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DIVING INTO THE TWEET
UNDERSTANDING WATER RESOURCES THROUGH TWITTER SENTIMENT ANALYSIS

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CONTENTS

PUBLIC SENTIMENT ON WATER RESOURCES

Water is a vital and fundamental resource that plays a crucial role in sustaining life, ecosystems, and socio-economic development. Its significance cannot be overstated, as it supports various essential functions in our daily lives and has far-reaching impacts on both the natural environment and human society. As the global population continues to grow, the demand for water resources intensifies, posing significant challenges for their management and sustainability.

Sustainability, in the context of water resources, encompasses multiple dimensions that must be carefully considered and balanced. These dimensions include economic, social, and environmental criteria. Water, being a cross-cutting element, flows through each of these dimensions, making its sustainable management a prerequisite for many environmental policies (UNESCO, 2020). It is crucial to recognize that sustainable water management goes beyond simply meeting current water needs; it also involves ensuring the availability and quality of water for future generations.

Achieving sustainable water management requires comprehensive strategies and concerted efforts from various stakeholders, including governments, communities, industries, and individuals. However, the success of implementing such strategies heavily depends on the public opinion and support for water-related issues (Dahal *et al.*, 2019). Public attitudes and perceptions towards climate-related issues and

environmental policies significantly influence the direction and effectiveness of water resource management initiatives (Mahafza *et al.*, 2017).

Understanding public sentiment and opinion towards water resources and environmental concerns is, therefore, of paramount importance for policymakers and decision-makers. It provides valuable insights into public perceptions, concerns, and attitudes, enabling them to align policies and strategies with the expectations and needs of the society they serve (Taufek *et al.*, 2021). This is where sentiment analysis, a subfield of natural language processing, comes into play.

Sentiment analysis offers a powerful approach to analyse and quantify public sentiment by examining textual data. By leveraging sentiment analysis techniques, researchers can gain deep insights into how individuals feel and think about specific topics, such as water resources. In recent years, the rise of social media platforms, like Twitter, has provided an abundant source of real-time data, making it an ideal platform for capturing and analysing public sentiment related to water resources.

Twitter, with its vast user base and the ease of publicly expressing opinions and concerns, has become a valuable tool for studying public sentiment. Users often turn to Twitter to share their thoughts, experiences, and emotions regarding various topics, including water resources. By extracting and analysing tweets that mention keywords associated with water resources, researchers can obtain a comprehensive understanding of the public's perceptions, emotions, and attitudes towards this critical resource.

The utilization of social media platforms, like Twitter, in academic research has emerged as a viable alternative to traditional analysis methods, such as surveys. Social media data offers several advantages, including faster and less expensive analyses, as well as direct access to a large pool of participants without geographical limitations. This eliminates the barriers that often accompany traditional research methods, allowing researchers to engage with a more diverse and representative sample of the population.

Moreover, social media platforms serve as dynamic hubs of communication and information exchange, where users actively engage in discussions and share their beliefs, opinions, and experiences related to

environmental issues (Day *et al.*, 2019). In the context of water resources, social media platforms provide a unique opportunity for users to voice their concerns, share their personal experiences with water-related challenges, and participate in discussions about environmental policies and conservation efforts.

From a broader perspective, social media platforms represent a new frontier for climate-related research and environmental accountability. They offer new communication channels that can foster public participation, engagement, and awareness in environmental issues (Rocca *et al.*, 2021). By utilizing social media platforms, researchers can tap into the collective intelligence and wisdom of the crowd, gaining valuable insights that can inform and shape policy decisions.

For the purpose of this study, data collection was conducted during the months of July, August, and September of 2022. This time period was selected due to the occurrence of extremely high temperatures and frequent weather events, which often stimulate discussions and heightened interest in water-related topics. By analysing the sentiment of tweets during this period, researchers aimed to capture the public sentiment and reactions to weather stresses, with a particular focus on negative sentiments associated with drought.

The analysis initially focused on the sentiment of tweets containing the hashtag (#) "water". By analysing a dataset comprising tweets with this keyword, researchers aimed to gain preliminary insights into public sentiment regarding water resources. Subsequently, the analysis was expanded to include a broader range of hashtags, such as "ocean", "sea", "lake", "river", and "glacier". This broader dataset allowed researchers to capture a wider spectrum of sentiments and assess the presence and relevance of topics related to global water resources, including ocean acidification, sea level rise, and glacier melting.

In addition to sentiment analysis, this research project also incorporates other analytical techniques to provide a comprehensive understanding of public sentiment towards water resources. These techniques include investigating the geographical distribution of Twitter users, conducting frequency classification of the most commonly used words in the datasets, and performing word network analysis. By considering these various aspects, researchers aim to gain deeper insights into the

public discourse surrounding water resources and the factors influencing public sentiment.

In summary, this study focuses on sentiment analysis methods and the R software to explore and analyse public sentiment regarding water resources using Twitter as a rich source of data. By leveraging social media platforms, researchers can tap into the collective wisdom of the public and gain valuable insights into public perceptions, emotions, and attitudes towards water resources. Understanding public sentiment is essential for effective policymaking and decision-making processes, enabling policymakers to align their strategies with the expectations and needs of the society they serve. Furthermore, the utilization of social media platforms in research offers new opportunities for engagement, participation, and accountability in environmental issues, potentially revolutionizing traditional forms of public involvement and communication.

