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Cimate Emergencies vs. Sanitation

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ABSTRACT
It is understood here that urban development, in general and specifically in relation to basic sanitation, is not taking place adequately. Basic sanitation is seen as one of the challenges in the face of climate change, especially in terms of water resources. Extreme events, such as long periods of severe drought and extreme rainfall, are increasingly present, calling into question the resilience of infrastructure and its ability to adapt to imminent risks to human health and the environment. A field study was carried out with a visit to the Civil Defense Secretariats of Maricá and Niterói - RJ. The objective of Civil Defense is the reduction of disasters, which is the result of adverse events, natural or caused by humans, on a vulnerable ecosystem, causing human, material and environmental damage and consequent economic and social losses. The municipal secretariats of Civil Defense are the bodies that take care of the lives of citizens. It presents how the Civil Defense Secretariats are prepared to predict the weather and the heavy rains that generate urban floods and how the sewage collection network is maintained. We understand that it could be responsible for the analysis of contaminants in the waters as well.

KEYWORDS: Flooding. Sanitation. Cities.

1 INTRODUCTION

"Natural disasters" are not truly natural, but the result of natural hazards combined with social, political and economic factors. After a climate disaster, the vulnerabilities of certain populations, due to race, ethnicity, gender, age, income or ability, are magnified, creating a greater risk.

Urban sanitation is important for the quality of cities, which face challenges related to water supply, sewage collection, rainwater drainage, flood control and waste treatment, among others.

Rains have been more concentrated and stronger in each place, nowadays than in the past and therefore, hilly places suffer more as greater volumes of water runs down the slopes. Soil waterproofing aggravates the problem as it prevents water infiltration, causing it to flow superficially, carrying solid waste left in its path, oils, chemicals, fecal coliforms, etc. Rain brings a significant amount of water to cities which, as it follows its natural course through the thalweg, often overcomes human interventions that try to stop or reduce its flow. Pollutants can be thus transported to bodies of water, causing pollution and/or contamination.

In its urban cycle, water ~~it~~ is used for cleaning. Around 80% of the water supply is transformed into sanitary sewage or wastewater (black and gray water) that needs to be treated to reduce its polluting load. Sludge resulting from sewage treatment must be recycled. Urban solid waste is generated by activities carried out in the city and it often remains where it is released, slowly degrading and becoming sources of pollution and contamination. Recycling is one of the solutions and depends on the available technology.

The intergovernmental panel on climate change (IPCC, 2023) highlights metropolises and their areas of influence as one focus of attention to face the climate issue. Global warming is the result of human influence on the atmosphere, ocean and soil. It is predicted that by 2030, around 5 billion people will live in cities, making them more vulnerable to extreme weather events. Green and blue infrastructure can reduce energy use and the risk of extreme events, generating benefits for health, well-being and livelihoods.

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The National Basic Sanitation Plan (Plansab) is the main instrument of the federal basic sanitation policy, with a 20-year horizon (2014 to 2033) and annual evaluation. In 2018, 384 Brazilian municipalities declared the occurrence of displaced or homeless people due to impactful hydrological events. The country faces a deficit of around 40% of the population without adequate access to water supply, 60% without sewage coverage and 40% without adequate management of urban solid waste (Sinis, 2023). Furthermore, the infrastructure for rainwater management and flood control faces significant deficiencies in many Brazilian municipalities, highlighting the urgency of actions to guarantee access to quality basic sanitation services throughout the country.

Municipal basic sanitation plans are made up of guidelines, studies, programs, projects, priorities, goals, normative acts and procedures that aim to assess the state of environmental health, including the provision of public services related to it, and define the programming of the actions and investments necessary to guarantee the provision of basic sanitation services.

Sanitation influences the Municipal Master Plan which directs its expansion. It is not possible to think of a Municipal Basic Sanitation Plan (PMSB) without relation to the Municipal Master Plan.

This work shows how prepared, or not, the civil defense departments of the municipalities, Marica and Niterói, in the state of Rio de Janeiro are to deal with extreme weather events and consequently with basic sanitation.

