EXAMINING THE REPRESENTATIVENESS OF GEORGIA'S STATE WATER PLAN

A Thesis
Presented to
The Academic Faculty

by

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In Partial Fulfillment
of the Requirements for the Degree
Masters of Science in the
School of Public Policy

Georgia Institute of Technology
December 2010

EXAMINING THE REPRESENTATIVENESS OF GEORGIA'S STATE WATER PLAN

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To my parents, for your endless faith in me, I love you both.

ACKNOWLEDGEMENTS

I would like to thank my family for their unconditional love and support throughout this long journey. My parents, Patrick and Pamela Marshall, have always been there to guide me and have supported me in every goal I have set myself. My siblings, Tracie and Michael, have always been my best friends and were willing to listen when I needed a sympathetic ear. Their willingness to spend hours discussing and revising with me made the work bearable. Without the support of my family, this journey would have seemed nearly impossible.

I owe a lot to my advisor, Professor Bryan Norton, who introduced me to environmental policy and inspired me to learn more about the field. His patience and guidance allowed me the freedom to explore my ideas and accomplish more than I ever thought I would. Without Dr. Norton, I would not have met Dr. Hirsch, nor would I have been introduced to the fascinating world of water planning.

I would like to thank my committee members: Dr. Paul Hirsch and Professor Doug Noonan, for their continued support throughout my graduate studies. They were always open to my ideas and pushed me to develop them further. Dr. Hirsch was a wonderful mentor and guide into the thesis research process, and encouraged me to continue the work he began.

Additionally, I would like to thank Shana Udvardy, the staff of the Georgia Conservancy, and the members of the Georgia Water Coalition for accepting me into their workplace and making me feel welcome.

Finally, I would like to thank all of my friends, to whom I have been a virtual stranger these last long months, especially Nancy Galewski for being such a wonderful commiserator and thesis support group member.

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SUMMARY

This thesis provides an analysis of the Georgia statewide regional water planning process, which has been declared to be operating in the adaptive management framework. The principal focus is to establish a paradigm for ensuring fair representation of interests in the state's water resources. Representativeness is a measure of the degree to which interests are represented. The paradigm stems directly from application of the theories of bounded rationality and adaptive management. Development of the framework was accomplished through application of theory and correlated empirical analysis.

Georgia is currently in the process of developing regional water management plans as part of comprehensive statewide water planning efforts. Guidelines given to regional water planners by the state plan indicated council makeup should reflect constituents' interests. A method for ensuring compliance with guidelines is choosing an appropriate framework of policy development. The framework used by the plan is adaptive management, which emphasizes the importance of public participation in the process. Public involvement occurs through meeting attendance and representation of interests by appointed committee members.

Observing and surveying the regional water planning process as it developed allowed the representativeness of the process to be analyzed. Observation of council meetings provided an initial perception of representativeness. Council members' survey results provided reinforcement for initial observations, thus improving the reliability and validity of qualitative research

methods. Comparison of survey results to regional water use data provided a quantitative method for examining the degree of representativeness present in water planning councils.

INTRODUCTION

This thesis provides an analysis of representativeness from the perspective of Georgia's incorporation of the adaptive management framework into their ongoing regional water management planning process. The study is divided into six chapters.

In Chapter 1, a background is provided for understanding the necessity for statewide water planning in Georgia. Brief histories of drought and water law are presented. The ideas of adaptive management and representativeness used throughout the paper are also introduced.

In Chapter 2, a literature review of the key concepts establishes the groundwork for the theoretical framework. Two major components of this review are the discussion of adaptive management, argued by C. S. Holling, Carl Walters, Norton and colleagues, and representativeness, argued by Shepherd and Bowler, Kenney and colleagues. These theories are examined and expanded to create a theoretical framework for a dynamic adaptive management framework.

In Chapter 3, the dynamic adaptive management paradigm is developed and described in detail. The characteristics of ideal representativeness and adaptive management are presented. Models are presented which highlight the dynamic aspect of the theoretical framework and ground it in the policymaking process.

In Chapter 4, a description of the empirical analysis of current regional water planning is presented. This analysis combines an examination of regional water demand characteristics, participant observation of regional water planning meetings, and a survey of regional water planning council members.

In Chapter 5, analysis findings are presented and potential impacts of improving representativeness through incorporation of the Metropolitan North Georgia Water Planning District (MNGWPD) and environmental interests are evaluated.

In Chapter 6, conclusions drawn from the analysis detail how process improvements can be accomplished. Limitations and opportunities for future study are presented.

CHAPTER 1. HISTORICAL BACKGROUND

For as long as Georgia has been a state, drought of varying magnitude has been a periodic occurrence affecting populations from small rural to major urban areas. Creation of a sustainable water management policy in Georgia requires an understanding of the water resources available and the current scope of interests and projected use for water throughout the state. We have reached a point in time where significant population growth has coupled with tremendous resource demand resulting in a significant increase in sensitivity to drought conditions. One such occurrence beginning in 2007 spanning approximately two years qualifies as a punctuated-equilibrium event which has driven the necessity for more comprehensive resource management methodology. Up until this point, fundamental principles of land ownership, resource availability and riparian rights were sufficient to ensure the balance of prioritization when determining water resource availability both locally and throughout the state. While these methods were sufficient to ensure Georgia's ability to rapidly adjust to water resource shortfalls, this philosophy is insufficient given the current statewide demand and drought sensitivity. A more dynamic management technique is necessary. These new techniques require comprehensive understanding of how water resource availability and trends change over time. Water management plans should result in a water use permitting process that continually monitors and assesses the balance between competing resource demands which in turn shape the pattern of Georgia's growth. A sustainable plan will encourage smart growth.

1.1. Background. Historical Account of Water in Georgia

Georgia contains fourteen major river basins. The state's 159 counties lie on top of these basins, many over more than one. The Chattahoochee is the main river in Georgia. It originates in a small watershed in Union County north of Atlanta and flows southwest through metro Atlanta, eventually forming the border between Georgia and Alabama. Throughout its length the flow of the Chattahoochee is controlled by dams and hydroelectric plants. The majority of Georgia's lakes are man-made reservoirs, which divert the flow of the state's rivers, capturing it for upstream use (Davis et al., 2002). The distribution of water across Georgia is not uniform, neither is the distribution of demand.

According to the United States Geological Survey (USGS), Georgia has a land area of 57,906.14 sq. miles and 1,016 sq. miles of water, making the state 1.8% water. In terms of the total percentage of the state composed of water, Georgia ranks 28th (United States Geological Survey, 2010). As of July 1, 2009, Georgia ranked ninth in population, with 9.8 million residents (United States Census Bureau, 2009). Georgia's size and climate have played a factor in water use. Georgia lies on four physiographic provinces, which alter the composition of streams. The Blue Ridge province lies to the northeast; it is forested and mountainous, with swift runoff to small drainage areas with high water yields. Water supply comes mainly from springs. The Valley and Ridge province lies to the northwest. It has deep river channels with wide flood plains. Water is supplied chiefly from rivers and springs, with some small reservoirs from the many dam sites. The Piedmont province has streams with generally moderate slopes, with streambeds of silt or gravel on bedrock. The small streams and rivers provide the major source of water to cities, and there are numerous reservoirs in the province. The Fall Line divides the

Piedmont province from the Coastal Plains, which make up the lower half of the state. The northern half of the state lies on top of hard crystalline rock, making groundwater difficult to access. The southern portion of the state lies on a bedrock of layered aquifers providing easy access to groundwater, and in the east, rivers empty into salt marshes. The Upper Coastal Plain has very permeable soil, and streams generally have a sluggish flow surrounded by swampy valleys. There are few reservoirs, and most water comes from groundwater sources, mainly artesian wells. The Lower Coastal Plain has very low flow; rivers are susceptible to tidal flow and often brackish. This region's main source of water is artesian wells (Thomson, Herrick, Brown, & others, 1956).

1.1.1. Drought in Georgia

Drought is typically defined as "a period of dryness especially when prolonged; specifically: one that causes extensive damage to crops or prevents their successful growth[1]." As drought naturally occurs in almost all climatic regions, the assessment of drought must be regionally specific. In addition to climate, socioeconomic characteristics determine the significance of drought impacts (Wilhite, 1993). A high-water use or densely populated society may be more vulnerable to drought depending on their location and water management strategies. A more functional characterization of drought specifies conditions such as onset, severity and frequency of drought. Georgia's Drought Management Plan of 2003 specifies conditions for drought declaration throughout the state. The plan indicates drought is determined by changes in drought indicator levels: precipitation amount, reservoir levels, groundwater levels and streamflow, for the nine

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[1] drought. (2010). In *Merriam-Webster Online Dictionary*. Retrieved August 2, 2010, from http://www.merriam-webster.com/dictionary/drought

climate divisions of Georgia. A change in an indicator value level signals the need for evaluation of the drought condition level for that climate division. Georgia has four levels of drought condition arranged in increasing severity. When conditions persist for two or more consecutive months, an evaluation of drought response level is performed. Drought response levels are reduced when all drought conditions become and remain less severe for a minimum of four consecutive months. Drought responses consist of the restriction of outdoor water use, for municipal users increasingly reduced schedules for watering at drought level 1 up to a complete watering ban at level 4 (*Georgia Drought Management Plan*, 2003).

Analysis of Georgia's history reveals drought is a normal occurrence in the Southeastern United States. In the past 325 years, Georgia has experienced 13 long-term, severe droughts.

> *"For Georgians this means that water management and drought mitigation plans should at least take into account known natural variability in the climate system. Policy makers should expect a drought of two years or more at least once every 25 years. This is regardless of any other pressures put on the water supply due to population growth…The human element is key to any successful planning. Changes in population, water needs and use, and perceptions must be taken into account in policy formulation (Stooksbury, 2003)."*

The two most recent severe droughts occurred during the period 1998-2002 and 2007-2009. The '98 drought reached its peak around December 18, 2001, when the state entered Drought Response Level 3 (D3), after which drought slowly receded until December 31, 2002 the state was back down to D0 (abnormally dry but no official drought). There were brief drought recurrences during spring and summer 2004. The next large-scale drought became apparent around March 2006, when the state entered an extended period of Level 1 drought. By March 27, 2007 the state had entered D2. On April 24, 2007 the state entered D3, and the drought escalated to D4 on June 12, 2007. On December 25, 2007, 50% of the state reported D4 conditions. Spring brought rain, and June 09, 2009 there was no drought in Georgia (National Drought Mitigation Center, 2010).   These recent experiences of severe drought have sparked a flurry of state water planning. Georgia's escalating population and increasing water demands causes periods of drought to be more acutely felt by the population.

Lake levels in Georgia and the rest of the Southeast were reaching critically low depths in summer 2008. The State Water Plan, precipitated by the 1998-2002 drought, was given serious attention. Approval of the draft Comprehensive State-Wide Water Management Plan in January 2008 set in motion the next level of planning, the development of regional water plans, yet as the drought eased in winter 2008 the new level of planning received less media attention.

Georgia's Water Plan states the rationale of the plan as follows:

> *"In order to support the state's economy, protect public health and natural systems, and enhance citizens' quality of life, Georgia must protect the ability of the state's water resources to meet all reasonable current and future water needs of the state. These needs include the offstream and instream uses that sustain the state's cities, counties, rural communities, farms, businesses, industries, and the environment (Georgia Water Council, 2008)."*

A seeming conflict-of-interest in the plan is that Governor Purdue is committed to at minimum maintaining the current level of economic growth in Georgia while still managing to satisfy the water demands of the growing population with a water supply that had not, and will not, increase without human intervention. As Davis et al. say in their paper on reservoirs in Georgia,

> *"We have moved from a period of having abundant water to one with growing demands for water for multiple uses and evidence of increasing environmental impacts from water impoundment and withdrawal. Water supply planning in Georgia must balance conflicting, varied demands while protecting the water required to sustain healthy, functioning streams and rivers (Davis, et al., 2002)."*

Georgia must address both water quantity and water quality issues. Its water quantity issues are manifest in the cyclical droughts that strike the state and are exacerbated by the apparently exponentially increasing population. This is felt most by highly concentrated urban areas such as Metro Atlanta, and areas of Northern Georgia which cannot fall back on ground water when rivers run low due to drought. Water quality issues occur in such problems as pollution, both point source pollution from factories and non-point source from chemical run-off from paved areas and farms; and low dissolved oxygen levels, mainly occurring with influxes of higher temperature water, endangering aquatic life.

1.1.2. Georgia Water Law

Before beginning the massive undertaking of statewide water planning, one should ask what consequences a plan of this scale will have. According to the state water plan, "regulated riparian legal doctrine, described by Georgia case law and the Official Code of Georgia Annotated (O.C.G.A.), including provisions regarding reasonable use, will continue to guide water management in Georgia (Georgia Water Council, 2008)." Therefore the regulated riparianism that has largely guided water rights in the state remains intact. In addition, existing State and Flint River Drought Management Plans remain in effect, such that existing water use priorities for times of drought remain intact. Regulated riparianism has proved problematic when dealing with prioritization of water in normal, non-drought conditions.

This problem stems from past ties between resource use prioritization and land ownership. It is no longer common for resource use prioritization to be tied to riparian rights. Further, the majority of citizens tip the balance of water resource prioritization toward the state-regulated water demand categories while possessing no intrinsic tie to riparian rights. Modern resource demand prioritization caters to growth and welfare of citizens through resource accessibility as applied to state demand prioritization. This contemporary prioritization has divided Georgia into four demand categories: municipal, agricultural, industrial, and energy water use. No one of these categories has priority over the others. Consequently, water planners will need to address the transition from traditional to regulated riparian water rights.

1.1.3. Regulated Riparian Rights

Many Eastern states, including Georgia, have adopted regulated riparianism in response to changes in perception of water availability. However, in the 1970s when regulated riparianism was adopted, technical knowledge of water systems was limited, especially regarding the properties of groundwater. Georgia treated groundwater as a stationary resource, and gave landowners "absolute dominion" to groundwater on their property, except for known "underground streams" and for water withdrawn with the malicious intent of hurting other landowners. This failure to link ground and surface water is now being addressed by state water planning.

Professor Joseph W. Dellapenna, keynote speaker at the 2005 Georgia Water Resources Conference, examined the course of riparian rights doctrine in Georgia. In the 1970s Georgia adopted two water statutes that follow reasonable use theory. The first was the *Ground Water Use Act of 1972* and the second was a 1977 amendment to the *Georgia Water Quality Protection Act of 1964*, dealing with surface water pollution. According to Dellapenna, these statutes provide a foundation for a regulated riparian system; they clearly give priority to protection of water resources and public welfare. Dellapenna also identified weaknesses with current regulated riparianism in Georgia, which were presumably recognized as important issues as they have been raised during regional water planning meetings (Dellapenna, 2005).

According to riparian rights, only riparian landowners possess the right to use water, and decisions of when, where and how are left to their discretion so long as their use is "reasonable relative to other users." Municipalities are dealt with as if they are private riparians, while water users in the city are considered non-riparian. This leaves room for riparian owners to challenge sale of water to individual, non-riparian users. There is also the option for challenges based on the pollution of surface water (Dellapenna, 2005).

Understanding water law as it existed prior to initiation of state water planning is important for gaining an understanding of the stakes, weaknesses to be addressed and challenges to overcome. Dellapenna provides reviews of two pivotal Georgia Supreme Court rulings favoring contextual judgments of reasonable riparian use. In *Pyle v. Gilbert* the Georgia Supreme Court showed a disinclination to consider temporal priority arguments in favor of judgment of reasonable use (*Pyle v. Gilbert*, 1980). Then, in *Stewart v. Bridges* the Georgia Supreme Court again ignored a temporal priority argument, and also found it "inappropriate" to provide summary judgment over whether one use is "more reasonable" than another based on "suppositions of economic utility." Presiding Justice Harold Hill, Jr. wrote in the opinion that water use arguments need to be tried contextually, based on riparian use theory, "and not on some *a priori* property theory (*Stewart v. Bridges*, 1982)." Knowing that current water law, as laid out in the O.C.G.A. and case law, only specifies water use prioritization for times of water crisis enforces the idea that water demand is extremely complex, and “reasonable use” is a vague term. The definition of reasonable use has historically been left to a jury to decide; the courts have given little or no instruction on the matter (Dellapenna, 2005).

A significant problem with riparian rights is it treats water as a common good, and as with any unregulated common good, when the carrying capacity of the resource has been reached it is subject to what Garrett Hardin described as a “tragedy of the commons.” The tragedy is that rather than managing the resource to make it last, all users continually and rationally increase their own demand to reap the full benefit of the resource before the others use it up. This quickly leads to the resource being ruined for all. When each individual maximizes their own utility, society as a whole suffers. Hardin explains that a free commons can only exist so long as population is low, and for a state like Georgia in which population is rapidly increasing, carrying capacity cannot hope to be maintained. Hardin’s suggestions are either to privatize the commons, or keep them as allocated public property (Hardin, 1968). We know fresh water demand is increasing globally, while supply is either remaining constant or declining, and water shortages have become increasingly common. Georgia received a small taste of this problem once again during the most recent drought. Historically, Georgia was seen as able to meet all water demands, even perhaps having a surplus of water. However, that view has changed, now water in Georgia needs to be viewed as an increasingly scarce resource, and demand must be examined and managed carefully.

1.1.4. Legislative History of Georgia Water Planning

On May 13th, 2004, Georgia Governor Sonny Perdue signed House Bill 237, the Comprehensive Statewide Water Management Planning Act, into law. H.B.237 emphasized sound scientific grounding, integrated planning, a local and regional approach to water management, public and private stewardship, participation and cooperation. The act called for the creation of a Statewide Water Management Plan, pursuant to the following policy statement: "Georgia manages water resources in a sustainable manner to support the state's economy, to protect public health and natural systems and to enhance the quality of life for all citizens" (Georgia General Assembly, 2004). All water withdrawal permitting decisions were to be made in accordance with the plan. Local municipalities found not to be in compliance with the plan would find state funding for water-related projects revoked.

Additionally, H.B. 237 mandated the establishment of a State Water Council, the purpose of which is fourfold: "(1) ensure cooperation among state agencies in the water planning process; (2) provide input to the Environmental Protection Division of Georgia's Department of Natural Resources, which was to author the plan; (3) review, modify and approve the plan; and (4) recommend the plan to Georgia's General Assembly (Georgia Water Council, 2008)."

According to Georgia State University's (GSU) Law Review (Allen, 2004) HB 237 was signed on May 13, 2004 by the Governor and assigned the Department of Natural Resources (DNR), therefore Georgia's Environmental Protection Division (EPD), responsibility for creating a state water plan by Legislative Session 2008. One of the actions of the Comprehensive Statewide Water Management Planning Act was the creation of a Water Council, whose purpose is to facilitate water planning activities between state agencies, and review, modify and give recommendations on the state water plan. A draft plan was created through EPD and available for review by the Water Council and public comment on June 28, 2007, and the Water Council released the final approved State Water Plan on January 8, 2008.

As a result of the plan's adoption, ten regional water planning councils were created, each with its own jurisdictional authority in the process. The plan's three year implementation schedule provided for the following: resource assessments on ground and surface water availability and quality; the creation of population and employment forecasts; forecasts of municipal, industrial, agricultural and energy water use; guidance for plan development; rulemaking—the majority of which is not scheduled to take place until the years 2010-2011; and regional planning (Georgia Environmental Protection Division).

The dominant criterion for structuring water regions is the natural topography of the state. This geographic topography establishes watershed regions. Due to jurisdictional logic, county and municipal boundaries from which previous regulatory control has been established determine local adjustments to the regional watershed boundaries prescribed from topography.

The ten regional water planning areas created by the state plan are:

1. Altamaha
2. Coosa-North Georgia
3. Coastal Georgia
4. Lower Flint-Ochlockonee
5. Middle Chattahoochee
6. Middle Ocmulgee
7. Savannah-Upper Ogeechee
8. Suwannee-Satilla
9. Upper Flint
10. Upper Oconee

The Metropolitan North Georgia Water Planning District (MNGWPD), which comprises an eleventh region, was previously created and had completed its own integrated regional wastewater, water supply and watershed plans in 2003 (Metropolitan North Georgia Water Planning District, 2006), prior to the adoption of the state water plan in 2009. According to the state plan, following completion of regional water planning in 2011, future revisions of the MNGWPD plans will ensure its consistency with state water planning (Georgia State-wide Water Management Plan, 2009).

The Georgia Water Council's Comprehensive State-wide Water Management Plan specified regional water development and conservation plans (WDCPs), commonly referred to as regional water plans, was to be prepared by ten regional water councils, or by EPD. The plan indicated regional councils were to broadly represent their regions' water interests, and to consist of no more than 30 total members: 25 voting members, 3 alternates, and 2 ex officio members. Members were required to be residents of the water planning region they represented, and should be taken from a mix of groups including agriculture, forestry, industry, commerce, local government, water utilities, regional development centers (RDCs), tourism, recreation, and the environment. The ratio of representation was to be determined by the Governor, Lieutenant Governor and Speaker of the House of Representatives, who were charged with making final appointments. The Environmental Protection Division, Department of Agriculture, Department of Community Affairs, and Department of Economic Development created a list of qualifications and experience, which they distributed with a call for nominees. These nominees were collected from all interested groups, and then reviewed. A list of nominees these agencies considered qualified was created, and it was specified this list would be presented to the Governor, Lt. Governor and Speaker upon request. The Governor, Lt. Governor and Speaker were also free to consider other individuals "as they may choose."

The Water council specified council member appointments were to be made as follows:

- The Governor appointed 13 members and one alternate, at least two of which were mayors or city council members, and at least another two of which were elected county officials.

- The Lt. Governor and Speaker each appointed six members, one alternate, and one non-voting ex officio member from the State Senate of House, at least one voting member of which was a mayor or city council member and at least one other was an elected county official (Georgia Water Council, 2008).

1.1.5. Atlanta's Water

The Metropolitan North Georgia Water Planning District (MNGWPD), which consists of the fifteen counties within the metro Atlanta area (Metropolitan North Georgia Water Planning District, 2006), has already created its own water supply and conservation management plans. MNGWPD is not included in this round of regional water planning. Over half of the state's population resides in this region. For its population size, the MNGWPD is on a relatively small watershed. As such, the MNGWPD exerts significant influence on all state regional water plans. Due to the hard bedrock of the Piedmont region on which it lies, over 99% of water supply is drawn from surface water. The District lies at the headwaters of five major river basins: the Chattahoochee, Etowah (a sub-basin of the Coosa), Flint, Ocmulgee, and Oconee basins. The Chattahoochee River Basin supplies approximately 73% of the drinking water for the District (Metropolitan North Georgia Water Planning District, 2006). As the metropolitan area has expanded, water demand has exceeded the capacity of the Chattahoochee River basin alone, which led to withdrawals from other basins in the District, such as Lake Allatoona in the Coosa River basin (U.S. Geological Survey, 2010).

1.2. Punctuated-Equilibrium

Drought conditions combined with record growth over the past three decades produced near catastrophic low water supply levels. Rapid population growth elevated demand potential, exacerbating drought conditions to dangerously deplete water reserves in MNGWPD and adjacent headwater regions. Public panic was one of the engines that drove the governor's response to the water management plan. While state officials and scientists had previously recognized the need for improved state water resource management, public perception of the water crisis demanded a widespread response and spread awareness of the variety of stakeholder interests in state water policy. Awareness is an important aspect of representativeness, both for constituents and their representatives.

1.2.1. Historical Equilibrium

Historically, state water management consisted of individual plans for various water functions. Plans were discontinuous, single focus, and built from the premise of an enduring water supply. There was little concern given for interdependency of water resources. Much of this was due to lack of comprehensive water resource assessments; without assessment there was no notion of a resource capacity ceiling. The nature of limited water resource demand established the conditions leading to static water management techniques. These techniques were more than adequate given limited competing resource demands. Georgia's geography provides for significant water reservoir capability. This capability thoroughly sustained Georgia's need for resource demand growth.

1.2.2. Contemporary Equilibrium

Following the 2007 drought, a shift in equilibrium occurred, leading state resource managers to acknowledge the existence of a water resource capacity ceiling. Equilibrium by definition is a sustainable state, hence the dilemma: the current trend in resource growth, now recognized as bound by a capacity ceiling, is not sustainable. The current state of Georgia water planning acknowledges this dilemma and establishes a process for achieving sustainability. It acknowledges that Georgia no longer possesses an enduring water supply as measured against resource demands and growth (Fanning & Trent, 2009; Governor's Office of Planning and Budget, 2010). Projected population growth, hence water resource demand, outpaces supply by 2035 (Georgia State-wide Water Management Plan, 2009), reference Figure 7-1. The end result, contemporary equilibrium recognizes resource demand equity as the metric for distribution. Growth and water resource demand now drive a necessary dynamic response to limited water resource allocation in demand distribution.

1.3. Adaptive Management

Dr. Gail Cowie, a senior member of EPD and key architect of the Georgia state water plan, declared the regional water planning process to be following an adaptive management framework (Cowie, Askew, & Tobin, 2009). Fundamental evolution of Georgia's water resource management process will include:

> *"1) water management challenges will be more difficult due to increasing and competing demands. This will require more sophisticated management and a need to look at the use of multiple sources, not just the cleanest, easiest or cheapest.*
>
> *2) there will be an increase in foresight and an increased investment in information regarding resource capacity and water demands.*

3) there will be a greater recognition of water sources as shared resources: upstream, downstream, across state lines, and within and between regions. This will also require more sophisticated management, instead of a simple first-come, first-served practice.

4) there will be an increased involvement of water users in regional planning for different regional futures (Cowie & Davis, 2009)."

Apparent in Cowie's description of these main elements, the Georgia state water planning process is shifting to embrace the precepts of adaptive management. Adherence to the expressed intentions applies tenets of adaptive management to future goals of the state water planning process. Through the attainment of this expressed change in ideology, the Georgia water planning process will have migrated to an adaptive management methodology.

1.4. Representativeness

The current state of representativeness is characterized by the correspondence between present council member selection and existing regional resource preferences. Representativeness has not been explicitly defined, however as directed in the state water plan general guidelines have been provided in an attempt to ensure adequate representation of regional interests by a corresponding distribution of regional water council members. The guidance specifically states the following:

"As described in detail below, regional water development and conservation plans will be prepared by a water planning council or by EPD. Water planning councils will be diverse and broadly representative of local governments, water users, and other water-related interests in each planning region. Membership will depend on the existing water-related organizations and institutions in each region as well as the characteristics of regional water resources, water uses, and regional economies (Georgia Water Council, 2008)."

Regional council members are authorized by the state government to create regional development and conservation plans, under guidance from EPD. The EPD has final authority to approve and adopt these plans, but some uncertainty still remains about settlement of conflicts of interest between council members and EPD. While a shift from closed committees to open forums: public notice of meetings in a timely manner, publication of meeting minutes, and time for public comment during meetings, indicates a slow migration toward adaptive management, process constraints still hamper a full transition. This emphasis on inclusion of public participation is consistent with the representativeness tenet for ideal communications and establishes a critical initial foundation for transition to an adaptive management paradigm.

1.5. The Problem – An Outdated Paradigm

The problem with Georgia's water management policy is broadly attributed to static management philosophy. That is, historical precedence conditioned policymakers to believe they could publish a plan that would resolve issues for the foreseeable future. These plans were comprehensive with respect to localities, but derived from incomplete information when examined from a broad perspective. As such, state impacts were neglected and plans were assumed to sufficiently characterize resource demands on watersheds.

EPD permitting methodology was not intended to balance water resource use; it was only intended to prevent negative impacts stemming from individual permit holders. Statewide growth in both population and water resource demand categories has reached a point where each individual permit holder impacts nearly all permit holders within regional watersheds.

The original permitting process requirements only apply for withdrawal requests greater than 100,000 gallons per day. When applied to tens of permit applicants this is a significant amount. However, when applied to hundreds or thousands of applicants withdrawals range in the tens to hundreds of millions of gallons per day. Under these conditions, permit holders have the potential to exert a demand equal to the daily withdrawal levels of a major municipal region.

1.5.1. Static Management Techniques

Previous, non-comprehensive state water plans formed a static water management paradigm which was unable to adequately respond to the demand growth variation. The static nature of individual plans was exacerbated by rapid state population growth, especially in the MNGWPD region.

Georgia's water management policy is derivative of overreliance on outdated, static methodologies intrinsically incapable of accommodating contemporary resource demand dynamics. Georgia has reached a point in development in which there is not enough water to meet the entirety of competing demands using existing methods of relying on static reserves. Building new reservoirs to sate demand is no longer a viable solution. Dynamic water management is necessary. A punctuated-equilibrium event confirmed the necessity for shifting from static management techniques to active management processes. The end result of this shift is the creation of comprehensive state water planning, whereby outdated static techniques are replaced by active management methodologies driving dynamic management processes. Adaptive management processes facilitate the dynamic sharing of water resources to meet the range of demands.

1.5.2. EPD Water Permitting and Environmental Soundness

Permitting is a process, and the vehicle for regulation, it is tied to a proper vision of growth. It should be founded on environmental soundness and facilitate beneficial growth reflective of regional development priorities. Environmental soundness is fundamental to an effective water management solution. With regard to water resource management, environmental soundness relies on the findings of water resource studies conducted at the start of the regional water planning process. Environmental protection puts an upper limit on environmental impact. There is a geophysical carrying capacity to Georgia's resources, human actions will only either destroy or preserve the habitat that supports the current web of life in the area. Altering the state of resources in the area will affect carrying capacity, and may ultimately lead to conditions which undermine expansion of any type.

Industrial, municipal and energy water users who wish to withdraw, divert, or impound more than 100,000 gallons of water per day from a water source must first petition EPD by filing a letter of intent with the EPD Director. This letter must specify the water source's location, it's forecasted wastewater and water treatment capacities, a water conservation plan, a drought contingency plan, and a timetable for developing and implementing a watershed protection, and if necessary reservoir management plan (EPD Watershed Protection Branch, 2009). Currently, EPD considers the reasonableness of the request according to riparian rights criteria (Dellapenna, 2005).

Since 1988, agricultural users have also been required to request an Agricultural Permitting Unit (APU) for groundwater or surface water withdrawals of over 100,000 gallons per day or a pump rate of over 70 gallons per minute from a Georgia source. First landowners must file a Letter of Concurrence to drill a well(s) or install a pump/multi-pump system, specifying manner and location of said well(s) or pump(s). Once permission is obtained and the above is in place, certification of correct installation and water flow meter installation are needed. APUs are transferable upon sale of the land if the purpose remains unchanged (EPD Agriculture Permitting Unit, 2008).

The exception to Georgia's standard of water prioritization is times of water crisis. Emergency stipulations have been established for water shortages, and priority is given first to direct human consumption, then to farm use, after that use follows guidelines delineated in the Georgia Drought Management Plan (*Georgia Drought Management Plan*, 2003).

