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Water and COVID-19 Pandemic: A Literature Review

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Abstract: ***This literature review analytically discovers how the complex dynamic between Water and the extraordinary challenges caused by the COVID-19 epidemic is associated the critical synthesis and Evaluation of the selected papers reveals a diverse set of techniques and results, contributing to the research knowledge of the complex interplay between the pandemic and water parameters. Ranging from different studies on the topic, the review comes up with a critical analysis of 15 water demand articles that deal in varied areas, covering water resilience in the United Kingdom and Ireland, water resource disruptions in India, and so on. What is more is that the analysis of varying results and methods leads to the highlight of common patterns and differences, which lays out the general direction of research on such a significant subject. By looking for common issues in different editions, the subject matter of the uncertainty involved becomes precise and complicated. The results highlight that the pandemic has affected multiple facets of Water globally. Each study offers a distinct perspective, from modeling in Saudi Arabia to researching water quality in Hawai'i during lockdowns. While "Water Sector Resilience in the United Kingdom and Ireland: The COVID-19 Challenge" focuses on adaptation strategies, "Changes in Water Use and wastewater generation influenced by the COVID-19 pandemic: A Case Study of China" looks at Regional Variations. The concluding section describes outcomes and suggestions for the broader perception of water associations with the pandemic.***

Keywords*: *COVID-19, Water, Pandemic, Complex Dynamic

I. INTRODUCTION

The global water problems and the worldwide scope of the COVID-19 pandemic are an exceedingly complex challenge that requires realistic and practical exploration and solutions. This comprehensive rereading of tremendous issues emanating from the health crisis that has affected water resources is underway. The essay illustrates a problem in three subsections, which are arranged in a way that highlights the salient features of the problem.

A. Literature Trends

Reviewing the recent trends in the research survey, the main ideas and inquiries found within the extensive water-connected studies during COVID-19 are identified. Using different studies in the area of literature, we attempt in this course to pinpoint common queries and patterns that other researchers used in this intersection of environment and health.

B. Scope

Inviting the research investigation is the main thing that will allow for a concise and comprehensive review of the research examination. This sub-theme is explained in detail, which defines the exact zones of the subject of Water during the coronavirus, which will be the object of our study. The literature review will begin with the water demand modeling and its implementations in various contexts till the resilience assessment in different geographical contexts. Through this, the literature review can provide a road map to the readers so that they are familiar with the path of the review.

C. Contributions

We advocate the analysis of this systematic assessment as an academic exercise and a best practice with the potential to enhance further the science we know. This part of the study is closely focused on the specification of the objectives of the review since it is the primary purpose of extracting the information that could be valuable for the future work. As research on water systems in the context of the COVID-19 pandemic is elevating, this paper focuses on the conclusions and the implications of this work, as well as supporting resource management. Through this research, the following two sections will present detailed narratives on twelve highly influential publications, each presenting a single aspect of the intricate connection between water systems and the profound changes created by pandemics. With synthesizing, analyzing, and critically evaluating these works in mind, the research goal is to produce a depiction of the current knowledge status to open the gate for further research in the core of the evolving area facing the most significant challenges.

II. LITERATURE SYNTHESIS

The present study offers some insights, including introducing different kinds of research (ranging from views on the relationship between water issues and the progression of the pandemic to the relation between the nature of water supplies and the spread of COVID-19). At the same time, research from a social housing complex in Brazil is combined with the pre- and post-water consumption patterns to establish more understanding of the regional trends (Cominato et al., 2022, [1][16]). The extraordinary situation of people confined to their places of residence and the loss of the tourism sector was a remarkable opportunity for some researchers (Garcia et al., 2023, [2]).

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Iin their paper regarding the tourism situation in the Balearic Islands, Spain.

Their work plugs the essential hole in water programs by looking into how much Water is turned directly or indirectly for tourism in the 2019 and 2020 comparisons.

