FINAL REPORT

Synopsis

Project Number: C-03

Title: "Models of Interstate Water Allocations in Theory and in Practice: The ACT-ACF Agreements as Applied Case Studies"

Investigators: Aaron T. Wolf, C. Hobson Bryan, Jeffrey L. Jordan, Clyde Kiker (originally C. Franklin Casey)

Congressional District: Alabama, District 7

Focus Category (s): LIP, MOD, ECON

Descriptors (key words): water allocation, conflicts, social impact assessment, mock negotiations, water treaties

Problem and Research Objectives:

The legislatures of three states riparian to the Apalachicola, Chattahoochee, Flint (ACF) and the Alabama, Coosa, Tallapoosa (ACT) river systems are currently in the process of negotiating water allocations for the management of these basins under the auspices of a compact. The challenge was to agree on an equitable system by December 1998 (now extended to December 1999).

In the meantime, researchers at the University of Alabama, in conjunction with multi-year projects sponsored by the World Bank and the U. S. Institute of Peace, had compiled and analyzed a data set of 149 national and international water treaties which include explicit water allocations. Another researcher at the University had developed an effective approach to assessing the social consequences of environmental alterations applicable to the water dispute. Colleagues at the University of Georgia and the University of Florida had been involved in theoretical and applied research into economic and game theoretical models of equitable water allocations.

The research objectives were to engage in an 18-month program for inter-state, inter-disciplinary research which would bring together both applied and theoretical experiences allocating water resources, in both the national and international settings, and apply the findings to the work of the ACT and ACF compacts. This was to involve four steps: 1) Assess and delineate the principles for water allocations actually used historically in national and international compacts and
treaties; 2) Assess and delineate economic and game theoretical models of equitable water allocations; 3) Apply the findings from steps 1 and 2 to ongoing negotiations over allocations between the ACT-ACF riparian states, delineating a "bargaining range" for tri-state equity; and 4) Assess the social impacts of implementing a range of possible solutions in the tri-state area.

Methodology:

Step 1. This included a content analysis of the 149 treaties. A systematic computer compilation of these treaties was developed, which catalogued each by basin, countries involved, date signed, treaty topic, allocations measure, conflict resolution mechanisms, and non-water linkages.

Step 2. Methodology was premised on the idea that different uses and users of the water along a given waterway may place differing values on the resource. Therefore, equitable water-sharing should take into consideration the possibility of increasing the overall efficiency of water utilization by re-allocating the water according to these values. Traditionally, a central planning authority who "knows best what to do," or a "water market" approach which employs the market mechanism to achieve an efficient allocation of scarce water resources among competing users, have been employed. But a "game theoretical approach" methodology is used here that allows for both economic and political variables to be incorporated in the decision process. Once a cooperative interest has been established, the essential elements of this process involve 1) partitioning cost or benefit so that each participant is better off than for a non-cooperative outcome, 2) giving preference to these participant entities over any sub-coalitions of participants, and 3) allocating all the cost/benefit.

Step 3. Data on demand and supply of water were collected and analyzed for the basins. Since water supply is sufficient to meet current and projected needs during most years, drought years are the critical times when allocations must be determined. The "bargaining mix"—a range of possible solutions to tri-state allocations during times of drought—was to be derived from data obtained from steps 1 and 2 above.

Step 4. Social impact assessment methodology was used to assess the different options of the bargaining mix. This approach uses the general logic of environmental impact assessment—assessing the effects of different environmental options—in this case, water allocation scenarios. Three alternatives were compared: a baseline or "no-action alternative," a "Georgia alternative" (which included Georgia's initial water demand estimations), and a "sustainability alternative" (which was based on flow regimes that were "most friendly to the environment"). The impacts of these alternative were assessed for different stakeholders in the basins including municipalities, industry (power-generation and March 17, 1999
others), property owners, recreationists, and the environment.