2 BASIC SANITATION AND ITS RELATIONSHIP WITH CLIMATE CHANGE

Global climate variations can have significant impacts on water supply, on the disposal of sewage and urban solid waste, and on rainwater drainage. It is essential to consider the impacts of climate change in the management of water and sewage services, to guarantee the resilience and quality of these services in the face of climate uncertainties.

The consequences of changes in precipitation patterns have already modified the water cycle and its natural fluctuation of fixed variation systems. It is no longer possible to plan water supply systems or sanitation infrastructure based on these fixed variation models, since such models are no longer reliable considering climate change scenarios and projections, says Ferreira Filho (2020).

The volume of rain above normal is adopted as a method of identifying the impacts of climate change, as it increases the proliferation of diseases in places where sewage collection and treatment are lacking, where there is a risk of contamination due to contact with this untreated effluent. Physic-chemical parameters of water can be easily compromised by increasing temperature, such as increased turbidity and fecal contamination which affects water potability, causing increasing costs for the operation of water treatment plants (WTPs), if the systems are not reevaluated. Faced with these occurrences, sewage treatment plants (ETES) receive a volume above normal.

Regarding the impacts of climate variations on the provision of sanitation services, it is possible to identify that water availability may be affected by the reduction in drought flows,

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which may lead to the need for emergency measures and system expansions, especially in large cities.

Urban drainage refers to the set of measures designed to manage rainwater runoff in urban areas. This includes the implementation of systems for capturing, transporting and treating rainwater, aiming to prevent flooding, erosion and other negative impacts resulting from water accumulation. Furthermore, urban drainage also considers the preservation of water quality and the mitigation of the effects of soil sealing resulting from urban development. The objective is to promote sustainable management of rainwater, contributing to safety and quality of life in urban areas. Stormwater management is already heavily impacted by variations in rainfall regimes, which can worsen the situation in urban areas with inadequate drainage systems. Standards and regulations can pressure the country to adopt changes in the conceptions of sanitation solutions, on account of international agreements. More intense rains tend to worsen the functioning of the drainage network, producing flows greater than those projected, while rising sea levels can increase the criticality of this scenario, generating restrictions in the system's discharge and creating backwater conditions and flooding. amount.

The increase in rainfall affects the water supply and sewage collection networks. The impact on the water supply system can be caused by both scarcity and excess rainfall. Intense rains tend to intensify erosion and leaching processes, generating increased turbidity and compromising the water treated by ETAs. In extreme situations, such as heavy rains or intense weather events, the structures they flow into, such as dams, may not be able to handle the volume of water, leading to overflow and compromising their integrity. This could result in flooding and significant damage to downstream areas, posing a serious risk to the safety of communities and the environment. The sanitary sewage system is impacted by the introduction of rainwater into the sewage networks. Rainwater management with a focus on reorganizing flows in basins and creating areas for the temporary storage of rainwater should alleviate the overload on the drainage system, which, in the face of climate variations, tends to lose conduction and drainage capacity. The main drainage channels in cities operate close to or at the limit of their capacity (sometimes they already have significant deficits). Therefore, the relevance of open spaces to deal with floods stands out, as they absorb the increase in rainwater volume deficits which can be worsened by climate change. Solving drainage problems paves the way for solving several other issues related to urban sectors and services.

Floods directly affect the conditions of occupation of urban space and can interrupt sanitation networks and others when failures occur. Sanitary sewage comprises the actions and systems aimed at the collection, transportation and adequate treatment of domestic waste, to preserve public health and protect the environment. These systems can range from conventional sewage collection to local collection systems such as septic tanks and latrines. The choice of the sewage system must consider the availability of water, cultural issues and technical feasibility, aiming to ensure adequate waste management and protection of the population's health. Floods resulting from extreme events can affect ETEs, Solid Waste Transshipment Stations or ETAs located in areas at risk of flooding, resulting in physical losses, infrastructure collapse and possible impacts on the operations of the sanitation sectors. More frequent and larger floods also have the potential to disperse solid waste throughout flooded areas, putting public health at risk and contributing to the degradation of the natural and built environment.

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Of the total number of Brazilian homes lacking a bathroom in 2022, 27.4% were in urban areas and 72.6% in rural areas, indicating a greater inadequacy of housing in rural areas. This idea is corroborated by the fact that 10 out of every 100 rural homes did not have a bathroom for exclusive use. This is due to the difficulties and high cost of collecting and transporting sewage in distant regions.

