Impact of Completed Navigation Projects

Lloyd G. Antle, U.S. Army Engineer Institute for Water Resources, Fort Belvoir, Virginia

The assessment of the impacts of the McClellan-Kerr Arkansas River Navigation System since its completion in 1971 by the U.S. Army Engineer Institute for Water Resources and the Southwestern Division Corps of Engineers is reviewed. The assessment covered navigation and ports, hydropower, flood control, recreation, sediment control, and other purposes, as well as the impact of the project on national and regional economies and in the social and environmental areas. The general trends of the early years of operation are that aggregate benefits have exceeded costs, but that the composition of benefits is quite different from that anticipated. The regional response has been uneven, and there has been only limited waterfront industrial development in Arkansas and Oklahoma. The transportation economy of the region has been affected significantly by the introduction of a new mode. The new river ports are acting as intermodal transfer points and serving other important distribution functions, and in many cases are prime locations for industrial development parks. The wider range of modal choice has affected transportation rate structures and reduced rates to counter the competition of the new mode are not uncommon.

The Corps of Engineers Institute for Water Resources (IWR) has been involved in the assessment of the impacts of the McClellan-Kerr Arkansas River Navigation System since its completion in 1971. A map of the system, which encompasses upstream reservoirs and navigation channels, is shown in Figure 1. The specific components of the project are Oologah, Keystone, and Eufala Lakes upstream and 17 locks and dams on the mainstem that include four multiple purpose projects, Webers Falls, Robert S. Kerr, Ozark, and Dardanelle. The project has cost $1.2 billion and is the youngest multiple purpose river basin plan implemented in the nation.

The values of the anticipated project benefits, updated to 1968 price levels, are as follows:

Benefit	Value ($)	Benefit	Value ($)
Transportation cost savings	40 470 000	Water supply	828 900
Power	14 383 900	Fish and wildlife	612 000
Flood control	6 602 600	Recreation	2 297 000
Channel stabilization	6 575 000	Redevelopment	3 355 800
		Total	75 580 200

The savings in transportation costs to users of the waterways are based on the following commodities:

Item	Quantity (Tg/year)	Item	Quantity (Tg/year)
Petroleum products	3.5	Flour and food	0.2
Iron and steel products	3.3	Less than barge lots	2.4
Coal	1.2	Miscellaneous	0.8
Wheat	0.5	Total	11.9

OBJECTIVES OF IMPACT ASSESSMENT

The objectives of the IWR study are related to the needs expressed by Fredrich J. Clarke in his remarks of March 14, 1969, to the Arkansas Basin Development Association:

> The Arkansas Basin Project for many reasons is the best laboratory we have ever had for the clinical observation of a major project through all stages of its development and on through the years of the fulfillment of its purposes. We are going to learn many lessons from its performance which will be of immeasurable future value to our whole country in determining where we are going in the field of water resources development, and how we are going to get there. I don't need to urge you to do all you can to assure the fullest success of this project. However, I do ask that you insure a broad appreciation of the full range of social benefits which water resources development provides. It will help in meeting the challenge of the future.

Thus, the object of the impact study is to document the changes in the economy, in the social and political structure, and in the natural environment of the region impacted by the McClellan-Kerr multiple purpose Arkansas River project under rigorous with and without project criteria.

IMPLEMENTATION OF IMPACT ASSESSMENT

Haveman (4) has discussed the advantages of and obstacles to expost investment evaluation. The advantages are manifold: "Real improvements in the public sector performance will not be achieved unless information on the input (costs) and output (benefit) results of ongoing and completed government undertakings is incorporated into the decision process." The obstacles include: (a) a substantial disagreement on what the legitimate objectives

of public investment are, and (b) the theoretical and empirical difficulties in filtering from a diverse set of changes in economic, social, and environmental indicators those that can be related to a public investment decision.

Two aims of the present study are to identify the changes associated with the use of the modified river regimen by the direct users of that system and to trace the indirect inputs through interaction models such as interregional input-output models.

ASSESSMENT OF EARLY IMPACTS

Antle (1) has described the impact assessment that was identifiable during the first full year of project operation (1971). The results are summarized below.

