Facilities location for disaster response teams using GIS

Localização de instalações para equipes de resposta a desastres através de SIG

Localización de Instalaciones para Equipos de Respuesta a Desastres mediante SIG

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Abstract

The recurrence of disasters in Brazil, stemming from extreme weather events and poor urban management, exposes the population to calamitous situations caused by floods, landslides, and other adversities. In the face of these events, the need arises to establish a network of assistance, known as humanitarian logistics, which brings together participants at different levels to alleviate human suffering. However, the literature highlights gaps, such as the problematic location of facilities, asset-based solutions, partnerships, and collaboration. In this context, the Sistema S, a nationally recognized entity with social interest, emerges as a potential solution to address these gaps. This paper aimed to evaluate the asset infrastructure of Sistema S located in Nova Friburgo, a mountainous region in the state of Rio de Janeiro, to assess its feasibility for aiding victims and restoring interrupted daily and economic activities due to disasters. To conduct the study, a literature review was carried out to support the theme, followed by an analysis of the study area through Georeferencing using the QGIS software. The results indicate that, despite the privileged location and infrastructure with service capacity, its spatial integration is vulnerable to being affected by the region's climatic events.

Keywords: Disaster Relief. Humanitarian Logistics. Facility Location. Georeferencing.

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Resumo
A recorrência de desastres no Brasil, provenientes de eventos climáticos extremos e má gestão urbana, expõe a população a situações de calamidade geradas por inundações, deslizamentos e outras adversidades. Diante desses eventos, surge a necessidade de estabelecer uma rede de ajuda, conhecida como logística humanitária, que reúne participantes em diferentes níveis com o objetivo de aliviar o sofrimento humano. No entanto, a literatura destaca lacunas, como a problemática da localização de instalações, soluções baseadas em patrimônio, parcerias e colaboração. Nesse contexto, o Sistema S, entidade de abrangência nacional e interesse social, emerge como possível solução para preencher essas lacunas. Este trabalho objetivou avaliar a infraestrutura patrimonial do Sistema S localizada em Nova Friburgo, região serrana do estado do Rio de Janeiro, visando afetar sua viabilidade para o auxílio às vítimas e o restabelecimento das atividades cotidianas e econômicas interrompidas por desastres. Para conduzir o estudo, realizou-se uma revisão de literatura para embasar o tema, seguida por uma análise da região de estudo por meio do Georreferenciamento feito com o software QGIS. Os resultados apontam que, apesar da localização privilegiada e infraestrutura com capacidade de atendimento, sua inserção espacial está vulnerável a ser afetada pelos eventos climáticos da região.


Resumen
La recurrencia de desastres en Brasil, provenientes de eventos climáticos extremos y mala gestión urbana, expone a la población a situaciones de calamidad generadas por inundaciones, deslizamientos y otras adversidades. Ante estos eventos, surge la necesidad de establecer una red de ayuda, conocida como logística humanitaria, que reúne a participantes en diferentes niveles con el objetivo de aliviar el sufrimiento humano. Sin embargo, la literatura destaca lagunas, como la problemática de la ubicación de instalaciones, soluciones basadas en patrimonio, asociaciones y colaboración. En este contexto, el Sistema S, una entidad de alcance nacional e interés social, emerge como posible solución para llenar estas lagunas. Este trabajo tuvo como objetivo evaluar la infraestructura patrimonial del Sistema S ubicada en Nova Friburgo, una región montañosa del estado de Río de Janeiro, con el fin de determinar
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Introduction

Public emergencies, such as floods, landslides, extreme temperatures, storms, and droughts, require a rapid deployment of resources to assist those affected. The recurrence of these events, which demand humanitarian support, presents distinct challenges related to the logistics supply chain. This has drawn the attention of the scientific community to a systematic analysis of the critical gaps in this context, directing efforts towards the identification of necessary solutions.

The effectiveness of a supply chain requires an efficient decision-making approach, with facility location problems being of vital importance in this context. Over time, renowned authors, such as Bertazzo et al. (2013), among others, have explored these issues in the literature, both at the national and international levels. Among the highlighted topics, the following are identified as relevant issues to be addressed: location of facilities, solutions based on assets, partnerships, and collaboration, as discussed by various scholars, including Akter & FossoWamba (2019), Dubey et al. (2019), Papadopoulos et al. (2017), Prasad et al. (2018), Yoo et al. (2016), Bealt et al. (2016), Moshtari (2016), Ahmadi-Javid et al. (2017), Fahimnia et al. (2017), Nedjati et al. (2016), Samani et al. (2018), Nunes et al. (2022).