Additionally, students were heavily involved in the project through the funding of three graduate research assistants and a student-centered “mock negotiation,” where each state identified five students to research and represent one stakeholder in the tri-state dispute. These students were brought together at the University of Alabama for simulated negotiations over a hypothetical compact. The negotiations were facilitated by a professional mediator.

**Principal Findings and Significance:**

The analysis of water treaties revealed that in almost all cases historically, agreements were reached in water disputes that transcended cultural and political conflicts and that a variety of avenues for resolution were successful. In the case of transboundary disputes, an autonomous "water commission" often proved to be a successful arrangement for resolving conflicts and managing the water resource.

Economic and game theoretical models for equitable allocation of scarce water resources are still in the process of being developed.

Social impact assessments have been completed for both the ACF and ACT basins, with the major finding being that the sustainability alternative offers the most "win-win" solutions for the varied stakeholders in these basins.

Mock negotiations were held in May and were attended by negotiators and advisors from both the states of Alabama and Georgia. Debriefings of students and officials attending indicated that the proceedings did indeed approximate "real life" scenarios. No agreement was reached, other than to refer the process to a third party, tri-state commission.

**List of Publications and Presentations:**


Agreements as Applied Case Studies." Presentations to the Twelfth Annual Alabama Water Resources Conference and Symposium and Deep South Environmental Conference, Gulf Shores.


Wolf, Aaron T., C. Hobson Bryan, Jeffrey L. Jordan, Donna J. Lee, and Steve Leitman. May 29-31. Mock negotiations involving university students from Alabama, Georgia, and Florida were held at The University of Alabama. The press and observers who had responsibilities for the actual ACF/ACT Compact negotiations attended.


Additional outcomes from the grant include Susanne Rose's thesis on the ACT being nominated by the Department of Geography for the University of Alabama's "Outstanding Thesis for 1997-98 Award" and she and Bryan being additionally funded by the Alabama Department of Economic and Community Affairs, Office of Water Resources, to undertake a social impact assessment for the ACT River Basin. This and additional work by Aaron T. Wolf to provide technical expertise for the ACT/ACF Compact negotiations were in the form of a $20,000 contract (retainer) for "Technical and Research Services for the ACT and ACF River Basins."
Project Completion Report

Research Problem and Objectives:

The purpose of this project is to further the understanding of the process of delineating the allocation of water when it crosses both political and physical boundaries. Results are intended to provide researchers as well as policymakers and stakeholders critical lessons-learned both to the Southeast and the country as a whole, of the processes used to make water allocation decisions in the Apalachicola, Chattahoochee, Flint (ACF) and the Alabama, Coosa, Tallapoosa (ACT) river basins in Georgia, Florida and Alabama.

The legislatures of the three states riparian to the ACF/ACT, as well as the U.S. Congress, have approved interstate river compacts for the management of these basins. Throughout 1998, negotiations were held to find "allocation formulas", a loosely defined term taken to mean a combination of flow regimes and management structures. As the December 1998 deadline approached, the three states extended the negotiations to avoid the reinstatement of the federal lawsuit that began the dispute.

This is the first time in U.S. history that interstate allocations are to be determined in a humid environment. Water conflicts and interstate compacts are common, particularly in the arid west. Disputes over water in places where there is up to 60 inches of rain per year would seem avoidable. However, population and economic growth pressures in the southeastern U.S. have made water conflicts a challenge to states and resource managers in Georgia, Florida and Alabama.
This project examines the issues at hand, present lessons learned from other places, and examine alternative allocation methods that might be applied to the southeastern U.S. The broad themes of our conclusions include: Methods and Models for the Southeast.

The project lays out alternative approaches to examining allocation issues in the southeast. An agreement on cross-boundary water allocations has to satisfy more than the individuals involved in negotiations. An agreement which will be stable over time must also satisfy as many stakeholders as possible. This section develops a framework to assess the different options for dealing with stakeholder impacts within and beyond the tri-state area. This section also develops a multi-alternative/multi-attribute analysis in making resource management decisions. The process goes beyond commonly employed forms of cost-benefit analysis in that is allows for the analysis and consideration of more than two options at any given time. It is relevant to the ACF/ACT basin situation because it allows for the incorporation of here-to-fore non-quantifiable variables. It provides a framework for presenting qualitative information in a systematic framework. Lessons from Beyond the Southeast.

