, consequently, the economy. Thus, the risk of disasters is a cause for concern and has led to the construction of new principles and standards that seek to reduce the damage caused, with preparation being one of the best ways to avoid them. This stage involves a complex set of actions which, integrated with disaster risk management, can reduce the intensity of the impacts caused by disasters in cities. This is only possible when the components of the preparation are defined, measured, and evaluated in line with the responsible institutions, their competencies, and priorities.

3. Methodology

The Preparation Indicator was applied in a sample cut between August 2016 and August 2017. Ten municipalities in the state of Paraná, Brazil, were selected, which had extreme events in this period. According to data from Paraná Civil Protection and Defense, 364 occurrences were recorded in 167 municipalities, resulting in more than 155 thousand affected people. Civil Defense records all types of disasters, whether they are of natural or technological origin. However, in the analyzed period, the greatest occurrences refer to disasters of natural origin. The disaster events with the greatest occurrences are gales, runoffs, floods, landslides, and hailstorms. Disaster events with the highest occurrences are mainly gales, followed by floods, landslides and hail storms.

In the same period, 20 disasters resulted in an Emergency Situation Decree, when state aid is needed to recover local damage, accumulating losses more than \$10 million. For the application of the indicator, the selected municipalities had an Emergency Situation Decree, which were: Cerro Azul, Guaratuba, Jaguariaiva, Marquinho, Matinhos, Pérola, Pitanga, Querência do Norte, Rio Bonito do Iguaçu and Roncador (Figure 1).

Figure 1. Location of participating municipalities



Source: the authors.

Structuring the Indicator

The Preparation Indicator was developed by professors and students of the Postgraduate Program in Urban Management, from the Pontifical Catholic University of Paraná, and professionals from the University Center for Studies and Research on Disasters, along with the discipline of “Disaster Risk Reduction in Cities”, in celebration of the Term of technical-scientific and financial cooperation of the Paraná Sanitation Company.

The indicator begins its structuring in the evaluation of the 11 variables of Pinheiro (2015). The Dimension of Institutional Development refers to the set of characteristics formally instituted and subject, therefore, to

documentary confirmation, which allows to evaluate the level of development of the local government through its strategies adopted to cope with the theme Disaster Risk Reduction. Human Resources Development is the set of actions triggered by the local government and its results in order to develop capacities and leaderships for disaster risk management and resilience.

Scientific and Technological Development deals with how the public authorities are seeking to associate their needs and responsibilities with academia, research institutes, also inserting the adoption of Information and Communication Technologies (ICT) to improve risk communication and interactivity with the community and sectors related to the theme. Cultural Change is the set of strategies triggered by the coordination or sectoral body, jointly or separately, but, in an orderly and integrated manner, aimed at developing the contact of people, sectors and institutions with the theme of disaster risk, providing the creation of a critical and collaborative view on the subject, characterizing changes in the population culture.

Motivation and Business Articulation are existing strategies to provide the business environment with awareness about the impact of disasters and knowledge of risks related to many aspects that directly or indirectly affect its activities. The Information and Epidemiological Studies on Disasters deal with the existence of a strategy instituted to better know the events that occurred and the results of their investigation, recording and disseminating data and information capable of influencing decision-makers and public policies directly or indirectly affected by disasters.

Monitoring, Alert and Alarm consists of the existence, operation and effectiveness of systems aimed at monitoring threats, alerts of potentially triggering events of natural or technological disasters and mechanisms of activation of the population and buildings exposed to these threats, located in risk areas, in order to reduce impacts by increasing preparedness. On the other hand, Disaster Risk Reduction Planning, Civil Protection and Defense and Resilience refers to the existence of updated plans: municipal protection and civil defense plan, local resilience plan, contingency plans.

The Strategies for the Protection of Populations against Focal Risks are the set of actions aimed at protecting the population inserted in disaster risk areas, in order to reduce the impact or create conditions for the elimination of risk. Mobilization is the capacity of activation and participation through the engagement of sectors essential for joint action during the stages corresponding to the set of protection and civil defense actions, especially in the response. The Equipment and Logistics Support is the set of measures to meet through the location, contacts, mobilization and other necessary measures, the needs resulting from a disastrous event.

