

WATERSHED PLANNING: CHANGING ISSUES, PROCESSES AND EXPECTATIONS

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WHAT DEFINES A WATERSHED?

Watersheds are typically defined in hydrology texts, and even in policy documents, as drainage areas – geographic areas whose runoff contributes to water bodies at particular points. A watershed can be as small as the area of land contributing water to a small creek and as large as the area of land draining into the Mississippi River. The term watershed, however, usually denotes a smaller geographical area than an entire river basin, although river basins are obviously also watersheds consisting of a number of smaller watersheds.

Water resources planners have long been aware that watersheds provide effective frameworks for addressing land and water management problems. This is evidenced, for example, by the geographic river-basin alignment of the US Army Corps of Engineers Civil Works boundaries. This river basin or watershed orientation has been effective in addressing problems and needs related to the Corps' traditional interests, i.e., navigation and flood damage reduction, but also to hydropower, irrigation, recreation, and other demands met by water resources. Watersheds are also appropriate, and even critical, for effectively restoring ecosystems and evaluating the impact of regulated activities pertaining to ecosystems.

While hydrologic boundaries of watersheds define logical regions for managing land and water, they do not usually coincide with the boundaries of countries or states and their public agencies or other institutions responsible for carrying out land and water resources management policies. Furthermore, some land and water resources problems in particular watersheds are caused by factors originating from areas much larger than, or from sources outside, those watersheds. Examples include problems caused by aquatic nuisance species (such as hydrilla, eurasian milfoil, zebra mussel and sea lamprey brought in from sources outside the watershed) and acid rain or nitrogen loading from the atmosphere.

Hence the appropriate scale in which to address particular land and water management problems, one could argue,

may vary depending on the particular problems and their possible solutions. A more operational view of a watershed, therefore, could be the 'problem-shed' - a region appropriate to the issues and problems being studied. If this definition is accepted, a watershed is not necessarily bounded by hydrological, physical or even political boundaries. Rather, a watershed is defined by the locations of its stakeholders who have an interest in one or more particular watershed management problems and who have the ability to address and solve them.

WATERSHED PLANNING - AN EVOLVING AND ADAPTIVE PROCESS

Water has traditionally been considered a public good, to be planned, managed and monitored by public agencies. Since the early 1800s, Federal, state and local governments have created and implemented plans and programs to develop and use our country's water resources. For over 200 years this country has considered the management and use of water in watersheds and river basins an effective way to enhance the quality of life and economic wellbeing of its people. The way water resources have been managed and used has changed over these some 200 years, and certainly the way we approach watershed and river basin planning has changed as well. Evidence of this is found in each of the papers written for this series on watershed planning.

This writer began his career in water by studying watershed management - a specialty within the field of forestry. This somehow expanded into water resources engineering, perhaps more by accident than by design, but clearly motivated by the challenges and public interest in this area, by its interdisciplinary character, and by the emerging computer-based methodology being applied to the planning and analysis of water resource systems at that time. Today we know more, at least a little more, than we did then, but the challenges, interest and technology are still there. New challenges, interests and technology have replaced the old ones. If anything, the problems we are trying to address seem more complex, and certainly more social and institutional. So, some 35

plus years later, this writer is still studying watershed management.

It seems to me that those of us who use and enjoy the resources of watersheds are typically in varying states of disagreement over what we want from our watersheds and how we want to get it. The challenge in watershed planning and management is how best to address the complexity of a continually changing state of confusion, conflict, and, on occasion, even chaos, with respect to the use of water and related land resources.

Some thirty five years ago Eugene W. Weber, Chief, Civil Works Planning Division of the US Army Corps of Engineers, described watershed and river basin planning as “adapting fast-growing human occupancy and economic activity to the great complex of land and water resources” (Weber & Hufschmidt: 1963). Resources within the watershed and river basin were to be used in ways that primarily promoted economic development. It involved designing and operating engineering structures that would reliably and inexpensively provide the water to places where and when it was needed, and in the amounts and quality needed. The best way to do this, most felt, was to focus on integrated multipurpose project planning and development within watersheds and river basins. Managing these land and water resources involved the proper consideration of their important interrelationships relevant to their development and use.

