PERSPECTIVES ON WATER MANAGEMENT FROM LOCAL WATER DECISION MAKERS IN A COASTAL REGION

By

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ABSTRACT

The effects of climate change are already apparent in eastern North Carolina. Higher than average global temperatures have been implicated in more extreme weather events, with more frequent and intense storms and prolonged periods without precipitation. Some of the impacts include flooding, droughts, and wildfires and each has caused loss of property and life, leading to economic and social consequences. Community water suppliers who are responsible for protecting public health and well-being are on the front lines of transitioning their communities to greater climate resiliency. Agencies at the federal level are developing case studies and training materials to assist in these transitions. However, beyond knowing the job titles that are held by individuals in local government and in utilities, this population of local water decision makers is under-investigated (Cockerill, 2014). This study employed a mixed methods approach of key informant interviews and a survey sent to a broader, representative population of these individuals to gather critical details to elucidate their priorities and provide avenues through which to reach them.

Perspectives on Water Management From Local Water Decision Makers in a Coastal Region

A Dissertation

Presented to the Faculty of the Department of Coastal Studies at

East Carolina University

In Partial Fulfillment of the Requirements for the Degree

Doctor of Philosophy in Coastal Resources Management

By

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December 2022

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DEDICATIONS

For Jessica, who spent half her childhood witnessing me write this dissertation.

For Steve, who has only known me as a graduate student and who has been so supportive.

For my Uncle Brad, who has inspired me in so many ways.

To the rest of my family, for whom I am grateful for all your love and encouragement throughout this process.

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CHAPTER 1: WATER MANAGEMENT IN THE COASTAL PLAIN OF EASTERN NORTH CAROLINA: AN EXPLORATORY ANALYSIS OF LOCAL WATER MANAGEMENT DECISION MAKERS

Local water decision makers are on the front lines of building climate resiliency in their communities and will need the support of state and federal agencies to be successful. Yet at this time, the individuals who make up this target audience are not clearly defined. The primary purpose of this study is to develop a detailed portrait by examining their perspectives on several key issues facing coastal regions in the 20th century. Illuminating important aspects of who they are and how they think will lay a foundation for developing the materials needed to help them transition to more resilient methods of water management. By knowing more about their education and training, channels of outreach to these water decision makers can be accessed more successfully. By understanding more about the challenges that they face on a daily basis, materials can be tailored to address what they identify as their most pressing needs. The water decision makers include elected officials, municipal and county managers, planners, and utility personnel who are directly responsible for the treatment and delivery of potable water to residents and businesses. The setting is the coastal plain (Figure 1) of North Carolina in which groundwater is being exploited and is now regulated by the state. This location provides a useful case study to examine local water decision makers in a regional setting facing the impacts of climate change.

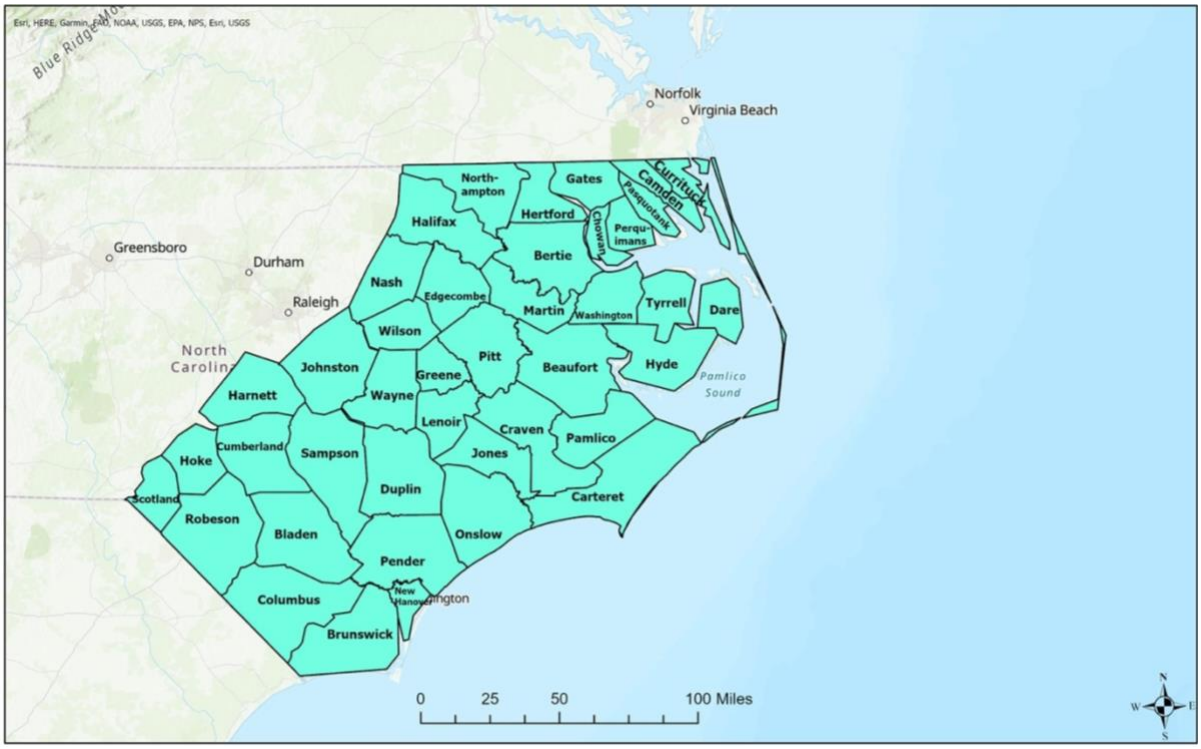

FIGURE 1. Coastal Plain of North Carolina, including 41 eastern counties (Layton, 2021).

The increasing effects of climate change, including more unpredictability in precipitation and sea level rise, have placed these local water decision makers on the front lines of dealing with the impacts that challenge the ability to provide a safe, reliable source of potable water (Cromwell, Spry, & Raucher, 2007; Lovelace, 2008). In addition to climate change, the growing population in the region and the continued use of the key aquifers are increasing demand and competition among users and causing saltwater intrusion into groundwater (Hibbs, 2016). These conditions threaten to cause a Tragedy of the Commons in which increased chloride levels degrade the quality of water in the aquifers.

To prepare for this new landscape, public water suppliers will need to take actions to increase climate resilience; however, there is still much that is unknown about them. At this time there is little evidence to know what efforts may improve uptake and action. Previous peer reviewed studies of similar populations have collected important data but were focused on a

narrow set of attitudes (Cockerill, Badurek, & Hale, 2014; Cockerill, 2014; Fitts, Fritze, Shao, & Vasconcellos, 2010; Kirchhoff, Lemos, & Engle, 2013). By contrast, the exploratory research presented here uses a mixed methods approach to develop a comprehensive portrait of local water decision makers in a rural, coastal region challenged by both population growth and climate change. This research gathers management-relevant information to develop an in-depth portrait of local water management personnel, exploring their education and training, along with a broad range of topics including views on best management practices, challenges faced at the local level, and perceived threats to their capacity to provide an adequate supply of water supply. This portrait can better inform agency efforts to create climate resilience toolkits by providing a better understanding of their roles, the circumstances that they face, and how they perceive threats to the water supply.

To create a more detailed portrait of local water management personnel and their contributions to decision making about local water resources, the following broad questions are explored:

1) Who are the local water decision makers in eastern North Carolina?
2) How do they perceive their water supply?
3) What attitudes and beliefs do they bring to their decision making?
4) What are their management preferences?
5) How are decisions about providing water made?
6) What challenges threaten to their ability to meet emerging water needs?

The mixed methods design of this research included face-to-face interviews with key informants (n=25) in nine counties in the Neuse River Basin, and a survey of a broad sample of local water management personnel across a 17-county region of Eastern North Carolina. Each data set is analyzed separately and then integrated to form a complete picture of these local decision makers' individual attributes, insights into which threats are most salient, how much

support they have for water conservation, their perception of state regulations put into place to protect groundwater, and how their educational training may influence their attitudes about water management.

Organization of the Dissertation

Chapter Two begins with a description of the context of the study, including the effects of climate change on freshwater resources. It discusses the regional water management in the United States including the influence of riparian rights on water use. It then narrows the lens to describe the specific circumstances of water management in eastern North Carolina. It concludes with a description of the roles of the water managers in the study region and how the devolution of responsibility for the safety of drinking water has passed from the federal government to the states and into the hands of individuals at the local level.

Chapter Three provides the rationale for a mixed methods approach to this case study. It includes the gathering of empirical evidence by two modalities to capture both a more representative sample with survey data and the insights garnered from interviews with key informants. The interview data adds depth and nuance and offers possible explanations for the patterns observed in the quantitative data. The methodology and data collection procedures of each phase of the study are described.

Chapter Four uses univariate and bivariate statistical analyses to describe the demographics of this population and identify differences between variables such as gender, age, educational attainment, and employer type. Overall, the population was more similar than dissimilar in their attitudes; however, some key findings found differences in attitudes between individuals who work for utilities versus those who work in other capacities such as

administration or planning. Key findings include a high level of trust in the North Carolina Department of Environmental Quality's website as a source of information and strong support for the regulations that were enacted to protection groundwater resources.

Chapter Five then analyzes the texts of the key informant interviews and gives examples of anticipated themes. These include a low level of concern about drought and water scarcity, and positive opinions about supply side management. However, the discovery of emergent themes helps to flesh out this picture. The local water decision makers in this population see themselves as public servants and are committed to protecting the health and well-being of their consumers. They are concerned about flooding and aging infrastructure. But they are also uneasy about a loss of institutional knowledge as people retire and they have trouble replacing them. They believe that the decision to conserve water is a question of morality, and they expressed a sense of resignation that they were not able to promote more of that behavior.

Finally, chapter Six integrates the data gathered from both the quantitative and qualitive phases of the research. It provides examples in which conclusions drawn from one set of data is supported by the other. Perhaps the most illuminating discovery is the existence of psychological distance in the population when facing drought. The finding of psychological distance provides information to help tailor messaging about climate change. This would decrease the chance that recommendations for actions to increase resiliency will be discounted. In fact, the use of the term "climate change" was omitted during the study and was only used by two individuals, despite the fact that many of the risks being discussed are connected either directly or indirectly to climate change. Sensitivity to the reactions that this term may cause should be considered when developing resiliency materials. The study concludes by providing suggestions for further research beyond the scope of this study.

CHAPTER 2: BACKGROUND AND CONTEXT FOR THIS STUDY

Introduction

The eastern region of North Carolina provides a unique opportunity to examine the perception of water decision makers. Like other regions in the state, the populations in some of these communities are rapidly increasing. The coastal area is experiencing sea level rise and saltwater intrusion into the aquifers that supply water resources to much of the population. The combination of growth and the stressors of climate change will lead to greater demand on these water resources in the future. How they are managed will have consequences for the consumers who rely on a public water supply.

This chapter presents why studying water management is important to future water security. It discusses water as a common pool resource that needs to be carefully managed and how factors such as climate change might threaten human communities, even in water-rich areas. It describes changes to water management in the United States and how these have impacted individuals working at the local level. It describes the necessity of moving from an emphasis on obtaining an adequate supply to greater attention to water quality and the recommendation to reduce demand. Additionally, the chapter narrows focus to describe how water is managed in eastern North Carolina in which the over-exploitation of groundwater in the region prompted the state to create a "capacity use area" in which tighter regulations on groundwater withdrawals have changed the way many communities acquire water. This action on the part of the North Carolina Department of Environmental Quality has forced communities to pump less groundwater from some aquifers, shifting them to other sources of water. The chapter presents the people who work on the front lines, the individuals responsible for the day-to-day

management decisions that are meant to ensure an adequate and safe source of water for the consumers they serve. Lastly, it provides contextual background to orient the exploratory analysis of the results that follow.

Consequences of Climate Change for Water Management

Climate change is already impacting freshwater resources in multiple ways, with effects expected to become more severe over the course of the 21st century (Jimenez Cisneros et al., 2014). Water management was already a challenging proposition, but the ongoing consequences of climate change have added complexity to the equation. Two major outcomes that will likely result are a decrease in water availability and an increased demand for water.

Climate Change Decreases Water Supply

Climate change has reduced the supply of available water. Higher temperatures cause higher evaporation rates of water from soils and water bodies, and sea level rise has caused saltwater contamination into freshwater resources. Changes in precipitation patterns have led to increased periods of drought, and flooding can degrade water quality, making it unpotable (Carter et al., 2014; Davis, 2015; Environmental Protection Agency, 2008a; Stewart, Serre, Kothegal, & Christenson-Diver, 2022).

Reduced Flows to Surface Water

Higher evaporation rates resulting from increased air temperatures will also decrease the volume of water stored in surface sources such as lakes, rivers, and reservoirs (United States Geological Survey, 2003). But they can also impact groundwater levels. In many locations, groundwater feeds streams, lakes, and ponds and during times of lower-than-average

precipitation serve as an essential source of water to both humans and other species (United States Geological Survey, 2016). When drought occurs, these flows may continue to discharge water to rivers, creeks, and reservoirs that supply drinking water to communities, decreasing the volume and possibly lowering the water table (United States Geological Survey, 2016). This can impact both ecosystems and humans who rely on this source of water. During the droughts that occurred in both 2007-2009 and 2010-2011 in the state, the eastern region saw decreased precipitation that was from 66%-88% below normal and surface flows that set records for minimum discharges (North Carolina Division of Water Resources, 2011). Groundwater levels were also below the normal levels during this time (North Carolina Division of Water Resources, 2009; North Carolina Division of Water Resources, 2011).

Reduced flows can also impact water supplies if the water level falls below the intake pipes of a drinking water treatment facility. If this occurs, the facility may no longer be able to extract water or may be faced with moving the pipe to a new location, a costly solution (Davis, 2015). For example, during the drought of 2007, the City of Rocky Mount, North Carolina experienced low water levels in the reservoir used for its drinking water. To ensure that it could provide to its residents it had to request emergency permission from the North Carolina Department of Environmental Quality to connect to the City of Wilson, NC (Davis, 2015; North Carolina Division of Water Resources, 2009). Reduced flows can also allow saltwater to migrate upstream, impacting wildlife and putting water treatment plants at risk of decreased supply if they are not designed to remove chlorides (US Army Corps of Engineers, 2022). During the same drought of 2007, the movement of the salt wedge up the Tar River created a tenuous situation for the utility company there because of the threat of increased chlorides to the drinking

water supply and the concern that treated wastewater could migrate upstream towards the drinking water treatment plant (Parsons, 2008).

Intensified Periods of Drought

Climate change has been acknowledged as the driver of increased drought conditions (Ostroff et al., 2017). Not surprisingly, drier regions are anticipated to experience significant reductions in renewable water resources due to a predicted increase in drought (Pachauri & Meyer, 2014). For example, historic drought in the western United States has led to conflict over water rights (Kann, Rigdon, & Wolfe, 2021). And even the eastern United States has experienced periods of extreme drought that pushed cities such as Atlanta, Georgia to having only a 75- day supply in reserve in 2007 (Evans, 2007). These conditions have caused legal battles to be fought over the water in the southeastern U.S. (Manuel, 2008). Droughts such as those experienced in 2007-2008 and 2011 are expected to intensify in the state as a result of the impacts of climate change (Davis, 2015; Kunkel et al., 2020; North Carolina Division of Water Resources, 2011).

Intensified Precipitation

Increased atmospheric temperatures will increase rates of evaporation from bodies of water, and this will impact the amount of water vapor in the atmosphere, leading to more intense precipitation events (Environmental Protection Agency, 2008b). More intense rainfall will result in increases in streamflow that can have an adverse impact on water quality. The quality in turn will be degraded due to pollutants washing off the land and into streams, rivers, and groundwater that serve as sources of drinking water (Pachauri & Meyer, 2014) These increased precipitation events are occurring in the state, causing the introduction of contaminants such as sewage, livestock waste, and sediment (Kunkel et al., 2020; North Carolina Department of Environmental

Quality, 2020). After Hurricane Matthew in October 2016, water quality was impacted for several weeks after the flooding caused by the storm. Wastewater treatment plants were inundated, releasing untreated sewage into surface water. The impacts were described as "transient," however some testing done over several months indicated elevated fecal coliform and NOx above previous ambient concentrations at multiple sampling stations (North Carolina Division of Water Quality, 2017)

Additionally, flooding can make treated water unavailable by inundating facilities and often knocking out electrical power. Apart from service interruptions, these conditions often require consumers to boil their water to prevent the transmission of disease-causing organisms . Less water may be available under these conditions, increasing competition between users, as well as between humans and ecosystems (Environmental Protection Agency, 2008; Pachauri & Meyer, 2014).

Saltwater Intrusion

Climate change is causing sea level rise which can lead to saltwater intrusion into coastal ecosystems and aquifers (Ferguson & Gleeson, 2012; Fiori & Anderson Jr, 2022; Kidwell, 2012; Manda & Klein, 2019; N.C. Coastal Resources Commission's Science Panel on Coastal Hazards, 2010; National Oceanic and Atmospheric Administration, 2009). It is predicted that overall groundwater resources will decrease, and coastal areas will be severely impacted by this phenomenon (Boretti & Rosa, 2019).The inundation of chlorides into aquifers is a threat to drinking water supplies. With saltwater intrusion, the water in the aquifer is often no longer potable without advanced treatment which requires a more expensive process such as nanofiltration or reverse osmosis (Ettouney, El-Dessouky, Faibish, & Gowin, 2002).This tragedy renders aquifers less useful for all users tapped into them. These areas are already

stressed by dense populations and urbanization (Boretti & Rosa, 2019). With 40% of the population of the United States living in coastal counties, this poses a pressing problem to water managers (National Oceanic and Atmospheric Administration Office for Coastal Management, 2018).

Climate Change Increases Water Demand

Unlike the climate change impacts discussed above that make managing water supply more challenging, the ongoing impacts discussed next tend to increase demand for water. The drying of soils and prolonged periods of drought increase water use primarily for irrigation of agricultural crops, livestock operations, and for residential lawns and gardens.

Higher Temperatures lead to higher Evaporation Rates

The first impact of climate change making it increasingly challenging to maintain adequate supplies of water is higher evaporation rates. Higher temperatures will speed the rate of evaporation from soils increasing demand for freshwater by both agricultural and natural vegetation. Higher use of soil moisture can lead to less run-off and decreases in freshwater availability (Mankin, et al. 2019). As average temperatures rise, crops and lawns will require more irrigation on a more frequent schedule (Becker, et al., 2021). Higher than average temperatures are also anticipated to change precipitation patterns that lead to longer periods of drought. It increases use of both surface and groundwater sources to meet demand, leading to negative consequences such as decreased water tables, lower flows in rivers, drops in reservoir levels, and even saltwater encroachment into aquifers. Drought impacts all aspects of human life from residential use to agriculture and manufacturing, leading to increased levels of competition. Competition between users will require careful management to avoid a tragedy of the commons scenario.

Water Resources and the Tragedy of the Commons

The Tragedy of the Commons is a situation in which the "commons" are public goods that cannot be privately owned. Under these conditions, individuals will place their own advantage over the collective well-being of their community and exploit those resources for their individual benefit (Hardin, 1968). Consequently, these common pool resources, such as water supplies, are more likely to be used to the point of degradation, diminishing their quality for all users.

Exploitation of surface water sources includes contamination with pollution and excessive extraction, reducing the volume of clean water available to both humans and other species. Similarly, groundwater can also be degraded by pollution, and over extraction can cause drops in water levels and saltwater intrusion, both of which can decrease supply. The consequences of climate change will exacerbate competition for freshwater, intensifying the tragedy unless adaptive management is undertaken.

To create a clearer picture of the importance of pursing management approaches that increase climate resiliency, the next section provides an overview of water management in the United States for the last century and how it has changed. This includes a shift in the approaches used to ensure a reliable water supply early in the 20th century to a greater focus on water quality by the federal government with the creation of the Environmental Protection Agency. It concludes with the important transition from more federal oversight of water resources to the allocation of responsibility for the water supply to local providers.

Context of Regional Water Management in the United States

Ensuring Water Quantity

During the 20th century water supply management focused on meeting rising demand for water by seeking to increase the water supply. Water supply challenges were met through a strategy often called the "hard path" (Gerlak, 2006; Gleick, Peter H., 2002; Gleick, Peter H., 2003; Wolff & Gleick, 2002) Hard path approaches focus on solving problems of water quantity by relying on technological innovation and the construction of a sophisticated system of water supply infrastructures. When faced with inadequate supplies, the central tenet of the hard path is to find "new" sources of water also known as "supply side management" (Gleick, P. H., 2003; Gleick, 2002; Wolff & Gleick, 2002). The hard path assumes that all water used in our lives needs to be of potable quality, which requires a high level of treatment and monitoring (Gleick, 2002). Therefore, the hard path requires a commitment of capital into large scale, centrally managed infrastructure projects with long life spans (Gleick, 2002; Gleick, 2003; Wolff & Gleick, 2002). Further, the "hard path" rests on the assumption that future water supply issues can be met with additional technological innovation.

During the period dominated by the "hard path", the U.S. Department of the Interior was responsible for both large- and small-scale projects, including iconic structures such as the Hoover Dam. Dams were built to provide water and control flooding (Gerlak, 2006). But dams are not the only technological solutions used; drilling wells, importing water from other sources, and constructing desalination facilities are all supply side methods to provide water. But the technological solutions used in the "hard path" create unintended consequences. Large-scale

infrastructure is expensive and requires a long planning horizon for maintenance. Committing to a project such as a dam or a desalination plant can lock water providers into using technology for the reasonable life of the project, which decreases flexibility and options as circumstances change (Brandes & Ferguson, 2004; Brooks, Brandes, & Gurman, 2009; Brooks & Brandes, 2011; Gerlak, 2006). It also promotes water users to pay the costs of the project, with little emphasis on efficiency or conservation. Additionally, the "hard path" has resulted in negative ecosystem impacts, such as loss of habitat, water pollution from chemicals used in the treatment process that requires disposal, and air pollution using fossil fuels to run equipment (Lamizana, 2019; Ligon, Dietrich, & Trush, 1995).

Because of the large investment of time and resources and the far-reaching impacts of these projects, emphasis on some types of technology has decreased. In fact, several dams have been removed because their adverse impacts outweighed the benefits. These include the hinderance of fish migration (Wildman, 2013), flooding of ecosystems behind the dam (Wildman, 2013), and lower transport of materials downstream, starving coasts of nutrients and sediment (Milliman, 2008). Instead, a movement to decrease the amount of water used became a new approach that complements the use of the "hard path". The growing realization that human actions were having negative impacts resulted in the next phase of water resource management in the last century (Gerlak, 2006). Because of the negative consequences of water pollution, the federal government moved to put greater protections into place.

Beginning in the 1970s water management policies changed in important ways. Those changes did not reduce concern with reliance on supply side management strategies to maintain adequate water supplies or the role of the hard path in meeting new challenges to adequate water

supplies. Rather, the changes focused on the new priority of protecting water quality from industrial and chemical pollution, administered nationally by the EPA

Environmental Protection – A Transition to Focus on Water Quality

As water pollution became a more pressing issue, the public was inspired by writers like Rachel Carson to promote protection of the environment and other species (Environmental Protection Agency, 2022c). The concern over the impacts of polluted water, air, and the decrease in bald eagle populations (the U.S. national symbol) were key reasons the Nixon-led federal government was prompted to create a new regulatory body: the Environmental Protection Agency (Environmental Protection Agency, 2022).With the passage of the Clean Water Act and Safe Drinking Water Act in the 1970s, this fledgling agency created laws to protect human health and the survival of non-human species.

The Clean Water Act

The Clean Water Act (CWA) was first passed in 1972 as an amendment to the Federal Water Pollution Control Act of 1948 (Environmental Protection Agency, 2022d). Its purpose was to protect the quality of surface waters by regulating and setting criteria for certain pollutants discharged into United States' waters. This includes the treatment of wastes released from point sources, discharges that are identifiable from a single location such as a pipe exiting an industrial complex or wastewater treatment plant. A registry of point sources exists as the National Pollutant Discharge Elimination System (NPDES) and although these permits are under the purview of the EPA, their administration is usually delegated to state, tribal and territorial governments for approval and enforcement (Environmental Protection Agency, 2022b).

The Safe Drinking Water Act

Following the CWA, the Safe Drinking Water Act (SDWA, 1974) established standards for 90 known contaminants that can negatively impact human health (Environmental Protection Agency, 2022e). Some examples of these pollutants are heavy metals such as arsenic, fecal coliform, pesticides such as methyl bromide, and nitrates (Environmental Protection Agency, 2021). These standards apply to community water systems (54,000 in the U.S.) that supply the same population year-round, typically to residences. The SDWA was amended later and includes the protection of sources of drinking water because it is easier to keep pollutants out of waters rather than try to remove them. Together, the EPA, state regulatory agencies, and public water systems cooperate to guarantee protection. It is notable that the focus of the EPA legislation has historically been more on water quality than quantity. The focus of the federal government on water quality continued, but an important shift occurred in who was responsible for enforcing the rules.

The Increasing Importance of Local Water Management

In the 1980s, there was a shift to federalism. The EPA still set standards for water quality, but state governments were given more responsibility to protect the water from pollution through both enforcement and funding (Gerlak, 2006). Enforcement of regulations such as the CWA and SDWA often fall to state regulatory agencies. The states pass these responsibilities onto the municipal governments, placing substantial obligations on them to protect the environment (Gerlak, 2006). Regional offices and local providers are required to test for identified contaminants and report issues such as water main breaks or spills into raw water sources that may cause threats to human health (North Carolina Division of Water Resources, n.d.).

Biological contaminants, suspected carcinogens, and other pollutants are monitored, and providers are required to publish an annual water quality report available to the public. Consumers are provided with information about chemical constituents but also the source of their water and how it is treated. Contact information for the public water supply provider is listed for the public. In some cases, a general phone number is given, but smaller providers often include the person in charge of water treatment or the laboratory that tests for pollutants. Therefore, providers are answerable to the consumers at the local level.

Water Management in the 21st Century

Proponents of the "soft path" advocate for a shift in our thinking about water from acquiring more volume to making water more productive (Gleick, 2002; Gleick, 2003; Wolff & Gleick, 2002). The goal is to provide all humans with adequate access to a reliable water source, while also protecting ecosystems. A way to increase the productivity of water is by matching water to its use, improving efficiency in residential, industrial, and agricultural settings and using economic incentives to promote conservation. (Gleick, 2002, 2003). An example of this is using recycled water from wastewater treatment plants for landscape irrigation or toilet flushing which do not require water to be potable. But water decision makers often rely heavily on individuals trained in engineering and hydrology to deal with water needs, rather than engaging all stakeholders (Gleick, 2003; Gleick, 2003). The risk is that these decision makers are wary about the "soft path" and more likely to rely upon hard path approaches (Brandes & Ferguson, 2004). Technology is still part of the solution, but more often on a smaller scale and in concert with other tools that encourage efficiency.

The Importance of Adoption of the Soft Path at the Local Level

Between 2010 and 2015, household water use in the United States decreased by 9% (Dieter et al., 2018). However, climate change scenarios indicate that depending on conditions due to climate, land use, and population growth, demand for water could continue to decline or could balloon (Warziniack et al., 2022). It is well known that communities in the western United States have faced water shortages for decades, causing conflict and leaving them vulnerable to drought, but the eastern states have also experienced conditions that have threatened their ability to keep pace with water demand under drought conditions (Mullin, 2009). In the southern region of the country, an increase in population is anticipated to increase water use despite water use efficiency in residences (Warziniack et al., 2022). Other users such as agriculture and power generation compete for the same supply of freshwater as households, and there is little cooperation while new sources of water are limited (Mullin, 2009). Local control gives municipal providers the right to craft solutions that match the needs of their situation, but also leaves them vulnerable because they must negotiate with other competing demands (Mullin, 2009). The age of infrastructure may limit the ability to provide enough to meet demand even in areas where access to water may be adequate (Mullin, 2009). This can decrease water security even in water-rich areas. Therefore, the importance of decreasing demand (moving to a "soft path") to support all users under the impacts of climate change, land use change, and increasing demand due to population growth, is essential. These decisions are made at the local level.

Water Management at the Local Scale

The devolution of governmental decision making has placed local decision makers on the front line of dealing with important environmental issues, such as the management of water resources (Lovelace, 2008). This study focuses on one population of these individuals, the local

elected officials, planners, and employed staff who make decisions about the management of drinking water resources in a coastal region. The region is already experiencing the negative impacts of climate change and the pressures of population growth, and industrial and agricultural demands. This population of individuals are making decisions for their communities that will impact their ability to face the challenges of the future, including increased competition for water and the impacts of climate change. The objective of this study is to create a detailed profile of who these individuals are and how they think about water.

Water Management in Eastern North Carolina

Like many other states east of the Mississippi River, North Carolina recognizes riparian rights for water, meaning individuals whose property is adjacent to or overlying sources of water may make "reasonable use" of the water (Whisnant, 2015b). It is important that use is "reasonable" and does not have a deleterious effect on other users. This seems to create protection of water resources and allows for legal resolution of conflict over water use; however, users can negatively impact others through over-use, particularly during times of drought, and there is little legal recourse available, making all public water suppliers relying on surface water vulnerable (Whisnant, 2015a). Because of historical cases of overuse or drought, the state has passed regulations; these include the capacity use area rules (CUA).

Because of the three different geologic regions, water resources differ across the state of North Carolina. The mountainous west and the plateau of the piedmont are primarily reliant on surface water because of their lack of extensive aquifer systems (EPA, 2022f). The coastal plain is underlain by marine sedimentary rock which consists of approximately ten hydrologic units

(Winner, 1996). The abundant groundwater is an important source of water in the eastern region; however, it has also been exploited.

The Regulatory Framework for the Central Coastal Plain Capacity Use Area

In the study region, the threat by competition to aquifers that have been the lifeblood of many communities is important to understanding the context of the study. The state decided to regulate the use of groundwater to prevent a tragedy of the commons from occurring. The details provided contribute to a better understanding of this region. The research area includes 15 contiguous counties in eastern North Carolina, designated by the state of North Carolina as the Central Coastal Plain Capacity Use Area (CCPCUA). The state's environmental regulatory agency, formerly known as the North Carolina Department of Environmental and Natural Resources (NCDENR) and now the Department of Environmental Quality (NCDEQ), created capacity use areas where water withdrawals are regulated to prevent adverse effect from aquifer extraction of water (North Carolina Division of Water Resources, 2018). In the late 1990s, the CCPCUA was identified as requiring management because of the exploitation of several aquifers leading to de-watering (North Carolina Division of Water Resources, 2005). In the 1998 annual report, the Central Coastal Plain is described as an area of concern because water levels in the Cretaceous aquifer are "dropping at an alarming rate" (CUA#1). The phenomenon called "de-watering" occurs in confined aquifers when the water level falls before the confining unit (North Carolina Division of Water Resources, 2005). This creates unsaturated zones that were previously filled with groundwater. De-watering of an aquifer often leads to a cone of depression, which is a drop in the water level surrounding the well from which the water is being pumped (United States Geological Survey, 2018). Multiple wells and cones of depression in the same aquifer are associated with problems such as subsidence, sink holes, and increased salinity

concentration in the aquifer near the coast, drawing in salt water that replaces freshwater (United States Geological Survey, 2019). To avoid a tragedy of the commons created by competition for the same sources of water, the state crafted the new regulation: "The intent of this Section is to protect the long-term productivity of aquifers within the designated area and to allow the use of ground water for beneficial uses at rates which do not exceed the recharge rate of the aquifers within the designated area" (North Carolina General Assembly, 2002).

The Importance of the CCPCUA Regulations

The CCPCUA rules are now considered a regulatory success by the state such that over the past 20 years that the groundwater hydraulic head in the aquifers have rebounded. Yet to continue to protect the aquifers from the dewatering experienced earlier, the rules have not been repealed by the NCDEQ. The fact that the rules have not been lifted by the state environmental agency confirms that water allocation in the eastern region of North Carolina is an important consideration for the future. The threats to water quantity/quality in the CCPCUA offers an opportunity to ascertain how demand side management vs. supply side management are viewed, what obstacles (real or imagined) to implementing demand side management are perceived, and what factors may influence management preferences in an area in which precipitation is abundant.

Managing the Impacts of Climate Change in Eastern North Carolina

Climate change is already having an impact on the state of North Carolina. The average temperature has warmed 1°F over the past 120 years, with a trend in warmer temperatures at night (NC Climate Education, n.d.). It is predicted that weather will be more extreme; higher temperatures and higher heat indices, more extreme precipitation, more intense hurricanes,

increased flooding and drought, increased risks of wildfires, and adverse impacts on coastal areas due to sea level rise (Kunkel et al., 2020). Higher air temperatures will increase demands for water, and drought intensity is likely to increase, placing greater stress on water resources: "Water availability affects all sectors and is vulnerable to climate change and increased demands from a growing population" (North Carolina Department of Environmental Quality, 2020).

Areas that receive regular and abundant precipitation may appear immune to water shortages, but periodic droughts can put both humans and ecosystems at risk. Despite its regular rainfall, parts of the southeastern United States were classified as mid-stress for water by the IPCC 2007 report (Kundzewicz et al., 2007). Droughts have already occurred since the start of the 21st century, yet cities such as Atlanta have not taken this into account. Instead, they have continued to plan for providing water for increasing populations without planning for the impacts of climate change (Sedlak, 2014). Sea level rise will expand saltwater intrusion into the coastal aquifers, necessitating the use of expensive treatment of both groundwater and surface water (North Carolina Department of Environmental Quality, 2020). Agriculture may also face economic impacts with less available freshwater due to saltwater intrusion (North Carolina Department of Environmental Quality, 2020). Climate change will impact water availability in eastern North Carolina in the future. Sun, *et al.* (2008) assessed the southeastern United States for the impacts of changes in climate, land use cover, and population on water supplies to predict which areas would experience water supply stress by 2020. The counties of the CCPCUA showed an increase in water supply stress in one of the two analyses of global climate change models (Had-CM2Sul and CGC1), the first which predicts wet and warm conditions in the southeastern U.S., whereas the other predicts a drier, hotter climate (Sun, McNulty, Moore Myers, & Cohen, 2008).

The contamination of the aquifers that are important sources of water for coastal populations have prompted the recommendation of better water management (Ferguson & Gleeson, 2012). Some countries are shifting water management to deal with the unpredictability of precipitation and river flows, yet "current water management practices are very likely to be inadequate to reduce the negative impacts of climate change on water supply reliability, flood risk, health, energy, and aquatic ecosystems" (Kundzewicz et al., 2007). The state recommends that local governments lead initiatives to "build capacity and leadership within communities most vulnerable to climate change impacts by promoting, supporting, and leveraging community specific-strategies, projects, and events" (North Carolina Department of Environmental Quality, 2020). This will include local water decision makers such as elected officials, managers, planners, and utility personnel.

The Need to Reduce Water Use in Eastern North Carolina

In 2002, the NC Rural Economic Development Center, Inc. paid to have a feasibility study done of the physical resource and the economic impacts of the new CCPCUA rules. The report included a section entitled "A siren call for better management," implying the strategies presently in use would not promote sustainability of the aquifers (Crews-Klein, 2002). The recommendations were multifaceted in that they used economics, technology, policy enforcement, and behavioral modification to ensure the success of the goal of the rule: to protect the aquifer and ensure its sustainability. For example, to achieve the reductions necessary, the study listed alternative water supply options, the majority of which were recommendations for supply side management, or "hard path" solutions. These included using other water sources such as shallower aquifers and surface water, reverse osmosis of brackish water sources, aquifer storage and recovery (ASR), and purchase of water from other supplies not in the CCPCUA

(Crews-Klein, 2002). Behavioral recommendations included encouraging water conservation and water reuse, (Crews-Klein, 2002). But when feasibility was considered, only one community was listed as a place in which conservation was recommended, and there were no recommendations for water reuse or desalination.

In 2018 the Governor of North Carolina, Roy Cooper, signed Executive Order 80 or "EO80" (Cooper, 2018) EO80 committed state agencies towards a clean energy future to reduce carbon emissions by promoting alternative energy and transitioning away from fossil fuel use. Through both adaptation and mitigation, the goal is to increase resilience in the state population to the effects of climate change. For water resources, threats to the water supply such as flooding, saltwater intrusion, and drought have been identified. Steps to increase resiliency include addressing flooding through reservoir construction and increasing the water supply. Education in "realistic" conservation measures is discussed briefly as a strategy in Local Water Supply Planning (North Carolina Climate Change Interagency Council, 2020). The most recent status report includes a hydrologic study in the Scuppernong River Basin, including Washington County, NC, to help water management, including flooding, drought, and sea level rise (North Carolina Climate Change Interagency Council, 2022).

An additional study of the CCPCUA conducted in 2005 reiterated that strategies such as water conservation and re-use were highly favorable for addressing the mandated reductions in aquifer use (Waters & Shrier, 2005a). At the time the report was published, (Waters, 2003) (Waters, Crews-Klein, & Renner, 2003) seven municipalities, three counties, and two military installations were noted as expecting the greatest increase in water usage, mostly due to population growth. The cost of water is an important tool for decreasing water demand, with increasing costs often driving conservation. One commonly used pricing tool that has been

effective is Increasing Block Rate (IBR). IBR encourages water conservation under the concept that as usage goes up, so does cost (Boyer, Adams, Borisova, & Clark, 2012). As of 2020, only three of the identified municipalities had an increasing block rate water schedule for both residential and commercial customers.

Water Management in North Carolina

The state of North Carolina serves as an interesting case study because despite its characterization as "water rich," it has been dealing with stressors on its water supply related to factors such as population growth, land use change, and climate change. These conditions reflect those of many other states in the eastern region of the country, making it a useful place to develop a clearer picture of local water decision makers.

Researchers have begun to examine water decision makers across the state of North Carolina to better understand their attitudes and beliefs about water resources and their management practices. A previous study surveyed a population of water decision makers, which were defined as planners, utility personnel, managers, and elected officials in western North Carolina. Water decision makers' perceptions of quantity and supply side management were characterized (n=85) (Cockerill, 2014), and it was determined that the water decision makers in this region are not concerned about water quantity but instead economic growth guides decisions about water management. The dominant attitude revealed is that water shortages can be (Fitts et al., 2010) addressed by increasing supply, not by decreasing demand.

Another study in central North Carolina (the "Triangle") surveyed a similar population of water managers, staff, and elected officials at different levels of local and state government (n=104) (Fitts et al., 2010). The sample consisted primarily of staff in water management (56%),

with the remainder of the sample city/county managers (20%), elected officials (21%), and respondents in planning, engineering, or education (3%). The study reported that the perception of water scarcity differed significantly between several groups. Elected officials (76%) perceived a higher risk of future water shortage in the area than managers/staff (55%). There were also significant differences between individuals at the state (43%) and local level (17%), with a greater percentage of state respondents than local respondents stating that scarcity is already an issue. However, at both the local and state levels, water quality was the greatest concern (state = 88%, local = 86). Overall, the respondents also indicated the importance of conservation for additional water supply.

An initial study in the coastal plain of North Carolina measured the knowledge and perception of water quality in the region, an area in which the drawdown of aquifers was occurring faster than the recharge (McSwain, 2006). In the survey, governmental officials (city and county managers) were compared to stakeholder groups (fishers, environmentalists, farmers, and scientists). Cultural consensus analysis was used in the assessment to "determine whether or not there is shared knowledge about a cultural domain" such as water quality (n=39). An ANOVA found differences between the groups, but there was cultural consensus within the groups. It was found that the public officials perceive a lack of interest on the part of citizens regarding water quality and watersheds. They also indicated that water quality in the region will likely be degraded more frequently in the future due to the release of partially treated or untreated wastewater into local waterways given a lack of capacity.

An important finding is that the CCPCUA are an example of effective groundwater management. Through interviews and archival research, the process has been investigated as a case study of procedural justice, a framework in which fairness is perceived because individuals

directly impacted are involved in the decision-making process (Rohl, 1997; Thibaut & Walker, 1976) .The rebound of the aquifers after the passage of the regulations can be attributed to how they were written, with different stakeholder groups invited to participate in their creation (Manda & Klein, 2014). The perception of fairness increases the likelihood that users will comply with the rules and the increased water levels in the previously degraded aquifers indicates that the rules are having the intended effect.

In summary, the previous studies of water decision makers across the state provide information about the importance of water quality over water quantity (Cockerill, 2014; Fitts et al., 2010; McSwain, 2006). However, differences exist with regards to water quantity. In one case, conservation was viewed as important, but in another, supply side management (i.e., the "hard path") was thought to be the best way to manage water scarcity (Cockerill, 2014; Fitts et al., 2010).

The Important Responsibility of Local Water Decision Makers

The individuals who manage drinking water resources, have the health and well-being of humans in their hands. Water decision makers are constrained by state and federal regulations and the citizens that they serve, yet their opinion and expertise is often solicited when important decisions are made. Although some studies of decision makers have been done, more focus has been given in areas with drier climates already facing shortages. The CCPCUA rules in North Carolina suggest that threats to water quantity and quality exist in this region, but perceived threats about water quantity by water decision makers has not been previously investigated. Identifying "perceived threats" is important because perceptions are precursors to action (Elshafei, Sivapalan, Tonts, & Hipsey, 2014), and water decision makers have significant

impacts on water policies and are, therefore, an essential population to examine (Cockerill, 2014). Decisions are made about water resources at the local level; therefore, gaining a perspective about the individual attributes and attitudes of local water decision makers are essential for future water resource management, particularly under the challenges presented by climate change and increasing population. A review of the criteria that water professionals take into consideration provides a starting point upon which this study builds to flesh out a profile of these water decision makers in more detail.

Water Decision Maker Roles in the Study Region

Providing water to residents is a public service in North Carolina. Water may be provided by a private company, nonprofit, county, or district, or by a municipality that operates a utility (Whitaker, 2012). The hierarchy for decision making in a North Carolina municipality is a board of elected officials. The board holds public meetings and hearings about local issues, and debates and votes on policies such as those related to water rates and capital projects. They are constrained by state and federal laws but can make decisions about specifics for their jurisdiction. Although elected officials vote on water management decisions such as changes to rate structure and investment in capital projects to fund technology/facilities, they often rely heavily on other water decision makers such as managers and water utility personnel. The managers and utility personnel make recommendations to the boards or commissions that can determine policy. As such, their attitudes towards SSM vs. DSM can impact the advice they give. In some cases, they make decisions about treatment on their own, having a direct impact on how water is managed.

In the case of most municipalities, a manager is hired to oversee the day-to-day operations of the local government. These individuals often have a professional degree, such as a

Master of Public Administration and serve at the pleasure of the board (Owens, Lovelady, & University of North Carolina at Chapel Hill, 2017; Whitaker, 2012). This individual is responsible for hiring, firing, and evaluating personnel such as water superintendents or public utility managers. They serve a key role in water decision making by bringing recommendations to the elected body for consideration.

For a facility that treats water to be distributed for public use, an Operator in Responsible Charge (ORC) is designated and recorded with the state. They are in charge of the complete operation of the facility. If a municipality supplies water to its citizens, typically this person reports to the manager (Owens et al., 2017; Whitaker, 2012). For utility personnel working in the field, treating water, maintaining equipment, repairing pipes, etc., operator certifications from the state of North Carolina are required. Different types of certifications exist for different types of water supply and treatment (ground vs. surface), but also for water distribution (North Carolina Department of Environmental Quality, n.d. d; North Carolina Department of Environmental Quality, n.d. e; Owens et al., 2017; Whitaker, 2012). The state has a certification board with members from various entities in positions related to the public water supply that oversees the schools that provide training and the assessments that are administered. (North Carolina Department of Environmental Quality, n.d.; North Carolina Department of Environmental Quality, n.d.; Owens et al., 2017; Whitaker, 2012) Those seeking to be certified must sit for a 3-hour exam for each certification, and to advance from one level to the next, an individual must apprentice for at least six months (North Carolina Department of Environmental Quality, n.d.; North Carolina Department of Environmental Quality, n.d.; Owens et al., 2017; Whitaker, 2012). An operator must also pursue continuing education credits every year to stay current in the job.

