WATER VERSUS DEVELOPMENT IN FLORIDA

Linda S. Johnson
Askew School of Public Administration and Policy
Florida State University

Abstract

Water consumption in Florida has been governed by a political institutional arrangement since 1972. In 1983, Consumptive Use Permitting was added to assure that new uses of water would be: reasonable and/or beneficial; not interfere with present legal uses; and within the public interest. The tradeoff is that water must provide for different human activities, yet have adequate supplies to maintain the natural environment. Florida is also a high growth state where economic development is significant. This study examines water in Florida at two points in time, 1980 and 1990 to see the impact of the governance institutional system, economic development, and land use on freshwater withdrawal. There is cautious optimism that in the 1990 model, withdrawal showed a slight movement towards the governance institutional arrangement.

Introduction

Florida is a water state. This is one of the attractions to visitors. According to Donald Patton and Rodney DeHan (1998: pp. 11-12), there are “1,197 miles of coastline, 7,700 lakes greater than 10 acres, more than 1,700 streams, 3 million acres of wetlands, and 27 first-magnitude springs (those with flows exceeding 100 cubic feet per second).” All this water supports a vast array of unique and fragile ecosystems and in the 1980s supported approximately forty million visitors a year (Betz, 1984). So, why are there talks of “water wars” in central Florida (Patton and DeHan, 1998: p. 12)?

Florida is also a high growth state (deHaven-Smith, 1998). There is a strong historical link between Florida’s growth, economy, land use patterns, and water resource use (Audirac, 1990; Blake, 1980; deHaven-Smith, 1998; Price and Feiock, 1994). Since 1972, water resources in Florida have been managed through an institutional arrangement to assure ample water supply for both people and the natural environment. This study examines the link between water management, water withdrawal, and economic development in Florida. The question addressed is: Does the Florida water management institutions promote economic development and increased water withdrawals or function as an institutional constraint on increased withdrawals?

Historically as a sparsely populated marshy, swampy state, Florida needed to entice permanent residents. Tourists would come during the winter months, since the warm climate and coastal location were attractive, but to attract permanent residents the state needed to develop the land and provide employment (deHaven-Smith, 1998). Thus, economic development to provide population growth became the paramount focus in the history of Florida's governing structure. From 1979 to 1993, public opinion polls listed economic problems and community development as two of the top three issues facing the state.

According to Ivonne Audirac (1990: p. 50), "[f]rom 1880 to 1980 Florida changed from 90 percent rural to 85 percent urban," with almost half of the residents living in unincorporated areas. She contends the urban areas were not centered around traditional manufacturing enterprises but, "construction, tourism, and population growth, of which 'footloose' retirees comprise a large segment, has resulted in historic urban patterns that are predominately residential and low density" (Audirac, 1990: p. 50). Nelson Blake (1980: pp. 285-286) noted that population growth benefited interests such as landowners, developers, construction, and the banking industry.

In the past, the supply of water was not the problem. In many cases, the problem for development was too much water in the wrong place. Central and South Florida were constantly plagued by flooding and drainage problems, and water supply was only a problem during times of drought (DeGrove, 1958: pp. 1-2). The Swamp and Overflow Lands Act of 1850 transferred twenty million acres of submerged lands from the federal government to the state of Florida for flood control, drainage, and reclamation (Canter and Christie, 1984: p. 130).

The earliest history of water management in Florida involved drain and fill projects to reclaim and provide dry land for development. Water was viewed as an obstruction to development that needed to be controlled. In 1885, the Florida Legislature created the Board of Trustees for Internal Improvement to provide land for railroads by draining and filling of low areas to produce high ground for tracks (DeGrove, 1958). Water management, at that point in time, was primarily drain and fill projects to reclaim land and the Florida General Drainage Act of 1913 provided an incentive, in the form of property rights, to Florida citizens to drain and fill submerged and wet lands (Canter and Christie, 1984).

After World War II, the population in Florida increased dramatically and the rate of growth began to strain the physical system. The United States Geological Survey (USGS) noted that the primary aquifer, the Floridan, had decreased forty to sixty feet over the twenty year period of 1949 to 1969 (Carter, 1974: p. 8). In 1957, the state enacted the Water Resource Law to address water deficiencies and flood control through the formation of water districts to regulate consumptive use, but authority was fragmented between different levels of government that produced a weak and inadequate governance system (Ausness, 1987).