In the early 60's I recall reading, and trying to comprehend, the writings of numerous economists and engineers proposing economic efficiency and redistribution criteria for multipurpose river basin development projects (e.g., Krutilla and Eckstein, 1958; Eckstein, 1958, Maass, Hufschmidt, Dorfman, Thomas, Marglin and Fair, 1962). Most of these books were written from a top-down perspective. Watersheds were being developed throughout the country by mainly federal and state agencies building and operating dams and hydropower plants, clearing and straightening stream channels, developing irrigation projects and adjusting cropping patterns to control water runoff, all to improve incomes (Tolley and Riggs, 1961). Engineers were often viewed as waging a war against the variability of nature and economists were busy trying to convince engineers how to use and value this tamed nature as a factor of production (K. Boulding in Smith and Castle, 1964).

The National Water Commission's report (NWC, 1973) undoubtedly marked a turning point in US watershed development policy. Their report argued for the end of big Federal engineering projects providing water and power to individuals without charging them for the cost

of it. This was to be replaced by more local involvement in planning and decision making and the requirement that

users pay, at least something, for what they get. In the Commission's view, planning, licensing and regulation would characterize the future. That vision was expressed almost two decades earlier in the 1955 USDA Yearbook titled Water. "The concept of the small watershed approach to land and water resource development and conservation is just beginning to be effectively applied on the ground. Those familiar with the need for the rehabilitation and better use of the resources believe that this approach will result in definite benefits to the resources, to the citizens of the watersheds, and to the Nation." (Brown and Murphy, in USDA, 1955). The vision of these writers in the 50s through 70s is remarkable. I wonder if our vision will prove to be as good.

Today, some three to four decades later, we find ourselves still addressing the subject of watershed planning and asking how that process can be improved to meet not only today's needs and conditions, but the needs and conditions of future generations as well. Watershed planning in the US today is no longer primarily oriented toward economic development. While economic development is still important and certainly of interest, the central focus seems to be shifting toward what has been broadly termed sustainability. How can we 'develop' and 'use' our land and water resources in ways that preserve and enhance the sustainability of our watersheds? One way, in part, is to preserve their natural ecosystems. This ecosystem focus comes from an increasing recognition of the economic as well as health benefits derived from natural ecosystems. Groups of scientists throughout the world are currently very busy trying to learn more about how land and water management decisions affect the health of various natural ecosystems and just how that 'health' can be measured and predicted (NSF, 1998).

Integrating and resolving conflicts over land use, water supply diversions, water quality protection, navigation, flood damage reduction, recreation, hydropower, and ecosystem restoration in watersheds involves nothing less than the active participation of all of impacted stakeholders. This includes the participation of professionally trained ecologists, economists, engineers, planners, and others. It includes the involvement of appropriate Federal, state and local governmental agencies. But these professionals and government agencies can not do this job by themselves. Watershed planning today requires the contributions of all impacted

stakeholders having any interest in the resources of the watershed. If sustainability is to be enhanced, everyone impacted by decisions regarding how land and water are managed and used needs to become informed and involved in the decision making process. They must somehow reach a common vision and work toward making that shared vision a reality.

Watershed planning is a continual process, constantly adapting to new knowledge and changing conditions, needs and objectives. This adaptive type of watershed planning is not an easy process. It is complex, it can be time consuming and inefficient, but current wisdom suggests it is the most likely one having a chance of improving the welfare of both the watershed and its inhabitants in any sustainable way.

CHANGING CONCERNS AND CHALLENGES

Many of the concerns and issues being addressed by watershed planners today are similar to those faced by watershed planners in the past. But clearly many of today's concerns and issues are different. Most of the new ones I believe are the result of two trends: 1) a growing concern for the sustainability of natural ecosystems and 2) an increased recognition for the need of what I will call the bottom-up 'grass-roots' approach to watershed planning and decision making.

Today we work for economic development and prosperity as we did in the more distant past, keeping in mind environmental impacts and goals as we have done during our recent past, but now recognizing ecological impacts and values as well. Watershed management may still be focused on flood control, hydropower production, irrigation development, sediment control and navigation, but only as these and similar activities are compatible with healthy ecosystems. Natural ecosystems require changes in the hydrologic regime within each watershed. Water resource systems must therefore provide rather than reduce hydrologic variability (and even sediment loads). Reservoir operators, for example, may have to modify their water release policies to create this variability. Farmers and land use developers must minimize rather than encourage land-disturbing activities. Flood plains may need to be flooded occasionally. Rivers and streams may need to meander and fish species requiring habitats along the full length of rivers to complete their life cycles must have access to those habitats. Clearly these ecological objectives, added to all the other economic and environmental ones, can only compound the conflicts and uncertainties with respect to land and water management and use.