Building Climate Resilience in Public Water Systems

The negative impacts of climate change on water supplies are being felt throughout the United States. Therefore, federal agencies have developed resources such as the EPA's Climate Resilience Toolkit to provide guidance to natural resource managers, such as water professionals who work in the public drinking water supply sector. The EPA has produced a website specifically for helping water utilities to address climate change: Creating Resilient Water Utilities (CRWU) (Environmental Protection Agency, 2022a). In keeping with the argument of the importance of decision making on a local scale, the website states that these local utilities can fulfill the important role of an "anchor institution" (Environmental Protection Agency, 2022). An anchor institution "adds to the social, economic, and environmental fabric of their community." The job of building resiliency falls on the shoulders of the local water decision makers described above. This critical population, the people already embedded in the day-to-day operation of providing water, is the target audience for the programs and materials created by federal agencies.

The Need to Study Support for Demand Side Management

Demand side management will be an essential tool for climate resilience. Studies that have investigated demand side management approaches have overlooked the role that water decision makers play, yet the success of adoption and implementation of these strategies is dependent upon their input (Wolfe, Sarah E., 2009). In the study of water decision makers in North Carolina described above, it was found that they are not concerned about water shortages, leading to less emphasis on demand side management (Cockerill, 2014). Therefore, a study of water decision makers in eastern North Carolina offers the opportunity to examine how perceptions differ based upon gender, educational training and background, and the type of

employer (municipality versus water utility) and provides new, valuable information for federal entities involved in climate resilience assistance.

Building an Understanding of the Conceptual Factors Important to this Study

This purpose of this study is to explore attitudes, beliefs, and perceptions of issues relevant to the local water decision makers in eastern North Carolina in the context of climate change and population growth. This section identifies four key issues relevant to understanding the perceptions of local water decision makers and raises questions to guide and orient the exploratory research presented. These include human assumptions about the natural world, our relationship to water, technological confidence, and the essential integration of hard and soft path strategies to manage water.

Human Assumptions about the Natural World

It may be assumed that our natural resources are limitless and our capacity to alter the environment can outpace the challenges that arise when resources decrease. These assumptions can be characterized into worldviews. This includes how we see ourselves, either as one of many thousands of species on Earth, subject to the same forces and processes as others, or as a separate species with abilities that others do not possess. Our worldview may lead us to assume our status on Earth is greater than other species and allow us to think of Earth as our birthright. Or it may lead us to place emphasis on the importance of other species and to see ourselves more as integrated than separate, part of the biosphere and its processes.

In 1974, Pirages and Ehrlich described the worldview of separateness as “the Dominant Social Paradigm (DSP),” (Pirages & Ehrlich, 1974) or the “Human Exceptionalism Paradigm (HEP),” (Catton & Dunlap, 1978; Catton & Dunlap, 1980). This worldview is seated in the

anthropocentric idea that humans are a unique species. Several important assumptions underly the DSP, including the idea that resources are unlimited, that human ingenuity will allow us to always solve environmental and resource problems, and that the planet's resources exist for human use. A competing worldview, the New Environmental Paradigm (NEP) assumes that humans are not separate. Instead, humans are one of many species, resources are limited despite our ability to develop technology, and due to misuse of resources and rampant human population growth, we are facing an ecological crisis.

The two paradigms appear to be diametrically opposed, but a continuum exists between the two extremes. This has subsequently led researchers to the creation of a scale to measure an individual's embrace of the NEP versus the DSP. The scale was originally developed with 12 Likert-type items, eight of which were pro-NEP and four which were anti-NEP (i.e., pro-DSP). It was then updated in 1991 to include 15 items, with five subscales. The aspects measured by the subscales are: "limits to growth," "the balance of nature," "ecological crisis," "anthropocentrism," and "human exemptionalism." Dunlap and Van Liere have refined the original scale and renamed it the "New Ecological Paradigm" scale (Dunlap, Van Liere, Mertig, & Jones, 2000a). It is now often used to measure "level of environmental concern" and has since been used in numerous studies around the world. Multiple studies have employed the updated NEP Scale to assess how worldview impacts the attitudes, perceptions, and opinions of individuals with regards to water resources. This includes whether differences in NEP Scale scores are correlated to water use in communities in Mexico, (Corral-Verdugo, V., Carrus, Bonnes, Moser, & Sinha, 2008) to water conservation in different countries (Corral-Verdugo, *et al.*, 2002) (Corral-Verdugo, Frías-Armenta, Pérez-Urias, Orduña-Cabrera, & Espinoza-Gallego, 2002), and towards water conservation and levels of environmental concern in Oregon (Wolters,

2014). Therefore, NEP is included in this study to help identify the worldview of this population as a reference point for understanding their relationship to the natural world and to water.

Human Relationship to Water

The New Ecological Paradigm scale is useful for understanding in general terms how a person views humans and the natural world; however, it does not directly assess the human relationship to water. This includes whether water is viewed as "abundant" or "scarce." This view effects the decisions that we make regarding water use (Wolters, 2014). If it is perceived to be "abundant," we will use more of it; if it is perceived to be "scarce," we are likely to conserve. These attitudes have implications for how water is managed.

Water "Rich" Regions and the Myth of Abundance

Areas that have historically had regular and copious amounts of rainfall are often described as "water-rich." This creates the perception that water resources are abundant because they are visible, often in large quantities in the form of lakes, rivers, and the ocean. This sets up a precarious situation in which circumstances caused by increased population growth and climate change are creating competition and stressing the available sources of water, yet that scarcity is not perceived. In fact, a National Science and Technology Committee (NSTC) report states there is a lack of adequate water quantity data and that people in humid areas may not perceive a need to quantify supplies (Cockerill, 2014; National Science and Technology Council, 2007). This has created a perception of adequate water resources that may not exist, which has been described as "the myth of abundance" (Praskievicz, 2019). It has been suggested that this is embedded in the consciousness of individuals living in humid and sub-humid climates under riparian rights for water management (Praskievicz, 2019). The myth of abundance is a concern because it can

increase the vulnerability of "water-rich" regions: "[*sic*] it can be argued that humid regions are less well prepared to deal with drought, because the myth of abundance is so pervasive in the public imagination, and water-governance systems are also generally based on the assumptions of abundant water" (Praskievicz, 2019).

The myth of abundance concerning freshwater resources has been investigated using case studies, including one of the Apalachicola-Chattahoochee-Flint basin (Praskievicz, 2019) Spanning three states (i.e., Georgia, Florida, and Alabama), the ACF basin in the southeast United States is the source of water for the large, urban population of Atlanta. It also supplies water to agriculture, hydropower, industry, and recreation in Alabama before becoming an important source of water in Florida. In Florida, the commercial shell fishing in the Apalachicola Bay relies upon its freshwater to support the shellfish stock. The present water management scheme used in the area is based on a period that may be the wettest in 400 years. But the historic drought of 2008-2009 brought conflict between the three states, who went to court over the right to water (Kann et al., 2021; Praskievicz, 2019). Records indicate that the drought was not an anomaly, and the impacts of climate change are likely to exacerbate fluctuations in precipitation and increase the likelihood that populations in this region will experience conflict over water again.

Like other states in the southeast, North Carolina is a precipitation-rich area operating under the riparian doctrine. Therefore, the state may be more vulnerable to the myth of abundance than more arid regions. People who perceive that there is an adequate supply of freshwater are less willing to change their behavior (Praskievicz, 2019). This can result in less emphasis on demand-side management such as water efficiency and conservation. Stressors such

as population growth and drought can increase competition in these regions, which can cause a scarcity of freshwater.

Defining Water Scarcity

The antonym of "abundance" is "scarce." According to Merriam-Webster, "scarce" means "deficient in quantity or number compared with the demand**:** not plentiful or abundant" (Merriam-Webster.com dictionary, n.d.). One commonly accepted definition of water scarcity is an "excess of water demand over available supply" (Food and Agriculture Organization of the United Nations, (FAO), n.d.). However, when writing about water resources the definition of "scarcity" is not universal. One set of definitions divides water scarcity into three orders (Wolfe, Sarah & Brooks, 2003): first order scarcity is the actual amount of the physical resource or "raw" water is lower than what is needed; second order scarcity exists when institutions rely on technology and more efficient uses to extend the supply; and third order scarcity shifts the focus from the technical to social realm, requiring "social, political, and cultural changes" when the first two types of scarcity cannot be overcome (Wolfe & Brooks, 2003). This includes how water is valued and used (Wolfe & Brooks, 2003). The objective of the in defining scarcity in different ways is to stress the importance of seeing water management beyond the physical and technical realm with solutions that include changes in behavior and attitudes.

Water Security versus Water Scarcity

Consequently, a more meaningful assessment may be to evaluate the resource in terms of "water security." The definition of water security has important elements in common with the third order of scarcity as defined by Wolfe and Brooks (2003) because the focus is not on the volume of water, but instead on the services that water provides to humans and ecosystems. As

defined by the United Nations, water security is the "capacity of a population to safeguard sustainable access to adequate quantities of sustainable quality of water for sustaining livelihoods, human well-being, and socio-economic development, for ensuring protection against water borne pollution and water-related disasters, and for preserving ecosystems in a climate of peace and political stability" (United Nations-Water, 2013).

The "water security" definition better represents the NEP because it does not assume that water is limited and it includes ecosystems and humans (Postel, 1992; Praskievicz, 2019). "Water security" also addressed the threats posed by water pollution, which is not considered in the definition of water scarcity, even though some contaminants can make a raw water source unusable. Most importantly, it acknowledges the need for a demand side management in addition to supply side management.

The worldviews identified by Dunlap and Riley (1978) are present in the scarcity versus security definitions. Like the DSP, "water scarcity" only considers the availability of water for humans (Postel, 1992; Praskievicz, 2019). The Dominant Social Paradigm views natural resource issues as solvable with human ingenuity, usually through the invention of new technologies. This allows humans to continue using water as if it is expendable and of little value. When these technologies become less effective or have too many costs (e.g., economic and environmental), a new one will be developed that can extend the limits on the resource for a period of time.

Faith in Technology

An important tenet of the DSP is faith in the power of technology to solve environmental resource problems (Catton & Dunlap, 1980; Dunlap & Van Liere, 1978; Dunlap et al., 2000; Dunlap, Van Liere, Mertig, & Jones, 2000b). This view has important implications for water management. Humans have been altering the hydrosphere for thousands of years, yet our ability

to do so has grown by leaps and bounds since the start of the Industrial Revolution. Beyond building aqueducts and damming rivers, we can now alter the course of major rivers and pull groundwater from far below the surface. This has allowed the populations to expand in places that were previously not hospitable to humans or agriculture, such as the American Southwest. However, this faith in the promise of technology and supply side management has also contributed to environmental degradation.

Technological Optimism

Technological optimism is the idea that human ingenuity will allow us to engineer our way out of problems (Costlow, Haila, & Rosenholm, 2017). Much of water management in the 20th century has been based on the use of technology to supply water to human populations. This includes large-scale projects such as hydroelectric dams that supply both water and electricity to communities. This mindset also dominates much of the thinking about adaptation to climate change which is seen as a technological problem which can be addressed with the use of technology (Bertana, Clark, Benney, & Quackenbush, 2022). The effects of climate change, including storm surge and sea level rise are thought to be manageable with solutions such as seawalls (Nightingale et al., 2020). How water decision makers perceive the future for their communities will likely influence the actions that they take now. If they choose large-scale infrastructure projects and supply side management, they may lock their communities into a course of action. This may reduce the flexibility to change tactics if the solution is no longer effective. Those who study climate change adaptation advocate for more holistic approaches that do not rely solely on the use of technology. They argue that technological solutions often produce maladaptive results because systems exist as interactions between the physical, social, political, and biological realms, not solely as a physical resource (Bertana et al., 2022).

Barriers to Demand Side Management

Unlike the perception of technology as a default solution to water shortages, demand side management is not a silver bullet to solve all problems but can be used to help meet the needs of the population and decrease the amount of wastewater requiring treatment. To implement DSM effectively, social science is needed, but many water decision makers have training in the use of technology with less emphasis on social, political, and economic approaches (Maas, 2003). This leads to an entrenched approach to water management, an "engineering bias" (Maas, 2003). A conclusion of this study is that engineering bias leads to a wariness about the use of DSM on the part of decision makers.

Following on Maas' report, Brandes and Ferguson (2004) created a conceptual model of barriers to DSM. These barriers include attitudes held by citizens and water managers, financial shortfalls, mistrust of DSM, and administrative barriers such as an engineering bias. Of particular interest are the root causes: the "Myth of Abundance" and "Human economy and built infrastructure are considered separate from the environment," both of which reflect the DSP. Brandes, and Ferguson's solutions are increased use of soft path and supply side management in addition to technology. This will require shifts in water management such as changing how water is governed, including an increase in DSM expertise in water planners and government officials (2004). The study area provides a place to examine the perceptions of water decision makers under the state regulations imposed due to water overuse. In a precipitation rich area with the pressures of increased demand due to a growing population and decreased predictability due to climate change, an opportunity exists to better understand what factors influence their thinking.

Summary

This chapter has presented a view of how climate change is impacting water resources. It has described how water management has changed in the United States, from a focus on quantity to quality and the recognition that demand side management and the "soft path" are essential for addressing the unpredictability caused by a warming planet. It has provided an overview of how water is managed in North Carolina and the importance of local water decision makers in building climate resiliency. It then concluded with some important background information about the psychological constructs important to understanding the different attitudes of water decision makers towards phenomena such as flooding and drought. The next chapter describes how this case study used a mixed methods design to create a detailed portrait of this population. Further chapters add valuable information to the literature provided by other studies by examining water decision maker' perceptions on a range of issues. These include support for DSM versus SSM, threats to the water supply, and level of environmental concern. It also provides information not collected previously such as opinions of the CCPCUA regulations and level of trust in the NC DEQ website. This is supplemented by information about training and education and how decisions are made at the local level. This will form the basis for a comprehensive characterization of the attitudes and beliefs of water decision makers in the context of a coastal region with a humid climate. This region is vulnerable to the negative effects of climate change and a growing population. Because groundwater resources have been overexploited to the point in which the state stepped in to regulate their use, the eastern region of North Carolina offers a useful location to elucidate who manages water in a local setting.

CHAPTER 3: RESEARCH DESIGN AND METHODOLOGY

Introduction

The research undertakes an exploratory, mixed methods design to construct an in-depth profile of water decision makers in a coastal region experiencing water management challenges increasingly affected by adverse impacts of climate change. Local water management personnel are on the frontlines of building a climate resilient water supply for their communities. Further, they are a target audience for materials developed by government agencies to assist in that transition. Two original sets of data were collected for this project and used to create exploratory analysis: in-depth interviews with key informants and a mail survey to a broad sample of local water management personnel working in a 17-county region of the coastal plain of North Carolina.

The interviews were analyzed for anticipated and emergent themes that provide insights, such as how the water decision makers perceive water scarcity, water management strategies, decision-making, the future of water in the region, and their educational background. The data gathered in the interviews informed the construction of the survey instrument that was then distributed to a wider sample of water decision makers in the same population. The data collected by the survey also provides information about education and training, attitudes towards management strategies, and perception of water scarcity, and provides additional details. This includes demographic information including gender, level of education, and years of experience working in the field, as well as levels of environmental concern, perception of state water regulations, and information about perceived threats now and challenges in the future.

The Benefits of a Mixed Method Approach

To elucidate the attitudes and attributes of local water decision makers in a regional setting, both interviews and a survey were administered to individuals in this population to create a comprehensive profile. In knowing about their educational backgrounds and training, what they perceive as issues, their decision-making process, and how they view the future of water management, the agencies charged with helping communities prepare for the impacts of climate change will have a clearer picture of their target audience.

As described by Creswell (Creswell, 2015), mixed methods research can be characterized as an approach that gathers, interprets, and integrates open-ended and closed-ended data to provide a better understanding of a problem identified by the researcher in the social, behavioral, or health sciences (Creswell, 2015). This understanding is the result of blending the different strengths of each type of data collection, going beyond what can be gleaned from either data set considered on its own (Creswell, 2015). The role of each type of data, the personal experiences revealed in the qualitative stage, and the statistical patterns revealed in the quantitative stage, is complementary and are considered together (Creswell, 2015). As with other research approaches, mixed methods require rigorous design and implementation of each type of data collection. The mixed methods approach is not just the combination of quantitative and qualitative; specific research designs are employed in which one type of data collection is informed by the other. These hallmarks allow a mixed methods research design to achieve its goal to create a complete picture of a particular issue.

Each approach in mixed methods has deficiencies that the other can help alleviate (Creswell, 2015). Qualitative research is often criticized for several reasons: 1) the inability to generalize to a greater population, 2) interviews can introduce bias because the investigator is

present during data collection which may influence informant answers. In contrast, quantitative research: 1) often misses nuances because the data is collected "at a distance" and responses are limited, and 2) clarification of terms or questions cannot be addressed during the data collection process and misunderstandings are more likely to occur. The methods complement each other because interviews can provide data that is unattainable through a closed-ended approach, and although the results may not be generalizable, they may be transferrable to another setting. If sampling has been done carefully, quantitative research can help to generalize to the wider population. And a survey can be completed in privacy and the responses can be anonymized. When thoughtfully integrated, each method helps to address the weaknesses of the other because of their contrasting strengths.

This study is a mixed methods approach with an embedded design in which the primary data collected (qualitative interviews) are supplemented by an original survey data collection (quantitative survey) to create a more extensive picture of this population (Creswell & Plano Clark, 2007). A triangulation design was used in this study in which the two data sets were collected at separate times. The interviews were done first, and a preliminary analysis of that data was used to help formulate the questions included in the survey questionnaire. The survey was then administered later to a broad, representative sample of the same population by conducting a census of all individuals meeting the criteria through public websites and including them in the survey sample. The two data sets were analyzed separately and then integrated in a convergence model to draw conclusions about the population (Creswell & Plano Clark, 2007). This allows for a greater reach of the results, with the data that is more generalizable from the survey explained by the themes that were characterized by the interviews.

Although other studies have sought to understand perspectives of local water decision makers, in North Carolina (Cockerill, 2014; McSwain, 2006) and in western states they have been narrowly focused (Kirchhoff, 2010; Kirchhoff et al., 2013). What has been left out is important information about individuals, such as their educational background and training, their level of environmental concern, and more in-depth perceptions of challenges and threats posed by climate change. This research presented here seeks to alleviate those shortcomings by combining in-depth interviews with a survey of the broader population of water decision makers in this coastal region.

Study Area

The study area included 17 contiguous counties in the coastal plain of eastern North Carolina (Figure 2). The counties stretch from the Atlantic Ocean to as much as 80 miles inland and constitute a diverse rural region in terms of economics, population size, and population density. Some counties have urban areas with populations greater than 50,000, such as Onslow and Pitt (OSBM State Demographer, 2022). Other counties are quite rural with small unincorporated communities such as Bertie and Jones, while others have high seasonal population density due to tourism such as Carteret, coupled with sparse year-round residents. The economy in the study area relies heavily on agriculture, but also includes manufacturing, military bases, and cities with medical and educational facilities.

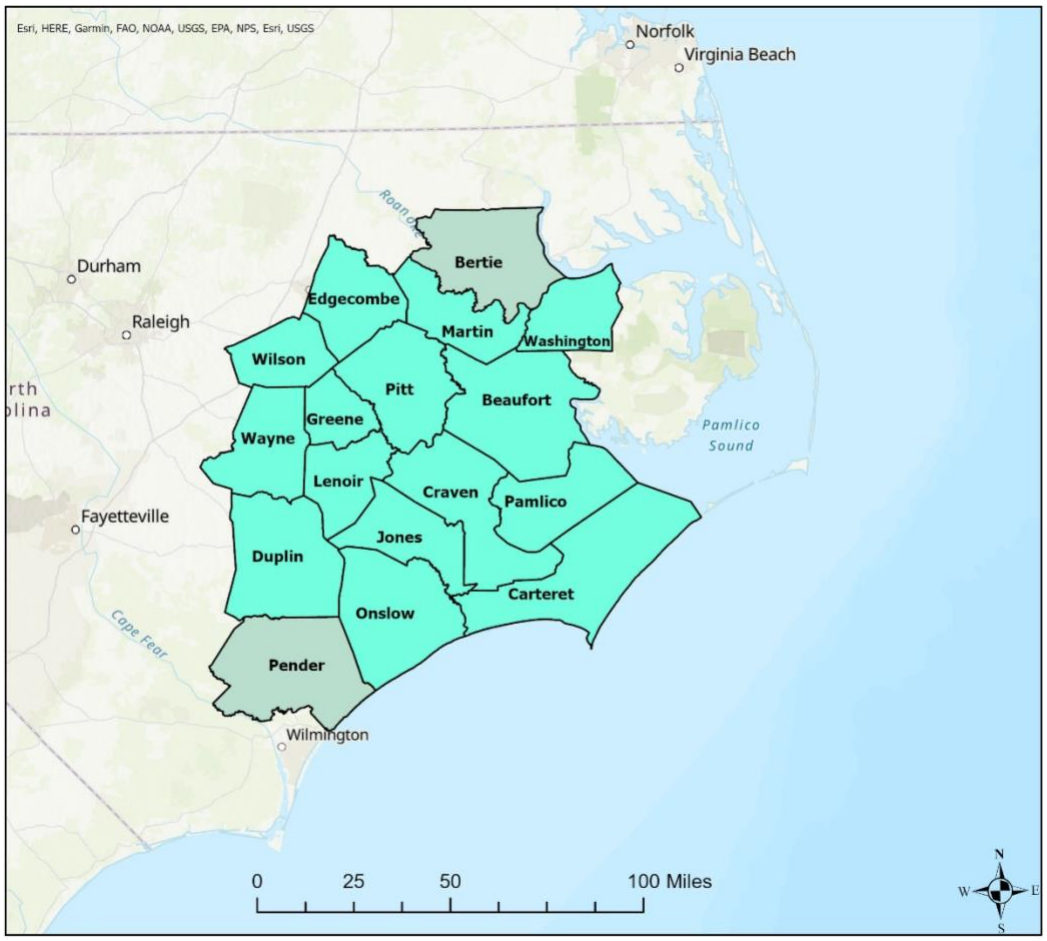

FIGURE 2. Counties Included in Study Area including the 15 Counties in the CCPCUA and 2 Additional Counties: Bertie and Pender (Layton, 2021).

All are experiencing negative impacts in several aquifers upon which their populations and economy depend. These impacts included dewatering, declining water levels, and saltwater intrusion (Central Coastal Plain Capacity Use Area & Assessment Report, 2018; North Carolina Division of Water Resources, 2005). Fifteen of the counties were considered “at risk” and are under the state mandated Central Coastal Plain Capacity Use Area: the CCPCUA (North Carolina Division of Water Resources, 2018) (Figure 2). Two additional counties, Bertie and Pender, were included because the potentiometric maps indicate that negative impacts occurring the aquifers extend past county boundaries. The area was identified by the state regulatory agency, the North Carolina Division of Environmental Quality (NCDEQ), in the late 1990s

because several aquifers in the region, including the Black Creek and Upper Cape Fear aquifers, were threatened by excessive pumping leading to unacceptable levels of dewatering and saltwater encroachment (North Carolina Division of Water Resources, 2005). Dewatering aquifers can bring about a host of negative consequences including subsidence, saltwater intrusion, and diminishing of surface water sources, as well as other effects (Glennon, 2002). The aquifers in the coastal plain are a common pool resource and were being exploited before the limits on groundwater extraction were imposed (Figure 3).

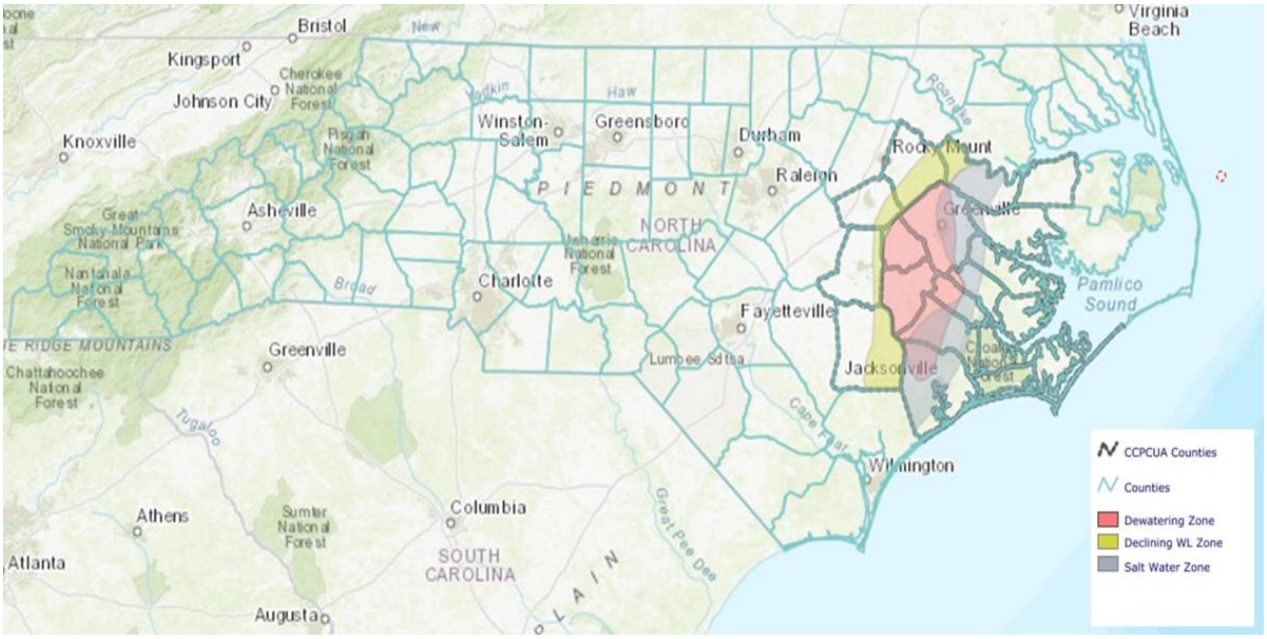

FIGURE 3. Central Coastal Plain Capacity Use Area, NC (Created in NC Division of Water Resources, GWMS, 2022).

In the counties under the CCPCUA rules, users must follow stringent requirements: any person pumping greater than 100,000 gallons of groundwater a day must obtain a permit, and those persons extracting more than 10,000 gallons a day from either ground or surface water must also register and all water use must be reported (North Carolina Division of Water Resources, 2005; North Carolina Division of Water Resources, 2018). Two additional counties

included in the study given their adjacency to the CCPCUA are geologically and hydrologically similar. Bertie County lies just north of the CCPCUA, while Pender County is just to the south. Using the potentiometric maps of the aquifers released by the state, it is apparent that the aquifers underlying these two counties have also experienced the decrease in water levels and increase in chloride concentrations, but users here are not subject to the same regulations (North Carolina Division of Water Resources, 2005; North Carolina Division of Water Resources, 2018).

In the 20 years since implementation of the CCPCUA regulations, hydraulic head levels in the aquifers have rebounded, and the rules remain in place to protect the aquifers from the dewatering previously experienced (North Carolina Division of Water Resources, 2005; North Carolina Division of Water Resources, 2018) The fact that the rules have not been lifted by the state environmental agency confirms water allocation in the eastern region of North Carolina will continue to be important now and in the future. The threats to water quantity and quality in the CCPCUA as identified by state regulatory agencies offer an opportunity to ascertain the attitudes and perceptions of water decision makers under these conditions: a limited water supply perceived as abundant. As the consequences of climate change become more frequent and more severe, securing the public water supply in these jurisdictions will become more critical, but also more challenging.

These aquifers serve as the only source of water for some public water suppliers in the region, and similarly to many locations, the public water supply is often provided as a service by a municipality. Most municipalities in the research area are the sole providers of their water supply; however, there are some water cooperatives, such as the Neuse Regional Water and Sewer Authority (NRWASA) and Onslow Water and Sewer Authority (ONWASA) (Onslow

Water and Sewer Authority, n.d.; Neuse Regional Water and sewer Authority, n.d.). Public water suppliers in the region also use different water sources, some relying solely on groundwater, others on surface water, while some use a combination of both. These circumstances offer multiple opportunities to generalize the results to other regions.

The coastal plain of eastern North Carolina serves as a model study area because of several key factors: 1) the region is a mix of urban and rural, with a varied economic base providing examples of circumstances in many other settings, 2) the aquifers underlying the region are also part of a larger geologic formation that stretches into Virginia and South Carolina, 3) the population is projected to increase in a third of these counties, which will place greater strain on the water supply (Table 1), 4) the water supply provided by aquifers is considered "at risk" despite the fact that the region is "water-rich," 5) sea level rise is adding to the increased chloride concentration in the aquifers, an impact experienced in other regions, 6) more than 75% of the population in North Carolina (North Carolina Division of Water Resources, n.d.), and 90% in the country, get their water from a community water system (Environmental Protection Agency, n.d.), 7) climate change is anticipated to make precipitation in the area more unpredictable, challenging the local water decision makers, 8) the devolution of responsibility has placed these individuals on the front lines of protecting the water supply for consumers under these conditions, and 9) the region's water decision makers have not been studied for their attitudes about water security and water quantity. Therefore, the region provides an example that can be generalized to other areas in the southeastern United States, as well as other regions of the country.

County	Percent Change	County	Percent Change
Beaufort	-3.6	Lenoir	-5.3
Bertie	-11.8	Onslow	10.5
Carteret	5.6	Pamlico	-2.9
Craven	0.1	Pender	13.7
Duplin	0	Pitt	10.7
Edgecombe	-13.5	Washington	-11.8
Greene	0	Wayne	-0.1
Jones	0	Wilson	2

Table 1. Population Growth Projections in Counties in the Study Region, 2030-2040 (Data from NC Office of State Budget and Management, 2022).

Institutional Review Board Process

To protect the rights and health of participants, all human subject research is subject to a review process by an Institutional Review Board (IRB). This requires a process in which any possible negative impacts to participants must be identified and disclosed by the researcher. Documents with standard language were edited to include specifics of the study, including contact information for the author and the university and any anticipated risks for both phases of the research. This also required submission of an executive summary of the study, stating its goals and objectives and what would be gained by doing the research. Access to any information gathered was also disclosed and how it would be stored, any sources of funding, and any possible conflicts of interest. The IRB approval was first granted in spring of 2017 (Appendix B).

For the interview phase, a draft of the semi-structured instrument was submitted, along with the recruitment emails and how possible informants would be identified (Appendix A). As required by the IRB documentation, at the start of each interview, the goals of the study were

reviewed and a document with contact information for the author and a university IRB representative provided. A description of how the responses would be kept confidential and kept secure was supplied, along with an explanation that the individual could decide not to participate, had the right not to answer any questions that they preferred not to answer, and they could stop at any time. Only after obtaining the consent of the participant, would the interview begin.

For the survey phase, a draft of the instrument as it would appear on a computer screen, the method of survey administration through Qualtrics, the number of anticipated participants, and how they would be recruited were submitted. The survey began with an introductory statement that explained the purpose and goals of the study, how the results would be used, how the responses would be anonymized, and contact information for the author and a representative at the IRB. The introduction explained that responses were voluntary and that by clicking on the survey link, the individual agreed to participate. The interview and survey instruments, all recruitment email messages, and consent to participate forms were submitted and approved by the Institutional Review Board in the spring of 2017 (Appendix B).

Interview Instrument Construction

In the construction of the interview instrument, the literature provided guidance about the topics related to the goals of the project. Questions used in other studies of water decision makers in other regions were useful models upon which to build the interview protocol. In addition to demographic information, several subsets of questions targeted important topics: 1) emphasis on conservation, 2) perceptions of water scarcity and water stress, 3) opinion about the state regulations, 4) their decision-making process, and 5) what they anticipate will be problems in the future (Appendix A).

What was not included in the instrument was any use of the terms “climate change” or “global warming.” The key informants all work in eastern North Carolina where the discussion of climate change’s impact on the region has promoted politically contentious actions in the past decade (Nc-20.2014). This choice was intentional based upon other research studies with which suggested that focusing on protection from flood risk might be more effective with individuals who doubt the existence of climate change if the term “climate change” were omitted (Bruine de Bruin, Wong-Parodi, & Morgan, 2014).

Selection of Key Informants

The enrollment criteria for this purposive sample were water decision makers from 60 political jurisdictions and associated nonprofit water suppliers. The sample was targeted to interview three individuals from each of the nine counties in the Neuse River Basin (Figure 4). The nine counties were chosen to narrow the scope of the interviews while still conserving the qualities of the entire study area. The counties in the Neuse River basin are representative of the study region, with some coastal and others inland, some more rural and others more urban. The sample was further stratified into four types of water decision makers: elected officials, managers/administrators, planners, and utility personnel (Cockerill, 2014). Using public websites from different municipalities or organizations in each of the nine counties, a list of possible participants was created by identifying a manager, an elected official, a utility employee, and a planner. In most instances, emails requesting an interview were sent to potential informants. Follow-up phone calls using publicly listed numbers were made if an individual did not respond to an initial email request. When the original individual was not available, another individual was substituted from the lists developed. A number of individuals were contacted but

did not respond or declined the invitation, this happening more frequently with elected officials than with the other groups.

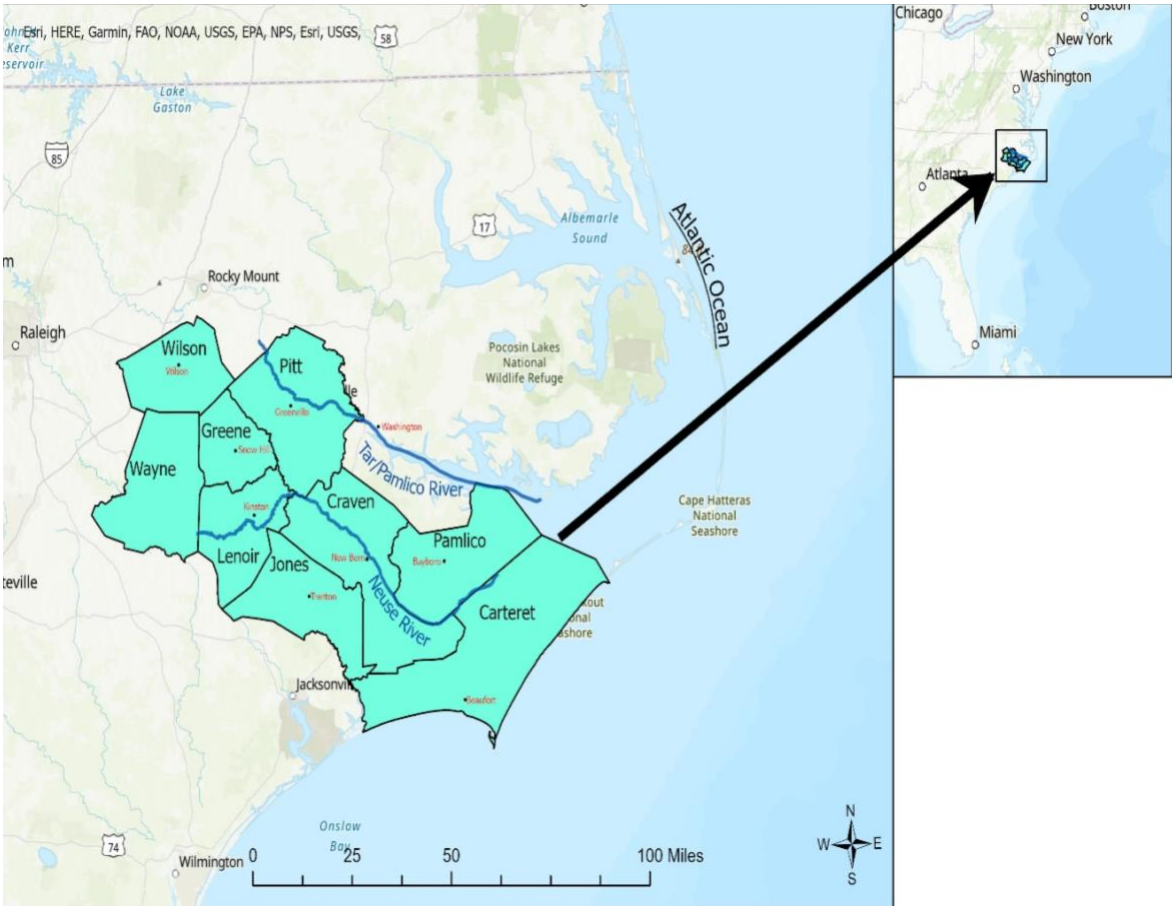

FIGURE 4. Counties in the Neuse River Basin from which Key Informants Were Recruited

A total of 25 individuals were interviewed between June and August of 2017 (Table 2). Subjects were contacted through email addresses listed on public websites (21 individuals), through attendance at public meetings (two individuals), or personal contacts (two individuals). The breakdown of the key informants by role is listed in Table 2.

Role	Number of Informants
Town Managers	5
Town Clerk	1
Elected Officials	4
Public Works Directors	5
Water Treatment Technician	1
Non-profit Water Company Executive	3
Water Superintendent/ORC	4
Planner	1
Water Advisory Board Appointee	1

TABLE 2. Key Informants by Water Decision Maker Role

Interview Process

At the start of each interview, the purpose of the research study was reviewed, and consent to participate was obtained from each before any questioning. The same semi-structured interview instrument was used during all 25 interviews (Appendix A). Most interviews were conducted in the interviewee's office or place of work and lasted approximately 60 minutes. In two instances, another individual was present (a public works director and a water treatment technician), and consent to be interviewed was also obtained from these individuals. During the interview, the researcher wrote responses in a notebook with only a numeric code and date to identify the subject. A list of the names and associated codes was kept separate from the notebooks to guarantee anonymity for all participants. Demographic information requested

during the interview included job title, number of years in the position, and educational training. Some individuals also provided unsolicited information such as age.

The field notes collected during the interviews were then transcribed into searchable Microsoft Word and pdf formats and the transcripts were analyzed in NVivo software (Version 12) using a coding process that first grouped responses into anticipated themes. These were themes that had been identified in the literature and were related to the goals of the study, such as a perception of water security with little concern about drought (Cockerill, 2014; Praskievicz, 2019), and a lack of emphasis on conservation methods (Brandes & Ferguson, 2004; Cockerill, 2014; Maas, 2003). This deductive approach was meant to ascertain whether these attitudes identified by other researchers existed in this population of water decision makers in eastern North Carolina. Then, an inductive approach was used with new themes developing out of the texts of the interviews. These "emergent" themes were topics and ideas that were not previously considered before beginning the interviews but were clearly important to understanding the attitudes and beliefs of this population. The important emergent themes identified include agency, responsibility and pride, and resignation.

Survey Questionnaire Construction

Questionnaire construction sought to craft questions to collect data about the water decision makers and their perspectives on water management. As the survey was being constructed, a literature review was conducted to identify previously used appropriate questions. Several questions from previous studies about water management were included that had generated interesting insights and addressed key issues pertinent to this project. Because threats were an important theme in the interviews, the author was seeking an effective way to present them in the survey. A study of water decision makers in other regions of the country (northwest

and southwest) had administered a survey identifying possible threats to the water supply and asked water decision makers to rank the top three (Kirchhoff, 2010). This allowed for the salience of the threats to be assessed by the survey in a way the interviews had not.

There are many issues that Community Water Systems face. Please select the three issues that are most important to your system (Kirchhoff, 2010):

Flooding	*Regulation/compliance*
Groundwater depletion	*Drought*
Lack of financial resources	

The lists were customized to issues in the region and threats important to the research goals of the study, including pharmaceutical pollution and algal blooms. Additional questions used from another study came from a similar population of water decision makers from the western region of North Carolina (Cockerill, Groothuis, Mohr, & Cooper, 2016). These addressed key issues such as conservation, anthropocentric versus biocentric orientation, and water security.

> *Water conservation is an issue that I have thought about frequently in the past year.*
>
> *In water planning the health of the economy is more important than protecting the environment.*
>
> *There is enough water in the mountains of western NC to meet future needs of all the people and business for the next 25 years.*

Because a barrier to demand side management has been identified as an "engineering bias" and "human infrastructure is separate from the built environment," environmental sociology literature provided questions to measure the environmental worldview of individuals. Therefore, the New Environmental Paradigm Scale (Catton & Dunlap, 1978; Dunlap et al., 2000) was included with the following Likert-type response language (strongly agree, mildly agree, unsure, mildly disagree, strongly disagree). A set of questions was written that asked about water

scarcity and offered "definitions" or circumstances under which scarcity might be perceived. These were informed by the definitions of scarcity that exist in the literature (Wolfe and Brooks, 2003), but also included statements that reflect specific circumstances in the study region, such as the use of technologies (desalination and nanofiltration) by some municipalities. Additionally, a set of demographic questions asked for information such as gender, age, level of educational attainment, education subject, water decision maker role, years in water management, and zip code. The survey also asked whether the employing entity was engaged in a water cooperative such as the two water authorities that exist in the study region. An additional question asked about whether there was a seasonal difference in population. Additionally, topics not previously considered by the researcher were developed from the responses in the key informant interviews. For example, a set of questions pertaining to the CCPCUA was written and included whether the respondent perceived the CCPCUA rules as successful, whether they were fair and equitable, whether they should be revised or removed, and how well they were working (Appendix A). During the interviews, issues such as aging infrastructure and a graying workforce were exposed as concerns for the key informants. Therefore, two additional issues (*Aging infrastructure, Training/human capacity)* from Kirchhoff's study (2010) were included given their importance had not been apparent before conducting the interviews.

The survey was edited by several colleagues and then pre-tested by three individuals. Two were individuals unfamiliar with the project, but both had held elected positions in the counties under research. The third individual was in the original interview pool and was employed by a utility in the study area. Based upon suggestions from these individuals, questions were edited, and the question order rearranged into a final form that contained 62 questions.

Sampling Criteria for the Water Decision Maker Population in the Study

A sampling frame for the population of local water decision makers in the study region was created. To accomplish this, all political jurisdictions and non-profit public water suppliers in the 17 counties were listed. All individuals who work or serve in one of the political jurisdictions or non-profit water suppliers, and who were one of three types of local water decision maker, were selected for to be included. All individuals meeting the above criteria were identified using the North Carolina League of Municipal Governments (*North Carolina League of Municipalities Municipal Directory*, 2019), the Division of Water Resources of the North Carolina Department of Environmental Quality (DWR-NCDEQ), and municipal websites. The North Carolina League of Municipalities is a nonprofit organization that provides resources for its members: municipal governments in the state. Members pay a fee to belong to the League which offers advice and training on topics such as public works and Continuing Education Credits (CEUs) for water and wastewater (North Carolina League of Municipalities, n.d.). The League had maintained a public list of managers and public works directors in the spring of 2019 and provided a list of individuals employed in the CCPCUA counties. For the municipalities that do not belong to the league, all Public Water Systems were identified using the North Carolina DEQ, Division of Water Resources website. Finally, maps of the study region were consulted to make sure that any smaller municipalities not listed through the League or the NCDEQ were added. These sources of information were then used to gather addresses on municipal websites which typically provide the names and/or contact information for managers and administrators, planners, and water utility personnel to create a final working list of potential respondents as the sampling frame (N=236). The sampling frame was broken down by water decision maker role (Table 3).