The score of the indicator was conditioned to the existence, or not, of the subitem in the municipality in question, and the final score was in the sum of all the sub-items of each theme. That is, all sub-items received the same weight, which was 0 (zero) if the analyzed action did not correspond to the description adopted in the indicator sub-item, and weight equal to 1 (one) when the evaluated practice contemplated the considered aspects.

The Preparation Indicator was applied based on data collection in local legislation, Contingency Plans, Disaster Information Forms, and through interviews with Municipal Civil Defense and Protection Coordinators. For the presentation of the results, the discussions were subdivided from the 11 dimensions belonging to the Indicator. It is important to highlight that this indicator was created considering the Brazilian Civil Defense and Protection structure. Therefore, it has not yet been adapted to be applied in other countries.

The detailed scoring instrument used for the application of the indicator can be seen in Table 2.

Table 2. Preparation Indicator: Detailed Scoring Instrument

Dimensions	Variables	Yes (1) No (0)
	Donations	1

Dimensions	Variables	Yes (1) No (0)
Equipment and logistical support	Shelters	1
	Logistical Support Base	1
	Budgetary Reserve	0
	Resource Registration	0
Scientific and Technological Development	Connection with universities	0
	Monitoring integration	0
	Alert System (coordination)	0
	Population Alarm System	0
	Intelligence Systems	0
	SMS-residents	0
	Applications	0
Human Resources Development	Basic training - coordination	1
	Sectorial Risk and Disaster Management Training	0
	Ongoing training	0
Institutional Development	Existence of a coordinating agency	1
	Exclusive technical team for coordination	1
	Appointment decree	1
	Municipal Council for Risk and Disaster Management	1
	Legislative Analysis/Participation	0
	Judicial Participation	1
Disaster Epidemiological Information and Studies	Disaster history	1
	Areas of attention	1
	Accuracy and Mastery of the Evaluation Methodology (data)	1
Mobilization	Sector Groups	1
	Volunteers	1
	Emergency Agency	1
Monitoring, Alert and Alarm	Contact with State/National Center	1
	Dissemination of Information	0

Dimensions	Variables	Yes (1) No (0)
	Quality control	1
	Existence of Alarm/Method	0
Business Motivation and Articulation	Entities participating in the Council	0
	PAM/NUDEC (Mutual Assistance Plan and/or Civil Defense and Protection Centers)	0
	Knowledge about damage value and impact	0
Cultural Change	Campaigns	0
	Risk Disclosure	0
	Cultural Icons	0
Strategies for protecting populations against focal risks	Evacuation Exercise	0
	Housing Programs	0
	Alarm	0
	Shelters	1
	Safety	1
Disaster risk reduction, civil defense and protection planning and resilience	Municipal Civil Protection and Defense Plan	0
	Contingency Plan	1
	Reviews / Disclosure	1
	Simulated	0

Source: the authors.

4. Results and Discussions

Equipment and logistical support

Two municipalities that received the maximum score were Guaratuba and Roncador, followed by Jaguariaíva and Matinhos (0.80) and Pérola and Pitanga (0.60). The other municipalities scored only 0.40. It was observed, in general, that all municipalities have shelters registered in the Contingency Plan. However, not enough data are always found to state that these locations strictly meet the individual and family guarantees to those affected, regarding security, logistics and organization, contained in the Federal Constitution. In Palmeira, the existence of a single shelter registered in the Contingency Plan was not enough to serve the affected population during the occurrence of three extreme events, especially that which occurred in 2014, when the affected represented a value 33 times greater than the capacity of the shelter (Ferentz, Fonseca, & Pinheiro, 2018).

In addition, there are problems with physical spaces, which should be used to store donations or equipment. Some municipalities do not have their own physical space for this purpose. Then, when necessary, donations are stored in the municipal guard or fire department, for example.

Thus, when the civil defense needs these materials, it must make the request to the institutions. It was also noted that the budgetary reserves existing in the municipalities are not intended exclusively for mitigation or response measures during disasters. The same is true for the resources and equipment used by the local civil defense. Due to this situation, the action to reduce risks and disasters in cities is compromised, in view of the sharing of resources.