Concern for ample water supply was apparent by the 1960s when groundwater overdraft, pollution, and transfers of water threatened the viability of the system (Ausness, 1987). A severe drought in 1970 and 1971 brought the need to address water allocation to the public and the state legislature. This alarming discovery (Downs, 1972) provided the incentive for the Florida legislature to enact several acts to manage the natural environment, development, and population growth. One of the new far reaching acts legislated was the Florida Water Resources Act of 1972, Chapter 373 FS, which declared the "waters of Florida belong to the people of Florida" (Canter and Christie, 1984: p. 132). According to Blake (1980: p. 231), the act, also, set up "areas of critical concern" to provide state management of environmentally and historically important areas and disrupt the alliance between local governments and developers.

The Act created five water management districts (WMD) to cover the main river basins of the state: (1) Northwest Florida (NWFWMD), (2) St. Johns River (SJRWMD), (3) Suwannee River (SRWMD), (4) Southwest Florida (SWFWMD), and (5) South Florida

(SFWMD). Oversight was vested in the Florida Cabinet and the Department of Natural Resources (Carter, 1974). According to Ausness (1987: p. 18), the act's intent was to establish a ". . . water regulatory agency with supervisory authority over the water management districts."

Florida's Governance Institution for Water Management

When governance of the waters of Florida became entrusted to five water management districts, the Florida Cabinet, and the Department of Natural Resources (DNR) in 1972, the Florida water governance regime became a hybrid of judicial, legislative, executive, and special purpose district structure (Lynne and Saarinen, 1993). A statewide constitutional referendum provided taxing authority to the districts and granted the power to plan, manage, and regulate water resources in Florida (Price and Feiock, 1994; Blake, 1980: p. 231). "Thus, our policy is directed toward providing the citizens of Florida with the water necessary to support a broad range of human activities while ensuring that sufficient water remains within the hydrologic system to maintain the functions of the natural system" (FL HCWP, 1995: p. 4).

In 1983, consumptive use permitting was established to assure that new uses of water fulfilled three objectives: uses would be reasonable and beneficial; uses would not interfere with present legal uses; and uses would be in the public interest (s. 373.216 FS). The water management districts were given the responsibility of resource inventory in order to assess the available quality and quantity of water resources in the state. The districts were required to define the groundwater basins: delineate the recharge zones, mark areas of over-consumption and pollution, establish minimum ground and surface water levels, delimit future water needs; generate reclaimed water sources, and define water quantities for potential use (s. 373.0395 FS).

Florida's Water Management Districts

The five districts differ in many ways. Since the districts were designed to follow the five main watersheds in Florida, district lines were drawn by the surface water drainage patterns. The districts, also, differ in their taxing abilities. The millage rate for SJRWMD, SRWMD, SWFWMD, and SFWMD is capped at 1 mill, but NWFWMD has a cap of 0.05 mills (OPPAGA, 1994; Purdum and Penson, 1998).

Northwest Florida WMD is comprised of the western fifteen counties in Florida plus a portion of one county, and a total area of 13,264 square miles (Purdum and Penson, 1998: p. 170). Sixty percent of the land is forests owned by private companies, individuals, and governmental units; ten percent is forested wetlands; sixteen percent is farms; and six percent of the area is water and urban areas, with a population, in 1990, of 1,008,780 (Purdum and Penson, 1998: p. 173). Many of the areas of critical concern for water lie along the coast where population growth is greatest (Purdum and Penson, 1998: p. 178). According to Purdum and Penson (1998: p. 171), NWFWMD with a taxing authority of 1/20 of the other WMDs "[m]ost of the districts funding comes from cooperative projects, grants, and legislatively funded programs such as Save Our Rivers and Preservation 2000."

The Suwannee River WMD has the smallest area and populations of the WMDs: 7,640 square miles and a 1995 population of approximately 280,000 people (Raulston, et. al., 1998: p. 194). Most of the area is tree farms and small traditional farms with most of the population to the west of the Suwannee River (Raulston, et. al., 1998: p. 197). Although water use has not changed significantly the greatest concern for the citizens is the threat of water transport from SRWMD to south Florida (Raulston, et. al., 1998: p. 203). The area has the lowest tax base of the state (OPPAGA, 1994: p. 14).

St. Johns River WMD runs along the Atlantic coastal area and inland, 12,400 square miles with approximately 3.7 million people in 1995 (McGrail, et. al., 1998: p. 214). Jacksonville/Duval and Orange county with Disney World has the greatest concentrated population and an economy based on tourism, agriculture, forestry, paper manufacturing, aerospace, electronics, ranching, and citrus groves (McGrail, et. al., 1998: pp. 217-218). Land development and population growth has dramatically increased the use and demand for water supply (McGrail, et. al., 1998: p. 222).