In analyzing the complicated relationships between water resources and the COVID-19 pandemic, "Water sector resilience in the United Kingdom and Ireland: The COVID-19 challenge" makes an essential contribution by diving into the water sector's Resilience (Walker et al., 2023, [3]). This study gives unique insights into the adaptive tactics used in response to the pandemic's challenges, illuminating the sector's ability to resist and traverse extraordinary change. Furthermore, "COVID-19 Lockdown Disruptions on Water Resources, Wastewater, and Agriculture in India" thoroughly analyzes the broad effects of lockdown measures on several elements of water use in India (Balamurugan et al., 2021, [4]).

"Impacts on water quality" seeks to delve into the indirect consequences that COVID-19 has on water quality, as evident in the association between the pandemic and most environmental variables (Raza et al., 2022, [5]). A new method is being studied, and a natural experiment is being carried out in Hawaii, concerned about tourism water usage during the closure period of COVID-19. However, it is a unique insight that is essential while covering the effect of the pandemic on water standards.

Spatially focused, the 'Evaluation of the influence of COVID-19 lockdown on surface water quality in Ireland' utilizes an advanced Irish water quality index model to appreciate the layered dynamics of lockdown impact on the region (Uddin et al., 2023, [6]). Also, the "COVID-19 pandemic lockdown modulation of physicochemical parameters of surface water" affirms COVID-19's influence on the Karamana River, Southwestern India's physicochemical parameters (Prasood et al., 2023, [7]). Investigations of these types provide diverse new perspectives on the specific interactive relationship between the COVID-19 pandemic and water quality accessories, thus contributing to the overall understanding of the severe implications for environmental health.

Table 1 Summarize and Synthesize

Study Title	Focus/Area	Methodology	Location	Authors
Indirect effects of Covid-19 on water quality	Indirect consequences on water quality	Study on the association between COVID-19 and environmental variables	USA	Raza et al., 2022, [5]
The Mathematical Modeling Approach for the Wastewater Treatment Process in Saudi Arabia during COVID-19 Pandemic.	identifying a coronavirus hotspot through existing wastewater plants in major cities of Saudi Arabia.	Mathematical Modeling Approach	Saudi Arabia	Abdullah et al., S.2022 [15]
Social housing complex in Brazil	Pre- and post-water consumption patterns	Comparative analysis with regional trends	Brazil	Cominato et al., 2022, [1][18]
Water sector resilience in the United Kingdom and Ireland	Water sector resilience during COVID-19	In-depth analysis of adaptive tactics	United Kingdom, Ireland	Walker et al., 2023, [3]
COVID-19 Lockdown Disruptions on Water Resources in India	Effects of lockdown measures on water use	Comprehensive analysis of lockdown impact on water use	India	Balamurugan et al., 2021, [4]

III. ANALYZE AND INTERPRET

The selected articles' presentations and reflective interpretation demonstrate a diversity in appreciation of the world effects of the COVID-19 pandemic on the hydrologic cycle. For instance, in Phuket, Thailand, a pandemic water use pattern is changing due to travel restrictions, high tourism activities, high and low tourism activities, and other more severe effects (Changklom et al., 2022, [8]). The diversity of the approaches, such as modeling techniques in Saudi Arabia and technologically advanced water quality indicators in Ireland, demonstrates the relationship between water fluctuations and the pandemic. "Water quality effects" is an article that deals with the indirect impacts of the pandemic on water quality and demonstrates a clear relationship between COVID-19 and the state of the environment of waters (Raza et al., 2022, [5]). On this note, it is particularly worth mentioning the study's uniqueness as Hawai'i is an uncommon single case study examining tourists' water usage during the shuttering of the COVID-19 pandemic. These studies demonstrate how human activities, pandemics, and water quality have intricate links.

"The study "Explain the Effect of Covid – 19 Lockdown on Surface Water Quality in Ireland" at a national level employs a highly developed water quality index model for Ireland. This is one of the methods of the research will use to understand the impacts of water lockdowns, specifically in Irish conditions. Likewise, "The effect of COVID-19 pandemic lockdown on the physicochemical characteristics of surface water in the Karamana River Basin in Southwest India" analyzes physicochemical parameters in the Karamana River Basin to reveal how localized effects caused by pandemic-based lockdowns work.