Scientific and Technological Development

The data found allowed to affirm the existence of actions aimed at the integration with the monitoring, intelligence systems and practices of disseminating alerts to residents by SMS. Municipalities are monitored by the National Center for Disaster Monitoring and Alerting for flood events and gravitational mass movements. Even so, many municipalities do not have alert or alarm systems, or campaigns to publicize risks, knowledge about the value of damages, Mutual Assistance Plan or Civil Protection and Defense Centers.

It is also noteworthy that the integration with educational institutions is not yet carried out in an official manner. This situation can be mitigated by a partnership between the municipality and the University Center for Studies and Research on Disasters of Paraná (CEPED/PR) and the State Network of Research, Teaching, Extension and Technological Innovation aimed at reducing risks and disasters in the state of Paraná (Redesastre). This network is the first officially created in Brazil with the purpose of promoting scientific and technological cooperation and exchange oriented to disaster risk reduction in the state. The proposal of action of CEPED/PR and Redesastre seeks to locate, encourage, and mobilize researchers wherever they are so that they can contribute to the DRR in Paraná and national territory (Pinheiro et al., 2019).

Thus, the worst results achieved were for Jaguariaíva and Rio Bonito do Iguaçu (0.14), followed by Marquinho, Pitanga and Roncador (0.29). No municipality reached the maximum score, with Guaratuba having the highest rating (0.86).

Human Resources Development

The need for a culture aimed at reducing disaster risks permeates the fact that the members of the coordination must be prepared to apply and encourage new social practices. Such practices should inevitably include “habits and behaviors that promote risk reduction, through the minimization of threats and vulnerabilities, capacity enhancement and guarantee of protection and social security” (UFSC-CEPED, 2012:7). This requires training that provides for the promotion and execution of policies and strategies, which will structure and strengthen local management. Also, it allows the acquired knowledge to be incorporated and implemented in the administrative activities of the municipality, through laws of land use and occupation, permissiveness of buildings and the promotion of quality of life (UFSC-CEPED, 2012).

Querência do Norte obtained maximum score. In most municipalities, training and capacity building is carried out for members of the local Civil Protection and Defense and may be extended to municipal guards and firefighters. There are situations of continuous training through distance education platforms, for example. However, Marquinho and Rio Bonito do Iguaçu zeroed in this dimension, even though the State Civil Defense provides annual training for the municipalities.

Institutional Development

The municipality is the locus of the occurrence of extreme events and disasters. Therefore, it is important that the municipal government is aware of the need to structure the civil defense and protection agency so that, together with the sectoral agencies and the community, it can coordinate prevention, preparedness, response and reconstruction actions. The Municipal Coordination of Protection and Civil Defense (COMPDEC) is the body responsible for planning, articulation, coordination, mobilization and management of the National System of Protection and Civil Defense (SINPDEC). The Municipal Executive Branch is responsible for encouraging its creation and implementation, in line with the responsibilities described in Federal Law 12.608/2012 and State Law 18.519/2015. The existence and operation of COMPDEC enables, in the event of a disaster, the transfer of federal resources to the municipality for the execution of reconstruction works.

All municipalities have a Municipal Civil Protection and Defense Coordination, established by appointment decree. On the other hand, coordinators do not always have an exclusive support team for local Civil Defense actions, as well as the position of coordinator itself is divided with other public management functions. It was also identified that the data in the Contingency Plans are out of date in some municipalities. The update of this plan is essential because, during disasters, it is necessary to consult the information of the responsible and emergency contacts of all sectorial areas. The only municipality with the highest score was Pérola. Roncador and Cerro Azul had the worst indexes (0.33).

In the municipality of Palmeira, the Civil Protection and Defense Contingency Plan is outdated, with only one correct contact from the technical team (Ferentz, Fonseca, & Pinheiro, 2018). The others were no longer responsible for certain assignments, changed secretarial or were not aware of being responsible. This situation highlights the ineffectiveness of the supervision of the State Coordination of Protection and Civil Defense (CEPDEC), since the task of auditing the plans is entrusted and ensuring that the information is adequate, seeking to verify its applicability and effectiveness (CEPED-PR, 2016).