CHAPTER 2. METHOD

This study begins with a comprehensive literature review which outlines applicable theoretical frameworks necessary to prescribe an appropriate water resource management methodology. From this review, the theoretical framework is able to develop a dynamic management process capable of proactively identifying impending water resource demand shortfalls. The framework establishes a baseline for comparative analysis with the on-going water resource planning process. This analysis highlights positive and negative aspects of the current process and serves as a point of departure for a recommended dynamic adaptive management paradigm. Throughout the analysis, the concept of representativeness is shown to be a critical function at all process levels.

2.1. Literature Review

Contemporary policy theories are examined in order to establish precedence for the necessary components of a theoretical framework which analyzes the suitability of the Georgia regional water planning process' incorporation of adaptive management methodology.

2.1.1. Walters and Holling on Adaptive Management

The concept of adaptive management was first presented in a collection of works edited by C.S. Holling published in 1978, which presented research convened by the United Kingdom's Scientific Committee on Problems of the Environment in 1974 to develop an adaptive approach to environmental impact assessment and management (Holling, 1978). This seminal work sets the stage for this study's development of the *dynamic adaptive management paradigm*.

The notion of passive versus active adaptation was introduced by Walters and Holling in 1990. Walters and Holling identify the possibility for adaptive management methods to be passive (static). They highlight the adverse impact of a static process on sustainment of adaptively managed systems. This work introduces the notion that sustained adaptive management programs thrive on active (dynamic) management techniques. The nature of the dynamic process is outlined in this work. Walters and Holling highlight the impact of continual assessment on an effective policy process and illustrate the necessity for active (dynamic) methods when managing large-scale perturbations in complex systems.

> *"…to expose uncertainties and management decision choices in a format that will promote both intelligent choice and a search for imaginative and safe experimental options, by using tools of statistical decision analysis…need for imaginative ways to set priorities for investments in research, management, and monitoring...that will be in place for long enough to measure large-scale responses…(C. J. Walters & Holling, 1990)"*

Their analysis highlights future challenges for Georgia in attempting to transition to a process capable of sustained resource management. Analysis of challenges motivates recommendations for reducing resource burden necessary to sustain an adaptively managed policy process. Walters and Holling emphasize that sustained frequent and successive assessment is essential to garnering thorough understanding of all resource complexities necessary to craft equitable and effective renewable resource policy.

2.1.2. Norton on Adaptive Management

Models of Adaptive Management followed in this work are based on the theory as it appears in later work by Holling (Gunderson & Holling, 2002) and Norton (Norton, 2005). This tradition, which emerged in the early to mid-1990s, holds the social aspects of decision making are at least as important as natural science models. Norton emphasizes the importance the adaptive management framework places on accomplishing a communal goal. Community involvement and participation are key aspects of adaptive management.

> *"Adaptive managers understand the search for improved environmental policies as one of designing institutions and procedures that are capable of pursuing an experimental approach to policy and to science. In the process of building such institutional and procedures, social learning is expected to improve understanding of the environment through an iterative and ongoing process that will require not just unlimited inquiry but also the encouragement of variation in viewpoints and the continual revisiting of both scientific knowledge and articulated goals of the community (Norton, 2005)."*

This description characterizes the necessity for a dynamic process. "This variety of viewpoints and the ensuing experimentation and political discussion are all important parts of the process of selection of more and more 'adaptive policies' (Norton, 2005)." Again, increasing the incidence of adaptive supporting policies is analogous with a dynamic process.

An ideal process will balance resource preference at the regional level and resource equity at the state level. This is encapsulated in Norton's argument for addressing problems at multiple scales. "One implication of the adaptational model for understanding environmental problems is to emphasize the importance of localism. Emphasis on local variation, on diversity from locale to locale and from region to region (Norton, 2005)."

Transition to adaptive management systems of policymaking requires complete engagement on the part of both representative and constituent. Norton identifies the problem as an uneven playing field. "The problem is that neither EPA nor the society as a whole has established a unified discourse about environmental policy, a discourse in which all voices can be heard and in which communication, deliberation, and experimentation can take place in an open and inclusive public manner (Norton, 2005)." Norton highlights the fundamental tenets of representativeness founded on ideal communication across all stakeholders, "we gain an advantage if we can start any inquiry from a diversity of possibilities (Norton, 2005)." Without thorough communication of all aspects of resource preference and prioritization across all stakeholders a true understanding of the resource allocation problem is not achieved, and the ability to reach an ideal policy solution is diminished.

2.1.3. Cowie on Incorporation of Adaptive Management

The need for regional water planning was determined by the State Water Plan. Stakeholders and interests to be considered by water planners were identified in part through advisory committees. Gail Cowie, of Georgia's Department of Natural Resources (DNR), outlined the methods by which the Comprehensive Statewide Water Planning Act led to the creation of advisory committees, which in turn provided input used by state agencies such as DNR to create Georgia's State Water Plan. Cowie described the main elements called for by the state plan and emphasized its intention to embrace the precepts of adaptive management, through eliciting representative stakeholder involvement in successfully managing the state's water resources (Cowie, et al., 2009).

According to Cowie et al., heightened awareness of the availability of water in Georgia, resulting primarily from the exacerbation of cyclical drought effects from a growing state population and from publicized inter-state water conflicts, had punctuated the need for efficient state water management. Fear of water scarcity served as an agent of change, which could be seen by policy makers as an example of the punctuated-equilibrium model (True, Jones, & Baumgartner, 2007).

2.1.4. Leach on Collaborative Public Management

Public participation is a necessary part of a representative government. In his work on *"Collaborative Public Management and Democracy"* William Leach defines representativeness as ensuring "the interests of all affected individuals are effectively advocated, either in person or through proxies (Leach, 2006)." His call for the use of proxies addresses the issue of representation thresholds. At some point, the proportion of individuals represented by individual council members will yield to the proportion of resource interests represented by individual council members. There needs to be an appropriate balance between the proportion of individual versus proportion of resource area preference when aggregating to determine regional prioritization of resource allocation.

In the course of Leach's work on collaborative public management and democracy, he developed a framework outlining seven democratic ideals for collaborative governance: inclusiveness, representativeness, impartiality, transparency, deliberativeness, lawfulness, and empowerment. These ideals are fundamental to the paradigm of adaptive management. Leach clarifies typical adaptation of the democratic ideals within representative management processes. This linkage directly ties fundamental representativeness to the tenets of adaptive management.

2.1.5. Shepherd and Bowler on Public Participation

Shepherd and Bowler's examination of public participation in environmental impact assessments argues for proactive, ongoing public involvement in environmental decision making. Reasons for public participation include ensuring proper, fair conduct of democratic government processes in public decision-making activities; ensuring the project meets citizens' needs; adding legitimacy to the project and reducing hostility by affected parties; and adding local knowledge and values to the process to improve the final decision. While a common argument against public participation is the loss of efficiency caused by the increased time and cost of public involvement (Shepherd & Bowler, 1997), neither effectiveness nor efficiency alone constitutes a good policy. Ineffective policy is intrinsically inefficient, and inefficient policy is implicitly ineffective. Short-term expediency in the policymaking process does not guarantee an optimal solution is achieved. Shepherd and Bowler's framework describes the improvements in democracy, suitability, conflict resolution, and improved planning that can be achieved through proactive public participation.

2.1.6. Scholz and Stiftel

Scholz and Stiftel editorialize a review of adaptive governance, a framework expanding adaptive management, which focuses further on the field of human institutions. Competing human interests for water resources is one of the major stumbling blocks to effective water management. The main argument against public involvement in policymaking, especially a complex problem such as water resource management, is the loss of efficiency created when a large number of representatives from competing interests are involved in the process.

Scholz and Stiftel further support the importance of considering all resource users when dealing with a collective action problem such as public resource management in their process of adaptive governance, which parallels adaptive management and collaborative public management techniques. Scholz and Stiftel explain that large-scale collective action problems such as competing demands for water resources can involve overlapping federal and state agencies, whose decisions may impact one-another. Therefore, a system of adaptive governance is needed in which agencies cooperate with one-another in order to achieve a solution that "leads to sustainable use of the natural system (Scholz & Stiftel, 2005)."

Scholz and Stiftel's book is a collection of pieces on adaptive governance, with Florida's efforts to adopt an adaptive governance strategy presented as an ongoing case study. An article by Ruhl identifies representation and scientific learning as two primary weaknesses in Florida's planning efforts. Ruhl identifies possible reasons for impeded representation as: a restrictive agency attitude; participants' lack of knowledge of their true interests and options; a collective action problem of how to organize to facilitate participation; and a lack of technical and legal expertise, particularly by participants representing community interests (Ruhl, 2005).

Florida's conflict over Aquifer Storage and Recovery (ASR) proceeded relatively smoothly until grassroots community organizations became involved and defeated the legislation with aid from environmental legal and technical experts. This illustrates the need for representation by all stakeholders. The exclusion of communities whose health would be affected by ASR led to the failure of legislation, delaying water planning efforts and wasting both time and money in an urgent policy process (Ruhl, 2005).

2.1.7. Kenney on Democratic Decision-Making

Kenney addresses an important question about democracy: if democracy is government of the people, by the people, and for the people, how do we define people, and how are they to govern? The determination of ‘the people’ has changed over time, as citizenship and voting rights have expanded. In water resource policy, arguments about the people involve the public interest, and community involvement in governmental policymaking processes. In his analysis of ‘the how,’ Kenney concludes that typically, a democratic government adopts a broad, utilitarian goal of providing the greatest good for the greatest number of people. How the greatest good is decided is a matter of the democratic decision-making process, and who and how people are given the opportunity to participate in the process changes with current perceptions. Kenney states the “appropriateness” of a democratic decision-making process is determined normatively, based on evolution of democratic beliefs, and changes with time (Kenney, 2000). While commonly accepted measures of democratic governance do not explicitly describe representativeness, the ideals of democratic decision-making do. The problem is democratic ideals of majority rule do not always guarantee an appropriate resource decision. The democratic majority position on resource allocation priority is likely to correspond with resource demand growth preferences, and may be counter to resource necessities. To provide for the common good is one of the democratic principles, and in this case may be a necessary principle which is not supported by the majority. Social learning is an important aspect of environmental management. An adaptive management process that fosters ideal communication, thereby social learning, bridges the gap between the democratic majority and accomplishment of the common good. Westcoat discusses the application of social learning and social movements to water management, which applies to the rise of adaptive management as a water policy framework. As Westcoat says, “a key principle in adaptive management is that societies can 'learn by doing' ecosystem experiments (Westcoat, 2005)." Through adaptive management both individuals and social groups can learn about the relevant values, science, and policies needed for successful water resource management.

The current trend in water policy is collaborative in nature; Florida and Georgia have both adopted collaborative/adaptive management techniques. Literature on water resources policy argues the pros and cons of public involvement in policymaking (Shepherd & Bowler, 1997), (Ruhl, 2005). The general consensus is public involvement improves the quality of a policy, especially the breadth of concerns covered, but does so at the expense of efficiency through increased time and money spent on the process. Loss of time and money are valid arguments, especially in economic conditions in which budgets are tight and policy is urgently needed to manage increasing demands on limited water resources. However, an efficiently designed plan that fails to address the range of values for water and does not obtain public support is a wasted effort. Indeed, failure to consider public interest may lead to policy failure and require a revised policy, which will cost more time and effort in the long run.

2.1.8. Pierce et al. on Water Politics and Public Involvement

Pierce notes in the 1970s governmental agencies began to receive pressure to increase public participation in their decision-making systems. Agencies were being encouraged by all sides to include all "relevant" interests' values and priorities in decision-making, rather than rely on a cost-benefit calculation to determine the best course of action. This indicates a shift toward adaptive management methodologies (Pierce & Doerksen, 1976). Pierce et al. assert "public involvement is central to water resource politics (Pierce & Doerksen, 1976)" They reiterate the loss of efficiency associated with public involvement, but emphasize the benefits of broader public involvement in reducing planning bias and leading to better decision-making.

The issue of conflict and consensus over allocation of water resources is not new to the United States. Many of the same issues facing water managers in Georgia today have long been faced by Western states. Pierce described 'fundamental value conflicts' inherent in water policy in a 1979 paper. According to Pierce, demand projections show insufficient water to meet all desired uses, creating a need for consensus regarding water use priorities. The problem lies in deciding what criteria are given priority after 'ensuring sufficient water to maintain human life.' Pierce and his colleagues urged the public to become involved in water policy to ensure their water interests are established. Otherwise, public interest may be underrepresented in the face of powerful interest groups (Pierce, 1979). In the creation, establishment, and sustainment of a truly dynamic adaptive management process, resource management categories will undergo redefinition. Some categories may be eliminated, some may be added, and some may be modified. Public recognition of the necessity for these changes serves as a metric to validate the resulting reprioritization. This necessity for adaptation should be expected and planned.

2.1.9. Hamann -- The Power of the Status Quo

Hamann illustrates the difficulty in changing the status quo of water use, even with an adaptive governance system in place. Water resource allocation in the form of permitting withdrawal/use of water grants permit holders the legal right to use of a specific quantity of water from a designated source for a set period of time. If research performed as part of ongoing adaptive governance shows water use is damaging the environment or causing some other undesired effect, decision makers must have some authority to lawfully change the existing permits. Making such changes will be unpopular with existing permit beneficiaries, and such change may not occur unless compelled by a strong force for change, such as litigation (Hamann, 2005). The requirement of force to alter the status quo resembles the punctuated-equilibrium framework developed by Baumgartner and Jones. Hamann illustrating such a requirement in an adaptive governance system such as the one used for water management in Florida shows the need for vigilant adaptive governance. Not only must adaptive governance systems be diligent in their performance of ongoing studies of water resources and environmental impacts, but they must have the foresight to maintain the authority to change water resource allocations in response to ongoing research. Adaptive management must mean that all water resource allocation decisions may be altered in response to new information. If this is not the case, then a system cannot truly be called adaptive.

2.1.10. True, Jones and Baumgartner on Punctuated-Equilibrium Theory

Bounded rationality reinforces incrementalism in policymaking. The status quo must be overcome. Stability is the norm. Reinforced stability requires significant inertia to overcome. A punctuation event causes fundamental change and leads to a new status quo. Jones et al. argue bounded rationality is the foundation of punctuated-equilibrium. Decision makers are boundedly rational, and tend to focus their attention on one primary concern at a time. "At the systems level, punctuated-equilibrium…leads us to expect that some policy punctuation is under way almost all of the time (True, et al., 2007)." Driving this is a change in beliefs or attentiveness associated with a shift in the status quo. "Punctuated dynamics, where any activity consists of long periods of stability interspersed with bursts of frenetic activity, may be the general case in human systems (True, et al., 2007)." Punctuated-equilibrium theory explicitly characterizes the recent transitions in Georgia water planning policy processes and the motivation for changes in the methodology.

2.1.11. Simon and Selten on Bounded Rationality

Herbert Simon proposed the idea of bounded rationality in the mid-1950s in an effort to link psychological and economic theories of optimal behavior. Humans are assumed to be reasoning, rational actors, yet time and again examples are found in which people act in a sub-optimal manner. Simon theorizes humans are as rational in the moment as they can be in a given environment; the ability to determine optimality is limited by time, the available information, and the predominant social beliefs of the time (Simon, 1982). The aforementioned limitations lead to a person only being able to achieve bounded rationality.

Selten describes Simon's view of bounded rationality as "a search process guided by aspiration levels." It describes the rational principles by which real people make non-optimal adaptive decisions. The individual, or firm, searches for alternative decisions that fall within acceptable limits. If the level is easily met, aspirations may be raised, if not they may be lowered. This process of raising or lowering aspirations depending on the situating is called satisficing (Selten, 1999).

In his work "Rationality as Process and Product of Thought," Simon discusses two aspects of rationality, substantive and procedural.

> *"A general proposition that might be asserted about organizations is that the number of considerations that are potentially relevant to the effectiveness of an organization design is so large that only a few of the more salient of these lie within the circle of awareness at any given time…In such a world, we must give an account not only of substantive rationality-the extent to which appropriate courses of action are chosen-but also procedural rationality-the effectiveness, in light of human cognitive powers and limitations, of the procedures used to choose actions. (Simon, 1978)."*

The rationale an actor employs in decision making can only be identified through empirical observation and deductive reasoning, making substantive rationality difficult to determine. The decision whether to focus on substantive or procedural decision making processes must consider whether one is "interested only in the decisions that are reached, or is the human decision-making process itself one of the objects of our scientific curiosity (Simon, 1997)." Application of Simon's theory of procedural decision making to the analysis of regional water planning is appropriate because this study is assessing the achievement of representativeness throughout each stage of the policy making process.

2.1.12. Hirsch on Environmental Problem Bounding

Hirsch's study of environmental problem bounding argues for the inclusion of all relevant stakeholder interests in environmental planning. He posits that it is not just the group one belongs to, but also where one is located in a complex physiology, that should matter in determining representativeness, and also that there are different ways of thinking about boundaries – conceptual boundaries help us get our minds around an issue or problem, managerial boundaries help us collaborate, share information, and work together. Hirsch makes a distinction between managerial boundaries without authority, and managerial boundaries with authority. He applies tenets of complex system theory to establish ideas of problem bounding at multiple scales and to delineate implications for the design of environmental policy mechanisms (Hirsch, 2008).

2.2. Theoretical Framework

This theoretical framework establishes an evolution from the current static management process to a dynamic management methodology. The framework emphasizes the specific transitional elements stemming from each of the fundamental tenets of the adaptive management framework. Highlighted throughout is the cyclical nature of the relationship between adaptive management and representativeness.

> *"…analysis shows that a proactive, rather than reactive, approach can provide benefits…democratic and timely public involvement, developing a suitable and mutually acceptable project, resolving conflicts and establishing co-operative relationships, and collaborative, iterative planning, can improve the process and outcome…(Shepherd & Bowler, 1997)"*

2.2.1. Dynamic Management and Punctuated-Equilibrium

Georgia must overcome problems stemming from a history of reactive water management processes. The solution is to shift from reactive to proactive governance. The ultimate reactive process is seen in punctuated-equilibrium theory (True, et al., 2007), which by definition is a radical shift in the norm as a result of a large-scale disruptive event that alters the status quo. Adaptive management is a dynamic process which proactively mitigates the potential for punctuated-equilibrium by continually assessing the environment at all echelons, ideally sensing necessary process shifts before they become catastrophic. Dynamic management demands anticipation of punctuated-equilibrium events and seeks to harness potential from impending punctuation events to drive change at a predictable and manageable rate; converting from catastrophic reactionary management to a fluid and predictable management continuum.

Before the public outcry from the fear of taps running dry triggered a shift in the status quo, the state water planning act had called for public involvement. After this punctuation event, public attention shifted to the water planning process, hence the beginning of dynamic engagement and initial realization of adaptive management fundamentals. One result of this shift was the conduction of a large-scale “public involvement process” in the initial state water plan, which took the form of creation of stakeholder advisory committees with the goal of understanding the scope of water interests. Water resource use had developed very differently across the state; it was seen in three distinctly different regions of Georgia: the Southeast, Southwest, and Metro Atlanta. Seven Basin Advisory Committees (BACs) were formed to span the different geographic interests, six were along river basin boundaries, and the seventh was Atlanta (Cowie, et al., 2009). The shift from six basin boundaries to ten water planning regions is typical of the dynamic nature of the water planning process.

The BACs were not intended to create a single goal for managing water, but rather to identify the existing interests and concerns for the state’s water. A Statewide Advisory Committee (SAC) was formed to examine the concerns of statewide water interest groups. Neutral facilitators oversaw the advisory committees. Each topic of concern was introduced at a BAC meeting, then at a SAC meeting, with pre-meeting material prepared by state agencies. Norton’s comprehensive accounting of communal values (Norton, 2005) details the necessity for this transitional stage in the migration to adaptive management. Open communication should result in co-opting stakeholder interests and energy needed to drive a proactive dynamic adaptive management cycle.

2.2.2. Representativeness

Determining the proper level and method of representation for decision-making is a normative process influenced by the values of the existing governmental system. Ideally, in a democratic system of government all stakeholders in water policy would be rational actors with perfect information who understand their values for water, and are educated in both the technical aspects of water management and in the policy process. In such an ideal system, all stakeholders would be able to discuss their values and create water management policy which will sustainably manage water resources while upholding their multiple water values.

In reality, no one has perfect information, and water policy officials and all other stakeholders are bounded in their rationality by lack of information, time and social constraints. Given the large population of the state, and subsequently the large number of stakeholders, it is reasonable to utilize a representative form of policymaking. This creates a need for determining a method of representation.

Consequences of new management techniques for complex systems that constitute our water resources demands planning input from all stakeholders. Data on water use throughout the state has only been collected by the USGS since 1980, and that data is incomplete since at the very least agricultural irrigation water monitoring did not capture all use, and self-supplied water use relies on estimates.

While measuring use does not capture all of the interests or values for water, it does give a baseline for management decisions. The state plan placed a priority on ensuring growth and economic development in the state would be able to continue under a sustainable comprehensive water management plan, therefore the four water demand sectors were prioritized, and this problem is bounded by those categories. As the understanding of values and water demands evolves this measurement process can be repeated with those values.

This paper focuses on examining the procedural rationality of Georgia's comprehensive water development management plan. As the process is ongoing a final determination on the appropriateness cannot be given, and substantive rationality would be difficult to make an overall determination. However, the procedures chosen along the way have been analyzed in light of the information available and with a particular definition of appropriateness, that of representing the needs of an entire state in terms of ensuring adequate water to meet their actual needs. Quantifying appropriateness and representativeness are challenging tasks. They are open to interpretation and likely vary among every individual. Great care must go into making decisions on what is appropriate in a situation that can so vitally impact every living creature in an entire state.

The selection of representatives is dependent on regional demand preference and regional council nominee affiliations. This set of nominees should be properly qualified to develop water policy and encompass the entire range of regional water resource interests in proportion reflective of the regional proportion of interests. Each nominee should be fully qualified to recommend policy consistent with their affiliation and sensitive to all resource interests within their region.

The current incarnation of Georgia's water plan is the development of regional plans, and is the focus of this analysis of representation. In the shift from reactive water management to a proactive system of management, water policy makers accepted the limits of the current knowledge of state water resources and sought a method of water planning which would allow the policy to develop as knowledge expanded. The first stage in this process was to commission statewide water quality and quantity resource assessments. These assessments were assigned to EPD, who contracted them out between various agencies and institutions to complete. As these studies were being performed, regional water planning councils were formed and the beginning stages of policymaking were begun: signing Memoranda of Agreement, adopting rules of order, forming communal goals. Ideal representativeness supportive of this framework must reflect the balance between regional water use and projected demand growth with regional preference and regional growth priorities.

2.2.3. Adaptive Governance

The ideal water planning committee is comprised of a group of representatives from all stakeholder groups who come to the table armed with the knowledge to inform their fellow participants of the importance of their interest to the overall problem area, the communication and policy skills necessary to develop a practical solution, and the trust and commitment necessary to participate fully in the process of combining interests into the development of a plan for obtaining a communal goal. A fundamental knowledge of the policy process and the process of working within a committee will ease the process into working with a group of varied interests and values. Communication skills, which includes listening to others thereby both giving and receiving knowledge, are essential to forming an image of the variety of stakeholder interests present and ease the transition toward development of a communal goal. Trust, or empowerment, within committees, between committees and state government and agencies, and between committees and their represented stakeholders, is essential to success of the process. Without trust, and a feeling that the process has legitimacy to carry out the goal, there is little incentive to expend the substantial amount of effort necessary to achieving a communal goal. Finally, full and active participation is necessary for successful representation of interests. Each committee member must actively represent the interest of their subset of stakeholders in order to ensure the best communal goal is reached. Without active participation by everyone, a communal goal may be reached that appears legitimate, but in actuality represents only the values of the stakeholders who did participate in the process.

Committee members inherently possess a diverse set of complex values and interests. Therefore, each will likely have multiple objectives when entering the planning process, and will have unique perspectives for balancing these interests. So long as each member shares their values with the group, and remembers to primarily represent the interest that led to their involvement in the process, the overlap of interests can be a good thing. The most important aspect of a committee of competing interests is for each participant to honestly adhere to an agreement of open consideration of all interests, and the willingness to balance those interests in the best way possible to achieve a sustainable communal goal while not violating any interest's individual values.

A framework for measuring the representativeness of Georgia's water planning policy has been developed to determine whether the emerging policy accurately meets the needs of its citizens. Water is such a comprehensive, vital resource that all of Georgia's citizens are affected by water policy affecting the management of water. This means all state citizens are stakeholders in regional water planning. Since water is not only used at home, but many peoples' livelihoods also depend on water use, there will be stakeholders with multiple interests in water policy. Regional water council members, as authors of draft regional water plans, are in the best position to ensure a sustainable water management plan; therefore they were the targets for creating a paradigm of representativeness. An analysis of how well stakeholder interests are represented in the policy process has been performed as an illustration of the representativeness paradigm.

It has been stated Georgia's state water planning process, of which regional planning is part, follows the precepts of adaptive management (Cowie, et al., 2009). Proper utilization of the adaptive management technique should ensure representativeness of the policy process. Combined with a commitment by state agencies, especially EPD, and their contractors to work with regional water planning councils using best available technology to model and forecast Georgia's water resource needs, an adaptive management strategy for water policy making should lead to the obtainment of Georgia's communal goal of a statewide policy for sustainable water resource management. Policymakers are responding to identified weaknesses with the current system to create a stronger, more comprehensive water plan. EPD facilitators of the regional councils were acting inclusively by incorporating a public involvement plan to allow all stakeholders to provide input and share their concerns regarding the water plan.

All of the above factors can lead to a successful, sustainable water management plan if instituted properly. The weakness lies in the implementation. Therefore, water council members and their facilitators are critical to the process. Not only must one have the right tools to create a successful plan, but those tools must be placed in the right hands. Therefore, the processes by which planners are chosen and the guidance they are given are key elements to analyze in the development of water resource policy. There remains an inextricable linkage between council members dedicated to adaptive management methodology and their full cognizance of the necessity for representative decision making.

2.2.4. Representative Equities and Fairness

A fair water planning process must begin with a clear definition of fairness. Regional water planning in Georgia must follow the guidelines delineated in the Comprehensive State-wide Water Management Plan; therefore fairness in regional water planning should be defined by this plan. The state water plan was approved January 8, 2008, therefore it is assumed the guiding policies and management practices detailed in the Plan were deemed fair, and so long as the regional water plans adhere to those policies and practices they will be deemed fair as well.

> *"(3) Designation of Water Planning Councils.*
>
> *For each water planning region, a water planning council will be designated to oversee preparation of a regional water development and conservation plan. Each water planning council shall have no more than 25 members and three alternates, who shall be residents of that water planning region. Each council will be broadly representative to include agriculture, forestry, industry, commerce, local governments, water utilities, regional development centers, tourism, recreation and the environment.*

The balance of representation among these interests will be determined by the Governor, Lieutenant Governor, and the Speaker of the Georgia House of Representatives through their appointment decisions, described below. This allows the flexibility necessary to accommodate the varying economic and resource needs across the state (Georgia Water Council, 2008)."

According to the above quote, councils will represent the interests of their water planning regions. The Governor, Lieutenant Governor, and Speaker of the House were charged with ensuring they met the needs of different regions in their council member appointments. Therefore, in the aspect of council membership, fairness means the appointing bodies made the effort to ensure regional council members actually represent the interests of their region. In the direct sense, this would mean the occupational mix of the region would be proportionally represented, as much as possible, by council members. There has to be some room for flexibility in terms of meeting qualifications for council.

2.2.5. Bounded Rationality

Optimal for an individual depends on the environment and is limited by time, the information available, and the predominant social beliefs of the era (Simon, 1982). Therefore, as Simon says we can only be boundedly rational. Furthermore, the processes an actor employs in decision making are not visible to the eye, outsiders can only identify these processes through empirical observation and deductive reasoning. Even if an individual records their decision making process, we cannot follow every thought that person had while making a decision. We must assume they have recorded the steps they took to the best of their ability and can only work with what is given. There are limits of variance based on preference and bounded by values. The union of the set of values is a plane, and the rational set of values lies within that plane.

This framework focuses on examining the procedural rationality of Georgia's comprehensive water development management plan. The procedures chosen along the way have been analyzed in light of the information available and with a particular definition of appropriateness, that of representing the needs of an entire state in terms of ensuring adequate water to meet their actual needs. Great care must go into making decisions on what is appropriate in a situation that can so vitally impact every living creature in an entire state. Acknowledgement of bounded rationality serves to guide policy limits on acceptable environmental impacts relative to desired water resource allocation.

2.2.6. The Problem

Regional Water Councils represent distribution of water resources fairly. The problem stems from the difficulty in fairly distributing water resources in a manner which all constituents in a planning region perceive as equitable. Addressing this issue entailed breaking it into its constituent parts. A definition of fairness pertaining to water resource distribution must be established. In this situation, fairness is balancing the interests of water users; environmental justice dictates no one should bear an unequal portion of the burden of resource use. Therefore all water interests ought to be given due consideration when developing a plan which will impact all avenues of water use. Sustaining life must be given top priority in water resource distribution. However, prioritization of subsequent water demands is unclear. There is no specified prioritization amongst the four state-identified water demand categories (agriculture, energy, industry, municipal). Therefore, regional councils must decide this prioritization on a council-by-council basis in accordance with their region's interests.

Laws regarding property rights have traditionally included regulated riparian water rights, which allow a property owner reasonable use of water bordering their land so long as it allows ones neighbors the same right. However, water in today's society has exceeded the bounds of normal riparian rights, especially in municipalities where the majority of the population relies on publicly supplied water. State planning has divided water demand into four use categories: agriculture, energy, industry, and municipal use. Expected standards of living require a balance of all four demands. The duty of water planners is to accurately measure market demand of these four categories to determine the ability of their region to maintain its population and support future growth. Water council members are responsible to their constituents, considering their best interests first and then the best interests of the whole state. The largest issue facing water planning is feelings of inequity and disenfranchisement among various water interests. A state water management plan must address all the needs and concerns of its citizens; its success in this endeavor is measured in part by the perceived equity of the plan among all participants.

The root of Georgia's water planning problem is the absence of an effective water planning process which ensures the availability of water resources for use consistent with directed priorities to support growth and economic development. The mechanism to accomplish this directive is by balancing regional demand for agricultural, industrial, municipal and energy water use and respective regional growth across these categories. Water was considered an unlimited resource until extreme drought and Supreme Court intervention into litigation with Florida and Alabama highlighted the resource sensitivity relative to maximal demands. Until now, growth and development had not levied demands in excess of regional water reserve capability. Using a balance of historical perspective relative to state and regional resource demands, it has become necessary to address the notion that current and future resource demands will henceforth exceed resource capabilities. Utilizing the adaptive management process linked to representativeness provides methodologies which enable dynamic management of evolving growth and economic development resource demands. With regard to the plan's four water resource demand categories, representativeness is the transcendental element that allows the balance of competing demands and the preservation of fundamental values needed to craft statewide water policy legislation which empowers dynamic methodologies and results in sustained growth reflective of regional preferences while maintaining the preservation of environmental standards.