The significant table, which helps in clearly sorting methodology and results observed from varied research papers, points out the usefulness of the findings. Now, this comparison is not just about highlighting the uniforms and differences but is the vehicle for more specific trends to surface in the articles. Through these studies, the pandemic further drives into the intricacies of water movement problems and serves as an input in environmental health studies and water management programs across the globe.

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Table 2: Analyze and Interpret

Study title	Focus	Methodology	Location	Authors
Social housing complex in Brazil	Pre- and post-water consumption patterns	Comparative analysis with regional trends	Brazil	Cominato et al., 2022, [1] [17] [19] [20]
Water sector resilience in the United Kingdom and Ireland	Water sector resilience during COVID-19	In-depth analysis of adaptive tactics	United Kingdom, Ireland	Walker et al., 2023, [3]
COVID-19 Lockdown Disruptions on Water Resources in India	Effects of lockdown measures on water use	Comprehensive analysis of lockdown impact on water use	India	Balamurugan et al., 2021, [4]
Evaluation of the influence of COVID-19 lockdown in Ireland	Lockdown impact on surface water quality	Utilizes an Irish water quality index model	Ireland	Uddin et al., 2023, [5]
COVID-19 pandemic lockdown modulation of physicochemical parameters	Influence on Karamana River physicochemical parameters	Analysis of lockdown modulation on river parameters	Southwestern India	Prasood et al., 2023, [7]

IV. RESULTS AND FINDINGS

This discovery reveals the inconsistencies that on-ground research shows in the dynamics of water systems, which are critical aspects as the pandemic progresses. As an illustration, "Water Demand Profile Before and during the

COVID-19 Pandemic in a Brazilian Social Housing Complex" is in complete contrast to the first one. Instead of presenting dissenting facts, it shows how water demand profiles have changed before and during the pandemic. Although COVID-19 lockdowns have impacted water demand differently worldwide, Resilience has become a priority, and actors in the existing food system are expected to show adaptive behaviors that may allow them to cope with either threats or opportunities (Zurek et al., 2022, [9]). The procedure acknowledges that implementing resilience enhancements involves ethical dimensions and ultimately necessitates negotiations among various interest groups.

During the COVID-19 pandemic, many positive and negative changes have happened; it allowed for the release of an enormous amount of medical waste while, on the other side, it also helped improve the air and water quality worldwide. Air quality data from remote sensing showed an apparent decline in pollutants, especially around waste centers like Wuhan, Italy, Spain, and the US during the lockdowns (Kazak et al., 2021, [10]). This set of changes, which also occurred on the beach and around, made for a quieter and cleaner environment. The literature represents the complex way the SARS-CoV-2 pandemic has affected water resources. It stresses the importance of integrating studies that fully time-lineally unfold the effects of the pandemic on water resources. The pandemic's unquestionable impact on water flow cannot be doubted, and it has resulted in changes in demand patterns, water quality, and the resilient nature of the water sector. The Articles "Water Sector Resilience in the United Kingdom and Ireland: For instance, the papers "The COVID-19 Challenge" and "COVID-19 Lockdown Disruptions on Water Resources, Wastewater and Agriculture in India" taken from the United Kingdom, Ireland and India, stand to exhibit the most expansive influence of pandemic-causing lockdown restrictions on the provision of Water and the management of wastewater and the agriculture field (Balamurugan, et al.,2021 , [4]) Through these researches one can see that public health work inextricably links hospital aquatic rehabilitation to global dilemmas in water management, stressing the worldwide interdependence between water and environmental problems to social and economic fate of the world. This leads to the formulation of adaptively flexible policies while creating a robust framework that can withstand global challenges at present and in the future.

According to the literature review, a comprehensive and complete picture of the multifaceted impacts of the COVID-19 pandemic on the trip of water dynamics is elucidated. The conclusions of the integration synthesis are undoubtedly clear on the fact that health and environmental management are interdependent at different levels. Thus, opponents of adaptive policies require a more profound understanding of the link between the two. This literature brings to the foreground myriad themes, trends, ironies, and gaps, which will form the basis for more intensive investigation in the future. The basic information about this issue is the starting point necessary for officials, scientists, and practitioners to process da concerning the water space and respond to global water challenges and environmental and human health accordingly.

