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SCIENTIFIC AND PUBLIC INTEREST IN SANITATION DATA: A MODELING ANALYSIS AND GEOSPATIAL AWARENESS

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Abstract: The research aims to assess both the scientific interest in spatial data on sanitation and the interest of the population in issues related to sanitation. This is especially relevant given the sensitive nature of this data, which must be accessible to the public. The availability of these data is crucial to drive advances in sanitation management. The analysis is conducted using bibliometric techniques and the Google Trends analysis tool. In the bibliometric analysis, a growing academic attention to the issue of modeling water and sewage networks in Geographic Information Systems (GIS) is observed, even if the number of studies is still limited. These studies are grouped into clusters that address topics such as GIS, water networks and treatment, climate change, systems management, water quality and sustainability. At the same time, in the public interest analysis with Google Trends, a significant increase in searches related to sanitation is identified in July 2020, possibly related to the approval of the new regulatory framework for the sector. Frequent searches include basic sanitation, water treatment, water quality and sewage networks. It is concluded that there is a growth in both academic interest and public awareness of sanitation. The results obtained can guide future research and public policies to improve water and sewage systems, moving towards the universalization of sanitation and the Sustainable Development Goals. The research has the potential to influence further studies and decisions related to sanitation, contributing to the well-being and sustainable development of society.

Keywords: sanitation, bibliometrics, google trends, sustainable development goals.

INTRODUCTION

This research intends to investigate whether there is scientific and citizen interest in sanitation data, since it is an infrastructure that guarantees life and directly impacts people's health. Knowing where, in which places investments and network expansion are being destined, public participation and awareness to understand a service that is provided to the population. And to understand if this topic, which is part of the Sustainable Development Goals 6, of the United Nations, is receiving attention from scientists.

And how can we contribute to expanding the data registered in areas where there is a data gap. For this, bibliometric software and the Google Trends tool were used.

When analyzing academic and scientific literature, bibliometrics software can help you identify trends and emerging themes in a field of study. This can be useful to understand where research is heading and which topics are gaining prominence, in addition to allowing you to follow the evolution of research in a specific area over time, identifying important milestones, changes in focus and growth of scientific production.

Google Trends is a free tool provided by Google that allows you to check public interest in topics, keywords or search terms over time. In addition, it provides information on interest in different geographic regions, which is useful for understanding variations across countries, states, or cities. It also makes it possible to validate hypotheses about public interest in certain subjects based on real research data. Furthermore, it is a useful tool for tracking public interest in current events, news and hot topics, providing insights into what is being discussed and sought after by the audience at specific times.

THEORETICAL REFERENCE

Almost 35 million people in Brazil live without access to treated water, while approximately 100 million do not have sewage collection, which results in preventable diseases and can lead to cases of contamination

with risk of death (BRASIL, 2022).

With the objective of achieving the universalization of basic sanitation services, the National Basic Sanitation Plan (PLANSAB) was created, which consists of an integrated planning for the sector until the year 2033 (ANA, s/d).

PLANSAB aims to achieve the Sustainable Development Goals (SDGs) related to sanitation by 2033 in Brazil.

The Sustainable Development Goals (SDGs) were established as a continuation of the Millennium Development Goals (MDGs). SDG n° 6 aims to achieve, by 2030, universal and equitable access to drinking water and sanitation for all (UN in Brazil, 2023).

The National Sanitation Information System (SNIS) provides data on sanitation in Brazil in spreadsheets and chloroplectic maps by region, but does not provide georeferenced data on the network and water and sewage treatment plants.

A Water Supply System is a set of works, facilities and services designed to produce and distribute water to a community, ensuring adequate quantity and quality to meet the needs of the population in domestic consumption, public services, industrial use and other purposes and the wastewater formed by domestic sewage, as well as any releases of industrial sewage and infiltration water, combined, constitute sanitary sewage (FNS, 2015).