Sanitation systems can be divided into:

External: these are ways in which sewage and fecal and domestic waste are taken outside the house. They must be sent to a sewage treatment plant (ETE) before being discarded into the environment. They are found in urban areas. They often provide greater convenience than on-site methods and ultimate responsibility for waste treatment and disposal usually lies with the owner, a utility or local authority. Conventional sewage is very expensive and requires a water supply to function properly. However, cost analyzes show that sewage treatment becomes cheaper than local methods at higher population densities. It is important to know the physical and hydraulic characteristics of collection networks; dimensions and location of interceptors; characteristics of the ETEs, as well as the cost of operating and maintaining the system and verifying the adequacy of the technological engineering and management model to the local reality.

Local: including septic tanks and all forms of latrines. Waste is stored at the disposal point where it undergoes some degree of decomposition. Systems require periodic emptying or construction of new facilities when full. They often pose a significant hazard because fecal matter accumulates in one place and contaminants leach out as well.

Pits typically retain the solid component in a sealed tank, where the matter decomposes anaerobically. Liquid effluent is usually discharged into a well. When they are well designed and constructed, the solid mass does not pose a significant danger. The liquid part that infiltrates the soil is called hydraulic load. Where hydraulic loads are high and exceed the natural attenuation potential in the subsoil, they can lead to direct water contamination. Latrines are generally not sealed and are generally appropriate when the level of water supply is low (community or backyard) and are not appropriate when large volumes of wastewater are generated. In most latrine designs, the liquid part of the waste is allowed to infiltrate the soil. Latrines are the cheapest form of sanitation and can be easily constructed. In rural areas, they often represent the only viable sanitation option, given the low level of water supply service. In many peri-urban areas latrines can pose a greater danger than in rural areas, as their number increases the potential for pollution.

The urbanization of a basin occurs with an accelerated process of waterproofing its surface, because of the construction of buildings, paved streets, sidewalks, parking lots, etc. These changes in soil permeability reduce infiltration and increase the volume runoff. In addition to reducing infiltration, there are other aspects that influence the “natural” characteristics of infiltration in urban areas, such as the presence of landfills, excavation, soil compaction, mixing of materials with different grain sizes, etc. The incorporation of semi-permeable and impermeable surfaces makes the ground surface smoother, which increases runoff speed. Storage in surface depressions is also reduced, further increasing the excess precipitation run off at the surface. In addition to these, there are other circumstances that can cause floods, such as the choking of the river section due to the construction of bridge pillars, impoundments

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generated by dams or larger rivers, among others. After the land occupation process, the basin's response to different types of rain changes. Under these conditions, the basin is capable of generating runoff for the most frequent events. The proportion of increase in surface flow is greater in more frequent events. Water losses due to interception and evaporation are negligible on the time scale of a rainy event in an urban basin.

Other changes resulting from urban development in the basin are changes in the drainage system, materialized in the construction of micro-drainage works and substantial modifications in macro-drainage, increasing the length of the channels that are straightened, and their surface is often coated. These changes generally increase runoff. The negative impact of the urbanization of a river basin should be highlighted not only by flooding and the increase in the volume of surface runoff, but also by other environmental impacts such as the worsening of the water quality of the watercourses that cross the city; the increase in sediment production; contamination of aquifers and the spread of water-related diseases.

There are three most worrying undesirable aspects arising from land occupation: considerable increase in the volume and speed of surface runoff; increase in sediment production due to erosion; and deterioration in the quality of water drained by storm sewers.

