# White Paper Series

## Paper #1

**SETTING THE AGENDA: EXPLORING SOUTH CAROLINA RESIDENTS' PERCEPTIONS OF WATER QUALITY AND CONSERVATION ISSUES**

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**INTRODUCTION**

Since the 1900s, water consumption in the United States has increased fourfold, while rainfall and snowfall levels have remained constant. This disparity has led to a depletion of the water supply, as noted by Spellman in 2020. Cook et al. (2014) predict that the 21st century will see more frequent and intense droughts. Blanc et al. (2014) and Brown et al. (2019) have warned of impending water scarcity in various U.S. regions, including the southeastern states, unless significant adaptive measures are undertaken, a concern echoed by Craig et al. (2019).

South Carolina's water quality is deteriorating due to contamination from various sources including industrial, municipal, agricultural, and domestic activities, particularly in cities like Charleston, Columbia, Greenville, and Spartanburg. The state also faces challenges from cyanobacteria blooms, urban development, droughts, floods, and saltwater contamination in coastal areas, as highlighted by Speiran in 1987. Leal et al. (2015) suggest that the general public's lack of engagement with water conservation efforts can be traced back to the readily available access to water. This accessibility appears to impact their conservation actions, as the ease of obtaining water reduces the urgency to practice or prioritize water-saving measures.

The state of South Carolina confronts several water-related challenges, these include managing hydroelectric power, relicensing hydropower projects by the Federal Energy Regulatory Commission, establishing instream flow requirements, and developing river conservation and watershed management plans. Additionally, issues like aquifer storage and recovery projects, saltwater contamination of coastal aquifers, and the spread of aquatic nuisance species are prevalent, as mentioned by Wachob in 2010.

The swift expansion of coastal areas in South Carolina, especially around Charleston, has raised substantial environmental issues. This urban development has caused the loss of natural habitats, disrupted natural cycles, and led to increased water contamination. According to Allen & Lu (2003), the Charleston area saw urban development surge by 256% from 1973 to 1994, a rate of growth that exceeded that of the population. While this urbanization brings economic benefits, it also has detrimental environmental impacts.

Eutrophication, defined as an increase in the supply of organic matter to an ecosystem resulting in part from enhanced inputs of the nutrients nitrogen and phosphorus from human activities (Nixon, 1995) is a global threat to water quality and aquatic life. Wayne et al. (2019) highlights its consequences, including anoxia, fish kills, cyanobacteria blooms, and contamination of drinking water and food supplies.

In areas like the City of Isle of Palms near Charleston, water quality is periodically compromised due to high levels of fecal coliform bacteria, leading DHEC to classify these waters as impaired, as noted by Scott et al. (2004). Although traditional water quality assessment methods can take over a day to receive, recent advancements in technology to test fecal coliform have enabled faster results in under 2 hours. This enables DHEC to provide faster information on the presence of sewage or fecal contamination, thereby mitigating major health concerns, as discussed by Wade et al. (2006).

Hughes et al. (2000) have documented that while water in certain river basins of South Carolina adheres to Federal and State regulations, urban and agricultural zones are experiencing elevated contaminant levels. This situation is compounded by Chepesiuk (2002), who highlights the health risks associated with

the presence of high uranium levels in some of the state's drinking water wells. These findings point to a pressing need for vigilant water quality management in these areas.

Further complicating water quality issues, cyanobacterial blooms present a significant challenge within the state, often resulting in more pronounced economic repercussions than chemical pollutants alone. Brooks (2016) emphasizes the extensive economic damage these blooms can cause, affecting not just the environment but also the economic stability of the affected regions. The threat of cyanobacterial blooms underscores the complexity of water management challenges, extending beyond simple pollutant mitigation to encompass broader ecological impacts.

Moreover, Carbone & Dow (2005) detail the profound impact of the severe drought that struck South Carolina from June 1998 to August 2002. The drought led to the implementation of both mandatory and voluntary water restrictions, driven by dwindling reservoir levels and heightened irrigation demands. The repercussions of this drought were far-reaching, affecting agriculture, forestry, tourism, and beyond, thereby illustrating the interconnectedness of water resource management with the wider economy and ecosystem. This period highlighted the critical importance of investing in water conservation strategies to mitigate the adverse effects of such environmental challenges on various sectors.