Kruszyński & Dawidowicz (2020) point out that decision support systems based on spatial information systems (GIS) associated with specialized software are becoming the modern management standard of water and sewage companies.

In the context of Brazilian sanitation companies, most of them already have their technical and commercial registration on a GIS platform, such as SANEPAR, SABESP, COPASA, CAESB, CAGECE, EMBASA, among others (Agostinho, 2019, p. 4).

According to a document published by SANEPAR on transparency and Information Security, the Technical Register of the Sanitation company of Paraná, Sanepar is confidential, in accordance with Article 173 of the Federal Constitution and Article 22 of Law 12,527/2011. Basic information, such as building alignment and depth, as well as complementary information, such as material and diameter, are considered confidential due to business secrecy issues and risk to competitiveness and corporate governance. The disclosure of this information requires the approval of the Information Classification Commission, and the secrecy period established is 15 years for the Technical Register - Basic Information and 16 years for the Technical Register - Complementary Information.

Many sanitation companies in Brazil, in addition to SANEPAR, have declared confidentiality of registration data.

To assess whether sanitation data, such as maps, is of interest to the population, it is possible to use a Google platform for analyzing internet data called Google Trends.

Google Trends is used to analyze data, which enables permanent monitoring of the population's interests and behavior, and thus qualifies it as an important analysis tool for public health decisions (LIMA, 2023).

By using Google Trends to analyze public interest in sanitation issues, it is possible to discover relevant time patterns, identify geographic regions of greatest interest, reveal related search terms, capture emerging trends, measure the impact of awareness campaigns, differentiate interest in specific aspects of sanitation and understand the evolution of searches over time.

The search strategy can be composed of terms and expressions. The use of quotation marks in expressions limits the results to this

exact form of writing (NUTI et al., 2014).

Considering that Google Trends presents real-time results and enables permanent monitoring, this portal is an important analysis tool for public health decisions (LIMA, 2023).

To assess the interest of scientists in sanitation topics and specialized data, it is feasible to conduct an analysis using information from scientific bases, which can be examined through the use of bibliometric tools, such as VoSViewer, allowing the interpretation and visualization of the results obtained.

Bibliometric methods have been used to track citations of academic journals and help in the organization and analysis of large amounts of information, helping through statistical and mathematical analysis to identify patterns (Daimet al., 2006).

METHODOLOGICAL PROCEDURES

In this section, the methodological procedures used to achieve the specific objectives and, consequently, the general objective of this research will be presented.

A) SEARCH THE WEB OF SCIENCE E SCOPUS DATABASE

The research[1] on the Web of Science was carried out on January 11, 2023, in the scientific database Web of Science, with the keywords "Modeling water and wastewater network GIS" (all fields), articles only, and in the years 2019 to 2022.

In the basis of Scopus[2] the survey carried out on March 14, 2023 used the following query: ITLE-ABS-KEY (modeling AND water AND wastewater AND network AND gis) AND (LIMIT-TO (PUBYEAR, 2023) OR LIMIT-TO (PUBYEAR, 2022) OR LIMIT-TO (PUBYEAR, 2021) OR LIMIT-TO (PUBYEAR, 2020) OR LIMIT-TO (PUBYEAR, 2019) AND (LIMIT-TO (DOCTYPE, "air")).

Using the VOSViewer Bibliometrics software, the information from the articles resulting from the search in each database was analyzed separately.

The software was calibrated with the word co-occurrence parameters (2 times).

B) RESEARCH ON INTEREST IN THE TOPIC OF SANITATION IN GOOGLE WEB SEARCH IN BRAZIL (2018-2023)

To investigate whether issues related to sanitation are of interest to the general public (non-scientists), an analysis was performed with a database made available by the Google Trends tool from the company Google. For this, search parameters made in Web searches were used, in all categories, in the last five years (07/03/2018 to 07/03/2023) in Brazil with the terms "Sanitation", "treated water", "water quality" and "sewage network". In a second search the parameters of searches made in Web searches, in all categories, in the last five years (08/11/2018 to 08/11/2023) in Brazil with the terms "sewage map", "water map", "sanitation data".