Therefore, to design a drainage network, the total length of the municipality's paved roads must be calculated / maintain the drainage capacity / use compensatory structures that favor the temporary retention of surface runoff and favor the infiltration and percolation of water into the soil, such as reservoirs , infiltration plans, percolation trenches, porous pavements, etc. / improve rain forecasting systems and alerts / develop environmental education projects and programs aimed at reducing the release of waste into networks / identify the main types of problems (flooding, overflowing streams, pipe capacity, etc.) observed in the area urban area and its frequency / verify the relationship between population evolution, occupation density, expansion of the urban area and the number of floods / verify the existence of maintenance and cleaning of natural and artificial drainage and the frequency with which they are carried out / have a geo-referenced sketch of the main basins contributing to micro and macro drainage in order to analyze the limit capacity and observe bottlenecks and critical flood areas / reduce average water velocities by recovering the natural conditions of the channel flow / survey morphological, morphometric characteristics and flow calculation for each drainage channel / publicize the risks of urban flooding / have permanent water depollution policies / develop environmental education projects and programs / establish zoning, with restrictions on occupation according to the flood risk / establish alert systems and emergency safety actions for areas where the only option is to live with floods / adapt to current legislation and the need to implement the Urban Drainage and Stormwater Management Master Plan.

Bathroom deprivation is related to the way garbage is collected. The management of urban solid waste is also a challenge for cities, which involves the collection, transportation, treatment and adequate final disposal of waste, aiming to minimize environmental and public health impacts. You must consider the reduction of waste generation, recycling and reuse of materials, in addition to the appropriate final disposal of non-recyclable waste. It is important to involve the population in waste management, through environmental awareness and education campaigns, aiming to promote shared responsibility in the management of urban solid waste. In its management, it must be considered that although its non-generation,

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minimization and recycling must be a goal to be pursued, there are difficulties in ensuring that the material cycle is achieved in the short and medium terms, which means that the area for final disposal of waste collected is still an important factor. The recycling process also requires area, which is important in planning. Another factor of great importance is the interface between public cleaning and the culture and social conditions of the local community. Urban cleaning and solid waste management services are highly dependent on credibility and acceptance by users so that they can be more effective. Furthermore, the fact that part of the urban solid waste has economic value must be considered, as there are people who make their living in “scavenging”.

3 CIVIL DEFENSE

Civil Defense aims to guarantee the natural right to life and safety, especially in disaster circumstances. It works in the reduction of disasters, which result from adverse events, natural or caused by humans, causing human, material and environmental damage, and consequent economic and social losses. The intensity of disasters depends on the interaction between the adverse event and the vulnerability of the environment, and can be quantified in significant damage.

The National Policy for Civil Protection and Defense (PNPDEC) covers prevention, mitigation, preparation, response and recovery actions related to civil protection and defense, integrating with territorial planning, urban development, health, environment, climate change and resource management policies, aiming to promote sustainable development.

Civil Defense is an integral part of the National System of Civil Protection and Defense made up of federal, state, municipal and Federal District public administration bodies and entities that work in the area of civil protection and defense, centralized by the National Secretariat of Civil Protection and Defense belonging to the Ministry of National Integration.

3.1 Civil defense in the municipalities

Municipal civil defense departments are responsible for civil protection and defense. In extreme events such as floods, floods and landslides, Civil Defense is the body responsible for political, administrative and executive coordination to resolve emergency problems and mitigate damage to the population in the first moment of the events occurring. It is important for the articulation of all emergency and contingency policies and actions at the municipal level, as it can connect to the regional, state or national level, wherever applicable. Civil Defense responds to climate emergencies.

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Figure 1 – Diagram showing the tasks performed by the Maricá Civil Defense Secretariat

Source: Lecture given by the coordinator of the Civil Defense Secretariat of Maricá on 10/10/2023 at PPGAU-UFF

There is equipment for climate forecasting:

Anemograph: Continuously records the direction (in degrees) and instantaneous wind speed (in m/s), the total distance (in km) traveled by the wind relative to the instrument and gusts (in m/s).

Anemometer: Measures the wind speed (in m/s) and, in some types, also the direction (in degrees).

Barograph: Continuously records atmospheric pressure in millimeters of mercury (mm Hg) or millibars (mb).

Mercury Barometer: Measures the atmospheric pressure in column of millimeters of mercury (mm Hg) and in hectopascal (hPa).

Tar Evaporimeter: Measures evaporation – in milliliters (ml) or millimeters of evaporated water – from a porous surface, kept permanently moistened by water.

Heliograph: Records the insolation or the duration of the sun's brightness, in hours and tenths.

Hygrograph: Records the humidity of the air, in relative values, expressed as a percentage (%).