Once the gaps have been identified, it is necessary to make them operational to provide not only assistance to those affected but also to restore the interrupted daily and economic activities, contributing to the recovery of the environment. In this context, both the public power and the private sector have a direct interest in the return to normality. Thus, the figure of the S System arises, composed of nine institutions established by the Brazilian Federal Constitution, which have a social bias of serving the population through actions linked to
social well-being, education, and, above all, the provision of services directed to the health of the population, including specialized medical clinics, laboratory tests, and dental care.

The figure of the S System, by incorporating the gaps identified by the authors, stands out, especially in the issue of facility location due to its extensive presence in the whole Brazilian territory. Decision-making related to location plays a critical role in organizational strategic planning, exerting direct influence on the performance of an entity. These high-cost decisions involve significant investments in the construction or repositioning of structures (Pinheiro, 2021).

Both the bodies and institutions linked to natural disasters and the scientific community recognize that the prevention, reduction, or minimization of the damage caused by these phenomena depends, to a large extent, on the adequate understanding by the population and the decision-makers of the nature of these events and how to act in the face of them. Therefore, GIS emerges as a valuable tool applicable to the different stages of natural disaster management (Cutter, 2003).

Geographic information systems (GIS) play an essential role in disaster management. At the national level, these systems provide information for decision-making, the formulation of public policies, and the development of measures aimed at reducing the vulnerability of specific areas. Additionally, they are essential for disaster inventory, identifying areas less impacted and more conducive to development. At the regional level, they map specific disaster risks, guiding mitigation strategies and identifying priority areas for detailed studies. At the local level, they generate maps of hazards and risks, being vital in prevention, preparedness, and response activities before a disaster, by mapping routes and facilities for emergency support (Van Western, 2002).

Therefore, this study was undertaken to identify and analyze the use of the S System facilities, focusing on the use of infrastructures dedicated to health care in a scenario of humanitarian operations aimed at acting in prompt response to disaster events. For this purpose, the following guiding questions were asked:

Research Question 1: Do the subsidiaries of the S System, in the mountain region of Rio de Janeiro, have a viable location to be used as a support base for disaster response operations in critical areas where there is a recurrence of disasters?

Research Question 2: Is the mobile infrastructure of the S System dedicated to the health area capable of accommodating teams to assist victims in the event of disasters?
This study is justified by the need that has already been recognized and pointed out in reference works, contributing to the improvement and increasing the existing repository. According to Gonçalves & Lima (2018), there is still a gap in the literature regarding the resources and capabilities that organizations involved in the humanitarian operations theater should improve to act in occurrences of different types, intensity, and scope.

This research contributes by employing georeferencing tools in the analysis of facility location, contrasting with its common application in disaster analyses, focusing on the pre-disaster phase to map risk situations, and the post-disaster phase to quantify their damages.

This work is structured in six sections, including the present introduction. The second part addresses the methodology, detailing the nature of the study and the technical procedure adopted for its execution. The third section presents the case study, characterizing the object of study and outlining the process of selecting the analyzed region and the eligible institutions. Next, the results are presented, followed by discussions that compare them with the relevant literature. Finally, the final considerations are presented, along with suggestions for future studies.

**Humanitarian Logistics**

The International Federation of the Red Cross defines humanitarian logistics as the processes and systems involved in mobilizing people, resources, and knowledge to assist vulnerable communities affected by natural disasters or complex emergencies. It seeks a prompt response, aiming to serve the largest number of people, prevent shortages and waste, organize the various donations received in these cases, and, most importantly, operate within a limited budget (Nogueira et al, 2010). In literature, there are distinct definitions of the topic, as specified in Figure 1.