With regard to related searches, that is, people who searched for the term (Sanitation, treated water, water quality and sewage system), but also made other queries, the Google Trends[3] (2023), provides data related to the following metric:

a) Main Searches, that is, the most frequent queries. The score is on a relative scale, where 100 is the most searched query; 50 is the query made half as often,

1. Link to survey carried outon January 11, 2023: https://www.webofscience.com/wos/woscc/summary/1fa43ff8-546d-4feb-9a-74-b8bf3605e341-6a126f8c/relevance/1

2. Scopus website. Available in:< https://www.scopus.com/search/form.uri?display=basic&zone=header&origin=recordpage#basic>.

3. Tool available on the website: https://trends.google.com/trends/?geo=BR&hl=pt-BR.

etc.

b) Rising searches are queries with the highest increase in search frequency since the previous period. Results marked with "Sudden increase" saw a very substantial increase, likely due to new queries that had zero or few previous searches.

RESULTS

In this section, the partial results for each research objective will be presented.

A) WEB OF SCIENCE SEARCH RESULT

The result was 19 keywords segmented into 4 clusters:

It is possible to notice that, despite the importance, there are still few searches in the Web of Science database on the subject.

Clusters divided research into four major areas:

1. GIS, networks and water treatment.

2. Climate change and management of water supply network systems

3. Modeling and simulation for water quality

4. Sustainability, optimization and spatial analysis.

Figure1 – Relational Map. Source: Prepared by the authors. To create this relational map, data from a survey carried out on January 11, 2023, in the scientific database Web of Science, with the keywords "Modeling water and wastewater networks GIS" (all fields), only articles, and in the years from 2019 to 2022.

The most recent research focuses on issues related to the water supply network, spatial analysis, sustainability and optimization.

When we select the connections for the keywords "water treatment" and "network", there is proximity to topics related to Geographic Information Systems.

Articles that present studies involving Climate Change, for the most part, carried out a framework of urban modeling of rainwater. Some articles, such as Fitobór et al. 2022, involve assessing the impacts of climate change and mitigating measures on the risk of flooding, pollution loads and impermeable areas.

Clusters divided searches into two areas:

1. Sewage, environment, models, gels and articles.

2. River pollution, sustainable development and water quality.

RESEARCH FOCUSES ON TOPICS SUCH AS:

The study by Kruszyński & Dawidowicz (2020) aimed to present the principles of creation and implementation of an integrated water and sewage management system based on hydrodynamic modeling in small and medium-sized municipal companies. For the authors, GIS, when associated with other specialized software, supports the decision of the management of sanitation systems and is becoming the standard of modern management of a water and sewage company. According to the authors, only in some cases, GIS systems contain modules that model the operation of the network under dynamic conditions.

Patault et al. (2021) aimed to evaluate the variability of sediment discharge in a water treatment plant according to multiple land use scenarios. For the authors, the strategic choice of water catchment sites in karst regions must be based on simulations with surface and underground water parameters and possible changes in land use. The scientists developed a waterfall modeling with a geographic information system (GIS) model of erosion runoff (WaterSed) and neural network-based algorithm.

Font et al. (2019) presents the GLOBAL-FATE as a model that simulates the human consumption and excretion of pharmaceutical products, in attenuation of the contaminant load in wastewater treatment plants rivers, lakes and reservoirs. This model allows interoperability with GIS. The tool can be used to test the effectiveness of large-scale management strategies related to controlling the consumption of pharmaceuticals.

B) RESULT OF PUBLIC INTEREST IN TOPICS RELATED TO SANITATION IN GOOGLE WEB SEARCH (2019-2023)

Figure 3 shows the interest and searches made by Google over time in the last five years (03/07/2018 to 03/07/2023), on the themes "Sanitation", "treated water", "water quality" and "sewer network":

There is a peak in searches in July 2020, when the new regulatory framework for sanitation was approved in Brazil.