Microbarograph: Continuously records atmospheric pressure in millimeters of mercury (mm Hg) or in hectopascal (hPa), on a scale larger than that of the Barograph, recording the smallest variations in pressure, which gives it greater precision.

Pyranograph: Continuously records variations in the intensity of global solar radiation, in cal.cm¬^{2}.mm¬^{1}.

Pyranometer: Measures global or diffuse solar radiation, in cal.cm¬^{2}.mm¬^{1}.

Pluviograph: Records the amount of rainfall (rain), in millimeters (mm).

Rain gauge: Measures the amount of rainfall (rainfall), in millimeters (mm).

Psychrometer: Measures the relative humidity of the air – indirectly – in percentage (%). It consists of two identical thermometers, one called a dry bulb thermometer, and the other with the bulb wrapped in gauze or cotton shoelace kept constantly wet, called a wet bulb thermometer.

Class A Evaporimetric Tank: Measures evaporation – in millimeters (mm) – on a water-free surface.

Thermograph – Records the temperature of the air, in degrees Celsius (°C).

Thermohygrograph: Records both the temperature (°C) and the relative humidity (%).

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Maximum and Minimum Thermometers: Indicate the maximum and minimum air temperatures (°C) that occur in the day.
Soil Thermometers: Indicate soil temperatures, at various depths, in degrees Celsius.
Weather radar: locates precipitation, calculates its displacement, estimates its type (rain, snow, hail etc.) and intensity. The variables obtained can be analyzed to determine the internal structure of the rain clouds (e.g., thunderstorms), and the associated ascending, descending, converging and rotational wind currents. From this analysis one can determine its potential to cause severe weather.

It was sought to know if/how the Civil Defense Secretariats of Maricá and Niterói are prepared to predict floods. This is shown by the resources that the two secretariats have.

3.2 Maricá

Maricá is a municipality with a population of 197,277 inhabitants (IBGE, 2022) with 545.61 inhabitants per km^2 and the GDP in 2020 was 216,519.52. According to the National Sanitation Information System, only 4.63% do not have sewage and 0% are subject to flooding (SINIS, 2021).

The municipality did not present the Master Plan until January 2024 (https://www.marica.rj.gov.br/plano-diretor/ accessed in January 2024). The basic sanitation plan was presented (https://www.marica.rj.gov.br/plano-diretor/ access in Oct 2023) with the diagnoses of water supply, sanitary sewage, drainage and solid waste, with the definition of objectives, with the proposal of interventions based on the analysis of different scenarios and establishment of priorities, with the physical, financial and institutional programming of the implementation of the defined interventions and with the review and update schedule.

Maricá has a Civil Defense Secretariat that aims to ensure the safety and well-being of the population in disaster situations. The secretariat works in the prevention, mitigation, preparation, response and recovery of disasters, coordinating protection and civil defense actions in partnership with other agencies and entities. In addition, it carries out awareness and education actions for the population on preventive and safety measures, promotes training and qualification for agents involved in disaster management, and prepares contingency and disaster response plans. The objective is to guarantee a quick and efficient response in emergencies, minimizing the impacts and losses caused by disasters in the municipality of Maricá.

Data relating to civil defense was collected.

Civil Defense has a Hydro meteorological Monitoring Center composed of 04 meteorological stations with continuous monitoring in 24 hours; 30 rain gauges and an alert system with 08 sirens for activation and local communication in case of possible events.

The instrument to quantify the volume of rain (in real time) is the rain gauge. In the municipality of Maricá, there are:

8 rain gauges from the CEMADEN network, linked to the Federal Govenment;

2 rain gauges from the INEA network, which are also accompanied by sensors that measure the river level; and

31 stations of the Maricá City Hall network, which are divided into: 14 Alert and Alarm stations, 7 for hydrological risk purposes (rain gauge + river level sensor + warning and alarm

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system), 6 for geological risk purposes (rain gauge + alert and alarm system) and 1 located at the bus station for the purpose of warnings and information to the population (rain gauge + alert and alarm system);

and more

7 hydrological stations (rain gauge + river level sensor),

5 meteorological (rain gauge + sensors for temperature, pressure, wind speed and direction, relative humidity and solar radiation), and

5 rainfall only.