Together, these studies paint a complex picture of the water management challenges faced by South Carolina. They underscore the importance of addressing both the quality and quantity of water resources in the face of urban expansion, agricultural runoff, natural contaminants, and climatic extremes. Addressing these challenges requires a multifaceted approach that includes strict regulatory oversight, public health initiatives, and sustainable water use practices to ensure the long-term viability of the state's water resources.

**PUBLIC PERCEPTIONS OF WATER QUALITY IN SOUTH CAROLINA**

Environmental and sociocultural elements significantly shape the public's perception of aquatic ecosystem quality. Factors such as the presence of aquatic flora, algae, debris, water odor, its flow, clarity, and aesthetic appeal, along with individual characteristics like age, education, gender, and localized knowledge, crucially influence these perceptions (Flotemersch & Aho, 2021). This complex interplay affects how individuals perceive and value water quality, ultimately shaping their attitudes towards conservation.

The linkage between perception and pro-environmental behavior is underscored by growing concerns over the health implications of declining water quality. The way these perceptions are formed and communicated to those in policymaking positions is critical for the successful management of water quality (Canter et al., 1992). DeLorme et al. (2003) suggest that improving public understanding of water quality issues is essential for promoting conservation efforts. However, the transient nature of responses to environmental crises, as observed by Syme et al. (2000), indicates the challenges in sustaining conservation efforts, which are deeply influenced by individuals' belief in their ability to effect change, trust in governmental actions, and collective efficacy.

The argument for the influence of perception on pro-environmental behaviors is further strengthened by the notion that increased awareness leads to a heightened sense of responsibility, propelling individuals towards environmentally friendly actions (Story & Forsyth, 2008). Moreover, McAfee et al. (2019) emphasize the need for a balanced approach in conservation communication to spur public engagement

and foster collaborations across various sectors. Despite the importance of communication programs highlighted by Howarth & Butler (2004), these alone are not enough to drive significant water conservation changes.

In South Carolina, the push for a comprehensive water management plan reflects the critical nature of water quality and conservation on the public agenda (Walker et al., 2019). Yet, the effectiveness of such plans is contingent upon addressing public concerns over water contaminants (Leal et al., 2015) and enhancing community knowledge to empower informed decisions regarding water safety and pollution (Munene & Hall, 2019). Doria (2010) found that personal experience often informs residents' perceptions of water quality more than media or social interactions, indicating a gap in effective communication strategies.

Therefore, promoting water conservation and improving water quality management require not just raising awareness but also translating this awareness into actionable behaviors in both recreational and household contexts. The engagement of environmental groups, advocacy, and government initiatives plays a critical role in motivating residents towards more sustainable actions (Lambright et al., 1996). By understanding and addressing the nuanced ways in which perceptions influence attitudes and, subsequently, pro-environmental behaviors, stakeholders can more effectively encourage conservation efforts and ensure the sustainable management of water resources.

**PURPOSE AND OBJECTIVES OF THE WHITE PAPER**

This study was conducted to enhance our grasp of how South Carolina residents perceive water-related challenges, with the goal of informing public policy and guiding the development of targeted communication and educational initiatives to tackle water quality and quantity issues.

The role of the media is pivotal in shaping public awareness and engagement with environmental issues. It not only disseminates information but also plays a crucial part in highlighting, framing, and often spurring action on these challenges. The media's influence extends to how environmental topics are introduced into public conversations, the perception of these topics among the general populace, and their potential to drive collective action.

Accordingly, our research was focused on delving into South Carolina residents' perceptions of water-related concerns, aiming to uncover the underlying values and attitudes that influence their stance on water quality and conservation efforts. The study was driven by specific research objectives designed to explore these aspects thoroughly.

1. Collect data to characterize South Carolina residents' opinions about water quality changes in the past decade.
2. Quantify the level of importance South Carolina residents place on water quality issues.
3. Describe the level of importance South Carolina residents associate with water conservation issues.

**METHODS**

The participants of this study were limited to individuals aged 18 years or older residing in South Carolina. We used an online survey that was adapted from the 2012, 2016, and 2017 RBC Canadian Water Attitudes Study, as well as Leal, et. al (2015)'s study titled "Setting the Agenda: Exploring Florida Residents' Perceptions of Water Quality and Conservation Issues."