**Figure 1**

*Concepts of Humanitarian Logistics*

<table>
<thead>
<tr>
<th>Concept</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Processes and systems involved in mobilizing people, resources, skills, and knowledge to assist vulnerable people affected by natural disasters and complex emergencies. It encompasses a series of activities, including purchasing, transportation, detection and monitoring, customs clearance, internal transportation, storage, and last-mile delivery.</td>
<td>Thomas (2003)</td>
</tr>
</tbody>
</table>
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Function aimed at the flow of people and materials in an appropriate and timely manner in the care chain, with the main objective of correctly serving the largest number of people. Beamon (2004)

A special branch of logistics that manages responses from the supply chain of critical materials and services with challenges, such as demand peaks, uncertain supplies, critical time windows, and the vast scope of their operations. Apte (2009)

Process of planning, executing, and controlling the flow and storage of goods and materials efficiently and economically, as well as related information, from the point of origin to the point of consumption to meet the requirements of the end beneficiary. Kovács and Spens (2009)

Function that is required to ensure the efficient and effective flow of supplies and people to save lives and alleviate the suffering of vulnerable people. Nogueira (2010)

Process of a complex and highly unstable nature, as it involves serious operational challenges such as: unknowns, time, logistical training, means of communication and financing, equipment and information technology, and interferences. Overstreet et al (2011)

Branch of logistics that deals with logistical aspects of the disaster management system, including various activities, such as the acquisition, storage, and transportation of food, water, medicines, and other supplies, as well as necessary human resources, machines, and equipment, and the injured before and after disasters strike. Nikbakhsh and Farahani (2011)

Process of planning, implementing, and controlling the efficient and economical flow and storage of supplies with the aim to alleviate the suffering of vulnerable people and preserve life. Reis (2018)

Source: Cited authors

Even without a consensus on a single definition of the topic of Humanitarian Logistics (HL), it is noted that the definitions made by each author complement each other. It is also emphasized that all concepts derive from the concepts of business logistics and are not dissociated from the concept of disaster, which is the occurrence of a sudden and calamitous event, that interrupts the activities of a population by generating losses of human lives and materials, in addition to economic and environmental losses, which exceed their recovery capacity through only their resources (Natarajarathinam et al, 2009).

The Interest in Humanitarian Logistics (HL) topic arose after the tsunami in Asia in 2004, where the mismatch of logistical actions in assisting victims was noticed. From 2006 onwards, a movement of studies on the topic was noticed in Europe and the United States. Specifically in Brazil, attention to the topic dates back to the year 2008, with UFSC being the pioneer on the subject in the country (Leiras & Yoshizaki, 2017).

When disaster strikes, a mobilization where different stakeholders rally to meet the demands imposed by the collapsed environment and its victims, is referred to as Stakeholders in Humanitarian Logistics. In the context of HL, Stakeholders Feng et al. (2012) defined as “those who affect the performance of humanitarian logistics and who are affected by humanitarian logistics operations”. Fontainha et al. (2017) list more than 300 stakeholders,
where ten are identified as main. Within these ten, there is a subdivision into three different groups, which are: public (military, Government, Legislative and regulatory), private (private sector, direct supplier and media), and society (international aid network, donor and local aid network).

These stakeholders interact in a common environment referred to as the humanitarian space. The Humanitarian Space is understood as an environment in which the planning and execution of actions aimed primarily at reducing human suffering and loss of human lives caused by adverse situations are developed. In this context, it is concluded that it is an environment characterized by the mutual cooperation of political, civil, and military actors focused on the stability of the situation (Metcalfe et al., 2012).

The humanitarian space was defined by Van Wassenhove (2006) by three basic principles: i) humanity; ii) neutrality; and iii) impartiality. By adhering to these principles, humanitarian organizations, both public and private: provide aid to those in need, wherever they may be found (humanity); do not influence the outcome of a conflict with their intervention (neutrality); and do not favor one group over another group of beneficiaries (impartiality).

Methodology

The methodology employed is classified as qualitative, exploratory, descriptive, and methodological. Exploratory research, according to Rovery (2000), is conducted to have a general overview of a specific topic. Regarding descriptive research, Vergara (2005) states that this type of approach exposes the characteristics of a particular population or phenomenon, without the commitment of detailing them. Still Vergara (2005), defines that methodological research is associated with the tools used to achieve a particular objective.

The technical procedure adopted involved a case study. For the analysis of the locality, we used projections in Geographic Information Systems (GIS). In this case, we used the open-source and cross-platform QGis software and related data. The use of the QGis software and the analyses made from the construction of georeferenced maps are of great help to decision-making, as this system provides data such as distances between shelters and the nearest health unit, the existence of obstacles in escape routes, the distribution of population clusters, water network, areas of susceptibility to mass movements and road network. This system is also useful for determining a viable location, as pointed out by Indriasari et al. (2010).
Characterization of the study object

The S System is composed of organizations classified as private legal entities with a social aspect in the provision of services, that is a third sector entity. It is characterized as an Autonomous Social Service and is managed independently by federations and confederations of the main economic sectors.