It is worth mentioning that the city hall's station network began its implementation in 2022 and still does not have verified data for studies, only for weather monitoring.

CEMADEN stations are in Espraiado, Guaratiba, Inoã, Itaipuaçu, Itapepa, Ponta Negra. INEA's stations are in Barra de Maricá and Mumbucá.

These networks have public data for monitoring, through the links:

CEMADEN Network:

http://sjc.salvar.cemaden.gov.br/resources/graficos/interativo/grafico_CEMADEN.php?idpcd=3713&uf=RJ

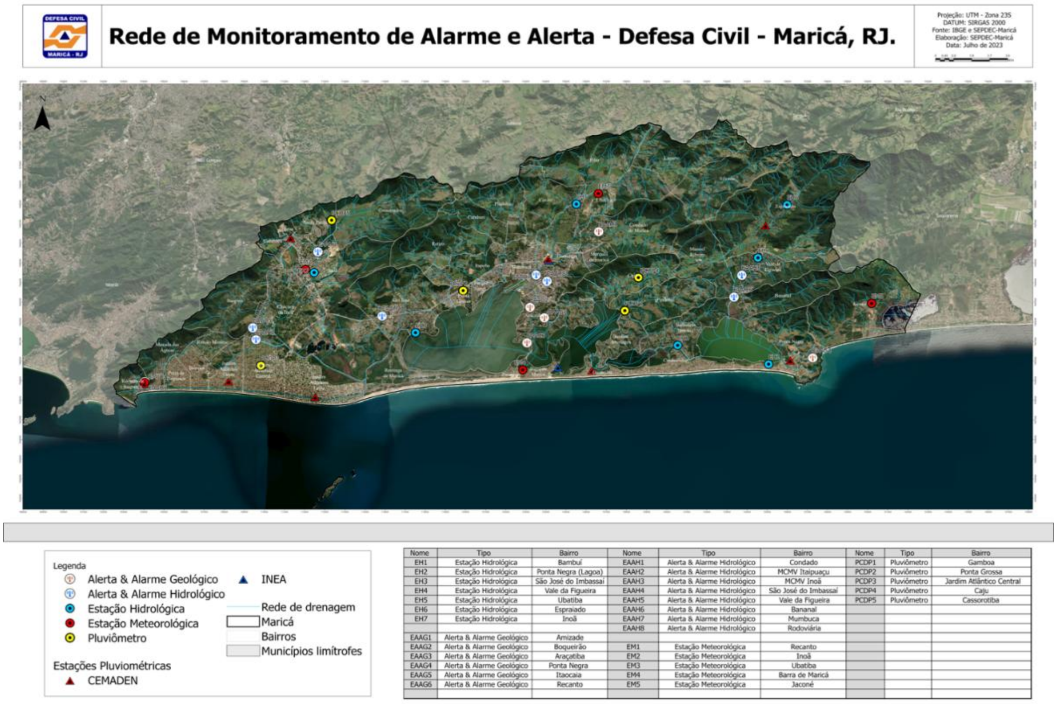
INEA Barra de Maricá Station:

http://alertadecheias.inea.rj.gov.br/alertadecheias/999992020.html

INEA Mumbuca Station: http://alertadecheias.inea.rj.gov.br/alertadecheias/224243520.html

The rain gauges, as well as the river level sensors and other sensors of the meteorological stations are shown in Figure 2.

Figure 2 – Image with the location of the INEA and CEMADEN Stations in Maricá



Source: Maricá Civil Defense Secretariat

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There are no radars implemented in the municipality, however, radar images are used, which show the displacement/formation of rain nuclei.

REDEMET, located at Pico do Couto in Petrópolis, whose link is: https://www.redemet.aer.mil.br/ with a range of 400 km. After accessing the link, click on Products (left side) and then on Radars. A new screen will open, and then the user must click on the arrow above Radar. Once this is done, one of Cappi's options must be chosen to then define the Pico do Couto/RJ radar in animation.

INEA, one located in the municipality of Macaé, and the other in the neighborhood of Guaratiba, in the city of Rio de Janeiro. All radars have public access through the link http://alertadecheias.inea.rj.gov.br/radar.php and have a range of 250 km.