CHAPTER II

FACING THE CHALLENGES AND THREATS OF WATER AND CLIMATE CHANGE

Water is a fundamental resource for sustaining life on Earth, and its availability and quality are crucial for ecological balance and human well-being. However, the escalating challenges of pollution and climate change pose significant threats to water resources worldwide. This scientific discourse examines the intricate connections between water, pollution, and climate change, delving into their multifaceted impacts and exploring potential solutions for a sustainable future.

Water pollution has emerged as a pressing global issue with severe ecological and human health implications. Industrial activities, agricultural practices, and urbanization contribute to the discharge of various pollutants into water bodies, compromising water quality and disrupting aquatic ecosystems (Smith *et al.*, 2021). Heavy metals, pesticides, fertilizers, and organic pollutants are among the major contaminants that pose risks to both aquatic life and human populations. These pollutants not only degrade water quality but also accumulate in the food chain, potentially leading to bioaccumulation and biomagnification of toxic substances.

The complex interplay between climate change and water resources exacerbates the challenges faced by communities and ecosystems. Global warming alters precipitation patterns, leading to changes in the timing, intensity, and distribution of rainfall. This variability in rainfall, coupled with increased evaporation rates, intensifies the occurrence

of droughts and water scarcity in certain regions (Vörösmarty *et al.*, 2020). Conversely, other areas experience more frequent and intense precipitation events, resulting in flooding and soil erosion. These shifts in hydrological patterns pose significant challenges for managing water resources effectively.

Water pollution and climate change have detrimental effects on aquatic ecosystems and biodiversity. Polluted waters disrupt the delicate balance of ecosystems, leading to the decline of native species and the proliferation of invasive species (Thompson *et al.*, 2021). Additionally, changes in water temperature and nutrient availability influence the composition and distribution of aquatic flora and fauna, leading to shifts in ecological communities. These ecological disruptions have far-reaching consequences, impacting the stability and functioning of entire ecosystems.

The ramifications of water pollution and climate change extend beyond ecological concerns and manifest in socioeconomic challenges. Impacted water resources affect agriculture, fisheries, and tourism industries, compromising livelihoods and exacerbating socioeconomic disparities (UNESCO, 2019). Moreover, contaminated water sources and water scarcity contribute to the spread of waterborne diseases, particularly affecting vulnerable populations lacking access to clean water and sanitation facilities. The health burden caused by water-related diseases further strains healthcare systems, particularly in developing countries with limited resources.

Addressing the complex issues of water pollution and climate change requires a multi-faceted approach involving mitigation and adaptation strategies. Mitigation efforts aim to reduce pollution and mitigate climate change impacts through sustainable practices and policy interventions. This includes implementing stricter regulations on pollutant discharges, promoting sustainable agricultural practices, and transitioning to renewable energy sources to reduce greenhouse gas emissions.

Adaptation strategies focus on building resilience and preparedness to cope with the changes in water resources. This entails developing water management plans that incorporate climate change projections, implementing efficient water-use practices, and investing in water infrastructure to enhance water storage and distribution systems (Schewe *et*

al., 2019). Additionally, public awareness, education, and community engagement are vital for fostering a culture of water conservation and sustainable water practices.

Water resources are under increasing pressure due to the interconnected challenges of pollution and climate change. By recognizing the profound implications of water pollution and climate change on ecosystems, human health, and socioeconomic systems, we can foster collaborative efforts to safeguard water resources. Through effective mitigation strategies, adaptation measures, and a collective commitment to sustainable practices, we can strive towards a future where water resources are protected, restored, and managed sustainably.

CHAPTER III

TWITTER: SENTIMENT ANALYSIS APPROACH

In this section, we will initially delve into the research surrounding sentiment analysis techniques and their diverse applications. Subsequently, we will shift our focus towards sentiment analysis utilizing Twitter as a valuable source of data. Following this investigation, we will provide a comprehensive overview of studies that have analysed the public's perception of climate change. The decision to include these studies primarily stems from the extensive research conducted on sentiment analysis of climate change, unlike the comparatively scarce exploration of sentiment analysis concerning water issues. It is worth noting that water issues and climate change are intrinsically interconnected, as problems related to water resources are intricate and exhibit interdependencies among multiple systems (Nguyen *et al.*, 2020). The United Nations World Water Development 2020 Report underscores this relationship by stating that "climate change affects ecosystems, human societies, and economies in a variety of ways, and water is the primary medium through which these impacts are felt". Consequently, most studies on climate change invariably address water resource concerns.

The sentiment analysis technique, which involves extracting emotions from subjective text and classifying sentiments as negative, positive, or neutral has been widely applied in various fields and scenarios (Priyavrat and Sharma, 2018). Market analysis extensively studies public opinion, with retailers analysing product reviews to enhance the

user experience (Shivaprasad and Shetty, 2017). Sentiment analysis is also prevalent in financial markets, where it helps forecast future prices by analysing the opinions of market participants (Mishev *et al.*, 2020). Furthermore, public opinion on health issues has been investigated, such as Twitter's public response to the Ebola epidemic (van Lent *et al.*, 2017) and the perception of vaccines (Klimiuk *et al.*, 2021).