Information and Epidemiological Studies on Disasters

This category scored above average, except for Marquinho, with 0.33. Guaratuba, Jaguariaíva, Matinhos and Roncador had the highest score, while the other municipalities reached 0.67. This information can be accessed in the historical databases filed in the municipalities, in the Civil Defense System and on the website of the State Coordination for Civil Protection and Defense. The data can also be accessed by the population.

Mobilization

It corresponds to the set of actions taken, mainly during the response, by the emergency agencies and supported by volunteers who are formally registered to support the actions during or after the occurrence of disasters. Although Guaratuba, Jaguariaíva, Querência do Norte and Roncador reached the maximum score, Rio Bonito do Iguaçu zeroed in on this dimension and Marquinho got only 0.33. In these cases, volunteers are not registered, or the information is not updated in the Contingency Plan.

Monitoring, Alert and Alarm

Monitoring, Alert and Alarm did not reach the maximum score. Guaratuba and Pitanga were the municipalities with the highest indexes (0.75). In general, permanent contact between the municipal, state, and national civil defense should take place in the event of major impact events. In this way, Marquinhos zeroed its score and Rio Bonito do Iguaçu and Roncador reached just 0.25.

In Brazil, the National Center for Monitoring and Alerting of Natural Disasters (CEMADEN) is responsible for issuing alerts when conditions that produce an imminent risk of geodynamic (mass movement) and hydrological

(flood) processes are observed. The risk alert is passed on from CEMADEN to the National Center for Risk and Disaster Management (CENAD), which in turn transfers the information to municipal civil defenses.

At the state level, Paraná has the State Center for Risk and Disaster Management (CEGERD), which monitors the level of rivers and the amount of rain in the municipalities in order to issue alerts about extreme weather events. In addition, CEGERD assists local managers in identifying risk sectors, managing and recording disaster events.

In the analyzed municipalities, disaster alert information is generally disseminated through social networks, but there are no exclusive alarm mechanisms installed or adopted to inform the population quickly. Thus, quality control is also non-existent in relation to monitoring the effectiveness and assertiveness of alerts and alarms sent.

Motivation and Business Articulation

In the Motivation and Business Articulation dimension, only Guaratuba obtained the maximum score, followed by Pérola and Rio Bonito do Iguaçu (0.67). The other municipalities resulted in 0.33, except for Matinhos, which zeroed out. This question is assessed by the presence of public policies that encourage the involvement between businessmen and Disaster Risk Reduction, and by the presence of sectorial groups addressing the issue. As for the knowledge of damage values, there are estimates in the Disaster Information Form, but there is no description of the methodology for calculating these amounts, or information to assess these data, attributing them to an unclear character.

Cultural Change

Cultural Change was the dimension with the worst results. Only Roncador scored above the average (0.67), and although Guaratuba, Jaguariaíva and Matinhos scored 0.33, all other municipalities zeroed out. Municipalities do not have thematic or educational campaigns aimed at protecting against risks and disasters, nor cultural icons. Social networks are the only way that the municipalities use for transparency and direct disclosure of risk to the population. This situation is also found in União da Vitória (Paraná). In this municipality, Garcias, Ferentz and Pinheiro (2019) show that, although the population knows the local risks, training is not performed, especially with vulnerable groups. Another element pointed out by the authors was the absence of a specific communication channel for the management of risks and disasters with the community, using the city's page on the website or Facebook for sporadic disclosures. There is also no specific community center for local risk issues, only residents' associations.

Strategies for the Protection of Populations against Focal Risks

There is not enough information to demonstrate concern and articulation previously ordered to guarantee the safety of properties inserted in evacuated areas, as well as shelters and their users. The highest score was obtained by Roncador (0.60). The other municipalities were below average, and Querência do Norte zeroed out. There could be support for the information to be more accessible to the population, in addition to alerts in case of disastrous events. Furthermore, information and citizen awareness campaigns must be designed and widely disseminated. These measures, if taken in the short or medium term, can bring the disaster preparedness stage of the municipality closer to the ideal, minimizing losses and improving the effectiveness of the contingency plan.