User Benefits Approach Costs During the First Year of Operation

The direct user benefits for the first year of operation (1971) are compared with those estimated on a 1968 base in Figure 2. Since there are valid criticisms of some of the assumptions, low and high bounds were also estimated and the rate of return to invested capital computed. There was a rate of return of between 2.5 and 7.4 percent during 1971. By comparison, the project benefits and costs computed for the 1970 budgetary presentation showed a 4.7 percent return to capital. The benefit-to-cost ratio has been unrevised since then.

Mix of User Benefits Differs From That Anticipated

The navigation benefits are substantial: The quantity of commodities moving on the waterway is developing at a rate that will probably exceed forecast levels within 10 years, but the mix is quite different from that forecast. This difference is, in part, attributable to the economic changes since the project was originally conceived in the early 1940s. The power benefits are somewhat lower than forecast because of a deficiency in flows during 1971 and because the total capacity has not yet been installed. The flood control benefits are also lower than forecast, but that is because of the absence of serious floods during 1971. The recreation benefits, however, are significantly higher than those used in project benefit-cost estimates.

Recreation benefits were not credited to the project during preauthorization planning studies in the 1940s or in the update in the 1950s because recreation benefit analysis was in its infancy; however, because of the recreational use at Corps of Engineers projects all over the nation in the early 1960s, parts of the overall system have been credited with recreation benefits. The high rate of recreational use at this project, as at many other water resource projects, is a result of increasing economic well-being, leisure time, and mobility, as well as of the recreational attractiveness of water resource projects.

Petroleum movements of the magnitude projected have not materialized, in part because of the pipeline network through the project area. However, in 1973 petroleum was 10 percent of the total tonnage. This is partly because the electrical utility in the Little Rock area is developing waterside petroleum handling facilities for receiving fuel oil for their power stations, and partly because the rail company is also developing fuel oil facilities. Grain movements are lower than estimated, mainly because of a lack of waterside grain-handling facilities, which is a result of rate changes introduced by competing modes. The existing waterside grain-handling facilities are characterized by a fast-handling design, limited storage, and low capital intensity, a trend that appears to be a reasoned response until competitive rate structures stabilize. One significant point in the benefit estimate is that about half of the 1971 tonnage accounted for about 95 percent of the benefits.

Regional Response to the Project Is Uneven

A University of Arkansas port study has illustrated the wide range in regional response to essentially similar stimuli of potential transport rate reductions. This range reflects basic differences in the perception of the potential gains (and losses); differences in port development strategy; and differences in the organizational, managerial, and financial resources available for port development. The Catoosa port in Tulsa is a heavily capitalized and massive attempt to focus the metropolitan economic development strategy on the port and its industrial park. Other port cities have opted for much less dramatic roles for port development, feeling that the port should simply serve the transfer function of moving shipments from one mode to another or to storage.

Industrial Revolution in Arkansas and Eastern Oklahoma Has Resulted in Limited Waterfront Industrial Location

The Tulsa Tribune of July 19, 1972, commented that "one of the striking features of the... navigation project is the lack of industrial development along the 440 mile long waterway" and noted that some developers "feel that the fact that the Army Engineers own back from the waterfront from 300 to 500 feet on each side is a deterrent," that others feel that the Engineer's ownership "is wise and express the fear that the Verdigris will in time become a sewer for industry unless the government keeps control" and that "recreation interests would like to see the entire government holding along the 50 miles of the Verdigris channel preserved as a public recreation area." Government ownership in fee is limited to that part of the project above lock and dam 13 in Oklahoma and around Ozark and Dardanelle Lakes in Arkansas.

Concurrently, industrial development in Arkansas has reflected a visibly successful state policy of attracting some industry to every county seat, rather than following a developmental pole or growth center strategy. It is also important that the development of Interstate 40 in Arkansas and the Muskogee Turnpike in Oklahoma parallels both the river and the time of development of the McClellan-Kerr project, so that the impact analysis is doubly complicated by these and other significant causes.