So, how can we manage all this conflict and uncertainty?

We have all heard that watershed planning should be founded on sound science, efficient public program administration, and broad participation of stakeholders. True enough, but obtaining each of these three conditions is a difficult challenge. While the natural and social sciences can help us predict the economic, environmental and ecological impacts of alternative decisions, those predictions are never certain. Nor can these sciences help us determine the best decision to make in the face of multiple conflicting goals held by multiple stakeholders - goals that have changed, and no doubt will continue to change, over time. Watershed planning and decision making is not as easy as "we know and can tell you what to do, all you need is the will to do it." Very often it is not clear what should be done. Professionals administering the science, often from public agencies (or even from universities) are merely among all the stakeholders having an interest in and contributing to the management of the watershed's resources.

Each governmental agency, consulting firm, environmental interest group, and citizen typically has its own limitations, authorities, expertise and conflicts with other people, agencies and organizations, all tending to detract from achieving a fully integrated approach to watershed planning and management. But just because of this, the participation and contributions of all these stakeholders, or their representatives, are needed. They must come together in a partnership if indeed an integrated approach to watershed planning and management is to be achieved and sustained. All views must be heard, considered, and acted upon by all involved in the watershed planning process.

Conflict among stakeholders has to be resolved by dialogue and compromise. Somehow all stakeholders have to feel their concerns and desires are being considered and that they are a part of an equitable decision making process. Watershed planning is not simply the application and implementation of science. It is creating an environment that gets all of us who should be involved, involved, from the beginning, in a continuing process of

- educating ourselves about our watersheds and how they work and function,
- identifying existing or potential options and opportunities for watershed enhancement and resource development and use,
- resolving the inevitable problems and conflicts that will result over who gets what and when and who pays who, what and when,
- making and implementing decisions, and finally of
- monitoring the impacts of those decisions, and repeating this process as surprises or new

opportunities or new knowledge dictates.

This concept of watershed planning is no small simple task. It is nothing less than recruiting and coordinating the active participation of all community institutions involved in economic development and resource management. How can this begin at the local stakeholder level? How does anyone get others interested in preventing problems before those problems are apparent, or especially before 'unacceptable' solutions are offered to deal with them? Who is in a position at the local watershed level to provide that leadership and needed financial support? In some regions of the US, non-governmental institutions have been instrumental in initiating and coordinating this process at local grass-root levels. I believe we will see more of this in the future.

Among the first steps in this process is becoming informed about how the watershed functions and what the economic, environmental and ecological impacts may be in response to possible decisions concerning land and water use. Today there are many computer models and databases available that can facilitate this learning process. Their successful use depends in large part on the confidence and feeling-of-ownership stakeholders have in those models.

The need for model building tools that can be used by all stakeholders to build their own models and databases, ones that they will have confidence in and have a feeling of ownership, has never been greater. These tools must provide opportunities for participation in the watershed model building and testing process by all interested stakeholders, without any of them having to engage in computer programming. These tools must be suited to building models that consider ecosystem restoration and watershed protection along with economic development and costs. The models built from these tools must cross disciplines and include multiple objectives without perceived bias. They must be able to permit the modeling of processes occurring at vastly different spatial and temporal scales. In addition, the resulting models must be compatible with the available data and must be able to serve stakeholders having interests and concerns at varying levels of detail.

Models of particular watersheds must be created by all the stakeholders and passed up the decision making structure. Models developed at the top (i.e., by a government agency or a university) and passed down to a few individuals who might want and know how to use them will not likely enjoy widespread confidence and a feeling of ownership by all stakeholders. The development and use of models must facilitate an open decision making process, not a closed one. Models that are developed and used must be

understood and accessible to all stakeholders, not just to a few. Finally, if decisions, or choices, are among the expected outcomes of planning, these models must be able to facilitate the process of making decisions and choices.

Participation of all stakeholders in a common model building exercise, one that permits the testing of various assumptions concerning model parameter values, data inputs, and how watershed processes work, will enhance the chances of everyone reaching a common or shared vision. That shared vision may be limited to how their watershed functions, and which assumptions are important and which are not. It might even help them agree as to what they want from their watershed. If not, some type of negotiation may be needed, and of course there are other computer programs that have been designed to help in those processes, but that is another story (Thiessen, et al., 1998).