Traditionally, surveys have been the preferred method for analysing public opinion. However, in recent years, social media platforms and microblogging sites, particularly Twitter, have emerged as popular forums for users worldwide to engage in discussions (Dahal *et al.*, 2019). Regarding sentiment analysis of tweets, Wang *et al.* (2022) conducted an in-depth survey that illustrated different levels and approaches to this type of analysis.

Public perception not only influences business, market dynamics, and social studies but also plays a vital role in the realm of environmental concerns, which have garnered increased interest (Fransson and Garling, 1999). Individuals often turn to social media platforms to discuss and acquire information about climate change, global warming, and natural disasters (Finch *et al.*, 2016). Notably, the perception of water issues on social media remains a sparsely investigated topic within the academic field (Noga and Wolbring, 2013). While a comprehensive global sentiment analysis on water resources has yet to be conducted, public opinion on climate change has received extensive research attention. As mentioned earlier, the majority of these studies encompass people's perception of water resource issues.

Cody *et al.* (2015) explored the social media response to news and events related to climate change. They observed a decrease in happiness scores following natural disasters, such as the 2012 Hurricane Sandy. It is worth noting that people's experiences also influence their social media content. Studies have demonstrated that opinions and concerns about global warming are influenced by outdoor temperatures (Joireman *et al.*, 2010).

A review of the literature reveals that most studies yield a predominantly negative sentiment for both climate change and water resource concerns. Taufek *et al.* (2021) investigated the Malaysian public's perception of climate change and found that the majority of the public

possesses insight into climate change, with sentiments largely tending towards the negative. The authors attribute these results to the public's indignation over how decision-makers handle climate change issues.

To cultivate more positive sentiments, the authors suggest that policymakers should reinforce their actions by developing effective mitigation and adaptation plans for climate change. Similar prevalence of negative sentiments is evident Rocca *et al.*, (2021), which analysed a dataset of Facebook posts from Italian citizens. The study revealed negative emotions prevailing in every environmental matter, with the highest percentages of negative emotions associated with water issues. In another study, Menendez *et al.* (2018) leveraged a global dataset of tweets to identify social, economic, environmental, and cultural factors related to sustainable environmental care and public health. The study's results indicate a negative sentiment prevailing on social media concerning the environment, climate change, water pollution, global warming, extreme weather events, acid rain, and massive industrialization. Dahal *et al.* (2019) evaluated public opinion across time and space by collecting a large sample of tweets using climate change-related hashtags. The sentiment analysis confirmed the prevailing negative sentiment trend, highlighting that discussions on climate change on Twitter primarily revolve around negative reactions to current events.

As previously mentioned, most research on water issues focuses on analysing the public's emotional response to specific water concerns and events. However, one study conducted by Noga and Wolbring (2013) closely aligns with the objective of this research. The study investigated public perception of water through an exploratory online survey in which 164 participants provided comments on a list of 37 questions addressing their beliefs about water consumption habits, water management agencies, water regulations, water footprints, water security, and other related topics. The results revealed significant heterogeneity in beliefs regarding these topics. Interestingly, concerning water scarcity, participants did not exhibit a substantial concern about the possibility of running out of water. The authors speculate that this result can be explained by the fact that most individuals surveyed live in water-abundant areas. This finding aligns with the results of Mahafza *et al.* (2017), who explored the role of proximity to water resources in

people's perception of water scarcity. The authors suggest that proximity to water bodies influences people's perception of water issues and their willingness to change habits and adapt to new water-saving policies.

Oh *et al.* (2020) conducted sentiment analysis on Twitter data to uncover public opinion on fluoridated water. Nearly 60% of the analysed tweets expressed a negative opinion on the topic, reflecting a biased information landscape surrounding water fluoridation. Noga and Wolbring (2013) also emphasized the need to educate and improve the quality of information provided to the public regarding water issues. They highlighted a knowledge gap among the public, particularly concerning water consumption rates. Li *et al.* (2021) investigated public opinion on recycled water among Chinese individuals using social media data and unstructured interviews. The study revealed a strong positive sentiment (83.6%) regarding the topic. Another study by Hu *et al.* (2011) examined the debate over tap and bottled water quality perception through a random mail survey.

In conclusion, sentiment analysis has emerged as a valuable tool for understanding public opinion across various domains. While studies on climate change sentiment analysis abound, water issues remain relatively underexplored. However, studies analysing public perception of climate change often touch upon water resource issues, recognizing their inherent connection. The prevailing sentiment on both climate change and water resource concerns tends to be negative. It is crucial for policymakers to address these sentiments by implementing effective strategies to mitigate and adapt to climate change. Furthermore, social media platforms, particularly Twitter, have become significant avenues for discussing environmental concerns, providing valuable insights into public sentiment. Future research should strive to bridge the gap in understanding public perception of water issues and focus on enhancing public knowledge and awareness through accurate and informative communication.