WDM Role	Number
Manager	99
Planner	50
Utility/Public Works	82
Other*	5
TOTAL	**236**

*Added based upon the recommendation of individuals completing the survey.

TABLE 3. Water Decision Maker roles

All of individuals in the sampling frame who had an email address available through the NC League of Municipalities list or on public municipal websites were included in the sample frame, and surveys were sent to all of them as a census sample (N=236). Individuals who only had a phone number or mailing address but no email address, were not included on the list.

Survey Administration

To increase the likelihood of a higher response rate, the survey administration followed the Dillman Tailored Method for electronic sampling (Dillman, Smyth, & Christian, 2014) The COVID pandemic delayed the survey administration, and this raised the possibility that some members of the sample had left their jobs and been replaced. Several steps were taken to assess and mitigate this potential problem such as checking municipal websites, and in cases where the individual was no longer employed, the present employee listed on the website was substituted. The survey and an Excel file containing names and email addresses were then uploaded into Qualtrics.

An electronic announcement "postcard" was emailed to the list from my university email address in July of 2020 (Appendix A). Six days after the announcement, the survey was sent via Qualtrics to the sample. Reminder emails were sent via Qualtrics to individuals who did not respond to the original request (four total sent at: 1 week, 2.5 weeks, 4.5 weeks, 14 weeks). Additionally, the responses collected were categorized by zip code (Figure 5) and position (planner/manager/water professional), and calls were made to counties and positions that were underrepresented in the sample over a period of eight weeks. Following those calls, emails with a link to the survey were sent to the individuals on the list who had been contacted.

The final list of email addresses contained N=236 individuals. Eight individuals on the list had a "Contact Us" website but no personal email address. The survey email and link were sent using that information on the same day as the original mass emailing, and phone calls were also made to a number of listed individuals to increase the likelihood that they were aware of the survey. There were two counties in which the email server rejected the Qualtrics email as spam or junk. These individuals (n=10) were sent a link to the survey using a personal university email address on the same day that the original survey was distributed. These emails from the university server were classified as "delivered." Five individuals were added to the survey list at the suggestion of original respondents and sent a link to the email address provided by the respondent. A small number of individuals (n=13) could not be contacted, i.e., emails returned/bounced, no email was available, or no one returned a phone call. There is a chance that individuals who received an email from directly from the author (not Qualtrics) forwarded their link to others; however, review of zip codes recorded in surveys indicate that the 20 surveys completed by this link were from zip codes associated with the original individual invited. All data had any names or email addresses stripped before it was analyzed.

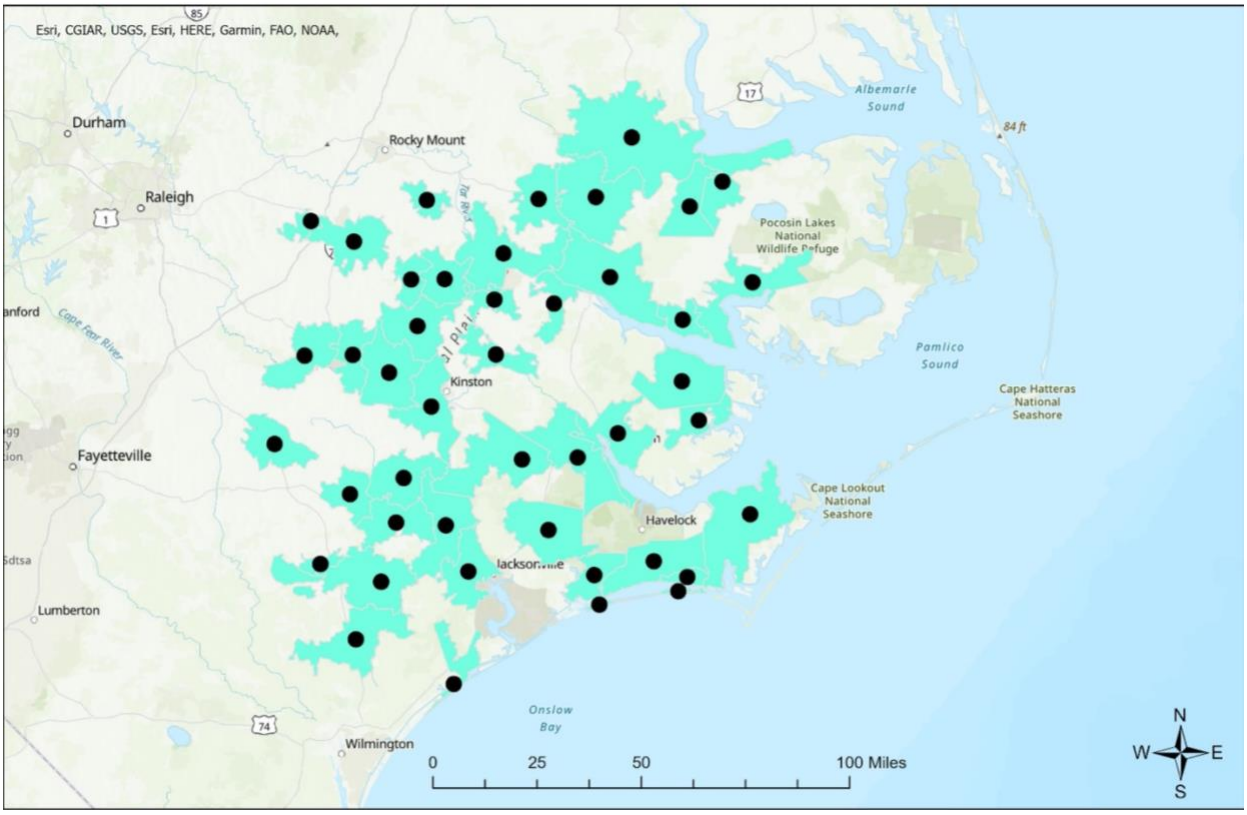

FIGURE 5. Map of Zip Codes Represented by Survey Respondents. Black circles indicate the location of zip code post office and blue shaded areas indicate the boundaries represented by the zip code (Layton, 2021).

Response Rate

One hundred and two surveys were started by individuals, but not all individuals completed the survey. Ten individuals viewed the introduction but did not answer any questions. Twenty-two individuals answered at least one question. Seventy individuals completed the survey, defined by Qualtrics as answering 100% of the questions. The response rate was 39.3% (n=70) and zip codes from throughout the survey area were represented (Figure 5). The Qualtrics responses were then converted into an SPSS file. Any respondents who clicked the link but did not answer any questions were removed from the data set before statistical analysis was begun. Univariate statistics were calculated for all demographic (percentages) and Likert type variables (mean and standard deviation). Then student t-tests and ANOVAs were used to detect

differences between independent variables for the bivariate data. The results of both the qualitative and quantitative stages are presented in subsequent chapters.

Summary

To provide a clearer picture of the people who will be responsible for guiding their jurisdictions to climate resiliency, a study integrating both in-depth interviews with survey responses from a population of local water decision makers was employed to better characterize their attitudes and attributes. These individuals all work or serve in a region of eastern North Carolina that is experiencing increased population growth compounded by the negative impacts of climate change. The region is similar to other coastal areas that are “water -rich” yet whose raw water supply has been threatened by a tragedy of the commons in which pumping from aquifers has created the necessity of greater government regulation. Important demographic information, such as their education and training, and attitudes towards the threats posed by climate change, such as flooding and droughts, were collected and analyzed.

CHAPTER 4: CHARACTERISTICS AND ATTITUDES OF WATER DECISION MAKERS IN A REGIONAL SETTING

Introduction

It must be stressed that climate change is already posing issues in eastern North Carolina (Environmental Protection Agency, 2017; Gallup Annual Environment Survey, 2021; North Carolina Demography, n.d.; Retchless, 2018). Like many of its neighbors, the state's coastal plain is important to its overall economy, and 27% of the population resides within the 41 counties of the (*2020 census results.*2020). Coastal regions around the world are experiencing population growth with 40% of the human population living within 60 miles of the coast (United Nations Environment Programme, 2009). Coastal areas are valuable because of the contribution of ecosystem services such as providing fish for food and recreation, storm impact mitigation, and tourism. Impacts from climate change such as seal level rise and saltwater intrusion into aquifers, may be unique to these areas, yet other impacts such as less predictable precipitation patterns and higher average temperatures are being felt across the globe. These impacts threaten the human population and the ecosystem services that these areas provide.

This chapter provides a comprehensive description and profile of water decision makers operating in the coastal plain of eastern North Carolina. To better understand those whose decisions help shape water resilience in a regional setting, this chapter: (1) describes demographic characteristics important for understanding this regionally important group of people including variations in gender, age, education and training, (2) identifies the environmental attitudes of water decision makers, (3) examines attitudes towards the "soft path" and demand side management of water resources, (4) characterizes attitudes towards water

management both in general and in the context of the region, and (5) provides a prioritized description of perceived threats and future challenges as ranked by the water decision makers. The overall purpose of this study is to create a snapshot of the water management professionals who would be the target audience for any tools to assist public water supply professionals and other local or regional resource managers in shifting to more climate resilient practices.

The population of local water decision makers work in various capacities that are complementary to one another with managers, planners, and utility personnel providing recommendations to elected officials. They work for a range of employers, play diverse roles in regional water management, and differ in their educational attainment, training, age, and gender. Even though they share a common resource, the North Carolina water supply contains differences that are important to quantify and describe. This study adds depth and breadth to what is already known about the types of people who are responsible for supplying a safe product to the public and to paint a more detailed picture than previously provided. Knowing more about them can aid in creating and disseminating materials to help them transition to climate resilience.

Demographic Profile

Due to the influence of demographic characteristics on attitudes and values, a profile of the water decision makers is provided here (Table 4). For each category, descriptions of educational attainment and characteristics of employment are provided.

Relevant Characteristics of Water Decision Makers in Eastern North Carolina	Sample
Total number of respondents	88
Gender	
Male	75.0%
Female	25.0%
Educational Attainment	
Less than 4-year degree	34.8%
4-year degree	33.3%
Greater than 4-year degree	31.9%
Educational Discipline	
Public or Business Administration	41.2%
Other	27.5%
Planning	19.6%
STEM	11.8%
Water Certifications*	
Zero	63.5%
One	36.5%
Employer Type	
Municipality	65.2%
Water District	34.8%
Water Cooperative Member	
No	73.2%
Yes	26.8%
Jurisdiction has Seasonal Use	
No	64.3%
Yes	35.7%
	Mean (SD)
Age (in Years)	50.31 (11.99)
Years as a WDM	16.04 (10.68)

* Two respondents (2.3%) reported they were pursuing a certification at the time of the survey.

TABLE 4. Characteristics of Water Decision

The water-related decision makers who responded to the survey were 75% male and 25% female, which is slightly higher than the average proportion of females (15%) in local government leadership positions (Antil, Letourneau, & Cameron, 2014). This was anticipated as many managerial and utility positions are still occupied primarily by males (American Public Water Works, 2020).

Educational Attainment

The sample is almost equally divided three ways in terms of academic attainment, with slightly more than a third having less than a 4-year degree (34.8%) and slightly less than a third (31.9%) having greater than a 4-year degree. These proportions are not representative of the overall population study area, but the proportions are not unanticipated given the population targeted by the sampling method which included planners, managers, and utility personnel. Each job position typically requires certain knowledge and skill sets that differ from the others. A high school diploma is required to pursue water operator certification whereas planners and managers are required to have a 4-year degree, but employers often prefer a master's degree, particularly for managerial positions.

Educational Discipline

Educational discipline is important due to differences in formal training in water treatment and management. Some courses of study have no requirements for specific training for managing utilities, yet many individuals who pursue administrative degrees will be required to manage water resources. Other programs, such as those in planning, may offer opportunities for water-related training, but in many cases, these are electives and not core courses. The only position that requires formal training in water resource management is that with water operator certifications.

Another consideration is the requirement for continuing education beyond completion of a degree or certificate. Of the professions represented by the sample, only those with planning, engineering, or water operator certificates are required to continue training beyond completion of

a degree or diploma. This is important because some individuals are not required to keep current with changes in their field. Therefore, any instruction that they pursue is voluntary.

The sample was divided into four educational disciplines, and degrees with a similar focus were grouped together, such as business and public administration which accounted for most of the sample (41.2%). The other category included degrees in the social sciences and humanities (27.5%). Those who indicated that they had STEM training were grouped together (11.8%); however, they were not parsed between those with less than and greater than 4-year degrees. Some engineering degrees allow for specialization in water resources planning and management. For example, a civil engineer may be trained to design water and wastewater systems. Engineers need to pass a licensing exam and take continuing education courses to keep their license current.

Because of the unique degree and skill set, planning (19.6%) was assigned its own category. The planning profession has a national organization that certifies planners by administering a licensing exam after completion of their degree and requires continuing education credits to maintain their credential. A subcommittee within the national organization for water planning does exist, indicating a need for planners to know and understand the water policy frameworks and the physical aspects of the public water supply. However, this is additional education, not a requirement of the degree or re-certification (*Using Climate, Information in Local Planning: A guide for Communities in the Great Lakes,* 2019). Some of the courses offered through the national organization, the American Planning Association, included courses in the impacts of climate change and creating sustainable communities, indicating the recognition that planners are involved in the transition to climate resilience (Climate Change Resources. n.d.; Meng, n.d.).

Unlike the other disciplines described here, those with administrative degrees have no organization that requires an exam to demonstrate competency or any maintenance of credentials beyond completion of the degree. This means that any additional training or education that an individual acquires is based on their own volition and needs. The curricula of many MPA and MBA programs do not require a course in the management of public works or utilities, so many individuals learn how to manage water on the job. Consequently, even though they play a crucial role in local water decision making, they may be the most difficult sector of this population to reach.

Water Certifications

Individuals who work in water treatment as technicians are required to pass licensing exams that are administered by the state. In addition to treatment processes and equipment, topics include policy, public relations, and water system planning. To be certified as a water operator requires an apprenticeship which provides hands-on training. Each certification curriculum requires time and on the job experience and must be updated because both policy and technology are continually changing. Therefore, to keep licenses current, individuals must complete six hours of continuing education courses annually (North Carolina Department of Environmental Quality, n.d.; North Carolina Department of Environmental Quality, n.d.). Water operators have training focused on the public water supply which makes them the default experts when it comes to water decision making (Brandes & Ferguson, 2004; Cockerill, 2014). Only slightly more than a third of the individuals held at least one certification as a water operator (36.5%), training that is mostly technical. The remainder did not hold any certifications (63.5%).

Employer Type

The state of North Carolina has multiple categories of public water supplier "ownership" including authority, business, county, district, municipality, non-profit, and the state, all of which are defined by North Carolina Water and Sewer Authorities Act (Chapter 162A water and sewer systems, 2021; North Carolina General Assembly, n.d.). The majority of the sample was employed by a municipality (65.2%) versus working for a water utility or "water associated" (34.8%). "Municipality" includes local government entities, such as a county, city, or town. "Water associated" includes the entities that are either independent utilities responsible for providing a public water supply, or they may be associated with a municipality. Those who work for municipalities may have a more indirect role in water management compared to those in the water associated roles depending on the municipality that employs them.

Water Cooperatives

Water cooperatives are partnerships between multiple public water providers in a region (North Carolina General Assembly, n.d.; Waters & Shrier, 2005b). Because of their large structure, differences exist in the number of individuals having input into any decisions about water management. Individuals who indicated their employer was part of a cooperative were in the minority (26.8%). When the CCPCUA came into existence in 2002, the rules required the shift of some providers from groundwater to more surface water. To offset the financial risk and to spread the cost across a wider base, water cooperatives in the study area were organized in the first decade of the 21st century. Two of these organizations in the study area are classified by the state as a "Water and Sewer Authority" or "WASA" and were organized because of state

regulations. In both instances of the WASAs, a board of directors makes decisions about rate increases and capital projects. The representatives are appointed from their member entities. These WASA cooperatives have bi-monthly meetings in which they discuss the present state of the water resource and vote on any updates or changes. This allows for regular communication and cooperation between the water suppliers who belong to these associations which cross municipal and county lines in the region.

Seasonality

Respondents in the sample were asked about whether their jurisdiction experiences a seasonal difference. The majority of water decision makers indicated that they do not experience a seasonal fluctuation in population size (64.3%). Communities located along what is known as the "Crystal Coast" of North Carolina in the southeastern portion of the study area experience tremendous changes in water use because of a tourist-based economy. This can mean an increase of greater than 10x the year-round population during the peak season from Memorial Day to Labor Day (Town of Emerald Isle, n.d.). This causes challenges for water managers in terms of both the physical resource and financially. The summer months are often when water stress occurs because of the higher temperatures causing higher rates of evaporation from surface water and soils. This means increased amounts of water drawn from aquifers, some of which have higher chloride concentrations in their raw water because of proximity to the ocean. More advanced treatment facilities like reverse osmosis, which is expensive, have already been installed in some of the communities in the study area. Additionally, a much lower volume of water is used in the off season, which means a lower revenue stream. Careful planning is required to ensure that an adequate water supply is provided during the peak season and there are

adequate financial resources for the months in which revenues are low, creating a management scenario that differs from those suppliers who do not experience seasonal fluctuations (65.2%).

Age

The average age of the water decision makers was 50.31 years, (SD=11.99) with the average number of years in water management just over 16. With an average work history of 30 years, the average water decision maker in the sample is mid-career.

Attitudes Towards Water Management

The questions in this section were used to assess important factors that influence attitudes and beliefs including environmental orientation, perceptions of water availability (scarcity or abundance), preference for demand side or supply side management (hard versus soft path), and definitions of water scarcity (Table 5).

Level of Environmental Concern and Perception of Water Availability in Water Decision Makers (N=75)	**Mean (SD)**
Support for the New Environmental Paradigm	
New Environmental Paradigm (full scale)	3.47 (.68)
Fragile Balance of Nature	3.53 (.82)
Ecological Crisis	3.31 (1.00)
Anti-Human Exceptionalism	3.96 (.63)
Limits to Growth	3.05 (.89)
Anti-Anthropocentrism	3.48 (.90)
Water Availability	
Water cycle guarantees water security	3.21 (.81)
Lack of raw water is the greatest threat	2.92 (1.06)
Contamination leads to scarcity	3.92 (.93)
Saltwater intrusion causes water scarcity	3.59 (.77)
Lack of funding for maintenance & infrastructure causes water scarcity	3.97 (.79)

TABLE 5. Environmental Concern and Perception of Water Availability in Water Decision Makers (On scale 1-5; 1= Strongly Disagree, 5= Strongly Agree)

New Ecological Paradigm Scale as a Measure of Environmental Concern

Due to the influence of attitudes on the beliefs of water decision markers (Stern, T. Dietz, Abel, Guagnano, & Kalof, 1999), the New Ecological Paradigm Scale was used to assess level of environmental concern (Corral-Verdugo et al., 2008; Corral-Verdugo, Victor, Bechtel, & Fraijo-Sing, 2003; Dunlap & Van Liere, 1978; Dunlap et al., 2000). The scale provides information about an individual's orientation to the natural world and humanity's place in it (Table 5). On the NEP scale, the population was skewed slightly towards "biocentric" (3.47, SD=.68). A lower score (1) is more anthropocentric, and a higher score is more biocentric (5). Differences between the subscales range from a maximum on the Anti-human exemptionalism to the minimum on limits to growth. The anti-human exemptionalism scale measures whether an individual perceives humans to be subject to the same laws of nature as other species. The mean on this subscale score indicates that the sample does not see humans as "special" or "different." The Limits to Growth scale measures the strength of the belief that human creativity can help to extend resources. This lower mean still indicates a more biocentric orientation.

Water Availability

How an individual defines scarcity includes not only the volume available from natural processes such as precipitation, but also by factors influenced by human actions, such as the ability to remove pollutants and adequate funding to treat and distribute water. If water is perceived to be abundant by an individual, they are less likely to be concerned about a potential lack of water, and this can influence their decision making. A high score on these statements would indicate that respondents had a strong perception of abundance and little perception of scarcity. Based upon the responses, the sample of water-related decision makers perceives the

physical water source as more abundant than scarce. The weak agreement (2.92, SD=1.06) with the statement “Lack of raw water is the greatest threat” indicates that the respondents are fairly confident that enough water is physically available to be treated and used by humans (Table 5). There was slightly stronger agreement with the question about the water cycle (3.21, SD=.81). Taken together both questions about the state of the resource convey a greater perception of abundance than scarcity.

The scores on the question about water availability indicate that these individuals perceive scarcity in the study region, but it is more from the impact of humans on the water sources, not a lack of raw water. In fact, the statement with the highest level of agreement was about water scarcity due to a lack of funding (3.97 SD=.97). The neglect that water infrastructure has experienced is a major concern because failure of aging pipes and treatment facilities often causes emergency situations that require resources (time and money) to fix.

Historically, water pollution garners attention and concern (Gallup Annual Environment Survey, 2021). “Contamination” as defined here is a result of the introduction of pollutants into the water by both human activity and saltwater intrusion as a result of sea level rise (which even though it is an indirect impact, is also a result of human actions). Two statements with highest agreement as a cause of water scarcity are “contamination” (3.92 SD=.93) and “saltwater intrusion” (3.59 SD=.77).

General Perspective on Water Management

The questions posed were designed to draw out opinions on a range of issues from the importance of water conservation to how environmental issues are perceived by these water decision makers. This includes questions about competition for water resources, attitudes

towards technology, and the view of non-human species and ecosystems. The following section details the general perspectives on water management from the survey results (Table 6).

Water Decision Makers' perspectives on water management **(N=82)**	**Mean (SD)**
General Perspectives on Water Management	
Conservation as priority	3.50 (1.02)
Technology can manage contamination, reducing scarcity	3.99 (.71)
Competition increases vulnerability	3.52 (1.05)
Non-human species are important in decision making	3.93 (1.01)
Human economics pose a greater challenge than protecting non-human species	3.34 (1.04)
Demand Side v. Supply Side Management Strategies	
Resources are limited	3.39 (1.13)
Technology can help us extend resources	2.73 (1.17)
Human ingenuity will solve our environmental problems	3.14 (1.21)
Preference for hard or soft path	2.93 (1.17)
The hard path is better for North Carolina	3.56 (1.03)
Nanofiltration and reverse osmosis can provide water for 25 years	3.51 (.75)
Water Management in Eastern North Carolina	
Eastern North Carolina is secure in its water supply for 25 years	3.84 (.87)
Water here is more secure than other places in the state	4.01 (1.11)
The economy takes precedence over the environment	2.37 (1.05)
Familiarity with local Water Shortage Response Plan	2.83 (1.44)
CCPCUA Familiarity	2.74 (1.38)
Rules Successful	3.56 (.83)
Rules Working Well	3.39 (.72)
Rules Fair and Equitable	3.01 (.87)
Rules should be expanded	3.32 (.85)
Rules should be revised	3.35 (.82)
Rules should be lifted	2.66 (1.08)
NCDEQ website most useful source of information	3.64 (.90)
Frequency of consultation	4.19 (1.56)
Water Management Perceived Threats and Challenges	
Current Threats (3 = greatest threat)	
Flood	1.44 (1.21)
Saltwater Intrusion	1.25 (1.21)
Groundwater Depletion	1.21 (1.19)
Drought	1.00 (1.06)
Pharmaceutical Pollution	.44 (.83)
Algal Bloom	.40 (.77)
Future Challenges (3 = greatest threat)	
Ability of aging infrastructure to support new or increased use	1.79 (1.24)
Ability to obtain money/resources from funding agencies	1.56 (1.18)
Population growth	.90 (1.76)
Compliance with state regulations	.77 (1.07)
Ability to retain utility staff/employees	.73 (1.04)
Water conservation by consumers	.60 (1.12)

TABLE 6. Perspectives on Water Management from Water Decision Makers
(On scale 1-5; 1= Strongly Disagree, 5= Strongly Agree)

Overall, the means for most statements were shifted towards “agree” to “strongly agree.” What we find is a moderate to strong level of agreement on issues such as conservation, technology, competition, and protection of non-human species.

It was not surprising that the strongest agreement in this set of questions was about using technology to manage water scarcity (3.99, SD=.71). Previous studies had identified support for increasing the amount of water extracted (supply side management) over reducing demand (demand side management). Therefore, it was anticipated that there would be a faith in technology and its ability to solve environmental problems in this population (Brandes & Ferguson, 2004; Cockerill, 2014; Maas, 2003). One example of a “technofix” would be taking a raw water source and removing chlorides to make the water potable. Chloride contamination is already an issue in the coastal plain of North Carolina and a main driver of the passing of the CCPCUA regulations.

The second highest mean score in the general perspectives set is about the importance of taking non-human species into account in decision making (3.93 SD=1.01). This reflects a more biocentric orientation on the part of the water decision makers and is in line with the scores on the NEP indicating level of environmental concern. The question with the lowest score in the set provides a contrasting opinion that human economy is more important than protecting other species, a more anthropocentric orientation that prioritizes human needs over that of other living things (3.34 SD=1.04).

Demand Side vs. Supply Side Management Strategies

Given the difference between the hard and soft path for water management is prefaced upon the assumption that supply side management utilizes "hard engineering" for water supply (i.e., dams and desalination), several appropriate NEP items are included. They assess attitudes towards natural resources and the human ability to create technology to "fix" problems, or "technofixes." The remaining items were written specifically for this study to add depth to the understanding of attitudes about supply side versus demand side management by asking about conservation and technology.

At first glance, the responses are a study in contrasts. The statement with the lowest level of agreement is from the NEP concerning the ability of technology to extend resources (2.73 SD=1.17); however, there was high agreement with the ability of specific technologies (e.g., nanofiltration and reverse osmosis) to provide water (3.51 SD=.75). Another statement with low agreement was a preference for the hard path (2.93 SD 1.17), yet the highest agreement was when asked about the benefit of the hard path for North Carolina (3.56 SD=1.03). It appears that they are confident about technology's effectiveness in North Carolina, but less supportive of its ability in general. When asked about whether they had thought frequently about conservation in the past year, there was moderate agreement (3.50, SD=1.02).

Combined with the general perspectives, the results can be summarized as follows: the water decision makers are concerned about other species and want to encourage conservation. Yet they are also in favor of the use of technology to provide water supplies when faced with pollutants that can reduce the volume of water available.

Water Management in Eastern North Carolina

This set of questions sought to reveal attitudes about water management in the study region. It includes questions to gauge the security of the water supply compared to other areas in the state. It then moves onto to questions about the economy and familiarity with state mandates, such as CCPCUA rules. It assesses views on those rules and the perception of the helpfulness of the North Carolina Department of Environmental Quality.

One question was posed about prioritizing the economy over the environment and had a moderate level of disagreement (2.37, SD=1.05); this is in line with the overall slightly biocentric orientation indicated by the New Ecological Paradigm scale score. A set of questions was included to evaluate the perception of the CCPCUA Rules put into place to protect the aquifers in the study region. The results indicated that overall, there was low familiarity with the rules, but they were viewed favorably, with agreement that they were "successful" and "working well." The lack of familiarity may have influenced the opinion of the rules, yet it should be noted that there was overall agreement that they had been successful (3.56, SD=.83), which had the highest mean of these questions. There was some support for expansion and revision of the rules with little difference noted between these two questions. The picture that emerges here is the rules should be kept in place (Table 6). The last set of questions in this group explored the NCDEQ state website, and there is fairly strong amount of agreement (3.64, SD=.90) that it is the most useful site for information regarding water management.

Water Management Perceived Threats and Challenges

The perception of what poses a threat can be predictive of actions (Elshafei et al., 2014); therefore, an understanding of which threats are considered most pertinent by water decision

makers can provide important information about where water decision makers are most likely to devote time and resources. To assess the perception of threats, key informants were asked about the "problems" they perceived, whereas the survey respondents were asked to rank their present threats and future challenges from two lists.

Perceived Current Threats

Although some possible threats had been identified prior to the interviews, items on the lists in the survey were added based upon the responses of the key informants. Identifying perceived threats is important because time and attention to more salient threats is likely to be greater and an antecedent to action (Elshafei et al., 2014). To gain a perspective on possible threats, a list of six possible threats was provided on the survey and subjects were asked to rank their top three from the list. Threats ranked first were assigned a score of "3," higher scores indicating higher priority.

The threat with the greatest salience for the survey respondents was flooding, ranked as the primary threat perceived (1.44 SD=1.21). Because of its location on the east coast, North Carolina experiences a significant number of hurricanes and is ranked 4th (NOAA, 2021). Flooding as an impact of both hurricanes and/or high precipitation events is a common occurrence in the study area. The second ranking threat was saltwater intrusion (1.25 SD=1.21) and the third choice for top threat was groundwater depletion (1.21 SD=1.19). The threat ranked in fourth position, just behind saltwater intrusion, is the potential for drought (1.00 SD=1.06).

Pharmaceutical contamination as an emerging threat was identified by some interviewees during the interview phase; therefore, the wording of "pharmaceutical" pollution was chosen. Even though pollution and water quality tend to be "hot button" issues for both the public and professional water providers (Gallup Annual Environment Survey, 2021), this response was low

in the ranking (.44 SD=83). Because these are not yet regulated by the EPA or state agencies and because additional testing requires additional financial resources, there is little incentive at this time for water suppliers to test for these chemicals.

The last threat ranked was harmful algal blooms (0.40 SD=.77). Algal blooms are a regular occurrence in the surface waters of the study area (North Carolina Department of Environmental Quality, n.d. a; North Carolina Department of Environmental Quality, n.d. b; North Carolina Department of Environmental Quality, n.d. c), yet not all are considered "harmful." The definition of a "harmful algal bloom" is one in which direct contact with the water (drinking, swimming) or adverse impacts due to close proximity occurs (Harmful algal bloom (HAB) associated illness.2022; Centers for Disease Control and Prevention, 2019; Sellner, Doucette, & Kirkpatrick, 2003). This is the result of some species of algae (cyanobacteria or "blue-green algae, etc.) producing toxic chemicals that can cause burning in eyes and respiratory membranes, skin rashes, or even death from inhalation or consumption (water or seafood) (Harmful algal bloom (HAB) associated illness.2022; Centers for Disease Control and Prevention, 2019; Sellner et al., 2003).. Algal blooms are often linked to non-point source runoff of nutrients from agricultural crops, lawns and golf courses, and animal waste from Concentrated Animal Feeding Operations (CAFOs). The region is home to a large number of livestock operations which are a major contributor in eastern North Carolina's agricultural economy (North Carolina Department of Environmental Quality, n.d.). Despite their regular appearance, algal blooms are often linked to fish kills that can have a negative impact on tourism (Bechard, 2020; North Carolina Department of Environmental Quality, n.d.; North Carolina Department of Environmental Quality, n.d.). Communities who use groundwater as their source are unlikely to experience any direct impacts to the quality of their supply.

Demographic Differences for Dependent Variables

Differences in the personal characteristics of water decision makers can influence their perceptions of issues in water management, such as their level of environmental concern, what they identify as a threat, and how they prioritize them. One-tailed independent t-tests were performed for each set of questions. The questions all used the 5-point Likert type scale with 1 = strongly disagree to 5= strongly agree. When t-tests were conducted on these dependent variables, several significant differences were detected.

Gender Differences

When the responses were analyzed for differences between the sexes, several significant ones emerged (Table 7). When examining the subscales of the NEP which measures level of environmental concern, only one showed a significant difference between the sexes. Females had higher agreement on the 3 items that make up the Ecological crisis scale ($p \leq .10$); however, no difference was detected in the overall NEP scores.

Gender differences in Water Decision Maker views on Water Management **(N=68).**	**Female (N=17)**	**Male (N=51)**
	Mean (SD)	**Mean (SD)**
Support for the New Environmental Paradigm		
Ecological Crisis	3.65 (1.16)*	3.21 (.95)*
Water Availability		
Contamination leads to scarcity	3.65 (.79)*	4.02 (.96)*
General Perspectives on Water Management		
Conservation as priority	3.82 (.95)*	3.43 (.99)*
Water Management in Eastern North Carolina		
CCPCUA Familiarity	2.18 (1.38)**	2.94 (1.33)**
Rules Successful	3.41 (.62)*	3.73 (.85)*
Rules Working Well	3.24 (.44)*	3.54 (.76)*
Rules should be expanded	3.18 (.39)*	3.50 (.86)*
NCDEQ website most use source of information	3.94 (.83)*	3.55 (.92)*
Current Perceived Water Management Threats		
Drought	.38 (.62)**	1.15 (1.11)**
Algal Bloom	.71 (.99)*	.33 (.72)*
Perceived Future Water Management Challenges		

* Results denoted with one asterisk (*) are statistically significant $\leq$ .10 (one-tailed).
** Results denoted with two asterisks (**) are statistically significant $\leq$ .05 (one-tailed).

TABLE 7. Gender Differences Among Water Decision Makers
(Scale from *1-5:* 1=Strongly Disagree, 5=Strongly Agree)

Males indicated a higher level of agreement with the statement "Contamination leads to scarcity" ($p \leq .10$). This result was unanticipated because it is often the case that women are more concerned with water pollution (Gallup Annual Environment Survey, 2021).When asked about conservation, females thought more frequently about water conservation than the males ($p \leq .10$).

Males also differed from females regarding their opinions of the CCPCUA Rules. They were more familiar ($p \leq .05$), thought that the rules were more successful ($p \leq .05$) and were working well ($p \leq .10$), and that they should be expanded ($p \leq .10$). A question concerning the website for the NCDEQ indicated fairly strong agreement that it is the most useful site for information regarding water management. However, differences did exist between males and

females, with the females expressing greater agreement ($p \leq .10$). When asked to rank current perceived threats, two differences emerged between males and females. Males ranked "drought" higher than females ($p \leq .05$), and females ranked "algal blooms" higher ($p \leq .10$). When asked about future challenges, there were no significant differences between sexes.

Differences between Degree Types

In terms of educational attainment, individuals in the sample were more similar than dissimilar. In other words, significant differences were found on relatively few variables considered. (Table 8). For example, a difference was detected on the ecological crisis subscale of the NEP those with greater than a 4-year degree had the highest score and those with less than a 4-year degree had the lowest ($p \leq .10$).

Educational attainment and Water Decision Maker views on water management **(N=69).**	**< 4-year degree (N=24)**	**4-year degree (N=23)**	**> 4-year degree (N=22)**
	Mean (SD)	**Mean (SD)**	**Mean (SD)**
Support for the New Environmental Paradigm			
Ecological Crisis	3.06 (.90)*	3.17 (1.04)*	3.73 (1.00)*
Water Management in Eastern North Carolina			
CCPCUA Familiarity	3.29 (1.16)**	2.30 (1.40)**	2.68 (1.43)**
Rules should be expanded	3.71 (.75)**	3.09 (.97)**	3.27 (.63)**
Rules should be lifted	2.17 (1.05)**	2.77 (.97)**	2.95 (1.09)**
Perceived Future Water Management Challenges			
Ability to obtain money/resources from funding agencies	1.91 (1.16)**	1.78 (1.20)**	.95 (1.02)**

* Results denoted with one asterisk (*) are statistically significant $\leq .10$ (one-tailed).
** Results denoted with two asterisks (**) are statistically significant $\leq .05$ (one-tailed).

TABLE 8. Educational Attainment and Water Decision Makers Views
(Scale from 1-5: 1=Strongly Disagree, 5=Strongly Agree)

Other differences were associated with management of water in the state of North Carolina. In terms of familiarity with the rules, it would be expected that those with less than a 4-year degree would be more familiar with the CCPCUA rules ($p \leq .05$). They also had the highest agreement with the statement that the rules should be expanded ($p \leq .05$) and the lowest agreement that the rules should be lifted ($p \leq .05$). This suggests that these individuals are more supportive of the rules and interested in expanding their protections to other communities.

The only other difference detected was in the ranking of future challenges. Those with less than a 4-year degree ranked ability to obtain funding higher than the other two groups ($p \leq .05$).

Employer Type

Municipal employees expressed more biocentric views than water associated employees on the balance ($p \leq .10$) and ecological crisis subscales ($p \leq .05$) (Table 9). There were significant differences noted here between employer types, with stronger agreement about the abilities of technology expressed by the individuals who were employed directly by municipalities versus people who are water associated ($p \leq .10$).

Employer Type and Water Decision Maker views on Water Management (N=69).	Municipality (N=45)	Water Associated (N=29)
	Mean (SD)	Mean (SD)
Support for the New Environmental Paradigm		
Fragile Balance of Nature	3.64 (.81)*	3.31 (.83)*
Ecological Crisis	3.51 (.94)**	2.94 (.97)**
Water Availability		
Lack of funding for maintenance and infrastructure causes water scarcity	3.84 (.81)**	4.25 (.74)**
Demand Side vs. Supply Side Management Strategies		
Resources are limited	3.52 (1.05)**	3.04 (1.23)**
Preference for hard or soft path	3.11 (1.15)**	2.63 (1.14)**
General Perspectives on Water Management		
Technology can manage contamination, reducing scarcity	4.11 (.66)*	3.83 (.82)*
Competition increases vulnerability	3.33 (1.07)**	3.88 (.99)**
Human economics pose a greater challenge than protecting non-human species.	3.20 (1.04)**	3.65 (.98)**
Water Management in Eastern North Carolina		
Familiarity with local Water Shortage Response Plan	2.49 (1.46)**	3.38 (1.25)**
CCPCUA Familiarity	2.40 (1.37)**	3.42 (1.18)**
Rules Successful	3.44 (.69)**	3.92 (.88)**
Rules Fair and Equitable	3.16 (.67)*	2.87 (1.14)*
Rules should be lifted	2.87 (1.01)**	2.17 (1.07)**
Frequency of consultation	4.57 (1.43)**	3.35 (1.47)**
Current Perceived Water Management Threats		
Groundwater Depletion	1.48 (1.22)*	1.04 (1.08)*
Perceived Future Water Management Challenges		
Ability to obtain money/resources from funding agencies	1.40 (1.12)**	1.92 (1.28)**
Population growth	.58 (.98)*	1.00 (1.38)*
Ability to retain utility staff/employees	.55 (.88)**	1.04 (1.20)**

* Results denoted with one asterisk (*) are statistically significant $\leq$ .10 (one-tailed).
** Results denoted with two asterisks (**) are statistically significant $\leq$ .05 (one-tailed).

TABLE 9. Employer Type and Water Decision Maker Views
(Scale from 1-5: 1=Strongly Disagree, 5=Strongly Agree)

When queried about water scarcity caused by a lack of funding, individuals whose positions are water associated differed from those who are in municipalities. There was higher agreement ($p \leq .05$) for those who are water associated regarding the lack of funding as a cause of water scarcity and they also perceived competition with other suppliers as a greater threat. Those

working for utilities also expressed a lower level of concern for other species and had lower scores on two of the NEP subscales, implying a more anthropocentric viewpoint.

Age

Few differences were noted between individuals above and below the mean age of the sample. Those with less than the average number of years in water management had higher average scores on the ecological crisis subscale (3.48 SD .88, $p \leq .05$), yet no differences were seen between age and any of the subscales (Table 10).

Age and Water Decision Makers views on Water Management N=67).	**≤ Mean[$] (N=33)**	**> Mean[$] (N=34)**
	Mean (SD)	**Mean (SD)**
Demand Side vs. Supply Side Management Strategies		
The hard path is better for North Carolina.	3.82 (.88)**	3.29 (1.17)**
Water Management in Eastern North Carolina		
Familiarity with local Water Shortage Response Plan	2.45 (1.54)**	3.06 (1.35)**
CCPCUA Familiarity	2.39 (1.46)**	3.03 (1.29)**
Rules Successful	3.33 (.65)**	3.91 (.87)**
Rules Working Well	3.22 (.61)**	3.68 (.73)**
Current Perceived Water Management Threats		
Pharmaceutical Pollution	.16 (.37)**	.64 (.99)**
Perceived Future Water Management Challenges		
Ability to retain utility staff/employees	.88 (1.22)*	.55 (.75)*

[$] Mean = 50.31 years.
* Results denoted with one asterisk (*) are statistically significant ≤ .10 (one-tailed).
** Results denoted with two asterisks (**) are statistically significant ≤ .05 (one-tailed).

TABLE 10. Age and Water Decision Makers' Views
(Scale from 1-*5:* 1=Strongly Disagree, 5=Strongly Agree)

Those who were younger and had fewer years in water management were more supportive of the hard path in North Carolina ($p \leq .05$). Those who were older were also more familiar with the CCPCUA rules ($p \leq .05$) and had higher agreement that the rules were successful and working well ($p \leq .05$).

Educational Discipline

Few differences were detected between individual disciplines (Table 11). One significant difference was in response to the NEP statement that Earth's resources are limited. Individuals who held a degree in planning had the highest level of agreement (p.<.05).

Educational Discipline and Water Decision Maker views on Water Management (N=51)	**STEM (N=6)**	**Planning (N=10)**	**Pub./Bus. Admin. (N=21)**	**Other (N=14)**
	Mean (SD)	**Mean (SD)**	**Mean (SD)**	**Mean (SD)**
Demand Side vs. Supply Side Management Strategies				
Resources are limited	2.33 (1.03)**	3.78 (.67)**	3.67 (1.16)**	3.29 (1.07)**
Water Management in Eastern North Carolina				
CCPCUA Familiarity	2.33 (1.03)**	1.89 (1.17)**	3.38 (1.24)**	2.07 (1.33)**
NCDEQ website most use source of information	3.50 (.55)*	3.11 (.93)*	3.95 (.87)*	3.71 (.73)*
Frequency of consultation	4.00 (1.67)**	5.67 (.50)**	4.11 (1.29)**	4.29 (1.68)**
Current Perceived Water Management Threats				
Groundwater Depletion	.17 (.41)*	1.00 (1.07)*	1.65 (1.23)*	1.23 (1.30)*
Drought	.83 (.98)**	1.00 (1.20)**	1.35 (1.04)**	.17 (.58)**

* Results denoted with one asterisk (*) are statistically significant ≤ .10 (one-tailed).
** Results denoted with two asterisks (**) are statistically significant ≤ .05 (one-tailed).

TABLE 1. Educational Discipline and Water Decision Makers' Views
(Scale from 1-5: 1=Strongly Disagree, 5=Strongly Agree)

Water Certifications

More significant differences were observed between individuals who hold water certifications and those who do not (Table 12). The greatest number of differences occurred when asked about managing water resources in North Carolina. Those without certification had a

higher overall NEP scale score ($p \leq .10$), with higher scores on two subscales, indicating a more biocentric orientation. Individuals with water operator certifications indicated higher levels of agreement about the security of water in eastern North Carolina for the next 25 years ($p \leq .10$). This is complemented by lower agreement with the statement about resources being limited ($p \leq .10$), conveying a sense of adequate water supplies; yet, they also had lower support for the hard path ($p \leq .10$), indicating support of conservation.

Having water operator certifications also increased the likelihood of being more familiar with the water shortage response plan and CCPCUA rules. This is unsurprising because they likely are working directly with water treatment, requiring them to be knowledgeable of the rules. Many differences existed regarding the CCPCUA rules, with those with certifications expressing more support of their success and their effectiveness and a desire to keep them in place (all significant $\leq .05$).