2.2.7. Current Paradigm

Georgia's state water plan directs that regional water planning councils be established and that they develop comprehensive water resource allocation plans. These plans establish a process to provide policy ensuring statewide water resource equity for municipal, agricultural, industrial, and energy demand. A component is to ensure sustainable water resources necessary for economic growth across all regions. Critical to accomplishing this plan is effective monitoring, assessment and policy adaptation. In order to fulfill the sustainment aspect of the plan, policy must be responsive to shifts in regional water demand and resource preference. The final phase in the process is a directed re-evaluation of the plan at 3-5 year intervals in order to assess policy effectiveness and determine necessary changes. Georgia has embraced an adaptive management philosophy (Cowie, et al., 2009); however, the current methodology lacks an anticipatory method of active engagement in the policy process necessary for continual evaluation of evolving resource demands and regional growth preferences. This process as described is static by design.

CHAPTER 3. NOVEL METHODOLOGY

Set forth in Chapter 3 is the innovative application of cutting edge theoretical framework. This novel application prescribes a direct transition from static management techniques to dynamic management methodologies. Theories used to develop this methodology are the contemporary ideas of adaptive governance (Scholz & Stiftel, 2005), adaptive management (Norton, 2005), bounded rationality (Simon, 1982), collaborative public management (Leach, 2006), punctuated-equilibrium theory (True, et al., 2007), and representativeness (Leach, 2006; Ruhl, 2005).

Motivated by Georgia water planning guidance to provide for growth, state water management requires a dynamic process not currently in use. Adaptive management possesses an intrinsic capability to accommodate dynamic problems. While the planning process is migrating toward an adaptive management mindset, it is not embracing the potential for synchronous management of dynamically complex systems. Among the statically dysfunctional resource management policy imperatives is the notion to assess maximum water resource demand against the maximal recorded drought. Constantly accessing the demand growth levels against maximal drought is unsustainable and unnecessary. This analysis technique fails to account for flexibility inherent in the real variations within actual water availability. Established in the current planning guidance is the requirement to categorize all water resource demand by one of four specified uses. This establishes a competition between each resource category. These four competitors provide for categorical specification of use volume. This creates a distorted specification of demand. In actuality, the demand varies continuously within and between each use category. Static accounting of demand fails to account for flexibility inherent in the system dynamics. The necessary dynamic process is self-correcting. It possesses flexibility which provides for an adaptive continual assessment of increasing resource demands against a balanced analysis of realistic drought conditions. The nature of this process protects against punctuated-equilibrium by virtue of continual assessment, which weighs dynamic problems against dynamic solution processes and establishes a continually self-correcting equilibrium.

3.1. A New Model

Representativeness is the underpinning for the dynamic adaptive management paradigm; it serves three crucial functions. First, representativeness orients the adaptive management process on the desired communal goal. Achieving representativeness amongst process participants links communal goals with regional interests. Second, garnering representativeness at each stage of the policy making process is the dynamic in dynamic adaptive management. The act of garnering the widest representation of interests provides the energy for the dynamic adaptive management process. Ideal representativeness is only possible when full accounting of all levels of interest has been accomplished. The more active the quest for representativeness at each level the more satisfactory the resulting policy. Finally, the level of representativeness of created policy provides a metric for the measure of policy success. The objective of the policy process is creation of a policy whose success is measured by the efficiency and effectiveness with which it solves the identified policy problem. Accurate identification of the policy problem is improved through representation of relevant stakeholder interests. Accomplishment of dynamic adaptive management is determined by assessment and monitoring which sustains the goal of establishing representative (i.e., effective and efficient) policy.

> *"…an environment where action has to be taken, however uncertain the outcome…is where active* [dynamic] *adaptive management can play a central role, because its premise is that knowledge of the system we deal with is always incomplete (C. J. Walters & Holling, 1990)."*

A truly comprehensive, sustainable state water management plan can be developed through the dynamic use of the adaptive management framework. The blending of the tenets of ideal representativeness applied to the adaptive management framework in a dynamic process enables continuous policy development, assessment, adaptation, and revision synchronous with the continuously evolving water resource demand assessment necessary to sustain viable growth in all aspects of development while simultaneously protecting environmental systems beneficial to statewide water resource sustainment.

3.1.1. Ideal Representativeness

Effective representativeness requires (Leach, 2006; Ruhl, 2005) at a minimum individuals who reflect the fundamental characteristics of representativeness: ideal knowledge of the problem and policy process, ideal participation, ideal communication and who will have been designated from an ideal selection process. Fundamental to an adaptive management process is the requirement for participants to accomplish communal goals by compromising individual preference while preserving individual values. Representativeness implies first that one is an active and willing participant, and second that one aspires to this system of compromise necessary for the accomplishment of communal goals. An ideal representative is an effective negotiator able to efficiently work toward accomplishing communal goals while preserving individual values, or the values of the group they represent.

Each of the four fundamental tenets of representativeness is related to an independent function necessary for adaptive management. The first tenet, ideal selection, imparts literal representation to the process and initializes the potential for ideal representativeness (Leach, 2006). Idealized Knowledge fuels the potential for a representative process; it focuses the potential on a problem set. Through sharing of knowledge representatives arm themselves with the tools needed to address the policy problem (Ruhl, 2005; Shepherd & Bowler, 1997; Westcoat, 2005). Ideal Participation allows the potential to act – to apply the potential against the specified policy problem (Pierce, 1979; Pierce & Doerksen, 1976) . Ideal Communication allows the potential to monitor and adapt the entire body of subsets of communication. It establishes the vehicle to monitor, assess, communicate, deliberate, and decide (Dunn, 2004). Accurate monitoring is critical to adaptive management, as this is the stage where recognition of either the success of the policy or the need to adjust the policy occurs. Next, communication is used to assess where the plan stands, this assessment must be communicated to all other interests (other councils, agencies, scientific experts, and the public).

> *"…resource policy decisions can be facilitated by explicit ways to identify alternatives, their likelihood and their outcomes in an environment that engages science, government, and the public (C. J. Walters & Holling, 1990)."*

Feedback obtained during communication leads to deliberation on whether to adapt the process. Accurate monitoring is necessary for adaptation. The loop will show one of these two perspectives, either adaptive management preserves representativeness, or representativeness is a guaranteed derivative of a true adaptive management process An effective adaptive management process is comprised of these four mutually exclusive and interdependent tenets. Each of these four tenets can be viewed from two perspectives, the demographic populous perspective and through the analysis of survey data that supports the proportion of resource demand.

The overarching, communal goal of this adaptive management process is a sustainable water management plan that accommodates desired growth. An adaptive management process is responsive to resource growth when faced with projecting vague requirements for a sustainable Georgia water plan. Even better, a dynamic adaptive management paradigm continually assesses varying growth requirements and accurately equilibriates resource demands in response to changing requirements. This in turn defines a sustainable water plan. This paradigm expands upon the work of scholars (Cowie & Davis, 2009; Leach, 2006; Norton, 2005; Scholz & Stiftel, 2005; Shepherd & Bowler, 1997) proposing an adaptive management process as the best method for accomplishing a fair, sustainable water plan.

3.1.2. Ideal Council Member Selection Process

There are two components to the selection of an ideal council: the selection of representative council members and the determination of regional demand characteristics. The first step is to determine the proportion of regional demand preferences. Next, from this established distribution of the four resource categories across the present regional demand determine a nominee pool size sufficient to select groups of thirty consistent with the resource demand distribution categories. In order to associate resource category representativeness nominees should be screened to assess strength between resource category affiliation and potential for council member representation.

There is a known distribution; it is accurately characterized and measurable. From this known distribution, standard practices will be applied to establish sample sizes necessary to ensure corresponding population distributions consistent with statistical attributes. Using a standard normal distribution model and the sample mean and standard deviation from the data-derived water resource category distribution a sample size and corresponding confidence interval are predicted. The sample size ensures attainment of a sufficiently large group of nominees necessary to select groups of 30 council members with affiliations corresponding to the resource distribution (Devore, 2000). This method allows the use of randomly selected individuals from the regional population to attain a properly distributed proportion of representatives. The nature of this random distribution serves to guarantee representation of regional demand characteristics regardless of professed nominee affiliations. This stems from the statistical power of unbiased estimators.

The strength of the representativeness-resource affiliation relationship is not randomly distributed. As such, an empirically derived filtering process will be employed to assess the potential for ideal representativeness amongst nominees. There is an independency between the protections afforded by randomization which guarantee correspondingly affiliated distributions and the notion to maximize the adaptive management-representativeness relationship. Therefore, screening for nominees most likely to be supportive of the adaptive management paradigm that fit the proportion of regional characteristics selects ideally representative nominees.

In order to prevent dominance by one sector of water demand interests, a representativeness paradigm is needed that both ensures inclusion of all stakeholder interests at the beginning of the process, and preserves the proportional representation of those interests throughout the process. Following modern adaptive management practices emphasizing community involvement and participation is essential to a policy process that preserves representativeness while committing to the creation of a policy that achieves a communal goal.

The developed paradigm for achieving a representative policy process uses the tenets of modern adaptive management to prevent selection bias and achieve ideal representation. Selection bias is avoided by acknowledging the potential for its occurrence and diligently working toward an inclusive candidate-gathering process. Ruhl identified lack of knowledge as a barrier to public involvement (Ruhl, 2005). Insufficient knowledge is a barrier to representation; if stakeholders are unaware of the stakes they may not involve themselves in the process, thereby not contributing to the understanding of the policy problem, meaning a true set of values for the resource cannot be compiled. Holding public meetings prior to committee formation with the intent to educate the public and acquire a list of potential stakeholders is important to overcoming this barrier and moving closer to ideal representation.

The paradigm prescribes a structured selection process, which includes a system of nominee screening and assessment prior to committee selection. There is a selection process empowered by the governor's directive for council member. The goal is active, engaged members. Achieving this goal requires assessment of nominees. Assessment requires tangible measures providing insight into quantifiable attributes. A first attempt to establish tangible measures between nominee attributes and nominee potential for representativeness stems from a theoretical framework established by Leach's work on Collaborative Public Management and Democracy (Leach, 2006). Adapted from Leach, this assessment at a minimum should measure sense of empowerment, knowledge, and participation. This data is supported by a survey experiment, during which these categories were associated with measurable attributes and administered a survey to current regional water council members in order to establish and validate the level of correspondence between these attributes. Stemming from Dr. Hirsch's work on problem bounding (Hirsch, 2008), survey criteria for associated individual attribute and attitude measures were used to establish and validate the potential for correspondence between measurable tendencies and quantifiable council member attributes.

Sense of Empowerment

Sense of empowerment is correlated with individual notions of water planning process response to personal input. While sense of empowerment is intangible, an individual's volume of input is measurable. Active involvement as a function of measured input during prior committee memberships can serve as a screening criteria to nominate members with a high sense of empowerment.

Knowledge

An adaptive management goal is to have the widest possible perspective on the problem to maximize the potential for communal goal accomplishment. Higher levels of knowledge correspond to a comprehensive perspective with regard to specific policy issues. Perspective is not measurable, but screening for knowledge level may effectively highlight the broadest possible perspective with regard to specific resource challenges. Broadness is necessary to ensure comprehensive communal goal compromise. As part of the screening criteria, demand category knowledge levels should serve as a metric for council member selection.

Participation

Participation is the metric that provides firsthand insight into representativeness. It is the feedback mechanism of assessment which checks policy actions with regard to council member primary versus secondary affiliations when assessing the functional level of representativeness across the breadth of resource management policies. The council member participation record should correspond to the documented proportion of resource demand preference and should align with the proportion of council member primary affiliations with respect to each of the demand categories. The evaluation of participation provides feedback on the success of the selection process at achieving representativeness. Feedback is fundamental to the self-correcting nature of the adaptive management process for allowing representativeness to drive the preference side of the dynamic water resource management paradigm.

3.1.3. Ideal Representativeness in Practice

A novel paradigm presupposes a system of best practices stemming from idealistically selected council members and known resource demands. This system must be applied unilaterally at both the state and regional level in order to guarantee both regional equity at the state level and resource preference equity at the regional level.

To illustrate this point, consider the following example:

As per state level guidance, each water planning region is assigned 30 council members. Assume a region 1 population of 30,000 and a region 2 population of 300,000 people. This yields representative proportions of 1,000:1 and 10,000:1 respectively.

Further, consider a resource preference distribution of 10% Agriculture, 30% Energy, 20% Industrial, and 40% Municipal in both regions.

One vote by the region 2 council carries the interests of 10,000 constituents, while 1 vote by the region 1 council carries the interests of 1,000 constituents.

Thus, the regional preferences per council member are represented as follows:

Region 1: (Population: 30,000)	Region 2: (Population: 300,000)
$\frac{3{,}000}{3}, \frac{6{,}000}{6}, \frac{9{,}000}{9}, \frac{12{,}000}{12}$	$\frac{30{,}000}{3}, \frac{60{,}000}{6}, \frac{90{,}000}{9}, \frac{120{,}000}{12}$

Figure 1 Examination of Two Hypothetical Water Planning Regions

Examination of Regional Equity at the State Level

The focus of statewide policy is to achieve regional equity and comprehensive support for statewide water demand priorities. Differences in relative sizes of regional populations highlight the potential for disparity in the balance of power among regions. The state prevents this disparity by directing that each regional council maintain thirty members. Without state intervention, disparity in council size would destabilize regional equities at the state level. If regional council size was based solely on direct proportion of regional demand interests to population size large regions would have the potential to dominate small regions at the state level.

Examination of Resource Preference Equity at the Regional Level

The goal at the regional level is to preserve resource preference equity. It is necessary to appropriately proportion representativeness with respect to constituent resource preferences. This proportional alignment ensures the number of council members is in accordance with the established resource characteristic baseline. Part of the equity focuses on growth. Representatives must be sensitive to regional preference for specific growth outside the norms of the established demand baseline. In theory, a fixed proportion of representation would drive re-designation of future councils with identical proportions. The common good is protected by the adaptive management framework, which enables adjustments to proportional redistribution of councilmember affiliations into future councils. Always selecting council members from an initial baseline proportion with corresponding preference affiliations implies growth would always be proportional to the aforementioned preferences, whereby these future preferences predetermine representative councilmember distribution.

Concluding Thoughts

Ideal representativeness at the regional level is characterized as proportional representation equivalent to the proportion of resource preference within the region. Members having affiliated interests and being constituents of the region themselves, are assumed to be acting consistent with inter-regional preference to the extent practical and are able to compromise when prioritizing resource demands across mutually beneficial resource needs, i.e. new school, hospital, factory, power plant, etc. Hence, ideal representativeness satisfies two fundamentals. It ensures balance of power between regions, and equitable prioritization of regional preference for water resource allocation and resource demand category growth. Fundamental to this process is the requirement to employ an affiliation screening process tied to the council member appointment system currently in place.

3.2. The Model Paradigm

The dynamic adaptive management paradigm applies the adaptive management framework in response to complex management dynamics addressing complex demand problems. At the heart of this paradigm, the fundamentals of representativeness drive the continuous policy adaptation process. The structure of the adaptive management framework stems directly from and upholds the tenets of the collaborative public management framework. The continuously adjusting dynamic adaptive management process constantly equilibriates the status quo, thereby proactively thwarting catastrophic punctuated-equilibrium. Following the structure of the policy making process, the model describes a continual process of issuing, monitoring, assessing, revising, adapting, balancing, and reissuing water resource management policy, thereby dynamically managing statewide water resources. Each of the following five figures (see Figures 2-6 below) was created to illustrate tiers of the dynamic adaptive management paradigm.

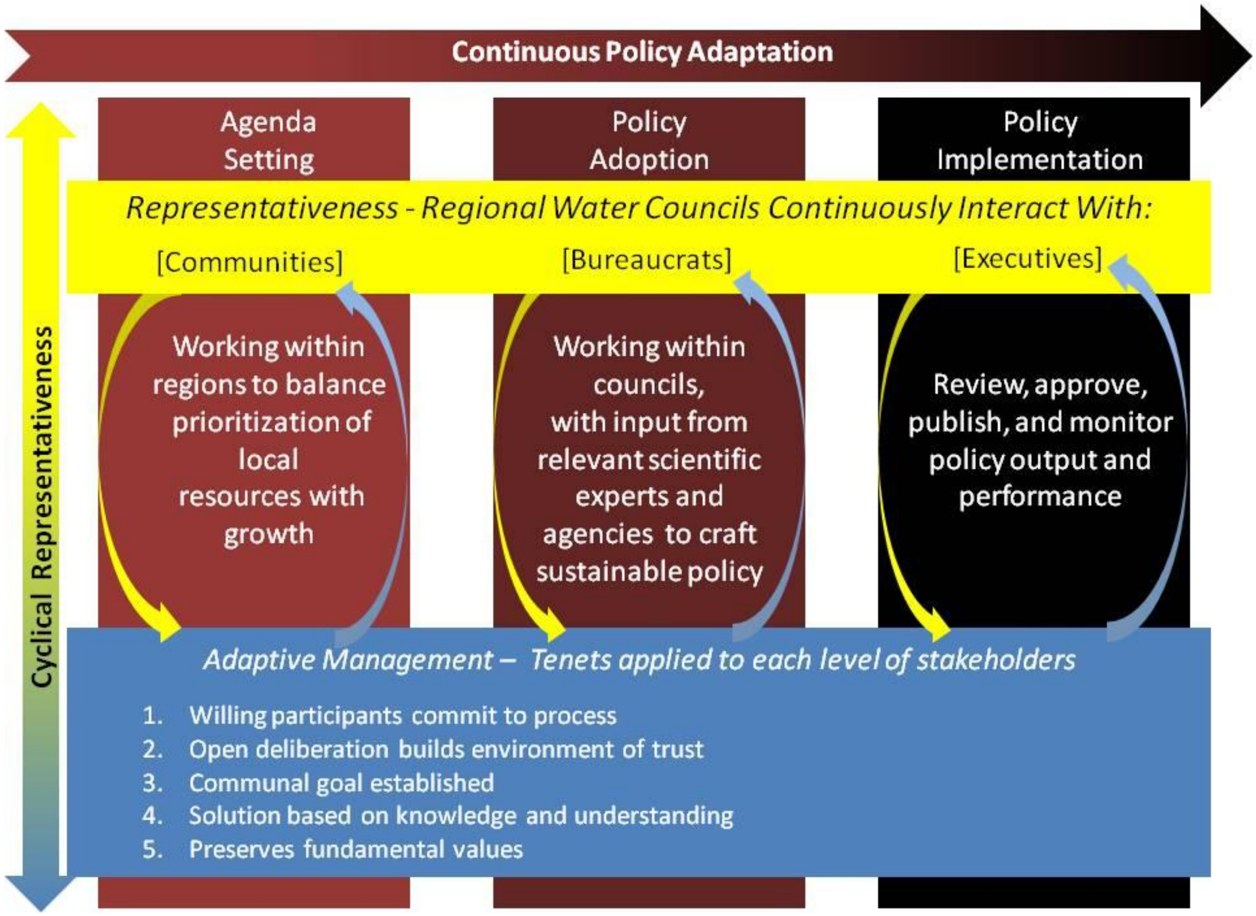

Figure 2 Continuous Policy Adaptation

Illustrated in Figure 2 is the relationship between continuous policy adaptation and the adaptive management-representativeness cycle. Achieving representativeness entails relevant levels of stakeholders working within the adaptive management framework in order to move policy development from one stage to the next.

Figure 2 highlights the cyclic relationship between adaptive management and representativeness, which drives the process of continuous policy adaptation. Applying the dynamic adaptive management paradigm (DAMP) to accepted Theory of the Policy-making Process (Dunn, 2004) drives a continuously adapting policy process supportive of continually changing resource priorities. As indicated by the vertical yellow-to-blue color band, maintaining representativeness within each stage of the policy process in turn maintains the tenets of adaptive management needed to complete that stage of the process and advance toward achievement of the communal goal, a sustainable regional water plan. The horizontal movement, the maroon-to-black color band, depicts the progression of the policy process. Both cyclical representativeness and continuous policy adaptation are described in further detail below (see Figures 3 and 4). Colors have remained constant throughout the five figures to maintain the continuity of the model.

The unknowns of attaining sustainable water policy call for continuous policy adaptation. Maintaining representativeness throughout this process therefore calls for an interactive cycling of representativeness and policy adaptation wherein representative policy makers adhere to the adaptive management framework throughout each stage of the policy process. For example, during agenda setting representatives in the form of regional council members openly discuss their respective interests, concerns, and goals with each other, state officials and the public in order to assure comprehensive understanding of the situation.

3.2.1. Dynamic Adaptive Management and Representativeness

Each stage of the policy process evolves and depends on cyclical relationship between adaptive management and representativeness.

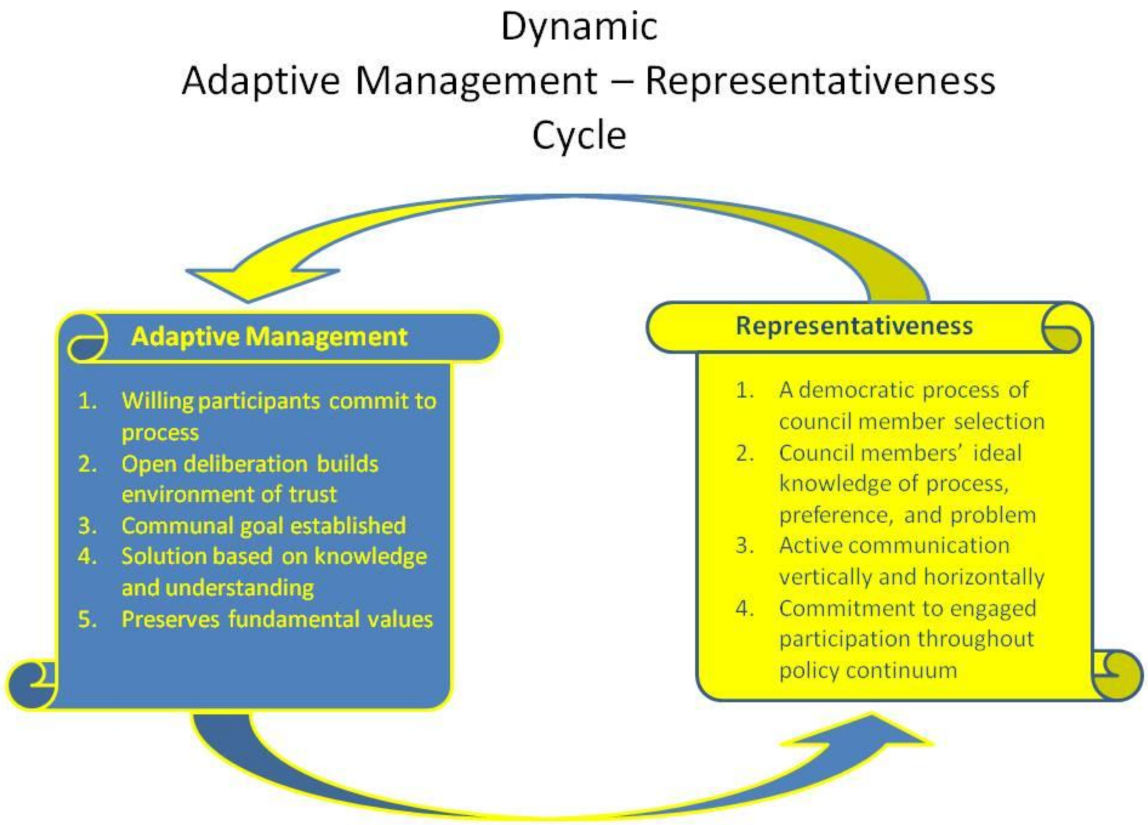

Figure 3 Dynamic Adaptive Management - Representativeness Cycle

Figure 3 depicts the cyclic relationship between representativeness and adaptive management. It highlights the connection between the principals of adaptive management and the tenets of ideal representativeness.

Adaptive management fosters representativeness. In turn, representativeness fuels adaptive management. The cycling of these fundamental components defines an intrinsic dynamic which is representative of the shift from outdated static management techniques to novel dynamic management methodologies.

Participants must come into the process willingly, make a commitment to see the process through. Open deliberation builds an environment of trust, through which a communal goal can be established. Once a goal is established a solution can be recognized. The final solution will preserve the fundamental values of all participants.

Idealized representativeness begins with a fundamental democratic selection process to appoint regional council members. The traditions of democratic processes set the conditions for representation which corresponds to the interests of the region represented. The precepts of representativeness build on each other. Representatives must first actively engage at all levels to establish notions of regional preference. Secondly, representatives must validate feasible policy alternatives necessary to accommodate regional preferences while sustaining adaptive management tenets. In addition to knowledge, representatives must communicate thoroughly both horizontally with other members and vertically to constituents, leaders and scientists to ensure fully coordinated, feasible policies necessary to affect regional preferences. Finally, representatives must be committed to fully engaged participation necessary to sustain the dynamic, self-correcting management methodology throughout the continuum of water resource plan supporting policy evolution (see Figure 4).

3.2.2. The Policy Continuum

> *"…stakeholders develop a management plan…the management plan is then implemented along with a monitoring plan. As monitoring proceeds, new data are analyzed and management plans are revised as we improve our understanding of how the system works (Johnson, 1999)."*

Figure 4 begins with the introduction of a plan containing numerous, integrated independent and interdependent supporting policies. Throughout the dynamic policy continuum, the water resource plan's policies are continually assessed per the adaptive management-representativeness cycle. A cycle begins with the issuance of a policy directive. Through this cycle, council members actively monitor for environmental response to the issued policy.

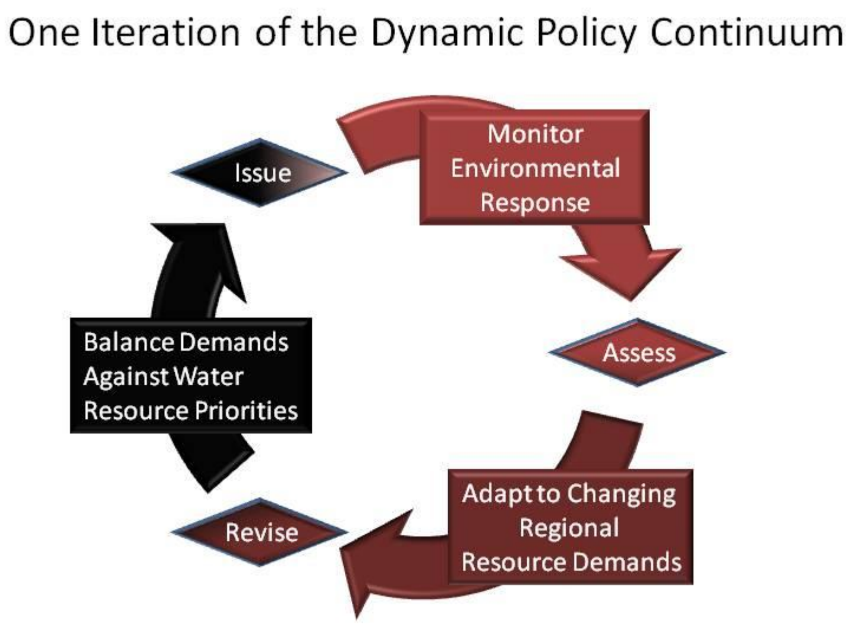

Figure 4 One Iteration of the Dynamic Policy Continuum

Figure 4 illustrates the evolution of the dynamic policy continuum. Highlighted are the steps of policy issuance and evaluation. Diamonds are steps in the policy evaluation process; blocks indicate subsequent evaluation actions.

At the end of this phase, the policy is formally assessed, during which adaptations are prescribed necessary to adapt to regional growth demands and potential resource imbalances. Upon identification of resource imbalances or previously unaccounted for changes in growth demand, necessary policy revisions are proposed. The proposed revisions are weighed against the state demand categories and overall affect on regional resources. At the end of the cycle, the revision is issued as the next iteration of policy directive(s) (see Figure 5).

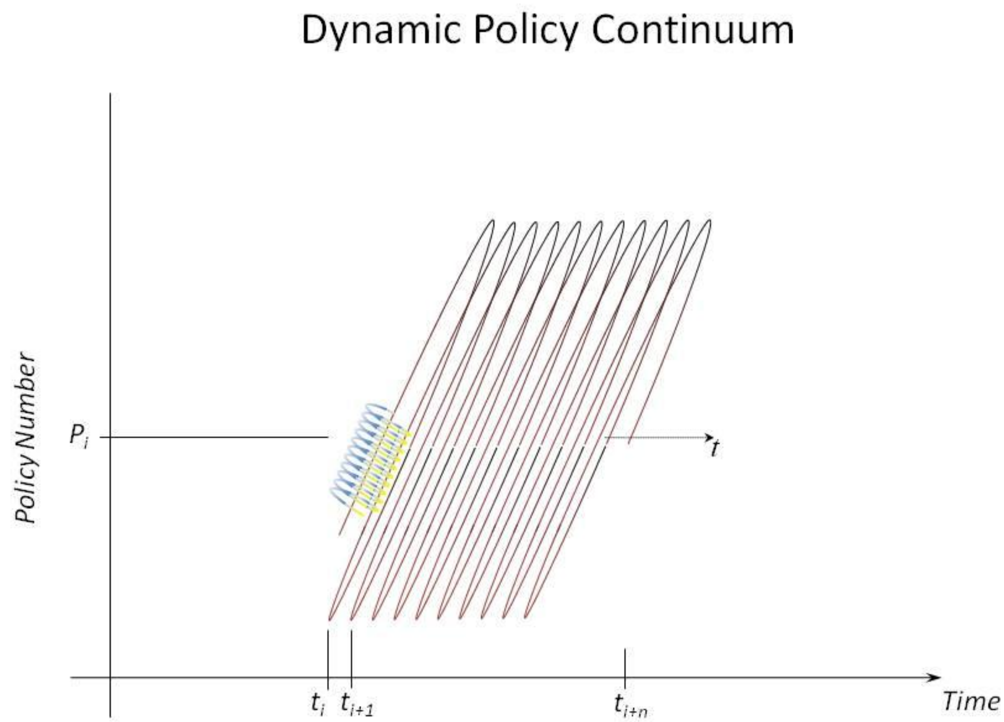

Figure 5 Dynamic Policy Continuum

Figure 5 illustrates one policy evolving along the dynamic policy continuum. The graph illustrates the time evolution of a single policy along the dynamic policy continuum. The large coil about the policy axis indicates the evolution of the dynamic policy continuum (Figure 4). The smaller coil illustrates the time evolution of the adaptive management-representativeness cycle (Figure 3) as it drives iterations of the dynamic policy continuum. From t_i to t_{i+1} represents one iteration of the cycle.