An over $1.1 billion investment has been reported for new industrial plants and expansion in the waterway area through early 1973. Over half of this is for power generation stations, with more than half of that for the Arkansas nuclear stations numbers 1 and 2 at Russelville. Cooling water is withdrawn from the Dardanelle Reservoir for one station, but a cooling tower is used for the other. Almost the only waterway traffic generated by the construction of these stations was the shipment of some of the large fabricated parts for the steam generator, but paradoxically, loaded coal barges destined for Tennessee Valley Authority power stations in Memphis pass the site. The latest power generation units to be announced in the project area will burn coal, with the Oklahoma Gas and Electric Company indicating plans to bring coal from Wyoming to the new Muskogee plant, evidently a response to air pollution regulations.

Figure 1. Arkansas River Navigation System.

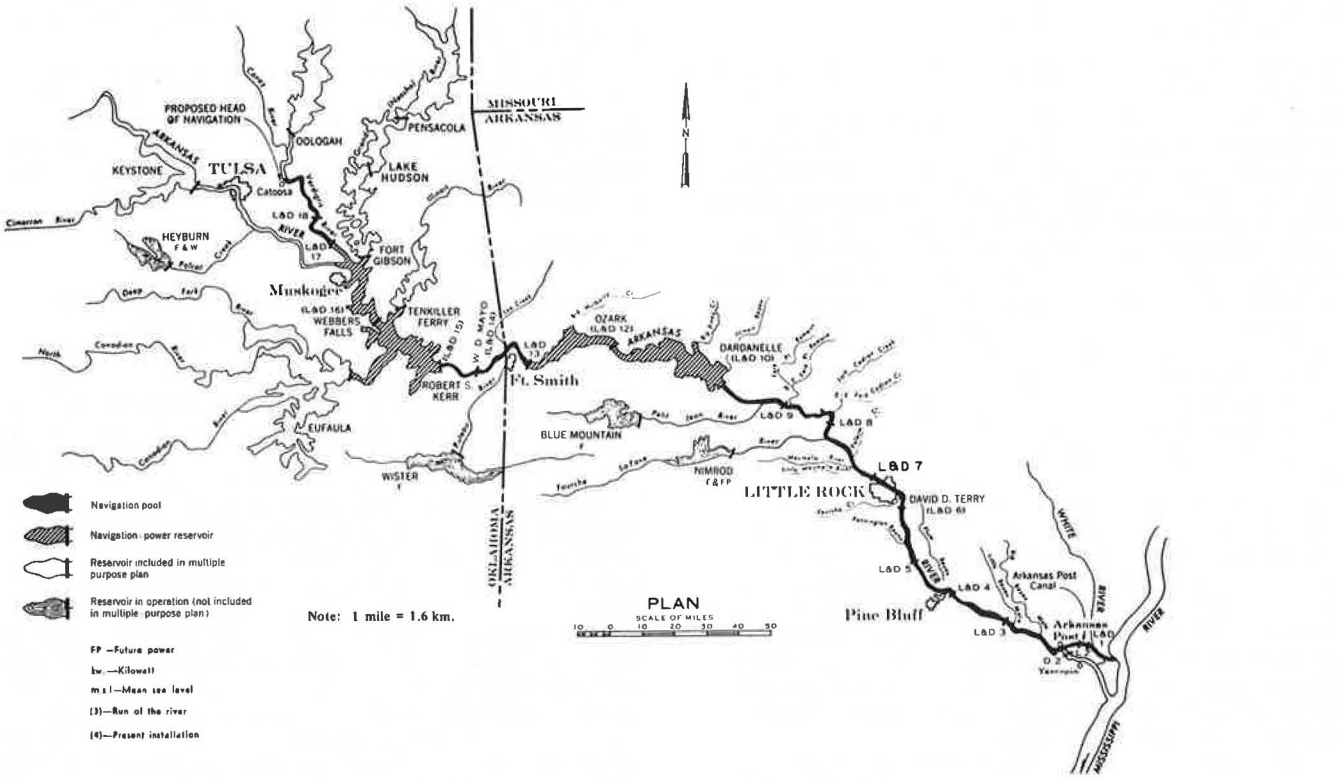
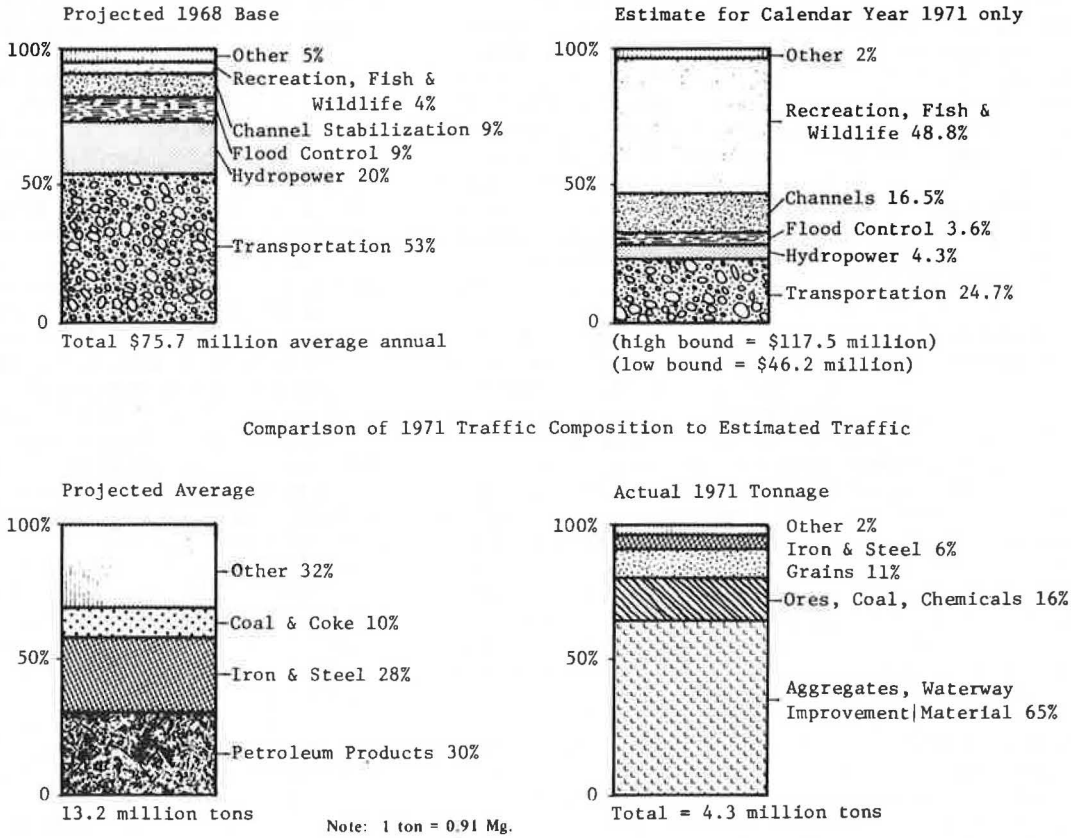