Water Operator Certifications and Water Decision Maker views on Water Management (N=74).	**Zero (N=47)**	**One or More (N=27)**
	Mean (SD)	**Mean (SD)**
Support for the New Environmental Paradigm	3.55 (.70)*	3.33 (.64)*
Fragile Balance of Nature	3.64 (.83)*	3.36 (.78)*
Ecological Crisis	3.51 (1.03)**	3.00 (.88)**
Demand Side vs. Supply Side Management Strategies		
Resources are limited	3.56 (1.03)*	3.11 (1.25)*
Preference for hard or soft path	3.09 (1.16)*	2.63 (1.15)*
Water Management in Eastern North Carolina		
Eastern North Carolina is secure in its water supply for 25 years	3.72 (.88)*	4.00 (.83)*
Familiarity with local Water Shortage Response Plan	2.45 (1.46)**	3.33 (1.21)**
CCPCUA Familiarity	2.47 (1.38)**	3.26 (1.29)**
Rules Successful	3.38 (.74)**	3.89 (.89)**
Rules Working Well	3.26 (.68)**	3.65 (.75)**
Rules should be lifted	2.87 (1.08)**	2.27 (1.00)**
Frequency of consultation	4.73 (1.34)**	3.35 (1.52)**
Perceived Future Water Management Challenges		
Ability to retain utility staff/employees	.55 (.93)**	1.04 (1.16)**

* Results denoted with one asterisk (*) are statistically significant $\leq .10$ (one-tailed).
** Results denoted with two asterisks (**) are statistically significant $\leq .05$ (one-tailed).

TABLE 22. Water Operator Certifications and Water Decision Makers' Views
(Scale from 1-5: 1=Strongly Disagree, 5=Strongly Agree)

Years in Water Management

With the exception of water management in eastern North Carolina, few significant differences in many of the dependent variables were seen related to years in water management (Table 13). Those with fewer years were more worried about ecological crisis as measured by the NEP scale ($p \leq .05$). Yet those with less experience expressed stronger agreement that water pricing is more challenging than wildlife protection. ($p \leq .05$). A difference was also detected between individuals with greater than the mean number of years in water management; they had a higher level of agreement indicating that they believe that the water supply will be secure until 2045 ($p \leq .10$).

Yet an interesting contrast also emerged because individuals with more time in the water management industry had higher levels of agreement with the statement that competition between water providers increases their vulnerability ($p \leq .10$). When asked about supply side management versus demand side management, those with lower than the average years of experience were more positive about using technology in their jurisdiction than more experienced individuals ($p \leq .10$). This sentiment was echoed by a similar difference in another question that asked directly about the ability of technology to manage scarcity ($p \leq .10$). The last significant difference occurred when prioritizing the current perceived threats. Those individuals with more experience ranked pharmaceutical pollution as a more pressing threat.

Length of time in water management and Water Decision Maker views on water management (WDM; N=67).	≤ Mean[$] (N=37)	> Mean[$] (N=30)
	Mean (SD)	Mean (SD)
Support for the New Environmental Paradigm		
Ecological Crisis	3.48 (.88)**	3.01 (1.10)**
Demand Side vs. Supply Side Management Strategies		
The hard path is better for North Carolina.	3.78 (.89)*	3.43 (1.17)*
General Perspectives on Water Management		
Technology can manage contamination, reducing scarcity	4.17 (.66)*	3.90 (.76)*
Competition increases vulnerability	3.35 (.98)*	3.73 (1.17)*
Human economics pose a greater challenge than protecting non-human species.	3.58 (.84)**	3.17 (1.18)**
Water Management in Eastern North Carolina		
Eastern North Carolina is secure in its water supply for 25 years	3.73 (.84)*	4.03 (.89)*
Familiarity with local Water Shortage Response Plan	2.46 (1.50)**	3.33 (1.18)**
CCPCUA Familiarity	2.41 (1.46)**	3.30 (1.09)**
Rules Successful	3.38 (.68)**	4.00 (.83)**
Rules Working Well	3.31 (.62)**	3.67 (.76)**
Current Perceived Water Management Threats		
Pharmaceutical Pollution	.29 (.52)*	.55 (1.02)*

[$] Mean = 16.04 years.

* Results denoted with one asterisk (*) are statistically significant ≤ .10 (one-tailed).

** Results denoted with two asterisks (**) are statistically significant ≤ .05 (one-tailed).

TABLE 13. Length of Time in Water Management and Water Decision Makers' Views (Scale from 1-*5:* 1=Strongly Disagree, 5=Strongly Agree)

Belonging to a Water Cooperative

A number of significant differences existed between individuals whose organization belonged to a water cooperative (Table 14). Those in co-ops were more biocentric, with higher scores on several of the subscales of the NEP ($p<.05$) as well as other items related to environmental protection. These included considering non-human species in decision making ($p\leq.05$) and higher disagreement that the economy is more important that the environment ($\leq.05$).

Water cooperative membership status and Water Decision Maker views on water management (N=71).	Member (N=19)	Non-member (N=52)
	Mean (SD)	Mean (SD)
Support for the New Environmental Paradigm	3.72 (.70)**	3.36 (.66)**
Fragile Balance of Nature	3.93 (.74)**	3.38 (.81)**
Ecological Crisis	3.61 (.86)**	3.17 (1.01)**
Anti Anthropocentrism	3.77 (.97)**	3.35 (.85)**
Demand Side vs. Supply Side Management Strategies		
Resources are limited	3.84 (1.07)**	3.18 (1.10)**
Nanofiltration and reverse osmosis can provide water for 25 years	3.74 (.87)*	3.47 (.70)*
General Perspectives on Water Management		
Technology can manage contamination, reducing scarcity	4.21 (.79)*	3.92 (.69)*
Non-human species are important in decision making.	4.32 (.67)**	3.76 (1.08)**
Water Management in Eastern North Carolina		
The economy takes precedence over the environment.	2.00 (.88)**	2.52 (1.09)**
Familiarity with local Water Shortage Response Plan	2.42 (1.07)*	2.92 (1.55)*
Rules Successful	3.84 (.90)*	3.52 (.78)*
Rules Working Well	3.68 (.89)**	3.33 (.62)**
Rules should be expanded	3.63 (.76)**	3.24 (.89)**
Rules should be revised	3.11 (.88)*	3.45 (.81)*
Rules should be lifted	2.16 (1.12)**	2.84 (1.05)**
NCDEQ website most use source of information	4.05 (.71)**	3.50 (.93)**
Perceived Future Water Management Challenges		
Compliance with state regulations	1.11 (1.20)*	.66 (1.00)*
Ability to retain utility staff/employees	.37 (.68)**	.88 (1.13)**

* Results denoted with one asterisk (*) are statistically significant $\leq$ .10 (one-tailed).
** Results denoted with two asterisks (**) are statistically significant $\leq$ .05 (one-tailed).

TABLE 14. Water Cooperative Membership and Water Decision Makers' Views (Scale from 1-5: 1=Strongly Disagree, 5=Strongly Agree)

Individuals who are members of water cooperatives differed from those who are not on questions about the uses of technology. For individuals who were co-op members, there was stronger agreement that technology can manage contamination ($p \leq .10$) and specific technologies (nanofiltration and reverse osmosis) can provide water for the next 25 years in the region ($p \leq .10$).

Members of water cooperatives had a more positive view of the CCPCUA rules and thought that the rules should be expanded ($p \leq .05$, Table 14). Those who were not members agreed that the rules should be revised ($p \leq .10$) or lifted ($p \leq .05$). This difference may have

important implications for the future of water management in the region. The rules were written by a collection of stakeholders from various interests across the region (Natural Resources Leadership Institute. 2015). They have been described as an example of procedural justice because those who were involved with crafting the new regulations had a positive view (Manda & Klein, 2014). This has been found to increase cooperation and compliance with rules in other circumstances (Borsuk, Clemen, Maguire, & Reckhow, 2001). However, if the rules were to be revisited in the future, based upon the response of the non-members, there may be pressure to reverse them. This would have serious implications for the conditions of the aquifers that were protected by the CCPCUA rules.

Water cooperatives have provided solutions to many of the small local water suppliers' problems in the region. Communities with small customer bases and low water rates make it difficult to maintain infrastructure and to get loans from the state government (Condon, 2019). The water authorities have improved conditions for many of these providers, despite increased water rates. These rate increases were likely inevitable for communities required to shift from groundwater to surface water. Now financial risk has been distributed across the members (Dowbiggin, Carl S. Frizzell, & C. Brandon Garner, 2009) . From the State's viewpoint, the added benefit is the support for the CCPCUA rules, and these water authorities have regular communication between members, which offers the opportunity to address issues of climate resilience with a larger number of communities more efficiently.

Seasonal Population

The barrier islands off the southeastern coast of the study region rely on tourism for their economy. Consequently, the difference in population has an impact on water resource management. Use is exponentially higher in the summer months than in the winter, which poses challenges with both the water supply, wastewater disposal, and cash flow (O'Driscoll, Bean, Mahoney, & Humphrey, 2019). Those individuals working in communities with no seasonal difference had higher scores on two questions measuring environmental concern: 1) Limits to growth ($p \leq .05$) and 2) Resources are limited ($p \leq .05$) (Table 15).

Seasonal population in jurisdiction and Water Decision Maker views on Water Management (N=70).	**Seasonal Difference (N=25)**	**No Difference (N=45)**
	Mean (SD)	**Mean (SD)**
Support for the New Environmental Paradigm		
Limits to Growth	2.77 (1.02)**	3.15 (.75)**
Water Availability		
Saltwater intrusion causes water scarcity	3.76 (.60)*	3.49 (.79)*
Demand Side vs. Supply Side Management Strategies		
Resources are limited	2.96 (1.14)**	3.56 (1.05)**
Water Management in Eastern North Carolina		
Water here is more secure than other places in the state.	3.76 (1.30)**	4.22 (.97)**
Familiarity with local Water Shortage Response Plan	2.44 (1.50)*	2.98 (1.41)*
CCPCUA Familiarity	2.24 (1.17)**	3.02 (1.42)**
Rules Successful	3.40 (.58)*	3.69 (.90)*
Rules Fair and Equitable	3.29 (.55)*	2.96 (.93)*
Rules should be revised	3.17 (.57)*	3.47 (.94)*
Frequency of consultation	3.88 (1.48)*	4.41 (1.52)*
Current Perceived Water Management Threats		
Saltwater Intrusion	1.64 (1.22)**	1.05 (1.15)**
Groundwater Depletion	.76 (1.05)**	1.51 (1.16)**
Drought	.60 (.91)**	1.21 (1.07)**
Perceived Future Water Management Challenges		
Water conservation by consumers	.96 (1.49)**	.35 (.72)**

* Results denoted with one asterisk (*) are statistically significant $\leq .10$ (one-tailed).
** Results denoted with two asterisks (**) are statistically significant $\leq .05$ (one-tailed).

TABLE 15. Seasonal Populations and Water Decision Maker's Views
(Scale from 1-5: 1=Strongly Disagree, 5=Strongly Agree)

Those who said they experienced seasonal population fluctuations had higher concern about saltwater intrusion causing scarcity ($p \leq .10$) and ranked it higher as a current threat to the water supply ($p \leq .05$). They were also less confident about the security of their water supply compared to other areas in the state ($p \leq .05$). However, they were less concerned about groundwater depletion ($p \leq .05$) and drought ($p \leq .05$) and ranked them lower as threats. It may be the case if they are already using RO then they could shift to ocean water and don't perceive the same level of threat.

Another difference is between those with a seasonal population change versus those without regarding the CCPCUA rules. Individuals who had a seasonal difference considered the rules more equitable but those without were more familiar ($p \leq .05$), thought that the rules were more successful ($p \leq 10$), and were also more likely to think that they should be revised ($p \leq .10$).

Differences in Opinion of the Central Coastal Plain Capacity Use Area Rules

Because the questions that generated the greatest number of differences were regarding the state rules to regulate water resources in the study region, a discussion of those warrants its own review. Males differed from females regarding their opinions of the rules. They were more familiar ($p \leq .05$), thought that the rules were more successful ($p \leq .05$), that they were working well ($p \leq .10$), and that they should be expanded ($p \leq .10$). Individuals with less than a 4-year degree were also more familiar ($p \leq .05$) and thought that the rules should be expanded ($p \leq .05$). But those with greater than a 4-year degree thought that the rules should be lifted ($p \leq .05$). People with educational disciplines in administration were more familiar and thought that the rules should be revised (both $p \leq .050$). Employer type also produced differences, with water associated employees more familiar with the rules ($p \leq .05$), deeming them more successful ($p \leq .05$), but municipal employees thinking the rules are more equitable ($p \leq .10$) and should be lifted ($p \leq .05$).

Those who held water operator certifications differed from those who did not; they were more familiar, thought that the rules were successful and working well. But those without certifications thought that the rules should be lifted (all $p \leq .05$). Age also influenced attitudes towards the rules; older individuals were more familiar and thought that the rules were successful and working well (all $p \leq .05$). This coincided with time in water management. Those with more time also held the same opinions as those individuals who were older than the mean of the sample (all $p \leq .05$). Members of water cooperatives were more likely to consider the rules successful, working well, and should be expanded, whereas those who were not thought the rules should be lifted or revised.

The more interesting results are with who finds the rules successful and working well versus those who think that they are equitable, should be expanded, and/or should be lifted. Members of water cooperatives—the individuals who are likely in regular communication with other members—had a more positive view of the rules and thought that the rules should be expanded. The non-members thought that the rules should be revised or lifted

Another difference is between those with a seasonal population change versus those without. Individuals who had a seasonal difference considered the rules more equitable but those without were more familiar and thought that the rules were more successful as well as more likely to think that they should be revised.

Conclusions

A summary of the demographic differences indicates that the water decision makers are mostly male, a majority have a degree in an administrative discipline, and they work directly for a municipality. Approximately a quarter work for an organization that belongs to a water cooperative and just over a third work in a setting which experiences a seasonal population

change. A little more than a third have one or more certifications as a water operator in the state of North Carolina. They are equally split in their educational attainment (<4 year, 4-year, >4p-year degree). The individual who typifies the mean of the sample is a mid-career professional with 16 years' experience.

When taken as a whole, the greatest number of significant differences existed between employer type (municipality vs water associated) and included level of environmental concern, the definition of scarcity, opinion of management both in general and specifically in eastern North Carolina, and perceived present threats and future challenges. The municipal employees were more biocentric, not only on the NEP, but on other measures. Yet these individuals also had a higher level of agreement with the hard path and supply side management as the means to ensure adequate water supply. Water associated employees were more likely to define water scarcity as a result of insufficient funding and were more concerned about competition. They ranked groundwater depletion lower as a current threat and were more concerned about funding, population growth, and staffing issues than municipal employees. A general interpretation is that municipal employees were more concerned about the water itself, whereas water-associated employees were more concerned about human aspects of management.

The fewest differences were detected between levels of educational attainment. The only differences were the perception of ecological crisis, several differences regarding the CCPCUA, (discussed separately), and in the ranking of funding issues as a future challenge. Similarly, fewer differences were detected between individuals due to degree subject, and they can be characterized as more similar than dissimilar. This was mirrored in the number of differences seen between those who hold water operator certifications which was slightly greater, with many of the differences occurring in water management in the region and no significant differences

occurring in their opinions of general water management. This result was unanticipated because the existence of an "engineering bias" was expected in those individuals with more technical training.

Because they are all working in the same region, it might be predicted that opinions would be more similar regarding management, yet the responses were more dissimilar. But when asked about water management in eastern North Carolina, the greatest differences in opinion emerged. There was disagreement based upon educational attainment, degree subject, and water operator certifications. There was also disagreement due to age and years in water management. Additionally, belonging to a cooperative and having a seasonal population also exhibited differences. Many of those differences were in perception of the CCPCUA rules, but there were also differences in environmental concern, the ranking of current threats, and future challenges.

Some specific differences were perceived regarding water management in the east. Those individuals with certifications and more years of experience expressed a greater sense of security in the water supply. Those who belonged to a water cooperative were more supportive of environmental protection over the economy, and those who did not experience a seasonal change in population thought that their water supply was more secure than other places in the state.

The last set of questions regarding management in the region has to do with the state website for the NCDEQ, and there is fairly strong amount of agreement that it is the most useful site for source of information regarding water management. Differences did exist between males and females, with the females expressing greater agreement. Those with administrative disciplines and members of a water cooperative also agreed. There were no differences in terms of educational attainment on this question, and there were no differences between employer type. But interestingly, those who were municipal employees, had a background in planning, without

certifications, and with no seasonal differences in population stated that they used the website frequently.

Support for demand side or supply side management also revealed more differences than similarities. This included differences between municipal and water-associated employees, degree subject and water certifications, age and years in water management, and whether an individual worked for a water cooperative or in a seasonal setting. In contrast, water availability (scarcity versus abundance) saw few differences, leading to the conclusion that more consensus about the physical resource exists than about other aspects of management. Because of the importance of using more demand side management and soft path approaches to ease the transition to climate resilience, these differences are notable. Although they exist as a "target audience" they are not a monolith in their opinion of the soft path and any toolkit materials developed might need to take this into account.

When asked about their environmental worldview, differences were detected between employer types (municipal vs. water-associated), educational attainment, water certifications, years in water management, belonging to a cooperative, or whether they worked in a seasonal community. Because some individuals are more biocentric they may be more receptive to acknowledging the need to plan for climate change impacts than other individuals. As is discussed later, some studies have indicated that experience with natural disasters influences perception of the threat (Andersen et al., 2019) and communications can be written without expressly using the term "climate change" which is politically sensitive. The differences detected here in environmental concern seem to confirm that these differences exist and should be considered when communicating with this audience.

Limitations of the study include sample size and the fact that a majority of respondents were male. This may be reflective of differences in gender in employment, but it should be noted that a more complete picture would be provided by having more females in the sample. Also, individuals who work in water management whose email address is not available publicly were not included. This likely means that water utility personnel and planners may be underrepresented. Given the fact that significant differences were detected between professional role and gender, these limitations should be considered when interpreting the results.

Summary

The quantitative survey provides a rich and diverse view of the water decision makers and helps to create a detailed profile of these local environmental decision makers. Despite working in the same region, differences exist possibly because of the large range of environmental, population, and economic conditions and because of the different educational requirements and skill sets for the different types of water decision makers. The next chapter draws out some of these differences and offers insights into the attitudes of water decision makers in this coastal region through the analysis of interviews. The key informants are reflective of the population described here; therefore, the interviews afford a more detailed understanding of how water decision makers perceive water availability and what they perceive to be threats. However, the interviews also provide novel perspectives that round out the information presented here.

CHAPTER 5: QUALITATIVE ANALYSIS OF INTERVIEWS

If climate resiliency is to be achieved, there is a need to study water professionals due to their influence on the daily lives of most American. Unlike the western United States which is facing historic drought with cities like Las Vegas, New Mexico which had approximately 20 days of clean water for residents in August of 2022 (Wornell, 2022), there has been less focus on water management in "water-rich" regions (Cockerill, 2014; Praskievcz, 2019). Consequently, less is known about the characteristics of the individuals who manage the public water supply under conditions which appear to be more water-secure than communities in the west.

The study area was identified and chosen because of two important characteristics: location in a humid climate which masks the threat of water scarcity, and groundwater that has been regulated due to exploitation by multiple users. The state of North Carolina is faced with the impacts of climate change, especially in the eastern region of the state where sea level rise is increasing salinity concentration in the aquifers (Fiori & Anderson Jr, 2022; National Oceanic and Atmospheric Administration, 2009). Additionally, as the state experiences one of the highest population growth rates in the country, competition for a limited supply of water is likely to increase. Because water management occurs at the local level, the description of water decision makers created by this study can provide helpful information to agencies tasked with developing resources to assist communities with the transition to climate resilience.

In this chapter, important themes are identified and analyzed to develop a profile of these water decision makers who are now facing the need to build climate resilience into their operations. Examples are provided in support of what the themes tell us about the perceptions of the water decision makers and the implications are discussed. This chapter will present an

analysis organized around anticipated themes that had been identified in previous studies, such a complacency about water quantity, and an engineering bias that causes greater support for supply side management over demand side management (Cockerill, 2014). The interview transcripts have also been analyzed for emergent themes that developed from the interviews such as: "resignation" due to the "politics as usual," which prevents raising the cost of water, discomfort with waste with a desire to promote more conservation, "pride" seated in a deep sense of responsibility for "getting it right"; and a confidence in water security despite signals of scarcity that leaves communities in the water-rich east vulnerable to competition from too many users and too little water.

Introduction

Like other places around the world, the eastern region of North Carolina is already experiencing the negative impacts of human-induced climate change. These impacts are forcing populations to deal with the effects of storms, droughts, and increased chloride levels in the water supply, causing changes in human water use. Water professionals are on the front lines of dealing with these changes and their decisions will have long-lasting impacts; therefore, a profile of those who make decisions about the public water supply provides useful information to agencies tasked with helping communities achieve climate resilience.

The water decision makers in the coastal plain of North Carolina are not unique in that the legal structure that governs the water supply is similar to other coastal states, especially those in the east. Although the federal and state governments regulate the water supply, the day-to-day management of water is in the hands of local utilities that are often under the umbrella of local government. Like other eastern states, the groundwater resources in eastern North Carolina are part of a geological structure that underlies much of the coastal plain stretching from New Jersey

to Florida (Winner Jr. & Coble, 1996). And like other coastal areas, eastern North Carolina is facing sea level rise and increased population growth. Therefore, this sample of water decision makers offer insights into the attitudes, beliefs, and values of who are more similar than dissimilar to water professionals in other regions of the state and other states in the country.

Managing a natural resource means not only managing the physical aspects of the water supply, but also managing people. Knowing the audience tasked with making a successful transition to climate resilience would be useful for those developing materials to aid in this process. The water decision makers in the sample are the utility personnel, local government administrators, planners, and elected officials. They had varying educational backgrounds with many of the utility people holding less than a 4-year degree but more water operator certifications; whereas the elected officials, planners, and managers were more likely to have college degrees. This understanding is essential because local government managers and elected officials rely on their "water people" for guidance and the utility personnel can have an outsized influence on any decisions.

Planners often have less direct impacts on water supply decision making, yet their land use planning will have long-range impacts. Also, because they are required to do continuing education credits to maintain their credentials, they may be more likely to be exposed to resilience planning strategies. This includes not only technical skills, but essential "soft skills." For example, an American Planners Association publication about climate change has a section entitled "know your audience" which acknowledges that beyond understanding the science of climate change, there is a need to understand the human dimensions (Climate change resources, n.d.).

This sample of water professionals exhibited some psychological characteristics that occur in other places, many of which are barriers to soft path adoption (Brandes & Ferguson, 2004, Cockerill, 2014; Maas, 2003). The characteristics include psychological distance, optimism bias, and technological optimism. Overall, they appeared to be psychologically distant from threats such as drought, describing low levels of concern about the chance that it will decrease their water security. This psychological distance existed on all four levels: temporal, spatial, social, and uncertainty.

They "othered" these impacts, explaining that phenomena such as drought and saltwater intrusion are something that happen in other places in the state or even other locations in the country. This is likely related to their optimism bias; they perceive their local circumstances more positively than they perceive those of others. They also demonstrated technological optimism or an "engineering bias," believing that using technology can solve many of the problems that they faced, such as reverse osmosis to deal with the higher levels of saltwater encroaching into aquifers. All these factors are reliant on the continued use of hard path approaches to water supply.

In sharp contrast, for water decision makers in this sample, flooding was a salient threat, and they exhibited psychological proximity to it. As documented in other studies, direct experience with natural disasters influences perceptions. They had experienced the acute adverse impacts of flooding and expressed concern about managing them successfully in the future. Less than a year before the interviews, Hurricane Matthew had devasted parts of the eastern North Carolina, reducing psychological distance for many of the key informants on the temporal, spatial, social, and uncertainty parameters.

Water professionals are also occupied with pressing concerns such as infrastructure failures and staff shortages. The lack of investment in maintenance, which is a common occurrence across the country as evidenced by the need for the bipartisan infrastructure bill, occupies much of their time and efforts. And the inability to recruit and retain qualified employees has added to that burden. Spending time on these issues means fewer resources available for resilience planning.

Despite their confidence in water security, many saw water as a valuable and finite resource. The water was a "blessing," and they should be "preaching conservation." They perceived the average citizen to take water for granted, which seemed frustrating to some. They expressed a desire to encourage greater conservation in their communities and believed that economic incentives would be effective at achieving demand side management yet were resigned to the political realities prevented the raising of rates.

This sample of water decision makers were intrinsically motivated. Because of the invisible nature of the water supply in which there is little recognition or reward for a job done well and much negative publicity when something goes wrong, intrinsic motivation is not surprising. The idea that they are public servants was evident in their responses to questions about how they managed the water supply. They expressed that they felt pride in the work that they did, that it was "more than a paycheck." They described a strong sense of responsibility and were protective of their consumers' well-being. With the health of so many of us in their hands as consumers of public water supplies, these personal characteristics are notable.

Lastly, many factors are beyond their control, such as aging infrastructure and inadequate funding, issues with recruitment and retention of employees, pollution from other users which present day to day challenges for them that often require immediate attention. Therefore, it is

unsurprising that they are optimistic about technology, which seems to provide a sense of agency and has allowed them to address scarcity in the past. They do predict that shortages will come, but in the future and often after they are no longer working in water management.

Textual Analysis of Interviews

The interviews were analyzed using themes that were anticipated based on the findings of other studies (Kirchhoff, 2012). As these were characterized, additional themes emerged inductively out of the texts that provide more information about the attitudes and beliefs of this sample of water decision makers. Presented below are tables of the anticipated and emergent themes (Tables 16 and 17) which include a brief description and an exemplar quote for each. Each theme is then described in a summary and detailed examples from the interviews are presented to demonstrate the theme. Lastly, a discussion of each of themes is given to explain how they fit into the bigger picture of what we already know about water decision makers in a regional setting and how these findings contribute to greater understanding of who they are and how they think.

Theme	Description	Example Quotes
Drought impacts/Water shortages	Droughts occurred in the region, but their impacts were minor. A sense of confidence that droughts were not a serious threat to the water supply was a recurring theme. Water shortages occur in other areas, not in their jurisdiction. They compared favorably to other areas in the state of North Carolina and even nationally.	"Some communities couldn't water lawns and had restrictions in place, but not here... During the drought of 2008 the governor was close to putting something across to the state, they had a plan in place.....the Neuse River was low, but there was no fear of running out." Informant P
Saltwater Intrusion impacts	Saltwater intrusion was defined as an issue in communities close to the coast and not a concern for people located inland but even coastal communities were not worried about its impacts.	"It would have to pass through a whole lot of counties before we would have saltwater intrusion here, ample time to worry about it." Informant G
Storm/Hurricane Impacts	Flooding was a recurrent problem that was seen as a major threat to water security. Hurricanes and tropical storms that regularly impact the state of North Carolina, particularly the coastal plain, were cited as the cause. This was described as a pressing concern.	"We do a poor job of managing flooding." Informant Q "More likely that the issue is having too much, like Matthew Flood mitigation is a bigger concern." Informant S
Pollution	Concern about emerging pollutants and not knowing what might be in the water was considered an issue.	"Pollution can make it [water] unusable." Informant L "There are pollutants we don't know about yet that are in the water supply." Informant P
Support for the Hard Path (SSM)	Support of the hard path indicated a faith in the use of technology to increase the supply of water available. New wells or the use of advanced filtration methods were discussed as effective methods.	"Technology is awesome!...If nothing comes out of the well, we now have the technology. We can make ocean water drinkable." Informant E "We need reservoirs between here and Raleigh because there is increased flooding (is what some people say)" Informant V
Barriers to the Soft Path and Demand Side Management (DSM)	Suggested methods to incentivize conservation included water saving fixtures, raising rates, more updated metering, reusing water, and consumer education. Some methods were considered less effective than others. But ultimately, getting consumers to conserve was perceived as too difficult and politically undesirable.	"I am thinking of implementing a program for more conservation. [Use] public education, put something on the website, fliers, a training or class, citizen academy with education on water management. Use pamphlets, mailers, word of mouth." Informant L "Propose that the rates be raised, and they scream and holler." Informant X

TABLE 3. Anticipated Themes

Emergent Theme	Description	Example quotes
The Value of Water: Support for the Soft Path/conservation	Religious language was invoked by some to communicate the need for conservation. The value of water and protecting the supply was expressed by multiple interviewees	"We need to be preaching water conservation." Informant N
Aging Infrastructure	Old pipes and meters were considered a major concern. This leads to breaks in water lines or leaks that lead to lost water and revenue. The barrier was financial, often not enough money was available for upkeep, often resulting in emergency situations.	"We do a poor job of maintenance" there is little money set aside for the future." Informant Q
Recruitment and Retention	A loss of institutional knowledge was a source of concern. Recruitment and retention of employees is difficult. The demands of the job which includes being on call for emergencies and lower pay by smaller providers were cited as reasons for the problem.	"No one is interested in coming into this field succession retiring workforce in the next 5-10 years can't replace-been here for decades, lose that history – pipes/values (knowing each one)" Informant H
Agency	Similar decision-making processes regarding the technological aspects of the water supply was described. Most managers/administrators weighed heavily on their "water people" to advise them and then those recommendations were presented to the elected officials. State regulations and outside consultants were also involved. Rate changes were the purview of the elected officials.	"Decision making "starts in this office, we have an initial discussion with supervisors." Informant M
Responsibility & Pride	Providing a safe supply of drinking water was source of concern. The health and well-being of consumers and the ramifications of contaminated water was expressed and communicated a sense of pride in the importance of the work that they do.	"They [the public] entrust the people supplying water to say when they can and can't use it (the water)." Informant E "For some it's just a job, not for me." Informant J
Water Management in the Future	Future predictions varied from positive to negative. More cooperation between water suppliers and the use of advanced technology was a common thread. But they were also concerned about conflict and the ability to find enough water in the future and recruit employees. Only two mentioned climate change but it was an underlying theme.	"I predict that there will be fighting over water right because of supply issues." Informant Y

TABLE 17. Emergent Themes

Theme Summary – Drought Impacts and Water Shortages

Drought is a regular phenomenon in the state of North Carolina. Yet because of its gradual cumulative effects, it does not provoke the strong, more immediate response often elicited by other natural hazards such as flooding or wildfires (Diggs, 1991; Wilhite & Glantz, 1985); however, its adverse impacts have been felt in the past. Information from NC Drought (part of the U.S. Drought Monitor network) indicates that the State had three time periods since 2007 with classifications indicating exceptional (D3) or extreme (D4) drought (2007-2008; 2011; 2017). The drought of 2007-2008 showed 80% of the state in these classifications (Figure 6).

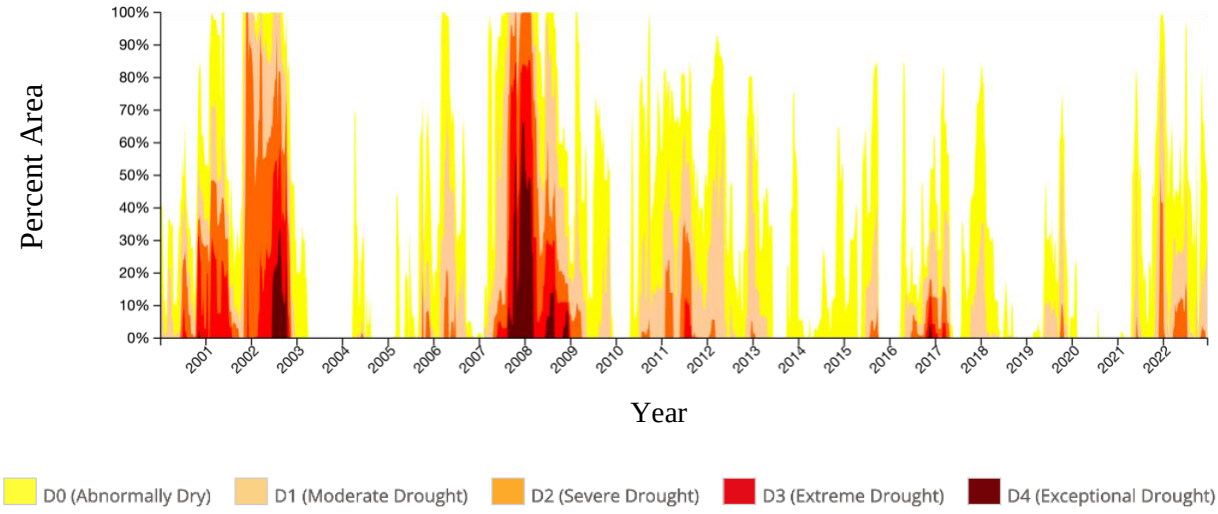

FIGURE 6. U.S. Drought Monitor Categories--North Carolina. (Adapted from US Drought Monitor, 2022)

Examples of Drought Impacts and Water Shortages

The city of Raleigh, located just 50 miles from the western border of the CCPCUA, was mentioned by almost a third of the interviewees as experiencing a crisis during the 2007-2008 drought. The city of Durham, not far from Raleigh, had only 38 days of water remaining in its

reservoir before relief came in the form of heavy rains in the Fall of 2008 (Davis, 2015). One elected official stated: "I do remember that Raleigh was dealing with water issues during the drought –[Jordan] lake was low" (Informant S). Other communities in the central and western regions of the state were under mandatory restrictions that prohibited non-essential water use (Davis, 2015).

During the drought of 2007-2008, some of the largest cities in the study area were also facing water shortages and the dire conditions were publicized by local newspapers and television stations. For example, Greenville--the 2nd most populous city--was facing a crisis because lack of precipitation decreased the flow in the Tar River which supplies much of the city with drinking water. This allowed the movement of saltwater upriver from the Pamlico estuary, and because the water treatment plant was not equipped with desalination equipment, it would have been unable to remove the chlorides from the water supply, disabling its ability to supply water to city residents (Parsons, 2008). Additionally, another crisis scenario was emerging in the 3rd largest city, Rocky Mount. The city was on the verge of running out of water because the flows had declined so dramatically that the intake pipes for the water treatment plant were almost above the surface of the river (Davis, 2015). Multiple impacts were described by key informants such as the low level of the river that left docks on land and the perilous nature of the crisis. One water treatment operator said: "In Rocky Mount they were within days of running out" (Informant M). Despite this, only three stated that drought had had a negative impact on their municipality. One administrator said: "It was a big thing and we tried not to use so much (in 2008). There were restrictions at the time.... on car washing" (Informant E).

Ironically, even the individuals from the so-called “impacted” communities also did not express much concern about drought conditions. In fact, an interviewee in the one of the cities mentioned above said, “There were no mandatory restrictions...We are positioned well to minimize exposure to drought” (Informant S). For the majority of the key informants, meteorological droughts were not a pressing source of concern, and they expressed a high level of confidence in their ability to continue to provide an adequate supply of water during these periods. However, droughts are predicted to be more extreme and more frequent as the climate changes (citation) (Craig, Feng, & Gilbertz, 2019; North Carolina Division of Water Resources, 2011; North Carolina State University; Van Loon et al., 2016), leading to greater vulnerability particularly in the more rural and impoverished communities. This will necessitate greater planning for a resilient response on the part of public water providers, yet they are less likely to act because of the attitudes that they hold presently about drought.

The picture painted by the interviewees is that water shortages happen elsewhere, not in their county. Direct experience has been cited as a factor in perception of hazards such as droughts (Anderson, 2019), leading to the conclusion that the individuals have not yet experienced droughts that have produced adverse socio-economic impacts strong enough to warrant apprehension about drought. They were optimistic about the ability to supply adequate water to meet needs even though they were aware of the conditions across the state and the southeast. There was an “othering” (McEwen, Bryan, Black, Blake, & Afzal, 2021) of locations but they were unaffected. Based upon their own lived experience, of the water decision makers consulted, the majority expressed the opinion that it may happen, but “not in my lifetime” (Informant I). Certitude resonates throughout the majority of the subject’s interviews; drought is not a threat to their ability to continue to provide water to consumers.

Theme Summary - Saltwater Intrusion

Saltwater intrusion was one reason for the passage of the CCPCUA rules designed to protect the integrity of these groundwater sources. The aquifers that had served as important sources of water in the region for decades were being degraded by over pumping, with increased chloride levels as one major consequence. Because all key informants were working in the CCPCUA region, it was anticipated that many would have knowledge of the threats to groundwater. However, most were complacent, believing that it would be a long time before saltwater might impact their community. This was true, even if they were located close to another community that had already installed more expensive desalination infrastructure to treat their groundwater to remove the chlorides. Similar to drought and water shortage, this issue was not troubling for many of the interviewees, although it clearly is a concern for other water suppliers who are already experiencing it.

Examples of Saltwater Intrusion

The CCPCUA rules were passed by the state of North Carolina around 2000 because chloride concentrations were a threat to some of the key aquifers in the east. The presence of chlorides is often a function of proximity to the ocean and sea level rise, but in the study region it was also a result of the over-pumping of aquifers (Central Coastal Plain Capacity Use Area & Assessment Report, 2018; North Carolina Division of Water Resources, 2005; North Carolina Division of Water Resources, 2018) This migration is known as saltwater encroachment or intrusion, the movement of saline water into freshwater aquifers laterally or from below. Despite the effects already experienced, the attitude of more than half of key informants towards saltwater intrusion (SWI) could be characterized as “unconcerned.” For some, even though they

had “very vaguely heard of it” (Informant S), they had no personal experience, and they did not perceive it a salient threat to their supply. This was particularly true for those who were using surface water and those who were further inland from the coast: “Don't hear about SWI, saltwater intrusion, not an issue here” (Informant L). SWI was described as a coastal issue that other communities had to address, and some mentioned other locations that they thought were experiencing increased chlorides. They also believed that the required routine testing for chlorides in the water supply would alert them to any changes in water quality and they had yet to experience it, or they were not worried because the aquifers they used were deep and less likely to be impacted. Even if they were aware of it and named a location where they believed it to be happening and that it might be problematic for their jurisdiction in the future, the time horizon was long. A water related manager said: “I have heard tell of it but never dealt with it. Don’t know about it. It would have to pass through a whole lot of counties before we would have saltwater intrusion here, ample time to worry about it.” (Informant G).

The few respondents who were concerned were located closer to the coast and already had treatment systems to address the higher chloride levels in place. A few informants from inland locations seemed to have a greater awareness of the state of the aquifers but were the anomaly in the sample. There was a sense of disapproval about this situation. As described by another water related manager: “Some haven't done anything but are benefitting because of the aquifer rebound. It’s less expensive to do nothing and pay fines to the state, but not the right thing to do. Impact on aquifer, some benefitted, us being proactive, others requested relaxation of rule at state level. SWI is somewhat of a concern, over pumping the aquifer is an issue” (Informant D).

Theme Summary- Storm/Hurricane Impacts

Like much of the southeastern United States, North Carolina is subject to tropical storms and hurricanes. In fact, it ranks in the top 5 states for adverse impacts and damages (Top ten most hurricane prone states, n.d.). Additionally, more frequent high precipitation events not linked to tropical storms are also impacting the region with excess water, including flash floods (Top ten most hurricane prone states, n.d.; Risk Factor, 2022). Storms are serious events that can cause loss of life and property with long term recovery horizons for communities. These events require an investment of time and energy in emergency planning and implementation. Flooding was described as a top-level concern by key informants and personal experience with these recurrent events was common. Despite their knowledge of flooding, many were pessimistic about the ability to deal with it, especially the perception that actions by people outside their jurisdiction had contributed to the severity. Curiously, climate change as a cause of flooding was discussed by only one key informant, despite the evidence that the increased impacts of tropical storms and high precipitation events are linked to its influence.

Examples of Storm impacts/flooding

Because of its location on the east coast of the U.S., North Carolina experiences a significant number of hurricanes. Not all these events resulted in flooding, but that circumstance has become a more frequent occurrence. For the two decades preceding the interviews (1997-2017), thirteen tropical storms or hurricanes were recorded in the study region (Top ten most hurricane prone states. n.d.; North Carolina State University, n.d.; Risk Factor, 2022; State Climate Office of North Carolina, n.d.). The flooding from several of these storms was unprecedented and caused millions of dollars in damages and loss of life. The aftermath of

Hurricane Floyd in 1999 in North Carolina was described as a 500-year flood event and displaced people, caused 35 deaths, killed millions of livestock animals, and even caused the floating of coffins from cemeteries (Schwab, 2000). At the time, it was considered the most damaging storm in the state's history (Schwab, 2000). Described as an anomaly at the time, it has been repeated by other storms in the region such as Hurricane Matthew (2016) and, more recently, Hurricane Florence (2018). Flooding is now anticipated when tropical storms are forecasted to hit the state of North Carolina, and even during other storm events (Risk Factor, 2022). The state environmental agency has resources for local government and water suppliers that address both planning and response/recovery to stormwater (Food resiliency blueprint. n.d.). Therefore, it is not surprising that many informants stated that flooding is a greater concern than drought. One informant explained: "More likely that the issue is having too much, like Matthew. Flood mitigation is a bigger concern" (Informant S).

Individuals who were interviewed in the summer of 2017 described Hurricanes Floyd and Matthew and their devastating impacts. There were road washouts and water main breaks (Armstrong, 2021; Schwab, 2000). One key informant described how inundation of some water treatment facilities led to contamination, boil notices, and the inability to provide water to citizens (Informant X). The effects were often compounded by the loss of electrical power that impacted the water supply even if water plants were not flooded. This caused concern about contamination of ground and surface water sources from animal and human waste, such as the breaching of hog lagoons or swamping of wastewater treatment plants. One key informant experienced being stuck at work during these crises with supplies brought in by boat for almost a week (Informant H).

Most key informants cited hurricanes as causes of flooding. In addition to the excess precipitation due to storms, other reasons given by key informants were the increased development that led to paving of previously permeable areas, allowing greater volumes of stormwater to flow into streams instead of into the ground. Interviewees indicated that although it is somewhat predictable, flooding is a threat because their ability to reduce the impacts are limited. Only one individual mentioned climate change, stating that it would cause more flooding events (Informant U). The absence of climate change or global warming is notable in these interviews.

One administrator stated: “We do a poor job of managing flooding" (Informant Q). Much of their language communicated a lack of agency, that they were dependent on decisions made by others upstream, and they don’t have much “influence” or “power” (Informant V). For example, two specifically spoke of a plan designed by the Army Corp of Engineers to construct basins along the Neuse River to capture stormwater that had never been implemented (Informant Q, Informant V). The reasons given for this were financial; there had been a delay and the cost is now prohibitive. Despite this, they were confident that the reservoirs would help to manage the flooding and were disappointed that they had been shelved. Flooding is the greatest concern, yet one of the aspects over which they have the least control.

Theme Summary – Pollution

Pollution was discussed by some interviewees even though it was not a specific focus of the study and no questions about it were posed. Multiple known contaminants and their sources were identified and discussed, with acknowledgement that others’ actions were the cause of the risk and that much of it was beyond their control. Interventions were described to decrease the known pollutants. Several key informants described how pollution impacted water quantity,

decreasing how much is available if pollutants cannot be removed using current technologies. An undercurrent of anxiety was expressed about emerging pollutants, either ones that have recently been identified--such as pharmaceuticals and Gen X--or ones that had not yet been discovered. There was a strong sense of responsibility expressed and a desire to protect consumers. The protections instituted by regulations were cited as being successful and improving water quality.