All this learning through model building and use may be good, in itself, but unless decisions are made with respect to the management of land and water, opportunities for meeting various economic, environmental and ecological goals and conditions in the watershed may be lost. Watershed planning should lead to a management strategy. The implementation of any strategy involves managing humans' use of waters and lands. Different values and perspectives are involved and winners and losers are often created. Losers must feel compensated by the winners, somehow. Costs must be paid, and this can mean taxes and/or user fees that no one likes. These 'tactical' implementation activities may not be a direct part of watershed planning, but they should be seriously considered in the process of deciding just what strategy to take.

WATERSHED PLANNING ISSUES AND QUESTIONS

Initiation Issues

How does one get a watershed planning process started? One way is to get one or more sponsors, organizations that will help pay at least part of the bill as well as provide expertise. If an agency like the US Army Corps of Engineers gets involved, they require cost sharing. US EPA, on the other hand, can provide grants. Both are potentially beneficial contributors to any watershed planning process, but both have different funding methods, different objectives (missions) and different areas of expertise and responsibility. Neither by itself is able to fund broad comprehensive watershed planning studies. Yet both, along with other institutions at various

levels of government and the private sector, can be

partners and contribute substantially to the planning process.

Issues prompting the need for watershed planning in the US vary, of course. Yet some seem to be more common than others. Some of the reoccurring issues include:

Issues regarding supply and demand for land and water

- Increasing conflicts over land and water use.
- Conflicts over the development of additional water supplies.
- Conflicts resulting from compliance with instream flow requirements.
- Conflicts over private property and states rights regarding water allocations.
- Increasing impacts of growing urbanization and for determining appropriate land use patterns in a watershed.
- Renegotiating water use allocations.
- Concerns about trans-basin water transfers, markets.
- Keeping agriculture viable.
- Improved demand management.
- Incentives for water reuse and water reuse financing.
- Increasing damages caused by droughts and floods.

Issues regarding the environment and water quality

- Upstream vs. downstream conflicts on meeting water quality standards.
- Threats from aquatic nuisance species to the chemical, physical and biological water quality of the watershed's aquatic resources.
- Quality standards for recycled water.
- Non-point source pollution - erosion control.
- Inadequate groundwater protection, compacts, institutions.

Issues regarding ecosystems

- The destruction and/or loss of the biological integrity of aquatic habitats caused by introduced exotic species.
- Reducing the decline in number and extent of wetlands and the adverse impacts to wetlands of proposed land and water development projects.
- Conflicts between needs of people vs. needs of ecological communities, including endangered species.
- Balancing environmental, economic and social values and identifying and making tradeoffs between

ecology and other benefits.

Issues regarding project planning and management

- Long-range planning vs. near-term incremental problem solving.
- Monitoring and modification of completed projects.
- Equitable cost and risk sharing and improved approaches to risk/cost management.

Process Issues

Once watershed planning has been initiated, common planning process issues include how to establish a partnership, achieve consensus on goals and objectives, and negotiate cost-sharing provisions. Successful planning involves participation, and that in turn involves motivating all potential stakeholders and sponsors to join and participate in the watershed planning process, determining their respective roles, and obtaining appropriate cost sharing among all stakeholders. Ideally this should occur before addressing conflicting issues so that all involved know each other and are able to work together more effectively. Cost sharing must consider the different cost-sharing arrangements and the potentially limited funds of each group of stakeholders. Some may be unable to cost share at all, and yet their involvement is no less important. Regulatory issues may also affect cost sharing. Agreements on goals and objectives and on the organization (or group formed from multiple organizations) that will lead and coordinate the watershed planning process should be reached before stakeholders bring their individual priorities or problems to the table. Once the inevitable conflicts become identified, the settling of administrative matters doesn't get any easier.

Somehow the watershed planning process must ensure adequate consideration of the interests of those who are unable to cost-share to the extent they 'should.' It must strive to achieve a common or 'shared' vision of goals and priorities among all stakeholders. It must be aware of and comply with all applicable laws and regulations. It should strive to identify and evaluate multiple alternatives and performance criteria - including sustainability criteria, and yet keep the process from producing a wish list of everything each stakeholder wants. In other words it must identify tradeoffs among conflicting goals or measures of performance, and prioritizing appropriate strategies. It must value and compare, somehow, the non-monetary impacts of environmental and ecosystem protection and restoration with other activities whose benefits can be expressed in monetary units. In doing all this it should use modern information technology, as available, to improve both the process and product. This technology, however, will not eliminate the need to reach

conclusions and make decisions on the basis of incomplete and uncertain data and scientific knowledge.

