



Impacts of Climate Change on Water Resources and Public Health: A Content Analysis in Brazil

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Research Article

Volume 8 Issue 2

Received Date: July 18, 2024

Published Date: August 01, 2024

DOI: 10.23880/phoa-16000290

Abstract

The article analyzes, through a review of scientific literature, the relationship between climate change, water quality and public health, over a decade (2011-2021), in Brazil. Key themes were listed, including organic contamination, water scarcity and the impacts of climate change on health. Database analyses demonstrate the little exploration of these topics where the great complexity of managing available water resources is emphasized. The few Brazilian articles found in a decade, just 6, support the need for integrated approaches between the economic, environmental and public health sectors. They reiterate that greater awareness and integration of different areas is necessary to face the effects of climate change for the effective management of water resources, aiming to mitigate their scarcity, loss of quality and, above all, avoid causing health problems in communities.

Keywords: Climate Change; Public Health; Drinking Water; Environment

Abbreviations

UN: United Nations; MRSP: Metropolitan Region of Sao Paulo; GDP: Gross Domestic Product.

Introduction

According to publications by the Intergovernmental Panel on Climate Change IPCC [1,2] and the Pan American Health Organization PAHO [3], the increase in the frequency and effects of natural disasters resulting from global environmental and climate changes, such as the acceleration of water cycle due to atmospheric heating, intense rains,

hail, floods, windstorms, heat and cold waves, forest fires and landslides, will cause even more serious consequences for the health and well-being of communities in the coming years, mainly, to poor and vulnerable populations because they do not have adequate means of protection OPAS [4].

The VI Report of the IPCC Working Group points out that the world will probably exceed 1.5°C of warming in the next two decades. Levin and Rhys go further and state that continued high gas emissions will lead to a 5.7°C increase in temperature by the year 2100, with catastrophic results for humanity Levin K, et al. [5].

Climate change has been a relevant topic on the agenda of governments, companies and society, as it demands broad commitment to actions aimed at reducing greenhouse gas emissions, aiming at their mitigation and adaptation to face climate change Fiocruz, et al. [6]. Limiting warming and avoiding severe climate impacts will depend on actions taken this decade, that is, only ambitious cuts in gas emissions will make it possible to maintain the increase in global temperature at the level of 1.5°C, the maximum limit accepted by scientists to prevent extreme climate impacts.

In this scenario, it is essential to discuss the availability and quality of water for human consumption, energy production, agricultural and industrial use in light of climate change and its impacts on the spread of diseases Cann KF, et al. [7]; Semenza JC, et al. [8].

The inaccessibility to drinking water for millions of people in rural areas of developing countries, even though it is a basic human right recognized by the United Nations (UN) General Assembly since 2010, and one of the goals of the UN Sustainable Development Goals, in addition to the risk of shortages and the intermittency of services in urban areas will favor the reappearance of diseases related to water consumption Aberilla JM, et al. [9].

The increase in temperature associated with precarious sanitation conditions contributes to the proliferation and reproduction of pathogens, with an increase in infectious diseases transmitted by vectors during heavy rainfall, extending the period of reproduction and distribution of diseases, the migration of vectors, insects and animals hosts Sterk A, et al. [10]; Sjerps RMA, et al. [11]; Ventura DFL, et al. [12]; Haikerwal A, et al. [13]. Climate change is also attributed to altering the quality of surface waters with potential implications for public health, especially regarding the treatability of water in drinking water treatment plants Valdivia M, et al. [14].

Researches show that emergence of resistance to antimicrobial drugs complicates the treatment of common water-borne diseases, such as *Escherichia Coli* infections, while drug residues lead to the evolution of resistant pathogens isolated in water underground and in water birds, whose concentration is expected to increase in the near future, given the scarcity of water resources Vittecoq M, et al. [15], WHO [16], Bonnedahl JM, et al. [17], Economides C, et al. [18], Petrovic MA, et al. [19].

Regarding non-infectious diseases and climate change, illnesses resulting from increasing concentrations of sodium in drinking water sources stand out, a situation that has already affected Southeast Asia. The significant presence of

sodium and its daily intake in drinking water in areas affected by salinity have become a risk factor for hypertension and the risk of gestational pre-eclampsia Khan AE, et al. [20], Talukder M, et al. [21], Scheelbeek PFD, et al. [22].

Another result of climate change on waters, freshwater environments are expected to become more favorable to the production of harmful blooms that generate cyanotoxins. A recent ecological study demonstrated a significant association between an increased risk of mortality from non-alcoholic liver disease and freshwater cyanobacterial blooms, just as epidemiological studies highlighted the relationship between cyanotoxins in drinking water and liver cancer and colorectal cancer. Such associations have identified cyanobacterial blooms as a global obstacle to public and environmental health, affecting bodies of fresh water that in turn are fundamental sources of drinking water Jiyoun L, et al. [23].