Examples of Pollution

Despite improvements in water quality since the 1970s with the passage of the Clean Water Act, water pollution is still a concern for many (Gallup Annual Environment Survey, 2021). Although no questions about water quality were directly posed to the interviewees, two-thirds mentioned water pollution and the threats it posed. In one case, quality can impact quantity. As one informant said: “Pollution can make it unusable. There is a need for treatment processes. If polluted, water can be undrinkable, we are facing a critical situation.” (Informant L). Multiple sources of pollution were cited including stormwater, runoff from livestock operations, chemical manufacturing plants, coal ash disposal pits, sewage, and the military bases in the region.

There was an acknowledgment by more than one key informant that upstream users had an impact on those downstream. An elected official said: "The Neuse River winds up here….it all flows downstream" (Informant R). A tension existed because the key informants expressed an awareness of the economic need for many of the activities cited as sources, but they were also uneasy about how those activities affected water quality. They discussed solutions such as the use of riparian buffers to reduce the contaminants from runoff into surface water sources, retention ponds, or technology such as reverse osmosis to remove pollutants from wastewater.

Some, such as more advanced water treatment, were actions that they could take if they have the money, but many were out of their control, they were reliant on others upstream to minimize impacts.

In addition to known pollutants, there was also concern expressed about contaminants of emerging concern (CECs); i.e., that little is known about them and their impacts, that they are not yet regulated, and that most conventional treatment processes are unable to remove them from drinking water (Contaminants of emerging concern in wastewater, n.d.). These included pharmaceuticals, "medicines" that are in the water supply from human wastewater, and chemicals such as Gen X, which have been detected in the Cape Fear River just to the south. The pharmaceuticals can be removed using reverse osmosis or nanofiltration (Singh, Ummalyma, & Sahoo, 2020), but this treatment is more costly and has negative environmental consequences.

In combination with the discussion of the CECs, they predicted new regulations and more required testing would be passed in the future to address these issues. One water utility manager explained: *"*We are finding more pollutants now; they are unregulated but will be regulated; need to test for [sic], people don't realize what goes into this" (Informant J). Despite some expressing frustration with government regulation, including that they were "unfunded mandates," more than one acknowledged the power of the Clean Water Act and Safe Drinking Water Act, and how it had accomplished its objective: "Overall quality is better because of regulations" (Informant M). The acknowledgement that the regulations have been successful is an important insight from this study. Because water pollution is a high priority concern for the key informants and the general public (Gallup Annual Environment Survey, 2021), the acceptance of legislation may be greater than for regulation that limits water use.

Theme Summary - Supply side Narratives, "The Hard Path"

It has been noted that individuals working in water management have technical training, but less background in public communication or knowledge of the social sciences (Brooks et al., 2009). This leads to *de facto* acceptance of technology to address problems associated with providing water. As predicted, the existence of a sense of technological optimism or an "engineering bias" was confirmed in this sample of water decision makers. Many used positive language about the use of technology to increase supply and its ability to solve problems. It was touted as an effective means to deal with saltwater intrusion and water shortages that are already facing some providers. However, some reservations about the use of technology were expressed. These concerns about the drawbacks of technology indicates an underlying desire to promote conservation and resignation that it is difficult to achieve under the present political climate.

Examples of Supply Side Narratives

As anticipated, a faith in the ability of technology ("technofixes") to address issues of both water quantity and quality were frequent. When asked about addressing a need to increase the amount of water extracted, the interviewees readily discussed supply side enhancements. In one case, a municipality had been drilling and encountered high chloride concentrations making the water from a new well unusable without higher levels of treatment. As one administrator remarked, the incident was a "surprise to us and the engineers…. we thought we were in like Flynn" (Informant O). The implication here is that supply side management, an additional well, was the desirable solution to their water supply problems. Having another well to produce more water was the goal and the interviewee expressed their disappointment when they couldn't use the water from the well.

Many subjects cited desalination techniques, such as reverse osmosis (RO) or nanofiltration, to remove impurities; and if they weren't using it themselves, they noted other communities who were. Water suppliers in many of the coastal areas of North Carolina have been reliant on this technology for decades. It permits the use of brackish or marine water sources as a water supply and has supported the continued development of the barrier islands since the technology was first installed in the late 1980s (Dare County Government, n.d.). A water associated manager stated enthusiastically: "We are able to take water that was undrinkable especially in the past 10 years. It's moving very fast; the hurdle is the cost." (Informant L).

The majority opinion was that technology was the primary approach to providing water. The underlying theme here is that water is *not* a scarce resource because using technology can increase the supply and reduce the threat posed by saltwater intrusion or encroachment. It was anticipated by some key informants that the use of desalination use will increase in the future. Use of desalination enables continued population expansion and supports the tourism sector in these counties, instead of requiring greater emphasis on demand side management and the soft path.

However, several respondents were more circumspect about using these technologies. They discussed the ability to remove salt and other contaminants from water and which communities had invested in it, but they didn't necessarily think it was feasible in their jurisdiction. The concern was usually financial because these technologies are more expensive than traditional drinking water treatment. Water from the some of the aquifers in the region needs little treatment and communities who had been pumping from these would face the decision of building new infrastructure. The expense includes the capital to build the treatment

facility, but also the continued expense to operate it, including cleaning and replacing costly membranes. One interviewee recounted a discussion with a colleague who upon hearing of what RO could accomplish was supportive of its use, but he expressed concern predominantly for financial reasons: “The price tag per gallon [of using RO], we couldn’t pay it off in decades.” (Informant U). Furthermore, they said that there might even be an incentive to have people use more water to be able to pay the cost of the infrastructure (Informant U). This is an example of the conservation “conundrum.” To pay off the debt of providing water, the community might encourage water consumption to generate the revenue needed to cover the costs of building the new facility.

More than one informant also mentioned that RO posed environmental challenges. This type of water treatment generates a waste product (brine), and the government requires a permit (NPDES) for an RO facility to discharge (Environmental Protection Agency, 2002; North Carolina Division of Environmental and Natural Resources, (NCDENR), n.d.). It has been documented that the higher salinity wastewater can have a negative impact on communities of organisms by altering the water chemistry in estuaries (Kleber, 2010; Rulifson, Woods, & Kleber, 2006). Estuaries are often critical habitat for commercial species of fish and shellfish; therefore, it could affect the local economy adversely. The Albemarle-Pamlico Estuary in eastern North Carolina is the second largest in the continental United States and in 2019 supported a commercial fishing industry of around $15 million (Allen, 2021). Furthermore, if more communities opt for this technology, multiple discharges could create a tragedy of the commons scenario and competition for appropriate discharge locations could increase. Consequently, finding an appropriate place to build new facilities could be challenging to small providers.

Theme Summary – Support for Conservation

There was strong support for conservation. For the key informants, water was valuable, and its supply was not "inexhaustible." It was described as being "precious" (Informant C) and one said that "everyone could be better about not wasting it" (Informant B). Some of the language they used regarding the water supply included the role that they imagined as protectors, as one water utility person stated: "The shortage will arrive at some point, we need to be responsible stewards" (Informant Y).

An interesting common thread that emerged was the use of ethical and religious language when discussing the water supply and water conservation. Water was considered a "blessing" (Informant E) and retrofitting of outdoor irrigation faucets to conserve water was "the right thing to do" (Informant W). The moral imperative to protect water was something that originated with the divine: "God gave us brains; we are supposed to take care of water resources. Be conscious, don't leave the hose on. Waste not, want not" (Informant G).

The sense of responsibility meant that many were more supportive of DSM and the soft path than was originally anticipated. Rather than discounting these approaches, they discussed different methods to reduce demand. There were examples of using reclaimed water, xeriscaping, water-saving fixtures, and matching water to its use. As one manager explained: "In China they treat water, but not to make it potable. How much water can you drink? It's a very small amount……We over treat, we don't conserve enough. I think that there should be more emphasis on conservation" (Informant Q). This quote also reflects a sense of frustration because although they were not concerned about water security, they did not think that water should be expendable. That water is essential for life hardly bears repeating, yet they perceived that it is "taken for granted" by their consumers and this was clearly an issue for many of the key informants. They thought that consumers did not appreciate the value of water and it was

something that they had trouble accepting. As a manager explained: “Water is quality of life, we can live without lights, we don’t need a car, but we can’t live without water. I don’t understand why it is this way [sic, that people take water for granted]. I want to know why” (Informant N).

Although many sounded disheartened by their inability to promote conservation, the use of better tracking through updating meter technology was described by several key informants and the overall opinion was favorable. More updated meter systems, such as Advanced Metering Infrastructure (AMI), are more accurate, help to detect leaks quickly, and allow consumers to see their usage in approximately real time, ostensibly impacting consumer behavior. The systems are expensive, yet one key informant predicted that it was the future of water management. Despite their concerns about getting consumers to conserve using other methods, the comments about updated metering were positive. Better meters had already saved water in some of the communities by identifying leaks. The assumption was that consumers would change their habits if they could see their usage before their monthly utility bills arrived. And the benefits went beyond water usage to changing the tasks of the job: staff were spending less time out in the field reading meters and facing potential on the job threats such as weather, animals, and even disgruntled consumers. This was predicted to save time but also money because of fewer workman’s compensation claims. With the most updated AMI, utility staff do not have to drive around town to extract meter data; it is transmitted over existing infrastructure and transmitted directly to the central system. This would allow workers to spend time on other tasks.

Theme Summary- Barriers to Demand Side Management

Despite the desire from more conservation by the key informants, many of the barriers to DSM and the soft path that have been described in the literature were also found in the

interviews. The first is an engineering bias related to technological optimism, which was discussed previously. This is combined with a perception of abundance on the part of the water decision makers, and the low cost of water, which encourages water waste. Additionally, the perception that conservation is ineffective causes wariness regarding its use (Brandes & Ferguson, 2004)

According to the individuals interviewed, the most effective methods to promote conservation were raising prices, but this was a political "non-starter." After that, the next best approach available to them is to install water saving fixtures that do not require a lot of thought on the part of the consumer. Public education was discussed, but its usefulness was questioned.

Examples of Barriers to DSM

The coastal plain of North Carolina is in the southeast United States which is characterized by a humid climate. The average yearly rainfall in the area is more than 50 inches and is often marked by the impact of large-scale tropical storms. These physical factors have allowed a level of confidence in water security to be the norm for water decision makers in (Cockerill, 2014; Praskievicz, 2019). When asked about it, one manager said: "I have a response- We don't have water supply issues" (Informant I). Yet, this perception of abundance is flawed because it arises from historical climate patterns which are no longer predictable because of climate change. With population and economic growth and the other impacts of increased global temperatures (sea level rise), competition for water and decreased water security is anticipated. Numerous articles in the past two decades claim that even in humid regions water managers will need to rely more on demand side management and the soft path under the pressures of climate change and an increased population (Brandes & Ferguson, 2004; Brooks & Brandes, 2011; Cockerill, 2014; Gleick, 2003).

The underpricing of this natural resource has been cited as unsustainable in economic and environmental terms and is considered a critical issue in water management, not only when considering conservation (Maas, 2003). Water rates the cost per gallon, typically does not pay for the water used, but for the other expenses of providing it such as the infrastructure for treatment and conveyance of water to residences, and the labor required for maintenance (Lam, 2015). Rates are historically low in many communities, too low to adequately pay even for those expenses. An example was expressed simply: *"*We sell water too cheaply.*"* (Informant Y). This lack of funding creates a management situation in which suppliers must frequently devote time and energy to seeking external sources of money. Often, they need to obtain loans from the state to pay the cost of infrastructure upgrades but if their rates are too low, they may be denied. And once they have built a new treatment plant or upgraded wells or pipes, they then need income to pay back the debt. Reducing water use without raising the water rates would mean a lower revenue stream, possibly leading to a default on their loan, a serious predicament for many small, rural, and impoverished communities. Therefore, a contradiction exists; the conservation "conundrum" that any method that encourages conservation can decrease the revenue collected by the provider (Brandes & Ferguson, 2004). A predictable revenue stream is essential to keep the operation afloat. The term "double edged sword" was used by a key informant to express the difficulties they face and a reason not to emphasize conservation. In fact, the cost incurred with new capital projects can be a reason to discourage water conservation. As one informant said: *"*Got to pay for water -tax revenues to pay operations and debt" (Informant T).

Even though many water suppliers have trouble borrowing money from the state if their rates are too low to service the debt for loans, the interviewees were convinced that charging more for water was political suicide. The key informants used strong language to express the

perceived response of consumers to any increase in rates. Public outcry to any increases was what they had experienced with consumers "screaming" or "hollering" and "the phone ringing off the hook." As one informant described it: "No one wants to raise rates. Two years ago, we went through restructuring-got it through to get updated meters, but it was as if they were killing babies" (Informant U).

As with many other aspects of water management, options are limited and there was an undercurrent of interviewees being resigned to "politics as usual." Because public resistance is high, they seem to realize that an economic solution is not viable in today's political climate. The pressure on elected officials to keep rates low is intense because the water decision makers perceived that consumers think water should be free, leaving little will to charge more. However, the prevailing opinion expressed by the majority of key informants was increasing water rates would achieve conservation*:* "In my opinion- to get people to reduce, take money out of their pockets then some might would reduce" (Informant G). Two individuals described how a price increase had the intended effect. Their communities had shifted from a flat rate charge to an Increasing Block Rate (IBR) that had resulted in reducing water usage among customers. IBR charges a higher rate for water usage as it increases. Despite this success, the primary reason for an increase in rates is financial no conservation. Some communities have raised their rates out of necessity, but a tension exists because access to adequate clean water is a considered a human right. The increase in rates in some cities in the U.S. prior to 2018 has made the cost of water unaffordable for many households and has been reported as an impending crisis (Lahkani, 2020). For the most economically disadvantaged, increased costs may impact their overall finances negatively. Paying late or not paying at all may result in shutoffs or even the loss of the residence (eviction). This is problematic because of the poverty that exists in many communities

in the study region. The need for the supplier to cover the costs of providing a safe supply of water to all residents is pitted against the reality that some households will not be able to pay at all.

Other than increasing the cost of water, managers often consider DSM methods "unreliable" because they require behavior modification, which is difficult. Many water decision makers have technical backgrounds, whereas shifting human behavior lies in the realm of social science (Brandes and Ferguson, 2004). One middle ground approach between the economic and the behavioral is to emphasize the installation of low flow fixtures (showers, toilets, faucets, washing machines). A third of the key informants discussed this method to promote conservation and stated that the benefit for this strategy was that it caused "conservation without thinking about it" (Informant M). The managers who favored "unintentional" or "inadvertent" conservation exemplify this wariness about changing behavior because the efficient fixtures reduce the consumer's actions in the equation. This distrust in the ability to influence human behavior results in less effort invested in DSM and more investment in engineered "solutions."

Multiple interviewees also discussed the use of education to encourage conservation among consumers. Some had practices already in place whereas others expressed a desire to implement a plan and had some ideas. One community had given away free low-flow shower heads at an energy fair, but the majority of methods described were public education efforts that included information included in utility bills, on supplier/town websites, or fliers posted where people come in to pay their bill. For example, one informant replied: "I send out tidbits with water bills, what you don't want to do, such as grease disposal. They are little bits of education" (Informant E). However, when asked if they had any ideas for conservation, one response was:

"Not really [any ideas]. We send out stuff every now and then, tell folks to be judicious in usage, put it in their bill, no one pays attention" (Informant O).

Similarly, at least one third of interviewees expressed pessimism about water conservation education. The language in the statements expresses a lack of confidence in these strategies. The education is a small effort ("tidbits") and ineffective ("no one pays attention"). Particularly concerning is the fact that individuals living in different regions of the country exhibit different attitudes about water and water conservation (Huang & Lamm, 2017). Adopting strategies to encourage conservation utilized in the arid western United States may not yield the same benefits in the east. Without greater knowledge on the part of the water decision makers about what methods might be most effective when addressing the issue with their residents, DSM methods are not likely to succeed under the physical and socio-economic conditions in this study region.

Theme Summary – Aging Infrastructure

The challenges of aging infrastructure have been noted in the water treatment/management industry literature, and in this sample the lack of investment in utilities was described as a major concern for those who work in water management. A frequent example cited by key informants was dealing with breaks in water lines often accompanied by the discovery that some were decades old and had not been replaced at the end of their useful life. This leads to a crisis of management when these events require immediate investment of time and money. Additionally, these incidences impact the ability to provide water and sometimes require the need to issue a boil notice because of possible contamination from outside sources. These circumstances elicited statements that conveyed resignation; they had little ability to invest

in maintenance except when it became pressing need. An underlying sense of deprivation from a lack of funding was an emergent theme. Water decision makers who are frequently dealing with these types of emergencies will likely have fewer resources to devote to planning for resiliency.

Examples of Aging Infrastructure

Infrastructure that was decades old, even dating back to the 1950s, was noted by a number of key informants, and the older the equipment was the more problems were anticipated. This was a common point of discussion during the interviews, particularly for the pipes that carry water to customers. It was often the case that the water decision maker did not know exactly how old the pipes were and some were surprised when repairing leaks or doing maintenance to find that some were made of cast iron, brick, or even wood. The pipes were supposed to be regularly replaced but a lack of funding has led to little maintenance, creating a sense of impoverishment. This comment from a water utility operator echoes the sentiment of many: “We don't put money into the system, we have 50-year-old pipes. Things have been let go” (Informant J). This lack of preventative maintenance often results in breaks that need immediate attention. These emergencies are costly and to secure loans requires rate increases, which then causes disapproval in the community. One administrator/manager communicated the urgency of the situation: “We are scrambling now for grants, cheap loans to fix the infrastructure problems. We are going up on rates for customers, they get hammered by increases. The customers are not accustomed to rates going up.” (Informant Q).

This is a source of stress for many who are “waiting” for these failures to occur, making decisions reactive instead of proactive. One comment that conveyed the sense of neglect was when the lines weren’t leaking, they were “out of sight, out of mind (Informant A)” and did not

need attention. Although many discussed trying to replace faulty infrastructure on a regular basis as part of their maintenance schedule, not all were able to do that because of a lack of funding. In one case, a facility was "falling apart" (Informant U), an indication of the dire circumstances of trying to provide a safe supply of water. Leaks can be a source of "major stress on the system if leaks are not recognized in a timely manner" (Informant D). As one informant explained about older infrastructure: "it requires planning to maintain it daily" (Informant B).

Often the leaking or bursting led to lower water pressure. Lower water pressure can impact water quality, allowing the introduction of pathogenic bacteria into the public water supply, which then requires the issuance of boil notices to protect the public from possible harm. In one case, an administrator described going door to door in their community to make sure that the notice had been communicated to everyone. She expressed concern about the danger to the health of her consumers. Leaks also impact revenue because water that is lost before it reaches a metered building is not billable. Breaks in water lines can cause road closures, impacting traffic and businesses, leading to lost revenue and downtime for both the water supplier and people in the community. Any time focused on dealing with the crisis leaves less time for other activities. This type of emergency management is reactive and leaves fewer resources available for planning for the future.

Theme Summary – Recruitment and Retention

Also present in the industry literature is the difficulty with recruitment and retention of employees in the utility sector because many employees are near or at retirement age and leaving the profession. This presented another crisis for many key informants who cannot find enough people to fill openings. Without sufficient staff to do maintenance and repair work, there is a

greater burden on those who already work there. Although the industry was described as "secure" and offered decent pay without requiring a college degree, the jobs are demanding with the need to be on call and deal with physical threats. Water decision makers in smaller systems discussed the reality that they would train novices who would then find better employment opportunities in larger systems, which contributed to their sense of resignation and privation. The loss of institutional knowledge weighed heavily on more than one key informant. The interviews were conducted pre-pandemic and before the worker shortage of the post-pandemic recovery, which increases the likelihood that this situation has not improved.

Examples of Recruitment and Retention

An aging workforce in the utility industry with few new employees in the pipeline creates a potential crisis in the not too distance future. Like many water managers throughout the United States, the key informants were facing shortages of funding and workers. Therefore, it is not surprising that there was anxiety associated with the loss of institutional knowledge in these water management systems. Losses were due to retirements and even the deaths of individuals as people were working past retirement age.

Compounding the loss of experienced workers was the inability to recruit new people. Many expressed disappointment that "no one is interested in coming into this field" (Informant H). This was a point of consternation given that the industry offered job security, decent pay, and opportunities to move up. A stumbling block described by several was the requirement to be on call for emergencies and that the work was physically demanding and sometimes dangerous. There was also cynicism expressed by some about the "younger generation" and their unwillingness to work in an occupation that faced these conditions. Besides the need to work

with equipment, they often encountered other threats such as storms and extreme temperatures, dogs, insects, and even snakes. As one informant explained:

> "I am concerned about the graying of the work force, it's hard to find employees. We advertised for 3 months-got only 2 applications. The local community college no longer has a program for water resource management. We tried recruiting at a job fair, but there are fewer people with mechanical skills. People don't want to do shift work, work weekends, deal with emergencies. There are lots of opportunity to advance, but management are always monitoring, even when not at work. You can't make a mistake, it can impact 100, 000 people" (Informant T).

The smaller systems are at an increased disadvantage because they cannot offer as much pay. Three key informants described how some individuals use these smaller systems as "steppingstones" to positions with higher salaries in larger systems, leading to high turnover of employees. Training someone is an investment and when they take that training and leave, the employer is faced with a need to recruit and invest again; these leads systems to contract with temporary workers to "fill the gap" (Informant N). Accordingly, "we struggle to have employees work in all fields. We compete with contractors, larger cities. A lot of knowledge going away because of the retirement of baby boomers" (Informant P). This can mean perpetually running a system with people who might be inexperienced and need extra support and time. Given the responsibility they have to protect the water supply, the reason for their concern is not unanticipated. But the comments also convey a sense of frustration about the lack of control over their circumstances; this was one more aspect in which they were facing deprivation, not having "enough." Despite this, the people who were working in water management expressed pride and satisfaction in their job, possibly making the inability to bring people in even more vexing to the interviewees. But the recognition that these jobs bring satisfaction beyond a financial reward is also important for recruitment opportunities.

Theme Summary – Agency

The manager/administrators and water related personnel described a similar decision-making process in which they consulted together, sometimes asking for advice from environmental or engineering firms, and then brought their ideas to the elected body. When related to the technological aspects, these recommendations were often presented as a formality. Consequently, many managers relied heavily on their "water people" for guidance even if they had been in management themselves for years. In fact, when requesting interviews with administrators they sometimes asked water personnel to answer the questions posed. Elected officials had a basic overview of providing water, and direct experience appeared be correlated with the depth of their knowledge. Rate changes were also something that was presented but were less likely to be approved by elected officials. Some administrators had formal training and possessed operator certifications, but many did not.

Examples of Agency

Each key informant was asked about how decisions were made in their organization. The responses reflected the differences in their role and their organizations, yet similarities existed that paint an interesting picture. The most common response was that decisions about the water supply related to equipment or treatment were in the wheelhouse of the utility personnel. For those directly working in the utility, options related to technology were considered and then discussed with the administrator/manager*;* "treatment related ones [decisions] are left to ORC, back up ORC" (Informant E).

The administrators/managers had various levels of background and experience, with some exuding more confidence than others about their knowledge. When contacting each

potential key informant, it was indicated to them that technical details about the water supply and its treatment were not the focus of the interview but to seek their opinion about issues concerning the water supply. However, in more than one instance a manager/administrator who also scheduled their "water person" to be present so that they could make sure questions were answered correctly. The inclusion of the utility personnel communicated a discomfort in answering questions about the technicalities of the water supply process. This was not the case with all administrators, some of whom clearly had significant background in how water is treated and supplied. The administrators were often clear that they and the personnel made the decisions together and presented it to the board*;* "I would keep the board informed but could handle it administratively" (Informant Q). But it was also clear that managers/administrators needed input from the people who had the technical training. One water utility person opined that the manager for his jurisdiction had little understanding about the water supply system, even after being on the job for four years. Therefore, they were the person that the council asked for guidance. Again, it is an important insight to note the weight that the water utility people have regarding technological decisions. But they also admitted that the board have information from the state: "I tell city council, but state needs to tell them. It needs to be verified for my request to be considered. What do we think? (I do get asked)" (Informant J).

The rates being the purview of the board was discussed by the administrators and water personnel. They could make suggestions/recommendations, but it was not up to them. And many expressed resignations about the ability to raise rates even when it seemed that they thought it would solve some issues with funding. A similar picture arose with the elected officials who had varying degrees of background in the water supply system. Some who seemed more knowledgeable had sought out information or had been in local government for many years. All

had some familiarity with regulations. Ironically, there was little discussion of their role in the rate changes, except to note that they felt pressure from their constituents not to raise the rates Rate increases were only done when there was no other choice, and they could not secure the loans needed from the Drinking Water State Reserve Fund (DWSRF) for capital projects or upgrades without higher rates. Some smaller systems did not always have the expertise needed in house and hired engineers or environmental consulting companies for recommendations. And the state influences the decision-making processes through regulations, including fines for not meeting requirements and a permitting process for changes in treatment.

Theme Summary – Responsibility & Pride

One compelling insight that emerged from the interviews was the sense of pride that many expressed in doing their job well. A strong sense of the gravity of their responsibility was described by multiple key informants. The product that they provide--drinking water--is in contact with us throughout the day as we bathe, cook, brush our teeth, and drink, and "getting it wrong" can mean illness and even death for consumers. There was an undercurrent of anxiety about the "unknowns" and the factors that they could not control but for which they might be held accountable to the community. But they also communicated a commitment to the importance of their work and that it meant more than just a paycheck.

Examples of Responsibility & Pride

Another important theme was responsibility. Protecting human health from risk was identified by more than one respondent as a serious concern. The water decision makers were aware of the consequences of "getting it wrong" in their duties. They expressed a strong sense of apprehension about the important role that they play in people's everyday lives and pride in their

work. The gravity of "getting it right" seemed to weigh heavily on many. They expressed awareness that any mistakes could have serious health consequences for the people under their care, although it should be noted that this sentiment was primarily linked to water quality and the threat of contaminants that might cause disease, not water quantity. As one said: "It's scary to think about the responsibility to provide safe, reliable drinking water. Failure of this is serious" (Informant Y).

A quarter of the key informants spoke directly to the burden of responsibility that they carried to keep their consumers safe. One described what he provided as a "public health" service (Informant D) and stressed its importance to the people working for him. Another indicated that he felt responsible for the 15,000 residents in his community. Overall, they described their emotions saying that they were sometimes worried or even scared because of possible failure. One said that he was speaking to an acquaintance in a different industry who said, "if I get it wrong, I kill fish, but if you get it wrong, you kill people (Informant K)." They spoke about how the public "trusted" them (Informant E) and how they were "held accountable" (Informant J). Under these circumstances, they also were aware of how much was out of their control and an underlying anxiety can be heard in their comments. One described: "Not being sure, not knowing is hard, I worry that I don't know, I am unaware. Uneasy feeling not I am not doing enough, could be doing more – I want to avoid causing harm. If you are not aware you can harm someone" (Informant H). Additionally, a few also expressed how the position was more than just a paycheck. There was a sense of pride and the work being more like a calling than just a job. The responsibility was for fellow humans, but other species were also included. As one explained: "I got involved because of a sense of environmental stewardship. Helping the environment is important to me" (Informant H).

Many acknowledged that the work was hard and dirty and not for everyone. But what emerged from these quotes was the sense of pride that many also felt in their jobs. When discussing their educational background, an interviewee explained that they needed a great deal of knowledge, which served as a source of accomplishment. The individuals working directly for a utility had a high school diploma but multiple certifications from the state, sometimes including the title of "ORC," or Operator in Responsible Charge. This is the person who often appears on the annual water quality report that is made public and who answers to both the consumers and to the state and federal government. A manager/administrator touted the ORC in her community because he had been awarded "Operator of the Year" by the state. Another explained: "For 8 years I served on water ORC board for certification. The qualifications are taken seriously. It's hard work, you need lots of knowledge" (Informant Y).

Another theme that emerged from the interviews is that they are proud of what they have accomplished. There was a clear acknowledgement of the complexity of managing a natural resource, having to balance the physical and technical aspects with the human dimensions. Decades of experience and knowledge were evident in their discussions. For some, they expressed the sentiment that it was "more than a job," that their choice of profession was greater than just earning a paycheck. They were proud of what that they do and felt that they were contributing in a positive way to the community.

Theme Summary – The Future of Water Management

The views described regarding the future touched on a multitude of subjects. This included how threats already identified, such as a larger population and more saltwater intrusion into the aquifers, would decrease water security. The threat of increased chloride levels in

aquifers generated various comments, some about the need for more technology in the form of desalination plants and more regulation: “Future: it will change when SWI becomes a reality in multiple systems” (Informant I).

There was concern expressed by a lack of planning on the part of some, that solutions being applied now were not enough to successfully face the challenges. Therefore, it was anticipated that there would be more conflict over water, with water being the “new gold” (Informant M) as scarce and as valuable as that metal. The conflicts that were predicted would end up in court with entities using the legal system to resolve issues about water rights.

More than one expressed the opinion that the present situation could not be sustained and there would be more awareness and an increased need to emphasize conversation. With more people and a need to promote economic growth, things will have to change, and many were looking down the road and predicting that shortages and decreased water security would occur*:* “More aware, cautious about use, facing source drying up, something we will be having conversations about moving forward, the way we live now is not sustainable” (Informant N). Because many were already in favor of conservation, this was also not a negative comment, but many acknowledged that rate increases would be necessary. A discussion of the opinions about rate increases and conservation are provided elsewhere but a short summary is there is little political support for charging more for water even though many thought it was helpful or even necessary in the present. With the suggestion that more technology would be needed, rates would help pay for those capital projects.

Another type of technology was also discussed that is presently used on a smaller scale but was predicted to increase. When asked what is considered the future of water management, one responded: “technology, with a smart grid, customers will get alerts on their phones”

(Informant P). The subjects expressed more confidence in this technology (Automated Meter Reading (AMR) and Advanced Metering Infrastructure (AMI) than in the others. AMI is a technology in which readings can be automatically collected by a device operated by utility personnel in proximity to the meters (Downs, 2020). They either walk or drive by and the water usage data is reported to the device and later downloaded to a database to bill customers for actual usage. Prior to AMR, personnel had to physically read the meters and if a meter was inaccessible water usage was estimated based upon past usage, which can be less than what was consumed (Downs, 2020). AMR can bill for the actual volume used, which can increase revenue. Additionally, utility personnel are less likely to be injured while reading meters, an occupational hazard that exists with the older meters in which they may encounter pets or wildlife (Informant L). One respondent described the increased revenue collected because of more accurate accounting for water used, with a secondary benefit the conservation of water*:* "We can catch water leaks before they get large, get phone updates (texts/alerts). It's a pilot project now. We can see water consumption for a customer, time of day identified, using a lot of water in the morning (people taking a bath). Customers see this (on the bill)" (Informant P).

All subjects who discussed the importance of newer meters, including smart metering technology, viewed it favorably. These technological solutions require the purchase of infrastructure (replacement meters and possibly meter boxes), software, and labor for installation, and can be beyond the budget of some communities. Because water infrastructure is a long-term venture, with the infrastructure required to last for decades, adopting it must be considered carefully; yet other communities have benefited from their decision to use it (Downs, 2020). But support for updating meters was expressed even if a subject could not install an AMR/AMI system because of expense and was seen as an essential tool in the future*:*

"Technology is costly but there is a lot of value. If there is a continuous flow, you may have something going on - leak, a running toilet. The benefit of better monitoring is to keep water loss down to a minimum. There are 700 miles of water lines and lots of chance of loss / unaccounted for water. The goal is to minimize this loss, it helps to protect source of water /supply." (Informant D)**.**

Conclusions

Water decision makers are presented daily with problems that must be addressed, often under constraints of time and money. These include internal challenges such as equipment failures and personnel issues, and external pressures such as pollution, flooding, and the consumer behaviors that they perceive wastes water. Thus, decisions about which technologies they will recommend ensuring that the security of the water supply may seem to present them with a greater sense of optimism. However, supply side management will not address all the challenges facing coastal regions under the pressures of climate change and population growth. To ensure the water supply for the future, a revolution is needed in which the soft path becomes the *de facto* approach and not a stop gap measure used when droughts occur only to be abandoned when the rains come (Drought, its causes and effects.1947; California Department of Water Resources, 2010; Craig et al., 2019; Crown, 2022; McEwen et al., 2021; Wilhite & Glantz, 1985; Yun, Jun, & Hong, 2012). Therefore, climate resilience tool kits need to go beyond planning for infrastructure resiliency and include additional information about how to promote demand side management and soft path philosophies to water management.

The "Hard" versus the "Soft" Path

An engineering bias, wariness about the effectiveness of DSM, low water rates, and the myth of abundance were all evident barriers to the soft path in this sample of key informants (Brandes & Ferguson, 2004; Maas, 2003). Because building resiliency is predicated on preparedness for a range of climate scenarios that exhibit a great deal of unpredictability, knowing that the water decision makers exhibit predictable responses towards the soft path and DSM is useful. These impediments are common to many water suppliers, therefore pursuing solutions to overcome them will likely yield improvements that are useful in other regions.

As predicted, respondents from all categories (managers, elected officials, utility workers) were optimistic about technology's ability to secure the water supply in their jurisdiction. According to Richter (Richter, 2014), water management decisions are often made by individuals with technical training who believe that it's easier to use supply side management because fewer individuals need to be involved. More than half the key informants in this sample had water operator certifications from the state of North Carolina and although the curricula for these certifications do include conservation as a topic, the focus is on the technical aspects required to successfully manage water supplies (North Carolina Department of Environmental Quality, n.d.; North Carolina Department of Environmental Quality, n.d.). This engineering bias may reflect the existence of technological optimism, the belief that technology can help alleviate scarcity and increase water security (Bertana et al., 2022). The results of this study in North Carolina provide empirical evidence of barriers to demand side management in this sample, similar to the water managers described by researchers in a humid region in Canada (Brandes & Ferguson, 2004; Maas, 2003).

Those who study climate adaptation are wary about the use of technological optimism as a means to increase (Bertana et al., 2022). The significance of this is that it is less likely that they will adopt mitigation and adaptation efforts under these drought conditions (Craig et al., 2019). To implement DSM effectively, social science is needed but many water decision makers have training in the use of technology, with less emphasis on social, political and economic approaches (Brandes & Ferguson, 2004; Maas, 2003). Because the soft path in based in behavioral change, this is an area in which water decision makers need support.

The transcripts of the interviews provide insights into why the barriers described by Brandes and Ferguson (2004) exist. When asked about conservation, they were resigned about their ability enact change. The obstacles that the key informants described were a political climate that does not value water and the inability to increase costs. Support for conservation was an important finding but there was distrust of its effectiveness; they were unconvinced that the general public was going to willing conserve unless the rates for water increased. As one manager stated about consumers: "you will use as much water as you want to use" (Informant Q).

What Water Decision Makers Value

One explanation for their perception of waste is that it is seated in their values. When interviewed, a water manager in California discussed how conservation was more than an environmental issue, it was an ethical issue (Jean Cowden Moore, 2015). Therefore, this study brings a new perspective about the importance of conservation, DSM, and the soft path for water decision makers in a humid region. An emergent theme was the recognition that many key informants were uncomfortable with excessive water use. They had a favorable opinion of conservation, and they described it in terms that were suggestive of a moral imperative. “We

should always conserve" is not the attitude of an individual who believes that water is an inexhaustible resource. It was communicated that water is valuable, and in many cases, limited. It is impossible to determine the source of the focus of conservation (human or ecosystem benefits), but it was more common than anticipated. Water conservation as a value-driven attitude exists in other populations; in a study of residents in Las Vegas, environmental value orientation, knowledge of drought, and concern about water use were used as predictors of support for water conservation policies (Salvaggio, Futrell, Batson, & Brents, 2014). Therefore, the detection of an engineering bias may be more complicated than merely technological optimism.

The focus of climate resilience tool kits is often on the natural capital (water) and the built infrastructure; however, human capital will be essential for success in building resiliency. The individuals who will help to transition to more resilient water utilities need to be well trained and well informed, but they will also need to be committed to these changes. Insights from the key informant interviews indicate a strong sense of responsibility and protection for the communities that they serve, and they appear to be intrinsically motivated, feeling rewarded because of the service that they provide. The communicated a strong sense of pride in their work. They also expressed anxiety about the potential for failure in their systems and a sense of resignation about the factors that they cannot control. Appealing to their strong sense of service may help to overcome any possible obstacles seated in their sense of inefficacy when trying to promote the soft path, or their distrust in climate change science. Therefore, it is recommended that the use of soft skills such as empathy be used to address their apprehensions

Psychological Distance and its Influence on Perception

Psychological distance has been identified as a factor to explain how proximity to an environmental crisis is perceived by an individual (Liberman & Trope, 2008; Trope & Liberman, 2003; Trope & Liberman, 2010). Unlike other regions of the world in which drought has led to physical conflict and loss of life from a lack of food (Craig et al., 2019; Doyle & Earley, 2021; Marchildon, Wheaton, Fletcher, & Vanstone, 2016; Shalsi Sarah, Ordens, Curtis, & Simmons, 2019; Wilhite & Glantz, 1985), the droughts in the study region have not yet been severe enough; they have not had a large socio-economic impact, allowing the majority of key informants to discount its existence as a realistic threat. Because personal experience has been shown in other cases to impact perception of natural disasters (Andersen et al., 2019) the minimization of the drought in the minds of the interviewees indicates it is likely that most of the individuals at the time of the interviews were psychologically distant from the experience. However, the drought from 2007-2009 is a wakeup call. Because of the economic impacts that occurred then, 59 counties-- including nine in the study area--were declared drought-disaster areas in the Fall of 2008 by the USDA so that the farmers impacted could apply for aid (WRAL News, 2008). The water supplies (surface and groundwater) are a common pool resource; if the farmers were impacted, then competition for the resources likely existed. This competition is not expected to diminish as economic and population growth in the east increases and the effects of climate change impacts water availability. However, it was evident from the majority of key informants that they have a low level of concern about water quantity.

The perception of abundance is likely also a contributing factor to the belief and attitudes expressed (Praskievicz, 2019; Sprague, 2003; WRAL News, 2008). This framework which features prominently in humid areas and is rooted in the riparian rights framework of the eastern

United States assumes that enough water will be available to meet the needs of all users. It may help to explain the existence of a high threshold for drought in the water decision makers and the mild response of the key informants when reflecting on the droughts that have occurred during their time working in eastern North Carolina (McEwen et al., 2021). Thresholds are "the level or point at which something starts to be experienced," (Grothmann and Patt, 2005; Joseph et al., 2015) For those who use surface water supplies, this might mean reduced flows resulting in lower water levels. However, groundwater does not allow for the visual impact of drought as river or lake levels, and this may increase the threshold at which drought is registered as an issue by an individual. Because groundwater is such an important source of water in the region, areas closer to the coast may generate greater psychological distance in the face of drought.

Similar to the perception of drought, psychological distance seems to exist for many of the interviewees with regards to saltwater intrusion, even the ones whose groundwater sources are near the coast. For the small number of interviewees whose groundwater was already experiencing chloride levels that were high enough to warrant advanced treatment, the issue was a daily concern, yet for many the threat of SWI is a distant event. The fact that the CCPCUA rules have been judged to be successful with aquifer levels increasing has contributed to the impression that the problem has been solved, and until the state issues a different set of rules, it is acceptable to continue with the status quo. There is an "othering" at work in which the SWI is something that is happening elsewhere and not a serious consideration. Again, the invisibility of groundwater reinforces their experience of psychological distance. The fact that drought can be as severe as flooding but seems less immediate is a major obstacle for action and can influence the decision-making process.

Pressing Issues: Psychological Proximity

As might be expected, other factors indicated psychological proximity. These were factors that were more immediate, often requiring daily attention, such as funding and aging infrastructure. Or they were phenomena such as storm impacts, which they had already experienced directly, or whose effects were evident in neighboring communities. They expressed less agency over these factors and a greater sense of urgency about being able to address them adequately.

Flooding is the greatest cause of damage from natural disasters in the United States ((Department of Homeland Security, 2022). The causes of flooding are complicated with high precipitation events occurring more frequently combined with the increase in development creating more impervious surfaces which forces water to pool and to drain more rapidly into waterways; this causes higher volumes of water moving at greater speed than in the past. This has created outdated FEMA flooding maps, placing structures and people in the flood zone. Climate change is expected to exacerbate flooding events and sea level rise will place even greater numbers of people and infrastructure at higher risk of flooding (Covi, Brewer, & Kain, 2021; National Oceanic and Atmospheric Administration, 2009; Retchless, 2018; Riggs & Ames, 2003).

In this case, the more frequent and well publicized impacts of storms is evident in the quotes from the key informants. Hurricane Matthew occurred only a year before the interview period and had done excessive damage to the region, leading to less psychological distance for these individuals. Because this threat ranks so highly on their list of issues, it is likely that mitigation measures targeted to prepare for the impacts of flooding will generate interest in this population.

Another pressing concern is the stress caused by the failures of infrastructure. The precarious state of water infrastructure in the United States is well-documented in the industry literature. A study published in 2017 states that pipe breaks had increased 27% in the 6 years previously (Folkman, 2018). Water main breaks have serious consequences, requiring significant time and effort on the part of utilities, disrupting traffic, causing damage to private property, and endangering human life through the introduction of contaminants into the water supply (Folkman, 2018). Infrastructure has been allowed to be in operation past its useful life span because the cost of maintenance often requires increased costs and water rates are historically low (Environmental Protection Agency, 2018; Waters & Shrier, 2005) . Smaller systems typically have twice as many main line breaks as larger ones because they have more miles of pipe per customer in rural areas (Folkman, 2018). Yet, these systems have the fewest resources, with smaller populations to support the system. It can also be the case that they are located in areas of high poverty, complicating the ability to maintain the system and provide what is considered a human right (i.e., the access to a safe, adequate supply of water for daily needs) by the United Nations (UNESCO, 2019). Utilities can apply for funding through the Drinking Water State Revolving Program (DWSRP) or through rate increases, but if they do not receive financial support from the state then they need to raise rates, which is politically unpopular.

In the study region, key informants describe an *ad hoc* approach to water management with respect to infrastructure; update infrastructure, when possible, but mostly wait for emergencies to occur and then "scramble" to mitigate the impacts. The lack of attention and funding that has dominated the approach to water services in the United States for the past decades is now presenting challenges that were already difficult, but with the added pressures of climate change, the stress has been magnified. The approach described is mostly reactive rather

than proactive, even though it was communicated that they desired the ability to be proactive. But with so many needs and inadequate resources, they described managing under the circumstances as awaiting the next crisis.

With the passage of the Bipartisan Infrastructure Package of 2021, this issue is now more squarely in the public eye. In July of 2022, $789.4 million was earmarked for 225 applicants in North Carolina for drinking water and wastewater upgrades (Tillis, 2021; Winstead, 2022). This funding will bring much needed improvements to communities in the region, yet not all projects were able to be funded. Only 85 of 222 applications (or 38%) for upgrades to drinking water systems were approved (Winstead, 2022). The strong opinion about neglect expressed by the key informants points to the fact that the water decision makers are dependent upon the voting public if transitioning towards climate resilience is going to be successful. Large infrastructure bills such as the one just passed are a likely a "once in a lifetime" occurrence and rates will need to increase to allow the treatment facilities to modernize if they are going to become climate resilient. Changes to rates will need to be approved by elected boards who are beholden to voters. Getting any increases passed, particularly in a water rich region, will be challenging.

The shortfall in utility budgets doesn't only have an impact on infrastructure, it also affects staffing. Efforts spent recruiting means less time and energy spent on other activities to build resilience. The tight labor market in the U.S. was impacting the water utility industry before the COVID-19 pandemic, which has exacerbated the problem. Therefore, the utilities have a few options: automate, pay a higher wage to the workers that remain, keep experienced retired employees on a retainer, or recruit more into the profession (Kline, 2007). This problem is occurring across the country and is not limited to the study region. The American Water Works Association created a subcommittee to manage an internship program to help define the

goals and stages, where to recruit, etc. to help open the pipeline to the industry (Mirvis et al., 2008).