Southwest Florida WMD is the oldest, created by the state legislature in 1961 to address flooding in the area (Wheeler, Owen, and Johnson, 1998: p. 238). Population of the district was approximately 3.6 million people in 1995, which does not include a substantial tourist population, and covered over 10,000 square miles (Wheeler, Owen, and Johnson, 1998: p. 241). The district has a governing board and is subdivided into nine hydrologic basin boards, with the funds from ad valorem taxes shared between the district and the nine boards (Wheeler, Owen, and Johnson, 1998: p. 238). Land use is a combination of 31.3 percent agricultural; 21.5 percent divided between industrial, commercial, and residential; 18.8 percent forests; and 18.6 percent wetlands (Wheeler, Owen, and Johnson, 1998: p. 240). This is the area where demand exceeds supply and has spawn "water wars" cited earlier (Patton and DeHan, 1998: p. 12).

South Florida WMD contains 17,000 square miles approximately 5.2 million people, estimated in 1990, with most of the population concentrated along the Gulf Coast, in the Fort Myers area, and Atlantic coast, the Miami area, and north central in the Orlando area (VanArman et. al., 1998: pp. 260-264). The center of the district contains the Everglades Agricultural Area (EAA) south of Lake Okeechobee and cattle ranches and dairies north of the lake (VanArman et. al., 1998: p. 264). Water supply needs are fairly constant with demands in the winter for tourists offset by the low demands from agriculture and when agriculture needs more water the tourist season is winding down, but when rainfall is low, water shortages can occur (VanArman et. al., 1998: p. 269).

Problems in Bureaucratic Supply of Water Management

The creation of districts on the regional watershed patterns was to provide governance based on regional dynamics (Patton and DeHorn, 1998). However, problems in water allocation and management continued. By the late 1990s, conflict over minimum water requirements for the environment and the determination of minimum water levels and flows were still not set in many areas (FL HCWP, 1995; Patton and DeHorn, 1998). In the administration of Florida water resources, supervision of the districts by DNR was seen as more a "partnership than "oversight (Ausness, 1987: pp. 29-30). This relationship was still evident in 1995 when the Department of Environmental Protection (DEP) became the successor agency to DNR (FL HCWP, 1995).

DEP, as the oversight agency and DEP's interaction with the districts as more of a partner in water allocation and provision rather than as regulatory supervisor could be a problem inherent in bureaucratic supply or in decentralization (Weimer and Vining, 1992). Under inherent bureaucratic supply problems, the "principal-agent" problem could easily apply to the interaction between Florida

Legislature, the WMDs, and DEP as overseer. Principal-agent problems emerge from different interests between the principal and the agent, monitoring the agent's actions become costly (Weimer and Vining, 1992; Niskanen, 1971). The principal, in this case the state legislature, must create an "organizational arrangement" that will reduce the "undesired behavior" of the agent (Weimer and Vining, 1992: p. 184). Monitoring is costly due to information asymmerty, the fact that the agent is privy to information about operations that is not known to the principal, which allows the agent to pursue their own self-interest (Weimer and Vining, 1992: p. 184).

Water as a Common-Pool Resource

The provision of a new governance structure to manage the waters of Florida was due in part to the characteristic of water and the perceived market failure in allocation and provision. Water is a common-pool resource (CRP) (Ciriacy-Wantrup and Bishop, 1975; Goetze, 1987; Ostrom, 1990; Ostrom, Gardner, and Walker, 1994; Bromley, 1992). The characteristics of water, as a common good, emphasize the difficulty managing the resource. It is difficult to exclude other users; there is competition in consumption; and the good can become congested with users (Weimer and Vining, 1992; Ostrom, 1990). The outcome can be overconsumption, misuse, and underinverstment in the management of the resource (Weimer and Vining, 1992: pp. 89-93). Therefore, "[r]esources are managed as common property by rules for user-group behavior when their continuing use is conditional upon the independent behavior of group members" (Gibbs and Bromley, 1989: p. 25).

The concept of water as a common pool resource suffers from the fact that it is not considered a resource until a human constructed institution is designed for management (De Gregori, 1987: p. 1242). Water management institutional arrangements must be designed to structure the incentives for effective and efficient resource use (Livingston, 1995). The construction of such an institution can be difficult since, the institution must be crafted to structure the actions of individual users (Ostrom, 1987). Elinor Ostrom (1987) notes that institutional arrangements for the successful resolution of common pool resource dilemmas can take two directions: (1) Transfer the commons to a private property regime, thus establishing property rights or (2) place authority of management and governance in an external authority that will provide control and regulation. It is this second institutional approach that Florida has chosen for water governance.

Method

In order to examine the extent to which Florida's water governance institution facilitates economic development or functions as an institutional constraint, two linear regression models were run that focus on supply and demand for water at two different points in water management history, 1980 and 1990. The 1980 point is eight years after the passage of the Water Resource Act of 1972 and should provide a good view of the initial water management institutional system. The 1990 point was chosen since it is seven years after the Consumptive Use Permitting Act of 1983. The hypothesis is that water consumption is dependent on the water management district, the population density, the agricultural land use, the per capita income, and the number of employees in the county, and permits for new single family houses in Florida.