This figure models the relationship between the adaptive management-representativeness cycle evolving along each iteration of the dynamic policy continuum. One loop of the dynamic policy continuum composes iteration *i*, lasting in duration from time *i* to time *i+1*. The progression of the dynamic adaptive management – representativeness cycle drives a sustained dynamic policy continuum.

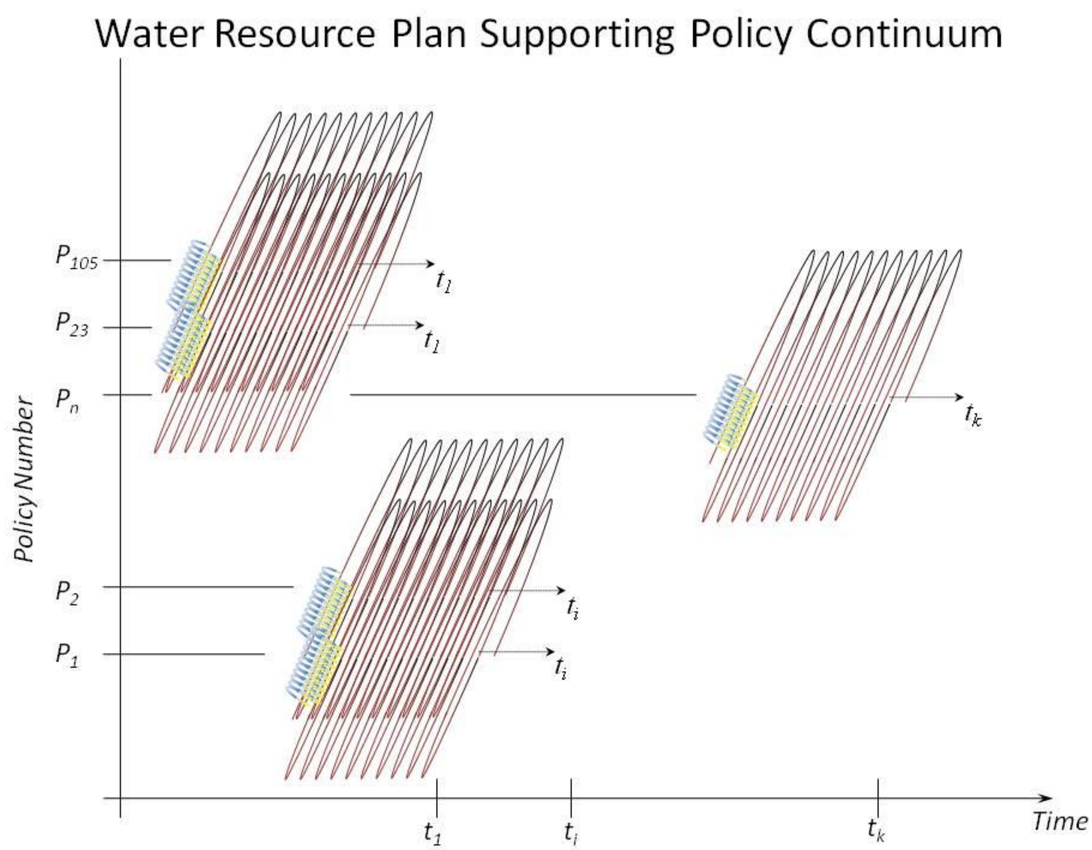

Figure 6 Water Resource Plan Supporting Policy Continuum

Depicted in Figure 6 are varying policy development relationships. Each P_i represents one policy developing along the dynamic policy continuum (Figure 5). Policies can depend directly on other policies (i.e., P_1/P_2), groups of policies can be independent of each other (i.e., P_1/P_2 and P_{25}/P_{105}) and some policies are completely independent (P_n). Further, these related policy developments can occur at either synchronous or asynchronous time intervals. These relationships highlight the dependency between varying degrees of policy complexity and the requisite time necessary to carry out the policy life cycle.

The policy plan is made up of a system of policies. Some if these policies form interdependent groups, which are independent from other groups of interdependent policies and independent policies. Some lag behind others on the timeline. Policies are being established, assessed, adapted, revised, and re-established along corresponding timeframes with interdependent supporting policies. Likewise, independent policies are being established, assessed, adapted, revised, and re-established during independent time periods. Throughout the policy lifecycle the dynamic adaptive management paradigm continually drives the Georgia regional water resource management process.

The current water planning process is geared to produce a plan. Even though this plan is scheduled for periodic revision, the process for doing so at 3-5 year intervals is static. While the plan is on the shelf in the 3-5 year interval the system is subject to punctuated-equilibrium. The current focus is to sustain the plan. However, the goal is not to sustain the Georgia water plan; the goal is to sustain Georgia's planning priorities. The adoption of a dynamic adaptive management process rather than a plan guarantees continual representativeness and vigilant assessment of the sustainability of the Georgia state water planning priorities. This paradigm supports sustaining the priorities. This entails a readiness to respond to necessary shifts in policy which correspond to incremental shifts in resource status quo.

3.3. Empowered Adaptive Management

Adaptive management drives the policymaking process as a process for continual improvement in response to water resources and resource demands. As understanding of the relationship changes through monitoring of the effectiveness and efficiency of the policy's successful accomplishment of the communal goal, policy adaptations are made.

> *"The policy process is composed of complex rounds or cycles. Each phase is linked to the next, in backward and forward loops, and the process as a whole has no definite beginning or end (Dunn, 2004)."*

The strength of adaptive management as a policymaking framework lies in its emphasis on continual adaptation, allowing policy development to continue under conditions of uncertainty. Mitigation of uncertainty is achieved by emphasizing representativeness of policymakers. Regional council members who know and are able to communicate their representative's interests will be better able to develop a regional water management plan that meets the communal goal of their constituents. Therefore, adaptive management demands representativeness throughout the process.

Prior to plan development, representatives adhering to an adaptive management process must develop a communal goal. This goal is reached through the willingness of representatives to foster an environment of open communication, both sharing the knowledge and values of the interest they represent and listening to the body of other interests.

3.3.1. Vested Stakeholders

Representativeness in the case of water policy refers to the inclusion of all interests affected by water management decisions. As regional water plans affect everyone within the region, and council members are drawn from citizens of the region, there is some level of representativeness guaranteed among council members. However, the selection process should ensure council members are vested stakeholders, fully committed to representing the interest they have been nominated to represent as well as developing a plan in the best interests of their region.

3.3.2. Essential Communications

Communication is a vital aspect of adaptive management, as well as a fundamental tenet of representativeness. At every stage of the process communication facilitates knowledge necessary to coordinate regional preference and regulatory constraint. Development of a water management plan representative of the region's interests requires knowledge of the interests and sharing of ideas for balancing demands within resource limitations. Communication must occur within councils, between council members and their constituents, and with scientific experts and government officials. An ideal representative will be best suited for managing essential communications across these multiple levels.

3.3.3. Continuous Assessment

The limit of Georgia's water resources and the uncertainty regarding a sustainable plan highlight the importance for an adaptive management framework to continuously assess regional plans. This assessment does not end with policy creation, it must continue indefinitely throughout the life of each policy. Shifts in the attitudes of constituents and their values, in population size, and in resource availability may occur at any time. Continuous assessment allows the recognition of these shifts and adaptation of the plan in a timely manner, proactively preventing policy failure.

CHAPTER 4. ANALYSIS

Data analysis, survey analysis, and firsthand participation served to assess the nature of current resource demands, the perceptions of managing individuals with respect to policy goals, and the propensity for regional council success. This analysis focuses on the core function of representativeness.

> *"Two primary challenges that impede efforts to develop and implement adaptive governance for decisionmaking…are representation and scientific learning…(Ruhl, 2005)"*

The aim here is to draw significant inference into the level of representativeness as it relates to the currently emerging regional water planning process. The existence of representativeness implies a significant potential for transition to a dynamic adaptive management process.

4.1. General

Research for this study was performed while assisting Dr. Paul Hirsch in part of his earlier study of the Georgia State Water Plan's Advisory Committees, and interning with Shana Udvardy, of the Georgia Conservancy. As part of ongoing interest in the State's water planning process I worked with Ms Udvardy and the Georgia Water Coalition, a non-profit alliance of 176 environmental interest organizations working toward fair water management for all Georgians (Georgia River Network, 2002), to coordinate public observation and participation in the Regional Water Planning process. Data collection was performed in three parts. The first consisted of the aforementioned participant observation and coordination in the form of attending Regional Planning meetings and collecting notes. The second part entailed designing a survey modeled on one performed by Hirsch (Hirsch, 2008), but adjusting for the new audience, timeline, and concerns identified through observation. The third area of research was collection of regional characteristics for comparison to regional council makeup.

4.1.1. Description of Population

Initially, participant observation of the water planning process had an all-inclusive population; anyone attending a regional planning meeting was considered a member of the population and subject to observation. This included all official parties attending regional water planning meetings, and all members of the public. Official parties consisted of the councils, their EPD staff facilitators, and EPD-hired contractors, who assisted in gathering material and offered expert knowledge on regional water planning. The composition of the public also varied. It included representatives from universities, environmental organizations, other government organizations not directly involved in planning, and concerned citizens whose livelihoods depended on council decisions. The survey population was limited to the three hundred regional council members, whose backgrounds differed, but were all elected government officials. The three hundred council members belong to ten regional councils, each consisting of 30 members: twenty-five voting members, three alternates and two ex-officio members. Together the council members were meant to represent Georgia's varied water interests, namely "agriculture, forestry, industry, commerce, local governments, water utilities, regional development centers, tourism, recreation and the environment" (Georgia Environmental Protection Divison, 2009).

4.1.2. Qualitative Analysis and Observational Research

The practice of analyzing representativeness in Georgia's regional water planning process began with participant observation of planning meetings. Through witnessing the process and hearing comments made by regional councils, state agency employees, and the attendant public, positive and negative aspects of the process were observed. This observation led to questions of how representativeness might be achieved, whether it was achieved by Georgia policymakers, and how it could be increased.

The regional water planning portion of Georgia's state water planning process began with a Kick-off Meeting held March 13, 2009. The Kick-off was followed by quarterly individual regional council meetings and joint council meetings between regions sharing river basins. These regular and joint meetings were open to the public. From March to December 2009, regional water planning processes were observed through attending the Kick-off meeting and several regional planning meetings. Additionally, EPD-provided regional facilitators were contacted and *Georgia's State Water Plan* webpage (Georgia Water Planning, 2009b), which became fully operational July 22, 2009, was monitored to obtain agendas and pre-meeting materials. During this time, coordination with the Georgia Water Coalition provided opportunities to discuss meeting agendas, and to share notes and observations from regional meetings. Finally, published facilitator notes for all meetings, publicly available from *Georgia's State Water Plan* webpage, were collected.

During participant observation and discussions, the key aspects looked for were statements made about the process: participant familiarity with the process, who was involved in decision making, their attitudes toward the process, and how questions were received. Compilation of notes revealed repeated areas of concern with the policy process (see Appendix). These concerns were considered, and from there it was decided stakeholder representation was an important aspect to the legitimacy of the process, and that the developing process provided an opportunity for analyzing representation as the process unfolded.

4.1.3. Quantitative Data: Regional Characteristics

An analysis of representativeness cannot occur without an accurate portrayal of the population. Actual regional data was needed to provide a basis of comparison for the affiliation of regional water councils gathered in the survey. Therefore, data was gathered regarding regional water use, such as population trends, occupational information by sector, and land use and water withdrawals for the four different use sectors. Gathering information on regional characteristics and then comparing them to the survey participants' characteristics revealed how well the interests of planning regions were represented by the council selection process.

4.2. Data Analysis -- Establishing Regional Demand Baseline

The United States Department of Agriculture's (USDA) Economic Research Service (ERS) State Fact Sheets: Georgia (USDA Economic Research Service, 2010) provided comparative data on population, employment and farm characteristics for the state. The ERS database also provided "County-Level Population Data for Georgia" which showed percent changes in county populations between 2000 and 2009 and mapped county changes.

Forecasted regional population data was obtained using information from the Georgia Governor's Office of Planning and Budget's (OPB) Georgia Population Projections 2010-2030 (Governor's Office of Planning and Budget, 2010), released on March 12, 2010. Regional Water Councils used the same data, with projections to 2050, for their own planning purposes. Since these were the official projections used by the state for planning purposes, they should be acceptable for use in population comparisons. The document was obtained, and the population projection data imported into MS Excel, after which counties were sorted according to their water planning region[2]. Water planning region population projections were obtained by adding populations for the counties in each region. Yearly growth rate was obtained by subtracting the population in 2010 from the projected population in 2030 and dividing the total by the span of years, twenty. The percentage growth rate was obtained by dividing the yearly growth rate by the initial population size in 2010 and multiplying the total by 100. These figures provide a sense of the overall population of each region and its growth rate (see Figure 8 below).

Georgia statewide industry employment data by sector was obtained from the United States Department of Labor's Bureau of Labor Statistics *Quarterly Census of Employment and Wages (QCEW) Location Quotient Calculator (U.S. Bureau of Labor Statistics, 2008)*. Percent employment for Georgia and Location Quotient numbers were used to understand the composition of employment industries in Georgia.

From UGA's Georgia Statistics System: Cross Sectional Analysis (Kriesel, 2010) a county-by-county analysis was performed to obtain county and statewide agricultural activity information.

[2] Listings of counties found in each water planning region can be obtained from the Georgia water planning website (Georgia Water Planning, 2009b).

Query steps were completed as follows:

Step 1: Selected "All Counties and State"
Step 2: Main Category: Agriculture
    Subcategory: Farm Characteristics
    Variables:
        Number of Farms, % Change, 2002-2007
        Land in Farms, % of Total Land, 2007
        Irrigated Acres, 2008
Step 3: Type of analysis: See the Data

Figure 7 Query Steps to Obtain Employment Data

The query was repeated to obtain employment data, variables chosen were: All Industries, Avg. Employment, 2008; Employed, Number, 2008; and Unemployment Rate, 2008.

A county-by-county overview of water use by sectors for 2005 was released by the Georgia Department of Natural Resources (DNR) in 2009, and the analysis provided by Drs. Fanning and Trent was used to compare trends in water use. The data also aided in an analysis of water use by the energy sector. County data was aggregated to water planning regions, thereby completing the view of regional activity for analysis.

4.2.1. Quantitative Data: Regional Characteristics

Comparison of water use by the four plan-identified water demand sectors approximates the actual proportion of water demand within regions. This proportion can then suggest the makeup of regional council members needed to achieve a truly representative mix of interests. One of the limitations to state planning was water use data had never been collected in a comprehensive manner, and thus a first attempt at obtaining this data is still being developed at the time of this study, and the available reports are in draft form. Data needed to make a comparison of all water demands throughout the state relied on these emerging drafts and earlier reports from different state agencies, such as USGS Water Use in Georgia by County for 2005; and Water-Use Trends, 1980-2005 (Fanning & Trent, 2009), from which some of the regional planning water use data was derived.

The state water plan divided water demand into four use sectors: agricultural, energy, industrial, and municipal. One of the mandates of the state plan was the construction of quantitative and qualitative resource assessments of the state's water and wastewater demand by use sector. These assessments were then used to create forecasts of water use by sector in ten year increments through 2050. There are key differences in water use: some sectors, such as hydroelectric power plants, use water in-stream with little effect on the water itself. However, with insufficient in-stream flow these plants may not be able to function. Public supply, which falls under the municipal demand category, is a much more consumptive use, and is also dependent on water quality sufficient for human consumption. Regional planning must account for the source of water, the quantity and quality used, and the consumptiveness of use for each of the four water demand sectors specified in the state plan.

4.2.2. Agriculture Water Demand

Agricultural water use figures used for regional planning consisted of agricultural irrigation data compiled by the University of Georgia's College of Agricultural and Environmental Sciences, under contract to Georgia EPD. The only relevant sector from Fanning and Trent's report for agricultural water use is irrigation. Fanning's data comes from 2004, and reports irrigation, including crops, large nurseries, athletic fields, and golf courses, used 752 Mgd, of which 65% was groundwater. Irrigation constituted the highest category of groundwater use in Georgia. This data is useful for the water use comparison of Fanning's data to survey data, but more recent and specific data has also become available. The University of Georgia's College of Agricultural and Environmental Sciences has worked under contract with EPD to provide agricultural water demand forecasts at county-by-county, watershed/aquifer and regional scales (Georgia State-wide Water Management Plan, 2009). Their 2010 regional data can be used to compare representation of agriculture by region to water council membership.

Table 1 Surface and Groundwater Irrigation Withdrawals, for an Average Precipitation Year (P50) (Mgd)

Region	2008	2010*	2011
Lower Flint-Ochlockonee	441.67	452.92	458.55
Suwannee-Satilla	123.79	126.73	128.21
Upper Flint	116.63	120.19	121.97
Altamaha	76.87	78.38	79.14
Savannah-Upper Ogeechee	51.98	52.51	52.78
Middle Ocmulgee	49.93	51.09	51.66
Middle Chattahoochee	22.36	22.97	23.27
Upper Oconee	20.03	20.20	20.29
Coastal Georgia	8.37	8.49	8.55
Coosa-North Georgia	2.99	3.03	3.06

UGA provided water use data in terms of millions of gallons for all counties. In order to compare irrigation data to the other three sectors of water demand, data was sorted by region, and then aggregated to obtain regional irrigation totals. Finally, the totals were divided by 365 to provide values for daily use (Mgd). Agriculture estimates were provided for the baseline year, 2008, and then for 2011 forward. In order to improve the comparison of current representativeness between water demand categories, an estimate of agricultural water demand for 2010 was created from the 2008 value and the projected rate of increase from 2008 to 2011 (see Table 1) using the equation $x_{2010} = x_{2008} + {}^{2}/_{3}(x_{2011} - x_{2008})$, where x equals water use for the year indicated in subscript. Data indicates that the region of greatest agricultural irrigation is by far the Lower Flint-Ochlockonee region, at about 453 Mgd.

Table 2 Farm Data from UGA's *Georgia Statistics System*

Region	Land in Farms, % of Total Land, 2007	Irrigated Acres, 2008	Number of Farms, % Change, 2002-2007
Lower Flint - Ochlockonee	56	631,688	1.37
Suwannee - Satilla	37	204,857	-2.92
Upper Flint	35	179,481	11.57
Altamaha	36	169,528	-5.56
Savannah - Upper Ogeechee	27	84,244	-0.04
Middle Ocmulgee	23	65,960	-0.35
Middle Chattahoochee	18	40,639	11.82
Coastal Georgia	9	23,160	2.25
Upper Oconee	26	20,293	2.51
MNGWPD	10	19,935	-23.86
Coosa - North Georgia	19	6,969	-1.81
State	28	1,446,754	-2.97

Farm data obtained from UGA's Georgia Statistics System (Kriesel, 2010) enhances the picture of agricultural activity in Georgia. The number of irrigated acres per region gives a sense of the scale of agriculture in each region. We can see that Lower Flint-Ochlockonee has the largest number of irrigated acres of the regions. This supports the finding that the Lower Flint-Ochlockonee has the greatest volume of water withdrawals for irrigation. The percent of total land used for farming indicates the amount of agricultural activity in the region. Lower Flint had 56% of its total lands in farms in 2007, and we can see by the positive 1.37 percent change in number of farms that percentage of land in farms and irrigated acres may have been increasing as more farms open in the region. The percent change in number of farms per region is very useful to the analysis of representativeness as it shows the trend in farm interest per region. An area that has a high percent change, such as the Altamaha, is losing farms. This might indicate stakeholder interest in the region is shifting away from agriculture. While this does not necessarily impact the calculation of representativeness of current interest, it is a useful tool to keep in mind as water planning continues, and as future council member selections are made.

4.2.3. Industry Water Demand

The state plan combined industrial, mining, and livestock water use under the umbrella of industrial use. Major users in these sectors include pulp and paper mills in Coastal Georgia, textile industries in Northwest Georgia, chemical manufacturers, mining and mineral industries, poultry, catfish and trout farming. The USGS reports that in 2005, at a statewide level, mining withdrew a comparatively small amount of water at 49 Mgd, of which 99% was groundwater. Industrial self-supplied water used an estimated 554 Mgd, of which 43% was withdrawn from groundwater. Livestock used about 28 Mgd, while aquaculture used about 38 Mgd. The majority of water used, 89%, was surface water.

Table 3 Total Industrial Water Demand by Region (Mgd), Average Annual Demand (AAD)

Region	2010	2020	2030	2040	2050	Increase (2050-2010)
Coastal Georgia	221.89	222.05	222.17	222.32	222.49	0.6
Savannah - Upper Ogeechee	159.06	165.27	169.79	174.73	180.33	21.27
Lower Flint - Ochlockonee	129.97	131.48	132.07	132.58	133.12	3.15
Coosa - North Georgia	81.47	98.88	113.58	125.97	138.83	57.36
Upper Oconee	70.21	79.48	88.49	97.45	106.59	36.38
Altamaha	62.28	67.16	69.24	70.83	72.6	10.32
Middle Ocmulgee	39.88	47.88	53.83	59.82	65.93	26.05
Upper Flint	20.19	27.08	28.78	30.46	31.24	11.05
Suwannee - Satilla	14.35	16.69	18.34	20.07	22	7.65
Middle Chattahoochee	5.19	5.47	5.56	5.65	5.77	0.58

Draft March 2010 Industrial Water and Wastewater Demand Forecasts (Georgia Water Planning, 2009a) were provided to regional councils by the Carl Vinson Institute at UGA, and demonstrate aggregated industry water demand by region (see Table 3). The relatively large water demand in Coastal Georgia is attributed to the paper industry in that region. The majority of Lower Flint-Ochlockonee's industrial water demand, 114.6 Mgd, comes from the paper industry. Savannah-Upper Ogeechee's 159 Mgd of water demand comes from equal demand by the paper and chemical industry.

Analysis of the forecasted demand reveals all regions are projected to experience growth in industry over the next forty years. Coosa-North Georgia is expected to show the largest amount of growth in industry water demand, and is expected to outpace Lower Flint-Ochlockonee in terms of industry demand by 2050. The projection of continual growth for industry in all of Georgia's water planning regions is significant to the adaptive management model, and to determining representativeness, as the projections imply consideration of industrial water demand interests will be at least as, if not more, important to water planning over the next four decades as it is today.

4.2.4. Municipal Water Demand - Regional Population Projections

Regional water planning considers municipal water use to include residential, commercial and light industrial water use. Using USGS data from Fanning's report, this would include Public Supply, Domestic and Commercial water use sectors. Public Supply consists of a variety of domestic, commercial, and industrial uses that use an insufficient amount of water to require EPD withdrawal permitting. For planning purposes, municipal demand is dependent on the region's population and the daily average water consumption per person, which according to the USGS is between 80-100 gallons per day (gal/d) (U. S. Geological Survey, 2010). Minimum public supply amounts could then be estimated by multiplying the water planning region's population by 100 gal/d. This would not capture other municipal use, such as commercial and light industrial use, but would provide a baseline for minimum requirements. According to Fanning, Public Supply use in 2005 was about 1,800 Million gallons per day (Mgd), of which 78% came from surface water and 22% from groundwater. Domestic water use, or normal indoor and outdoor household uses like drinking, bathing, watering lawn, washing car comes primarily from the public supply, but some is self-supplied, primarily through wells or springs. A survey done in 1983 by the Georgia Water-Use Program (GWUP) estimated that domestic self-supplied water use is about 75 gal/d. In 2005, the estimated self-supplied domestic use of water was 1.6 million people, or 18% of the population (Fanning & Trent, 2009). Commercial water use includes businesses: i.e. restaurants, hotels, retail; government facilities; i.e. institutions: schools, hospitals, prisons; and recreational facilities. According to Fanning and

Trent, domestic and commercial withdrew about 120 Mgd and 29 Mgd respectively in 2005. Combined, public supply, domestic and commercial water use totals an estimated 1,329 Mgd of Municipal water use statewide in 2005.

Regional water councils were provided with Draft Municipal water and wastewater demand forecasts for use in developing their regional plans. These projections combined data from residential, commercial, and light industrial use, and gave forecasts by region through 2050 (see Table 4). This data is dependent on population projections developed by OPB, and a water use rate. The report indicates that 2005 was used as a base year for calculations in most cases(Governor's Office of Planning and Budget, 2010). The report released to the public by OPB only includes population projections from 2010-2030 (see Figure 8).

Table 4 Total Municipal Water Demand (Mgd), AAD

Region	2010	2020	2030	2040	2050
Altamaha	27.14	29.49	31.74	33.78	35.86
Coastal Georgia	78.27	93.79	110.97	126.76	142.52
Coosa	103.39	122.25	144.15	167.63	193.48
Lower Flint-Ochlockonee	51.96	56.42	60.81	64.43	67.58
Middle Chattahoochee	77.14	91.21	106.62	121.49	136.93
Middle Ocmulgee	75.38	88.97	105.27	121.84	138.6
Savannah-Upper Ogeechee	92.88	104.85	117.42	128.34	139.27
Suwannee-Satilla	49.73	55.62	61.85	67.74	73.75
Upper Flint	31.36	35.28	39.42	43.65	48.08
Upper Oconee	72.68	87.95	106.41	126.28	147.81

Population projections for water planning regions and the state showed a large projected growth rate for the state, spread across regions at varying rates. The state as a whole is expected to have a population of 14.7 million people by 2030, an increase of 4.6 million in 20 years. The state as a whole is predicted to grow by 2.29% per year. Of the ten water planning regions, the Upper Oconee region is predicted to have the highest yearly % growth, at 2.74%. This is larger than the Metro region's projected 2.52% growth, although in terms of population is significantly smaller at just over a half million, and is projected to reach almost 900,000 by 2030, while the Metro region will be at 7.8 million at that time. Coastal Georgia is, and is projected to remain, the most populous of the ten WPRs.

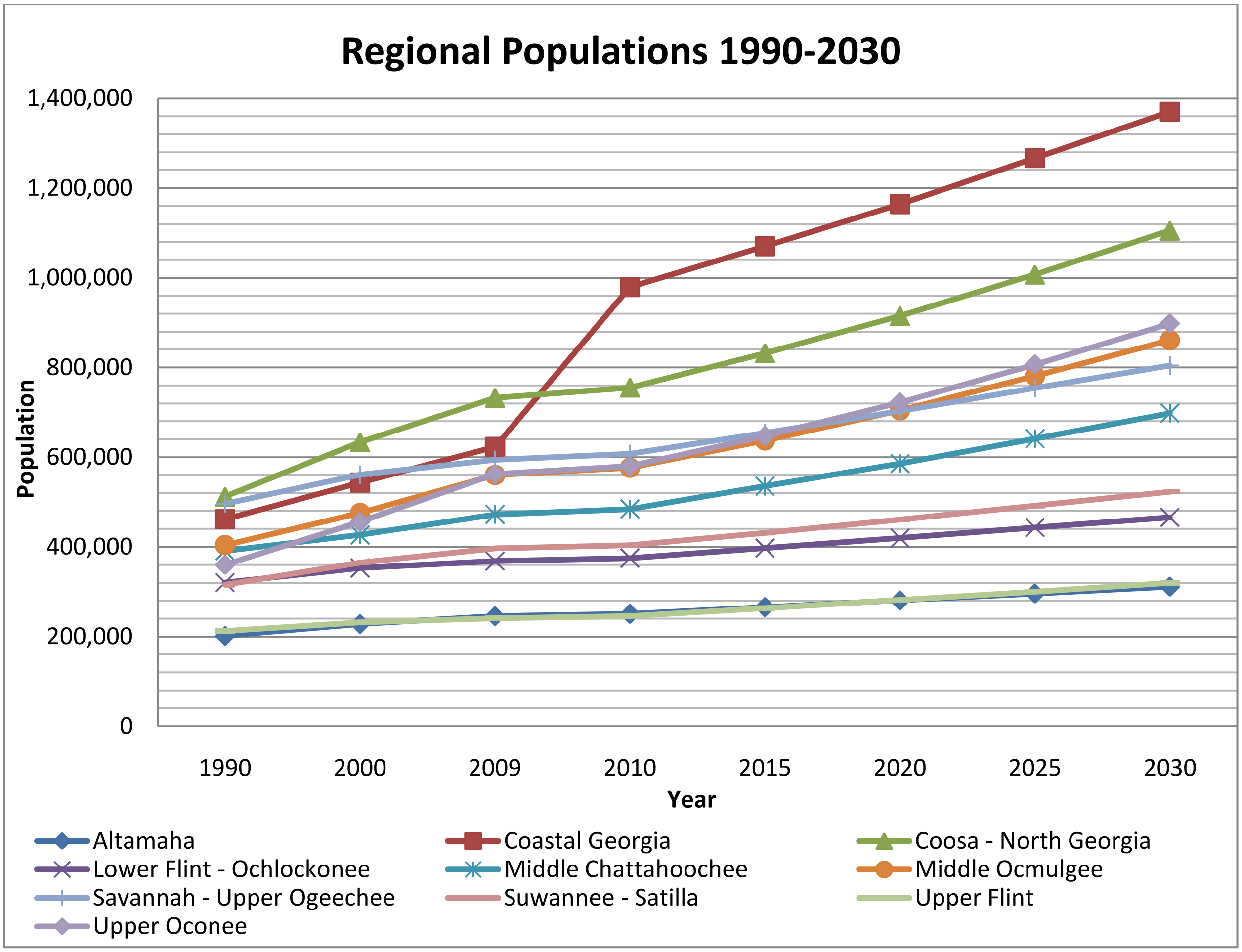

Figure 8 Water Planning Region Populations, 1990-2030

Figure 8 above shows the forecasted growth patterns of the ten water planning regions. Population growth data from 1990-2009, obtained from the USDA ERS, has been compared to the OPB's forecasted population growth. Both sets of data have been aggregated to the regional level. Analysis of the data reveals all regions are expected to experience a population increase over the next twenty years.