Regarding the interest by sub-region of the 5 most interested in topics in Brazil:

a) Sanitation: Amapá, Acre, Sergipe, Alagoas and Amazonas.

b) Treated Water: Goiás, Minas Gerais, Rio Grande do Sul, Bahia and Paraná.

c) Water quality: Roraima, Rondônia, Paraíba, Pará and Piauí.

d) Sewage Network: Mato Grosso, Mato Grosso do Sul, Minas Gerais, Espírito Santo and Paraná.

Table 1, breaks down by region the percentage of interest of the theme on the Web in the period from 03/07/2018 to 03/07/2023.

According to SNIS (2021), the investment deficit in access to water and sewage services is greater in the North and Northeast regions of Brazil, while in the Southeast, South and Midwest regions the percentage of investments is greater than the deficit.

Regarding related searches, that is, people who searched for the term (Sanitation, treated water, water quality and sewage system), but also made other queries, the terms searched with the highest scores were:

a) Sanitation:

I) Main: basic sanitation, basic sanitation, what is sanitation, sanitation in brazil, what is basic sanitation.

II) Rise: sanitation legal framework, new sanitation framework, new sanitation legal framework, basic sanitation legal framework, new basic sanitation framework.

b) Treated water

I) Main: water treatment, how water is treated, drinking water, basic sanitation and mineral water.

II) Ascension: what care needs to be taken in regions where water is not treated, brainly, what is basic sanitation, what are the stages of water treatment, academic google.

c) Water quality:

I) Main: no, water quality, water, water pollution, pollution.

II) Ascension: water pollution combined with waste has generated several problems for the maintenance of this precious asset. in order to contribute to the quality and responsible use of water, what does dbo mean and why is it one of the parameters for verifying water quality, in relation to the instruments of public environmental control policies, what are the main contributions of water to the human being? and a city is supplied by a reservoir with a capacity of 3.

d) Sewer network:

I) Main: what is the sewage network,

sewage collection network, sewage treatment, sewage box and cesspool.

II) Ascension: non-biodegradable detergents, inside the sun, the solar system is located in the position indicated by, the sun is approximately 150 million kilometers from the earth, it is important that the houses have access to the sewage collection network and which non-biodegradable detergents.

The graph of the second survey expressed in Figure 1, denotes a constant interest in sanitation data, with peaks in the middle of 2022. Water maps have higher searches than other terms, with significant interest from Google users in Brazil.

The research related to the theme, according to Google Trends (2023b), most prominently is "lack of basic sanitation in Brazil", with most searches in the State of São Paulo. And the second related subject is "data", which showed a sudden increase in searches.

DISCUSSION

In this discussion chapter, the main results obtained from the methodological procedures described above will be addressed. Exploratory research was carried out in different databases, bibliometric analyses, analysis of public interest by themes related to sanitation and research on spatial data available on the web about water and sewage networks in Brazil.

1. Results of the research in the Web of Science and Scopus databases: In the exploratory research in the Web of Science and Scopus databases, it was possible to identify the existence of scientific research on the theme of "model of water and sewage networks in of Geographic Information". The results showed that there is academic interest around this subject, although the number of studies is still limited. The articles were grouped into clusters that address different aspects of the topic, such as GIS, water networks and treatment,

climate change and management of water supply systems, modeling and simulation for water quality, sustainability, optimization and spatial analysis.

2. Search results on public interest in sanitation in Google search: The analysis of public interest in topics related to sanitation in Google search revealed patterns of interest over time and by region of Brazil. There was a significant increase in searches related to sanitation in July 2020, probably related to the approval of the new regulatory framework for basic sanitation in the country. The most frequent surveys are related to basic sanitation, water treatment, water quality and sewage networks. In addition, rising terms were identified, indicating emerging topics of public interest.