In Brazil, around 80% of energy comes from hydroelectric plants, which makes it highly dependent on hydrological regimes. Water is a fundamental resource for the country in the economic sphere, as agricultural productivity represents more than 25% of the national economy CEPEA [24]. Water resources have been the target of enormous demands for grain production and livestock in the central west, irrigated fruit growing in humid valleys in the semi-arid northeast, expansion of the hydroelectric sector in the northern region and mining in the states of Bahia and Minas Gerais. The impacts resulting from activities carried out using water have generated serious consequences for the environment and affected populations, generating conflicts that perpetuate and expand in the explored territories Peixoto FS, et al. [25].

The way water resources are being managed in Brazil has not mitigated or resolved these conflicts. The hierarchical structures linked to the water resources management system have fed back into the actions of hegemonic groups interested in increasingly exploiting them to the detriment of the rights and interests of local and socially vulnerable groups that do not have the strength and mobilization conditions for effective political action Peixoto FS, et al. [25].

Research carried out between 2013 and 2015, in the Brazilian semi-arid region, showed that the reservoirs studied suffered sharp losses in water volumes, leading community members to adapt their behaviors and seek water from alternative sources in response to long-term droughts. Climate change affects seasonal rainfall patterns which, in turn, will determine the availability and quantity of water resources, causing changes in the sources of water used by human populations, their strategies for accessing this resource and patterns of water use Galvao J, et al. [26].

In addition to the environmental and social impacts inherent to the excessive exploitation of water resources in the country, the lack of rain and the occurrence of extreme events resulting from climate change in recent years, depending on their origin UFSC [27], IPCC [2]:

- 1) Climatological (drought, drought): 54%
- 2) Hydrological (sudden and gradual flooding and flooding): 33%
- 3) Meteorological (cyclones, gales, storms): 7% and
- 4) Geological (mass movements, landslides and other types of disasters): 6%.

The Water Crisis in Sao Paulo, Brazil and the Risks to Public Health

In the southeastern region of Brazil, intense seasonal droughts have already occurred in 1953, 1971 and 2001, and in recent years, the metropolitan region of Sao Paulo (MRSP) has experienced one of the greatest droughts in its history. The combination of low rainfall, particularly in the summers of 2013-2014 and 2014-2015, the large increase in water demand and the lack of adequate planning for water resource management have generated the so-called “water crisis”.

Sao Paulo state is located in the southeast region, with an area of 248,209 km² (3.0% of the Brazilian territory) and a population about 45 million inhabitants. It is the most populous state and ranks first nationally in innovation, being economically the richest representing 31.2% of the national Gross Domestic Product (GDP) in 2022 Brasil [28], IBGE [29]. However, despite enjoying a prominent position, the latest Inland Water Quality Report in the State of Sao Paulo points out that 89% of inhabitants have sewage collection, but only 66% receive effluent treatment before being released into water bodies. This fact leads to contamination by sewage and consequent eutrophication of water bodies, which aggravated by low volumes of rain, much lower than historical averages since 2021, results in the occurrence of cyanobacteria blooms affecting important water sources for the production of drinking water Rijsberman FR, et al. [30], Salehi M, et al. [31], CETESB [32].

The high demand for water for urban-industrial activities and the periods of drought and water rationing in recent years, led the Sao Paulo public authorities to seek water increasingly further afield, such as the largest transfer of water from the basins of the Juquiá and Itapanhaú Rivers, Sao Lourenço, Itatinga, promoting a contribution of around 6.7 m³/s, to other systems that supply the Metropolitan Region of Sao Paulo with enormous economic and socio-environmental costs Soriano LDR, et al. [33], Peixoto FS, et al. [34].

In the 2014 drought, there was a significant reduction in water resources in this region, affecting natural ecosystems and the supply of water for human consumption, with the use of other more costly and unsafe forms of water supply such as tanker trucks and bottled mineral water, among others Marengo JA, et al. [35], Silva JL, et al. [36]. In 2021, the low annual volumes of rainfall presented in the state of Sao Paulo, considerably lower than the respective historical averages, and the reduction in the flow of water bodies with restricted rainfall volume, resulted in the death of fish due to the low concentration of dissolved oxygen associated the low flow in rivers and the reduction in the volume of dams. The lack of rain and contamination by sewage led to the eutrophication of the water body with the occurrence of cyanobacteria blooms with serious health risks CETESB [32].

Understanding social and environmental determinants and conditions such as demography, sanitation, mortality and hospitalizations in Brazil becomes fundamental, considering the correlation between illnesses, socioeconomic contexts, and diseases resulting from inadequate environmental sanitation Gracie R, et al. [37].

Given this context of situational worsening, this work proposes, based on a review of the integrative scientific literature, to identify the most recent publications on the interrelationship of the theme “Climate Change, Water and Health”.

Methodology

Based on the identification and analysis of articles published on the subject in the period 2011-2021, this study carried out searches on the Scopus, PubMed and Google Scholar platforms and considered the following combinations of descriptors: “Climate Change, Public Health”; “Climate Change, Drink Water” and “Climate Change, Public Health, Drinking Water” to collect articles published in English.