The significance of the population projections lies in the slopes, which appear to parallel each other. All regions appear to have the same trend in growth, and the proportional representativeness remained balanced based on the data. Therefore population growth is not going to throw off the proportions of municipal water use. There was very little variation in the growth between the regions, with the exception of Coastal Georgia. Coastal Georgia has experienced significant population growth the last twenty years, and is expected to more than double in size by 2030. However, the huge population increase of an estimated 400,000 people between 2009 and 2010 is unusual, especially as the other nine regions saw a more reasonable increase projected for a year's time. Trends in growth to the left and right of 2009-2010 have much flatter slopes, making this sudden increase suspect. Further study is necessary to determine if there is a reasonable explanation for the jump, or if it is due to an error in calculation. The similarity of growth paths for the ten water planning regions, with the exception of Coastal Georgia, indicates that while municipal water demands will be increasing steadily in the decades to come, the proportion of demand should remain similar. Therefore, with a proportional representativeness system based on interest over differences in population, such as the regional councils have, the balance between councils should remain roughly the same.

4.2.5. Energy Water Demand

Water use by the energy sector includes thermoelectric (coal-fired, oil, natural gas, and nuclear) and hydroelectric power generation. Hydroelectric power is non-consumptive and uses in-stream flow of surface water to generate power. Thermoelectric power withdraws the vast majority of water used for cooling. It therefore also relies heavily on in-stream flow for sufficient withdrawal quantities. The vast majority of water withdrawn is returned down-stream, giving thermoelectric low consumption rates, which are dependent upon the cooling system used at each plant. Fanning reported thermoelectric power used about 2,721 Mgd in 2005 (see Figure 15), while hydroelectric used approximately 54,096 Mgd. Using a coefficient of consumption it was estimated that thermoelectric facilities consumed approximately 184 Mgd (see Figure 16), comprising 14% of total water consumption in 2005. Forecasts of energy water demand have not yet been provided to regional water planning, so the data is not available for comparison. However, 2005 data can be used as a rough basis for comparison.

Table 5 Trends in Water Use by Thermoelectric Power Sector, for 1985-2005 (Mgd)

Region	1985	1990	1995	2000	2005
Altamaha	55.39	57.06	65.37	61.47	62.2
Coastal Georgia	501.53	505.4	607.32	255.21	292.67
Coosa-North Georgia	434.66	416.45	402	536.83	535
Lower Flint-Ochlockonee	178.23	107.75	109.34	166.17	120.9
Metro North Georgia	869.8	814.07	738.66	949.5	432.58
Middle Chattahoochee	22.84	3.64	0.05	71.04	65.53
Middle Ocmulgee	198.48	45.59	85.79	222.31	59.02
Savannah-Upper Ogeechee	198.48	45.59	85.79	222.31	59.02
Suwannee-Satilla	0	0	0	0	0
Upper Flint	2.2	0	0	0	0
Upper Oconee	1063.5	1046.6	1008.1	984.31	1092

Utilizing data included in the United States Geological Survey's "Water Use in Georgia by County" for 1995, 2000 and 2005 (Fanning & Trent, 2009), and Georgia Power's Summary of Consumptive Surface Water Use for 2005 (Georgia Power, 2006), a descriptive model of Georgia's current water use trends was created. Emphasis was placed on water use and consumption by thermoelectric energy producers, by water basin, as this data was not found elsewhere. Comparing the consumption levels from the 2005 data to total withdrawal amounts that year; percentage consumption was obtained for the thermoelectric industry, which we then applied to earlier reports to obtain consumption estimates for those years. A multivariate regression analysis was performed to explain how withdrawals in each sector impacted total consumption for a county (see Figure 9).

Thermoelectric power generation was the largest water user in Georgia in terms of total withdrawals from Georgia's ground and surface water supply, with an average withdrawal for the sector of 2,721 million gallons per day (see Figure 15). Withdrawals for thermoelectric power generation accounted for almost 50% of all withdrawals in the State (see Figure 16).

An analysis of thermoelectric withdrawals by river basin showed that demand by thermoelectric facilities was not evenly distributed across Georgia's river basins. The Oconee and Coosa river basins had Georgia's two largest power facilities in terms of average daily withdrawal, while the Chattahoochee basin's four power facilities combined to create the large demand seen for this basin (see Figure 15). An analysis of total water consumption by thermoelectric facilities revealed consumption did not mirror withdrawal levels in each river basin (see Figure 16). For example, the Oconee river basin had the highest level of withdrawal by a thermoelectric facility, averaging 1,092 Mgd, while consumption for this basin was only 3.3 Mgd. This very low level of consumption was due to facility-specific factors, such as cooling technology used, water chemistry at the facility, and other plant-specific factors. While the consumptive rate at this facility was 0.3%, consumption ranges from 0% to 70% of withdrawals for thermoelectric facilities in Georgia. Plant cooling technology is the primary determinant of consumptive rate, with nuclear the most consumptive, followed closely by coal and oil facilities, with combined cycle the least consumptive. While local factors such as water pH make each plant different, in general nuclear facilities consume 0.8 gallons per Kwh of electricity produced, coal and oil consume 0.7 gallons per Kwh produced, and combined cycle facilities consume 0.3 gallons per Kwh (Georgia Power, 2006).

While thermoelectric power generation represented the largest user of water in terms of withdrawals, this sector was not the most consumptive of the sectors presented in this analysis. Thermoelectric power generation was responsible for almost 50% of water withdrawals, and an estimated 14% of water consumption (see Figure 19). Although thermoelectric users had a low rate of consumption, the fact that they withdraw such a large volume of water means their absolute consumption was still quite high, at 184 Mgd. This was more than the total withdrawals for the domestic/commercial sector, which averages 149 Mgd or the livestock sector, which withdrew on average 67 Mgd.

The low consumption rate of the thermoelectric energy sector is encouraging, as it indicates the high demand for water does not represent complete loss of that water. However, the total volume of water demand is still removed from the water system, and while 93% of the total water withdrawn may be returned to the same system from which it was withdrawn, that is not necessarily the case. The water may be returned into a different system, which may flow into a different river basin. The quality of the water may also be altered, especially if it is filtered and treated as it cycles through the cooling process. Therefore, as the initial water withdrawal level is the amount actually demanded by thermoelectric water users, withdrawal amounts should be used in comparison.

4.2.6. Regression Model

Dependent Variable: Y = Total County Water Consumption 2005

Independent Variables: Total Sector Withdrawals for each sector

X_1 = Public Supply	1% sig
X_2 = Domestic/Commercial	
X_3 = Industrial/Mining	
X_4 = Irrigation	1% sig
X_5 = Livestock	
X_6 = Thermoelectric	1% sig

The regression results are as follows:

Total Consumption = 1.7 + .12(Public) + .49(Commercial) + .045(Industrial/Mining) + .98(Irrigation) + .16(Livestock) + .03(Thermoelectric)

$R^2 = .64$

Figure 9 Regression Analysis of Total Water Consumption by Use Sector

This figure illustrates the regression model used to examine the relationship between withdrawal and consumption by water use sectors. Highlighted is the fact that no sector grows in consumption at the rate of withdrawal, implying that no water use sector is 100% consumptive.

A regression model was used to explain the impacts of withdrawals per water use sector on total consumption for a county. The 158 counties of Georgia were examined with respect to the six US Geological Survey (USGS) water use sector categories (see Figure 9) in the development of this model. Creation of this model relied on the USGS data and Georgia Power's self-reported water use. The USGS began monitoring water withdrawal levels in 1980, but did not begin collecting reports of water consumption levels from different sectors until 2005. This is likely due to the state water planning process, which began subsequent to the USGS's 2000 report. However, comparing the consumption levels from 2005 to total withdrawal amounts that year percentage consumption for the thermoelectric industry was obtained, then applied to earlier reports to determine consumption estimates for those years.

The Beta coefficients for each sector indicate the magnitude that 1 Mgd of withdrawals in that sector have on total water consumption for that county. The R^2 value 0.64 gives confidence in the model, which assumes that water withdrawals accurately predict water consumption rates. This anecdotal vignette highlights a significant difference between withdrawal and consumption, specifically within the category of thermoelectric water use. While not all coefficients had a high level of statistical significance, the coefficient on thermoelectric withdrawals is significant at the 1% confidence interval, and is quite low. The model indicates that for every 1 Mgd of withdrawals for thermoelectric use, water consumption increases by just 0.03 Mgd. While the value of the coefficient is likely not precise due to limitations placed on the model by limited data, the results of the regression analysis are consistent with other analyses that indicate thermoelectric power generation is not highly consumptive. Both withdrawal and return rates from the thermoelectric sector are high compared to other sectors. Further, thermoelectric water demand is positively skewed toward withdrawal and negatively skewed toward consumption. The net result is a weakened ability for withdrawal to predict consumption.

This analysis highlights the potential to further improve the water resource management process through integration of adaptive management by incorporating a consumption metric as a feedback mechanism for policy process assessment. This improvement would allow more precise resource demand accounting as a function of consumption.

4.2.7. Quantification of the Environment

Fanning and Trent's proportions of total water withdrawals in 2005 provide an initial comparison of water demand to representation of water sectors by survey respondents.

Table 6 Water Withdrawals in 2005 by State Water Demand Sectors

State Water Use Sectors	2005 Water Withdrawals (Mgd)	Percentage of Total Withdrawn
Energy Water Use	2,721	49.7%
Municipal Water Use	1,329	24.3%
Agricultural Water Use	752	13.7%
Industry Water Use	671	12.3%
Total Water Use	5,471	100%

As can be seen in Table 6, in 2005 statewide the energy sector withdrew the greatest amount of water, comprising almost 50% of total withdrawals. Municipal water use was second largest at 24% of withdrawals, followed by agricultural at 14% and industry at 12%. This data is useful to get a complete picture of state water demand, however as this includes demand from the Metro North Georgia region, it cannot be directly compared to the data provided by 2010 Draft Water Demand information provided for regional water planning.

4.3. Survey Analysis -- Assessing Council Member Affiliation and Representativeness

A survey of regional water planning members was conducted in order to determine a methodology for assessing council member affiliation and the corresponding representativeness. By this I mean to establish a metric relating council member primary and secondary affiliations to level of representativeness.

4.3.1. Survey Development and Execution

As part of the original water policy research, a survey was conducted of Regional Water Council Members' views towards the State Water Planning Process. This survey examined interests delineated by council members and stakeholders during public comment periods and conference calls. In addition to current interests, this research was seen as an opportunity to further observations made by Dr. Paul Hirsch, who performed a similar study with the Basin Advisory Committee (BAC) in 2007. The survey questions are closely modeled after those of Hirsch's BAC survey to enable some comparison of decision-making rationale through different stages of plan progression. Changes were made to account for new stages and membership, and to tailor the survey toward examination of water management values. The majority of survey questions asked participants to choose from a set of provided responses. Response categories for the survey consisted of a mix of "forced choice" responses and Likert scale responses. "Forced choice" responses were used when the question focused on a topic for which a neutral response would provide no benefit to the study.

In order to have the largest, most representative sample possible all 300 regional council members were included in the study. Their contact information was then obtained from the EPD as a matter of public record. Given the large number of council members, located throughout the entire state, a desire to keep continuity with Hirsch's previous survey, and because this study was unfunded the decision was made to use an electronic survey, distributed to council members via e-mail.

The online survey software SurveyMonkey™ was used to develop the survey. Once the target participants were decided upon and the questions were written, Georgia Tech's Institutional Review Board (IRB) was contacted, and the study goals and final survey questions were approved in October 2009. The survey questions focused on identifying values and decision-making strategies of participants. All survey data are confidential. The study relies on aggregate responses, not individual data.

Survey administration began immediately following IRB approval. Electronic survey methodology and techniques outlined in Dillman's Tailored Design Method (Dillman, 2007) were followed. Council members were first sent a pre-survey notification message on November 10, 2009 giving information about the survey and offering to address any questions they might have, after which a feedback period was provided council members, before the survey was sent via e-mail on December 4, 2009. Council chairmen were contacted separately at this time, to give them further information about the study and ask if they had any further questions or concerns to address, but none were forthcoming. A follow-up email was sent on December 30, 2009 giving council members a final week to complete the survey and thanking everyone for their participation. The survey was closed on January 5, 2010 and data was gathered to begin analysis. Out of a potential pool of 240 participants, 86 council members chose to participate in the study, and 75 completed the survey. For the 75 completed surveys used in the analysis, there was a completion rate of approximately 31%.

Survey questions were designed to provide insight into regional water council members' decision-making processes, specifically whether any correlations could be found linking views to variables such as region of origin or organizational affiliation. An ideal council member will put the needs of their region first, but if council members were indeed chosen in a proportion that accurately reflects the make-up of their region, representing the views of their primary organization should allow the needs of the region to be accurately expressed. Another intention of the survey was to examine council members' participation in the process and how they felt developing regional water plans addressed the water concerns of their citizens. Questions with this goal ranged in scope from asking members how many regional planning meetings they attended, to what they considered their major affiliations to be, and what they considered to be of greatest concern for water management. Another possible area of analysis was a comparison of decision-making dynamics between the earlier Advisory Committees of the state plan, and current regional water council members.

Primary organizational affiliation, length of residence in Georgia, type of location and relative location in the state (upstream/downstream) are some of the parameters comprising the decision-making values of Regional Council Members. Each of these parameters has an effect on the way a member will view the state's water issues. For this reason, participants were asked to provide the above information.

The first five survey questions portray respondent demographics. Participants were asked to identify their water planning region and meeting attendance rate. Establishing this enabled a sense of average participation rate. Ideal planning groups will have high attendance rates and be comprised of empowered members.

Questions three and four established respondents' primary and secondary affiliations, which allowed comparison of council composition and overall regional interests. If the council member appointments matched the guidelines laid out in the State Plan, i.e. were "broadly representative" of their regions, then the spread of council member organizations should appear similar to the region's makeup. Assumptions were made that a council member's stated affiliation represents a use interest.

Question five established the length of time respondents lived in their current location, and in Georgia. The assumption was the longer a person lived in a place the more attached to it they are, and thus council members who had lived in Georgia for lengthy periods would be more invested in representing its interests. Similarly, the longer they'd lived in their region the more invested they would be in representing its interests.

Questions six thru eight asked council members to identify water quantity and quality concerns. Ideally, council members would be united in a maximal concern for both water quantity and quality. Results were used to compare concern among types of users and their beliefs in the effectiveness of the planning process.

Questions nine and ten established the prioritization for planning process goals and management techniques in order to discern council member perceptions of state-identified planning directives. Priority differences between organizations and regions were highlighted. Ideally, council members would agree with state prioritizations.

Questions eleven and twelve identified planning weaknesses and regional boundary effectiveness. Boundaries are county-based, and aligned along natural watersheds (Georgia Water Council, 2008). Focusing on the priority to provide water for human consumption first, we were interested in seeing if council members agreed that the boundaries meet the needs of humans at various planning levels from local to state level.

The thirteenth survey question asked for level of agreement with statements made at water planning meetings regarding water resources in order to determine council member agreement with prioritization of water use. Ideally, council members will represent the interests of the main water uses for their region, so prioritization should be consistent across their region.

Question fourteen assessed perceived fairness of representation of interest groups. We were interested in determining if council members felt any interests were either over or underrepresented. Council member representation should correspond to the distribution of regional interests.

The final question ranked perceived impact of council member involvement on the water plan, and vice versa. Council members' sense of empowerment was assessed. Ideally, council members feel highly empowered, thus ensuring their active participation in the process. Organizational affiliations listed in the survey were not exact matches to state water use sectors. However, these four use sectors were prescribed by the state plan as the way in which water demand would be considered for state planning purposes. Therefore, the affiliations presented in the survey were grouped as follows: agriculture remained as is; local government, water/wastewater facilities, Georgia citizen, environmental group, state government, and outdoor recreation were aggregated into the Municipal sector; industry (business) remained alone; unfortunately energy was not specified as a category in the survey, however there was one write-in under *Other*. Energy may have been somewhat represented in industry, but that cannot be determined.

4.3.2. Councilmember Representativeness

The council member selection process represents a pivotal portion of the regional water policymaking process in terms of effective adaptive management and assurance of representativeness. This is the stage where representativeness is either created or not, depending on who is appointed to serve on the council. An ideal selection process would know the mix of stakeholders in the region, solicit nominations based on that mix, and then appoint members who exactly match the regional interest mix. Thus, the beginning of the selection process is the initialization of the potential for representativeness.

As described earlier in this paper, the council member selection process was conducted by Georgia's Governor, Lt. Governor and Speaker of the House. The state plan prescribed the appointment of council members to represent the interests of the region. The threshold of representativeness of the resulting council members can be observed through compilation and comparison of regional water use data and population data. Following the model of ideal representativeness (chapter 3.1.1), current representativeness can be assessed for its fit to the ideal model.

Table 7 Estimate of Current Water Use per Sector for Water Planning Regions, 2010 (Mgd)

Region	Agriculture	Industry	Energy	Municipal	Combined Daily Water Demand per Region
	P50 2010	2010	2005	2010	2010
Altamaha	78.38	62.28	62.2	27.14	230.00
Coastal Georgia	8.49	221.89	292.67	78.27	601.32
Coosa-North Georgia	3.03	81.47	535	103.39	722.89
Lower Flint	452.92	129.97	120.9	51.96	755.75
Middle Chattahoochee	22.97	5.19	65.53	77.14	170.83
Middle Ocmulgee	51.09	39.88	59.02	75.38	225.37
Suwannee-Satilla	126.73	159.06	59.02	92.88	437.69
Savannah-Upper Ogeechee	52.51	14.35	0	49.73	116.59
Upper Flint	120.19	20.19	0	31.36	171.74
Upper Oconee	20.20	70.21	1092	72.68	1255.09
Total for 10 Planning Regions	936.52	804.49	2286.34	659.93	4687.28
Proportion of Demand	0.20	0.17	0.49	0.14	1.00

Mean of proportions: 0.25, Standard deviation: 0.1603

Table 7 above shows data compiled from draft estimates created under contract to EPD for use in regional water planning and posted to the state water planning webpage (Georgia Water Planning, 2009b), with the exception of the energy estimate. Where necessary, data was compiled into regions and transformed into units of millions of gallons per day (Mgd) for accurate comparison purposes. Industry and municipal data are estimates of average annual demand (AAD). The agricultural irrigation data used is an estimate of the amount of water withdrawal needed for irrigation based on variation in climate conditions. Estimates were provided on a scale of climate extremes, from extremely dry to extremely wet. For this comparison the data chosen was that based on an average climate condition (P50). Agriculture estimates were provided for the baseline year, 2008, and then for 2011 forward. In order to improve the comparison, an estimate for 2010 was created using the equation $x_{2010} = x_{2008} + {}^{2}/_{3}(x_{2011} - x_{2008})$, where x equals water use for the year indicated in subscript. A draft energy demand report was not yet completed at the time of this study, thus the next-best available data was obtained from a USGS report by Fanning and Trent published in 2009 (Fanning & Trent, 2009), which reported trends in water use by the thermoelectric energy sector through 2005. Due to large positive and negative shifts in water use when thermoelectric plants opened and closed, forecasting to 2010 was not feasible with this data set and 2005 data was left in its present condition. That this data is in draft form, and incomplete, is a limitation on the accuracy of the current suggestion of ideal representation, but the model can still be used to gain an idea of comparisons.

Table 8 Actual Regional Water Demand by Use Sector

Region	Agriculture	Industry	Energy	Municipal	Total	St Dev by Region	Mean
Altamaha	34%	27%	27%	12%	100%	0.09	25%
Coastal Georgia	1%	37%	49%	13%	100%	0.22	25%
Coosa-North Georgia	0%	11%	74%	14%	100%	0.33	25%
Lower Flint	60%	17%	16%	7%	100%	0.24	25%
Middle Chattahoochee	13%	3%	38%	45%	100%	0.20	25%
Middle Ocmulgee	23%	18%	26%	33%	100%	0.07	25%
Suwannee-Satilla	29%	36%	13%	21%	100%	0.10	25%
Savannah-Upper Ogeechee	45%	12%	0%	43%	100%	0.22	25%
Upper Flint	70%	12%	0%	18%	100%	0.31	25%
Upper Oconee	2%	6%	87%	6%	100%	0.41	25%
Mean	0.28	0.18	0.33	0.21			
St Dev by Sector (Total all Regions)	0.25	0.12	0.29	0.14			

Within regions, we assumed the sample mean (mean of each of the four use sectors) is equal to the average of the total population of committee members affiliated with that sector in that region. If use for agriculture is 34%, we assume 34% of the population is affiliated with that sector. This drives a mandate for 34% of the regional representatives to be affiliated with agriculture. Comparing the proportions of representatives per sector based on total state population to the actual regional use proportions per sector provides a relationship between state and regional sectors.

Table 9 Ideal Number of Representatives per Water Use Sector Based on Regional Water Demand Characteristics

Region	Agriculture	Industry	Energy	Municipal	Total
Altamaha	10	8	8	4	30
Coastal Georgia	0	11	15	4	30
Coosa-North Georgia	0	3	22	5	30
Lower Flint	18	5	5	2	30
Middle Chattahoochee	4	1	12	13	30
Middle Ocmulgee	7	5	8	10	30
Suwannee-Satilla	9	11	4	6	30
Savannah-Upper Ogeechee	14	4	0	12	30
Upper Flint	21	4	0	5	30
Upper Oconee	0	2	26	2	30
Total	83	54	100	63	300
Percent of Total	28%	18%	33%	21%	100%

Mean of regional council members: 30, standard deviation: 0

By holding the number of council members per region constant at 30, the number prescribed by the state plan, then multiplying the proportion of water use per sector in each region (see Appendix, Table 24) by 30, the ideal number of representatives per region based on regional characteristics was obtained (see Table 9). Assuming ideal representativeness matches actual regional interest characteristics, the proportion of representatives obtained should represent the ideal of representativeness.

Examination of the proportion of representatives per sector reveals that, based on actual water demand, energy should have the largest portion of representatives, followed by agriculture, municipal, and finally industry. This distribution of representativeness as a proportion of water demand can then be compared to the reported organizational affiliation of survey participants (see Table 10) to determine how closely the sample population of council members resembles proportional demand.

Table 10 Primary Affiliation of Survey Participants

Region	Agriculture	Industry	Energy	Municipal	Total
Altamaha	3	3	0	5	11
Coastal Georgia	0	2	0	6	8
Coosa - North Georgia	0	1	0	5	6
Lower Flint - Ochlockonee	4	0	0	2	6
Middle Chattahoochee	1	3	1	6	11
Middle Ocmulgee	3	1	0	4	8
Savannah - Upper Ogeechee	2	2	0	6	10
Suwannee - Satilla	4	3	0	0	7
Upper Flint	2	1	0	7	10
Upper Oconee	1	0	0	5	6
Total	20	16	1	46	83
Percent of Total	24%	19%	1%	55%	100%

A first look at the proportions of water use sectors between ideal and survey participant responses reveals a large amount of disparity between representativeness of the sample population and ideal representation. Based on the results of survey question 4, in which participants reported their primary organizational affiliation, Municipal water demand is the most highly represented interest sector, with 55% of participants choosing an organization that falls within the Municipal water demand category. Agriculture and industry interests are close to actual demand proportions. Energy appears to be grossly underrepresented in the sample population. Only one participant identified themselves with the energy sector, and according to regional characteristics approximately 33% of participants should represent energy.

Table 11 ALL Affiliations of Survey Participants

Region	Agriculture	Industry	Energy	Municipal	Total
Altamaha	10	8	0	16	34
Coastal Georgia	2	6	0	21	29
Coosa - North Georgia	2	3	0	12	17
Lower Flint - Ochlockonee	4	2	0	12	18
Middle Chattahoochee	4	7	1	27	39
Middle Ocmulgee	4	5	0	15	24
Savannah - Upper Ogeechee	4	6	0	19	29
Suwannee - Satilla	5	6	0	5	16
Upper Flint	3	6	0	24	33
Upper Oconee	3	5	0	14	22
Total	41	54	1	166	262
Percent of Total	16%	21%	0%	63%	100%
Total No. of Participants	86				

The third survey question asked participants to identify all the organizations with which they were affiliated, with no limit to number of responses per participant (see Table 11). Upon examination of the reported interests of survey participants, one can see the proportion of agriculture and industry represented swap places, and multiple interests which fall under Municipal demand are counted by some participants, but otherwise the rank ordering of proportion by demand sector remains similar.

Table 12 Ideal Number of Representatives Based on Proportion of Regional Population

Region	Agriculture	Industry	Energy	Municipal	No. of Representatives
Altamaha	5	4	4	2	14
Coastal Georgia	1	21	27	7	56
Coosa-North Georgia	0	5	32	6	43
Lower Flint	13	4	3	1	21
Middle Chattahoochee	4	1	11	12	28
Middle Ocmulgee	7	6	9	11	33
Suwannee-Satilla	10	13	5	7	35
Savannah-Upper Ogeechee	10	3	0	10	23
Upper Flint	10	2	0	3	14
Upper Oconee	1	2	29	2	33
Total	61	59	119	62	300
Percent	20%	20%	40%	20%	100%

Mean of regional council members: 30, Standard deviation: 12.95

Individual regional response rates per sector were of such small size that they are not feasible for individual regional statistical analysis. Aggregating representatives per sector to the state level gives more reasonable sample populations.

There is a correlation between standard deviation of interests and runaway power of that interest, i.e. if there's more standard deviation between interests there is a greater opportunity for one interest to have a controlling vote. The fact that standard deviation is lower implies that there is less variation in the level of representativeness per interest. Table 9 shows representation based on proportion of interest, while holding the number of representatives in each region constant. This type of division gives a balance of power to all districts, and favors less variation in statewide representativeness of individual interest groups. Table 12 holds the number of total representatives constant, but adjusts the number of representatives per region relative to the proportion of state population, which in turn increases the representativeness of specific functions while increasing the variation in functional representation across the state. Table 12 is creating disparities between regions by allowing more populated regions to have more representatives and thus have their interests dominate at the state level. It demonstrates the fallacy of majority rule; representation based on proportion of the population is ideal in principle, but not necessarily in practice, depending on one's goal. If the goal is to give every interest equal weight, then the current system in practice, equal number of council members per region, is the more appropriate system. State water planning using this method of council provides evidence of an adaptive management process.

Adaptive management is meant to balance goals among highly complex, multi-level functional priorities. A communal goal based on competing interests should not be determined by majority rule, or the democratic idealization of one man, one vote. The ideal state is that no one person, or group, is less than any other group. The determination of best practices by which to reach a communal goal of sustainable water management must consider all interests, including ones held by less populated regions. The interest-based system depicted in Table 9 gives a better balance of power to dominant interests in less densely populated regions. For example, a sparsely populated, highly agricultural area would not receive as many representatives in a population-based representation framework as it would in one based on interest.

Table 13 2010 Regional Population Estimates and Representativeness

Region	Population	Constituents per representative
Altamaha	250,659	8,355
Coastal Georgia	979,240	32,641
Coosa-North Georgia	755,255	25,175
Lower Flint	374,935	12,498
Middle Chattahoochee	484,390	16,146
Middle Ocmulgee	576,351	19,212
Suwannee-Satilla	607,167	20,239
Savannah-Upper Ogeechee	403,498	13,450
Upper Flint	245,827	8,194
Upper Oconee	579,873	19,329
Total	5,257,195	

The downside of a fixed number of council members per region is the sacrifice of population representativeness. From Table 13 one can see having 30 council members per region does not give an equal amount of representation to each region population-wise. There is a high degree of variation in population size between regions. The Upper Flint has the smallest regional population, at 245,827 people. Based on the total number of people in the ten regions, if council members are representing the population of their region proportionally, each council member in the Upper Flint region represents 8,194 people. Coastal Georgia has the largest regional population, at 979,240 people. Thus, each Coastal Georgia council member represents 32,641 people. There's a difference in representation of over 24,000 people between the largest and smallest regions. The Upper Flint representative has four times the power of the Coastal Georgia representative at the state level, but regions are independent and everyone only gets one vote.

Given the huge ratios of constituents to committee members, having eight representatives instead of ten should not make much of a difference. The biggest problem with disparity between representatives between regions is at joint committee meetings. If a region has no representatives for a sector, they have no voice to defend their interests. The need for equal power between interests is an argument for why each region needs representatives from every sector. It is also the reason why each committee should have the same rules of order with regard to voting quorums.

Intuition tells us having a smaller proportion of constituents per committee member provides better representation. A difference in proportions between regions seems less than ideal.

Table 14 Comparison of Proportions by Water Demand Sector 2010

Proportion Based On	Agriculture	Industry	Energy	Municipal	Descriptive Statistics	
Primary Affiliation Of Survey Participants	0.24	0.19	0.01	0.55	Mean	0.25
					St Dev	0.22
All Affiliations Of Survey Participants	0.16	0.21	0.00	0.63	Mean	0.25
					St Dev	0.27
Ideal Based On Regional Population Proportions	0.20	0.20	0.40	0.21	Mean	0.25
					St Dev	0.10
Ideal Based On Regional Demand Characteristics	0.28	0.18	0.33	0.21	Mean	0.25
					St Dev	0.07

Comparing the resulting proportions of interest between the survey participants and regional demand characteristics, we see agriculture and industry interests are likely represented within an acceptable threshold of actual regional interest. Energy interests are greatly underrepresented in reporting. Municipal interests are overrepresented compared to regional water demand, but given the wide variety of interests covered under the umbrella of municipal demand, this is not unexpected.

Environmental stakeholders are only captured as a portion of municipal interests, which does not afford a measure of their water demand. As such, the measure of representativeness of this individual group is not captured by regional characteristics of water demand which were gathered for this comparison.

4.3.3. Framework: Construct for Ideal Representativeness

In order to achieve ideal representativeness, there must be representatives capable of accomplishing the following things: effective knowledge of the problem and policy process, communication, deliberation, negotiation. In yielding individual interests to accomplish a communal goal, one must effectively negotiate so as not to violate individual values. This is the essence of adaptive management. An effective representative is a negotiator able to efficiently work toward accomplishing communal goals while preserving individual values.

An effective adaptive management process is comprised of four mutually exclusive and interdependent tenets: an ideal selection process, ideal knowledge, ideal participation, and ideal communication. In Georgia's water planning process, the determination of the ideal state will refer to the ability to fulfill the requirements of water policy development. The positive aspects of these attributes are mutually selective; meaning each of these four tenets brings their own unique strength to the process of representation. The tenets themselves are interdependent in that each leads to another.

The first step in creating an ideal policymaking process is to ensure an ideal selection process; otherwise the process is subject to bias from the very beginning. An ideal selection process will guard against bias on both sides of the nomination process: the creation of the pool of candidates, and the selectors making final nominations. Candidates should be drawn from a pool of volunteers who want the task and have demonstrated their qualifications as a policymaker, thereby creating as ideal a pool to select from as possible. Choosing from a group of volunteers increases the likelihood all candidates want and have sufficient time to fulfill the position requirements. Appointing officials should nominate council members from these well-qualified candidates in ratios consistent with attributes matching the interests of their region. Ideal knowledge requires possession of the necessary skills before initiation of the planning process. This knowledge is precise and accurate. Ideal participation includes willing and active participation in all stages of the planning process. This can be characterized by attendance at all regional committee meetings, as well as any germane meetings across functions and regions. For example, representatives of agricultural interests should make a point to be aware of meetings in which demand affecting their water interests is being discussed. Ideal participation stems from ideal knowledge, in this instance possession of timely and accurate information regarding the availability of the current water resource system to handle the demands. Another aspect of ideal participation is sharing expert knowledge with other participants. Ideal Communication is the shared knowledge of the ability of the water resource to meet the demands of their interest. Communication must occur between all levels of participants, peer-to-peer, as well as with constituents and higher levels of government. This must be done to share expert knowledge and allow ideal participation.