The panel of experts overseeing the survey included three individuals with specialized knowledge in water quality and quantity, tourism management, public opinion research, and survey design to ensure the face and content validity of the survey instrument.

Respondents were asked to indicate their opinions about the change in water quality over the past decade by rating the water quality of various sources on a four-point Likert-type scale. The sources included Springs, Estuaries, Groundwater, Lakes, Rivers, Oceans, and Bays. Respondents were asked to rate whether the water quality of the sources presented was Better, No Change, Worse, or Unsure, compared to a decade ago, by using the respective numbers 4, 3, 2, and 1.

A five-item Likert-type scale was used to measure the importance of water quality to the lives of SC residents. This scale ranged from 5 = Extremely Important, 4 = Highly Important, 3 = Fairly Important, 2 = Slightly Important, and 1 = Not at all Important.

Respondents were asked to rate the level of importance associated with the quality of the following water sources: Drinking water, Groundwater, Beaches, Lakes, Oceans, and Estuaries. A Likert-type scale comprising five options was used to determine the importance of water quantity. The scale included the following options: (1) extremely important, (2) highly important, (3) fairly important, (4) slightly important, and (5) not at all important.

In addition, respondents were asked to evaluate the level of importance of the availability of water for various activities, such as agriculture, recreational swimming, golf courses, beach activities, commerce, cities, landscapes/aesthetics, aquifers, springs and rivers.

The respondents received a non-cash incentive in exchange for completing the survey. A research company called Pollfish$^{R}$ collected the resulting data using non-probability methods. Non-probability samples are commonly used in public opinion research to estimate population, despite limitations associated with selection, exclusion, and non-participation bias (Baker et al., 2013). Pollfish is reputable and employs an advanced sampling methodology known as Random Device Engagement (RDE). It utilizes a machine learning algorithm designed to identify and filter out fraudulent bots and suspicious activities. This detection process is meticulous, capable of identifying irregularities ranging from illogical open-ended responses to unusually rapid questionnaire completions. Leveraging artificial intelligence, the system promptly eliminates any insincere responses, ensuring the integrity and reliability of the collected data.

The survey included 1000 individuals from South Carolina. An stratified random sample respondents for each of the following counties was employed: Lexington, Anderson, Beaufort, Horry, Abbeville, Chester, Darlington, Berkeley, Aiken, Cherokee, Charleston, Richland, Oconee, Colleton, Georgetown, Edgefield, Chesterfield, Dillon, Calhoun, Allendale, Greenville, Dorchester, Newberry, Pickens, Hampton, Greenwood, Fairfield, Florence, Clarendon, Bamberg, Spartanburg, Saluda, Jasper, Laurens, Kershaw, Lee, Orangeburg, Barnwell, McCormick, Lancaster, Marion, Sumter, Union, Williamsburg, and Marlboro.

Data for each research objective were analyzed using SPSS ® 29.0.1.0. Descriptive analyses were used to assess respondents' judgment on changes in water quality and their level of importance on various water quality and availability issues. Table 1 shows the demographic make-up of the respondents, for respondents categorized by gender, race, and age groups.

Table 1: *Demographics of Survey Respondents*

| Characteristic | n | % |
|---|---|---|
| **Gender** | | |
| Female | 319 | 37.7 |
| Male | 528 | 62.3 |
| | | |
| **Race** | | |
| White | 670 | 79.1 |
| Black | 124 | 14.6 |
| Hispanic | 19 | 2.2 |
| Multiracial | 11 | 1.3 |
| Other | 8 | 0.9 |
| Prefer not to say | 5 | 0.6 |
| Latino | 4 | 0.5 |
| Arab | 3 | 0.4 |
| Asian | 3 | 0.4 |
| | | |
| **Age** | | |
| 18-24 | 110 | 13.0 |
| 25-34 | 188 | 22.2 |
| 35-44 | 241 | 28.5 |
| 45-54 | 112 | 13.2 |
| >54 | 196 | 23.1 |

**RESULTS**

*Perceptions of Water Quality Changes among South Carolina Residents*

The survey explored South Carolina residents' views on changes in water quality over the past decade, focusing on whether they perceived improvements, declines, or no change across different water bodies. Results showed a diverse spectrum of opinions. Many participants expressed uncertainty about water quality, with estuaries having the highest uncertainty rate at 34.13% and lakes the lowest at 11.84%. Notably, lakes and oceans were perceived to have experienced the most significant deterioration, while springs were seen in a more positive light, with the least negative perceptions. Stability in water quality was most associated with springs, indicating a general belief in their unchanged condition. Conversely, bays were least perceived as stable. However, there was a moderate level of optimism about water quality improvements, particularly for springs and groundwater.