❖ For the Combinations Researched were Found:

- “Climate Change, Public Health”: 18,984 articles and 1,060,000 citations;
- “Climate Change, Drink Water”: 4,646 articles and 20,500 citations and,
- “Climate Change, Public Health, Drinking Water”: 297 articles, (11 of which are duplicates) and 17,800 citations.

In a first scan, 286 articles relevant to the theme “Climate change, Water and Health” were found, including full text and abstracts. From this universe, 40 articles were excluded with duplicate information, low quality citations

and problems such as absence of abstract, incomplete text, without identification data, editor, volume and/or edition of the journal, reaching “N” of 246 articles for analysis published around the world in all databases of the Universe of 246 Publications, all abstracts were read. Only seven (7) were of Brazilian origin and all of these texts were read in full and analyzed.

Results and Discussion

In the review it was possible to observe that 31% of the articles focus on organic contamination, 20% on water resources management, 10% inorganic contamination, 7% water-related diseases, 6% scarcity, 5% efficiency in water treatment and 21% related to other topics. It was also possible to analyze great concern with water quality as found in 41% of the articles and with the management of these waters in 20% of publications. It is important to highlight the low number of publications (16%) on the topic by developing countries, which are the most vulnerable to the impacts of climate change.

The Universe of 246 Publications, Only Seven (7) were of Brazilian Origin.

Seven studies were relevant to the topic, however one of them was not considered. This study carried out by Valente and Campos in 2019 that discusses the risks of chemical contamination of water from the point of view of animal health and its economic impacts, not being the direct object of this study Valente-Campos S, et al. [38].

The six Brazilian publications analyzed are directly or indirectly associated with issues relating to efficiency in water treatment and the eutrophication of water bodies.

Four discuss how climate change can impact the health of populations by reducing water availability, whether in quantity or quality. These studies were carried out in the Brazilian semi-arid region, a region most vulnerable to water scarcity.

The Table 1 explains the six Brazilian articles, according to authorship and their respective thematic axes.

Themes	Sena et al.	Walter et al.	Barros et al.	Fiocruz	Azevedo et al.	Peixoto
Eff. In water treatment	X					
Scarcity	X	X			X	X
Water diseases				X		
Inorganic contamination	X		X			
Water resource management			X	X	X	X
Organic contamination		X	X			X
Others				X		

Table 1: Brazilian articles according to thematic axes and authorship.

Research carried out by Sena A, et al. [39] reviews the SDGs to understand their relationships from the point of view of social, economic and environmental dimensions, water treatment and in particular the relationship between water, drought (desertification) and health Sena A, et al. [39]. Study carried out by de Azevedo E, et al. [40] assesses the impact of climate change that affects seasonal precipitation patterns, reducing the availability and quantity of water resources, causing changes in the sources of water used by human populations Azevedo E, et al. [40].

The reduction in rainfall regimes and, in turn, the amount of water available in springs causes an increase in the concentration of pollutants, which in turn, promotes the proliferation of toxic cyanobacteria in public supply reservoirs Walter JM, et al. [41], Barros MUG, et al. [42].

Brazilian environmental conditions, where 57.6% of the population does not have sewage collection and 60% of the sewage collected is thrown, in natura, into water bodies Brasil [29] exacerbate concerns related to the triad relationship of climate change, water resources and public health. Despite Brazil appearing on the world stage in a privileged situation in relation to the degree of water scarcity, water pollution and contamination increase in an urban-industrial territorial configuration of gradual increase year by year due to more demand for water Fiocruz, et al. [6], Peixoto FS, et al. [25,34].

Conclusion

There is no lack of evidence that the health sector should be concerned about climate change, as it can influence the quantity and quality of water for human consumption and the spread of diseases.

The analysis of the publications shows that most of the problems related to the quality and availability of water are linked to the disorderly demands for different uses such as agriculture, industry, hydroelectric power and supply for human consumption, leading to the displacement of families and traditional populations due to poor water quality and frequent droughts. The damming of rivers, flooding of areas for construction of dams and dams and reduction of flow produce several socioeconomic conflicts in the affected regions, generating significant impacts on the living conditions of populations, mainly in relation to access to water in its quantity and quality for human consumption.

In this complex scenario, the effective integration between the economic, environmental and health sectors is also repeatedly highlighted in the analyzed production, as fundamental to the adequate planning of actions to mitigate the impacts of climate change on Public Health, since ongoing climate change have changed the magnitude and frequency of flood and drought events, resulting in environmental, economic and social damage, with serious consequences for the health.

Database analyses demonstrate the little exploration of these topics in Brazil. The six Brazilian articles found in a decade about these thematic axes, support the need for integrated approaches between the economic, environmental and public health sectors. All of them reiterate that greater awareness and integration of different areas is necessary to face the effects of climate change for the effective management of water resources, aiming to mitigate their scarcity, loss of quality and, above all, avoid causing health problems in communities.

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