4.3.4. Council Member Selection Process

The survey provides insight into actual representation by current regional water councils. While survey results are not proof of representativeness one way or another, they can be analyzed to demonstrate a paradigm for preserving representativeness in a policy process. Through empirical analysis of survey results we can compare and contrast the current level of representativeness to the ideal representativeness of the developed paradigm, which allows the benefits of adaptive management decision making. From analysis of the survey we can attempt to assess whether adaptive management is actually occurring. If there is adaptive management in action, representativeness will be preserved.

4.3.5. Process Knowledge and Sustaining Representativeness

The knowledge a council member possesses regarding the policy process, and the specific problem of sustainable statewide water resource management, fuels the potential for effective adaptive management, and thereby representativeness. The more policy tools a council member brings to the table, the more likely it is they will be able to defend their constituents' interests in water management. Without knowledge of relevant policy problem subject matter a representative's participation may be futile. It is essential for both the stakeholders and their representative to understand the scope of the problem, i.e. what is at stake. An ideal representative is aware of their constituents' values, goals, and desired actions. They will assess those values against what is possible. An ideal representative understands the limits of power their position holds, and what is possible through working with other representatives and state agencies. There is some overlap between knowledge and ideal communication, but the two reinforce one another. A knowledgeable representative will be a better communicator and more effective participant.

Table 15 Q. 6 Level of Concern for Water Quality and Quantity in the Representative's Region and in the State

	Regional Level		State Level		
	Quality	**Quantity**	**Quality**	**Quantity**	**Avg. %**
Urban (9)	3	5	6	8	
	33.33%	55.56%	66.67%	88.89%	61.11%
Suburban (14)	8	7	7	9	
	57.14%	50.00%	50.00%	64.29%	55.36%
Rural (51)	27	33	36	44	
	52.94%	64.71%	70.59%	86.27%	68.63%

Respondents were asked to identify their level of concern as either: *Very concerned*, *Somewhat Concerned*, *Only a Little Concerned*, *Not at All Concerned*, or *Not Sure / No Opinion*. Including *Somewhat Concerned* in measure captured over 80% of responded, therefore only responses of *Very Concerned* were assigned a value of 1, or else a value of 0 was assigned. Values were added, and the percentage of people concerned out of total number of respondents for that category was found. In general, very few members reported being *not at all concerned* for water quality or quantity in their region, and none reported being *not at all concerned* for water at the state level. The majority of participants chose *very concerned* for both water quality and quantity at the regional and state levels. The greatest area of concern was an 83% report of *very concerned* for water quantity in the state, followed by water quality in the state at 65%, water quantity in the region at 60%, and water quality in the region at 50% (see Table 16).

Table 16 Q. 6 Concern for Water Quantity and Quality

Level of Concern for Water Quality in the Region	N	%	Cumulative %
Not at all concerned	1	1.33	1.33
Only a little concerned	13	17.33	18.67
Somewhat concerned	23	30.67	49.33
Very Concerned	38	50.67	100.00
Not Sure	0	0.00	
Total	75	100.00	

Level of Concern for Water Quantity in the Region	N	%	Cumulative %
Not at all concerned	5	6.67	6.67
Only a little concerned	6	8.00	14.67
Somewhat concerned	19	25.33	40.00
Very Concerned	45	60.00	100.00
Not Sure	0	0.00	
Total	75	100.00	

Level of Concern for Water Quality in the State	N	%	Cumulative %
Not at all concerned	0	0.00	0.00
Only a little concerned	3	4.00	4.00
Somewhat concerned	23	30.67	34.67
Very Concerned	49	65.33	100.00
Not Sure	0	0.00	
Total	75	100.00	

Level of Concern for Water Quantity in the State	N	%	Cumulative %
Not at all concerned	0	0.00	0.00
Only a little concerned	3	4.00	4.00
Somewhat concerned	6	8.00	12.00
Very Concerned	62	82.67	94.67
Not Sure	4	5.33	100.00
Total	75	100.00	

In Table 16 one can see an overall high level of concern regarding water resources. Interpreting level of concern as a measure of awareness of a problem one can associate a higher degree of concern with a higher state of awareness. From this we can infer that level of concern is an indicator of knowledge of the topic, but it tells us nothing about the quality of that knowledge.

Table 17 Perceived Reflection of Interests by Current Water Planning Structure

Scale	Current structure does not reflect issues, needs, and concerns	Current structure somewhat reflects issues, needs, and concerns	Current structure moderately reflects issues, needs, and concerns	Current structure strongly reflects issues, needs, and concerns	Rating Average	Response Count
Georgia's Residents	5	10	34	23	3.04	72
Georgia Local Municipalities	2	14	40	16	2.97	72
Georgia Cities	1	14	42	14	2.97	71
Georgia Counties	1	17	37	16	2.96	71
The Atlanta Metro Region	5	14	26	24	3.00	69
The State of Georgia as a Whole	3	19	29	20	2.93	71
Georgia's Watersheds	4	15	29	22	2.99	70
Georgia's Regional Development Centers	5	25	31	8	2.61	69
Watersheds of The Southeast	7	24	31	7	2.55	69
The United States	15	23	21	9	2.35	68
The environment	2	22	32	14	2.83	70
Industry	5	16	35	13	2.81	69
				Expected Mean	2.83	
					answered question	72

Analysis of Question 12 (see Table 17) suggests the perception participants have of representativeness at different interest levels. The perceived reflection of interests speaks to the knowledge representatives have about the plan. While this question cannot say how much participants know about the way in which these different scales of interest are represented, knowledge of the focus of regional water planning, and state water planning as a whole, should allow council members to answer these questions confidently. An ideal council member would know these answers, and if all council members were ideal, there would be some consensus in how well these different scales of interest were represented. The rating average for each scale reflects the average number of participants who chose each of the four answer options. Current *structure does not reflect interests* received a rating of 1, and *somewhat reflects, moderately reflects*, and *strongly reflects* received ratings of 2-4 respectively. The rating average suggests that most participants felt most scales of interest were somewhat to moderately reflected by the current water planning structure.

Similar to question 12, survey question 14 asked participants their opinion on the success of the current water planning process at reflecting stakeholder interests. This question focused on specific groups, rather than scales of interest. The groups specified matched the organizational affiliations listed in questions 3 and 4, with which participants were asked to identify themselves. Very few participants indicated they felt any of the identified groups were not represented; the highest response was 4% who felt homeowners were not represented. The responses seem to indicate homeowners and recreational interests were felt to be the least well represented interest groups. More than half the participants (53%) felt agriculture was represented a great deal, and the majority of the rest of the participants felt it was moderately represented. Water utilities, electric generation and business were felt to be the three next best represented interests (see Figure 10).

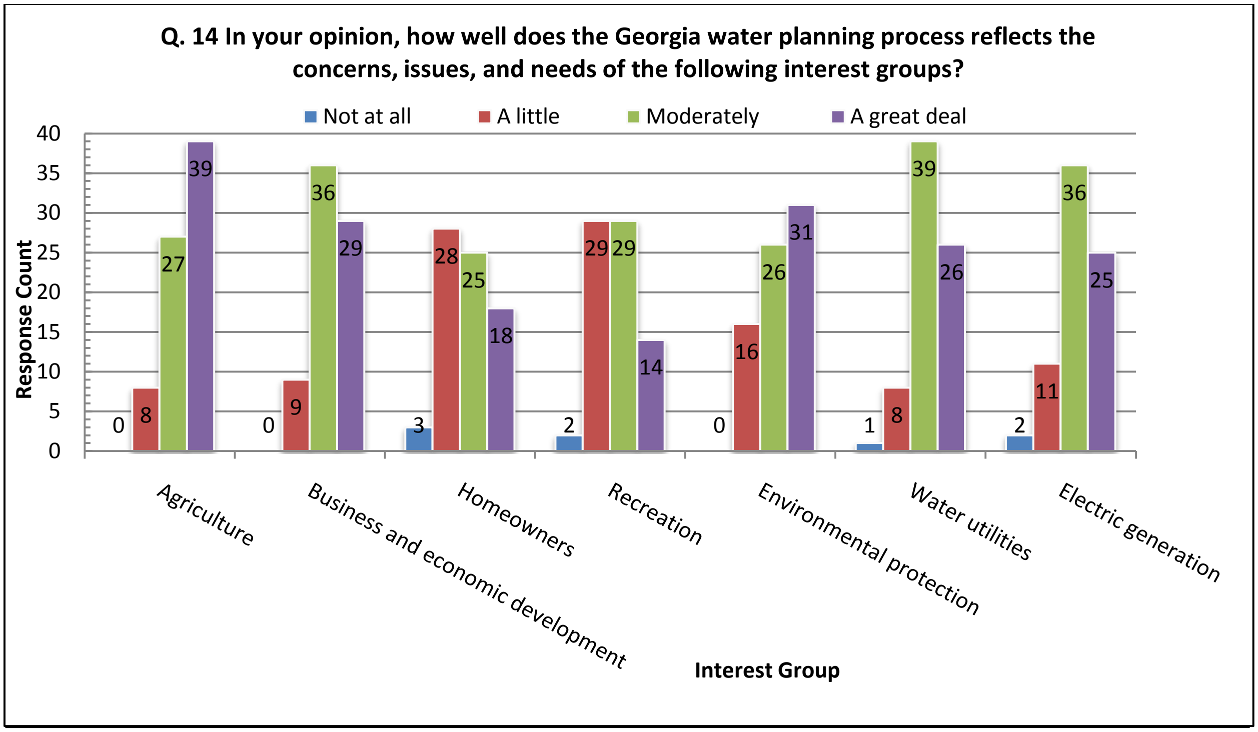

Figure 10 Level at Which Water Planning Reflects Interests

Comparison of these responses to the number of participants who affiliated themselves with each interest group reveals that, after local government (city or county) with 31% of participants, agriculture had the largest number of primary affiliates with 21% of the sample population.

Council members were asked to rank a list of activities according to how great a threat they felt it posed to Georgia's water quality or quantity. Response choices were either *No*, *Low level*, *Moderate*, or *Major threat*, or *Not Sure/No Opinion*. Responses were then assigned values of 1-4 for No-Major, respectively, while Not Sure was ranked 0. Average responses clustered at a rating of 2.62, or just between *Low* and *Moderate threat*. In order to better visualize the difference in views, responses were recoded to assign *Not Sure*, *No* or *Low level of threat* a value of 0 and *Moderate* or *Major threat* a value of 1. In order to understand how different groups thought about threats to water, responses were next ranked according to the type of location participants reported residing in. There was in general a recognizable disparity between urban responses and suburban or rural responses. The event of most concern to all three groups was droughts or other climatic events, though 78% of urban participants ranked it as higher priority, while only about 43% of suburban and rural participants did the same. No urban or suburban respondents felt building or expanding reservoirs posed a threat to water quantity or quality, while 8% of rural respondents thought it did. Urban residents were more concerned with runoff in general, be it from residential areas, CAFOs or general storm water (see Appendix, Table 27).

Participants were asked to rank the priority of listed water planning goals. If a goal was ranked as *high* or *highest priority* (4 or 5) it was scored as 1, else it was scored 0. The '% high priority' represents the percentage of the cohort that was scored as 1, and the average rating is the average of the participants' original rankings, on a scale of 1-5. The average of all goals was just under 4, indicating a centralization of scoring around *moderate* to *high priority*. Responses were compared across location types to examine differences in importance of goals between urban, suburban, and rural areas. Some differences were revealed, although the large size difference between groups may influence the significance of results (see Table 18). A sufficient sample was achieved for all three groups, but 69% of participants classified themselves as rural, meaning they are very highly sampled compared to the other two groups. All three groups considered ensuring available, affordable drinking water to everyone to be a very high priority, with the lowest average at 4.43 by urban participants. Fostering economic growth was ranked as significantly higher priority by urban-dwelling council members than suburban or rural members. Protecting water resources was ranked as higher priority by suburban dwellers than the other groups. It is interesting to speculate on the reason for these goals. Availability of water should be the highest priority goal of council members, as fear of insufficient water supply gave impetus to state water planning. It also seems reasonable for urban participants to favor economic growth more than other groups, as urban areas are typically centers of economic growth. We can infer that rural inhabitants are not against economic growth, as they ranked it at around a moderate priority.

Table 18 Prioritization of water planning goals

Q. 9 Georgia's regional water plans are being designed to accommodate the condition and capacity of water resources in each specific region. Please rate the following goals on a scale of 1 to 5, with 1 indicating a goal of the lowest priority and 5 indicating a goal of the highest priority.		Foster economic growth	Ensure affordability and availability of clean drinking water for everyone	Minimize conflict between water users	Maintain biodiversity in Georgia's waters	Protect and enhance recreational opportunities	Maximize agricultural productivity	Protect Georgia's water resources from other states	Ensure enough instream flow for both instream and downstream interests	Improve understanding of Georgia's water resources through increased monitoring and sound science	Average %
Urban (9)	% high priority	55.56%	66.67%	33.33%	11.11%	11.11%	11.11%	33.33%	55.56%	55.56%	37.04%
	avg. rating	4.57	4.43	3.57	3.43	3.71	3.57	3.71	4.29	4.43	3.97
Suburban (14)	% high priority	21.43%	78.57%	21.43%	28.57%	7.14%	21.43%	50.00%	57.14%	28.57%	34.92%
	avg. rating	3.86	4.71	3.50	3.64	3.36	3.57	3.86	4.36	3.93	3.87
Rural (51)	% high priority	21.57%	66.67%	11.76%	3.92%	1.96%	19.61%	21.57%	33.33%	27.45%	23.09%
	avg. rating	3.84	4.53	3.41	3.04	3.08	3.69	3.67	4.16	3.82	3.69

Examination of water policy goals speaks to the potential for cooperation among representatives. The greater the disparity in ranking of goals, the harder the task of reaching the communal goal prescribed by adaptive management. However, representativeness is concerned foremost with ensuring all interests are voiced. Therefore, it is important that representatives understand the goals of different interests, in an effort to understand what values must be upheld in the effort to reach a communal goal. For this reason, a discussion of goal prioritization is very important in the overall process of water planning.

4.3.6. Council Member Active Participation

No matter how much effort is put into ensuring all stakeholder interests are represented in regional councils, if those council members do not actively participate in the policymaking process, they may as well have not been appointed at all. A representative who does not participate in the process is not actively representing, and can be perceived as representing less than other council members, thereby changing the balance of representativeness. Therefore, part of ensuring an effective selection process has obtained the most representative mix of regional councils possible is assessing the nominees for participation, knowledge and communication skills.

The 75 participants were first identified by region, in order to compare differences in participation between regions. Total number of participants per region was overlaid onto a map of the water planning regions obtained from the EPD (see Figure 11 below).

Regional membership provides a sense of place, and shows the distribution of participants.

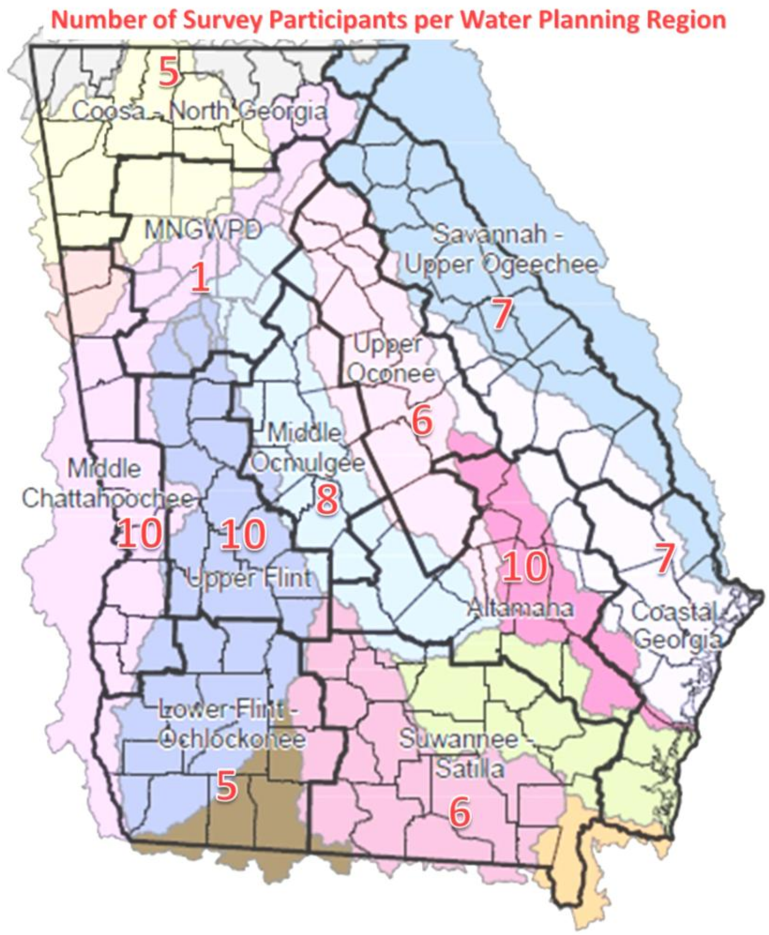

Figure 11 Number of Survey Participants per Water Planning Region. Map Background from Georgia State Water Plan 2008

From Figure 11 we can discern basic participant demographics. The majority of the regions, in excess of 70%, participated at a level sufficiently large by region for the statistics to have meaning. Three of the regions participated at a low level, which loosens the correlation between statistical inferences as they apply to populations in those regions. We cannot infer from this level of participation that ¾ of the population who did not respond are unwilling stakeholders, but we can infer that at least 25% demonstrated firsthand a willing cooperation in the process by simply completing the survey. The Metro region is an outlier because it is not involved in this stage of state water planning, but because statistical analysis of the overall tendencies throughout the state of Georgia is aggregated it was decided to leave this sample response in the data set.

Table 19 Water Planning Meeting Attendance Rate

No. of Meetings Attended	Response Count	Response %	Cumulative %
1	2	2.67%	2.67%
2	0	0.00%	2.67%
3	10	13.33%	16.00%
4	27	36.00%	52.00%
5	32	42.67%	94.67%
6+	4	5.33%	100.00%
Total No. of Responses	75		

Council member that do not show up to meetings cannot represent the interests of their stakeholders. Therefore, after the method of council member selection, meeting attendance is the most vital requirement of representativeness. Ideally, all council members would attend all relevant council meetings. At the time of the survey, there had been four Regional Water Planning Meetings in addition to the Kick-off Meeting and various other meetings called by Governor Purdue and individual Councils. From question two we can infer the majority of participants, 84%, had attended most of the planning meetings. This implies participants are more or less matching the ideal for participation required by the representativeness paradigm.

The sense of obligation is a necessary condition supporting ideal participation, ideal communication, and ideal knowledge. Obligation is usually associated with a sense of loyalty, which is more strongly tied to a relationship with a person, tying it more closely to participation and communication. Strong sense of obligation, coupled with a strong sense of constituent loyalty, stemming from a sense of place, serve to inspire a representative into action, and lead to ideal representatives.

Table 20 All Organizations, Groups, or Interests to Which Representatives Consider Themselves Affiliated

Answer Options	Response Percent	Response Count
Business / Industry	64.0%	48
City or County government	48.0%	36
Agriculture	44.0%	33
Environmental conservation	37.3%	28
Georgia citizen at large	34.7%	26
Water and/or wastewater facility	33.3%	25
Outdoor recreation	28.0%	21
Other (please specify)	14.7%	11
State government	6.7%	5
University	4.0%	3
	Answered question	**75**

The mode for this question is Business/Industry, with 64% of participants indicating they are in some way affiliated with this organization. The next highest affiliation is City or County government, with 48% of participants indicating they are affiliated with this organization in some manner. Interestingly, Agriculture, Environmental conservation, citizenry, and water/wastewater facilities all had greater than 30% of participants as affiliates.

Table 21 Primary Organization, Group, or Interest to Which Representatives Consider Themselves Affiliated

Answer Options	Response Percent	Response Count
City or County government	32.0%	24
Business / Industry	20.0%	15
Agriculture	17.3%	13
Water and/or wastewater facility	10.7%	8
Other	8.0%	6
Georgia citizen at large	4.0%	3
Environmental group or organization	2.7%	2
State government	2.7%	2
Outdoor recreation	1.3%	1
University	1.3%	1
	Answered question	**75**

Participants chose the organization they considered to have led to their participation in the water planning process. The mode for primary organizational affiliation is City or County government, with 32% of responses. The next highest answer was for Business/Industry, with 20% of responses. Agriculture forms the third largest group of affiliates, with 17.3% of participants. These three comprise 69% of all primary affiliations. Altamaha, Middle Chattahoochee and Upper Flint were the most participatory councils. City or County government had the greatest number of affiliates, at 24 (32%) participants. Respondents who chose *Other* responded that they were affiliated with electrical generation, higher education, tourism, and two members of forestry. Including environmental organizations, state government, outdoor recreation and universities, with the four categories from *Other*, each of which had two or less affiliates, about 16 % of participants belonged to a group that appears to be in the vast minority among council members.

From questions three and four we can see 69% of participants who identified themselves as somehow affiliated with industry do not consider it their primary affiliation; 93% of participants affiliated with environmental groups do not consider it their primary affiliation; and 60% of the participants associated with agriculture do not consider it their primary affiliation. The comparisons go on, but from this analysis we can infer there are overlapping interests among council members. This makes sense; people are not typically one-dimensional in their interests. Farmers are one example, they must be businessmen to sell their product, and they should have a vested interest in preserving the environment to some degree in order to have clean soil and water for production of healthy crops.

According to the survey results, approximately 72% of respondents lived in an area classified as rural, while 17% lived in a suburban area, and 11% lived in an urban location. The average length of residence in Georgia was 41 years, and average residence in the members' current city was 26 years; 12% of respondents had lived in Georgia all their life, and 5% of respondents had lived in their current city or town their entire life.

4.3.7. Council Member Sense of Empowerment

Sense of empowerment addresses representatives' perceived ability to influence the planning process.

Table 22 Perceived Impact of Water Planning

Region	Function	How much of an impact do you think your personal participation in the water planning process will have on the final regional Water Development and Conservation Plan in your area?	How much of an impact do you think the state-wide planning process as a whole will have on the final regional Water Development and Conservation Plan in your area?
Altamaha	Avg. (St. Dev.)	2.30 (±1.25)	2.90 (±0.99)
Coastal Georgia	Avg. (St. Dev.)	3.14 (±0.69)	2.86 (±0.69)
Coosa - North Georgia	Avg. (St. Dev.)	3.20 (±0.84)	3.20 (±0.84)
Lower Flint - Ochlockonee	Avg. (St. Dev.)	3.20 (±0.84)	3.40 (±0.55)
Middle Chattahoochee	Avg. (St. Dev.)	2.40 (±0.55)	2.60(±0.89)
Middle Ocmulgee	Avg. (St. Dev.)	3.20 (±0.84)	3.20 (±0.84)
Savannah - Upper Ogeechee	Avg. (St. Dev.)	2.60 (±1.14)	3.00 (±0.00)
Suwannee - Satilla	Avg. (St. Dev.)	3.40 (±0.55)	3.80 (±0.45)
Upper Flint	Avg. (St. Dev.)	3.40 (±0.55)	3.00 (±1.73)
Upper Oconee	Avg. (St. Dev.)	3.00 (±0.71)	3.60 (±0.55)
Total	Average	2.98	3.16

Participant responses were sorted by region, and coded numerically. The five possible responses were *No Opinion*, *No impact*, *Very little impact*, *Some impact*, or *Great impact*, and were scored 0 - 4 respectively. Question 15.1 asked council members what impact they felt their personal involvement in planning would have on the final regional plan. The greatest number of participants, 50%, felt they would have some impact on the plan.

The following are inferred from Question 15: Greater than 74% of participants felt their personal participation in the water planning process would ensure a representative Water Development and Conservation Plan for their region supported by the moderately/strong impact belief. At a threshold of 89%, participants felt their involvement in the planning process increased their representativeness by improving their shared knowledge. 81% of participants felt the state-level planning has a greater impact on their regional plan than regional representativeness, and thus the state has power to override their regional values. 88% of participants were moderately to highly correlated with a shared sense of representativeness within planning regions.

4.4. Participant Observations

Attendance at regional water council meetings afforded a firsthand opportunity to observe council member interactions and discussions. This information was collected in order to broaden the perspective rendered by the survey in order to expand on the relationship between council member perceptions and council member group interaction. Council member comments highlight their perception of influence.

4.4.1. Council Group Dynamics

A perceived lack of influence came in the form of council comments made during the first regional water planning meetings of the Middle Ocmulgee and Upper Flint Councils, one comment was "How much authenticity do these councils have?" (see Appendix, Table 23). Council members at both meetings questioned their autonomy in designing the plan, seeing as the MOA states EPD has final authority to approve the plan, and in the event the council and EPD cannot reach an agreement on a plan, EPD has the power to institute their own plan. Since this same concern was voiced by multiple council members at different planning meetings, it suggests EPD ought to have made their role in regional water planning clearer, and specified exactly what powers they and regional council members have with regards to creating and approving the plan.

4.4.2. Definition of a Majority

The determination of consensus size was another significant concern dealt with by councils. Each regional council was asked to participate in a consensus-building exercise, and asked to determine as a group their own definition of consensus. While this may have been beneficial in breaking the ice within individual councils, it also potentially gave councils dominated by one interest group the power to lower consensus to 50% plus one and control voting. Some councils decided 50% plus one was enough to achieve consensus, while others adopted a 2/3 requirement. Ideally, councils would all have the same requirements for consensus so that all management decisions, which will undoubtedly influence neighboring regions, are made on equal footing. Mathematically, having unequal requirements of consensus means that councils with a lower requirement for authority, 15+1 vote is majority versus 20 is majority, would carry more weight. Proportional representativeness will not be upheld in this system. Regions with the 2/3 requirement would have a more difficult time reaching a majority interest on a topic compared to other regions. The ideal system should not tolerate a difference in requirements for consensus.

CHAPTER 5. FINDINGS

The preceding analysis of regional population and water use characteristics, and of regional water council survey responses, provided a platform for summarizing the current state of representativeness of regional water councils. This analysis also revealed areas where representativeness could be improved, especially through inclusion of the MNGWPD in regional councils, and inclusion of environmental interests as a water demand category.

5.1. Current State of Regional Councils

Results of the analysis indicate structural deficiencies in the current process. There exists a significant imbalance from region to region with regard to the representative to constituent ratio. Council size is determined by the need for state equity and council composition is determined by the distribution of regional preference. In order to ensure representativeness, the expected proportion of representativeness was estimated based on regional demand characteristics. Implications of council size stem from the notion that too large a council impacts the ability to achieve consensus for communal goals, while too small a council limits the ability to ensure representativeness.

5.1.1. Representative to Constituent Ratio

A regional council size fixed at thirty members results in every representative grossly over representing, and that ratio varies significantly between regions. This stems from the small council size relative to the large regional populations. The smallest representative to constituent ratio in any planning region is still sufficiently large to completely overwhelm council members when assessing appropriate representativeness ratios. Across the ten water planning regions, the best case representative ratio is 8000:1 in the Upper Flint while the worst is 32,000:1 in Coastal Georgia (Governor's Office of Planning and Budget, 2010).

5.1.2. Balancing Council Size and Composition

Functional representation is the matching proportionalization of representatives to regional demand preference (recall Figure 1). Council sizes are limited to thirty members. Council size based on functional representation prevents any single resource agenda from become overwhelmingly dominant in size and controlling the vote.

5.1.3. Estimating Expected Proportion of Representativeness Interests Based on Regional Populations

In an effort to obtain an approximation of the current proportion of representative interests in each of the four water demand sectors, the sample population was used to approximate the discrete distribution as a standardized normal random variable with a mean of 0.25 and a standard deviation of 0.09845, values equal to the sample mean and standard deviation of resource distribution by water demand sector (see Table 12). It was assumed the expected distribution of any of the four affiliations in the total population is normally distributed across the population of 300. Also, since the utilization of resource by region should be reflective of the interest by region, it is assumed that corresponding affiliation representativeness would match the corresponding resource distribution by category.

To ensure a 95% confidence in the estimation of sample proportion the standardized value estimated from the simulated distribution was measured at two standard deviations. The respective sample proportions as measured from the standardized distribution which reflects the four water demand sector proportions: 0.2, 0.2, 0.4, and 0.21 respectively would then be: 5 representatives with agricultural affiliations, 5 with industry affiliations, 11 with energy affiliations, and 7 with municipal affiliations.

5.1.4. Council Size and Composition Implications for Regional Water Planning

Analysis of water demand representation in the sample population composed of regional council members who participated in the survey revealed an unequal proportion of representation. Participants primarily affiliated with municipal water demand (public supply, commercial, and light industrial water demand) formed 55% of representatives. Of this interest sector, city or county government officials formed the majority of the sector. Agriculture was the next most represented interest sector, followed by industry, and finally energy with only 1 representative. Examination of all affiliations revealed 37% of participants were somehow affiliated with an environmental organization (see Table 11), although only 3 participants reported an environmental organization as their primary affiliation.

The empirical data is not an exact match of regional characteristic data obtained from EPD-contracted water demand analyses and a USGS report of water use by the thermoelectric energy industry. Agricultural and industry interests were the closest match to regional characteristics, but municipal was largely overrepresented in proportion to water demand, and energy was underrepresented.

The provided state water demand data does not appear to have been designed with a goal of measuring use by individual interests, but rather seems intended to provide a measure of major water demand types. The subcategories of municipal water use are all reliant on public supply water. Industry, agriculture and energy water demand all require permits for use. The most effective way to think of these divisions is in the type of monitoring EPD will be performing and the type of water use permit required, if any.

5.2. Impact of Integrating the Eleventh Planning Region -- MNGWPD

Integrating the MNGWPD and its resource demands into the statewide water plan is destined to be a significant challenge. The resource plan sustainability cannot be assessed until all statewide water demands, to include those known to require interbasin transfer for support, are accommodated. In analyzing to determine the effects of integration statewide equity and adjacent region resource prioritization must be considered.