Planning for Disaster Risk Reduction, Civil Defense and Protection and Resilience

Only Cerro Azul was below average (0.25). Guaratuba and Pitanga scored 0.75 and the remaining municipalities scored 0.50. The assessment of this dimension was carried out by investigating the existence of Civil Defense

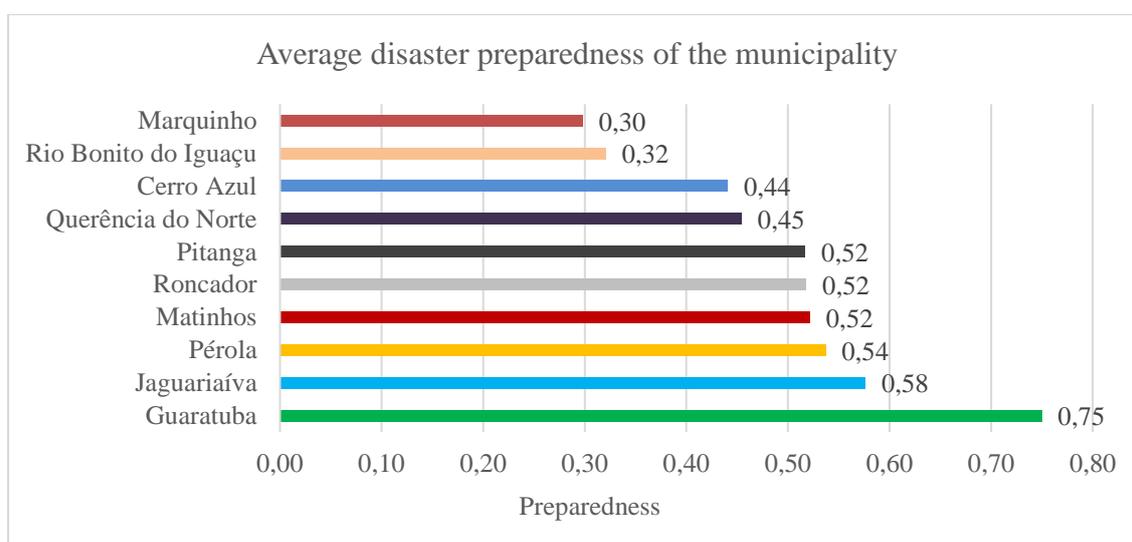
Master Plans, updated Contingency Plans and simulated exercises. In general, municipalities' Contingency Plans are updated. However, it is noteworthy that not all disasters are contemplated in this plan, such as the case of sea surfs constantly suffered by Guaratuba and Matinhos. Erroneous classifications of disasters were also found, when there is a confusion of terms of events caused by the overflow of water from the riverbanks and failures in urban drainage.

Overview of municipalities' preparedness for disaster risk

When evaluating the results of each municipality, it may be observed that Guaratuba presented 75% of the information necessary for good disaster preparedness, followed by Jaguariaíva (58%) and Pérola (54%). The municipality with the worst result was Marquinho (30%), followed by Rio Bonito do Iguaçu (32%) and Cerro Azul (44%), as represented in Chart 1.