Sixty-six Florida counties were used in this study; one county was eliminated due to missing data.[1] County level data were used in this study since they represent the fundamental operational level of decision making. Decisions to withdraw water are made at the county level. Water withdrawals and water use has been collected at the county level since the 1950s, but usable data for saline and fresh water withdrawals were not differentiated until 1965 (Marella, 1995: p. 6).

Dependent Variable: Water Consumption

The dependent variable chosen for this study is total freshwater use in million gallons per day for each county (Marella, 1995). This includs ground and surface water. Since the institution for governance was set in 1972 and the consumptive use permitting system was enacted in 1983 we should see different attributes that influence the water usage at these two times. If the water institutions constrain the economic development attributes, then the governance system structures the appropriate action and follows the intent of the legislation. If the institution accommodates economic development and market based supply and demand, then there should a positive effect of the economic and land use attributes on water withdrawal. However, if the water management district is important to the outcome then there should be a negative effect of water management district on withdrawal.

Independent Variables

The independent variables are chosen to represent different characteristics of the governance and economic systems: the water management districts, population density, the number of wage and salaried jobs, agricultural land use, and new single family housing permits. These variables will test whether water consumption is influenced by management institutions or economic development.

Institutional attributes are the five water management districts: Northwest Florida Water Management District (NWFWMD), St. Johns River Water Management District (SJRWMD), Suwannee River Water Management District (SRWMD), Southwest Florida Water Management District (SWFWMD), and South Florida Water Management District (SFWMD). These were coded as four dummy variables. Counties were placed in one management district: NWFWMD, SJRWMD, SWFWMD, or SFWMD, depending on where they received their water based on Marella (1995). Suwannee River WMD is the baseline. The Florida water management districts do not follow political boundaries, but surface hydrologic watersheds, so there are thirteen counties that share districts. The coding decision was to place the county in the district where it withdrew public supply water and if water was supplied by more than one the largest supplier was used.[2]

Population density was chosen to reflect the population that is sustained in a given area. The number of people per square mile was obtained by dividing the population in a county by the dry land area, both measures are from the Florida Statistical Abstract (BEBR, 1983; 1993). Dry land area was used instead of total land since people usually inhabit dry land. There should be a decrease in the amount of freshwater withdrawal as population density increases. This is based on the assumption that the greater the number of people on the same square mile of land the less likely they will have single family houses with yards that require water. However, if as Audirac (1990: p. 50) notes that Florida has always had an average population density in urban areas slightly lower than the national average, but that the average density outside urbanized areas is higher than the national average, then the effect should not be strong.

Agricultural land use was added to capture land use. The expectation is that as agricultural land use decreases the land will be used for residential and/or commercial use. This will increase water consumption if the model functions to promote economic development. Agricultural acreage is measured as acres in production in the 66 counties and was derived from the Florida Statistical Abstract (BEBR, 1986; 1993). The agricultural census is reported every five years, in years ending in 2 and 7. However, for the 1980 values, the report was from 1978 and 1982, so a mean was used for the value. In 1990 the reports were from 1987 and 1992, so the values were normalized to get the 1990 value. Franklin County had missing data for the time periods.

Three measures of economic development were: the number of wage and salaried jobs, per capita real income, and the number of single family house permits in the counties for 1980 and 1990 (BEBR, 1982; 1993). The per capita real income was obtained by dividing the per capita income by the individual county price index for the targeted year (BEBR, 1981; 1991). This gives a measurement of the per person real income level of the county. These attributes are chosen to indicate employment opportunities in the counties; the desire for single family housing and acreage; and the influx of population. Increase in these variables should not greatly impact water consumption if the institutional arrangement governing the system functions as an efficient consumptive constraint.

Results

Between 1980 and 1990 there was a decrease of almost 3 million acres of farmland. In 1980, agricultural acreage varied from a low of 77 acres in Monroe County to a maximum of 2,092,201 acres in Volusia County with a mean of 221,774 acres for the state. By 1990, the average acreage in agriculture had decreased to 179,307.5 acres and ranged from 30 acres, again in Monroe, to 997,336 acres in Walton County. Volusia’s farmland had decreased to 160032 acres by 1990.

Two separate linear regressions were run, one for 1980 and one for 1990. The 1980 model provides a snapshot after eight years of formal institutional arrangements for water management were in place. The regression coefficients are provided in Table 1.