Overall, the survey highlighted varied perspectives, from uncertainty and concerns about worsening conditions to moderate optimism about improvements or stability in water quality across different environments.

Table 2: *Respondents' perceptions of water quality changes*

| | Unsure | | Worse | | No Change | | Better | |
|---|---|---|---|---|---|---|---|---|
| | n | % | n | % | n | % | n | % |
| Springs | 128 | 22.0 | 93 | 16.0 | 185 | 31.7 | 177 | 30.4 |
| Estuaries | 199 | 34.1 | 112 | 19.2 | 180 | 30.9 | 92 | 15.8 |
| Groundwater | 98 | 16.8 | 165 | 28.3 | 168 | 28.8 | 152 | 26.1 |
| Lakes | 69 | 11.8 | 211 | 36.2 | 172 | 29.5 | 131 | 22.5 |
| Rivers | 73 | 12.5 | 195 | 33.5 | 164 | 28.1 | 151 | 25.9 |
| Oceans | 82 | 14.1 | 201 | 34.5 | 153 | 26.2 | 147 | 25.2 |
| Bays | 163 | 28.0 | 151 | 25.9 | 156 | 26.8 | 113 | 19.4 |

*Assessing the Importance of Water Quality Issues Among South Carolina Residents*

Participants were asked to rate the level of importance they associate with the quality of seven different water sources (Table 3). The table presents the perceived importance of different water sources, ranging from 'Not at all important' to 'Extremely Important' The survey findings indicate a strong focus among respondents on the significance of water quality issues, with drinking water identified as the paramount concern by the majority. Groundwater, too, is deemed crucial, with a substantial number of participants considering it either 'Extremely' or 'Highly Important'. The importance extends to beaches, lakes, and oceans, suggesting a broad recognition of the essential role these water bodies play in public health and environmental integrity. While estuaries received slightly lower priority, they are still valued by a considerable segment of the population. Very few respondents view these water quality issues as negligible, underscoring a widespread agreement on the necessity of preserving water quality within the community. Overall, the data highlights drinking water as the most valued, with oceans and beaches also receiving high importance, followed closely by groundwater, lakes, estuaries, and shell fishing.

Table 3: *Level of importance associated with water quality*

| | Not at all important | | Slightly Important | | Fairly Important | | Highly Important | | Extremely Important | |
|---|---|---|---|---|---|---|---|---|---|---|
| | n | % | n | % | n | % | n | % | n | % |
| Drinking | 15 | 2.6 | 15 | 2.6 | 46 | 7.9 | 132 | 22.6 | 375 | 64.3 |
| Groundwater | 15 | 2.6 | 46 | 7.9 | 130 | 22.3 | 231 | 39.6 | 161 | 27.6 |
| Beaches | 22 | 3.8 | 34 | 5.8 | 138 | 23.7 | 242 | 41.5 | 147 | 25.2 |
| Lakes | 25 | 4.3 | 39 | 6.7 | 151 | 25.9 | 234 | 40.1 | 134 | 23.0 |
| Oceans | 14 | 2.4 | 40 | 6.9 | 88 | 15.1 | 226 | 38.8 | 215 | 36.9 |
| Estuaries | 37 | 6.3 | 59 | 10.1 | 200 | 34.3 | 188 | 32.2 | 99 | 17.0 |
| Shell fishing | 35 | 6.0 | 73 | 12.5 | 148 | 25.4 | 183 | 31.4 | 144 | 24.7 |

*Evaluating South Carolina Residents' Prioritization of Water Conservation Concerns*

Participants were requested to indicate the degree of importance they associated with the amount of water available for various activities (as presented in Table 4). The table reflects varied perceptions of the importance of water sources for different purposes. The survey highlights agriculture as the most crucial concern regarding water quantity, with over half of the respondents marking it as 'Extremely Important' and a negligible percentage considering it insignificant. On the other end of the spectrum, golf courses were perceived as the least critical. Recreational swimming garnered a moderate level of importance. Beach activities were rated more favorably, with a substantial number considering them 'Highly Important' and a notable portion 'Extremely important', indicating a higher valuation of beach-related water use.