Water conflicts are not new and lessons can be learned from other parts of the U.S. as well as other parts of the world. Drawing on the Transboundary Freshwater Dispute Database, this portion describes lessons learned from 145 international water treaties. This database is used to examine case studies in which allocations were delineated, and which may be applicable to the ACF/ACT
basins. Lessons learned from three federal river compacts in the northeast are also defined. The context for the analysis are the features that are essential to the successful cooperative interstate management of shared water resources. The role of the federal government is highlighted in the success of these compact commissions. This section also includes the long and rich history of interstate river compacts in the western U.S.

Issues and Directions.

Although as yet addressed in the ACF/ACT negotiations, it is apparent that any allocation mechanism will include the interbasin transfer of water. If any issue can derail an agreement, it is how "our water" is moved from one place to another and what, if any, compensation agreements are made. This section takes up the issue of interbasin transfers and suggest a compensation approach that deals with how water markets can aid allocation agreements. The final section also summarizes the issues addressed previously, especially the idea that when looking at allocation, the debate must go from rights to needs.

Methods and Procedures

What is readily available to the scholar and policy maker interested in water conflicts are the results of a particular period of negotiations -- usually a treaty or other agreement which allocates the resource. This tells us little about the process by which the disputes were resolved. For example, What were each side's opening positions? What underlying interests informed those positions? What obstacles were encountered during negotiations and how were those obstacles overcome? What principles were finally agreed to for water allocations, provisions for resolving future water conflicts, and enforcement mechanisms? And finally, how effective has
the agreement been?

Our collective methodology is an attempt to answer these questions through our respective disciplines and research foci. One portion of the study is applied. We use stakeholder interviews and analysis to determine and delineate a range of possible solutions, and the respective social impacts of each, to the current tri-state negotiations. Another portion is theoretical -- economic models are used in conjunction with the Shared Vision model to determine weights and values to be used in the matrix framework. The matrix framework is used to delineate the economic, ecological and social implications of proposed allocation and management alternatives. A game theoretic approach is then used to develop an understanding of the effects of externalities and the implications for a sustainable allocation framework.

In the final portion of the study take the results of our experience and generalize them. We develop a set of procedures and guidelines which can be transferred to and applied in other humid basin management situations.

Related Research:
Integration of Economic and Hydrologic Models, Equity and Efficiency

Examples of economic approaches to equitable allocations can be found in several studies which consider institutional and economic aspects of international cooperation for interbasin development. Goslin (1977) examined the economic, legal and technological aspects of the Colorado River Basin allocation between the US riparian states and Mexico. Krutilla (1969) analyzed the economics of the Columbia River Agreement between the US and Canada. LeMarquand (1977) has developed a framework to analyze economic and political aspects of water basin development.

Game theoretical equity

The literature dealing with the application of game theory solutions does not
provide many examples of regional-international water sharing problems. Rogers (1969) applied a game theory approach to the disputed Ganges-Brahmaputra subbasin that involves different uses of the water by India and Pakistan. The results suggest a range of strategies for cooperation between the two riparian nations which will result in significant benefits to each. In a recent paper, Rogers (1991) further discusses cooperative game theory approaches applied to water sharing in the Columbia basin between the US and Canada, the Ganges-Brahmaputra basin between Nepal, India and Bangladesh, and the Nile basin between Ethiopia, Sudan and Egypt. In depth analysis is conducted for the Ganges-Brahmaputra case where a joint solution where each country's welfare is better off compared to any non-cooperative solution (Rogers 1991). Dinar and Wolf (1994), using a game theory approach, evaluate the idea of trading hydro-technology for inter-basin water transfers among neighboring nations.