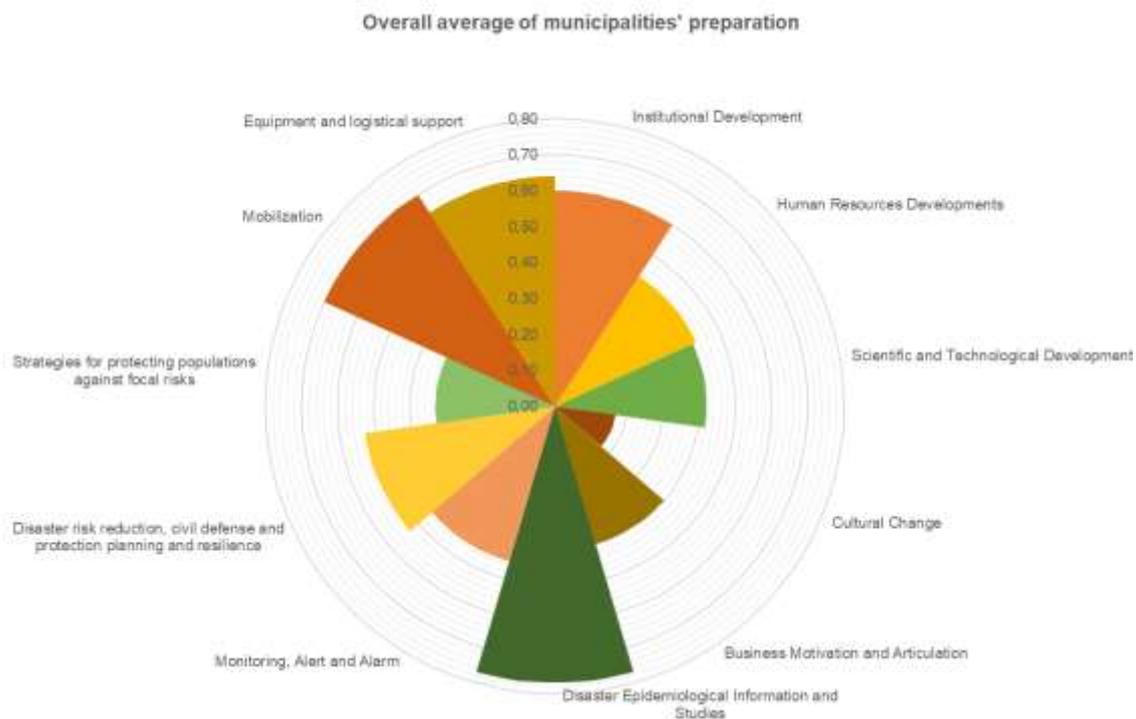
In coastal cities, the risk of coastal destruction was observed on the days when sea surfs occur, since civil construction does not support the force of the waves. This type of disaster is not considered in the Contingency Plans, and its inadequate planning and management increases the negative impacts in these regions. In the other municipalities, the lack of periodicity in public cleaning and the little environmental awareness of society, which deposits waste in inappropriate places, are factors that increase the risk of flooding, while this waste accumulates in the rainwater runoff channels. These cases boost local damages and losses, given that many affected areas have commercial establishments, in such a way that most municipalities concentrate their economic activities on trade.

Chart 1. Total Average of Preparation by Municipality



Source: the authors.

Overall, the average of the 10 municipalities represented a total of 49% of the items assessed for preparation. The Cultural Change dimension obtained the lowest index, followed by Planning to project populations against focal risks and Motivation and business articulation. On the other hand, the highest index was for Information and Epidemiological Studies on Disasters, followed by Equipment and Logistical Support and Institutional Development (Chart 2).

Chart 2. General Average of Municipalities

Source: the authors.

This visualization allows us to see which items need greater investments to improve disaster preparedness measures. Although the municipalities have demonstrated a low degree of compliance with the preparation actions, this is an important data and must be considered by the local administration. In this sense, it is possible to visualize the areas in greater need for immediate measures, and it can also serve as a diagnostic parameter in the long term, in order to ascertain whether the indicated actions have been improved.

This type of indicator is essential for the Civil Protection and Defense system, considering that there are currently no official instruments for assessing the measures to reduce risks and disasters in the municipalities. The preparation stage is crucial for managers and the local population to understand their responsibilities during an emergency. It is recommended that the application of this indicator be carried out annually. The continuous monitoring of actions will produce knowledge about the measures taken to increase resilience in communities.

It is worth noting that this study was conducted with municipalities in the state of Paraná. However, it can be replicated in any part of Brazil. Also, there is no limitation in terms of different types of disaster. Granted, it is a volatile instrument and it can be adapted to any situation. The indicator was developed based on the principles of the National Policy of Protection and Civil Defense and other official plans.

Thus, the following priority measures are suggested for municipalities to improve their disaster preparedness system:

1. Detailed scientific studies to understand the risk areas of municipalities, including rural areas and maritime disasters, and update contingency plans with more reliable and better-quality information from these studies;
2. Consolidation, engagement and training of technical teams for the coordination of civil defense protection in municipalities, in order to seek better qualities in disaster risk planning and management, including the entire process characterized by prevention, mitigation, preparation, response and recovery;