Its creation dates back to the 1940s, due to the limits and inefficiency of the State's action and, as a result of this bottleneck left by the public power, they emerge to meet demands in specific segments, such as assistance activities; recreational; environmentalists; educational; sports; and, religious and others. The entities that compose it are detailed in Figure 2.

Figure 2

S System organizations

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Name</th>
<th>Year of creation</th>
</tr>
</thead>
<tbody>
<tr>
<td>SENAI</td>
<td>National Industrial Training Service</td>
<td>1942</td>
</tr>
<tr>
<td></td>
<td>(Serviço Nacional de Aprendizagem Industrial)</td>
<td></td>
</tr>
<tr>
<td>SESC</td>
<td>Commercial Social Service</td>
<td>1946</td>
</tr>
<tr>
<td></td>
<td>(Serviço Social do Comércio)</td>
<td></td>
</tr>
<tr>
<td>SESI</td>
<td>Industry Social Service</td>
<td>1946</td>
</tr>
<tr>
<td></td>
<td>(Serviço Social da Indústria)</td>
<td></td>
</tr>
<tr>
<td>SENAC</td>
<td>National Commercial Training Service</td>
<td>1946</td>
</tr>
<tr>
<td></td>
<td>(Serviço Nacional de Aprendizagem Comercial)</td>
<td></td>
</tr>
<tr>
<td>SEBRAE</td>
<td>Brazilian Service of Support to Micro and Small Businesses</td>
<td>1972</td>
</tr>
<tr>
<td></td>
<td>(Serviço Brasileiro de Apoio às Micro e Pequenas Empresas)</td>
<td></td>
</tr>
<tr>
<td>SENAR</td>
<td>National Rural Training Service</td>
<td>1991</td>
</tr>
<tr>
<td></td>
<td>(Serviço Nacional de Aprendizagem Rural)</td>
<td></td>
</tr>
<tr>
<td>SENAT</td>
<td>National Training Service and Transportation</td>
<td>1993</td>
</tr>
<tr>
<td></td>
<td>(Serviço Nacional de Aprendizagem e Transporte)</td>
<td></td>
</tr>
<tr>
<td>SEST</td>
<td>Social Service of Transport</td>
<td>1993</td>
</tr>
<tr>
<td></td>
<td>(Serviço Social dos Transportes)</td>
<td></td>
</tr>
<tr>
<td>SESCOOP</td>
<td>National Cooperative Training Service</td>
<td>1998</td>
</tr>
<tr>
<td></td>
<td>(Serviço Nacional de Aprendizagem do Cooperativismo)</td>
<td></td>
</tr>
</tbody>
</table>

All of these establishments are linked in some way to the productive sector.
Selecting Locations and Organizations

To select the organizations to be analyzed, Figure 3 presents the occurrence of major disasters, in chronological order of events. Of these four cases selected, the most striking and impactful is the one in 2011, considered one of the largest disasters to occur in the country, and the milestone for the structuring of Civil Defense as it is known today (Senado Federal, 2011).

Figure 3
Selected disaster occurrences for the study

<table>
<thead>
<tr>
<th>Year</th>
<th>Location</th>
<th>State</th>
<th>Victims</th>
<th>Type of occurrence</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>Niterói (Morro do Bumba)</td>
<td>Rio de Janeiro</td>
<td>267 people were killed, and only 48 bodies found</td>
<td>Landslide</td>
</tr>
<tr>
<td>2010</td>
<td>Angra dos Reis</td>
<td>Rio de Janeiro</td>
<td>53 people killed</td>
<td>Floods and landslides</td>
</tr>
<tr>
<td>2011</td>
<td>Rio de Janeiro Serrana region (Petrópolis, São José do Vale do Rio Preto, Teresópolis, Nova Friburgo, Bom Jardim, Cachoeiras de Macacu, Areal)</td>
<td>Rio de Janeiro</td>
<td>918 killed, 100 missing, and 35,000 displaced</td>
<td>Floods and landslides</td>
</tr>
<tr>
<td>2022</td>
<td>Petrópolis (Morro da Oficina)</td>
<td>Rio de Janeiro</td>
<td>241 killed; 1 missing</td>
<td>Floods and landslides</td>
</tr>
</tbody>
</table>