Because of the unidirectional nature of water movement and the interdependence between upstream and downstream users there is a real issue of externalities associated with water allocation formulas. Bennet, Ragland and Yolles (1998) have determined that in these situations there is a tendency for a "victim pays" outcome, where the downstream user compensates the upstream user to insure water quantity and quality. They suggest that a traditional game theoretic approach may not adequately capture these interdependencies. They suggest a repeated, noncooperative interconnected game approach to dealing with these issues.

These studies help us in our attempt to develop a broader, more realistic approach that addresses both the economic and political problems of the process. 

**Multiple Alternative-Multiple Attribute Analysis**

For some time now, government and private entities tasked with resource planning have known that broad public involvement is key to the development of
sustainable management solutions. They recognize the need to formulate alternatives in a more complete socio-economic framework. However, creating alternative choices is difficult especially with diverse groups and nontechnical. The application of a Multi Alternative/Multi Attribute framework accomplishes this end.

The methodology was developed by McLeod (Mcleod et. al., 1984) and was applied by the Southwest Florida Water Management District to evaluate their proposed Green Swamp Project. It was refined by Kiker and Lynne (1989) for use in the development of a water supply planning model. It has also been used by the EPA and the Army Corps of Engineers (Flournoy, 1994) in their work done on wetlands valuation.

The methodology is based on public participation in the identification of various economic, technical, financial, environmental and institutional attributes. Once identified attributes are weighted and presented in an array. This array is used to evaluate various alternatives. Alternatives are proposed plans or actions involving water needs, sources, and decisions. The attributes and alternatives are arranged in a matrix framework. Anderson (1981) suggests a cascaded trade-off methodology for carrying out a values analysis and recommends a Multiple Attributes Tradeoff System (MATS) developed by Brown et. al.(1986).

Work to date on the ACT/ACF basin, including the development of the Shared Vision Model and the accompanying demand spreadsheets and the development of detailed stakeholder profiles, has already provided much of the information necessary for the development and application of this type of framework.

Social impact assessment

Social impact assessment (SIA) is a well-documented and established process dating from the mid-1970s (e.g., see Bowles 1981, Bryan 1996, Bryan and Hendee
1983, Burdge 1994a and b, President's Council on Environmental Quality 1978, Cronin 1987, Freudenburg 1986, Leistritz, et al., 1994-95, Taylor and Bryan 1987, and Taylor, et al. 1995). Two basic approaches characterize the field: One is termed the "technocratic approach" to analysis and decision-making, which assumes that the process is largely done by technical experts with the public at best "informed," but not involved in the analysis, projection, and decision processes (Bryan 1996). The other assumes that the process is conducted by both technical experts and informed stakeholders—the public is both informed and involved. The approach advocated here is the latter. The contention is that effective decision-making is conditioned on public participation in and understanding and acceptance of both the process and the decision. Therefore, it is proposed that a major impetus will include early identification and involvement of major stakeholder groups in the process.

Project Findings:

I. International Water Agreements and Implications for the ACF/ACT:

We have combined the results of two studies to help assess the process of delineating water allocations which cross state boundaries:

A. A Transboundary Freshwater Dispute Database. In conjunction with funded projects from the World Bank and the US Institute of Peace, we were able to broaden an existing electronic database of 145 international treaties to include all 56 interstate US compacts as well. This new robust version of the database was assessed for case studies in which allocations were delineated, and which may be applicable to the ACT-ACF basins. (International treaties which allocate water are included as Table 1.)
B. Assessment of Stakeholder Interests.

Stakeholders in the ACT-ACF basins were identified, and each of their interests were assessed. Using an existing STELLA model of the basins, we were able to evaluate how the interests of each stakeholder group were affected given a variety of flow regimes and allocation formulas. We found, in general, that during most years, water supply is sufficient to meet all the current and projected water needs. It is during drought conditions when the determination of allocations is critical. Allocation models therefore must determine water supply and demand during drought conditions among all competing needs: municipal, hydropower, agricultural, recreational, and in-stream requirements.