3. Disseminate information about the risk, increase and improve the understanding of the phenomenon by allowing them to know its relevance and when it is likely to occur, and, thus, assist in decision making;
4. Studies and adoption of alert and alarm techniques in the face of possible extreme events, in addition to cultural awareness campaigns for the population, aiming at reducing vulnerability in the face of these disasters;
5. Recovery and preservation of permanent preservation areas (APPs) as defined in legislation, including mainly areas of riparian forest, hillsides and hill tops. This is the first measure aimed at containing river floods and floods;
6. Reconstruction of roads, seeking drainage techniques that avoid flooding. Sustainable drainage techniques can be adopted, including the construction of infiltration ditches and green corridors that go around the roads in order to reduce the water speed, protecting the paths in the same way that the riparian forests protect the rivers. The relief should also be taken into account, with the location of some roads likely to change.

All the presented suggestions are aimed at enabling disaster risk reduction in the analyzed municipalities. All components missing from the Preparation Indicator system should be considered as essential for disaster preparedness, and this system is an important tool for the management of civil defense planning in the municipality.

5. Conclusions

The present project demonstrated that, for an effective applicability of the Preparation Indicator, it is necessary, above all, to understand the concepts applied to each item and sub-item that make up the structuring of the indicator. The correct understanding of the conceptual definition of a given natural disaster is another fact found in the extracted information, because, in some cases, the event reported in the forms and records is not characterized as the disaster that occurred. Although many data are not easily accessible for consultation by the population (Fonseca, Ferentz, & Garcias, 2020), the information was obtained directly from those responsible for Civil Protection and Defense in the municipalities. With the set of data analyzed in the study, there was a lack of knowledge about the risk of disasters in municipalities in general.

In addition, as main points to be highlighted, it can be mentioned that no areas of rural risk or maritime disaster are foreseen in the contingency plans, and these are the places with the greatest economic losses for the municipalities; disconnection between the local civil defense team, as those responsible are not always described in the contingency plan; and the precariousness of the information systems aimed at alerting and alarming the population faced with a possible disaster. These findings reflect the main vulnerabilities of municipalities in terms of disaster risk.

In order to improve the Preparation Indicator, it is necessary to develop a scale that allows local managers to include actions that are being developed. At this point, the only statements that can be made are whether the actions exist or not. Another opportunity to be highlighted is that this indicator belongs to only one of the five phases of Risk and Disaster Management. In this way, it is possible to go deeper into the elaboration of indexes that characterize the stages of Prevention, Mitigation, Response and Recovery.

Therefore, it may be emphasized that the preparedness indicator can be an excellent instrument for assessing the performance of the Municipality's preparation composition for a possible disaster, and may contribute to a specific analysis of the existing structure, and provide decision-making for improvements in aspects that are still lagging or fragile. With this instrument, it is possible to carry out continuous monitoring of local actions, especially if it is inserted into the State Civil Defense System (SISDC).

All municipalities in Paraná have access to SISDC. In this way, local managers can constantly update the indicator. In conclusion, this methodology can act as a compass to guide better Civil Defense policies, re-evaluate the current risk reduction measures, and as a mechanism to support claims to the administration for better risk and vulnerability management.