The message that emerges here is that public water suppliers feel hamstringed by the lack of funding. They expressed a sense of guardianship towards their consumers' well-being, and these crises pose stressful events that divert resources from other endeavors. It is the main charge of the utilities to cope with these occurrences, but the managers expressed as much concern as the utility personnel. They would be responsible for overseeing the coordination of multiple departments and communicating with elected boards and the public during a crisis, often as one of the "public faces." From crises such as flooding to water main breaks to staffing shortages, local water decision makers have a lot on their plates.

Discussing Climate Change

This study did not set out to directly assess the attitudes about climate change, yet many of the impacts about which WDM were asked are the impacts anticipated. The difference is that the patterns of precipitation are now less predictable when many of these individuals were in training or in their early careers. An oblique approach to the issue of climate change was intentional because in a region like eastern North Carolina, it is known to be a contentious political and economic issue. Despite not being directly queried, much information about their attitudes about climate change can be read between the lines.

Little more than a decade ago there was outcry in the coastal communities that scientific predictions would harm property values, so HB 819 was passed in 2012 by the North Carolina State Legislature. It included 20 counties, known later as "NC-20" (Nc-20.2014) The concern was that a scientific panel appointed by the NCDEQ predicted 39 inches (1 meter) of sea level

rise by 2100 and that much of the coast would be flooded (N.C. Coastal Resources Commission's Science Panel on Coastal Hazards, 2010). This would put many properties that were not considered at high risk previously in the flood plain and increase their insurance rates. The coalition that formed of municipal, business, and homeowner representatives lobbied to have this struck out of the state regulations, and they won.

This rule still exists a decade later (An act to study and modify certain coastal management policies, 2011). Three of the counties in NC-20 are in the study region and a total of 8 individuals were interviewed from those counties. It is likely that anyone working in municipal government or water utilities in the region at the time was aware of the bill and its implications, whether they supported it or not. Even if they did not support the bill, it may be that they would not publicly discuss their stance. Sensitivity to this may help to craft language that stresses the importance of public protection in addition to the technical and scientific aspects of building climate resilience. This would allow engagement with the materials designed to build resiliency despite political orientation of the municipal and utility employees, the public, and their elected boards.

Building Resiliency – The Need for "Soft Skills"

To build resiliency requires not just changes to infrastructure, it requires attention to the "soft" aspects of managing water i.e., the people required to maintain and repair equipment. Resiliency toolkits that focus only on the physical aspects (infrastructure and climate data) but do not address human capital are missing a key aspect of their mission. Returning to the importance of decision making at the local level, the interview data indicates that key decisions are made in the offices of manager/administrators in conjunction with utility personnel. As in many public water systems (Cockerill, 2014), the ultimate source of information on water management lies

with these individuals. Moving beyond a focus on technical aspects to include the importance of human capital is recommended.

Summary

This chapter presented the results of the qualitative phase of the research which included in-person interviews with 25 water decision makers across nine counties in one river basin in eastern North Carolina. The sample of the elected officials, local government managers, planner, and utility personnel represented towns and operations of different sizes with different economic bases, reflecting the range of industries and economic activities across this region. The interviews allowed for anticipated themes to be elucidated, including drought, water security, flooding, pollution, as well emergent themes such as staffing issues, aging infrastructure, pride, responsibility, support for conservation, agency, the future of water management, and resignation at the political realities at play in their communities. The profile of these individuals developed here is unique to their circumstances and yet also reflects the realities that many face in other places. Knowing who they are and what threats they perceive and what risks they feel can be discounted is useful for any agency seeking to help communities increase their climate resiliency as they face increasing challenges in the 21st century.

They next chapter will present an integrated analysis of the qualitative and quantitative data to complete the picture of water decision makers in a regional setting. This will meld together the findings from the larger survey sample (n=70) with the insights from the interviews (n=25), to present a complementary view of issues that are important to these people, but also a greater understanding of their demographic characteristics, their environmental orientation, and

their opinions about technology and the use of the soft path to address possible threats to water security in the future.

CHAPTER 6: DISCUSSION & CONCLUSIONS

Introduction

The adverse effects of climate change on the public water supply are already evident. More unpredictable precipitation including extreme weather phenomena are occurring in coastal areas, such as the eastern region of North Carolina. Although the region is rich in water, the supply is vulnerable to shortages caused by flooding, droughts, and saltwater intrusion into aquifers. Additionally, the population of the state is growing, increasing the demand for water. If they have not already begun the process, communities across the region will need to transition to climate resilience rapidly to ensure the security of their water supplies. The target audience for federal and state agencies creating programs to assist with this transition are the individuals who work directly and indirectly with water resources like the local WDMs -- the subject of this research. Yet, there has been limited effort to document their attitudes and their educational backgrounds and other demographic characteristics that may influence their attitudes. Through a mixed methods investigation, the information gathered by this study contributes to the body of knowledge already collected about the people who protect human health by providing a safe supply of potable water to the residences in the United States. It creates a detailed profile of their attitudes and opinions regarding water resources, which is essential to entities working to create materials intended to assist them with building climate resilience.

Facilitating the Transition to Climate Resilience in eastern North Carolina by Defining the Target Audience

The management of water resources is a complex activity that straddles the social, political, biological, and physical realms. Local water decision makers practice under stressful

conditions in which they must protect the health and wellbeing of citizens so that every time someone turns on their tap, the product is safe and reliable. Much of what they face is beyond their control: failing infrastructure due to lack of adequate funding, being on call for emergencies at night and on weekends, and separation from their families during storms when systems are threatened by power outages or flooding. A better understanding of their attitudes and their challenges can help support them in their efforts as they deal with a less predictable future.

This study set out to discover how education, training, and attitudes about water resources compare across this population of local decision makers facing the impacts of climate change in a coastal region. The issues facing the water decision makers in the coastal plain are not unique to this setting, as similar conditions exist up and down the east coast of the United States and in other coastal areas. A mixed methods approach of interviews with key informants and a survey of the broader population was used to enhance what is already known about the attitudes and beliefs of water professionals regarding aspects of water management, including water quantity and the "soft path," a strategy that emphasizes conservation. Key informant interviews provided details and nuances that cannot be garnered through a structured survey, but because interviews require an investment of time and funds, the survey allowed for a larger, more representative sample size and increased the number of individuals from whom data was collected. Taken together, the interviews help to provide possible explanations for the responses gathered from the broader quantitative sample. These findings help to paint a more complete portrait of water decision makers, the individuals on the front line of dealing with climate change at the local scale.

Diverse federal entities ranging from NOAA and the EPA to the FEMA and the GAO are working to help communities move towards greater climate resilience across the country (Basics

of water resilience 2022; Climate resilience in action.2022; NOAA, 2020). Included among their "clients" are local decision makers, people who will be acting on their recommendations with limited time and resources. Some research has been done to articulate the attitudes and concerns about water resources in similar populations (Cockerill, 2014; Fitts et al., 2010; Kirchhoff et al., 2013) yet these studies focused on specific attitudes without including information about education and training, the sources of information used, and details about communities. Each study offers important details about specific aspects of water management, such as the use of climate information, perceptions of water scarcity, or how much water decision makers use hydrological data (Cockerill et al., 2014; Cockerill, 2014; Fitts et al., 2010; Kirchhoff et al., 2013; Maas, 2003); however, without considering the attitudes and beliefs that underlie such perceptions, existing studies present a disjointed picture of the individuals working to secure the future of their communities. The research presented here provides a more complete portrait to better inform federal and state efforts to provide support of local water management efforts.

As they face changing conditions, local water professionals will need assistance to ensure that their communities can not only survive but thrive. By integrating a population-wide profile elucidated with in-depth interviews, the research presented here provides a more complete profile of local WDM confronting the impacts of climate change. This information can then be used to design communications that directly address their needs and delivery of these can be enhanced.

The following discussion incorporates information gathered through both modalities and describes demographic characteristics important for understanding this regionally influential group of people, including differences in gender, age, education, and training. But demographics are the tip of the iceberg and do not provide the depth necessary to grasp factors that may cause

people to act. Because an individual's attitudes and beliefs are reflective of their values, they hold important sway over their thinking and impact their decisions (Cockerill et al., 2014; Cockerill, 2014; Fitts et al., 2010; Kirchhoff et al., 2013; Lovelace, 2008; Maas, 2003). To bring them into focus, the study examines beliefs about natural resources and water quantity, characterizes attitudes towards the "soft path" in water management that might create barriers to its adoption, and discusses several psychological constructs that may be at play. These psychological constructs include psychological distance and technological optimism.

Attitudes & Beliefs of Water Decision Makers in a Regional Setting

The individuals who make local decisions about water supplies include politicians, municipal administrators, planners, and water utility personnel. They bring a range of educational backgrounds and work experience to their jobs, yet there appears to be a great deal of consensus among the water decision makers of eastern North Carolina on key issues, including which risks are perceived as most relevant and how to encourage water conservation in consumers. They believe their water supply is secure, but they are concerned about flooding. They embrace technology and supply side management, yet they think about water conservation. They think that the state rules meant to protect the aquifers from a tragedy of the commons are working, and they trust the state environmental agency to provide them with recommendations.

Issues of Greatest Concern Tell Us about Local Water Decision Makers

Because of limited time and resources, individuals need to prioritize where to focus their energies. Circumstances that we think are most likely to affect us positively or negatively are likely to occupy more of our attention. When something is viewed as a risk or threat, we are more likely to act (Cockerill et al., 2014; Cockerill, 2014; Elshafei et al., 2014; Fitts et al., 2010;

Kirchhoff et al., 2013; Lovelace, 2008; Maas, 2003). In contrast, if something is not considered pressing it is more likely to be minimized and action less likely to be taken. By knowing which circumstances are most worrying and which are not, the needs of the local water decision makers can be addressed more efficiently. This is also likely to help keep avenues of communication open allowing for the greater possibility of acceptance by the local water decision makers. If priorities differ between federal and state agencies and members of the target audience, voluntary participation is less likely, impacting the success of the objective, which is to increase resilience in local water supplies. The top two concerns revealed by the survey responses were also reflected in the interviews. They were flooding (current) and aging infrastructure (future). The prioritization of the threats provides a starting place for addressing key issues upon which these individuals are most likely to act.

Flooding as an Opportunity to Communicate

The loss of life and property has been catastrophic for many communities in the study region over the past 25 years. Data from both methodologies indicate that flooding takes precedence over other risks. While this is unsurprising, what should be noted is that quotes from the key informants indicate a sense of powerlessness and resignation with regards to flooding. Assistance with flood mitigation would likely be welcomed. Flood mitigation is not limited to relocating infrastructure such as moving above the highest previous water level. Flood mitigation includes updating of flood maps and help with communicating with citizens about flood risk, such as avoiding the continued use of flood plains as appropriate places to build.

Also, flooding and water quality are connected because floodwaters can often move pollutants into surface and groundwater. Consequently, water quality issues loom large whereas water quantity is less of a concern amongst the individuals surveyed. This is not surprising

because polls reveal that water pollution is a concern in general and protecting human health is a primary objective of providing water (Gallup Annual Environment Survey, 2021). Water decision makers feel the weight of the responsibility on their shoulders for the safety of citizens and the need to protect them from the risks posed by water pollution. This opinion was expressed by multiple key informants who discussed a range of contaminants that included those already known but also included "contaminants of emerging concern" or CECs. The survey respondents were less concerned about "pharmaceutical pollution," one specific type of CEC, but did agree that water contamination leads to scarcity; therefore, focusing on the protection of water quality is likely to resonate with this population.

Aging Infrastructure

It is also unsurprising that these water decision makers are concerned about aging infrastructure and that their systems are underfunded. This problem is often discussed in water industry literature, yet the author was unaware of it until it was noted by multiple key informants in the interviews. Before beginning the interviews, much of the peer reviewed literature on water infrastructure focused on other countries or was restricted to discussion of the risks of communicable diseases posed by out of date and underfunded water infrastructure. As a concern for the future, it ranked top of the list for the respondents, and asking them to "do more with less" is not likely to achieve the goal of increasing resilience.

Creating climate resilience will require an investment of money; however, in many communities this is challenging under the current circumstances. Additional funding will be required. The recent bipartisan infrastructure bill has provided money from the federal government but despite its investment, it will likely not be enough to solve all issues in all communities. Rates will have to increase and attitudes about water across the board--suppliers

and users--will need to change. As noted in a recent NPR interview, water expert Park Williams said that we need to "change our relationship to water" (Rott, 2022). Assistance with messaging to citizens may be required to begin to shift to a greater acceptance of water as a commodity rather than being infinite. That means accepting higher prices and increasing conservation. Funds in the infrastructure bill are likely intended for capital projects, but part of the equation is transforming human attitudes and behaviors. Part of the approach needs to be on the social aspects of water management, not just on machinery and pipes. Understanding how local water decision makers perceive the issues can help to address the human dimensions of developing climate resilience.

Psychological Factors Underlying Local Water Decision Maker Attitudes & Beliefs

Despite the difference in magnitude of reaction, it has been observed in other studies that events such as drought and flooding produced a heightened sense of risk for individuals who had encountered these phenomena (Brody, Zahran, Vedlitz, & Grover, 2008; Diggs, 1991; Hamilton & Keim, 2009; Spence & Pidgeon, 2010; Woudenberg & Wilhite, 2008). And this insight has been suggested as an avenue to increase the likelihood of action because those with direct experience perceive higher risk than someone without it (Anderson, et al. 2019). Yet drought does not seem to elicit the same level of concern as flooding in these local water decision makers. The fact that the socioeconomic impacts of drought have been less than those of flooding may have reduced the magnitude of the threat. It has been suggested in other settings that how the threat of drought is communicated might be altered to shift these attitudes to make them more pro-active and less reactive (McEwen et al., 2021). These findings should be considered when addressing drought mitigation measures during times of abundance rainfall.

Perceptions of Drought

For both key informants and survey respondents, drought was a low-level concern. The region has experienced several severe droughts in the decade prior to this research, yet when asked about it, key informants minimized the impacts of drought. During the drought of 2008-2009 which impacted the entire southeastern United States, they described how other places in the state were in danger, and the governor had ordered restrictions on certain types of water use across multiple counties, but not in their communities. Such restrictions had not been required to conserve water and maintain a stable supply. They perceived their supply to be secure, and they "othered" communities who had been required to enact water restrictions or whose water supply was within weeks of running out. Even when they were less than 30 miles away from those locations, they stated that they were not experiencing a crisis. This attitude is consistent with the survey respondents who ranked drought fourth in a list of six possible threats to the water supply, behind "Flooding," "Saltwater Intrusion," and "Groundwater Depletion." Drought is not perceived as a significant threat to the areas served by the local decision makers, yet they acknowledged it was a problem elsewhere in the region.

Perceptions of Saltwater Intrusion

Similarly, the majority of key informants were unconcerned about saltwater intrusion despite the reality of increasing chloride concentrations in the deep aquifers. In fact, some were not familiar with the extent of the saltwater intrusion and encroachment even though these conditions were an impetus for the state to enact the CCPCUA rules. Those rules shifted many communities from groundwater to surface water sources, or to other less desirable aquifers with raw water that requires more treatment which increases costs. Therefore, the rules had a broad

impact across the study region even if a jurisdiction was not experiencing saltwater intrusion. And despite the apparent effectiveness that has allowed the rebound of groundwater levels in the study area, the state has kept them in place even though they were slated to expire in 2018 (Central Coastal Plain Capacity Use Area & Assessment Report, 2018; McEwen et al., 2021).

By contrast, survey respondents were less sanguine than key informants about the risks posed by saltwater intrusion, placing it second behind "flooding" as a threat. The reason for this is unknown, although several years had elapsed between the interviews and the survey, and circumstances may have shifted in that time. Or the fact that a map of the CCPCUA with the zones impacted by chlorides was presented at the start of the survey may have influenced their responses. They appear more concerned than the key informants, but they were also agreed that more advanced treatment such as reverse osmosis and nanofiltration could help to provide water for the next 25 years in the region. Although the optimism about saltwater not reaching their systems is not as strong as it is with drought, concern about this issue is low. The question that arises is, why do these individuals seem indifferent to these threats despite the evidence that they pose real risks to the water supply in the region?

Reasons for the lack of concern: Psychological Distance

The concept of psychological distance helps to understand the lack of concern about drought and saltwater intrusion. Detecting the presence of psychological distance in this population is important because if these problems are construed as something that occur in other places and at other times, it may be more difficult to get them to act on planning for climate resilience. Perceived distance from the risk would likely cause drought to be downplayed and proactive steps by the individual would be less likely taken. With technological optimism an

individual embraces the promise that engineered approaches will provide the optimal solutions to problems, including those that involve the management of natural resources, such as water.

Psychological Distance and Drought

Based upon the key informant interviews, the water decision makers appear to be psychologically distant from droughts. They perceive the consequences of drought to be happening at other times, in other places, and in other communities. Consequently, the population appears to have a strong sense of water security when it comes to periods of lower-than-average precipitation. Psychological distance was reflected in the language used by interviewees in which they described communities both in close proximity and on the other side of the state whose experience of major droughts had been dire compared to their own experience. Therefore, psychological distance may pose challenging impediments to mitigate the possible impacts of drought in the future. The danger is that this may cause them to be less likely to act upon recommendations for drought mitigation, such as decreasing demand.

Psychological Distance and Saltwater Intrusion

An interesting insight from the survey is that overall, the water decision makers held the opinion that the CCPCUA regulations, which were enacted to protect the aquifers from dewatering and saltwater intrusion, have been successful. In this case, because degradation of the aquifers had been reduced in the near term, the individuals interviewed are less concerned about negative impacts in the future. A similar example of psychological distance was evident when water decision makers were asked about the risks posed by saltwater intrusion, a predicted consequence of sea level rise and a warming climate. Although it was ranked as the second most pressing threat by the survey respondents, comments by the key informants could be

characterized as “indifferent.” Although they were aware that some communities at the coast were already dealing with chlorides in their aquifers and needed to use advanced technology to remove them, saltwater intrusion in their areas was a problem in the distant future. They had heard about it, but as they stated when discussing drought, they were distant both spatially and temporally from saltwater intrusion. It had to “pass through many counties” before its impact would be felt.

In water resource management, technology has been the primary approach and has allowed people in the United States to live safer, more comfortable, and convenient lives. But it can steer an individual away from considering other strategies, even if the technology creates additional problems that then need additional solutions. Technological optimism has also allowed us to downplay the problems and the necessity of addressing changes to behavior that help to reduce risks. The existence of these two psychological phenomena must be considered when aiming to develop tools and materials designed to help with the shift to resiliency. Finding strategies to reduce these will not be easy but knowing that they exist is an important starting point.

Psychological Proximity: Opportunities to Build Trust with Local Water Decision Makers

Effective communication begins with trust. If the climate resilience toolkits are perceived as an overreach by the federal government or unrealistic for financial reasons or other circumstances, then they may be met with skepticism. Evidence of this arose during the interviews when one key informant expressed frustration with government above the local level and the issue of “unfunded mandates.” The devolution means that the municipal governments are held responsible for compliance and enforcement of state and federal rules, yet they often

struggle because of issues with funding. This can lead to mistrust between the parties and impact how messages are received.

The evidence gathered through this study provides insights into the day-to-day concerns of this population. If these challenges are acknowledged and considered when materials are developed, then they may be accepted as relevant and helpful. Seizing an opportunity to build trust might increase the likelihood that climate resilience measures are not seen as just another instance of big government requiring action without providing support.

Psychological proximity is the opposite of psychological distance and can be a useful tool for building the trust necessary for effective communication under these circumstances. As discussed, flooding, water pollution, and aging infrastructure do register as major concerns for this population of local water decision makers, and threats that are viewed as salient are more likely to promote action (Elshafei et al., 2014). An important revelation from the interviews is that these individuals are intrinsically motivated and feel responsible for those that they serve in the here and now. Protecting the health and well-being of their constituents is a motivating factor and may be an impetus for enacting measures that increase resiliency by addressing their most pressing concerns.

The reality is that the day-to-day experience of water decision makers is not focused on the effects of large, catastrophic events but on ensuring that when a consumer turns on the tap, the water is safe. Psychological distance helps explain why future events and circumstances are discounted, while attention is focused on more proximate threats like current water pollution. Unlike saltwater intrusion, individuals were concerned about bacterial or anthropogenic pollutants, those that might be revealed during the routine daily testing required at water treatment plants.

Even though big storms are not a daily event, both the key informants and survey respondents provide evidence that little psychological distance exists regarding flooding. It has been suggested that climate change messages will be more effective if they are framed as increasing security against localized flooding (Bruine de Bruin, Wong-Parodi, & Morgan, 2014). Knowing that local water decision makers perceive flooding as a salient risk may provide opportunities to help communities transition to climate resilience. Materials can be tailored to emphasize risks perceived as more pressing because there is greater psychological proximity to them. Because building trust and cooperation between local governments and their constituents are key to helping increase climate resilience (Dekker, 2018), it is likely an important consideration for federal and state agencies working to assist in this process. Therefore, addressing their priorities can help to develop trust between the federal and state agencies and the target audience.

Reducing Psychological Distance towards Drought and Saltwater Intrusion

The question then arises, how can psychological distance be reduced when addressing the local professionals who will be making decisions that have long term ramifications for their communities and might increase or decrease climate resilience? Although flooding, drought and saltwater intrusion impact water security in different ways, the soft path can achieve positive results on all three issues. Therefore, communicating with these local water decision makers might focus more on helping to lessen the consequences experienced from excessive precipitation events in the region using methods that can also help protect water security during times of drought and from saltwater encroachment.

"Soft path" solutions for water issues emphasize both conservation and water efficiency. An obvious approach is using less water which means fewer impacts on both groundwater and

surface water sources, lowering the risks posed by the tragedy of the commons. But how can the soft path be applied to flooding, as having too much water is not likely to encourage water conservation? An interesting answer to that question is using stormwater and treated wastewater as acceptable sources of water (Chanan, Vigneswaran, & Kandasamy, 2010). Water re-use was discussed by multiple key informants who already had examples of this in their jurisdictions. But these possible uses will probably face public resistance as the re-use of treated wastewater has posed challenges in other places (Tennyson, Millan, & Metz, 2015). Knowing that some water decision makers in the region already accept re-use may provide opportunities to consider whether to place greater emphasis on soft path approaches when communicating with this population.

The Role of the State Environmental Agency in the Region

An interesting insight from WDM opinions about the CCPCUA and the North Carolina Department of Environmental Quality website offers a potential approach to reducing psychological distance associated with regional water management issues. Regional water decision makers in the survey were in overall agreement that the CCPCUA were working and successful and this attitude was echoed by the key informants who were most familiar with them. It must be noted here that the rules were a result of a decision-making process that involved regionally representative stakeholders and moderators. When the rules were being crafted, the state held multiple stakeholder meetings and sought members from different constituencies to give their input about what they perceived to be fair (Natural Resources Leadership Institute, 2011). Stakeholder input was balanced by what the state thought was necessary to protect the aquifers. The acceptance of the rules has been noted as an example of procedural justice (Manda & Klein, 2014) in which the actors involved felt that because their voices are considered, they

were more likely to accept and abide by the rules. Therefore, the value of involving stakeholders in the creation of plans to increase climate resilience must be considered as a means to increase the likelihood that they will be positively received. The success of this endeavor offers a possible approach for the creation and dissemination of materials related to climate resilience.

Involving local water decision makers in the design and implementation of these materials is one possible approach. It may be that being able to discuss issues with other stakeholders and state personnel facilitated by a moderator trained in conflict resolution The Natural Resources Leadership Institute is an organization can help to increase acceptance of recommended climate change resilience actions. And when people accessing materials see names that they know and recognize on the materials, they may be more receptive and more likely to act. This would require an investment in meetings such as focus groups with trained professionals to record responses and moderators to keep discussions on track. Of course, just because an idea is mentioned does not mean that it will be accepted or that it is an action that increases climate resiliency, but if "action" is better than "no action" compromises will need to be made. If individuals feel represented in the process and go out into their communities and describe their experience positively, "buy-in" in their communities might be higher.

The Elephant in the Room: Climate Change

In many spheres outside of scientific research and academia, climate change is a "sticky" subject. It can elicit reactions in people that can shut down a conversation before it even begins or set up an adversarial dynamic that reduces the likelihood that responses are focused on the topic at hand and instead becomes an exercise in trying to convince someone that their view is the "right" one. Therefore, the term "climate change" was omitted intentionally from both aspects of data collection in this study. This was done to reduce the likelihood that responses

would be politicized. However, the challenges facing the water decision makers in this coastal region are the result of climate change. Therefore, the study sought to examine if any key informants or respondents would voluntarily mention climate change.

Despite not including any direct reference to "climate change," even though the consequences of climate change were the focus of much of the study, of the 25 people interviewed, only one key informant used "climate change" and another used "global warming." In both cases they attributed negative effects, such as flooding and drought, to the phenomenon. The opportunity to further investigate this was more limited during the second phase of data collection due to the survey's use of closed-ended questions. However, respondents were permitted to write in responses in several places, including a question about their perception of their water security. Although the responses expressed concern about sea level rise, flooding, groundwater depletion, and pollution, there was no mention of either "climate change" or "global warming." Since the individuals in this study chose to leave out any reference to "climate change," it is recommended that language be considered carefully when crafting communications for this population of water decision makers. Even if they think that climate change is a threat, they may work in communities where the scientific evidence is discounted, and they may have to carefully consider the language that they use.

Consequently, noting when the term was used by the individuals in the study was intended to indicate whether its use is recommended when developing training materials. This may influence the likelihood that messages will be embraced and not disregarded. A similar suggestion emerged from a study of flood mitigation in Pittsburgh, PA in which it was recommended that the term "climate change" not be used in any communications (Bruine de

Bruin, Wong-Parodi, & Morgan, 2014) This was to reduce the likelihood that individuals would reject the opportunity to take action to protect themselves against flooding.

It may be counterintuitive to create climate resilience materials that do not focus on climate change. Yet, because some regions may have constituents who are still not convinced that there is an anthropogenic cause or that it does not exist as a threat, it may be important to consider the omission of the term as indicative of an important attitude that could impact how information is perceived. This is indeed advocating for "the end justifies the means" approach if it increases the likelihood that steps to mitigate the negative impacts of climate change will be taken. If the goal is to help adaptive strategies to increase climate resiliency, then the attitudes of the target audience must be considered. These water decision makers are concerned about flooding, pollution, and aging infrastructure. If using the term "climate resilience" proves to be a stumbling block that delays or prevents action, it is suggested that presenting strategies to help address the water decision makers' concerns be the primary goal.

Recognizing the Influence of the "Water People" in Decision Making

The initial step in helping to create climate resilience is to identify how to reach members of the target audience. Because local water decision makers come from different educational backgrounds, accessing each group may require different tactics and avenues. Some individuals are required to participate in regular training, others are not. And because their level of influence on decision making differs, knowing where to concentrate efforts to reach each key constituent group can help to increase efficiency of knowledge transfer.

The water decision makers examined in this study hold different, but important roles in managing the water supply. These differences can indicate how best to reach the individuals who are facing the challenges of climate change examined here and how to tailor materials that may

suit their needs. This includes who they are in terms of their educational backgrounds, which determines whether they will be actively seeking continuing education opportunities and where. A key understanding is the importance of the water professionals whose training and opinions make them the default experts in this realm. It also provides an interesting insight into the importance of the North Carolina Department of Environmental Quality's website.

The findings of this study reiterate the importance of utility professionals in influencing decisions (Brandes & Ferguson, 2004; Maas, 2003). Of the key informants interviewed, individuals serving in management positions or as elected officials stressed the importance of their "water people" and their reliance upon the expertise and recommendations of their staff. The "water people" are utility personnel at the water treatment plant and are certified by the state. In some cases, if an administrator has not made the effort to learn the details, then the person at the utility becomes even more influential. One interviewee who worked directly in a water utility stated: "The manager here doesn't know water or sewer, despite being in the position for four years" (Informant J).

Differences in utility personnel opinions compared to those of water decision makers in other roles were uncovered in the survey results and should be considered when designing climate resilience materials. Notable differences included the utility personnel being more supportive of the CCPCUA and greater concern about competition for water in the region, but less agreement that resources are limited or that there is an ecological crisis. Additionally, the use of NC Department of Environmental Quality website saw utility workers relying on it less than the other two groups (managers and planners). Because they are so influential in decision making at this level, the views that they bring to the table could sway jurisdictions towards or

away from actions that increase climate resiliency. Therefore, how those materials are designed and delivered might take these insights into account and diversify training materials accordingly.

Reaching Out to Local Water Decision Makers: Continuing Education

Continuing education offers an opportunity to disseminate climate change resilience materials to several categories of local water decision makers. Approximately one in three survey respondents held at least one state water certification. Those certifications need to be renewed regularly, requiring these individuals to obtain continuing education credits. The curriculum for the certification is updated as conditions change and provides an opportunity for professionals to stay current in their field. For those seeking to offer information about transitioning to climate resilience, engaging the process of reviewing and revising recertification curricula affords a possible avenue for training and communication.

Planners are also likely to seek out training to maintain their licenses. As has already been noted, the national organization offers CEUs that directly address planning for climate change. Planners' influence on water decision making is less direct. When the key informants were discussing how decisions were made it was often the collaboration between managers and utility personnel who would then bring their recommendations to the elected officials. They agreed more that resources are limited, had consulted the state environmental website with the lowest frequency, and thought it to be less useful than the other categories. This may reflect their more secondary role in the decision-making process. A place to invest time and effort may be to encourage meetings between different types of water decision makers that include planners to also include other considerations like land use planning.

Planners and water operators are required to complete CEUs, and this opens an avenue for communication. However, because managers and administrators are not required to pursue

training beyond their degree, incentives to do so must be made to appear relevant to facilitate their participation. Time and resources are always at a premium so communication should address their priorities and be easy to access and be marketed as "value added." How information is presented needs to be targeted to the benefits of planning for climate resilience that address their most pressing concerns: flooding and aging infrastructure. And an avenue to communicate needs to be identified. In the state of North Carolina, the Department of Environmental Quality may already be helping to serve that purpose.

When questioned about who water decision makers consulted for information about water resources, the NCDEQ website was viewed favorably. Overall, there was agreement that the NCDEQ website was the most useful source of information and those without water certifications indicated that they consulted it "frequently," making it a potentially effective avenue to disseminate training materials to the managers and administrators. Those individuals with water operator certifications consulted the state environmental website less frequently than those who held none. Perhaps this is because they are getting information from a different source such as their CEU courses or recertification exams, which could be further investigated; however, it is important to note that this website is a good clearinghouse for information.

Another way to reach the target audience is to reach out to the water authorities or other water cooperatives. The key informants expressed pride about their membership in those organizations and what had been accomplished. In both the survey and the key informant interviews their members had strong support for the state regulations to protect the aquifers. A public meeting was attended in which the participating municipalities were well represented and information about the state of the water supply, infrastructure, and funding was shared. These

regular meetings may also be an effective starting place for communication with state and federal agencies.

In summary, this research has identified several ways to tailor specific approaches to different segments of the regional water decision maker population. Some professions require regular training, so coordinating with the entities that offer those opportunities is essential. For example, state environmental agencies or the American Planning Association may help to improve delivery of climate change resilience materials. Reaching the administrators and elected officials is a greater challenge. They appear to rely on what they learn "on the job" and seem likely to pursue training only if they feel it is valuable. National and state organizations for managers exist and provide opportunities for communication and training through listservs and annual meetings. This avenue may be pursued when considering how to best reach this subset of the population of water decision makers.

Policy Implications of the Study Findings

The Infrastructure Investment and Jobs Act, a bipartisan bill signed into law November 2021 means that federal money has been allocated to some communities to address concerns such as aging infrastructure. This includes $440 million for clean water in North Carolina over the next five years (Tillis, 2021). This affords an opportunity to make decisions about how to spend this money in ways that increase climate resiliency. If water decision makers focus more on supply side management and choose high priced infrastructure for their jurisdiction, that infrastructure will likely be in place for the next generation of citizens. This is a decades long commitment that may have long-term costs that outweigh the benefits, such as the community cannot afford the financial commitment, or the technology chosen may be valuable under present circumstances but not appropriate in the future.

As sea level rise leads to higher concentration of chlorides in some aquifers, conventional drinking water treatment technologies will not be effective for treating the water supply. Aging systems will need to be updated to desalination technology, which is more costly and comes with a higher environmental price tag. The increasing population in the region is projected to increase demand on groundwater, and competition for surface water sources will increase. Although the CCPCUA rules are working well now, this might change as circumstances change. Today's conditions cannot be used as predications for future conditions, but soft path tactics are a "win-win" proposition in which water security is increased. Therefore, knowing that this population would like to promote conservation is important. However, the choice to pursue demand side management and soft path approaches presents challenges. These include political backlash from water rate increases, a reduction in water use decreasing the revenues, and no guarantee that citizens will conserve water despite these actions.

But "business as usual" methods that are presently employed will not increase climate resilience. How to encourage this shift in attitudes, or at least to increase the willingness of water decision makers to accept novel approaches, relies on understanding their attitudes towards the water supply. This may include steering them to invest in some technologies over others. Better metering was discussed by several of the key informants as an important tool in the future. It can help to reduce water consumption by detecting leaks quickly and allowing consumers to track usage in real-time and adjust behavior accordingly. And advanced metering works with any type of water treatment and thus may have a longer usable life. It cannot be claimed that pursuing this strategy will achieve the desired results, but the investment in this technology may mean more flexibility and time to determine the next type of capital investment for the future.

Limitations of this Study

The small survey sample and purposive selection of key informants does present some limitations to the reach of the results. Although every effort was made to include different subsets of water decision makers, elected officials were often reluctant to agree to a face-to-face interview. Consequently, they were not included in the survey but are still important participants in water decision making and more needs to be known about them. An additional issue is that only individuals who had a public email address were included for contact in the survey. This meant that individuals such as water associated personnel and planners were less likely to be included because only managers and administrators usually have this information listed on municipal and county websites. As this was a census survey approach, the individuals who responded were self-selected and willing to take the time to complete the survey.

As a case study, the insights gathered here cannot be transferred directly to other populations; however, his does not imply that the information is only useful in this one location. Similar circumstances exist in other coastal states, especially those in the southeastern United States. But it is recommended that further research is undertaken in other coastal regions to ascertain whether the results found here are useful for helping to define the target audience for climate change resiliency materials.

Suggestions for Further Research

The research presented here suggests several fruitful lines of inquiry for future research, which encompass a broad range of possibilities such as in-depth research into attitudes and assumptions about the role of humans in the environment, additional demographic factors that influence the attitudes of water decision makers and finding ways to decrease psychological distance and assessing trust.

The relationship between humans and the natural environment and natural hazards is a topic that requires additional investigation. If we know that technology can reduce the perception of risk for phenomena such as flooding (White, 1942), why haven't we made more progress at protecting people and infrastructure? Because flood mitigation includes physical alterations of the environment, such as installing retention basins to changes in zoning laws that restrict building in areas that have previously flooded, questions need to be asked of natural resource decision makers. These include whether it will ever be possible to move away from techno-fixes and focus on changing human behavior.

Because overall respondent views were so similar, an important question arose from the results of this study: are water managers similar because of their training, interests, or education, or have their attitudes been shaped by past experience and the colleagues with whom they interact? If it is desirable to influence attitudes that promote soft path approaches as a method to increase climate resiliency, understanding the source of the attitudes and beliefs of this population is essential.

Other factors to be considered are correlated to the psychological distance observed in this population with regards to the risk posed by drought. The objective would be to address this distance, particularly if it is a barrier to action. A starting place may be why drought elicits greater psychological distance than flooding. And what might be learned about psychological distance from these two phenomena? Additionally, the peer reviewed literature on how psychological distance impacts climate change adaptation and mitigation behaviors states that there is a need for more investigation into this phenomenon (Maiella et al., 2020). Although drought is not a proxy for climate change, the link between the two provide opportunities to

develop a greater understanding of the importance of psychological distance and human behavior.

A rich opportunity for research lies in the use of the terms “climate change” or “global warming” and how they are perceived by local water decision makers and natural resource decision makers. If the terms create barriers to information acceptance, then a difficult discussion must be undertaken about the usefulness of titling a resource “a climate resiliency toolkit.” This harkens back to the “mitigation” versus “adaptation” debate that has been present for decades (Zinn, 2007). The downplaying of “adaptation” because it might result in complacency, and the emphasis on “mitigation” has not increased either activity. Despite well intentioned climate professionals the debate has become moot as mitigation at the levels needed to slow or stop climate change has not been achieved (Stoddard et al., 2021). The famous saying, “you can lead a horse to water, but you cannot make him drink” seems apt here. Adaptation has become a reality and any approach that moves jurisdictions and communities towards greater climate resilience should be considered. Therefore, gathering more information about how these terms are perceived is recommended with the caveat that if individuals do not respond favorably to “climate change” or “global warming,” then it is incumbent upon those seeking to increase resiliency to relinquish the use of the terms.

An interesting finding was the level of trust regarding the state environmental agency’s website as a source of information. Assessing the level of trust in national agencies such as the EPA would be useful information to ascertain how receptive a water decision maker might be to using those resources, or whether they should be deployed by another route. And a better understanding of how and why the average citizen has become so disconnected from the source of their water is the next step in helping citizens in the United States transition to greater water

security and sustainability (Bekkar, Kuper, Errahj, Faysse, & Gafsi, 2009; Bendz & Boholm, 2020; Megdal, 2018). Without the participation of the public, progress cannot be guaranteed to ensure climate adaptation.

Conclusions

The target audience for those seeking to communicate about climate change resilience is individuals who are intrinsically motivated and see themselves as public servants with a strong sense of responsibility to protect their citizens from harm. The people who make decisions about our water supplies include elected officials, municipal administrators, planners, and water utility personnel. They bring a range of educational backgrounds and work experience to their jobs, yet there appears to be a great deal of consensus about some key issues among the water decision makers of eastern North Carolina, including which risks are perceived as most relevant and how to encourage water conservation in consumers. They embrace technology and supply side management, yet they think about water conservation. They desire more soft path approaches for ethical reasons, but they are resigned to the reality that water is undervalued, underpriced, and likely to remain so in the foreseeable future. They are confident that their water supply is secure, but they are concerned about flooding and failing infrastructure, concerns that likely eclipse any threat from droughts. It is suggested that the result of psychological distance and optimism bias may lead to a discounting of the future impacts of climate change. If discounting exists, it presents a considerable hurdle to overcome when transitioning to climate resilience.

Although it is likely that discounting the risks posed by the impacts of climate change is an important factor to be considered, other impacts are already occurring and on the minds of these professionals. Focusing on concerns such as infrastructure, pollution, and flooding may help to create messaging that resonates with this population. And assisting with communication

to citizens about the threats posed by natural disasters may be an avenue that yields results. By concentrating on this important aspect of their collective psyche, agencies may be able to better assist this population to transition to climate resilience. This study has provided a detailed profile of the attitudes and beliefs of this critical audience regarding water resources already impacted by climate change and possible ways to reach those seeking to deliver assistance in the face of an unpredictable future.

Lastly, this study did not overtly seek to assess attitudes towards climate change, yet the absence of the use of the term does offer some important information. Lack of the term is not an indication of lack of acceptance of its existence and cause but may be a reflection of political beliefs or a response to the political climate in the region. But even those individuals who acknowledge that climate change is occurring due to anthropogenic action may discount its severity. Therefore, how information is presented should be carefully designed to reflect the fact that differences in the level of acceptance, a warming planet as crisis likely exist in many populations of water decision makers. Communicating that actions that increase climate resiliency also improve responses to climate change-induced natural disasters may yield better outcomes.

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APPENDIX A: INTERVIEW AND SURVEY INSTRUMENTS

Subject: East Carolina University Water Resource Project in the Central Coastal Plain

Dear _____:

I am a doctoral student at East Carolina University conducting research about how governmental officials and managers perceive water resources in eastern North Carolina.

I am seeking to interview individuals involved with managing public water supplies in the Central Coastal Plain Capacity Use Area of North Carolina at the county and city and town levels.

If you are willing to participate in this study, I would like to schedule an interview. It would require about one hour of your time and would take place in a location and at a time most convenient to you. All information that you provide will be assigned a unique code number which will be kept separate from your name. These materials will be kept confidential and secure for a period of five years.

Thank you in advance for any assistance that you can provide. I look forward to hearing back from you.

Regards,

Anne Bunnell
PhD Candidate
Coastal Resources Management
Bunnella98@students.ecu.edu
252-412-5856

INTERVIEW INSTRUMENT

1.0 Please tell me your name, job title, and something about your educational background, e.g. where did you go to school, what degrees do you hold, what are your areas of expertise, and so forth.
2.0 How many years have you worked in your present position?
3.0 How many years of experience do you have working in water resource management in the CCPCUA? Please tell me about other areas of the state you have worked in. If you have worked in coastal areas in other states, would you please tell me a little about your experiences there?
4.0 Would you please discuss your knowledge of water supply issues as they relate to the CCPCUA, e.g. what things or activities result in threats water availability and water quality?
5.0 Please describe current practices to maintain water supply within your area of responsibility.
6.0 How much emphasis on reducing water demand exists in your jurisdiction?
7.0 Has your community/jurisdiction implemented any water conservation measures?
8.0 Please tell me about other issues or problems your organization faces regarding water resources management (i.e., regulations, finances, human/technical capacity, environmental, etc.).
9.0 Regarding the issues just discussed in the question above, would you please discuss how these issues, in your opinion, may be addressed to lessen their respective impact(s) upon water quantity?
10.0 Would you say that you cooperate with other users in the CCPCUA when it comes to extracting water from the aquifers?
If they say yes, then follow up with the question: With whom do you cooperate? Would you describe how this cooperation happens?
11.0 Does your jurisdiction belong to an alliance or league of cities, counties, so forth that has been formed to address county or region-wide **water supply** issues, e.g. if you draw water out of an **aquifer**, do you work with other municipalities or other users to minimize the impacts that may occur to the **aquifer**? If so, please describe the alliance or networks to which your jurisdiction belongs and tell me something about the entities that belong to the association.
12.0 Do you foresee future problems regarding your jurisdiction's water supply, e.g. shortages, saltwater identified problems? If plans have been developed, please discuss the plans.
13.0 Can you please describe the process your organization uses to make decisions related to the critical issues you mentioned including what helps and what hinders this process?
14.0 How do *you* define water scarcity?
15.0 Would you say that water is scarce here in the CCPCUA? Please explain more about your answer.
16.0 How could water stress be measured/assessed in your district?
17.0 What is your opinion of water stress indices in which the number of residents is divided by the amount of water removed?
18.0 How would you modify this measurement? What are your suggestions?

Study ID:UMCIRB 17-000993 Date Approved: 6/15/2020 Expiration Date: 6/14/2021

March 2020

Dear Water Resource Professional:
Dear Planner:
Dear Manager:

Every person in North Carolina needs water. In many parts of the state, the same sources of water are used by households, businesses, farms, and wildlife. Sometimes it may be possible to meet all of these water requests, but at other times doing so may be quite tough. One of the challenges North Carolina faces is how to balance many different uses of water. Please make your voice heard about the state of water resources here by taking part in *Our Future in Every Drop*, a research study conducted by a team of researchers in Coastal Resources Management at ECU.