Combining the results of these two studies, our preliminary assessment suggests five possibilities for the ACT-ACF:

i) Jointly delineate an acceptable range of quantity, quality, and timing parameters for every tributary of the basin. This option would be extremely costly in terms of negotiations and monitoring, and close to impossible on uncontrolled stretches. (See, for example, the 1959 India/Nepal agreement.)

ii) Allocate in real time. With extensive monitoring and modeling, an agreement might focus on a percentage of any existing regime. (The 1996 treaty between India and Bangladesh offer allocations based on various flow regimes.) The problems here, along with difficulties in monitoring, would be either a general limit to development, or a regular process of renegotiation to accommodate it.

iii) Divide sovereignty for maintaining standards of each tributary. Under this scenario, Georgia might be allowed greater development of some tributaries, for example, in exchange for allowing others to flow relatively freely to the main stem. (See, for example, the 1950 accord between Austria and Bavaria).

iv) Allocate benefits, not water. If each use to which water is put has economic value, it may be easier to focus on this more quantifiable aspect in negotiations. (See, for example, the boundary waters accords between Canada and the US.) The major stumbling block, of course, is valuing instream uses.
v) "Enlarge the pie" by including joint development and even non-water parameters in negotiations. The absolute quantity/quality of water is only critical if one is looking at existing uses or extrapolating based on those uses. With some creativity, there might be projects which would interest all three states, yet would address stakeholder concerns. The 1959 India/Nepal accord creates a package of reforestation, irrigation, transportation, and power generation to the benefit of both states. One might add recreation, conservation, or tourist development to create a package for the ACF, building, perhaps, on the interests of cross-boundary stakeholders (eg. Southern Company, environmentalists, farming interests).

The major lesson this exercise is that flexibility in agreements is almost more critical than the initial agreements themselves. Needs, interests, flow regimes, and values all change over time.

II. Economic Models and the ACT-ACF

Economic models are typically used to emphasize tradeoffs between social management and uncontrolled use of water resources. They have also been used to examine the merits of different resource management tools. Hydrologic and engineering models, on the other hand, focus primarily on issues related to flow dynamics. The combination of economic and hydrologic models presents a unique opportunity to evaluate the interrelationships between the physical and the social elements of a basin system. Integrated economic-hydrologic modeling provides a more complete set of results than either model would in isolation.

Work to date on the ACT/ACF basin has resulted in the creation of a Shared Vision model which can be used to evaluate the impact of management decisions on flows within the basin. Agricultural and industrial water use data has also been collected. Stakeholders and stakeholder interests have been identified. This information can be used to conduct an economic assessment of proposed
management alternatives. When tied to a hydrologic model of the basin, more complete information regarding the ecological and environmental implications of alternatives can be provided. The numeric results of this type of analysis contributes directly to the development and application of a multi-objective multi-attribute matrix which can be used by planners to assess the impacts of various decisions through time.

Experience has shown that a major stumbling block to sustaining allocation agreements through time is the failure to consider the effects of externalities. Quite often, when there is interdependence between water users, quantity and quality externalities are imposed on downstream users by upstream users. The historically observed response (and the predicted outcome of traditional game theory approaches) to these types of trans-boundary externalities has been for the downstream user to "bribe" the upstream user in order to insure water quality and quantity- a loser pays situation. An interconnected game modeling approach with issue linkages allows one to account for these types of issues. This sort of noncooperativie repeated game theory approach also allows for the study of behavior where agreements are not binding, as in the ACT/ACF allocation process.