CONCLUSION

Through the methodological procedures adopted, it was possible to obtain relevant results on the theme of "model of water and sewage networks in a Geographic Information System". Scientific studies on the subject are limited, but there is growing interest in the subject, especially related to sustainability, climate change and systems optimization. Public interest in sanitation in Brazil is significant, peaking at relevant times, such as the approval of the new regulatory framework for basic sanitation.

As for the spatial sanitation data available on the web, it was found that there is information available in institutions such as SNIS and IBGE, however, not all of them make the data available for download. It is important that institutions continue to improve the availability and accessibility of these data so that they can be widely used in research and decision-making in the sanitation sector.

In short, this research contributed to the understanding of the current scenario of scientific studies, public interest and
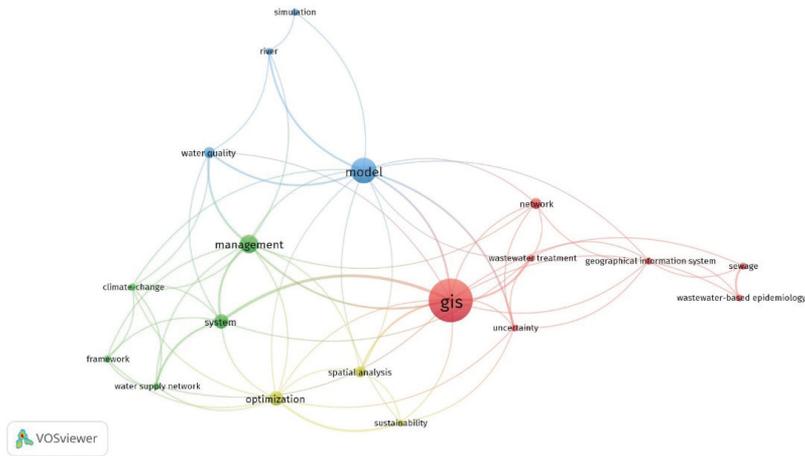
Figure 1: Keyword relationship map throughout the publication period in VOS Viewer
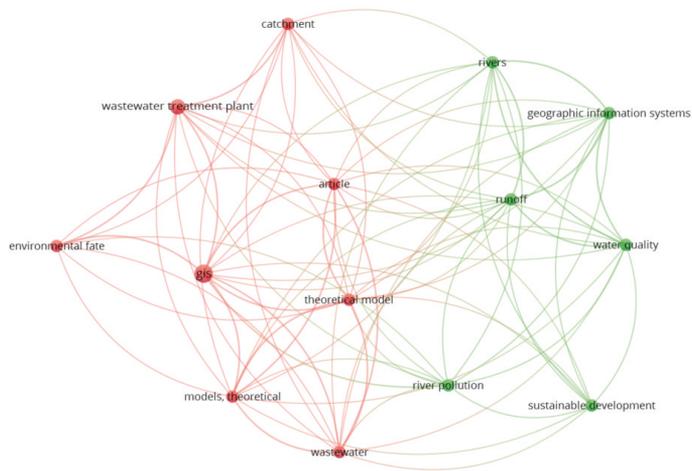

Figure 2 - Keyword relationship map over the publication period in VOS Viewer

Source: Figure prepared by the author with data from research carried out in March 2023 on Scopus, with the keywords "Modeling water and wastewater network GIS" (all fields), articles only and in the years 2019 to 2022.
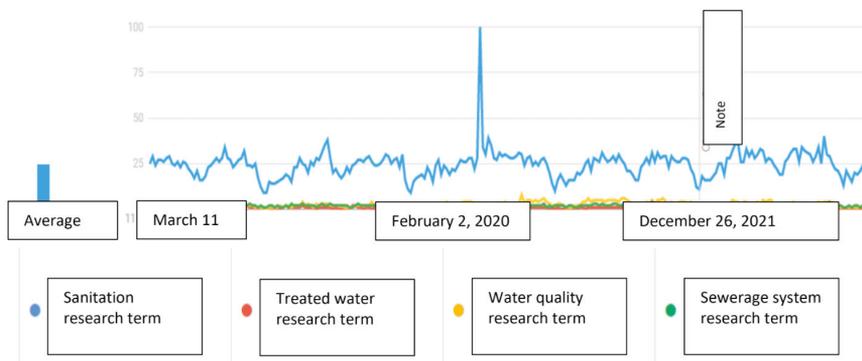

Figure 3: Interest over time (2018-2023).