To participate you simply need to complete the enclosed survey. It should take you no more than 15 minutes. Your answers will help us better understand the attitudes and opinions of people involved in water management in eastern North Carolina.

Your name was randomly selected from public websites such as the North Carolina Department of Environmental Quality, American Planning Association-North Carolina Chapter and the North Carolina League of Municipalities. Because your privacy is important to us, your responses are anonymous. Participation is *completely* voluntary.

We would prefer that it be returned by **(date to be determined)**. You do not have to answer every question. If you prefer, you may take the survey online at (link to be provided) or through your smart phone by aiming your camera at the QR code (the black square shown below).

If you have questions about the survey, please call Ms. Anne Bunnell at 252-328-9840. If you have questions about your rights as someone taking part in research, you may call the East Carolina University and Medical Center Institutional Review Board (UMCIRB) at phone number 252-744-2914 (days, 8:00 am-5:00 pm).

Thank you for your time. We hope to hear back from you.

Sincerely,

Anne E. Bunnell
PhD Candidate, Coastal Resources Management

SURVEY INSTRUMENT

Our Future In Every Drop

Dear Public Works Director, Planner or Manager/Administrator:

We invite you to participate in a research study titled, Our Future in Every Drop, conducted by a team of researchers at East Carolina University. Your contact information was selected randomly from among a relatively small number of utility personnel, planners, and managers in our region.

Please complete the survey. We want to understand how individuals knowledgeable about the public water supply view water issues in North Carolina. The information you provide is important and will help us get an accurate picture of how things are in the eastern region of the state today.

This survey will take about 15 minutes to complete. It is anonymous. The survey does not ask you to give your name or any other information that would identify you. We ask that you please complete the survey no later than two weeks after receiving it.

Your participation in this research is voluntary. You do not have to answer every question. If you have questions about the survey, please call Ms. Anne Bunnell at 252-328-9840. Or call the East Carolina University and Medical Center Institutional Review Board (UMCIRB) at 252-744-2914 about your rights as a research participant.

Many Thanks,
Anne Bunnell

Water Resources in North Carolina in the Coastal Plain

I am interested in your opinion about the water supply here, both now and in the future. Please respond to the following questions regarding the community or jurisdiction in which you are employed. (Note: "Raw water" refers to water that has not been treated for drinking.)

There is enough water in the region of eastern North Carolina to meet the needs of all the people and businesses for the next 25 years (until 2045).
1 Strongly disagree 2 Disagree 3 Undecided 4 Agree 5 Strongly Agree

At the present time, my community/jurisdiction is less vulnerable to water shortages than other places in North Carolina.
1 Strongly disagree 2 Disagree 3 Undecided 4 Agree 5 Strongly Agree

In the following questions "PWS" (public water supply providers) refers to municipalities and other organizations that treat raw water for drinking. These are identified by the state by a PWSID number.

PSWs face many management challenges. I am interested in your opinion on these issues. Of the following, please rank the TOP 3 that you think pose the greatest threat to the water supply in your jurisdiction. (Please use "1," "2," and "3," with "1" as the GREATEST threat).

Saltwater Intrusion or encroachment
Pharmaceutical pollution
Harmful algal blooms
Potential for drought
Severe flooding impacting the ability to provide potable water
Groundwater depletion
Other _____

Every PWS in the state of North Carolina is required to file a Water Shortage Response Plan (WSRP), also known as a Drought Contingency Plan (DCP). How familiar are you with the details of your community's WSRP?
1 Not familiar at all 2 Slightly familiar 3 Moderately familiar 4 Very familiar 5 Extremely familiar

Water withdrawals by other users nearby increase the risk of my community not having enough water.
1 Strongly disagree 2 Disagree 3 Undecided 4 Agree 5 Strongly Agree

The Central Coastal Plain Capacity Use Area Rules

The Central Coastal Plain Capacity Use Area (CCPCUA) was established by the Department of Environmental Quality (NCDEQ) around 2000 to regulate groundwater use. Rules about withdrawals were put in place because of declining water levels in several aquifers in eastern North Carolina.

How familiar are you with the CCPCUA rules?
1 Not familiar at all 2 Slightly familiar 3 Moderately familiar 4 Very familiar 5 Extremely familiar

Please indicate how much you agree with the following statements.

The rules that regulate groundwater withdrawals from the Central Coastal Plain Capacity Use Area (CCPCUA) have been successful in protecting the aquifers in eastern North Carolina.
1 Strongly disagree 2 Disagree 3 Undecided 4 Agree 5 Strongly Agree

The rules are working well.
1 Strongly disagree 2 Disagree 3 Undecided 4 Agree 5 Strongly Agree

The rules are enforced fairly and equitably.
1 Strongly disagree 2 Disagree 3 Undecided 4 Agree 5 Strongly Agree

The rules should be expanded to include adjacent counties.
1 Strongly disagree 2 Disagree 3 Undecided 4 Agree 5 Strongly Agree

The rules should be revised.
1 Strongly disagree 2 Disagree 3 Undecided 4 Agree 5 Strongly Agree

The rules should be lifted.
1 Strongly disagree 2 Disagree 3 Undecided 4 Agree 5 Strongly Agree

Please feel free to provide additional comments about the CCPCUA rules (optional).

Providing Water

Technological advancements will enable us to always provide the needed supply of water in eastern North Carolina.
1 Strongly disagree 2 Disagree 3 Undecided 4 Agree 5 Strongly Agree

Technological advancements will enable us to always provide the needed supply of water in eastern North Carolina.
1 Strongly disagree 2 Disagree 3 Undecided 4 Agree 5 Strongly Agree

Water pricing is a greater challenge in water management than providing enough water for non-human species.
1 Strongly disagree 2 Disagree 3 Undecided 4 Agree 5 Strongly Agree

Your opinion about water scarcity

Water scarcity exists in situations where saltwater intrusion requires desalination to provide fresh water.
1 Strongly disagree 2 Disagree 3 Neither agree nor disagree 4 Agree 5 Strongly Agree

Water scarcity exists in situations where saltwater intrusion requires desalination to provide fresh water.
1 Strongly disagree 2 Disagree 3 Neither agree nor disagree 4 Agree 5 Strongly Agree

The water cycle guarantees that we will have a secure supply of raw water for the next 25 years (2045).
1 Strongly disagree 2 Disagree 3 Neither agree nor disagree 4 Agree 5 Strongly Agree

Technologies such as nanofiltration and reverse osmosis will be able to provide an adequate supply of raw water for the next 25 years (2045).
1 Strongly disagree 2 Disagree 3 Neither agree nor disagree 4 Agree 5 Strongly Agree

Water scarcity exists when raw water is contaminated and is unsafe for human consumption.
1 Strongly disagree 2 Disagree 3 Neither agree nor disagree 4 Agree 5 Strongly Agree

Water scarcity can be managed by the use of technology to remove contaminants, such as salt or other pollutants, from the raw water source.
1 Strongly disagree 2 Disagree 3 Neither agree nor disagree 4 Agree 5 Strongly Agree

Water scarcity can be managed by the use of technology to remove contaminants, such as salt or other pollutants, from the raw water source.
1 Strongly disagree 2 Disagree 3 Neither agree nor disagree 4 Agree 5 Strongly Agree

Please rank the top 3 that you think are most important to your jurisdiction's ability to plan for future water supply requirements. (Please use "1," "2," and "3," with "1" as the MOST important issue.)

Ability of aging infrastructure to support new or increased use
Compliance with state regulations
Water conservation by consumers
Ability to obtain money/resources from funding agencies
Ability to retain utility staff/employees
Population growth
Other (Please describe)

General questions about managing water supply

I have thought about water conservation frequently in the past year.
1 Strongly disagree 2 Disagree 3 Undecided 4 Agree 5 Strongly Agree

The greatest threat to the water supply is the lack of available raw water.
1 Strongly disagree 2 Disagree 3 Undecided 4 Agree 5 Strongly Agree

When making decisions about meeting water supply needs in eastern North Carolina, the health of the economy is more important than protecting the environment.
1 Strongly disagree 2 Disagree 3 Undecided 4 Agree 5 Strongly Agree

Non-human species and habitats ought to be considered in any decision making regarding water resources.

1 Strongly disagree 2 Disagree 3 Undecided 4 Agree 5 Strongly Agree

Demographic Information

The following questions ask about you, where you work, and your education.

In which county is your jurisdiction?

Please enter the zip code of your place of employment.

Is your jurisdiction part of a cooperative water agency, such as an authority, district or non-profit?

Is there a seasonal difference in population (summer/winter) in your jurisdiction?

Which of the following BEST describes your position in water management?

- Town Administrator
- Planner
- Water Superintendent or Public Works Director
- Utility Worker
- Other

How long have you served in this position?

How many years have you worked in the public water supply field?

Which of the following North Carolina Drinking Water Operator certifications do you hold (now or in the past)? Please check all that apply.

- Distribution
- Surface
- Well
- Pursuing certifications (which ones?)
- None

Which of the following diplomas or degrees do you have? Please include the discipline, subject, or major. Please indicate if you are presently pursuing a degree.

- Some undergraduate
- Associate degree
- Undergraduate degree
- Master's degree
- Doctoral degree
- Other

Please check any of the following subjects in which you have a degree or certificate. Please select all that apply.

Geological sciences
Hydrology
Planning
Public administration
Business administration
Other

What is the year of your birth?

Sex
Male
Female
Other/prefer not to identify

You are more than halfway through!

The New Environmental Paradigm Scale

Please answer the following general questions about humans and their relationship with the natural environment. These 15 questions will provide important information about how you see the world.

Humans will eventually learn enough about how nature works to be able to control it.
1 Strongly disagree 2 Disagree 3 Undecided 4 Agree 5 Strongly Agree

Despite our special abilities humans are still subject to the laws of nature.
1 Strongly disagree 2 Disagree 3 Undecided 4 Agree 5 Strongly Agree

Human ingenuity will insure that we do not make the Earth unlivable.
1 Strongly disagree 2 Disagree 3 Undecided 4 Agree 5 Strongly Agree

The Earth has plenty of natural resources if we just learn how to develop them.
1 Strongly disagree 2 Disagree 3 Undecided 4 Agree 5 Strongly Agree

Humans have the right to modify the natural environment to suit their needs.

1 Strongly disagree 2 Disagree 3 Undecided 4 Agree 5 Strongly Agree

Humans were meant to rule over the rest of nature.
1 Strongly disagree 2 Disagree 3 Undecided 4 Agree 5 Strongly Agree

Plants and animals have as much right as humans to exist.
1 Strongly disagree 2 Disagree 3 Undecided 4 Agree 5 Strongly Agree

The balance of nature is strong enough to cope with the impacts of the modern industrial nation.
1 Strongly disagree 2 Disagree 3 Undecided 4 Agree 5 Strongly Agree

We are approaching the limit of the number of people the Earth can support.
1 Strongly disagree 2 Disagree 3 Undecided 4 Agree 5 Strongly Agree

The so-called "ecological crisis" facing humankind has been greatly exaggerated.
1 Strongly disagree 2 Disagree 3 Undecided 4 Agree 5 Strongly Agree

When humans interfere with nature it often produces disastrous consequences.
1 Strongly disagree 2 Disagree 3 Undecided 4 Agree 5 Strongly Agree

Humans are seriously abusing the environment.
1 Strongly disagree 2 Disagree 3 Undecided 4 Agree 5 Strongly Agree

The earth is like a spaceship with very limited room and resources.
1 Strongly disagree 2 Disagree 3 Undecided 4 Agree 5 Strongly Agree

The balance of nature is very delicate and easily upset.
1 Strongly disagree 2 Disagree 3 Undecided 4 Agree 5 Strongly Agree

If things continue on their present course, we will soon experience a major ecological catastrophe.
1 Strongly disagree 2 Disagree 3 Undecided 4 Agree 5 Strongly Agree

Almost done!

The NC DEQ website is the most useful source of information regarding water resources in your jurisdiction.
1 Strongly disagree 2 Disagree 3 Undecided 4 Agree 5 Strongly Agree

About how often do you consult the NC DEQ regarding water supply management?

Weekly
Once a month
Every few months
About every 6 months
About once a year
Never

During the last year, which of the following organizations/institutions did you get information from regarding water supply decisions in your jurisdiction? Check all that apply.

North Carolina State University
East Carolina University
Elizabeth City State University
University of North Carolina at Wilmington
Other
I have not been in contact with any of them in the last year.

Please list the 3 PWSs, other than your own, that you had the most direct contact with (such as phone calls, email, face to face meetings) regarding water supply management decisions in the last year.

About how often do you have contact with someone from the PWSs on the list?

I have regular contact with more than 3 other PWSs regarding water supply issues.

Open Ended
How secure do you feel about your source of water? Why do you feel that way?
How does your town/county track the condition of your water supply (its quality and quantity)?

We thank you for taking the time to complete this survey. Your responses have been recorded.

Interested in the results of the study? Please send an email to the following address to receive a summary: bunnella98@students.ecu.edu

APPENDIX B: IRB DOCUMENTS

Wednesday, January 4, 2023 at 16:27:25 Eastern Standard Time

Subject: IRB: Continuing Review Approved
Date: Thursday, June 16, 2022 at 8:55:16 AM Eastern Daylight Time
From: umcirb@ecu.edu
To: Bunnell, Anne

EAST CAROLINA UNIVERSITY
University & Medical Center Institutional Review Board
4N-64 Brody Medical Sciences Building· Mail Stop 682
600 Moye Boulevard · Greenville, NC 27834
Office **252-744-2914** · Fax **252-744-2284** · rede.ecu.edu/umcirb/

Continuing Review Approved

ID:	CR00009736
Title:	2022 Review for UMCIRB 17-000993 Water Perceptions: Mapping Threats and Consensus in the CCPCUA
Description:	Your continuing review has been approved as of 6/16/2022. To navigate to the project workspace, click on the above ID.

IRB00000705 East Carolina U IRB #1 (Biomedical) IORG0000418
IRB00003781 East Carolina U IRB #2 (Behavioral/SS) IORG0000418

East Carolina University

Informed Consent to Participate in Research

Information to consider before taking part in research that has no more than minimal risk.

Title of Research Study: Water Perceptions: Identifying Threats and Mapping Consensus in the Central Coastal Capacity Use Area, Phase I

Principal Investigator: Anne E. Bunnell
Institute for Coastal Science & Policy, Coastal Resources Management Program
Mailing Address: Department of Biology, Howell Science Complex, Mail Stop 551
East Carolina University
Greenville, NC 27858
Telephone #: 252-328-9840
Email: bunnella98@students.ecu.edu

Researchers at East Carolina University (ECU) study issues related to society, health problems, environmental problems, behavior problems and the human condition. To do this, we need the help of volunteers who are willing to take part in research.

Why am I being invited to take part in this research?

The purpose of this research is to investigate how people who make decision about municipal water management perceive threats to water supply in eastern North Carolina. You are being invited to take part in this research because have decision making responsibilities in how water is managed by a public water provider in the Central Coastal Plain Capacity Use Area. The decision to take part in this research is yours to make. By doing this research, we hope to learn whether there is consensus about the critical threats to water supply and ways to address them, among water decision makers in the coastal plain of North Carolina.

If you volunteer to take part in this research, you will be one of about 20-30 people to do so.

Are there reasons I should not take part in this research?

If you are not a utility worker, a county/city planner or an elected official for one of the public water providers in the 15-county Central Capacity Use Area of North Carolina then you should not volunteer for this research. If the time required to participate in this research will negatively impact your employment, then you should not take part in this research.

What other choices do I have if I do not take part in this research?

You can choose not to participate. If you choose not to participate in a face to face interview, you may be asked in the future to participate in an anonymous written survey.

Where is the research going to take place and how long will it last?

The research will be conducted at a location of your choosing and at a time/date that is convenient to you The total amount of time you will be asked to volunteer for this study is 2 to 3 hours over the next 1 year

What will I be asked to do?

Water Perceptions: Identifying Threats and Mapping Consensus in the Central Coastal Capacity Use Area

You will be asked to do the following: Participate in a least one face to face interview with me. I will have a list of questions regarding water use, what threats to water supply you think exist, and how to manage those threats. I would also like to know about your educational background and experience working in water resources management. If I have follow up questions I may ask to interview you again either in person, over the phone or via an internet link. I plan to take written notes during the interviews. I may also ask if you would agree to have the interview audio recorded using a small electronic device, but this is optional and not a requirement.

What might I experience if I take part in the research?
I don't know of any risks (the chance of harm) associated with this research. Any risks that may occur with this research are no more than what you would experience in everyday life. I don't know if you will benefit from taking part in this study. There may not be any personal benefit to you but the information gained by doing this research may help others in the future.

Will I be paid for taking part in this research?
I will not be able to pay you for the time you volunteer while being in this study.

Will it cost me to take part in this research?
It will not cost you any money to be part of the research.

Who will know that I took part in this research and learn personal information about me?
ECU and the people and organizations listed below may know that you took part in this research and may see information about you that is normally kept private. With your permission, these people may use your private information to do this research:

- Any agency of the federal, state, or local government that regulates human research. This includes the Department of Health and Human Services (DHHS), the North Carolina Department of Health, and the Office for Human Research Protections.
- The University & Medical Center Institutional Review Board (UMCIRB) and its staff have responsibility for overseeing your welfare during this research and may need to see research records that identify you.

How will you keep the information you collect about me secure? How long will you keep it?
I will assign a code number to you that will be used during the research. All data collected from your interviews, including any written or typed notes or audio recordings, will be linked only to your coded identification. To reduce the likelihood that your identity will be revealed, the master list containing your name/identity will be kept in a separate file on a secure computer drive at East Carolina University. Only myself or my faculty advisers will have access to the files with your identification.
The data collected will be maintained indefinitely as this is part of my dissertation research which will take place over the next 2 years. The data may further be used in publications after the research has been completed.

What if I decide I don't want to continue in this research?
You can stop at any time after it has already started. There will be no consequences if you stop and you will not be criticized. You will not lose any benefits that you normally receive.

Who should I contact if I have questions?
The people conducting this study will be able to answer any questions concerning this research, now or in the future. You may contact the Principal Investigator at ***252-328-9840*** (days, on Monday, Wednesday, Friday between ***9 a.m and 5 p.m.***).

Water Perceptions: Identifying Threats and Mapping Consensus in the Central Coastal Capacity Use Area

If you have questions about your rights as someone taking part in research, you may call the Office of Research Integrity & Compliance (ORIC) at phone number 252-744-2914 (days, 8:00 am-5:00 pm). If you would like to report a complaint or concern about this research study, you may call the Director of the ORIC, at 252-744-1971

I have decided I want to take part in this research. What should I do now?
The person obtaining informed consent will ask you to read the following and if you agree, you should sign this form:

- I have read (or had read to me) all of the above information.
- I have had an opportunity to ask questions about things in this research I did not understand and have received satisfactory answers.
- I know that I can stop taking part in this study at any time.
- By signing this informed consent form, I am not giving up any of my rights.
- I have been given a copy of this consent document, and it is mine to keep.

_____

Participant's Name (PRINT) **Signature** **Date**

Person Obtaining Informed Consent: I have conducted the initial informed consent process. I have orally reviewed the contents of the consent document with the person who has signed above, and answered all of the person's questions about the research.

_____

Person Obtaining Consent (PRINT) **Signature** **Date**

APPENDIX C: ALL TABLES

Table 3: Relevant Characteristics of Water Decision Makers in Eastern North Carolina	**Sample**
Total number of respondents	88
Gender	
Male	75.0%
Female	25.0%
Educational Attainment	
Less than 4-year degree	34.8%
4-year degree	33.3%
Greater than 4-year degree	31.9%
Educational Discipline	
Public or Business Administration	41.2%
Other	27.5%
Planning	19.6%
STEM	11.8%
Water Certifications*	
Zero	63.5%
One	36.5%
Employer Type	
Municipality	65.2%
Water Utility	34.8%
Water Cooperative Member	
No	73.2%
Yes	26.8%
Jurisdiction has Seasonal Use	
No	64.3%
Yes	35.7%
	Mean (SD)
Age (in Years)	50.31 (11.99)
Years as a WDM	16.04 (10.68)

* Two respondents (2.3%) reported they were pursuing a certification at the time of the survey.

Table 4: Level of Environmental Concern and Perception of Water Availability in Water Decision Makers (N=75)	Mean (SD)
Support for the New Environmental Paradigm	
New Environmental Paradigm (full scale)	3.47 (.68)
Fragile Balance of Nature	3.53 (.82)
Ecological Crisis	3.31 (1.00)
Anti-Human Exceptionalism	3.96 (.63)
Limits to Growth	3.05 (.89)
Anti-Anthropocentrism	3.48 (.90)
Water Scarcity or Abundance	
Water cycle guarantees water security	3.21 (.81)
Lack of raw water is the greatest threat	2.92 (1.06)
Contamination leads to scarcity	3.92 (.93)
Saltwater intrusion causes water scarcity	3.59 (.77)
Lack of funding for maintenance & infrastructure causes water scarcity	3.97 (.79)
Demand Side v. Supply Side Management Strategies	
Resources are limited	3.39 (1.13)
Technology can help us extend resources	2.73 (1.17)
Human ingenuity will solve our environmental problems	3.14 (1.21)
Preference for hard or soft path	2.93 (1.17)
The hard path is better for North Carolina	3.56 (1.03)
Nanofiltration and reverse osmosis can provide water for 25 years	3.51 (.75)

Table 5: Water Decision Makers' perspectives on water management **(N=82)**	**Mean (SD)**
General Perspectives on Water Management	
Conservation as priority	3.50 (1.02)
Technology can manage contamination, reducing scarcity	3.99 (.71)
Competition increases vulnerability	3.52 (1.05)
Non-human species are important in decision making	3.93 (1.01)
Human economics pose a greater challenge than protecting non-human species	3.34 (1.04)
Water Management in Eastern North Carolina	
Eastern North Carolina is secure in its water supply for 25 years	3.84 (.87)
Water here is more secure than other places in the state	4.01 (1.11)
The economy takes precedence over the environment	2.37 (1.05)
Familiarity with local Water Shortage Response Plan	2.83 (1.44)
CCPCUA Familiarity	2.74 (1.38)
Rules Successful	3.56 (.83)
Rules Working Well	3.39 (.72)
Rules Fair and Equitable	3.01 (.87)
Rules should be expanded	3.32 (.85)
Rules should be revised	3.35 (.82)
Rules should be lifted	2.66 (1.08)
NCDEQ website most useful source of information	3.64 (.90)
Frequency of consultation	4.19 (1.56)
Water Management Perceived Threats and Challenges	
Current Threats (ranked on a scale from 0 to 3 with 3 being the greatest threat)	
Flood	1.44 (1.21)
SWI	1.25 (1.21)
Ground Depletion	1.21 (1.19)
Drought	1.00 (1.06)
Pharmaceutical Pollution	.44 (.83)
Algal Bloom	.40 (.77)
Future Challenges (ranked on a scale from 0 to 3 with 3 being the greatest threat)	
Ability of aging infrastructure to support new or increased use	1.79 (1.24)
Ability to obtain money/resources from funding agencies	1.56 (1.18)
Population growth	.90 (1.76)
Compliance with state regulations	.77 (1.07)
Ability to retain utility staff/employees	.73 (1.04)
Water conservation by consumers	.60 (1.12)

Table 6: Gender differences in Water Decision Maker views on Water Management **(N=68).**	**Female (N=17)**	**Male (N=51)**
	Mean (SD)	**Mean (SD)**
Support for the New Environmental Paradigm	3.63 (.77)	3.42 (.66)
Fragile Balance of Nature	3.61 (.82)	3.53 (.83)
Ecological Crisis	3.65 (1.16)*	3.21 (.95)*
Anti-Human Exceptionalism	4.10 (.59)	3.91 (.66)
Limits to Growth	3.12 (.99)	3.05 (.86)
Anti-Anthropocentrism	3.67 (1.03)	3.42 (.86)
Water Scarcity or Abundance		
Water cycle guarantees water security	3.29 (.77)	3.16 (.86)
Lack of raw water is the greatest threat	2.82 (.95)	2.98 (1.09)
Contamination leads to scarcity	3.65 (.79)*	4.02 (.96)*
Saltwater intrusion causes water scarcity	3.41 (.71)	3.65 (.80)
Lack of funding for maintenance and infrastructure causes water scarcity	4.19 (.66)	3.92 (.82)
Demand Side vs. Supply Side Management Strategies		
Resources are limited	3.29 (1.26)	3.45 (1.10)
Technology can help us extend resources	2.88 (1.22)	2.71 (1.18)
Human ingenuity will solve our environmental problems	3.29 (.99)	3.12 (1.29)
Preference for hard or soft path	3.00 (1.28)	2.80 (1.15)
The hard path is better for North Carolina.	3.76 (.97)	3.49 (1.08)
Nanofiltration and reverse osmosis can provide water for 25 years	3.56 (.81)	3.51 (.76)
General Perspectives on Water Management		
Conservation as priority	3.82 (.95)*	3.43 (.99)*
Technology can manage contamination, reducing scarcity	4.06 (.57)	3.94 (.76)
Competition increases vulnerability	3.41 (1.12)	3.57 (1.03)
Non-human species are important in decision making.	3.73 (1.03)	4.06 (.99)
Human economics pose a greater challenge than protecting non-human species.	3.24 (1.15)	3.30 (1.02)
Water Management in Eastern North Carolina		
Eastern North Carolina is secure in its water supply for 25 years	3.65 (.79)	3.90 (.88)
Water here is more secure than other places in the state.	4.24 (.83)	3.96 (1.20)
The economy takes precedence over the environment.	2.31 (1.14)	2.36 (1.05)
Familiarity with local Water Shortage Response Plan	2.53 (1.55)	2.86 (1.41)
CCPCUA Familiarity	2.18 (1.38)**	2.94 (1.33)**
Rules Successful	3.41 (.62)*	3.73 (.85)*
Rules Working Well	3.24 (.44)*	3.54 (.76)*
Rules Fair and Equitable	3.18 (.53)	3.02 (.96)
Rules should be expanded	3.18 (.39)*	3.50 (.86)*
Rules should be revised	3.47 (.80)	3.30 (.84)
Rules should be lifted	2.82 (.95)	2.50 (1.07)
NCDEQ website most use source of information	3.94 (.83)*	3.55 (.92)*

Frequency of consultation	4.13 (1.50)	4.20 (1.59)
Current Perceived Water Management Threats		
Flood	1.65 (1.37)	1.44 (1.18)
SWI	1.35 (1.22)	1.23 (1.21)
Ground Depletion	1.41 (1.33)	1.21 (1.17)
Drought	.38 (.62)**	1.15 (1.11)**
Pharmaceutical Pollution	.35 (.70)	.46 (.85)
Algal Bloom	.71 (.99)*	.33 (.72)*
Perceived Future Water Management Challenges		
Ability of aging infrastructure to support new or increased use	1.65 (1.32)	1.84 (1.51)
Ability to obtain money/resources from funding agencies	1.41 (1.12)	1.57 (1.21)
Population growth	1.29 (2.91)	.78 (1.23)
Compliance with state regulations	.65 (1.67)	.76 (1.03)
Ability to retain utility staff/employees	.71 (.99)	.70 (1.04)
Water conservation by consumers	.53 (.94)	.65 (1.22)

* Results denoted with one asterisk (*) are statistically significant $\leq$ .10 (one-tailed).

** Results denoted with two asterisks (**) are statistically significant $\leq$ .05 (one-tailed).

Table 7: Educational attainment and Water Decision Maker views on water management **(N=69).**	**< 4-year degree (N=24)**	**4-year degree (N=23)**	**> 4-year degree (N=22)**
	Mean (SD)	**Mean (SD)**	**Mean (SD)**
Support for the New Environmental Paradigm	3.41 (.59)	3.38 (.75)	3.63 (.72)
Fragile Balance of Nature	3.58 (.74)	3.35 (.91)	3.68 (.82)
Ecological Crisis	3.06 (.90)*	3.17 (1.04)*	3.73 (1.00)*
Anti- Human Exceptionalism	3.96 (.63)	3.87 (.59)	4.05 (.70)
Limits to Growth	3.00 (.85)	2.96 (.98)	3.24 (.82)
Anti-Anthropocentrism	3.49 (.88)	3.54 (.87)	3.45 (.97)
Water Scarcity or Abundance			
Water cycle guarantees water security	3.33 (.70)	3.22 (.85)	3.05 (.95)
Lack of raw water is the greatest threat	2.75 (1.07)	3.00 (.91)	3.05 (1.17)
Contamination leads to scarcity	3.61 (1.16)	4.00 (.85)	4.09 (.75)
Saltwater intrusion causes water scarcity	3.42 (.72)	3.65 (.83)	3.68 (.78)
Lack of funding for maintenance and infrastructure causes water scarcity	4.13 (.74)	3.91 (.75)	3.86 (.89)
Demand Side vs. Supply Side Management Strategies			
Resources are limited	3.33 (1.31)	3.22 (1.13)	3.68 (.89)
Technology can help us extend resources	2.75 (1.03)	2.61 (1.12)	2.86 (1.39)
Human ingenuity will solve our environmental problems	3.13 (1.26)	2.87 (1.14)	3.45 (1.22)
Preference for hard or soft path	2.92 (1.14)	3.00 (1.21)	2.77 (1.23)
The hard path is better for North Carolina.	3.46 (.98)	3.57 (.99)	3.68 (1.21)
Nanofiltration and reverse osmosis can provide water for 25 years	3.52 (.85)	3.39 (.78)	3.64 (.66)
General Perspectives on Water Management			
Conservation as priority	3.42 (.88)	3.70 (.97)	3.50 (1.14)
Technology can manage contamination, reducing scarcity	3.92 (.78)	3.86 (.78)	4.18 (.59)
Competition increases vulnerability	3.83 (1.05)	3.22 (1.04)	3.50 (1.06)
Non-human species are important in decision making.	3.88 (1.08)	4.18 (.91)	3.90 (.94)
Human economics pose a greater challenge than protecting non-human species.	3.30 (1.11)	3.43 (.84)	3.09 (1.15)
Water Management in Eastern North Carolina			
Eastern North Carolina is secure in its water supply for 25 years	4.00 (.78)	3.61 (.78)	3.91 (1.02)
Water here is more secure than other places in the state.	4.29 (.75)	3.83 (1.19)	3.95 (1.33)
The economy takes precedence over the environment.	2.61 (1.20)	2.23 (.87)	2.14 (.99)

Familiarity with local Water Shortage Response Plan	3.17 (1.27)	2.57 (1.59)	2.59 (1.47)
CCPCUA Familiarity	3.29 (1.16)**	2.30 (1.40)**	2.68 (1.43)**
Rules Successful	3.83 (.87)	3.48 (.67)	3.59 (.85)
Rules Working Well	3.50 (.72)	3.45 (.51)	3.41 (.85)
Rules Fair and Equitable	2.92 (1.02)	3.23 (.69)	3.00 (.82)
Rules should be expanded	3.71 (.75)**	3.09 (.97)**	3.27 (.63)**
Rules should be revised	3.46 (.72)	3.05 (.79)	3.50 (.91)
Rules should be lifted	2.17 (1.05)**	2.77 (.97)**	2.95 (1.09)**
NCDEQ website most use source of information	3.71 (1.00)	3.57 (.84)	3.59 (.85)
Frequency of consultation	3.83 (1.47)	4.55 (1.71)	4.29 (1.49)
Current Perceived Water Management Threats			
Flood	1.29 (1.27)	1.57 (1.38)	1.53 (1.02)
SWI	1.63 (1.28)	1.04 (1.15)	1.05 (1.08)
Ground Depletion	1.17 (1.17)	1.17 (1.15)	1.58 (1.26)
Drought	.88 (.99)	1.17 (1.07)	.94 (1.16)
Pharmaceutical Pollution	.58 (.93)	.26 (.54)	.47 (.91)
Algal Bloom	.46 (.72)	.43 (.79)	.42 (.96)
Perceived Future Water Management Challenges			
Ability of aging infrastructure to support new or increased use	1.83 (1.19)	1.74 (1.77)	1.76 (1.38)
Ability to obtain money/resources from funding agencies	1.91 (1.16)**	1.78 (1.20)**	.95 (1.02)**
Population growth	.74 (1.21)	1.26 (2.62)	.71 (1.10)
Compliance with state regulations	.96 (1.15)	.52 (.85)	.86 (1.20)
Ability to retain utility staff/employees	1.00 (1.24)	.57 (.84)	.55 (.91)
Water conservation by consumers	.70 (1.49)	.52 (.90)	.67 (.97)

* Results denoted with one asterisk (*) are statistically significant $\leq$ .10 (one-tailed).

** Results denoted with two asterisks (**) are statistically significant $\leq$ .05 (one-tailed).

Table 8: Employer Type and Water Decision Maker views on Water Management (N=69).	Municipality (N=45)	Water District (N=29)
	Mean (SD)	Mean (SD)
Support for the New Environmental Paradigm	3.53 (.67)	3.32 (.68)
Fragile Balance of Nature	3.64 (.81)*	3.31 (.83)*
Ecological Crisis	3.51 (.94)**	2.94 (.97)**
Anti-Human Exceptionalism	3.99 (.59)	3.90 (.73)
Limits to Growth	3.06 (.88)	2.96 (.85)
Anti-Anthropocentrism	3.45 (.87)	3.49 (.95)
Water Scarcity or Abundance		
Water cycle guarantees water security	3.16 (.85)	3.33 (.76)
Lack of raw water is the greatest threat	3.00 (1.02)	2.92 (1.10)
Contamination leads to scarcity	4.02 (.87)	3.74 (1.10)
Saltwater intrusion causes water scarcity	3.58 (.75)	3.63 (.77)
Lack of funding for maintenance and infrastructure causes water scarcity	3.84 (.81)**	4.25 (.74)**
Demand Side vs. Supply Side Management Strategies		
Resources are limited	3.52 (1.05)**	3.04 (1.23)**
Technology can help us extend resources	2.61 (1.17)	2.92 (1.06)
Human ingenuity will solve our environmental problems	3.20 (1.21)	3.13 (1.19)
Preference for hard or soft path	3.11 (1.15)**	2.63 (1.14)**
The hard path is better for North Carolina.	3.60 (1.07)	3.50 (1.02)
Nanofiltration and reverse osmosis can provide water for 25 years	3.55 (.66)	3.54 (.93)
General Perspectives on Water Management		
Conservation as priority	3.49 (1.01)	3.58 (.93)
Technology can manage contamination, reducing scarcity	4.11 (.66)*	3.83 (.82)*
Competition increases vulnerability	3.33 (1.07)**	3.88 (.99)**
Non-human species are important in decision making.	3.98 (.91)	3.88 (1.15)
Human economics pose a greater challenge than protecting non-human species.	3.20 (1.04)**	3.65 (.98)**
Water Management in Eastern North Carolina		
Eastern North Carolina is secure in its water supply for 25 years	3.76 (.86)	3.96 (.86)
Water here is more secure than other places in the state.	3.93 (1.16)	4.21 (1.02)
The economy takes precedence over the environment.	2.36 (1.06)	2.39 (1.03)
Familiarity with local Water Shortage Response Plan	2.49 (1.46)**	3.38 (1.25)**
CCPCUA Familiarity	2.40 (1.37)**	3.42 (1.18)**
Rules Successful	3.44 (.69)**	3.92 (.88)**
Rules Working Well	3.38 (.68)	3.57 (.73)
Rules Fair and Equitable	3.16 (.67)*	2.87 (1.14)*
Rules should be expanded	3.31 (.73)	3.48 (.99)
Rules should be revised	3.36 (.77)	3.35 (.89)
Rules should be lifted	2.87 (1.01)**	2.17 (1.07)**

NCDEQ website most use source of information	3.68 (.88)	3.63 (.97)
Frequency of consultation	4.57 (1.43)**	3.35 (1.47)**
Current Perceived Water Management Threats		
Flood	1.57 (1.17)	1.33 (1.31)
SWI	1.19 (1.15)	1.46 (1.32)
Ground Depletion	1.48 (1.22)*	1.04 (1.08)*
Drought	.93 (1.03)	1.17 (1.09)
Pharmaceutical Pollution	.29 (.64)	.50 (.83)
Algal Bloom	.48 (.89)	.25 (.53)
Perceived Future Water Management Challenges		
Ability of aging infrastructure to support new or increased use	1.88 (1.28)	1.83 (1.09)
Ability to obtain money/resources from funding agencies	1.40 (1.12)**	1.92 (1.28)**
Population growth	.58 (.98)*	1.00 (1.38)*
Compliance with state regulations	.84 (1.13)	.67 (.96)
Ability to retain utility staff/employees	.55 (.88)**	1.04 (1.20)**
Water conservation by consumers	.49 (.83)	.63 (1.41)

* Results denoted with one asterisk (*) are statistically significant $\leq .10$ (one-tailed).

** Results denoted with two asterisks (**) are statistically significant $\leq .05$ (one-tailed).

Table 9: Age and Water Decision Makers views on Water Management (N=67).	≤ Mean[$] (N=33)	> Mean[$] (N=34)
	Mean (SD)	Mean (SD)
Support for the New Environmental Paradigm	3.43 (.63)	3.48 (.75)
Fragile Balance of Nature	3.49 (.75)	3.55 (.90)
Ecological Crisis	3.35 (.87)	3.25 (1.12)
Anti-Human Exceptionalism	3.90 (.58)	4.00 (.70)
Limits to Growth	3.00 (.87)	3.08 (.91)
Anti-Anthropocentrism	3.41 (.90)	3.52 (.94)
Water Scarcity or Abundance		
Water cycle guarantees water security	3.21 (.74)	3.21 (.91)
Lack of raw water is the greatest threat	2.79 (.99)	3.12 (1.09)
Contamination leads to scarcity	3.84 (.92)	3.94 (1.01)
Saltwater intrusion causes water scarcity	3.67 (.69)	3.50 (.86)
Lack of funding for maintenance and infrastructure causes water scarcity	4.03 (.68)	3.94 (.90)
Demand Side vs. Supply Side Management Strategies		
Resources are limited	3.24 (1.09)	3.56 (1.19)
Technology can help us extend resources	2.73 (1.10)	2.65 (1.20)
Human ingenuity will solve our environmental problems	3.21 (1.08)	3.03 (1.34)
Preference for hard or soft path	3.03 (1.13)	2.71 (1.22)
The hard path is better for North Carolina.	3.82 (.88)**	3.29 (1.17)**
Nanofiltration and reverse osmosis can provide water for 25 years	3.45 (.71)	3.61 (.83)
General Perspectives on Water Management		
Conservation as priority	3.55 (.97)	3.53 (1.05)
Technology can manage contamination, reducing scarcity	4.09 (.68)	3.88 (.78)
Competition increases vulnerability	3.39 (.97)	3.65 (1.13)
Non-human species are important in decision making.	3.91 (.91)	4.03 (1.06)
Human economics pose a greater challenge than protecting non-human species.	3.44 (.95)	3.15 (1.11)
Water Management in Eastern North Carolina		
Eastern North Carolina is secure in its water supply for 25 years	3.79 (.89)	3.82 (.83)
Water here is more secure than other places in the state.	3.88 (1.19)	4.18 (1.06)
The economy takes precedence over the environment.	2.47 (1.02)	2.27 (1.13)
Familiarity with local Water Shortage Response Plan	2.45 (1.54)**	3.06 (1.35)**
CCPCUA Familiarity	2.39 (1.46)**	3.03 (1.29)**
Rules Successful	3.33 (.65)**	3.91 (.87)**
Rules Working Well	3.22 (.61)**	3.68 (.73)**
Rules Fair and Equitable	2.97 (.86)	3.12 (.88)
Rules should be expanded	3.38 (.66)	3.44 (.89)
Rules should be revised	3.22 (.75)	3.47 (.90)
Rules should be lifted	2.63 (.94)	2.56 (1.16)
NCDEQ website most use source of information	3.61 (.90)	3.68 (.95)

Frequency of consultation	4.15 (1.56)	4.28 (1.61)
Current Perceived Water Management Threats		
Flood	1.61 (1.17)	1.30 (1.29)
SWI	1.45 (1.23)	1.18 (1.21)
Ground Depletion	1.19 (1.11)	1.30 (1.26)
Drought	.93 (1.05)	1.00 (1.09)
Pharmaceutical Pollution	.16 (.37)**	.64 (.99)**
Algal Bloom	.42 (.89)	.45 (.75)
Perceived Future Water Management Challenges		
Ability of aging infrastructure to support new or increased use	1.69 (1.26)	1.79 (1.22)
Ability to obtain money/resources from funding agencies	1.53 (1.24)	1.64 (1.14)
Population growth	.78 (1.21)	1.03 (2.27)
Compliance with state regulations	.75 (1.02)	.73 (1.13)
Ability to retain utility staff/employees	.88 (1.22)*	.55 (.75)*
Water conservation by consumers	.69 (1.31)	.52 (.97)

[$] Mean = 50.31 years.

* Results denoted with one asterisk (*) are statistically significant $\leq$ .10 (one-tailed).