Table 1
1980 Model Total Freshwater Withdrawals

Independent Variables	***Coefficient***	***Standard Error***	***t***
Population Density	-0.123*	0.048	-2.553
Farm Land	0.000102*	0.000	2.084
Jobs	0.000365*	0.000	2.013
House Permits	0.03603*	0.014	2.61
Per Capita Real Income	0.001798	0.01	1.858
NWFLWMD	6.105	40.401	0.151
STJWMD	-46.688	45.4	-1.028
SFLWMD	-6.81	52.526	-0.13
SWFLWMD	-23.246	45.464	-0.511
(Constant)	-106.891	73.662	-1.451

Note: R^2 = 0.596; Adjusted R^2 = 0.531; SEE = 98.6232
F = 9.181 (sig. F = .000)
* t < .05; ** t< .01; *** t<.001 two tailed test

The adjusted R square of 0.531 indicates that the model explains a little over half of the variation in freshwater withdrawals. Four of the explanatory variables were significant at the .05 level. Per capita real income and the water management districts were not significant. Partial correlation procedures were run on the model and none of the variables were highly associated.[3] Population density is in the expected direction and is significant at the .05 level. An increase in population density of 10 people, all other attributes held constant, would have an associated reduction of freshwater withdrawal of over a million gallons per day.

Agricultural land, employment, and single family housing permits are positively associated with water withdrawal and significant. An increase of just one acre of land in production, on average, is comparable to an increase of 102 gallons of water per day, all other variables held constant. While, an increase of one wage and salaried job is associated with an increase of 365 gallons of water per day.

Housing permits and employment were significant at the .05 confidence level. However, their effect on water withdrawal may seem small, but the impact of one new single family house permit is associated with an increase of 36,000 gallons of freshwater water withdrawal a day, all other attributes held constant. A change in the per capita real income of just one dollar per year would on average with other attributes constant increase the freshwater withdrawal by 1,798 gallons per day.

Although, the water management districts coefficients were not significant the trend is interesting. NWFLWMD had a positive effect while the other three had negative effects.

The 1990 model is presented in Table 2. In 1990, agricultural land, employment, and per capita real income were significant. The model explains over 60% of the variation in water withdrawal. Again partial correlation test were run and there was not high correlations in the independent variables.[4] Population density, again, had a negative relationship with ground water. However, with a significance level of .077 it just misses significance at the .05 level. The variable coefficient may seem small, but since freshwater withdrawal is in million gallons per day the impact can be great. The increase of an additional ten people per square mile from a low density area to a higher density area in a county, on average, could decrease the freshwater withdrawal by 773,100 gallons per day, with all other variables held constant. This could be an incentive to direct growth to areas where population density is high.

Agricultural land, employment, and per capita real income had positive relationships with water and the effects were significant. An increase of just one acre of agricultural land in production, on average, would increase the freshwater withdrawal by 305 gallons per day, other attributes held constant. The increase of only one wage and salaried job would, on average and other attributes constant, increase the withdrawal rate by 680 gallons per day.

The one surprising coefficient was the direction of housing permits for single family housing. In 1990, the relationship was negative and significant at the .01 level. The addition of one new single family house permit, on average, decreased the water withdrawal by 18,390 gallons per day. This could be the effect of the growth management laws or it could signal a change in the type of houses and the growth that occurs. New houses could be more resource efficient and could be on smaller lots that have smaller lawns. This would decrease the rate of water use. This would be true for townhouses. An alternative scenario is that new single family house have shallow lawn pumps for lawn water. This attribute would be interesting to explore.

Table 2
1990 Model Total Freshwater Withdrawals

Independent Variables	***Coefficient***	***Standard Error***	***t***
Population Density	-0.07731	0.043	-1.801
Farm Land	0.000305***	0.000	4.032
Jobs	0.00068***	0.000	5.892
House Permits	-0.01839	0.014	-1.29
Per Capita Real Income	0.001302***	0.0041	3.381
NWFLWMD	-25.75	41.595	-0.619
STJWMD	-22.418	48.588	-0.461
SFLWMD	17.031	54.517	0.312
SWFLWMD	-30.278	48.072	-0.63
(Constant)	-171.93**	61.44	-2.798

Note: $R^2 = 0.668$; Adjusted $R^2 = 0.614$; SEE = 100.6103
F = 12.510 (sig. F = .000)
* t < .05; ** t< .01; *** t< .001 two tailed test

Per capita real income is also positive. In 1990, the increase in one real dollar in the annual per capita income was, on average, associated with the increase of 1302 gallons of water per day, all other attributes held constant.

Finally, the coefficients for the four water management districts were not significant. However the signs are interesting. South Florida Water Management district had a positive effect on water withdrawals. The other three districts had a negative association. In the 1980 model the Northwest Water Management District had a positive association and South Florida had a negative relationship with water withdrawal.