V. CRITICALLY EVALUATE

The analysis of the selected studies against each other gives way to a complex context in which strengths and limitations are revealed, resulting in a better understanding of the diverse changes in water dynamics at COVID-19 times. "Understanding Household Water-Use Behavior and Consumption Patterns during COVID-19 Lockdown in Saudi Arabia" how the online questionnaire survey spatial approach can dependably evaluate the water demand effects. Although a case study within Saudi Arabia would help illuminate the Saudi Arabia movement, the findings may not present a generalizable application. Just like that, "Water demand profile at the eve of the COVID-19 pandemic and during the COVID-19 pandemic in a Brazilian Social Housing complex" is the study that analyzes pre and post-pandemic water demand profile.

Nevertheless, implementing the VILA system in urban environments other than favelas may need to be revised.

The role of water security in the immediate global arena is a foremost matter, especially in the Pacific region, which is highly exposed to climate change factors. World statistics on this issue sound alarming by showing 600 million people have no clean drinking water and about 2,4 billion have no proper sanitation. Thus, the situation is urgent. Coinciding with the significance of climate change on water sources is the situation in a state like Hawaii, where most of its groundwater is used (DeMaagd et al., 2022, [11]). Though small on a global scale, the tourism sector still imposes a significant problem in water-intensive places; for example, in Hawaii, hotels and resorts cover the higher rate of water demand. The direct and indirect link between tourism growth, water scarcity, and climate change is addressed using Bali as a case of unsustainable local aquifer exploitation, which is linked to tourism.

Over the years, COVID-19-induced modifications in the ways of life, mode of production, and trade routes have affected water consumption and pollution. Already a massive problem worldwide, water scarcity will become more severe with multiple consequences for volume and quality (Jia et al., 2022, [12]). The pathogenic viruses in Water and sewage networks transfer diseases. Therefore, patients in hospitals or healthcare-suffocated buildings face the danger of contamination and hazards, hence the need for intelligent sanitation systems.

Within the context of water sector resilience, "Water sector resilience in the United Kingdom and Ireland: The document 'COVID-19 confrontation'" presents a detailed analysis. The strengths of Stretch Studio include reminding us that it is of utmost importance to consider the distinctions between the two locations. Still, we need to pay more attention to these differences.

The catastrophe of COVID-19 has negatively impacted the global industrial supply chain, with China contending as the principal manufacturing center for raw materials. In 2020, Chinese coastal regions like Fujian Province followed strict lockdown policies. Consequently, the drivers of sectoral trade were severely shaken. Despite the global economic crisis, water quantity and quality were the winners in the aftermath of the pandemic lockdown management, which the global ecology had achieved (Yu et al., 2023, [13]). This research aims to explore the case of Fujian Province, which combines the three components of wasteful and polluting Water: physical, virtual, and total. The study found a drop in the quantity of natural Water and an increased level of local water quality when the lockdown was lifted.

In the study of water quality dynamics, "Impacts on water quality" makes a significant contribution by investigating the indirect impacts of COVID-19, enhancing the literature with nuanced findings. However, difficulties separating these impacts from other environmental elements may bring complexity that undermines the study's validity. On a separate point,

"Tourism water use during the COVID-19 shutdown: A natural experiment in Hawai'i" provides an interesting perspective. Nonetheless, the possible constraint in generalizability owing to the unique Hawaiian environment cautions against applying findings to other contexts, underlining the need for more studies in different geographical locations for a complete understanding.

"Evaluation of COVID-19 lockdown effect on surface water quality in Ireland" differentiates primarily in applying Ireland's water quality index, enabling a deeper assessment (Uddin et al., 2023, [6]). Nonetheless, the focus of the study being on Ireland alone may be a limiting factor to reaching the study's applicability to the cases of other geographic regions. Similarly, the "COVID-19 pandemic lockdown affected the physico-chemical parameters of surface water in the Southwest India" showed that the study provides SWN with essential insights (Prasood et al., 2023, [7]). Nevertheless, ascertaining the exact relationship between the observed physicochemical variances and the prevalent pandemic impacts continues to be complex, underscoring the necessity to have a myriad of data that give a broad knowledge of all the environmental phenomena in the study area.