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References

- Brazil (2012). *Lei n° 12,608*, de 10 de abril de 2012. Brasília.
- Brazil (2014). *Lei n° 12,983*, de 24 de agosto de 2014. Brasília.
- Castro, A. L. C. de. (1999). *Manual de Planejamento em Defesa Civil*. Brasília: Ministério da Integração Nacional. Secretaria Nacional de Defesa Civil.
- CEPED-Pr. Centro Universitário de Estudos e Pesquisas sobre Desastres do Paraná. Fundação de Apoio à Unespar (Funespar). (2016). *Construindo um Estado Resiliente: o modelo paranaense para a gestão do risco de desastres*. Curitiba: CEPED/FUNESPAR, 156p.
- CRED. Centre for Research on the Epidemiology of Disasters (2014). 2013 - *Disasters in Numbers*. Unisdr and Usaid.
- Cronstedt, M. (2002). *Prevention preparedness, response, recovery – an outdated concept?*. Australian Journal of Emergency Management., 17, 10–13. <http://classic.austlii.edu.au/au/journals/AUJEmMgmt/2002/16.pdf>.
- EIRD/Un. Estrategia Internacional de Redução de Desastres. (2004). *Vivir con el riesgo: informe mundial sobre iniciativas para La reducción de desastres*. United Nations: Secretaria Interinstitucional de La EIRD/UN.
- Ferentz, L. M. S., Fonseca, M. N., Pinheiro, E. G. (2018). Gestión de riesgo de desastres y los planes municipales de contingencia: estudio de caso en el municipio de Palmeira/PR. *Revista Contribuciones a las Ciencias Sociales*. <https://www.eumed.net/rev/cccs/2018/10/desastres-planes-municipales.html>.
- Fonseca, M. N. da, Garcias, C. M. (2020). Comunicação de risco de inundação: instrumento fundamental da gestão de riscos de desastres. *DRd – Desenvolvimento Regional em debate*, 10, 1139–1159. <http://www.periodicos.unc.br/index.php/drd/article/view/2882>.
- Fonseca, M. N. da, Ferentz, L. M. S. (2020). Percepções sobre as consequências e prejuízos de inundações: estudo aplicado em Pinhais, Paraná. *Revista Brasileira de História & Ciências Sociais – RBHCS*, 12, 23. <https://periodicos.furg.br/rbhcs/article/view/11135>.
- Fonseca, M. N. da, Ferentz, L. M. S., Garcias, C. M. (2020). Disponibilidade de dados abertos para a resiliência às inundações em Curitiba (Paraná). *Revista de Morfologia Urbana*, 8, 2, e00139. <http://revistademorfologiaurbana.org/index.php/rmu/article/view/139>.
- Garcias, C. M. (2001). Indicadores de qualidade ambiental urbana. In N. B. Maia, et al. *Indicadores ambientais*. São Paulo: EDUC.
- Garcias, C. M., Ferentz, L. M. S., Pinheiro, E. G. (2019). A Resiliência como Instrumento de Análise da Gestão Municipal de Riscos e Desastres. *Redes* (Santa Cruz do Sul. Online), 24, 2, 99–121. <https://online.unisc.br/seer/index.php/redes/article/view/13241>.
- Hancock, J. R. (2015). Sete lugares que vivem à espera da próxima catástrofe: A Terra é um planeta normalmente acolhedor, se ignorarmos os terremotos, os vulcões. *El País*. https://brasil.elpais.com/brasil/2015/04/27/internacional/1430152000_608140.html.

Kapucu, N. (2009). Public administrators and crosssector governance in response to and recovery from disasters. *Administration and Society*, 41, 7, 910–914. <https://journals.sagepub.com/doi/10.1177/00953997>.

Pinheiro, E. G. (2015). *Gestão pública para a redução dos desastres. Introdução da variável risco de desastre à gestão da cidade*. 1ª edição. Curitiba: Apris.

Pinheiro, E. G. (2017). *Orientações para o Planejamento em Proteção e Defesa Civil - Plano Setorial de Proteção e Defesa Civil*, 1. 1ª edição. Paranaguá: Funespar.

Pinheiro, E. G., Stringari, D., Cova, G., Fonseca, M. N., Simiano, L. F. (2019). Redesastre: a contribution from Paraná to the management of disaster risk in Brazil. *Global Assessment Report. UNDRR*, 1–26. https://www.preventionweb.net/files/66784_fpinheirostringaricovafonsecasimian.pdf.

Shi, P., Kaspersen, R. (eds.) (2015). *World Atlas of Natural Disaster Risk*. BNUP. Springer.

UFSC-CEPED. Universidade Federal de Santa Catarina. Centro Universitário de Pesquisa e Estudos sobre Desastres. (2012). *Capacitação dos Gestores de Defesa Civil para uso do Sistema Integrado de Informações sobre Desastres (S2iD)*. Texto: Jairo Ernesto Bastos Krüger, 2ª edição. Florianópolis: CAD/UFSC.

UNDP. United Nations Development Programme. (2013). *Gestão de Riscos e Desastres*. <http://www.br.undp.org/content/brazil/pt/home/projects/risco-e-desastres.html>.

UNDP. United Nations Development Programme. (2004). *La reducción de riesgos de desastres Un desafío para el desarrollo. Un Informe Mundial*. Dirección de Prevención de Crisis y de Recuperación.