Discussion

These two simple models look at two points in the Florida water institutional arrangements for water resource management. The increase in productive agricultural land use slightly increased water use in both 1980 and 1990. However, in 1980, the impact was not as great as the economic development measures. A one unit change in agriculture was not as great as a one unit change in jobs, house permits, or income.

In the 1990 model, a one unit increase in agricultural land did not have as great an impact as a one unit change in either jobs or income, but did have a greater impact than a one unit increase in single family house permits. The negative association of housing permits on water is consistent with Richard Feiock's (1994) study of growth management and building permits.

There is a need for a better measure of the water management institutions and their effect at the county level. The next step is to look at the number of water permits issued by each water management district as well as the number of permits denied by each district. Since the denial of a permit can cause conflict, the number of court cases or dispute resolutions for each district could be useful.

Since each district has different tax assessment ability, the per capita revenues from the taxes could provide information on the districts. Other budget measures could also be useful. Water rates would be useful. In 1988 and 1989, residential water rates (BEBR, 1993) in NWFWMD varied from $0.82 and $0.84 per 1,000 gallons in Fort Walton Beach, Okaloosa County, and Tallahassee, Leon County, respectively, to $0.96 per 1,000 gallons in Pensacola, Escambia County. Orlando, Orange County in SJWMD, with Disney World paid the lowest residential water rate in the state, 1988-1989, of only $0.53 per 1,000 gallons while the Florida Keys in Monroe County SFWMD, paid the highest rate of $5.56 per 1,000 gallons (BEBR, 1993). However, these numbers are provided only for large metropolitan areas and not for every year. A useful measure for each county is needed.

The next step is to apply a dynamic framework for analyzing water resources. Ronald Oakerson's (1992) framework would provide the mechanism to examine the physical and technological attributes, the decision-making arrangements, and the patterns of interaction between actors. There are several measures that could be included for the physical and technological attributes. Oakerson (1992) notes that the capacity of the system is important to the outcome. Measures of the groundwater and surface water levels, precipitation, plus measures of the recharge of the system could provide important information on the needs of the physical/ environmental component. Another measure would be the physical attributes of access, such as the degree to which access can be limited and controlled (Oakerson, 1992). This could include water transfers, since they represent physical movement of water from one place to another. These are becoming increasingly important.

Measurements of the institutional arrangements for water resource management are the second set of attributes in Oakerson's framework. These are the rules that provide the authority to govern. Oakerson (1992) demarcates three levels of rules that make up the resource regime: the day to day operational rules; the collective choice that structure the day to day actions; and the external arrangements level outside the commons, either at the constitutional level, adjudication level or the market. Florida has enacted several growth management statutes in the past thirty years. Including these pieces of legislation can provide an insight into the dynamic system. Court cases and dispute resolution cases, also, can provide a foundation for the institutional arrangements. Market arrangements that include water transfers and public, nonprofit, and private partnerships can provide information on the system.

Finally, the patterns of interaction are important attributes to the outcome of water resources. These are the strategies that either persuade or discourage the desired action (Oakerson, 1992: pp. 49-50). Measures of the actors and their selective incentives and political factors at the county level could be added here and may also provide greater insight into the interaction. Demographic factors and patterns of dissimilarity can allow the mapping of the incentives to comply or to defy the rules in place.

Future directions for the study include extending the model forward to the present and back into the 1960s before the water resource management institutions were formed. This would entail the use of a time series or event history analysis. Event history analysis could be employed to predict the maximum likelihood of a change in both the institutional management arrangement (Yamaguchi, 1991). This could provide greater knowledge of Florida's path dependency in water use as well as probabilities that governance institutional arrangements would structure the desired outcome of sustainable growth and environmental maintenance. This would allow the incorporation of the newest trends in water legislation, water usage and allocation, water transfers, and the changing role of water in Florida's economy.

Water institutions must be designed to elicit the appropriate action from individual users of the resource. Feldman (1991: p. 14) characterizes water policy as "gratuitous", since it ". . . permits certain people to demand benefits from government without paying for them, without rewarding those who pay for them, without respecting the fragile, depletable character of natural resources . . . ignoring the issues of equity and by attempting to placate every interest, the result is often policy without any strings attached." Viessman (1990) observed that the public does not realize the true cost of water and that effective water management has suffered from the public perception that water is a "free good" and the desire to encourage growth and development. If Douglass North (1990) is correct that "history matters" and that institutional arrangement create a "path dependency" in the choices and outcomes, then for Florida it may be difficult to change the supply and demand growth in water allocation.