The findings indicate a differentiated perspective on the importance of water for various uses. Commerce is notably valued, with a significant portion of respondents recognizing its importance, though a small fraction disregard it. Cities emerged as a critical area of concern, receiving high importance ratings from the majority, with very few viewing them as unimportant. The aesthetic value of landscapes also garnered attention, though it was slightly less prioritized compared to commerce and urban needs. Natural water bodies like aquifers, springs, and rivers were highlighted as extremely important by a considerable majority, underlining their critical role in the ecosystem and for human use.

Agriculture stood out as a primary concern regarding water availability, reflecting its vital role in food production and the economy. Conversely, golf courses were deemed less essential, indicating a lower priority for water use in leisure compared to more fundamental needs such as drinking water and agriculture. The findings collectively emphasized the crucial importance of managing water resources effectively, prioritizing essential services and natural ecosystems while also accommodating recreational and commercial interests to a lesser extent.

Table 4: *Level of importance associated with water quantity*

| | Not at all important | | Slightly Important | | Fairly Important | | Highly Important | | Extremely Important | |
|---|---|---|---|---|---|---|---|---|---|---|
| | n | % | n | % | n | % | n | % | n | % |
| Agriculture | 14 | 2.4 | 24 | 4.1 | 78 | 13.4 | 170 | 29.2 | 297 | 50.9 |
| Recreational swimming | 21 | 3.6 | 78 | 13.4 | 166 | 28.5 | 183 | 31.4 | 135 | 23.2 |
| Golf Courses | 124 | 21.3 | 132 | 22.6 | 171 | 29.3 | 94 | 16.1 | 62 | 10.6 |
| Beach activities | 21 | 3.6 | 52 | 8.9 | 144 | 24.7 | 217 | 37.2 | 149 | 25.6 |
| Commerce | 28 | 4.8 | 57 | 9.8 | 146 | 25.0 | 200 | 34.3 | 152 | 26.1 |
| Cities | 15 | 2.6 | 38 | 6.5 | 92 | 15.8 | 208 | 35.7 | 230 | 39.5 |
| Landscapes/aesthetics | 23 | 3.9 | 77 | 13.2 | 177 | 30.4 | 190 | 32.6 | 116 | 19.9 |
| Aquifers, Springs and Rivers | 11 | 1.9 | 34 | 5.8 | 89 | 15.3 | 212 | 36.4 | 237 | 40.7 |

**DISCUSSION**

Expanding on the findings, the study's insights into public perceptions of water quality changes are aligned with global concerns regarding water pollution and its impact on ecosystems and human health. Research by Gleick (2014) and the World Health Organization underscores the urgency of addressing water quality deterioration, particularly in lakes and oceans, due to industrial runoff, agricultural pollutants, and climate change effects. This aligns with our observation of a general consensus on the deterioration of these water bodies and the more optimistic view of springs, possibly due to their often-protected status and the perception of natural filtration processes (Postel & Richter, 2012).

The paramount concern for drinking water quality resonates with findings from the United Nations World Water Development Report (2019), which highlights the critical role of clean drinking water in achieving public health objectives and sustainable development goals. This is further supported by research indicating the direct correlation between groundwater quality and public health outcomes (Foster & Chilton, 2003), emphasizing the necessity of preserving these water sources not just for environmental integrity but also for the well-being of communities.

The prioritization of water conservation for essential activities, particularly agriculture, reflects broader socio-economic considerations. Agriculture is a significant user of freshwater resources, and its prioritization underscores the critical need to balance water use efficiency with food security demands (Pimentel et al., 2004). The minimal importance attributed to water use for golf courses signifies a growing recognition of the need to prioritize water allocation towards more sustainable and essential uses, a perspective supported by studies on sustainable land and water management practices (Woods et al., 2017).