Figure 2. Estimated 1971 user benefits compared to annual user benefits estimated on a 1968 base.



The 1971 estimate reflects the first year of operation of the water way to Catoosa, whereas the project estimate was based on an average value to be achieved over the life of the project.

Decision-Making Process Reflected in the McClellan-Kerr Project Influences Impacts of the Project

The McClellan-Kerr project reflected a highly personal style of decision making among a limited number of participants. Controversy at the regional level was limited to concern for emigration versus concern for loss of land, but controversy between regional advocates and the Washington decision-making community was significant and persistent (5). One of the interesting attributes of the controversy was that of the legitimate objectives of the project (6). Regional political advocates generally described the project rationale as that of economic development in a region characterized by relatively low income, low employment growth, and high emigration rates, especially of young people.

With this rationale dominating, the question addressed to the Corps of Engineers was "Can you justify the project?" However, the corps' justification criteria are formally limited to narrowly defined efficiency criteria and resulted in reports that never directly related the Arkansas River project to economic development strategies for the nation or for the region. Rather, the reports, which are clearly addressed to the Washington-level review community, discuss technical engineering issues and benefit versus cost calculations limited to project (budget) costs and direct user benefits (which is typical of all corps reports). Thus, there is a gap between the articulated concerns and issues of the region and the water resources plan.