These process issues focus on the need to make watershed planning as efficient and effective as possible. Many issues will arise in terms of evaluating alternatives and establishing performance criteria (prioritizing issues and possible actions), performing incremental cost analysis, and valuing monetary and non-monetary benefits. Questions must be answered as to how much data must be collected, with what precision, and how much is enough, and what types of modern information technology (e.g., GIS, remote sensing, Internet, decision support systems, etc.) can be beneficially used.

Product Issues

What is the desired product of watershed planning? If it is a report, what should it contain? Clearly one result should be a prioritized list of strategies for addressing problems and opportunities in the watershed. Recently, emphasis has shifted from structural engineering solutions to more non-structural alternatives, especially for ecosystem restoration. Part of this shift reflects the desire to keep more options open for future generations. As we learn more about how watersheds work, and how humans can manage and benefit from them, we do not want to be regretting what we have done in the past that may preclude obtaining those benefits. In some situations it may be desirable to create a 'rolling plan', one that is continually updated so that resource management and regulatory questions can be addressed when they are asked, not just when a new planning exercise takes place, on into the future. Will watershed organizations have the financing and political will to maintain and update the software, collect and analyze new data, and keep the expertise, all of which are necessary for continuous planning (rolling plans)?

Consideration also needs to be given to improving the quality of the watershed planning review process and focusing on outcomes themselves rather than output measures. One of the outcomes should be an increased understanding of some of the relationships between alternative human activities in the watershed and its hydrology and ecology. The models developed for predicting the economic as well as ecologic interactions and impacts due to changes in land and water management and use in the watershed could be used to address questions such as:

- What are the ecological and economic consequences of clustering or dispersing human land uses such as urban and commercial developments and large residential areas? Similarly, what are the

consequences of concentrated versus dispersed patterns of reserve lands, stream buffers, and forest land?

- What are the costs and ecological benefits of a conservation strategy based on near-stream measures (e.g., riparian buffers) versus near-source (e.g., upland/site edge) measures? What is the relative cost of forgone upland development versus forgone valley or riparian development? Do costs strongly limit the use of stream buffer zones as mitigating for agriculture, residential, and urban developments?
- Should large intensive developments be best located in upland or valley areas from economic as well as aquatic ecosystem viewpoints? From the same viewpoints, which is most efficient and desirable: a highly fragmented landscape or a highly zoned landscape that produces centers of economic activity?
- To what extent can riparian conservation and enhancement mitigate upland human land use effects? From an economic cost perspective, how do upland land controls compare with riparian mitigation measures?
- What are the economic and environmental quality tradeoffs associated with different major classes of land use such as commercial/urban, residential, agriculture, and forest?
- Can the effects on hydrology, aquatic ecology, and water quality of urban areas be better mitigated with upstream or downstream management approaches? Can limited land controls like stream buffers be used at reasonable cost within urban areas?
- Is there a threshold size for residential/commercial areas that yield marked ecological effects?
- What are the ecological states at the landscape scale that once attained become irreversible with reasonable mitigation measures? For example, once stream segments in an urban setting become highly altered by direct modification (e.g., channel bank protection and straightening) and indirect effects (urban runoff), can they be restored with feasible changes in urban land use or mitigation measures?
- Mitigating flood risk by minimizing floodplain developments coincides with conservation of aquatic life in streams. Are the economic costs of this type of risk avoidance prohibitive?
- In terrain like the Northeast US, major roads often follow the valleys and urbanization tends to form as strips of development adjacent to streams and rivers. What would be the economic and ecological ramifications of zoning to avoid this pattern?
- What are the economic limitations and ecologic benefits of interspersing light residential zones between waterways and commercial, urban, or agriculture lands?

- What are the economic development decisions that are irreversible on the landscape? For example, once land is used for commercial development, it is clearly too costly to return it to agricultural land. This would identify limits on planning for conservation and development.
- What would have been the economic and ecologic effects of implementing conservation elements (set-asides matched with new developments, routine environmental investments, etc.) with each development on the pattern of accumulating impacts? And, what would be the benefits and constraints now?
- What are the associated ecological and economic impacts of the trend in residential, commercial and forests lands replacing agricultural lands?