Source: S2ID

There is a recurrence of events in the Serrana region of Rio de Janeiro, with flooding and landslides being the most frequent. Based on the selection of localities by relevance and impact on society, the representation of each entity by region is listed, as shown in Figure 4.
Even though they belong to the Serrana region of Rio de Janeiro, the localities of Teresópolis, Bom Jardim, Cachoeiras de Macacu, Areal, and São José do Vale do Rio Preto were not included because they do not have representations of the subsidiaries of the S system. As discussed, the Serrana region of Rio de Janeiro suffers from constant disaster occurrences, even if the disaster phase cycle is fully complete. In this context, the locality of Nova Friburgo, the site of one of the country's largest natural disasters, will be evaluated.

**Results**

To answer the first research question, about the viability of the location of the study, we used GIS projections. The first georeferencing is inherent to the location of the entities in the municipality of Nova Friburgo - RJ and their spatial distribution. It is noticeable the proximity between some of the facilities and the way they are distributed in the locality. Figure 5 illustrates the insertion of the S system subsidiaries in the city.
Figure 5

Spatial insertion of S System units in the city of Nova Friburgo - RJ

The georeferencing was done encompassing all the representations of the different entities installed in the municipality, as shown in Figure 5, confirming the presence of the entity in the locality. However, for this study, only the SESI and SEST SENAT units will be considered, as they are the ones that have health infrastructure.

The infrastructure is located in the central region of the city, with access to the main access roads to neighborhoods and other highways. There is a large concentration of commercial and residential buildings. In the first analysis, the infrastructures meet the purpose of concentrating teams and using infrastructure as a central support point for disaster response activities.

Following the analysis, the georeferencing of the locality is provided, as shown in Figure 6, by analyzing the relief of the region. It is then found that these facilities are located in a valley bottom region.
Figure 6

*Georeferencing of the relief of the study area*

Figure 6 shows the insertion of the locality and the contour lines of the region, showing the slopes around the built-up and inhabited area. The fact that its insertion is in a valley bottom region, alerts to the possibility of susceptibility and exposure to risks in cases of extreme climate events.

As a continuation of the analysis, Figure 7 shows the georeferencing of the slope of the region.
Figure 7 shows the relief and slope of the locality, reaffirming its location in a valley bottom region. This confirms the locality's susceptibility and vulnerability to hydrological events. In the case of landslides, there is also the risk of rockfall, which can further aggravate the consequences of a climate event.

Continuing the analysis, Figure 8 shows the layout of highways and city streets in relation to the location of the facilities.
Figure 8

Roads and city streets in the study area

Figure 8 shows the georeferenced highways and city streets in the study area, in the city of Nova Friburgo, Rio de Janeiro. The city center is well-urbanized according to the information obtained for the creation of this map. However, there is only one main exit from the city via a highway. In the event of a disaster that interrupts or renders the highway unusable, this could hinder a prompt response to a future disaster. The positive point is that, due to the special layout of the roads, there are secondary roads for access to the neighborhoods.

Finally, the georeferencing of the region and the location of the facilities under study, address the region's flood index, according to Figure 9.
As shown in Figure 9, the region where the facilities are located is prone to flooding. This makes the facilities unviable, as they need to be located in a safe area with clear access for disaster response teams. Climate-related disasters are recurrent in this region, as evidenced by recent history.

**Analysis of S System Mobile Facilities**

To respond to the second research question, the patrimonial infrastructure was analyzed, which is comprehended in mobile units, as the first research question made the use of fixed infrastructure unfeasible.

In this analysis, mobile health infrastructures were listed. In addition to the fixed patrimonial structure, with equipment, facilities, technical staff, and others, some subsidiaries have mobile units for these services. These structures can guarantee versatility in the care of disaster victims on site, or nearby. These structures are listed in Figure 10.
Figure 10

*Mobile health facilities owned by the S System subsidiaries*

<table>
<thead>
<tr>
<th>Entity</th>
<th>Equipment Type</th>
<th>Purpose</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sesc Rio</td>
<td>Mobile Unit (Truck)</td>
<td>OdontoSesc - Mobile Clinics</td>
<td>6</td>
</tr>
<tr>
<td>Sesc Rio</td>
<td>Mobile Unit (Truck)</td>
<td>Sesc Saúde da Mulher - Mobile Clinics</td>
<td>2</td>
</tr>
</tbody>
</table>

Source: Sesc Rio

These units are complete health clinics, able to meet both emergency and point-of-care demands. For such use, a routing study will be necessary based on restrictions arising from the post-disaster scenario time, due to the possibility of using the area closest to the disaster site.