It uses METAR code information (regular aerodrome meteorological report) from Maricá airport (SBMI), through the Aeronautics Command Meteorology Network (REDEMET) website, which contains wind information (speed/direction), temperature, dew point temperature, atmospheric pressure, present weather and cloudiness.

To monitor the weather, satellite images are used from the Center for Weather Forecasting and Climate Studies (CPTEC https://www.cptec.inpe.br/dsat/) and the National Institute of Meteorology (INMET https://satelite. inmet.gov.br/).

3.3 Niterói

Data related to civil defense were collected on the websites.

Niterói is a municipality with a population of 481,749 inhabitants and a population density of 3,601.67 inhabitants per km², with a GDP of 79,464.67 in 2020 (IBGE, 2022).

Only 4.45% of the population does not have access to basic sanitation, and housing is subject to flooding (SNIS, 2021).

Regarding sanitation, the Niterói Master Plan (https://urbanismo.niteroi.rj.gov.br/ anexos/Plano%20Diretor/Revisão%20PD/Lei%20nº%203385-19%20PL%2008-17%20 republicação. pdf) contains general goals and guidelines for environmental sanitation policy. Integrated basic sanitation or the use of services in an integrated manner is mentioned that it should be a guideline, of the capacity for expansion and densification of urban areas based on the capacity of the installed infrastructure Therefore, sanitation is the guiding element in reading the city and the zoning proposal. The urban policy instruments established in the City Statute, when proposed for cities, must consider the overload on the infrastructure that they may generate. Sanitation solutions appropriate to socio-environmental realities that aim for sustainability must support the proposals of the municipal master plan. It characterizes and analyzes the conditions of water sources in use and the waterproofing rate of an allotment or plots reflects the parameters defined based on the relationship between urban flooding and soil waterproofing.

The possibility of reusing rainwater can help in solving problems detected during the municipal planning analytical phase such as the most suitable place for the final disposal of urban solid waste, the survey of areas at risk of flooding and restrictions on waterproofing, the measures for rainwater collection must also be considered as well as the need for sewage treatment plants and their best location.

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Flooding problems occur in areas bordering the Maruí and Bomba rivers, mainly due to the existence of several choke points in the drainage section, a consequence of poorly planned urbanization. The effect of tides also contributes to intensifying the problem.

Niterói Municipal Basic Sanitation Plan was made available at https://www.seconser.niteroi.rj.gov.br/plano-municipal-de-saneamento-basico. It includes diagnoses of water supply, sewage, drainage and solid waste with the definition of short, medium and long-term objectives; the proposal of interventions based on the analysis of different scenarios and establishment of priorities; the physical, financial and institutional program for the implementation of the defined interventions and with the programming review and update.

Civil Defense has a hydro meteorological Monitoring Center composed of 04 meteorological stations with continuous monitoring 24 hours/a day: 46 rain gauges and a warning system with 30 sirens for activation and local communication in the event of possible events. Among them:

17 rain gauges from the CEMADEN network, linked to the Federal Government.

2 rain gauges from the INEA network, which are also accompanied by sensors that measure the river level.

The CEMADEN stations are in Badu, Praia João Caetano, Itaipu, Piratininga, Maria Paula, Jurujuba, Santa Bárbara, Largo da Batalha, Morro do Castro, Charitas, Visconde de Itaboraí, Barreto, in Várzea das Moças and Fonseca.

The INEA stations are in Engenhoca and at the Highway Police Battalion

The radar images that show the displacement/formation of rain nuclei in real time, are:

Niterói City Hall, located in Parque da Cidade, whose access link is https://www.defesacivil.niteroi.rj.gov.br/niteroi-radar which has a range of 100 km

INEA, located in the municipality of Macaé, and another in the neighborhood of Guaratiba, whose access link is http://alertadecheias.inea.rj.gov.br/radar.php, which have a range of 250 km.

Rio de Janeiro City Hall: located in Sumaré, Niterói is in a shadow region and this radar ends up not being useful.

REDEMET RADAR: https://www.redemet.aer.mil.br/ After accessing the link, click on Products (left side) and then on Radars. A new screen will open, and then the user must click on the arrow above Radar. Once this is done, one of the Cappi options must be chosen to then define the Pico do Couto/RJ radar in Animation.