Region	Sanitation	Treated water	Water quality	Sewerage system
Sergipe	95%		5%	
Santa Catarina	89%	1%	5%	5%
Amapá	100%			
Tocantins	88%		12%	
Roraima	81%		19%	
Alagoas	92%		8%	
Pará	82%		14%	4%
Federal District	89%		6%	5%
Acre	100%			
Bahia	81%	2%	9%	8%
Piauí	86%		14%	
Pernambuco	85%	2%	9%	4%
Rondônia	77%		16%	7%
Paraná	82%	2%	7%	9%
Maranhão	79%		14%	7%
Paraíba	86%		14%	
Ceará	81%	2%	11%	6%
Goiás	78%	3%	10%	9%
Amazonas	90%		10%	
Mato Grosso	77%		12%	11%
Rio Grande do Norte	89%		11%	
Rio de Janeiro	87%	2%	6%	5%
São Paulo	86%	2%	6%	6%
Mato Grosso do Sul	77%		12%	11%
Espírito Santo	79%		11%	10%
Minas Gerais	75%	3%	12%	10%
Rio Grande do Sul	84%	2%	8%	6%

Table 1 Percentage of interest by topic and region on the web in the period from 03/07/2018 to 03/07/2023.

Source: Prepared by the author with data from Google Trends (2023).
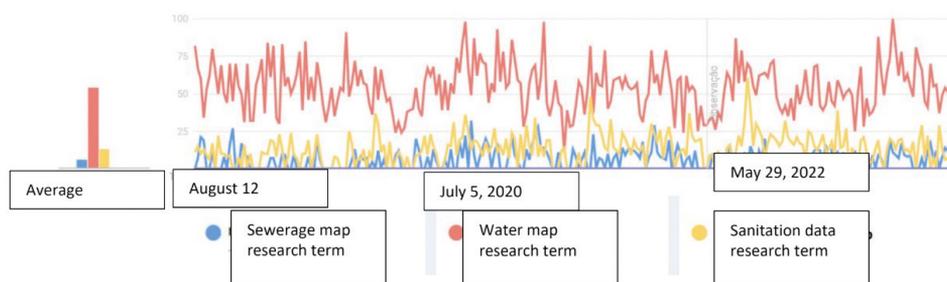

Figure 4 - Interest in the topics "sewage map", "water map" and "sanitation data" over time (2018-2023).

Source: Google Trends, (2023b). Available at: https://trends.google.com/trends/explore?date=today%20 5-y&geo=BR&q=mapa%20de%20esgoto,mapa%20de%20%20agua,data%20de%20saniamento&hl=pt. Accessed August 11, 2023.

availability of spatial data related to water and sewage networks in Brazil. It is hoped that the results presented here can support future research and public policies aimed at sanitation and the use of geospatial technologies to improve water supply and sanitary sewage systems in the country.

Ultimately, the pursuit of universal sanitation in Brazil goes beyond access to water and sewage, involving public awareness, scientific support, and ongoing collaboration across diverse sectors. The dissemination of information, the use of technological tools and the active engagement of society are essential pieces to promote the much-needed change towards a healthier and more sustainable future.

It is hoped that this study will stimulate the continuity of research on sanitation and its georeferenced data, and that the results presented here can be used as a basis for the implementation of effective public policies, thus contributing to the improvement of the living conditions of the population. and the sustainable development of the country towards the universalization of sanitation services and the Sustainable Development Goals.

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