The analysis of water dynamics, "Driving forces and variation in water footprint before and after the COVID-19 lockdown in Fujian Province of China," and "COVID-19 water sector responses in Europe: The primary 'scoping review of preliminary recommendations for governmental interventions' can also be considered (Antwi et al., 2021, [14]). Nevertheless, the latter can be drivers of water cycles. Therefore, it may refer to a more direct causation analysis that will limit the development of a complete set of mechanisms responsible for water footprints' fluctuation. On the one side, a recommender analysis of European countries' governmental initiatives may have limitations because of the necessity to choose only a few of them and monitor them. Stressing these considerations illustrates the need for more research on whether an established connection exists and, if so, what the best intervention for that specific case would be.

A significant part of this critical review is related to the fact that both positive and negative characteristics of each paper should be taken into consideration, the differences in methodology should be discussed, as well as the details regarding the geographic location of the study; in general, the sum of all papers of this kind extended the global knowledge of the complex connection between COVID epidemic and the world water problem.

Identifying the strengths and locating the gaps unveiled here will be instrumental in formulating more comprehensive and enlightened programs that guide the research activities of the given field. This activity is essential for designing strategies suited for protecting water resources as the world continues to face various global challenges in the future.

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Table 3: Critical Evaluation

ARTICLE TITLE	STRENGTH	WEAKNESS
Walker et al., 2023, [3]	Provides in-depth analysis of water sector resilience in the United Kingdom and Ireland.	Limited emphasis on potential variations between the two regions.
Balamurugan et al., 2021, [4]	A comprehensive examination of pandemic-induced disruptions on water resources in India.	It may need to address regional disparities within India thoroughly.
Raza et al., 2022, [5]	Explores indirect effects of COVID-19 on water quality, adding depth to the literature.	Potential challenges in isolating indirect effects from other environmental factors.
DeMaagd et al., 2022, [11]	Presents a unique natural experiment in Hawai'i, contributing an unconventional perspective.	Generalizability may be limited due to the uniqueness of the Hawaiian context.
Uddin et al., 2023, [6]	Utilizes advanced Irish water quality index model for nuanced assessment.	The focus on Ireland might limit broader applicability. |
Prasood et al., 2023, [7]	Investigates pandemic-induced modulation of physico-chemical parameters in Southwest India.	Potential challenges in attributing changes solely to pandemic effects.
Yu et al.,2023, [13]	Examines driving forces and variations in water footprint in Fujian Province, China.	It may lack direct causation analysis between driving forces and variations.
Antwi et al., 2021[14]	A scoping review offers a preliminary understanding of governmental interventions in Europe.	A more in-depth analysis of the effectiveness of interventions may be needed.
Kazak et al., 2021, [10]	Explores changes in water demand patterns in a European city.	Limited generalizability to diverse urban contexts globally.
Jia et al., 2022, [12]	Case study of changes in China's water use and wastewater generation during the pandemic.	Limited focus on potential regional variations within China.

VI. CONCLUSION

Finally, this literature review thoroughly examines the impacts of the COVID-19 pandemic on global water dynamics. The critical synthesis and Evaluation of the selected papers reveals a diverse set of techniques and results, contributing to the research knowledge of the complex interplay between the pandemic and water parameters. Each study offers a distinct perspective, from modeling in Saudi Arabia to researching water quality in Hawai'i during lockdowns. While "Water Sector Resilience in the United Kingdom and Ireland: The COVID-19 Challenge" focuses on adaptation strategies, "Changes in Water Use and wastewater generation influenced by the COVID-19 pandemic: A Case Study of China" looks at Regional Variations.

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Ethical Approval and Consent to Participate	No, the article does not require ethical approval and consent to participate with evidence.
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Authors Contributions	I am only the sole author of the article.

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