The radars that cover the municipality of Niterói have the following ranges:

Niterói City Hall: 100 km

INEA radars (Guaratiba and Macaé): 250 km

For monitoring Niterói's weather, there are still satellite images from the Center for Weather Forecasting and Climate Studies (CPTEC https://www.cptec.inpe.br/dsat/) and the National Institute of Meteorology (INMET https: //satelite.inmet.gov.br/).

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4 FINAL CONSIDERATIONS

As for the sanitary sewage system, there are major deficiencies due to the capacity of the installed system or clandestine sewage connections. There is a risk of flooding which, through the potential increase in volumes of water precipitated, may exceed the hydraulic capacity of the drainage and intensify overflow into the sewage networks. In addition, each liter of water that infiltrates the slope is an extra mass of one kilogram, that is, the entry of water into the slope reduces resistance and increases the load, which is why there are frequent landslides. The implementation of a sanitary belt to intercept illegal sewage from the storm sewer can be a solution to reinforce environmental resilience in the sanitary sewage system, as it ensures a certain level of treatment. Solid waste management seeks to optimize the space allocated to the final disposal of these materials. This occupation can be reduced through recycling policies, reverse logistics and reuse of construction waste. It is essential to monitor the efficiency of household waste collection services and their destination. Currently, garbage has a strong impact on storm drains, rainwater networks and urban rivers, worsening floods and polluting water sources, with negative consequences for environmental quality and public health.

Regarding the stormwater management system, the combination of structural and non-structural measures, together with the use of urban landscape structures with hydraulic functions, enable an approach capable of dealing with the problem of flooding in a balanced and sustainable way. This approach has been considered more appropriate for the treatment of urban flooding, as it addresses the problem in a systemic way and proposes actions that aim to minimize the impacts of urbanization, treating the runoff generation process with interventions at the source (addressing the causes) from the beginning, since plot level. It is essential to deal with runoff distributed across the basin's urban landscape to reduce and delay flood peaks, allow groundwater recharge and seek to restore natural runoff conditions. Preventing the spread of floods must be a premise in the development of new areas and the recovery of degraded areas. This trend, even if not driven by climate change, is in line with the possibility of an effective approach to urban flooding, in contrast to the traditional approach that focuses mainly on increasing drainage capacity through canalization actions. The objective is to adjust the capacity of rivers and canals to the flows generated by the urban basin. Considering the increase in average sea level and the increase in precipitation, the attempt to increase the drainage capacity of the channels does not offer a real capacity to discharge the system. Reservoirs help to reorganize runoff and provide time for the system to discharge more slowly, reducing discharge restrictions due to rising sea levels and requiring a smaller capacity of galleries and channels that receive runoff after buffering. In addition to considering flood reduction as a primary outcome, it is crucial to assess the risk and have a comprehensive view over time of the performance of the proposed solution, in terms of maintaining resistance, functioning capacity and recovery, to increase resilience environmental impact of the rainwater management system.

We are all part of civil defense, which is an integral part of the National Civil Protection and Defense System. In extreme events such as floods, inondations and landslides, Civil Defense is the body responsible for articulating emergency and contingency policies and actions at the municipal level, which can also be articulated at the regional, state or national level, where

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applicable. With regard to climate emergencies in the municipalities of Maricá and Niterói, a survey was carried out in the Civil Defense Secretariats of these municipalities. Maricá uses 5 radars, none of which are in Maricá. In Niterói, only 4.45% of the population does not have sewage service, their homes are subject to flooding (SNIS, 2021). There is a hydrometeorological monitoring center made up of 4 meteorological stations and 46 rain gauges. It uses 4 radars and information on wind (speed/direction), temperature, dew point temperature, atmospheric pressure, current weather and cloudiness and weather monitoring and satellite images from the Center for Weather Forecasting and Climate Studies and the National Institute of Meteorology.

We understand that Civil Defense could, with adequate training, be responsible for more things, for example regarding analyzing contaminants in water. Municipal Civil Defense departments are adapting to climate change, although this adaptation is very slow. Regardless of climate change, the sanitation axis must become more effective, in order to reduce consumption losses and waste, increase spatial coverage and mitigate operational deficiencies.

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