Notes

1. The county eliminated was Franklin. The missing data were the amount of agricultural acreage. This amount was not reported in all the years to avoid identifying an individual landowner. The other measurements for the county were in 1980: total water use 1.3 million gallons per day; population density 14.6 people per square mile; wage and salary employment 1,632; single family house permits 17; standard of living $6,210.74 per year; and it is in Northwest Florida Water Management. Measurements for 1990 were: total water use 2.7 million gallons per day; population density 16.79 people per square

mile; wage and salary employment 2,209; single family house permits 80; standard of living $14,195.77 per year.

2. For example, Jefferson County is shared by both NWFWMD and SRWMD, but in 1990 withdrew public supply water from only NWFWMD. Counties that obtained water from more than one district were placed in the district that provided the most water.

3. Correlation coefficients between variables that were above .5 were: jobs and population density at .6207; house permits and population density at .639; and house permits and jobs at .6489.

4. In the 1990 model only one correlation coefficient was above .5. Jobs and population density had a correlation coefficient of .6763.

References

Audirac, Ivonne. 1990. “Urban Development Patterns.” In The Economy of Florida. Eds. David A. Denslow, Ann C. Pierce, and Anne Shermyen. Bureau of Economic and Business Research. Gainesville FL: University of Florida.

Ausness, Richard C. 1987. “The Influence of the Model Water Code on Water Resource Management Policy in Florida.” Journal of Land Use and Environmental Law. 3(1): pp. 1-32.

Betz, John V. 1984. “Water Use.” In Water Resources Atlas of Florida. Eds. Edward A. Fernald and Donald J. Patton. Tallahassee FL: Institute of Science and Public Affairs.

Blake, Nelson Manfred. 1980. Land into Water – Water into Land: A History of Water Management in Florida. Tallahassee FL: University Presses of Florida.

Bromley, Daniel W. 1992. “The Commons, Property, and Common-Property Regimes.” In Making the Commons Work: Theory, Practice, and Policy. Ed. Daniel W. Bromley. San Francisco: Institute for Contemporary Studies Press.

Bureau of Economic and Business Research (BEBR). 1982. Florida Statistical Abstract. Gainsville FL: University of Florida Press.

------. 1983. Florida Statistical Abstract. Gainsville FL: University of Florida Press.

------. 1986. Florida Statistical Abstract. Gainsville FL: University of Florida Press.

------. 1991. Florida Statistical Abstract. Gainsville FL: University of Florida Press.

------. 1992. Florida Statistical Abstract. Gainsville FL: University of Florida Press.

------. 1993. Florida Statistical Abstract. Gainsville FL: University of Florida Press.

Canter, Bram D. E. and Donna R. Christie. 1984. "Water Regulations and Policy." In Water Resource Atlas of Florida. Eds. Edward A. Fernald and Donald J. Patton. Tallahassee FL: Institute of Science and Public Affairs, Florida State University.

Carter, Luther J. 1974. The Florida Experience: Land and Water Policy in a Growth State. Washington, D.C.: Resources for the Future.

Ciriacy-Wantrup, Siegfried Von and Richard C. Bishop. 1975. "Common Property as a Concept in Natural Resources Policy." Natural Resources Journal. 15: pp. 713-727.

De Gregori, Thomas R. 1987. "Resources Are Not; They Become: An Institutional Theory." Journal of Economic Issues. 2(3): pp. 1241-1245.

DeGrove, John M. 1958. Approaches to Water Resource Development in Central and Southern Florida, 1845-1947. Studies in Public Administration, no. 17. Gainesville FL: Public Administration Clearing House, University of Florida.

deHaven-Smith, Lance. 1998. "Unfinished Agenda in Growth Management and Environmental Protection." In Government and Politics in Florida. 2nd ed. Ed. Robert J. Huckshorn. Gainesville FL: University Press of Florida.

Downs, Anthony. 1972. “Up and Down with ecology: The issue-Attention Cycle.” Public Interest. 28: pp. 38-50.

Feiock, Richard C. 1994. “The Political Economy of Growth Management.” American Politics Quarterly. 22: pp. 208-220.

Feldman, David L. 1991. Water Resources Management: In Search of an Environmental Ethic. Baltimore MD: John Hopkins University Press.

Florida House Select Committee on Water Policy [FL HCWP]. 1995. Water Supply Policy Considerations. Interim Project Report. Catalog Number WP-001.1295. Tallahassee FL: State of Florida.

Gibbs, Christopher J. N. and Daniel W. Bromley. 1989. “Institutional Arrangements for Management of Rural Resources: Common-Property Regimes.” In Common Property Resources: Ecology and Community-Based Sustainable Development. Ed. Fikret Berkes. London: Belhaven Press.