5.2.1. Statewide Equity

Assuming Georgia embraces a statewide adaptive methodology as stated, the MNGWPD must be integrated fully into the statewide water policy process. This entails a complete integration of all aspects of the MNGWPD council. In order to preserve the tenets of adaptive management and representativeness the balance of council member selection and preference affiliation must be maintained statewide. As such, a common set of guidelines for council composition must be applied to the MNGWPD council. If it is necessary to alter the guidelines in order to ensure representativeness across the MNGWPD, then to preserve equities across the state these changed guidelines must be applied to the other ten planning councils. Given the disproportionately large population and municipal demand use of the MNGWPD, it is highly unlikely that a balanced proportion of representativeness can be achieved by council compositions constrained under the current policy. As such, adjustments in council size and composition will likely prove necessary.

5.2.2. Inter-Region Water Resource Prioritization

Independent regions are deliberately structured to accommodate demand use preferences strictly from within their region. When called upon to support interbasin transfers to any other region, the current process provides no structure enabling support of preference for the demand category being transferred. The issue is lack of a mechanism from within individual regions to provide a representative preference for supporting extra-region demand. This is most likely to be an issue for the municipal demand sustained by MNGWPD, which encompasses portions of river basins from five neighboring water planning regions: Coosa-North Georgia, Middle Chattahoochee, Upper Flint, Middle Ocmulgee, and Upper Oconee. A dynamic adaptive management plan should include a mechanism to allow region-to-region support under peak demand conditions.

Three alternatives for addressing the management of regional water transfers are the assignment of a state-level committee, a requirement for regions to incorporate regional transfer support demands into their proportion of use preference, and standing sub-committees within regional councils tasked to adaptively manage potential regional transfer requirements. The least representative alternative is for a state-level committee to manage regional transfers. This clearly is inconsistent with the fundamental tenets of adaptive management. Another alternative for managing regional transfers is to identify and adjust the proportion of demand with respect to the relevant water demand category. While this is a possible option, it is inconsistent with the tenets of adaptive management. Since there is no requirement for regional councils to routinely interact with all aspects of other regions, ideal communication, ideal knowledge and ideal participation with regard to extra-region demand preference are unlikely. Additionally, the requirement for council members to be residents of the planning region they were nominated to represent precludes the addition of extra-region preference from being represented within the region providing the transfer. The optimal method of addressing the need for regional water transfers would be creation of standing sub-committees within each region designated to specifically address resource preference given to any demand use category participating in region-to-region sharing. Regional sub-committees are ideal as they are maximally representative given the circumstance, preserve the tenets of adaptive management, and form a proactive mechanism necessary for dynamic adaptive management of regional preference for region-to-region resource support.

5.3. Impact of a Fifth Planning Category -- Environmental Interests

The basic definition of environmental protection is preservation of natural resources ("environmental protection"). From an environmental policy standpoint, the description of environmental protection as characterized by EPA seems most relevant, since their mission is “to protect human health and to safeguard the natural environment—air, water, and land—upon which life depends (U.S. Environmental Protection Agency, 2009), ” and a priority of state water resource management is protection of public health and natural systems. My working definition is the preservation of life-sustaining habitat for all indigenous species. It is not in my own best interest to eliminate species, neither deer nor scuppernongs.

> *"Water resources, and the related ecosystems that provide and sustain them, are under threat from pollution, unsustainable use,…The integrity of ecosystems has clearly not been ensured through sustainable water resource management…(McDonald, 2003)"*

5.3.1. System of Competitors for Water

Water quantity forecasts measure municipal, agriculture, industry, and energy demand. Unfortunately, these categories do not capture all water interests, and they create artificial lumping of interests, especially municipal, based on the water supply used. Environmental interests represent a major stakeholder group excluded from this set of demands. The focus of state water planning on water resource demand and preservation of growth impedes stakeholders who value protecting water quality and natural systems. Their participation in the planning process cannot be quantified as one of the measures of water demand; as such their contributions to the water planning process are devalued. Environmental stakeholders are not viewed as bona fide contributors to the water resource policy solution.

> *"Water management, notwithstanding its technical aspects, is largely a problem of governance…In democratic societies, conflict about the commons is best managed via effective deliberative process…critical to devising management systems that can change as conditions change. This is the essence of adaptive management (Ostrom, Stern, & Dietz, 2010)."*

Environmental protection is not one of the four priorities listed in the state water plan; that only 3% of regional survey participants primarily represent environmental interests seems to reflect this prioritization (see Table 21). Reason suggests that, although not captured by the governor or state water councils' priorities, environmental interests do make up a portion of the state population's water interests. This is supported by 37% of survey respondents who listed environmental conservation as one of their interests (see Table 20). Since over a third of respondents support environmental conservation, even if only 3% have made it their primary affiliation, there ought to be a mechanism for supporting environmental interests in place in the water council. Since EPD has been charged with granting approval to regional water plans before they are presented to the governor's office, some may feel this is enough for ensuring environmental interests are represented. However, if environmental interests are not given an active voice in the actual planning process, they are not being equally represented.

> *"…recommended that good water governance include all stakeholders in the decision-making process (McDonald, 2003)."*

In its present form, regional water planning provides avenues for environmental interests in the form of public comment by environmental interest groups and through advice given by EPD facilitators and contracted scientific experts. While the state plan has not explicitly divided regional councils into the four water demand categories, the expectation is council members will represent the interest from which they were nominated. Water use does depend on adequate water supply and sufficient quality to meet the specific need, therefore environmental protection is of some interest to all council members. However, the importance of non-use interests, such as the value of undisturbed water systems and preservation of habitat for non-endangered species may go unargued without a direct voice on water councils.

Competition cannot correct faulty reasoning with regard to sustainable water policies. Traditionally, competition determines the winner. The competitor that should be responsible for water policy is ill-defined; in an economically-driven system environment does not compete directly with profit. The natural environment is the delineation of the competition for environmental interests as a resource demand category. It needs to be recognized as such in water policy. The governor's goal is to ensure adequate water to meet the needs of all competitors, one of which is water resource reserves, while accommodating economic growth. There can be no reserve water resource capability exclusive of an environmental resource reserve capacity. Destruction of natural systems undermines the notion of sustainability and depletes the capacity for growth.

5.3.2. Components of Responsible Water Management

Representativeness is a function of regional preference. Presently, Georgia water planning guidance calls for a balance of wise water management, including natural resource protection, and assured economic viability.

> *"The wise use and management of water is critical to support the state's economy, to protect public health and natural systems, and to enhance the quality of life for all citizens (Georgia Water Council, 2008)."*

As it stands right now, growth preference in any of the four water demand categories implies a race to the bottom, i.e. a preference for consumption ensures resource exhaustion. To balance this, a preference favoring preservation of natural systems should be admitted as a component of the regional water planning process.

Water uses overlap, and people benefit from multiple uses. Water demand for agriculture is used to produce the food we eat. Water demand for municipal use supplies the water we use to drink, bathe, clean, and perform other day-to-day tasks. Water demand for industrial use and energy use produces the goods and the power to fuel them that we need to meet our standard of living. Environmental protection demands seek to preserve water resources so that water is available for other species and for future generations. These environmental protection measures are accomplished by encouraging sustainable and efficient water use.

Responsibility is a necessary component for sound water management. A representative process does not guarantee responsible management. While it typically achieves responsible management by virtue of comprehensive and balanced representation of all interested parties, the potential exists for a singular interest to remain completely unrepresented. This highlights a critical flaw in the aggregated resource demand categories. By lumping interests into four categories and defining representativeness through primary affiliations of council nominees with regard to these four categories, principal secondary interests not defined as one of the four resource categories can be completely neglected.

> *"Highly aggregated information may ignore or average out local information that is important in identifying future problems and developing solutions (Dietz, Ostrom, & Stern, 2003)."*

An ideally representative adaptive management process provides for the extension of democratic ideals and incorporation of public participation into the water planning process, thereby increasing the transparency of the planning process and driving equal protection from environmental exploitation for individuals, groups, and communities regardless of race, ethnicity, or economic status. This applies to the development, implementation, and enforcement of environmental laws, regulations, and policies. Transition to dynamic adaptive management guards against irresponsible, but well-intended, management practices through active continual monitoring, assessment, and adaptation.

5.3.3. Theoretical Implications

Adaptive management's ability to adjust to shifts in interest and scale while sustaining all policy functions will allow expansion of the planning process to incorporate a fifth demand category for environmental interests. Survey responses indicate environmental impact is a concern for council members. When surveyed, 73 of 74 respondents felt regional councils had either a *moderate* or *high* level of responsibility to protect Georgia's water resources, while 16, 26 and 31 of 73 respondents felt the current Georgia water planning process afforded either *little*, *some*, or *a significant level* of environmental protection (see Appendix-A Table 28, 29). It is substantiated by council member perceptions that there is some level of responsibility to protect environmental interests and that some level of policy protection is being established.

The dynamic adaptive management paradigm affords the integration of a control mechanism. Responsibility is the fundamental control mechanism of water resource policy. The recognition of environmental protection as a fifth category of water resource demand is ideally suited to function as the metric for responsibility when assessing policy in development.

CHAPTER 6. SUMMARY AND RECOMMENDATIONS

The dynamic adaptive management paradigm is a fully responsive management methodology which enables incorporation of all facets of the management process, to include full transparency of developing policy, incorporation of changes in demand preference, resource availability, and environmental constraints. The paradigm is sensitive to all fluctuations in system equilibrium and proactively adjusts the status quo. This is accomplished through execution of the policy continuum.

> *"Institutions must be designed to allow for adaptation because some current understanding is likely to be wrong, the required scale of organization can shift, and biophysical and social systems change (Dietz, et al., 2003)."*

The responsiveness of the dynamic adaptive management paradigm is ideally suited to cope with the large-scale uncertainties and system complexities inherent in Georgia's water resource management problem.

6.1. Concluding Thoughts

The commitment to dynamic adaptive management ensures representativeness, while striving to ensure representativeness empowers adaptive management. The strength of adaptive management lies in its ability to provide for a dynamic solution, characterized by continual assessment of policy addressing continuously evolving resource challenges. Dynamic adaptive management fully empowers sustainable water resource management.

6.1.1. A New Paradigm

There is a need for a new paradigm. Evidence for this need comes from a series of punctuated-equilibrium events affecting perception of water resources, in turn reshaping water resource management philosophy. Significant departures from traditional resource management philosophies have led to the emergence of numerous policy management theories with the common themes of democratic ideals, communal good, decision by committee, enlightenment, empowerment, proactive society for the good of society, involved engaged citizenship. A common theme spanning these results in overlapping fundamental tenets involving ideal communication, knowledge, participation, representativeness, transparency, empowerment, public participation. Underlying the entirety of process models is rapid evolution of information technology. The ability to project these tenets across all levels of citizenship and government leadership is made possible by these technological advances.

The current process, while claiming to adhere to an adaptive management framework, still culminates with the publication of a plan. This plan is to be periodically assessed at approximately 3-5 year intervals. Barring a trigger event of significant magnitude forcing yet another punctuated-equilibrium, the current process remains a fundamentally static methodology. While the current paradigm does preserve representativeness, it does so with nominal effectiveness. Planning efficiency also affects the ability to properly synchronize and coordinate highly complex processes.

"There are three ways to structure management as an adaptive process: (1) evolutionary or "trial and error," in which early choices are essentially haphazard, while later choices are made from a subset that gives better results; (2) passive adaptive, where historical data available at each time are used to construct a single best estimate or model for response, and the decision choice is based on assuming this model is correct; or (3) active adaptive, where data available at each time are used to structure a range of alternative response models… (C. J. Walters & Holling, 1990)."

Transition from pure adaptive management to a dynamic adaptive management paradigm will include improvements in the selection process which enhance the functional representativeness and active engagement of council members at the regional level and councils at the state level. Within the emerging state water resource planning process significant disruptions could result from the necessary inclusion of the existing MNGWPD water plan, the integration of the MNGWPD council, and the potential for incorporation of direct management of environmental impact across all water resource demand categories. While this process is encumbered by the necessity to develop detailed input capabilities sufficient to synchronize existing policy and processes, integrate councils and council resources, and establish the means to readily acquire detailed scientific and engineering information sufficient to understand the integration of the regions, the dynamic adaptive management methodology provides for direct input of these necessary policy process integrations for any number of these evolving functions. The net result is a fully integrated and accommodating sustainment and expansion of all policy functions.

6.1.2. Automating the Policy Planning Process

The adaptive management process is inherently resource intensive. The propensity for an incomplete transition to adaptive management is correlated with the availability of the necessary significant level of management resource availability to sustain adaptive processes (C. Walters, 1997).

> *"Many applications of adaptive management have stopped at the assessment phase and have failed to implement meaningful changes in management (Johnson, 1999)."*

In addition to expediting the process flow of decision information, automation architecture serves to minimize the physical management resource demands. The incremental inclusion of relevant policy, scientific data, and public record information into intelligent database systems alleviates the burden of both record development and management. Additionally, web-based components of the architecture afford nearly real-time ideal communication across all councils and constituents, further reducing the database maintenance burden. Obligation to sustain the state water planning process drives an obligation to sustain trained participants responsible for the process. Automation of the water resource management process allows a training continuum, preventing the knowledge void traditionally occurring with the replacement of council members between terms. It has been demonstrated that significant resource demands of adaptive management impede policy making agencies from adopting and sustaining adaptive management techniques. The reduction in management burden that should result from adopting an automated architecture should significantly increase the potential for policy agencies to achieve a complete transition to adaptive management methodologies.

6.2. Dynamic Adaptive Management Paradigm

The paradigm shift in equilibrium has been punctuated by recognition that static management processes can no longer support existing resource demands. The dynamic adaptive management paradigm should serve as an ideal resource tool for water management in Georgia. Evolving demand conditions stemming from known population growth and known cyclical occurrences of drought highlight that even with conservation practices, at the current levels of demand water shortages will occur by 2040 (Georgia State-wide Water Management Plan, 2009). The state water plan calls for balance in the current demand and provision for growth, therefore resource contraction is not a solution. The directive to begin a process of statewide deliberate water resource management and comprehensive planning demands a focus on resource scope as a key facet in determining an appropriate set of feasible techniques.

> *"Fixed rules are likely to fail because they place too much confidence in the current state of knowledge, whereas systems that guard against the low probability, high consequence possibilities…"* [punctuated-equilibrium] *"…and allow for change…prove wiser in the long run* (Dietz, et al., 2003).*"*

The dynamic adaptive management paradigm is not limited by scope; it can accommodate expanding scope to the same degree it can accommodate increasing demand categories. At the same time, dynamic adaptive management can admit a demand category that allows a preference for preservation of water resources, thus enabling a control mechanism for unbounded growth. While this potential could prohibit growth, adaptive management applies this control to regulate water resource demand preference, thereby managing growth potential. This seamless ability to accommodate growth at all levels while sustaining current policy functions across all management activities is due to the dynamic nature of the paradigm and continuity of the process.

6.2.1. Structure and Scale

Conflict among competing goals and the uncertain outcomes of competing policy alternatives categorizes the development of comprehensive water management as an ill-structured problem (Dunn, 2004). Dynamic adaptive management is ideally suited to address this structural problem as it provides for the continuous integration of competing resource demand perspectives, knowledge of physical resource limitations, and coupled policy alternatives. The dynamic adaptive management paradigm applied against the water resource management policy process is the perfect partnering of a problem set that requires the greatest amount of structure and a solution method that provides the greatest amount of structure in a continuous decision-analysis cycle.

Transition from contemporary adaptive management to a dynamic adaptive management paradigm allows for adaptive management to serve as an adaptive governance process.
From the state perspective, the dynamic adaptive management paradigm functions across multiple scales of government and multiple agencies. As such, it now functions as an adaptive governance process. Adaptive governance effectively expands the representativeness paradigm to the resource scope or span necessary to direct all agencies in a coordinated team focused on representative fulfillment. The dynamic adaptive management paradigm as outlined is fully functional and fully enables all governmental scales and all relevant agencies in a coordinated and synchronized policy process. Current management research highlights that failure to alleviate the resource burden jeopardizes any potential for transition to an adaptively managed policy process.

6.2.2. Dynamic Policy Response

A water policy built on an adaptive management framework will provide for sustainable water management plans while fairly representing all stakeholder water needs. Initial population projections and measures of water demand have shown current levels of use are not sustainable and policymakers must account for this in their management recommendations. While preserving human life is the number one priority of the water plan, and continued growth and economic development are vital to Georgia's future, an equitable water plan will also include consideration for other water use values in planning for future water allocation. To that end, regional water planning committees should be representative of their constituents' interests. Collaborative public management and adaptive management share the notion of stakeholder cooperation and require representativeness. Adaptive management is a social learning process in which feedback from research to policymakers advances understanding of the process and allows change to occur throughout the process. Ideal participation intrinsically links ideal constituents and ideal representativeness. Communication of needs and corresponding policy options between representative and constituent drives and sustains the cycle of representativeness throughout the process. The dynamic adaptive management paradigm is responsive to needs. Rather than waiting and responding to catastrophes which require attention to policy, a dynamic policy process responds to actual needs in a progressive manner. The degree to which a policy meets actual need is the metric for policy success.

The span of policy is enhanced when necessary through execution of the dynamic adaptive management method. Physical monitoring, assessment and adaptation of regional plans occur without regard to policy making. Farmers will dig wells when they need them; the ability for agricultural water resource demand policy to be knowledgeable of ever-changing situations provides energy to the policy process. An integrated dynamic adaptive management process is the vehicle that allows the policy process to capitalize on the naturally occurring inertia of these circumstances in order to efficiently craft comprehensive and effective policy for each water resource demand category. These activities can and should occur prior to, during, and after discrete policy making stages. This process serves as the vehicle to empower continual monitoring, assessment, and adaptation of regional plans. These actions drive the adaptive management process.

Important to dynamic adaptive management is a feedback system which serves to allow effective policy assessment. Accurate consumption accounting serves as this control, and provides a necessary check on withdrawal projections. If withdrawal is a measure of preference, consumption measures the projected impact of preference on water resource availability. Withdrawal rate is necessary to understand day-to-day function, while consumption projects long-term impact on resource availability. Even more importantly, the coupling of withdrawal and consumption provides a comprehensive understanding of near-term resource availability, which in turn enables dynamic management of water resource distribution. One method of improving the current adaptive management process would be to expand water use monitoring, and thereby ensure accurate accounting of net resource availability.

6.3. Recommendations -- Improving the Georgia Regional Water Planning Process

Complete adaptation of the dynamic adaptive management paradigm as detailed in this study should result in an ideally representative set of regional water plans. Barring resources to accomplish this, transitioning to a process model that maximizes representativeness should allow critical adaptations to take place.

6.3.1. Complete Adaptation of the Novel Dynamic Methodology

The current process, while claiming to adhere to an adaptive management framework, remains a static management technique. The following adjustments to Georgia's evolving water planning process should result in complete adaptation of the novel dynamic adaptive management methodology.

Recall all adaptive management tenets stem from and depend on representativeness. Selection is a critical component of representativeness; lack of a fully comprehensive selection process inhibits representativeness which in turn marginalizes all aspects of adaptive management. Transitioning to a dynamic adaptive management process should begin with adoption of a comprehensive selection process.

Discontinuous flow of information across all levels of stakeholders severely hampers contemporary adaptive management. Policymaking progress only occurs during council meetings. Information gathered during the period between meetings is assessed, distributed to selected individuals or committees, and summarized in packets distributed prior to subsequent council meetings. This marginalized participation is counter to representativeness. Lack of knowledge or lack of knowledge in a timely manner hampers stakeholders' ability to actively participate. Lack of active participation minimizes council member contributions to the policy process. In order to engage all parties, thereby ensuring ideal information flow and active participation, these discontinuities should be eliminated. Mitigation of the discontinuous information flow can be accomplished by development and integration of mechanisms that continuously assess resource demand and regional preference.

Processes lacking monitoring, assessment and adaptation capabilities cannot regulate. Regional council members are responsible for creating a recommended water management plan that balances regional preferences and resource capabilities. However, responsibility for assessing, implementing and monitoring the plan falls to EPD. In order to successfully accomplish assessment, monitoring, and adaptation they require the same level of fidelity in regional information used to create the initial plan. This implies EPD will be dependent upon a continuous, functioning regional assessment and monitoring capability in order to correctly adapt water management policy. The shortfall in this process is regional councils are only required to create a plan, and then reconvene to adjust the plan at 3-5 year intervals, rather than continuously as a dynamic adaptive management process requires. None of the adaptive management tenets are currently supported until this fundamental component of policy analysis is established. A remedy for this lack would be development and implementation of a mechanism for policy monitoring and assessment at the regional level. Continuous resource demand assessment is fundamental to even static contemporary adaptive management. Monitoring regional preference with the aim to adapt policy as required to changes in the distribution of regional water demand should be accomplished in a continuous manner consistent with the imperatives of Georgia's state water plan.

6.3.2. Emplacing a Paradigm of Ensured Representativeness

A viable public policy incorporates the democratic ideals of inclusiveness, representation, impartiality, transparency, deliberativeness, lawfulness, and empowerment (Leach, 2006). Lacking the resources to adopt a full dynamic adaptive management methodology, a minimal recommendation is to adopt a policy process which guarantees maximal representativeness.

There are structural flaws in the current council member selection process. The discretion of the Governor, Lieutenant Governor, and Speaker of the House to appoint council members regardless of recommendation and affiliation creates the potential for disproportionate representation. All appointed council members should be selected from under the same selection constraints regardless of the source of selection. There is no unilaterally supported protection from randomly distributed nominee affiliations. No guidelines were issued which established conditions that would ensure representative proportion between council members and regional preferences. No effort was made to match proportions of affiliated council members to the proportions of regional preference, thereby establishing representativeness of interests. The minimal recommendation for an improved water resource management policy is to incorporate a comprehensive selection process which ensures a proportional selection of regional council members that corresponds to the proportion of regional resource preference. In addition, this process should include screening measures which are designed to ensure the selection of ideal council members. That is, council members possessing the attributes of willful participants, possessing ideal knowledge, ideal participation, and ideal communication.

6.4. Study Limitations

Study limitations include the exclusion of the MNGWPD and its water plan, the chronological disparity between resource demand data sets, a mismatch between existing regional characteristics and demand categories, lack of consideration of environmental impact, and an uneven survey response rate.

6.4.1. Exclusion of Metro-North Planning Council Demographics

The overall state municipal water demand is well documented; however, with no council member demographic to assess for the MNGWPD it is not possible to comment on the actual correlation between management methodology and level of representativeness. The analysis does extrapolate to a distribution of what the MNGWPD council member affiliations should be to ensure resource equity both within the region and across the state. The impact of this exclusion is nominal overall as the paradigm is easily expanded to include all facets of the MNGWPD, its policy, and can easily accommodate its council. The only consequence here remains a state requirement to balance council sizes.

6.4.2. Data Aggregation and Demand Category Association

All water resource demands are force fit into the four water demand categories specified by the state water plan. In accumulating data to determine resource demand baselines, the various category baselines are derivative of data sets from different time periods. Energy demand data only existed up through the year 2005. While water quality requirements, use and consumption rates differ between the four demand categories all of these categories were assessed purely from a demand standpoint. The only real impact is that the actual assessment of demand against potable water resources is most likely less than assessed in this analysis. The benefit being this analysis serves as a representation of "worst case" resource drain.

6.4.3. Recognition of Environmentally Sound Management Practices

The state directive forces all water resource demand growth to be managed as one of four use categories, Agricultural, Industrial, Energy, or Municipal. This aggregation applied to the currently organized councils does not allow for an assessment of the level of representativeness required to ensure appropriately balanced resource demand growth planning and sustainment of minimum environmental controls. Ideally there would be a level of representativeness to assess undesirable environmental impacts during the planning process. The failure to delineate the requirement to assess environmental impact limits the ability to assess the overall policy impact. This is a nominal impact; the paradigm as detailed can accommodate the extension of policy adjustment with regard to an environmental planning category. The development of the dynamic adaptive management paradigm is independent of all resource categories.

6.4.4. Survey Respondent Rate

It is important to note that inferences are typical and may not be strongly correlated within individual regions. Specifically, three of the eleven regions are underrepresented by the survey. This impact is marginalized by the fact that all survey inference is derivative of a proportional analysis.

6.5. Future Work

All recommended future work extends from adaptation of the dynamic adaptive management paradigm for Georgia's regional water planning policy.

6.5.1. Re-administration of Council Member Affiliation and Representativeness Survey

A policy review should be conducted that would gather actual data on council member affiliations and conduct actual policy decisions to assess trends in representativeness. The survey used in this study was conducted very early in the regional planning process. Re-administering the survey would establish a baseline for assessing representativeness trends in future cycles of the policy process, and would help guide the development and implementation of a comprehensive council member selection process.

6.5.2. Improvement of Periodic Policy Assessment Measures

A post-policy publication process review should be conducted in order to monitor and validate the implementation of an adaptive management framework as a component of the new Georgia state water resource planning process. This would serve to guide and develop the employment of the policy analysis loop for the forthcoming Georgia regional water management plans and to provide a measure which assesses policy performance.

6.5.3. Automation Architecture Development

The development of an automation architecture which enables full automation of the Dynamic Adaptive Management Paradigm as detailed in this thesis should minimize the resource burden typical of adaptive management processes, thereby allowing successful integration of the expressed intent to utilize an adaptive management framework in Georgia's regional water planning process. As highlighted during the construction of this thesis, the majority of the data and assessment information necessary to support this analysis exists in a collection of automated systems.

There is a significant potential for a single architecture to link these systems and establish a push-pull information flow between policy makers and public records supporting all facets of necessary adaptive management information requirements. This architecture could be readily developed from web-based technologies and would support real-time information gathering and communication necessary under the auspices of ideal communication, ideal knowledge, ideal participation, and fully empowered representativeness. Implementation of such architecture would serve as a final phase in the complete adaptation of the dynamic adaptive management paradigm.

6.5.4. Development of a Schema for Comprehensive Expansion of Water Resource Demand Categories

While water demand categories appear geared toward establishing a logical prioritization with the aim to regulate and manage growth, they fail to independently assess actual demand with respect to physical distribution systems and watershed regions. This categorization focuses on economic growth and fails to comprehensively account for demand sources. Enhanced understanding of the demand sources will better illustrate the complexity of interests in water and lead to more effective water management policy. When fully deployed as detailed in this study, the dynamic adaptive management process can easily integrated additional demand categories across all policy development processes. The adaptation of this proposal should provide for the complete integration of environmental interests throughout statewide water planning policy.

APPENDIX

Table 23 Significant Observations Made During 1st Round of Regional Council Meetings

Meeting	Region	Topic	Observation	Significance
1	Middle Chattahoochee	Demographics	All members present are Caucasian males	Theory of Bureaucratic Representativeness
		Facilitated consensus exercise	Defined as “not all in perfect agreement but we can live with the solution” At least 2/3 of council votes. Need 2/3 majority. Consider effects on and record opposing views of members.	Very important, if there is a majority viewpoint will competing views be recognized?
		Public notice	What constitutes public notice? (will post all meeting material on website)	Speaks to transparency of process
1	Middle Ocmulgee	Memorandum of Agreement (MOA)	Concern for binding properties, legal ramifications and responsibilities	Legal responsibility for outcomes of plan
			Concern that EPD can override Council’s plan	Question of autonomy
		Consensus exercise	Quorum is 2/3 to hold vote	Same as Middle Chattahoochee
			Consensus is reached at 2/3 of those voting	
		Councilmember comment	“Need for land conservation to protect water quality - Fluctuation of supply and demand”	Environmental value
			“Shouldn’t we look at historical trends and try and *change* the way we act? Direction of change needs to be addressed.”	
1	Upper Flint	Demographics	2 women on council	
		MOA	“How much authenticity do these councils have?”	Again, questions of autonomy
			Do councils have the authority to question the validity of forecast data?	
		Council comments	How effective can a plan be if the population keeps increasing?	Valid, is there a maximum sustainable yield for population given water resources

Table 23 (continued)

Meeting	Region	Topic	Observation	Significance
1	Upper Flint		Concern for quality of life for our children	Sustainability
			Budget concern	Feasibility, how will the state pay for water plan
1	Upper Oconee	Demographics	4 women on council	Theory of Bureaucratic Representativeness
		Consensus	Set at 2/3, most councils set at 51%	Same as above
			Spent too much time on dissenting vote in past and didn't get much done. Hold 2 votes, shoot for 2/3 majority, then if at a stalemate use 51%. Will decide at next meeting.	Time constraint issue, if there are strong opposing views will they be outvoted in the interest of moving forward?
		Council comments on water trends	Be aware of Interbasin transfers	
			Reservoir permitting process takes to long	Multiple members have mentioned need for more reservoirs as a solution-desire more efficient reservoir creation process
			There is a water management problem, not a water shortage	Can increased management solve water problems

Dear Regional Water Council Member,

Thank You for taking the time to participate in this survey, which is part of a research project at the Georgia Institute of Technology's School of Public Policy. This research is being conducted independently of Georgia's Environmental Planning Division (EPD) or any other state or federal agency.

The goal of this research is to help improve problem solving and decision making about complex resource issues such as water quality and water availability. You have been chosen for this research because of your participation in Georgia's water planning process. We value your perspective on water resource issues in Georgia.

There are 15 questions in the survey, and it should take approximately 20 minutes to complete. Please check or type in the best answer or answers for each question. Questions with a star next to them must be answered in order to continue. The rest are optional, but we would greatly appreciate your taking the time to complete them.

Your participation is completely voluntary and confidential. No attempt will be made to match survey answers with specific individuals. All results will be reported in aggregate, and raw data will be completely confidential under NSF guidelines. Results of the study will not include any information that could personally identify participants in the study.

For more information, contact Dr. Bryan Norton, Professor of Public Policy of the Georgia Institute of Technology at (404) 894-6511 or Amanda Marshall, Masters Student by email at amanda.marshall@gatech.edu.

If you have questions about your rights as a research volunteer please contact Melanie J Clark, Compliance Officer at Georgia Institute of Technology at (404) 894-6942.

Thank you for your time.