The answers to these questions may well differ in different watersheds. However, if we can address them on a regional scale, i.e., in multiple watersheds, we just might begin to understand and predict better the interactions among a watershed's economy, environment and ecology as a function of how we manage and use its land and water. This in turn may help those living in the watershed better manage and use their land and water resources for the betterment of all - now and on into the future.

Post-Planning Issues

Once a plan or strategy is produced, common implementation issues include seeing that the plan is followed, or modified and then followed, as appropriate over time. What incentives need to be created to insure compliance? How are the impacts resulting from the implementation of any decision going to be monitored, assessed and modified as required and desired? Who is going to be responsible? Who is going to pay, and how much? Who will keep the stakeholders informed? Who will keep the plan current? How often should plans and their databases be updated? How can new projects be operated in ways that increase the efficiencies and effectiveness from joint operation of multiple projects in watersheds - rather than each project being operated independently of the others?

The questions in this category should be asked and answered, at least in general terms, before the watershed planning process begins. These questions should be revisited after the process reaches a decision when answers to them can be much more specific.

SO, WHAT DO WE KNOW?

Over the past 35 some years of my exposure to watershed management, it seems to me we have learned what we can do well and what we can not do very well. We have learned we are good at spending a lot of money on designing, building and operating engineering structures to control natural water resource systems. We have also learned we are less effective in implementing non-structural measures for managing the development and use of our resources. We have learned that over-control of natural watersheds can lead to the long-term detriment of both the ecology and the economy.

We also know we are good at designing, building and operating end-of-pipe solutions for resource protection from pollutants and that those measures are not sufficient. Undoubtedly we will continue building and operating things. However we are all recognizing that investing more money in infrastructure will not solve many of today's problems concerning the management and use of our land and water. Maybe as a result of this, at least in part, we seem to have less money to spend on that type of activity.

It's becoming increasingly apparent that to achieve a more sustainable economy and use of our watershed resources we will have to modify our management objectives and reduce, if not eliminate, the production of pollutant byproducts at their sources. To do this we must change our production and consumption habits. This is a big order. Is this possible, and, if so, how long will it take us to get started?

The big issue: How can we solve today's, and attempt to prevent many of tomorrow's, problems when spending money to build things is not sufficient? How can we change our production and consumption habits? One suggestion is by forcing us to do what we might not otherwise do by enacting laws and regulations 'for the common good.' In my opinion not many will view such regulations as for their common good. Regulations work only if we the people want them to. Right now we are clearly demanding less governmental control of our activities, not more. I don't see that attitude changing unless some crisis occurs that we now cannot foresee. Hence, an alternative suggestion, and the only one I can think of, is through a combination of education and economic incentives.

Changing people's habits has never been easy. This has been true in the past and surely will continue to be true now and on into the future. It is a challenge that will take leadership. We will need that leadership to increase and sustain popular public support and to maintain an active and relevant research program to support the economic and political processes and to help them go in

directions we, the people, want them to go.

Isn't it just possible that this leadership can begin at the local watershed level?

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REFERENCES

Eckstein, O., 1958, *Water Resource Development: The Economics of Project Evaluation*, Harvard University Press, Cambridge, MA.

Krutilla, J.V. and O. Eckstein, 1958, *Multiple Purpose River Development*, Johns Hopkins Press, Baltimore, MD

Maass, A., et al., 1962, *Design of Water Resource Systems*, Harvard University Press, Cambridge, MA

National Science Foundation (NSF), 1998, *Proceedings 1998 Water and Watersheds Program Review*, Corvallis, Oregon, January 28-29

National Water Commission (NWC), 1973, *Water Policies for the Future*, US Government Printing Office, Washington, DC

Smith, S.C. and E. N. Castle (eds), 1964, *Economics and Public Policy in Water Resources Development*, Iowa University Press, Ames, Iowa

Thiessen, E.M., D.P. Loucks and J.R. Stedinger, 1998, "Computer-Assisted Negotiations of Water Resources Conflicts," *Group Decision and Negotiation*, Vol. 7, No.

Tolley G.S. and F.E. Riggs (eds), 1961, *Economics of Watershed Planning*, Iowa State University Press, Ames, Iowa.

USDA, 1955, *Water, The Yearbook of Agriculture*, US Government Printing Office, Washington, DC

Weber, E.W. and M. M. Hufschmidt, 1963, *River Basin Planning in the United States*. UN conference paper.