Goetze, David. 1987. “Identifying Appropriate Institutions for Efficient Use of Common Pools.” Natural Resource Journal. 27: pp. 187-199.

Livingston, Marie L. 1995. “Designing Water Institutions: Market Failures and Institutional Response.” Water Resource Management. 9 (3): pp. 203-220.

Lynne, Gary D. and Phyllis Park Saarinen. 1993. Water Markets: What Role Can They Play in Florida. Staff Paper SP 93-9. Food and Resource Economics Department. Gainesville FL: Institute of Food and Agricultural Sciences, University of Florida.

Marella, Richard L. 1995. Water-Use Data by Category, County, and Water Management District in Florida, 1950-90. USGS Open File Report 94-521. Tallahassee FL: USGS.

McGrail, Linda, Kenneth Berk, Donald Brandes, Douglas Munch, Clifford Neubauer, William Osburn, Donthamsetti Rao, John Thomson and David Toth. 1998. “St. Johns Water Management District.” In Water Resources Atlas of Florida. Eds. Edward A.

Fernald and Elizabeth D. Purdum. Tallahassee FL: Institute of Science and Public Affairs.

Niskanen, William A. 1971. Bureaucracy and Representative Government. Chicago IL: Atherton.

North, Douglass. 1990. Institutions, Institutional Change, and Economic Performance. Cambridge MA: Cambridge University Press.

Oakerson, Ronald J. 1992. “Analyzing the Commons: A Framework.” In Making the Commons Work: Theory, Practice, and Policy. Ed. Daniel W. Bromley. San Francisco: Institute for Contemporary Studies Press.

Office of Program Policy Analysis and Government Accountability (OPPAGA). 1994. A Review of the Water Resources Management Program Administered by the Department of Environmental Protection and Water Management Districts. Report No. 94-17. Tallahassee FL: State of Florida.

Ostrom, Elinor. 1987. “Institutional Arrangements for the Resolving the Commons Dilemma: Some Contending Approaches.” In The Question of the Commons: The Cultural and Ecology of Communal Resources.

Ostrom, Elinor. 1990. Governing the Commons: The Evolution of Institutions for Collective Action. New York: Cambridge University Press.

Ostrom, Elinor, Roy Gardner, and James Walker. 1994. Rules, Games, and Common-Pool Resources. Ann Arbor MI: The University of Michigan Press.

Patton, Donald J. and Rodney DeHan. 1998. “Water Issues: Global, National, State, Ecosystem.” In Water Resources Atlas of Florida. Eds. Edward A. Fernald and Elizabeth D. Purdum. Tallahassee FL: Institute of Science and Public Affairs.

Price, Benjamin and Richard C. Feiock. 1994. “Development Management: Growth Management and Economic Development.” In The Florida Public Policy Management System: Growth and Reform.

Ed. Richard Chackerian. Tallahassee: Florida Center for Public Management.

Purdum, Elizabeth D. and Georgann Penson. 1998. “Northwest Florida Water Management District.” In Water Resources Atlas of Florida. Eds. Edward A. Fernald and Elizabeth D. Purdum. Tallahassee FL: Institute of Science and Public Affairs.

Raulston, Marvin, Cindy Johnson, Kirk Webster, Carolyn Purdy, and Ron Ceryak. 1998. “Suwannee River Water Management District.” In Water Resources Atlas of Florida. Eds. Edward A. Fernald and Elizabeth D. Purdum. Tallahassee FL: Institute of Science and Public Affairs.

VanArman, Joel, Winnie Park, Patti Nicholas, Patricia Stayer, Agnes McLean, Barry Rosen, and Jim Gross 1998. “South Florida Water Management District.” In Water Resources Atlas of Florida. Eds. Edward A. Fernald and Elizabeth D. Purdum. Tallahassee FL: Institute of Science and Public Affairs.

Veissman, Warren, Jr. 1990. “Water Management: Challenge and Opportunity.” Journal of Water Resources Planning and Management.116: 155-169.

Weimer, David L. and Aidan R. Vining. 1992. Policy Analysis: Concepts and Practice. 2nd ed. Englewood Cliffs NJ: Prentice Hall.

Wheeler, Wes, Richard Owen, and Terry Johnson. 1998. “Southwest Florida Water Management District.” In Water Resources Atlas of Florida. Eds. Edward A. Fernald and Elizabeth D. Purdum. Tallahassee FL: Institute of Science and Public Affairs.

Yamaguchi, Kazuo. 1991. Event History Analysis. London: Sage.

Biographical Sketch

Linda Johnson (lsj1874@garnet.acns.fsu.edu) is a doctoral candidate in the Askew School of Public Administration and Policy at Florida State University, Tallahassee, Florida.