Amanda Marshall
Georgia Institute of Technology
School of Public Policy

APPROVED *Consent Form Approved by Georgia Tech IRB: October 01, 2009 - Indefinite*

Figure 12 IRB-Approved Survey Consent Form

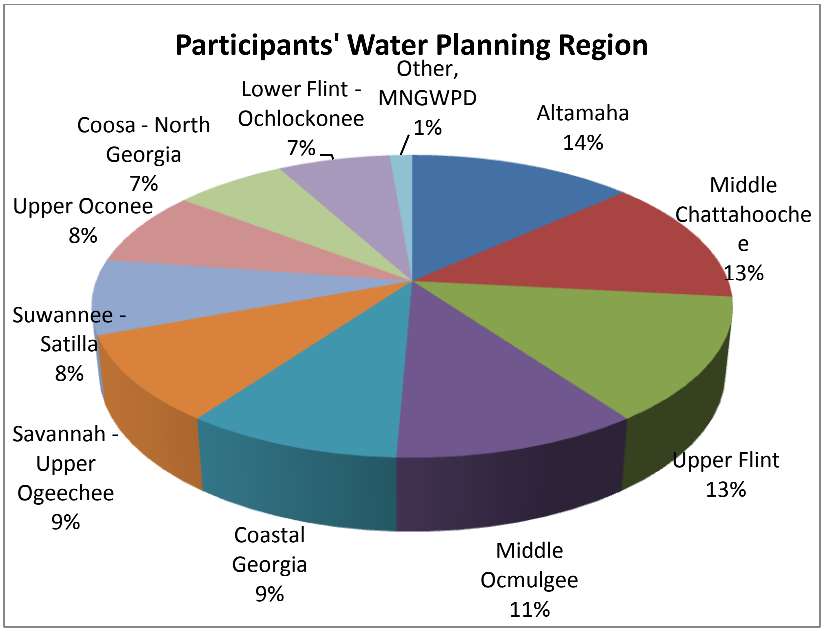

Figure 13 Participants' Water Planning Region

Table 24 Desired Proportion of Representatives to Water Use Sectors

Region	Agriculture	Industry	Energy	Municipal
Altamaha	34.08%	27.08%	27.04%	11.80%
Coastal Georgia	1.41%	36.90%	48.67%	13.02%
Coosa-North Georgia	0.42%	11.27%	74.01%	14.30%
Lower Flint	59.93%	17.20%	16.00%	6.88%
Middle Chattahoochee	13.44%	3.04%	38.36%	45.16%
Middle Ocmulgee	22.67%	17.70%	26.19%	33.45%
Suwannee-Satilla	28.95%	36.34%	13.48%	21.22%
Savannah-Upper Ogeechee	45.04%	12.31%	0.00%	42.65%
Upper Flint	69.98%	11.76%	0.00%	18.26%
Upper Oconee	1.61%	5.59%	87.01%	5.79%

Table 25 Classification of Location by Survey Participants

Classification of current location:	N	%	Length of Residence:	N	Min	Max	Avg.	St. Dev.
Rural	51	71.83%	Length of residence in Georgia* (years)	68	4	73	41.23	17.51
Suburban	12	16.90%	Length of residence in City/Town** (years)	68	1	73	26.33	19.54
Urban	8	11.27%	*Georgia = "All my life"	9	12.00%			
Total	71	100.00%	**Current City = "All my life"	4	5.33%			

Table 26 Participants Primary Affiliation by Specific Interest

Affiliation	No. of Responses
City or County government	26
Agriculture	18
Business / Industry	16
Water and/or wastewater facility	9
Environmental group or organization	3
Georgia citizen at large	3
Forestry	2
State government	2
electrical generation	1
Higher Education	1
Outdoor recreation	1
Tourism	1
University	1
Total	84

Table 27 Threats to Water Quantity or Quality in Georgia

Please rate the extent to which the below activities are a threat to the quantity and/or quality of water available in Georgia	Rural (51)		Suburban (14)		Urban (9)	
Droughts or other climatic events	43.14%	22	42.86%	6	77.78%	7
Building new/expanding existing reservoirs	7.84%	4	0.00%	0	0.00%	0
Inter-basin transfers	52.94%	27	42.86%	6	33.33%	3
Other States	45.10%	23	28.57%	4	33.33%	3
Urban areas	62.75%	32	64.29%	9	33.33%	3
Agriculture	5.88%	3	7.14%	1	11.11%	1
Business and Industry	3.92%	2	14.29%	2	0.00%	0
Power plants	11.76%	6	14.29%	2	0.00%	0
Landscape water use	7.84%	4	0.00%	0	0.00%	0
Runoff from residential areas (lawn treatments, washing vehicles, motor oil, etc.)	11.76%	6	7.14%	1	33.33%	3
CAFOs (Concentrated Animal Feeding Operations)	3.92%	2	28.57%	4	33.33%	3
Septic systems	17.65%	9	7.14%	1	22.22%	2
Sewer systems and treatment facilities	15.69%	8	7.14%	1	11.11%	1
Storm water runoff	17.65%	9	28.57%	4	44.44%	4
Wildlife	1.96%	1	7.14%	1	0.00%	0
Percent Average	20.65%		20.00%		22.22%	

Table 28 Council Assessment

13. Please indicate your level of agreement or disagreement with each of these statements, made at one or more water planning meetings.	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
If you take water from a basin you should return it.	3	10	14	34	12
In-stream flows should mimic natural flows.	3	12	20	29	8
We should determine how much water is available in each region, and limit population through planning and zoning to match.	17	15	9	23	9
It is acceptable to move water from one basin to another if that will favor economic development and job creation.	23	19	14	13	4
The best government is the one that governs the least.	3	6	8	29	26
Water resources are finite. There is only so much water to go around.	2	5	7	25	32
A first consideration of any good political system is protection of property rights.	4	4	13	22	30
When trade-offs need to be made between economic development and protecting the environment, the emphasis should be on protecting the environment.	3	15	29	22	4
Decisions about development are best left to the economic market.	5	21	17	21	8
The best government is local government.	1	8	16	26	21
We have a responsibility to protect our water resources for future generations.*	1	0	0	25	47
Water is a necessary resource for all life; it should be used but not owned.	6	15	12	29	11

Table 29 Council Member Perceptions

How well does the Georgia water planning process reflect the concerns, issues, and needs of the following interest groups?	How well does the Georgia water planning process reflect the concerns, issues, and needs of the following interest groups?	How well does the Georgia water planning process reflect the concerns, issues, and needs of the following interest groups?	How well does the Georgia water planning process reflect the concerns, issues, and needs of the following interest groups?	How well does the Georgia water planning process reflect the concerns, issues, and needs of the following interest groups?	How well does the Georgia water planning process reflect the concerns, issues, and needs of the following interest groups?	How well does the Georgia water planning process reflect the concerns, issues, and needs of the following interest groups?
	Not at all	A little	Moderately	A great deal	Rating Average	Response Count
Agricultural interests	0	8	27	39	3.42	74
Business and economic development interest	0	9	36	29	3.27	74
Homeowners	3	28	25	18	2.78	74
Recreational interests	2	29	29	14	2.74	74
Environmental protection interests*	0	16	26	31	3.21	73
Water utilities	1	8	39	26	3.22	74
Electric generation	2	11	36	25	3.14	74

Table 30 Employment Data from UGA's Georgia Statistics System

Region	All Industries, Avg. Employment, 2008	Employed, Number, 2008	Unemployment Rate, 2008
Altamaha	73,098	98,721	8
Coastal Georgia	249,973	295,438	5
Coosa - North Georgia	248,570	344,983	6
Lower Flint - Ochlockonee	133,807	158,405	6
Middle Chattahoochee	185,369	199,350	8
Middle Ocmulgee	198,064	255,212	7
MNGWPD	2,210,559	2,393,283	6
Savannah - Upper Ogeechee	207,769	270,957	8
Suwannee - Satilla	142,692	172,450	7
Upper Flint	70,728	98,320	7
Upper Oconee	199,596	258,565	7
State	4,029,673	4,545,675	6

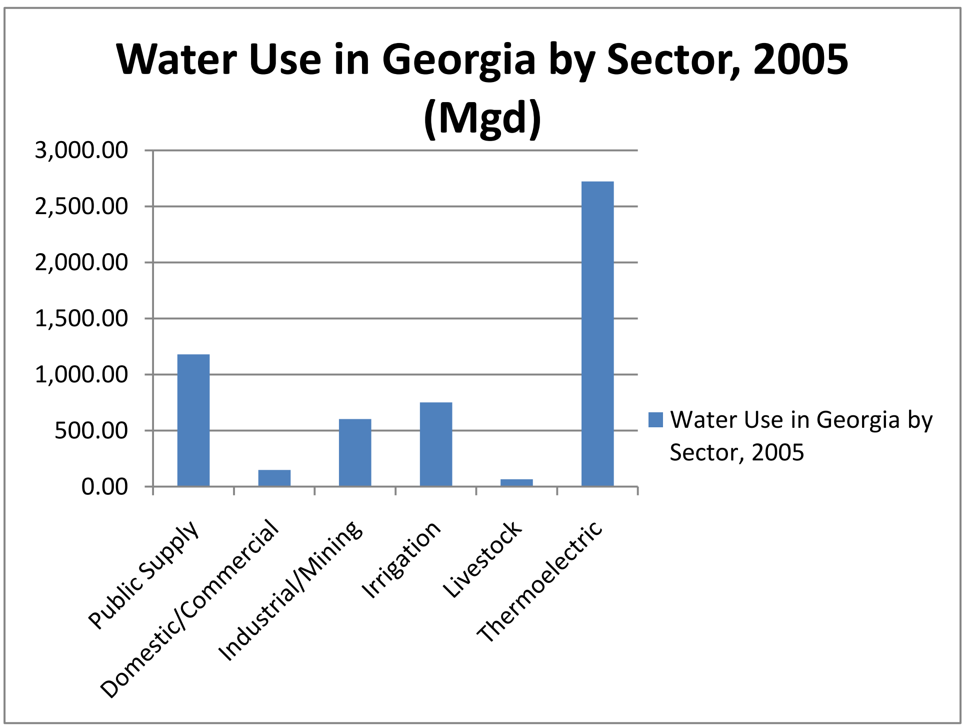

Figure 14 Water Use in Georgia by Sector, 2005

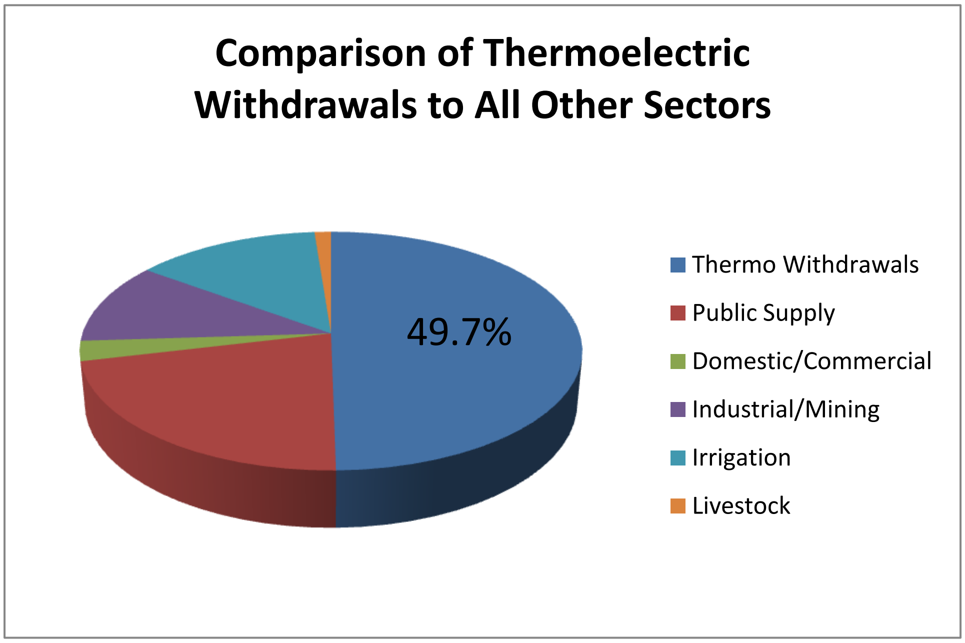

Figure 15 Comparison of Thermoelectric Power Production Withdrawals to All Other Withdrawal Sectors.

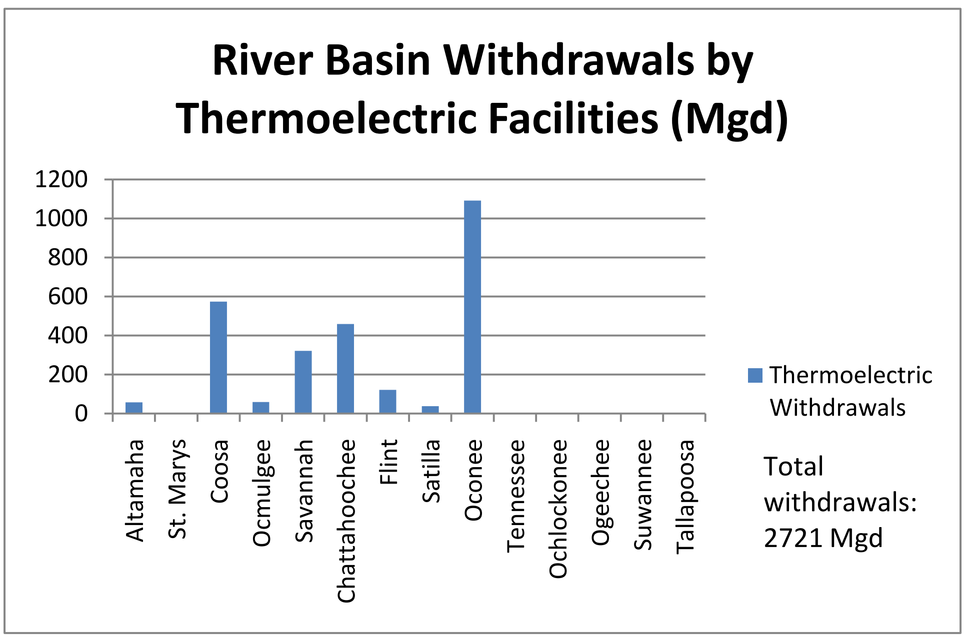

Figure 16 Water Basin Withdrawals by Thermoelectric Facilities (Mgd)

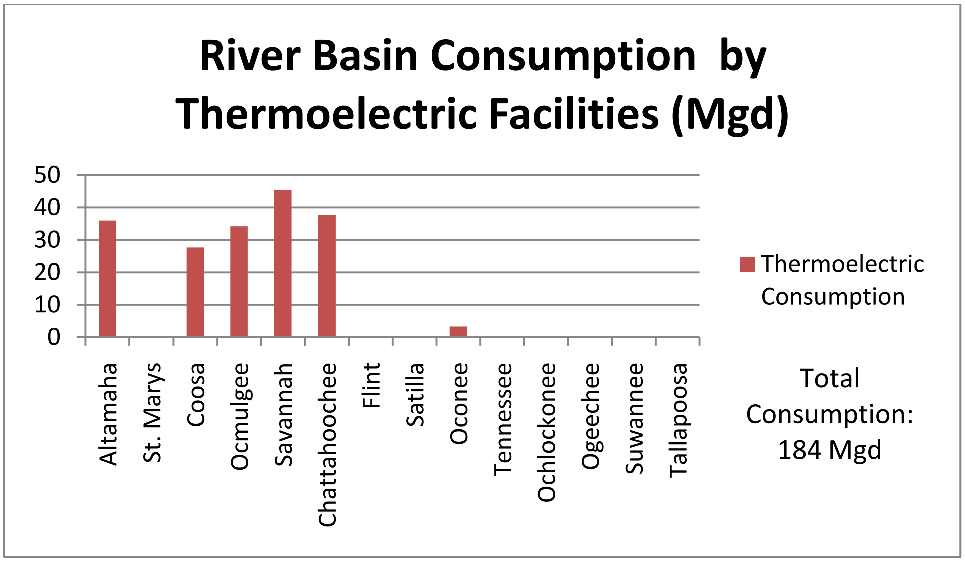

Figure 17 Water Basin Consumption by Thermoelectric Facilities (Mgd)

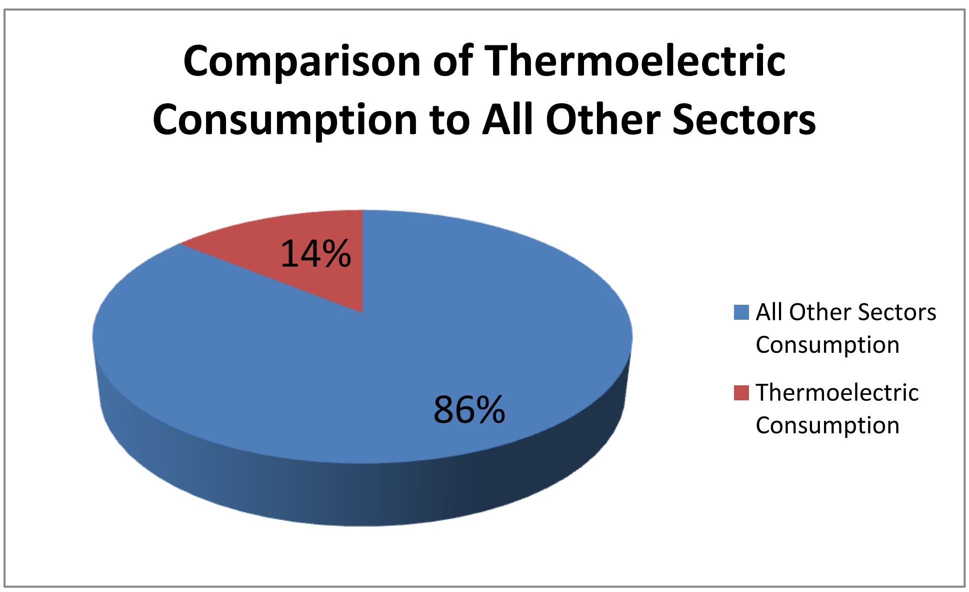

Figure 18 Comparison of Thermoelectric Consumption by All Sectors

Table 31 Trends in Water Use and Population by Water Planning Region, 1985-2005

Trends in water use and population by Water Planning Region, 1985-2005							
(Water withdrawals in million gallons per day, Population in thousands)							
Region	**Factor**	**1985**	**1990**	**1995**	**2000**	**2005**	**Trend**
Altamaha	Population	202.8	201.36	210.94	228.02	239.331	+
	Groundwater	131.59	113.99	129.45	141.29	131.68	+
	Surfacewater	78.34	89.09	96.5	107.7	107	+
	Total	209.93	203.08	225.95	248.99	238.68	+
Coastal GA	Population	418.3	461.45	510.49	542.976	572.665	+
	Groundwater	224.47	249.22	231.52	218.61	169.4	-
	Surfacewater	599.95	611.16	730.67	381.81	389.18	-
	Total	824.42	860.38	962.19	600.42	558.58	-
Coosa-North Georgia	Population	478.4	512.1	557.72	633.492	699.444	+
	Groundwater	32.82	37.42	42.41	47.87	57.27	+
	Surfacewater	542.85	537.37	541.92	707.44	687	+
	Total	575.67	574.79	584.33	755.31	744.27	+
Lower Flint	Population	330.6	320.44	334.21	352.88	361.806	+
	GW	223.79	206.32	314.92	485.03	293.2	+
	Surface water	322.51	254.7	294.36	401.86	299.84	-
	Total	546.3	461.02	609.28	886.89	593.04	+
Metro North Georgia	Population	2,437.70	2,804.95	3,255.03	3,913.98	4,516.96	+
	Groundwater	32.69	36.6	37.89	36.47	54.49	+
	Surface water	1,241.16	1,260.37	1,303.69	1,556.17	1,044.23	-
	Total	1,273.85	1,296.97	1,341.58	1,592.64	1,098.72	-
Middle Chattahoochee	Population	380.8	390.8	409.17	426.615	452.782	+
	GW	15.01	11.97	15.22	14.6	13.81	-
	Surface water	100.77	93.91	100.17	175.11	148.86	+
	Total	115.78	105.88	115.39	189.71	162.67	+
Middle Ocmulgee	Population	395.7	403.76	436.78	475.25	526.689	+
	Groundwater	75.97	72.33	85.51	96.22	95.97	+
	Surface water	257.23	102.98	152.05	300.06	123.66	-
	Total	333.2	175.31	237.56	396.28	219.63	-
Savannah-Upper Ogeechee	Population	481.7	495.69	533.89	560.821	579.529	+
	Groundwater	63.51	62.34	68.36	103.9	72.1	+
	Surface water	116.57	201.17	215.1	238.36	227.35	+
	Total	180.08	263.51	283.46	342.26	299.45	+
Suwannee-Satilla	Population	312.6	315.36	336.43	364.925	378.559	+
	Groundwater	90.73	99.29	127.08	142.15	130.78	+
	Surface water	21.71	46.64	55.52	60.62	47.78	+
	Total	112.44	145.93	182.6	202.77	178.56	+
Upper Flint	Population	208.1	212.24	221.48	231.644	237.689	+
	Groundwater	49.02	44.81	73.87	99.12	83.33	+
	Surface water	47.52	47.6	55.41	68.83	45.63	-
	Total	96.54	92.41	129.28	167.95	128.96	+
Upper Oconee	Population	329.4	360.11	394.87	455.855	507.124	+
	Groundwater	65.33	61.56	66.12	77.02	78.01	+
	Surface water	1,113.23	1,112.19	1,080.36	1,071.28	1,170.90	+
	Total	1,178.56	1,173.75	1,146.48	1,148.30	1,248.91	+

Table 32 Trends in Water Use by Category, 1985-2005

	Trends in water use, by category of use, for 1985-2005						
Region	**Sector**	**1985**	**1990**	**1995**	**2000**	**2005**	**Trend**
Altamaha	Thermoelectric power	55.39	57.06	65.37	61.47	62.2	+
Coastal Georgia	Thermoelectric power	501.53	505.4	607.32	255.21	292.67	-
Coosa-North Georgia	Thermoelectric power	434.66	416.45	402	536.83	535	+
Lower Flint-Ochlockonee	Thermoelectric power	178.23	107.75	109.34	166.17	120.9	-
Metro North Georgia	Thermoelectric power	869.8	814.07	738.66	949.5	432.58	-
Middle Chattahoochee	Thermoelectric power	22.84	3.64	0.05	71.04	65.53	+
Middle Ocmulgee	Thermoelectric power	198.48	45.59	85.79	222.31	59.02	-
Savannah-Upper Ogeechee	Thermoelectric power	198.48	45.59	85.79	222.31	59.02	-
Suwannee-Satilla	Thermoelectric power	0	0	0	0	0	0
Upper Flint	Thermoelectric power	2.2	0	0	0	0	-
Upper Oconee	Thermoelectric power	1063.5	1046.6	1008.1	984.31	1092	+
	Total	3525.11	3042.15	3102.42	3469.15	2718.92	-

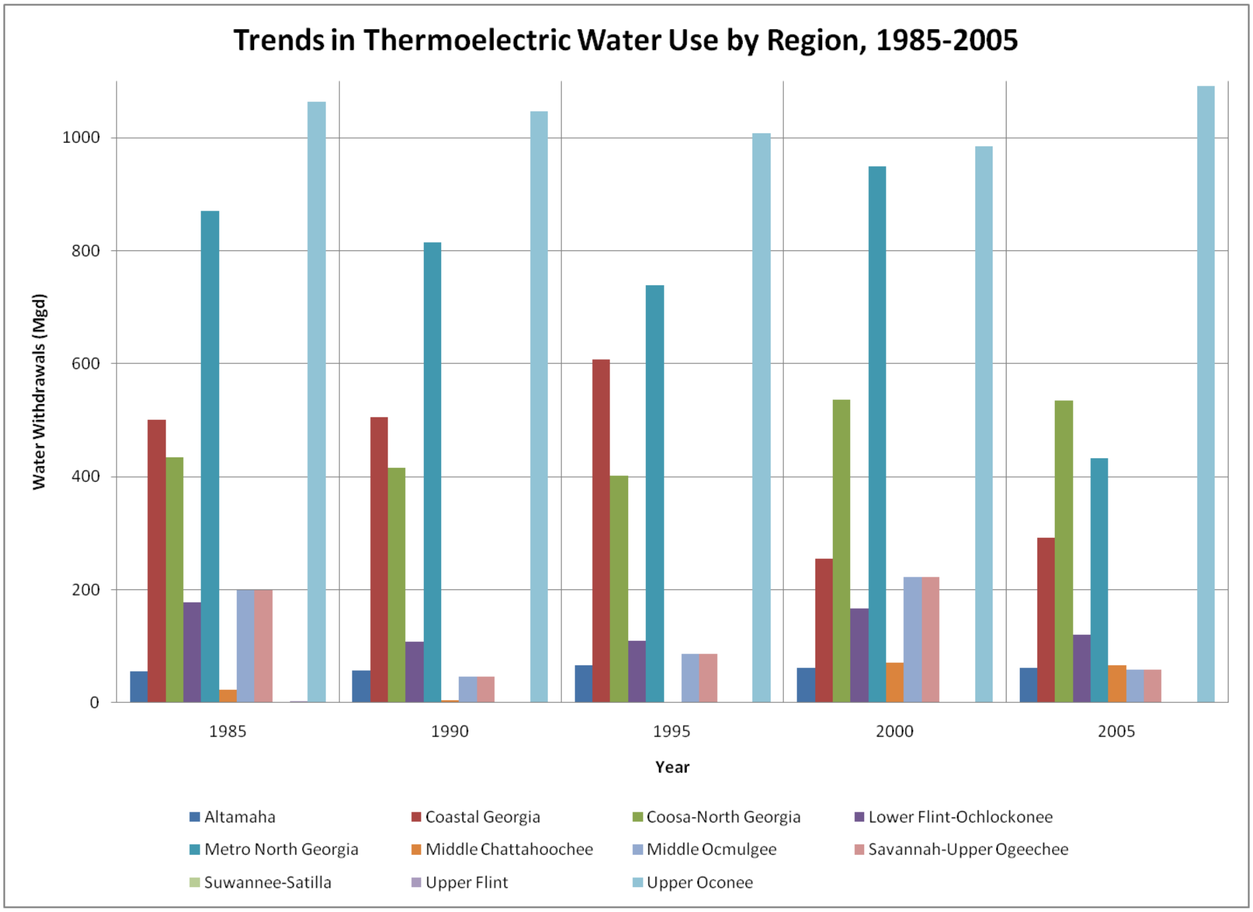

Figure 19 Trends in Thermoelectric Water Use by Region, 1985-2005

Table 33 Thermoelectric Water Use in Georgia by County, 2005

Water Use in Georgia by County, 2005														
County	Thermoelectric Withdrawals (Mgd)	Total Withdrawals	Total Consumptive use	Thermo. Consumption as a % of Total Consumption	Ratio of consumptive/ total water use	Plant Type	Plant Cons. Coefficient (gal per kw)	Plant Name	Thermo. % consumption (reported by GA Power)	Thermo. Plant kw capacity	Thermo. consumption Mgd calculated using coefficient and capacity	Ratio of thermo. consumption to thermo. total using coeff. and capacity	Thermo. consumption using GA Power data
Appling	57.77	63.02	39.60	90.91%	62.84%	nuclear	0.8	Hatch	0.62				36
Bartow	38.92	63.36	32.34	85.45%	51.04%	coal	0.7	Bowen	0.71				27.6332
Burke	65.36	83.82	59.45	72.33%	70.93%	nuclear	0.8	Vogtle	0.66				43
Chatham	161.18	244.10	17.46	0.00%	7.15%	coal	0.7	Kraft	0				
Cobb	362.58	459.07	17.29	0.00%	3.77%	coal	0.7	McDonough	0				0
Coweta	31.08	42.51	21.43	73.97%	50.41%	coal	0.7	Yates	0.51				15.8508
Dougherty	120.14	159.39	15.52	0.00%	9.74%	coal	0.7	Mitchell	0				0
Effingham	94.53	150.87	5.13	44.83%	3.40%	Combined Cycle	0.3	McIntosh	0.02				2.3
Floyd	535.00	589.29	18.50	0.00%	3.14%	coal	0.7	Hammond	0				0
Glynn	36.96	115.73	7.90	0.00%	6.83%	Oil	0.3	McManus	0				0
Harris	1.20	12.66	3.13	?	24.72%	Combined Cycle	0.3	Cataula (Sonat Energy Services)					
Heard	64.33	65.89	22.97	95.22%	34.86%	coal	0.7	Wansley	0.34				21.8722
Monroe	59.02	62.80	35.65	96.02%	56.77%	coal	0.7	Scherer	0.58	3272000	2.2904		34.2316
Putnam	1,092.00	1,097.15	6.33	51.75%	0.58%	coal	0.7	Branch	0.003	1,539,700	1.07779	0.000986987	3.276
Worth	0.76	13.79	11.18	?	81.07%			?					
Total:	2,720.83	5,471.47	1,310.43	49.73%	23.95%								

Table 34 Thermoelectric Water Use in Georgia by Plant, 2005

Plant name	2005 Thermo % consumption	2005 Thermoelectric Consumption (Mgd)	2005 kwh production		2005 gallons per kwh	2008 Thermo % consumption	2008 Thermo consumption	2008 kwh production		2008 gallons per kwh
Hatch	0.62	36	6,874,386,430	13,721,330,200	**0.96**	0.62	36	6,970,684,542	13,913,542,000	**0.94**
Bowen	0.71	28	22,337,673,000	22,337,673,000	**0.45**	0.61	27	22,232,525,000	22,232,525,000	**0.44**
Vogtle	0.66	43	8,140,554,253	17,813,029,000	**0.88**	0.66	43	8,124,526,806	17,777,958,000	**0.88**
Kraft	0	0			**0.00**	0	0	1,026,131,000	1,026,131,000	**0.00**
McDonough	0	0	3,638,965,000	3,638,965,000	**0.00**	0.23	6.3	3,116,156,000	3,116,156,000	**0.74**
Yates	0.51	16	6,862,634,000	6,862,634,000	**0.84**	0.33	16	6,872,200,000	6,872,200,000	**0.85**
Mitchell	0	0	636,154,000	636,154,000	**0.00**	0	0	522,039,000	522,039,000	**0.00**
McIntosh	0.02	2	n/a	n/a	**n/a**	0.042	4	677,987,000	677,987,000	**2.15**
Hammond	0	0	4,361,408,000	4,361,408,000	**0.00**	0	0	4,027,360,000	4,027,360,000	**0.00**
McManus	0	0	61,653,000	61,653,000	**0.00**	0	0	-3,000	-3,000	**0.00**
Cataula (Sonat Energy Services)										
Wansley	0.34	22	7,026,371,113	13,133,403,950	**0.61**	0.31	21	6,419,503,018	11,999,071,062	**0.64**
Scherer	0.58	34	5,988,094,467	35,856,853,096	**0.35**	0.67	35	4,894,024,835	29,305,537,934	**0.44**
Branch	0.003	3	9,797,453,000	9,797,453,000	**0.12**	0.003	3	10,152,991,000	10,152,991,000	**0.11**
?										
		184		128,220,556,245	**0.52**		191		121,623,494,996	**0.57**

1995	withdrawals		% of total
thermo		total	
3074.33		5818.369	52.8%
2000	withdrawals		% of total
thermo		total	
3309.96		6486.58	51.0%
2005	withdrawals		% of total
thermo		total	
2,720.83		5,471.47	49.7%

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