** Results denoted with two asterisks (**) are statistically significant $\leq$ .05 (one-tailed).

Table 10: Educational Discipline and Water Decision Maker views on Water Management (N=51).	STEM (N=6)	Planning (N=10)	Pub./Bus. Admin. (N=21)	Other (N=14)
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
Support for the New Environmental Paradigm	2.91 (.85)	3.50 (.76)	3.57 (.64)	3.57 (.70)
Fragile Balance of Nature	2.89 (1.07)	3.59 (.81)	3.68 (.85)	3.52 (.74)
Ecological Crisis	2.72 (1.34)	3.41 (1.06)	3.52 (.86)	3.48 (1.08)
Anti-Human Exceptionalism	3.72 (.65)	3.93 (.66)	3.98 (.69)	4.19 (.58)
Limits to Growth	2.33 (.84)	3.15 (.80)	3.22 (.87)	2.98 (1.07)
Anti-Anthropocentrism	2.89 (.78)	3.44 (.94)	3.43 (.81)	3.67 (.93)
Water Scarcity or Abundance				
Water cycle guarantees water security	3.83 (.98)	3.22 (.67)	3.05 (.87)	3.21 (.89)
Lack of raw water is the greatest threat	2.83 (.98)	3.00 (1.12)	3.33 (1.02)	2.64 (1.01)
Contamination leads to scarcity	4.00 (.89)	4.00 (1.12)	4.00 (.63)	4.21 (.89)
Saltwater intrusion causes water scarcity	3.83 (.75)	3.56 (.88)	3.33 (.58)	3.93 (.92)
Lack of funding for maintenance and infrastructure causes water scarcity	4.17 (.75)	3.67 (1.00)	3.90 (.72)	4.07 (.92)
Demand Side vs. Supply Side Management Strategies				
Resources are limited	2.33 (1.03)**	3.78 (.67)**	3.67 (1.16)**	3.29 (1.07)**
Technology can help us extend resources	2.33 (1.37)	2.78 (1.30)	2.90 (1.34)	2.36 (.93)
Human ingenuity will solve our environmental problems	2.33 (1.51)	3.11 (1.27)	3.52 (1.17)	3.29 (1.27)
Preference for hard or soft path	2.67 (1.03)	2.78 (1.39)	3.14 (1.15)	2.79 (1.12)
The hard path is better for North Carolina.	3.33 (1.03)	3.67 (.71)	3.29 (1.38)	3.93 (.83)
Nanofiltration and reverse osmosis can provide water for 25 years	3.83 (.75)	3.22 (.67)	3.52 (.68)	3.86 (.54)
General Perspectives on Water Management				
Conservation as priority	3.33 (.82)	3.67 (1.00)	3.33 (1.16)	3.79 (.80)
Technology can manage contamination, reducing scarcity	4.00 (.63)	3.89 (1.05)	4.05 (.39)	4.21 (.58)
Competition increases vulnerability	3.50 (1.38)	3.89 (.78)	3.24 (1.14)	3.21 (.89)
Non-human species are important in decision making.	4.50 (.55)	4.33 (.71)	3.84 (.96)	4.07 (.92)
Human economics pose a greater challenge than protecting non-human species.	3.00 (.89)	3.00 (1.00)	3.29 (1.06)	3.57 (1.16)

Water Management in Eastern North Carolina				
Eastern North Carolina is secure in its water supply for 25 years	4.50 (.55)	3.56 (1.01)	4.05 (.74)	3.71 (.91)
Water here is more secure than other places in the state.	3.83 (1.47)	3.67 (1.00)	4.05 (1.40)	4.29 (.91)
The economy takes precedence over the environment.	1.83 (.41)	2.56 (1.13)	2.25 (.97)	2.29 (.99)
Familiarity with local Water Shortage Response Plan	3.00 (1.79)	1.89 (1.36)	3.05 (1.36)	2.36 (1.39)
CCPCUA Familiarity	2.33 (1.03)**	1.89 (1.17)**	3.38 (1.24)**	2.07 (1.33)**
Rules Successful	3.67 (.82)	3.33 (.71)	3.67 (.80)	3.64 (.84)
Rules Working Well	3.50 (.55)	3.22 (.44)	3.57 (.87)	3.43 (.51)
Rules Fair and Equitable	3.33 (.52)	3.11 (.33)	3.10 (.89)	3.07 (.83)
Rules should be expanded	3.33 (.82)	3.00 (.50)	3.43 (.93)	3.43 (.65)
Rules should be revised	3.00 (.63)	3.22 (.67)	3.52 (.87)	3.07 (.92)
Rules should be lifted	2.50 (.55)	3.11 (.78)	2.76 (1.18)	2.71 (1.07)
NCDEQ website most use source of information	3.50 (.55)*	3.11 (.93)*	3.95 (.87)*	3.71 (.73)*
Frequency of consultation	4.00 (1.67)**	5.67 (.50)**	4.11 (1.29)**	4.29 (1.68)**
Current Perceived Water Management Threats				
Flood	1.83 (1.47)	1.63 (1.41)	1.30 (1.13)	1.92 (1.04)
SWI	1.00 (1.10)	1.25 (1.49)	1.25 (1.16)	1.08 (1.19)
Ground Depletion	.17 (.41)*	1.00 (1.07)*	1.65 (1.23)*	1.23 (1.30)*
Drought	.83 (.98)**	1.00 (1.20)**	1.35 (1.04)**	.17 (.58)**
Pharmaceutical Pollution l	1.00 (1.27)	.38 (.74)	.25 (.72)	.46 (.66)
Algal Bloom	.67 (1.03)	.63 (.92)	.15 (.37)	.69 (1.18)
Perceived Future Water Management Challenges				
Ability of aging infrastructure to support new or increased use	1.67 (1.51)	1.78 (1.30)	1.90 (1.25)	1.93 (1.21)
Ability to obtain money/resources from funding agencies	1.67 (.82)	1.33 (1.00)	1.65 (1.23)	1.29 (1.27)
Population growth	1.17 (1.33)	1.78 (3.96)	.55 (.83)	.71 (1.27)
Compliance with state regulations	.33 (.82)	.44 (.88)	1.00 (1.12)	.43 (.85)
Ability to retain utility staff/employees	.33 (.52)	.44 (1.01)	.57 (.93)	.57 (.76)
Water conservation by consumers	.83 (1.33)	.67 (1.12)	.35 (.81)	.64 (.84)

* Results denoted with one asterisk (*) are statistically significant $\leq$ .10 (one-tailed).

** Results denoted with two asterisks (**) are statistically significant $\leq$ .05 (one-tailed).

Table 11: Water Operator Certifications and Water Decision Maker views on Water Management (N=74).	Zero (N=47)	One (N=27)
	Mean (SD)	Mean (SD)
Support for the New Environmental Paradigm	3.55 (.70)*	3.33 (.64)*
Fragile Balance of Nature	3.64 (.83)*	3.36 (.78)*
Ecological Crisis	3.51 (1.03)**	3.00 (.88)**
Anti-Human Exceptionalism	3.98 (.57)	3.94 (.74)
Limits to Growth	3.10 (.87)	2.96 (.92)
Anti-Anthropocentrism	3.53 (.88)	3.40 (.93)
Water Scarcity or Abundance		
Water cycle guarantees water security	3.17 (.79)	3.30 (.87)
Lack of raw water is the greatest threat	2.89 (1.03)	2.96 (1.13)
Contamination leads to scarcity	3.98 (.79)	3.81 (1.17)
Saltwater intrusion causes water scarcity	3.60 (.80)	3.59 (.75)
Lack of funding for maintenance and infrastructure causes water scarcity	3.93 (.79)	4.04 (.81)
Demand Side vs. Supply Side Management Strategies		
Resources are limited	3.56 (1.03)*	3.11 (1.25)*
Technology can help us extend resources	2.67 (1.23)	2.81 (1.08)
Human ingenuity will solve our environmental problems	3.12 (1.26)	3.19 (1.15)
Preference for hard or soft path	3.09 (1.16)*	2.63 (1.15)*
The hard path is better for North Carolina.	3.66 (1.01)	3.37 (1.08)
Nanofiltration and reverse osmosis can provide water for 25 years	3.52 (.69)	3.52 (.85)
General Perspectives on Water Management		
Conservation as priority	3.53 (1.06)	3.44 (.97)
Technology can manage contamination, reducing scarcity	4.04 (.63)	3.89 (.85)
Competition increases vulnerability	3.40 (1.12)	3.70 (.95)
Non-human species are important in decision making.	4.02 (.91)	3.78 (1.16)
Human economics pose a greater challenge than protecting non-human species.	3.28 (1.02)	3.38 (1.06)
Water Management in Eastern North Carolina		
Eastern North Carolina is secure in its water supply for 25 years	3.72 (.88)*	4.00 (.83)*
Water here is more secure than other places in the state.	3.94 (1.05)	4.19 (1.18)
The economy takes precedence over the environment.	2.43 (1.11)	2.27 (.96)
Familiarity with local Water Shortage Response Plan	2.45 (1.46)**	3.33 (1.21)**
CCPCUA Familiarity	2.47 (1.38)**	3.26 (1.29)**
Rules Successful	3.38 (.74)**	3.89 (.89)**
Rules Working Well	3.26 (.68)**	3.65 (.75)**
Rules Fair and Equitable	3.04 (.72)	2.96 (1.11)
Rules should be expanded	3.26 (.79)	3.46 (.95)
Rules should be revised	3.43 (.83)	3.23 (.82)
Rules should be lifted	2.87 (1.08)**	2.27 (1.00)**
NCDEQ website most use source of information	3.58 (.85)	3.74 (.98)

Frequency of consultation	4.73 (1.34)**	3.35 (1.52)**
Current Perceived Water Management Threats		
Flood	1.51 (1.20)	1.39 (1.27)
SWI	1.24 (1.17)	1.31 (1.29)
Ground Depletion	1.40 (1.21)	1.08 (1.13)
Drought	.91 (1.05)	1.15 (1.05)
Pharmaceutical Pollution	.44 (.81)	.50 (.91)
Algal Bloom	.44 (.81)	.38 (.75)
Perceived Future Water Management Challenges		
Ability of aging infrastructure to support new or increased use	1.81 (1.30)	1.74 (1.16)
Ability to obtain money/resources from funding agencies	1.49 (1.10)	1.67 (1.30)
Population growth	.91 (2.00)	.89 (1.34)
Compliance with state regulations	.67 (1.02)	.93 (1.14)
Ability to retain utility staff/employees	.55 (.93)**	1.04 (1.16)**
Water conservation by consumers	.67 (.99)	.48 (1.31)

* Results denoted with one asterisk (*) are statistically significant $\leq$ .10 (one-tailed).

** Results denoted with two asterisks (**) are statistically significant $\leq$ .05 (one-tailed).

Table 12: Length of time in water management and Water Decision Maker views on water management (WDM; N=67).	≤ Mean[$] (N=37)	> Mean[$] (N=30)
	Mean (SD)	**Mean (SD)**
Support for the New Environmental Paradigm	3.53 (.63)	3.33 (.72)
Fragile Balance of Nature	3.53 (.74)	3.47 (.87)
Ecological Crisis	3.48 (.88)**	3.01 (1.10)**
Anti-Human Exceptionalism	4.05 (.58)	3.88 (.70)
Limits to Growth	3.02 (.82)	2.98 (.93)
Anti-Anthropocentrism	3.56 (.86)	3.33 (.91)
Water Scarcity or Abundance		
Water cycle guarantees water security	3.19 (.74)	3.27 (.91)
Lack of raw water is the greatest threat	2.86 (1.00)	3.00 (1.11)
Contamination leads to scarcity	3.97 (.85)	3.83 (1.05)
Saltwater intrusion causes water scarcity	3.57 (.77)	3.63 (.72)
Lack of funding for maintenance and infrastructure causes water scarcity	4.06 (.67)	4.00 (.87)
Demand Side vs. Supply Side Management Strategies		
Resources are limited	3.31 (1.06)	3.40 (1.19)
Technology can help us extend resources	2.58 (.97)	2.83 (1.34)
Human ingenuity will solve our environmental problems	3.19 (1.09)	3.20 (1.35)
Preference for hard or soft path	3.11 (1.17)	2.77 (1.10)
The hard path is better for North Carolina.	3.78 (.89)*	3.43 (1.17)*
Nanofiltration and reverse osmosis can provide water for 25 years	3.47 (.74)	3.60 (.81)
General Perspectives on Water Management		
Conservation as priority	3.54 (.99)	3.47 (1.01)
Technology can manage contamination, reducing scarcity	4.17 (.66)*	3.90 (.76)*
Competition increases vulnerability	3.35 (.98)*	3.73 (1.17)*
Non-human species are important in decision making.	4.00 (.93)	3.79 (1.08)
Human economics pose a greater challenge than protecting non-human species.	3.58 (.84)**	3.17 (1.18)**
Water Management in Eastern North Carolina		
Eastern North Carolina is secure in its water supply for 25 years	3.73 (.84)*	4.03 (.89)*
Water here is more secure than other places in the state.	3.97 (1.01)	4.23 (1.19)
The economy takes precedence over the environment.	2.46 (1.01)	2.27 (.94)
Familiarity with local Water Shortage Response Plan	2.46 (1.50)**	3.33 (1.18)**
CCPCUA Familiarity	2.41 (1.46)**	3.30 (1.09)**
Rules Successful	3.38 (.68)**	4.00 (.83)**
Rules Working Well	3.31 (.62)**	3.67 (.76)**
Rules Fair and Equitable	3.06 (.83)	3.07 (.94)
Rules should be expanded	3.36 (.80)	3.43 (.90)
Rules should be revised	3.28 (.78)	3.43 (.90)
Rules should be lifted	2.75 (1.23)	2.43 (.90)

NCDEQ website most use source of information	3.75 (.84)	3.63 (.96)
Frequency of consultation	4.21 (1.61)	3.93 (1.46)
Current Perceived Water Management Threats		
Flood	1.60 (1.24)	1.28 (1.25)
SWI	1.34 (1.21)	1.28 (1.25)
Ground Depletion	1.29 (1.15)	1.28 (1.25)
Drought	.91 (1.00)	1.07 (1.10)
Pharmaceutical Pollution	.29 (.52)*	.55 (1.02)*
Algal Bloom	.40 (.78)	.41 (.83)
Perceived Future Water Management Challenges		
Ability of aging infrastructure to support new or increased use	1.76 (1.21)	1.93 (1.26)
Ability to obtain money/resources from funding agencies	1.73 (1.22)	1.43 (1.14)
Population growth	.73 (1.15)	.70 (1.12)
Compliance with state regulations	.68 (1.00)	.90 (1.16)
Ability to retain utility staff/employees	.78 (1.11)	.57 (.82)
Water conservation by consumers	.57 (1.19)	.57 (1.01)

[$] Mean = 16.04 years.

* Results denoted with one asterisk (*) are statistically significant $\leq$ .10 (one-tailed).

** Results denoted with two asterisks (**) are statistically significant $\leq$ .05 (one-tailed).

Table 13: Water cooperative membership status and Water Decision Maker views on water management (N=71).	Member (N=19)	Non-member (N=52)
	Mean (SD)	Mean (SD)
Support for the New Environmental Paradigm	3.72 (.70)**	3.36 (.66)**
Fragile Balance of Nature	3.93 (.74)**	3.38 (.81)**
Ecological Crisis	3.61 (.86)**	3.17 (1.01)**
Anti-Human Exceptionalism	4.04 (.69)	3.93 (.62)
Limits to Growth	3.23 (.96)	2.96 (.85)
Anti-Anthropocentrism	3.77 (.97)**	3.35 (.85)**
Water Scarcity or Abundance		
Water cycle guarantees water security	3.26 (.87)	3.19 (.79)
Lack of raw water is the greatest threat	3.00 (1.20)	2.90 (1.02)
Contamination leads to scarcity	4.05 (1.13)	3.90 (.83)
Saltwater intrusion causes water scarcity	3.79 (.86)	3.54 (.70)
Lack of funding for maintenance and infrastructure causes water scarcity	3.95 (.91)	4.00 (.75)
Demand Side vs. Supply Side Management Strategies		
Resources are limited	3.84 (1.07)**	3.18 (1.10)**
Technology can help us extend resources	2.84 (1.21)	2.68 (1.17)
Human ingenuity will solve our environmental problems	3.37 (1.30)	3.06 (1.19)
Preference for hard or soft path	2.95 (1.35)	2.92 (1.12)
The hard path is better for North Carolina.	3.74 (1.24)	3.50 (.96)
Nanofiltration and reverse osmosis can provide water for 25 years	3.74 (.87)*	3.47 (.70)*
General Perspectives on Water Management		
Conservation as priority	3.68 (1.00)	3.40 (1.02)
Technology can manage contamination, reducing scarcity	4.21 (.79)*	3.92 (.69)*
Competition increases vulnerability	3.42 (1.22)	3.54 (1.02)
Non-human species are important in decision making.	4.32 (.67)**	3.76 (1.08)**
Human economics pose a greater challenge than protecting non-human species.	3.47 (1.02)	3.25 (1.06)
Water Management in Eastern North Carolina		
Eastern North Carolina is secure in its water supply for 25 years	3.74 (.99)	3.90 (.82)
Water here is more secure than other places in the state.	3.95 (1.18)	4.10 (1.09)
The economy takes precedence over the environment.	2.00 (.88)**	2.52 (1.09)**
Familiarity with local Water Shortage Response Plan	2.42 (1.07)*	2.92 (1.55)*
CCPCUA Familiarity	2.84 (1.39)	2.75 (1.41)
Rules Successful	3.84 (.90)*	3.52 (.78)*
Rules Working Well	3.68 (.89)**	3.33 (.62)**
Rules Fair and Equitable	2.89 (.99)	3.10 (.81)
Rules should be expanded	3.63 (.76)**	3.24 (.89)**
Rules should be revised	3.11 (.88)*	3.45 (.81)*
Rules should be lifted	2.16 (1.12)**	2.84 (1.05)**

NCDEQ website most use source of information	4.05 (.71)**	3.50 (.93)**
Frequency of consultation	4.22 (1.83)	4.15 (1.46)
Current Perceived Water Management Threats		
Flood	1.67 (1.24)	1.41 (1.22)
SWI	1.17 (1.25)	1.33 (1.21)
Ground Depletion	1.33 (1.24)	1.24 (1.18)
Drought	1.06 (1.11)	.98 (1.04)
Pharmaceutical Pollution	.61 (1.04)	.35 (.69)
Algal Bloom	.28 (.58)	.47 (.86)
Perceived Future Water Management Challenges		
Ability of aging infrastructure to support new or increased use	2.05 (1.22)	1.72 (1.23)
Ability to obtain money/resources from funding agencies	1.53 (1.12)	1.60 (1.20)
Population growth	.79 (1.23)	.96 (1.95)
Compliance with state regulations	1.11 (1.20)*	.66 (1.00)*
Ability to retain utility staff/employees	.37 (.68)**	.88 (1.13)**
Water conservation by consumers	.74 (.99)	.56 (1.18)

* Results denoted with one asterisk (*) are statistically significant $\leq .10$ (one-tailed).

** Results denoted with two asterisks (**) are statistically significant $\leq .05$ (one-tailed).

Table 14: Seasonal population in jurisdiction and Water Decision Maker views on Water Management (N=70).	Seasonal Difference (N=25)	No Difference (N=45)
	Mean (SD)	Mean (SD)
Support for the New Environmental Paradigm	3.31 (.71)	3.53 (.66)
Fragile Balance of Nature	3.37 (.88)	3.60 (.78)
Ecological Crisis	3.12 (1.06)	3.38 (.96)
Anti-Human Exceptionalism	3.99 (.49)	3.97 (.71)
Limits to Growth	2.77 (1.02)**	3.15 (.75)**
Anti-Anthropocentrism	3.31 (.87)	3.53 (.89)
Water Scarcity or Abundance		
Water cycle guarantees water security	3.24 (.78)	3.20 (.84)
Lack of raw water is the greatest threat	2.92 (1.08)	2.91 (1.06)
Contamination leads to scarcity	3.79 (.78)	4.00 (.98)
Saltwater intrusion causes water scarcity	3.76 (.60)*	3.49 (.79)*
Lack of funding for maintenance and infrastructure causes water scarcity	3.96 (.84)	3.98 (.76)
Demand Side vs. Supply Side Management Strategies		
Resources are limited	2.96 (1.14)**	3.56 (1.05)**
Technology can help us extend resources	2.72 (1.24)	2.70 (1.15)
Human ingenuity will solve our environmental problems	3.16 (1.14)	3.16 (1.27)
Preference for hard or soft path	2.92 (1.19)	2.93 (1.20)
The hard path is better for North Carolina.	3.64 (.91)	3.51 (1.12)
Nanofiltration and reverse osmosis can provide water for 25 years	3.52 (.77)	3.52 (.73)
General Perspectives on Water Management		
Conservation as priority	3.52 (.82)	3.42 (1.10)
Technology can manage contamination, reducing scarcity	4.04 (.61)	3.95 (.78)
Competition increases vulnerability	3.60 (.87)	3.42 (1.16)
Non-human species are important in decision making.	3.92 (.95)	3.91 (1.07)
Human economics pose a greater challenge than protecting non-human species.	3.17 (1.01)	3.38 (1.07)
Water Management in Eastern North Carolina		
Eastern North Carolina is secure in its water supply for 25 years	3.88 (.97)	3.87 (.82)
Water here is more secure than other places in the state.	3.76 (1.30)**	4.22 (.97)**
The economy takes precedence over the environment.	2.21 (.83)	2.43 (1.15)
Familiarity with local Water Shortage Response Plan	2.44 (1.50)*	2.98 (1.41)*
CCPCUA Familiarity	2.24 (1.17)**	3.02 (1.42)**
Rules Successful	3.40 (.58)*	3.69 (.90)*
Rules Working Well	3.33 (.48)	3.47 (.82)
Rules Fair and Equitable	3.29 (.55)*	2.96 (.93)*
Rules should be expanded	3.33 (.64)	3.31 (.95)
Rules should be revised	3.17 (.57)*	3.47 (.94)*
Rules should be lifted	2.63 (.88)	2.71 (1.20)

NCDEQ website most use source of information	3.68 (.95)	3.60 (.88)
Frequency of consultation	3.88 (1.48)*	4.41 (1.52)*
Current Perceived Water Management Threats		
Flood	1.68 (1.14)	1.37 (1.27)
SWI	1.64 (1.22)**	1.05 (1.15)**
Ground Depletion	.76 (1.05)**	1.51 (1.16)**
Drought	.60 (.91)**	1.21 (1.07)**
Pharmaceutical Pollution	.28 (.74)	.49 (.83)
Algal Bloom	.56 (1.00)	.33 (.64)
Perceived Future Water Management Challenges		
Ability of aging infrastructure to support new or increased use	1.60 (1.29)	1.91 (1.19)
Ability to obtain money/resources from funding agencies	1.48 (1.19)	1.60 (1.16)
Population growth	1.08 (1.38)	.77 (1.96)
Compliance with state regulations	.64 (1.00)	.81 (1.08)
Ability to retain utility staff/employees	.80 (1.16)	.68 (.98)
Water conservation by consumers	.96 (1.49)**	.35 (.72)**

* Results denoted with one asterisk (*) are statistically significant $\leq$ .10 (one-tailed).

** Results denoted with two asterisks (**) are statistically significant $\leq$ .05 (one-tailed).

APPENDIX D: FREQUENCIES FOR DEPENDENT SURVEY VARIABLES

These results appear in the same order as the survey questions. Abbreviated variable names from the statistical tables are provided in addition to the original question text.

Water Resources in North Carolina in the Coastal Plain

There is enough water in the region of eastern North Carolina to meet the needs of all the people and businesses for the next 25 years (until 2045).

Eastern North Carolina is secure in its water supply for 25 years.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Mildly disagree	4	4.3	4.9	4.9
	Unsure	26	28.3	31.7	36.6
	Mildly agree	31	33.7	37.8	74.4
	Strongly agree	21	22.8	25.6	100.0
	Total	82	89.1	100.0	
Missing	System	10	10.9		
Total		92	100.0		

At the present time, my community/jurisdiction is less vulnerable to water shortages than other places in North Carolina.

Water here is more secure than other places in the state.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	3	3.3	3.7	3.7
	Mildly disagree	6	6.5	7.3	11.0
	Unsure	13	14.1	15.9	26.8
	Mildly agree	25	27.2	30.5	57.3
	Strongly agree	35	38.0	42.7	100.0
	Total	82	89.1	100.0	
Missing	System	10	10.9		
Total		92	100.0		

PSWs face many management challenges. I am interested in your opinion on these issues. Of the following, please rank the TOP 3 that you think pose the greatest threat to the water supply in your jurisdiction. (Please use "1," "2," and "3," with "1" as the GREATEST threat).

Threat of saltwater intrusion

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Most important	21	22.8	39.6	39.6
	2nd choice	13	14.1	24.5	64.2
	3rd choice	18	19.6	34.0	98.1
	4th choice	1	1.1	1.9	100.0
	Total	53	57.6	100.0	
Missing	System	39	42.4		
Total		92	100.0		

Threat of pharmaceutical pollution

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Most important	5	5.4	20.8	20.8
	2nd choice	5	5.4	20.8	41.7
	3rd choice	10	10.9	41.7	83.3
	4th choice	1	1.1	4.2	87.5
	5th choice	1	1.1	4.2	91.7
	Least important	2	2.2	8.3	100.0
	Total	24	26.1	100.0	
Missing	System	68	73.9		
Total		92	100.0		

Threat of algal blooms

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Most important	2	2.2	9.5	9.5
	2nd choice	7	7.6	33.3	42.9
	3rd choice	9	9.8	42.9	85.7
	5th choice	3	3.3	14.3	100.0
	Total	21	22.8	100.0	
Missing	System	71	77.2		
Total		92	100.0		

Threat of drought

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Most important	8	8.7	17.0	17.0
	2nd choice	18	19.6	38.3	55.3
	3rd choice	20	21.7	42.6	97.9
	4th choice	1	1.1	2.1	100.0
	Total	47	51.1	100.0	

Missing	System	45	48.9		
Total		92	100.0		

Threat of severe flooding

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Most important	25	27.2	43.1	43.1
	2nd choice	21	22.8	36.2	79.3
	3rd choice	12	13.0	20.7	100.0
	Total	58	63.0	100.0	
Missing	System	34	37.0		
Total		92	100.0		

Threat of groundwater depletion

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Most important	17	18.5	34.7	34.7
	2nd choice	18	19.6	36.7	71.4
	3rd choice	14	15.2	28.6	100.0
	Total	49	53.3	100.0	
Missing	System	43	46.7		
Total		92	100.0		

Every PWS in the state of North Carolina is required to file a Water Shortage Response Plan (WSRP), also known as a Drought Contingency Plan (DCP). How familiar are you with the details of your community's WSRP?

Water Shortage Plan Familiarity

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not familiar at all	23	25.0	29.9	29.9
	Slightly familiar	7	7.6	9.1	39.0
	Moderately familiar	17	18.5	22.1	61.0
	Very familiar	20	21.7	26.0	87.0
	Extremely familiar	10	10.9	13.0	100.0
	Total	77	83.7	100.0	
Missing	System	15	16.3		
Total		92	100.0		

Water withdrawals by other users nearby increase the risk of my community not having enough water.

Competition increases vulnerability.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	2	2.2	2.6	2.6
	Mildly disagree	14	15.2	18.2	20.8
	Unsure	15	16.3	19.5	40.3
	Mildly agree	34	37.0	44.2	84.4
	Strongly agree	12	13.0	15.6	100.0
	Total	77	83.7	100.0	
Missing	System	15	16.3		
Total		92	100.0		

The Central Coastal Plain Capacity Use Area Rules

How familiar are you with the CCPCUA rules?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not familiar at all	20	21.7	26.3	26.3
	Slightly familiar	16	17.4	21.1	47.4
	Moderately familiar	12	13.0	15.8	63.2
	Very familiar	20	21.7	26.3	89.5
	Extremely familiar	8	8.7	10.5	100.0
	Total	76	82.6	100.0	
Missing	System	16	17.4		
Total		92	100.0		

The rules that regulate groundwater withdrawals from the Central Coastal Plain Capacity Use Area (CCPCUA) have been successful in protecting the aquifers in eastern North Carolina.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Mildly Disagree	4	4.3	5.3	5.3
	Unsure	37	40.2	49.3	54.7
	Mildly Agree	22	23.9	29.3	84.0
	Strongly Agree	12	13.0	16.0	100.0
	Total	75	81.5	100.0	
Missing	System	17	18.5		
Total		92	100.0		

The rules are working well.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	1	1.1	1.4	1.4
	Mildly Disagree	4	4.3	5.4	6.8
	Unsure	37	40.2	50.0	56.8
	Mildly Agree	29	31.5	39.2	95.9
	Strongly Agree	3	3.3	4.1	100.0
	Total	74	80.4	100.0	
Missing	System	18	19.6		
Total		92	100.0		

The rules are enforced fairly and equitably.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	7	7.6	9.5	9.5
	Mildly Disagree	5	5.4	6.8	16.2
	Unsure	43	46.7	58.1	74.3
	Mildly Agree	18	19.6	24.3	98.6
	Strongly Agree	1	1.1	1.4	100.0
	Total	74	80.4	100.0	
Missing	System	18	19.6		
Total		92	100.0		

The rules should be expanded to include adjacent counties.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	3	3.3	4.1	4.1
	Mildly Disagree	2	2.2	2.7	6.8
	Unsure	44	47.8	59.5	66.2
	Mildly Agree	18	19.6	24.3	90.5
	Strongly Agree	7	7.6	9.5	100.0
	Total	74	80.4	100.0	
Missing	System	18	19.6		
Total		92	100.0		

The rules should be revised.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	1	1.1	1.4	1.4

	Mildly Disagree	4	4.3	5.4	6.8
	Unsure	46	50.0	62.2	68.9
	Mildly Agree	14	15.2	18.9	87.8
	Strongly Agree	9	9.8	12.2	100.0
	Total	74	80.4	100.0	
Missing	System	18	19.6		
Total		92	100.0		

The rules should be lifted.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	13	14.1	17.6	17.6
	Mildly Disagree	14	15.2	18.9	36.5
	Unsure	38	41.3	51.4	87.8
	Mildly Agree	3	3.3	4.1	91.9
	Strongly Agree	6	6.5	8.1	100.0
	Total	74	80.4	100.0	
Missing	System	18	19.6		
Total		92	100.0		

Providing Water

Technological advancements will enable us to always provide the needed supply of water in eastern North Carolina.

The hard path is better for North Carolina.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	4	4.3	5.3	5.3
	Mildly disagree	8	8.7	10.7	16.0
	Unsure	15	16.3	20.0	36.0
	Mildly agree	38	41.3	50.7	86.7
	Strongly agree	10	10.9	13.3	100.0
	Total	75	81.5	100.0	
Missing	System	17	18.5		
Total		92	100.0		

Providing a greater supply of water is a better way to meet future demand rather than encouraging water conservation in my system.

Preference for hard or soft path

Water supply over conservation

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	10	10.9	13.3	13.3
	Mildly disagree	21	22.8	28.0	41.3
	Unsure	10	10.9	13.3	54.7
	Mildly agree	32	34.8	42.7	97.3
	Strongly agree	2	2.2	2.7	100.0
	Total	75	81.5	100.0	
Missing	System	17	18.5		
Total		92	100.0		

Water pricing is a greater challenge in water management than providing enough water for non-human species.

Human economics pose a greater challenge than protecting non-human species

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	14	15.2	20.0	20.0
	Mildly Disagree	31	33.7	44.3	64.3
	Unsure	11	12.0	15.7	80.0
	Mildly Agree	13	14.1	18.6	98.6
	Strongly Agree	1	1.1	1.4	100.0
	Total	70	76.1	100.0	
Missing	System	22	23.9		
Total		92	100.0		

Your opinion about water scarcity

Water scarcity exists in situations where saltwater intrusion requires desalination to provide fresh water.

Saltwater intrusion causes water scarcity

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Somewhat disagree	3	3.3	4.0	4.0
	Neither agree nor disagree	35	38.0	46.7	50.7
	Somewhat agree	27	29.3	36.0	86.7
	Strongly agree	10	10.9	13.3	100.0
	Total	75	81.5	100.0	
Missing	System	17	18.5		
Total		92	100.0		

The water cycle guarantees that we will have a secure supply of raw water for the next 25 years (2045).

Water cycle guarantees water security.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	1	1.1	1.3	1.3
	Somewhat disagree	12	13.0	16.0	17.3
	Neither agree nor disagree	35	38.0	46.7	64.0
	Somewhat agree	24	26.1	32.0	96.0
	Strongly agree	3	3.3	4.0	100.0
	Total	75	81.5	100.0	
Missing	System	17	18.5		
Total		92	100.0		

Technologies such as nanofiltration and reverse osmosis will be able to provide an adequate supply of raw water for the next 25 years (2045).

Nanofiltration and reverse osmosis can provide water for 25 years

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Somewhat disagree	6	6.5	8.1	8.1
	Neither agree nor disagree	29	31.5	39.2	47.3
	Somewhat agree	34	37.0	45.9	93.2
	Strongly agree	5	5.4	6.8	100.0
	Total	74	80.4	100.0	
Missing	System	18	19.6		
Total		92	100.0		

Water scarcity exists when raw water is contaminated and is unsafe for human consumption.

Contamination leads to scarcity.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	1	1.1	1.4	1.4
	Somewhat disagree	5	5.4	6.8	8.1
	Neither agree nor disagree	14	15.2	18.9	27.0
	Somewhat agree	33	35.9	44.6	71.6
	Strongly agree	21	22.8	28.4	100.0
	Total	74	80.4	100.0	
Missing	System	18	19.6		
Total		92	100.0		

Water scarcity can be managed by the use of technology to remove contaminants, such as salt or

other pollutants, from the raw water source.
Technology can manage contamination, reducing scarcity.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Somewhat disagree	3	3.3	4.1	4.1
	Neither agree nor disagree	10	10.9	13.5	17.6
	Somewhat agree	46	50.0	62.2	79.7
	Strongly agree	15	16.3	20.3	100.0
	Total	74	80.4	100.0	
Missing	System	18	19.6		
Total		92	100.0		

Water scarcity exists because not enough money is available to build and maintain the infrastructure needed to supply adequate amounts of potable water.
Lack of funding for maintenance & infrastructure causes water scarcity
Scarcity definition: not enough money for infrastructure

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Somewhat disagree	3	3.3	4.2	4.2
	Neither agree nor disagree	14	15.2	19.4	23.6
	Somewhat agree	37	40.2	51.4	75.0
	Strongly agree	18	19.6	25.0	100.0
	Total	72	78.3	100.0	
Missing	System	20	21.7		
Total		92	100.0		

Please rank the top 3 that you think are most important to your jurisdiction's ability to plan for future water supply requirements. (Please use "1," "2," and "3," with "1" as the MOST important issue.)

Future Challenge - Aging infrastructure

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Most important	31	33.7	56.4	56.4
	2nd choice	15	16.3	27.3	83.6
	3rd choice	9	9.8	16.4	100.0
	Total	55	59.8	100.0	
Missing	System	37	40.2		
Total		92	100.0		

Future Challenge- Compliance with state regulations

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Most important	7	7.6	23.3	23.3
	2nd choice	12	13.0	40.0	63.3
	3rd choice	11	12.0	36.7	100.0
	Total	30	32.6	100.0	
Missing	System	62	67.4		
Total		92	100.0		

Future Challenge - water conservation

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Most important	4	4.3	19.0	19.0
	2nd choice	8	8.7	38.1	57.1
	3rd choice	8	8.7	38.1	95.2
	Least important	1	1.1	4.8	100.0
	Total	21	22.8	100.0	
Missing	System	71	77.2		
Total		92	100.0		

Future Challenge- Funding/resources

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Most important	22	23.9	40.7	40.7
	2nd choice	16	17.4	29.6	70.4
	3rd choice	16	17.4	29.6	100.0
	Total	54	58.7	100.0	
Missing	System	38	41.3		
Total		92	100.0		

Future Challenge- Utility staff/employees retention

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Most important	3	3.3	9.7	9.7
	2nd choice	13	14.1	41.9	51.6
	3rd choice	14	15.2	45.2	96.8
	5th choice	1	1.1	3.2	100.0
	Total	31	33.7	100.0	
Missing	System	61	66.3		
Total		92	100.0		

Future Challenge- Population growth

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Most important	9	9.8	33.3	33.3
	2nd choice	6	6.5	22.2	55.6
	3rd choice	10	10.9	37.0	92.6
	4th choice	1	1.1	3.7	96.3
	12	1	1.1	3.7	100.0
	Total	27	29.3	100.0	
Missing	System	65	70.7		
Total		92	100.0		

General questions about managing water supply

I have thought about water conservation frequently in the past year.
Conservation as a priority.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	2	2.2	2.8	2.8
	Mildly Disagree	10	10.9	13.9	16.7
	Neither agree nor disagree	22	23.9	30.6	47.2
	Mildly Agree	26	28.3	36.1	83.3
	Strongly Agree	12	13.0	16.7	100.0
	Total	72	78.3	100.0	
Missing	System	20	21.7		
Total		92	100.0		

The greatest threat to the water supply is the lack of available raw water.
Lack of raw water is the greatest threat.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	6	6.5	8.3	8.3
	Mildly Disagree	22	23.9	30.6	38.9
	Unsure	19	20.7	26.4	65.3
	Mildly Agree	22	23.9	30.6	95.8
	Strongly Agree	3	3.3	4.2	100.0
	Total	72	78.3	100.0	
Missing	System	20	21.7		
Total		92	100.0		

When making decisions about meeting water supply needs in eastern North Carolina, the health of the economy is more important than protecting the environment.*
The economy takes precedence over the environment.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	14	15.2	20.0	20.0
	Mildly Disagree	31	33.7	44.3	64.3
	Unsure	11	12.0	15.7	80.0
	Mildly Agree	13	14.1	18.6	98.6
	Strongly Agree	1	1.1	1.4	100.0
	Total	70	76.1	100.0	
Missing	System	22	23.9		
Total		92	100.0		

Non-human species and habitats ought to be considered in any decision making regarding water resources.
Non-human species are important in decision making.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	2	2.2	2.9	2.9
	Mildly Disagree	5	5.4	7.1	10.0
	Unsure	11	12.0	15.7	25.7
	Mildly Agree	30	32.6	42.9	68.6
	Agree	22	23.9	31.4	100.0
	Total	70	76.1	100.0	
Missing	System	22	23.9		
Total		92	100.0		

The New Environmental Paradigm Scale

Please answer the following general questions about humans and their relationship with the natural environment. These 15 questions will provide important information about how you see the world.

Humans will eventually learn enough about how nature works to be able to control it.
14 ANTI-EXEMPTIONALISM

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly agree	29	31.5	41.4	41.4
	Mildly agree	22	23.9	31.4	72.9
	Unsure	11	12.0	15.7	88.6

	Mildly disagree	8	8.7	11.4	100.0
	Total	70	76.1	100.0	
Missing	System	22	23.9		
Total		92	100.0		

Despite our special abilities humans are still subject to the laws of nature.

9 ANTI-ANTHROPOCENTRISM

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	1	1.1	1.4	1.4
	Unsure	3	3.3	4.3	5.7
	Mildly agree	10	10.9	14.3	20.0
	Strongly agree	56	60.9	80.0	100.0
	Total	70	76.1	100.0	
Missing	System	22	23.9		
Total		92	100.0		

Human ingenuity will insure that we do not make the Earth unlivable.

4 ANTI-EXEMPTIONALISM

Human ingenuity will solve our environmental problems.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly agree	12	13.0	17.1	17.1
	Mildly agree	15	16.3	21.4	38.6
	Unsure	19	20.7	27.1	65.7
	Mildly disagree	19	20.7	27.1	92.9
	Strongly disagree	5	5.4	7.1	100.0
	Total	70	76.1	100.0	
Missing	System	22	23.9		
Total		92	100.0		

The Earth has plenty of natural resources if we just learn how to develop them.

6 LIMITS

Technology can help us extend resources.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly agree	5	5.4	7.1	7.1
	Mildly agree	17	18.5	24.3	31.4
	Unsure	10	10.9	14.3	45.7
	Mildly disagree	30	32.6	42.9	88.6
	Strongly disagree	8	8.7	11.4	100.0
	Total	70	76.1	100.0	

Missing	System	22	23.9		
Total		92	100.0		

Humans have the right to modify the natural environment to suit their needs.

2 ANTI-ANTHROPOCENTRISM

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly agree	14	15.2	20.0	20.0
	Mildly agree	22	23.9	31.4	51.4
	Unsure	12	13.0	17.1	68.6
	Mildly disagree	18	19.6	25.7	94.3
	Strongly disagree	4	4.3	5.7	100.0
	Total	70	76.1	100.0	
Missing	System	22	23.9		
Total		92	100.0		

Humans were meant to rule over the rest of nature.

12 ANTI-ANTHROPOCENTRISM

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly agree	18	19.6	25.7	25.7
	Mildly agree	15	16.3	21.4	47.1
	Unsure	10	10.9	14.3	61.4
	Mildly disagree	24	26.1	34.3	95.7
	Strongly disagree	3	3.3	4.3	100.0
	Total	70	76.1	100.0	
Missing	System	22	23.9		
Total		92	100.0		

Plants and animals have as much right as humans to exist.

7 ANTI-ANTHROPOCENTRISM

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	3	3.3	4.3	4.3
	Mildly disagree	12	13.0	17.1	21.4
	Unsure	4	4.3	5.7	27.1
	Mildly Agree	28	30.4	40.0	67.1
	Strongly Agree	23	25.0	32.9	100.0
	Total	70	76.1	100.0	
Missing	System	22	23.9		
Total		92	100.0		

The balance of nature is strong enough to cope with the impacts of the modern industrial nation.

8 BALANCE

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly agree	16	17.4	22.9	22.9
	Mildly agree	21	22.8	30.0	52.9
	Unsure	17	18.5	24.3	77.1
	Mildly disagree	13	14.1	18.6	95.7
	Strongly disagree	3	3.3	4.3	100.0
	Total	70	76.1	100.0	
Missing	System	22	23.9		
Total		92	100.0		

We are approaching the limit of the number of people the Earth can support.

1 LIMITS

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	9	9.8	12.9	12.9
	Mildly disagree	11	12.0	15.7	28.6
	Unsure	28	30.4	40.0	68.6
	Mildly agree	13	14.1	18.6	87.1
	Strongly agree	9	9.8	12.9	100.0
	Total	70	76.1	100.0	
Missing	System	22	23.9		
Total		92	100.0		

The so-called "ecological crisis" facing humankind has been greatly exaggerated. 10 ECO-CRISIS

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly agree	12	13.0	17.1	17.1
	Mildly agree	10	10.9	14.3	31.4
	Unsure	25	27.2	35.7	67.1
	Mildly disagree	18	19.6	25.7	92.9
	Strongly disagree	5	5.4	7.1	100.0
	Total	70	76.1	100.0	
Missing	System	22	23.9		
Total		92	100.0		

When humans interfere with nature it often produces disastrous consequences. 3 BALANCE

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Mildly disagree	9	9.8	12.9	12.9
	Unsure	13	14.1	18.6	31.4
	Mildly agree	29	31.5	41.4	72.9
	Strongly agree	19	20.7	27.1	100.0
	Total	70	76.1	100.0	
Missing	System	22	23.9		
Total		92	100.0		

Humans are seriously abusing the environment.
5 ECO-CRISIS

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	2	2.2	2.9	2.9
	Mildly disagree	12	13.0	17.1	20.0
	Unsure	10	10.9	14.3	34.3
	Mildly agree	27	29.3	38.6	72.9
	Strongly agree	19	20.7	27.1	100.0
	Total	70	76.1	100.0	
Missing	System	22	23.9		
Total		92	100.0		

The earth is like a spaceship with very limited room and resources.
11 LIMITS
Resources are limited.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	2	2.2	2.9	2.9
	Mildly disagree	19	20.7	27.1	30.0
	Unsure	10	10.9	14.3	44.3
	Mildly agree	28	30.4	40.0	84.3
	Strongly agree	11	12.0	15.7	100.0
	Total	70	76.1	100.0	
Missing	System	22	23.9		
Total		92	100.0		

The balance of nature is very delicate and easily upset.

13 BALANCE

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	3	3.3	4.3	4.3
	Mildly disagree	19	20.7	27.5	31.9
	Unsure	12	13.0	17.4	49.3
	Mildly agree	26	28.3	37.7	87.0
	Strongly agree	9	9.8	13.0	100.0
	Total	69	75.0	100.0	
Missing	System	23	25.0		
Total		92	100.0		

If things continue on their present course, we will soon experience a major ecological catastrophe.

15 ECO-CRISIS

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	6	6.5	8.6	8.6
	Mildly disagree	13	14.1	18.6	27.1
	Unsure	22	23.9	31.4	58.6
	Mildly agree	22	23.9	31.4	90.0
	Strongly agree	7	7.6	10.0	100.0
	Total	70	76.1	100.0	
Missing	System	22	23.9		
Total		92	100.0		

Communication

The NC DEQ website is the most useful source of information regarding water resources in your jurisdiction.

NC DEQ website usefulness

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	2	2.2	2.9	2.9
	Mildly disagree	4	4.3	5.7	8.6
	Unsure	21	22.8	30.0	38.6
	Mildly agree	33	35.9	47.1	85.7
	Strongly agree	10	10.9	14.3	100.0
	Total	70	76.1	100.0	
Missing	System	22	23.9		
Total		92	100.0		

About how often do you consult the NC DEQ regarding water supply management?

Frequency of consult of NC DEQ

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Weekly	4	4.3	6.0	6.0
	Once a month	5	5.4	7.5	13.4
	Every few months	16	17.4	23.9	37.3
	About every 6 months	11	12.0	16.4	53.7
	About once a year	11	12.0	16.4	70.1
	Never	20	21.7	29.9	100.0
	Total	67	72.8	100.0	
Missing	System	25	27.2		
Total		92	100.0		