III. Envisioning Alternative Futures: The Organization of Information for Water Negotiations, Public Participation:

After the broad negotiation of the ACF and ACT Compacts are concluded, there will be an ongoing need to track the performance of compact management. Existing information on the river system and the interests of stakeholders may not be sufficient to maintain all aspects of the compact as envisioned in the original
agreement. Consequently, the three state governments as agents of their citizens may need to periodically revisit various components of the compact. At such times, it will be important to have updates of regional information carefully organized in a way that facilitates confident public decision-making.

New means of organizing information for public involvement and the status of information handling in the present compact negotiations are unfolding. Specific focus is on the use of river simulations to help interested people better understand the hydrologic consequences of various alternative allocations. Also presented is a simple, but effective, method of organizing information on potential consequences of various alternative allocations. In this method the emphasis is on the development of information on the full range of attributes related to the alternatives being considered. The method, referred to as a Multiple Alternative/Multiple Attribute approach, identifies all of the possible consequences of an alternative and seeks means of measurement sufficient to help people envision outcomes. The approach accomplishes two important goals: first, it allows people to contrast the outcomes for different attributes resulting from the alternatives, and second, points up the areas in which meaningful information is lacking. Overall, the approach is intended to facilitate adaptive approaches to managing a complex river system.

IV. Legal Issues of the ACF-ACT Compacts:

Atlanta straddles the headwaters of four different basins, all of which drain out of Georgia into other states. As the city operates an integrated city-wide water system, virtually everything done in managing the city's water system has
implications for interbasin and interstate water transfers. The robust growth in the Atlanta area had led to large withdrawals, with projections for even larger withdrawals in the near future. In 1991, Alabama and Florida brought suit to enjoin the U.S. Corps of Engineers from developing a reservoir in fulfillment of Atlanta's plans. Alabama also saw other plans for new reservoirs in western Georgia as threatening Alabama's development plans. Florida was anxious to assure that sufficient water flowed into Apalachicola Bay to nourish oysters and other marine life.

Eventually, the parties agreed to hold back on the litigation while studying and negotiating a solution. The growing controversy among Alabama, Florida, and Georgia over the ACF/ACT has led to two agreements among those states and the federal government sometimes referred to collectively and the Southeastern Water Compact. (Florida is only involved in the Chattahoochee dispute). These agreements essentially froze present uses on both river systems in place while the three states and the Corps of Engineers undertook to study how to resolve the controversy. The three states agreed to fund an elaborate joint study while holding the legal action in abeyance. While the compact was to become void if the states fail to reach agreement by December 31, 1998, the three governors met in Montgomery, Alabama, on December 18, 1998, and voted unanimously to extend the deadline one additional year. Extending the deadline seemed to be about the only thing the three states could agree on, however.

V. Valuing Interbasin Water Transfers:
Although more common in the western US, inter- and intra-state water conflicts have reached the more humid eastern part of the country. Over several years, officials from Georgia, Florida, Alabama and the US Army Corps of Engineers have been moving toward completion of two interstate compacts designed to allocate water in the ACF/ACT river basins. Presently, with the two compacts in place, the negotiations revolve around the meaning, definition and agreement on a water allocation formula. However defined, the allocation formula will be concerned with, and affected by, the price of water and the value and extent of any interbasin transfer of the water resources in the basins. Indeed, to satisfy all the demands on the basins, transfers may be an integral part of any water allocation formula. Consequently, it is necessary to understand the issues involved in pricing and valuing interbasin transfers of water.

As water is allocated in the Tri-State area, prices will have a significant impact on the ability of each state to meet allocation targets, particularly if transfers are employed. In addressing the value of water as reflected in its price the following five points should be considered:

1. The price of water should include the marginal scarcity rent of the resource as well as the risk component of the cost of service.

2. The price of water should also include estimates of the externality effects (both positive and negative) of the use of the resource.

3. The full cost pricing of water will also include the equity or third party effects when water is transferred across basins.

4. Consequently, the price of water will necessarily increase and the use of water, either individually or by transfer, may decrease from anticipated levels.

5. Only be considering the full cost (or value) of water will an economically efficient
use of the resource be achieved.
LITERATURE CITED