**Discussion**

Authors such as Bealt et al. (2016); Dubey et al. (2019); Moshtari (2016); Papadopoulos et al. (2017) highlight issues related to collaboration and partnerships in the context of Supply Chain Management in humanitarian contexts. In this context, the S System is configured as a central partner of high relevance to meet these demands, given its assistance orientation, comprehensive national reach, and strong financial support, providing a solid foundation for effective collaboration in supply chain management in humanitarian scenarios.

As evidenced by Ahmadi-Javid et al. (2017), Fahimnia et al. (2017), Nedjati et al. (2016), and Samani et al. (2018), the problem of facility location in LH management presents itself as a recurring issue, both in national (confirmed by this case study) and in international contexts. This phenomenon is a direct consequence of the inherent peculiarities of each disaster, including the type of event, location, geographical extent, and damage resulting from such events. Due to the complexity resulting from these factors, each disaster situation is unique and demands a specific approach for its resolution. Therefore, the optimization of facility location in LH scenarios is a multidimensional challenge that requires in-depth analysis and adaptive strategies to deal with the complex demands that arise in disaster situations.

Indriasari et al. (2010) highlight GIS as a decision-making support tool, providing information such as distances between shelters and the nearest health unit, identification of obstacles in evacuation routes, mapping of areas with population concentration, analysis of
the water network, identification of areas susceptible to mass movements, and detailing of road infrastructure. However, it is important to note that this statement can be considered partially accurate, as its effectiveness depends on the quality and availability of available geospatial data. In many cases, data from government sources is outdated and incomplete, which limits the accuracy of the analyses. In addition, the dynamics of disasters, characterized by the rapid occurrence and frequent changes in conditions, often cannot be captured accurately by data collection satellites or by their timely availability, which poses additional challenges in the use of GIS as a decision-making support tool in disaster situations. Therefore, the usefulness of GIS as a decision-making tool is conditioned by the quality of the data and the information processing capacity of the response teams.

Conclusions

This case study sought to analyze the use of the S System's patrimonial infrastructure for response to disasters. The research was developed based on two guiding questions that were partially answered.

The first research question, which asked about the territorial positioning of the S System subsidiaries, received a negative answer. The GIS showed that the area is susceptible to the impacts, specifically flooding, leaving the infrastructure inoperable for use by rescue teams.

The second research question, which asked whether the use of the health facilities of the S System subsidiaries in support of rescue teams is possible, was partially answered since the first research question makes the use of the units unfeasible. For this, it was suggested an analysis of the situation in which the equipment will be used for support at the time of pre-positioning in the face of the disaster, analyzing routes and locations for better use.

Some limitations were identified, which were related to data collection and the nature of the disasters and their consequences. Regarding data collection, there was a limitation in the availability of data from some subsidiaries of the S System, such as equipment inventory. As for the GIS of the region, the data was found to be incomplete, outdated, and insufficient. Regarding the nature of the disasters, the limitation lies in the particularity of each event, as they are unique occurrences with different consequences. Therefore, the required needs, even if similar, are not the same in all events, varying in severity and scope.
However, it is important to note that structural problems continue in the locality and the mountain region of the state of Rio de Janeiro as a whole. The recurrence of these disasters should act as an inducer of change, eliminating repetitive cases. The Sustainable Cities Index, an initiative that addresses the sustainability of Brazilian cities, addressing the 17 Sustainable Development Goals of the United Nations, including specifically, item 11.5, which deals with the reduction of the number of deaths and people affected by disasters, lists the city of Nova Friburgo in 757th place in a general classification of 2023 involving 5570 cities (IDSC, 2023). This demonstrates the disregard of public authorities for the commitments they have assumed and with their citizens.

As a suggestion for future studies, new research is proposed based on the use of the infrastructures targeted by this work but focused on other humanitarian operations, aimed at the human development perspective, and directed at supporting military forces that are active in these types of demands. The association between the Armed Forces and the S System is recommended, due to the similarities in territorial presence and reach of the civilian population.

According to Cardoso (2019), Brazil is a country with no threats, and the current employment of the armed forces is supported by, among other items, support for the preservation of the societal fabric, focused on activities to mitigate the effects of disasters, natural or man-made, and involvement in humanitarian actions.

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