The diverse valuation of water for commercial, recreational, and aesthetic purposes, and the critical view of urban areas, commerce, and natural water formations, highlight the multifaceted role of water in supporting economic activities, recreational needs, and ecosystem services. This aligns with the principles of Integrated Water Resources Management (IWRM), which advocate for a holistic approach to managing water resources that considers the interdependencies between water uses and promotes the equitable and sustainable distribution of water resources (Global Water Partnership, 2000).

In conclusion, the study underscores the complex interplay between public perceptions of water quality and quantity, conservation priorities, and the broader implications for policy and management practices. It emphasizes the need for informed, sustainable water management strategies that address the multifaceted demands on water resources, echoing the call for action by international organizations and researchers to ensure water security and sustainability for future generations. These findings offer valuable insights for policymakers, environmental managers, and communities, suggesting a path forward that balances human needs with the preservation of the natural environment. In conclusion, the study underscored the intricate public perceptions and priorities regarding water management, advocating for enhanced educational efforts and community engagement to foster sustainable practices. The emphasis on drinking water and agriculture points to an acute awareness of water's essential role, suggesting that future strategies should prioritize these areas while also considering the broader implications for environmental conservation and resource allocation.

**RECOMMENDATIONS**

To address the water quality and quantity concerns identified by this study, a comprehensive set of recommendations is proposed.

1. Public awareness and education programs created, implemented and evaluated by government agencies, such as DHEC are essential. These campaigns should address the lack of awareness in public perceptions of water quality and conservation efforts, particularly differing views on oceans and lakes, and drinking and groundwater. Given the current focus on environmental efforts like wind energy and solar in the State of South Carolina, these campaigns can leverage existing environmental initiatives to highlight water issues. A statewide communication campaign could significantly increase general awareness of water issues, particularly in areas where public knowledge is lacking, thus bridging the current disconnect. These campaigns should be offered across a multitude of diverse venues like local media, community workshops, and school curricula to educate the public about water quality issues, especially the impact of contaminants like PFAS, following Sunderland et al. (2019).
2. An additional recommendation is to engage in collaboration with media outlets to ensure accurate and constructive environmental messaging. This partnership could include training journalists in environmental reporting and creating regular features on water conservation to positively influence public behavior (Sunderland et al., 2019).
3. We recommend investing in enhanced water quality monitoring and reporting which is transparent and up to date. This monitoring and reporting should involve modern sensor technologies and community-based citizen science initiatives which allow for accessible reporting mechanisms such as user-friendly digital platforms to make the process easier to report, as highlighted by Hu et al. (2011).

4. Given the scarcity of groundwater resources, a concerted effort in groundwater research and conservation is crucial, including strategies for water-saving technologies and protecting recharge areas, as pointed out by Spellman (1996).
5. Integrating tourism development with water conservation is also vital. This involves promoting eco-tourism and sustainable water management in tourist facilities, ensuring minimal environmental impact and raising awareness among tourists about water conservation (Ulbrich et al., 1987; Vigil, 2003).
6. Tailoring water management strategies to specific community needs and engaging community leaders and residents in planning and decision-making processes are important to address local water challenges effectively (Hu et al., 2011).
7. The study also underscores the need for increased consideration of a public agenda by government agencies concerning water issues. Opening communication channels between policymakers and researchers regarding consumer perceptions of water issues is crucial. These channels would allow constituents' views to be known, guiding policymakers in creating and revising policies addressing state problems. Addressing these priorities effectively will determine how issues are publicly introduced, understood, and acted upon within the public agenda (Graffy, 2006), addressing misconceptions and enhancing understanding of current water issues. This approach would also allow government officials to better comprehend water issues in different areas of South Carolina, allowing the governmental agenda to more accurately reflect the concerns of residents statewide.
8. Community engagement in water management is essential to foster a sense of ownership and responsibility among residents. This can be achieved by involving communities in monitoring, decision-making, and conservation initiatives, creating forums where residents can actively participate (Mishra et al., 2021).
9. Lastly, collaboration with neighboring states is crucial to develop regional strategies for water resource management, sharing research, resources, and best practices for a collective approach to water conservation and pollution control.

By implementing these comprehensive strategies, South Carolina can ensure a sustainable, responsible, and inclusive approach to water resource management, aligning policies and practices with both ecological requirements and socio-economic realities of the region.

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