The conflict was characterized by the issuance by the Board of Engineers for Rivers and Harbors of a not convinced declaration to the navigation features of the project in 1945; by a 1955 letter from S. D. Sturgis (the chief of engineers) that informed Congress, "While the ultimate economic feasibility appears to be established, the margin of future net benefits over costs and the reliability of the estimates are insufficient to justify a commitment to construction of the plan as a whole in the immediate future"; by the impoundment of funds allocated to the Arkansas project by President Eisenhower in 1956 (although work on some portions of the project had begun in 1950); and by omission of construction funds in the 1957 budget message, which ultimately resulted in Congressional addition of funds for construction starts on Eufaula and Dardanelle reservoirs.

It may be that the conflict itself transformed the issues into highly abstract images on all sides, as they appear to be when discussed with people who were involved in the controversy. The abstractions range from the image that the project would, by itself, transform the region into a modern industrial economy, to the image that the project justification was insufficient, from a national efficiency accounting stance, to warrant federal investment. Some simply do not want to advocate the use of federal water resources programs for any objective other than efficiency, but an effort to elicit some of the proponents' views of the mechanisms of the desired transformation resulted in responses that border on a faith that it would happen without further action beyond the completion of the project.

This problem of images and myths and that of conflicting interest groups within the region converge to stifle aggressive nonfederal action to achieve a modern industrial economy with planned avoidance of environmental blunders. Thus, state and local action is fragmented and hesitant. The federal agencies having direct responsibility for economic development make grants for cooperating investment (for example, ports) without long-range plans or even a vision of a desirable one. Local communities are left to their own devices to develop grant proposals. Consistent, continued planning and decision processes to achieve the politically persuasive objectives for the Arkansas River project have not been available.

Even if the objectives for water resources development cannot be agreed upon, it would be desirable to shift some attention to the postconstruction implementation phase, rather than concentrating all of the decision-making resources on authorization and appropriation for construction.

Follow Through Has Failed

In common with the problems of relating public goals to planning objectives for public works projects, there should be a consistent dialogue with widespread public involvement and a broad-based decision process. In no other federal program is there such a preponderance of federal presence and funding in the planning, design, and construction phases as in water resources projects. The Corps of Engineers is capable of and responsible for bringing a project such as McClellan-Kerr on line, subject to the consensus of the local, state, and federal political structures. But, what of the economic goals that played such a significant role in motivating the regional proponents? Obviously, economic development in an area characterized by long-run emigration, low income, and limited industrialization requires a more deliberate sequence of steps than it would in a region that possessed an active economic base, huge capital and managerial resources, and a diversified labor force. In the latter case, the alteration of factors that affect prices (such as lowering transportation or electrical costs or improving the supply of industrial sites) might result in an instantaneous reaction of the economy.

This is not the case in underdeveloped regions and would not exist if factors and prices were freely mobile and if the production possibility frontiers were common (3). Long-run underdevelopment and the accompanying low incomes and productivity are generally accompanied by risk-adverse behavior and social controls that reflect social risk aversion. Confronted by significant uncertainties about new production arrangements, markets, distribution of factor payments, and the possibility of dramatic shifts in the distribution of social and political power, underdeveloped regions require a special set of stimuli beyond the alteration of prices factor (5).

The development of public entrepreneurship is strategic to successful economic development. Entrepreneurship requires the acceptance of risk to achieve projects or social payoff, as well as the skill to organize production factors into the desired configuration. Developing public sector entrepreneurship and organizing its activities in such a way as to reduce information costs and uncertainty about private production possibilities would offer substantial benefits.

If local or regionally defined design objectives were accepted first and then evaluated from a local, a regional, and finally a national accounting perspective, formulating a plan might be expedited. Public involvement should focus on implementation steps rather than be limited to a yes or no decision to authorize and construct, since, in many cases, the level and distribution of impacts can be managed by operation rules. The Appalachian Water Resources Survey demonstrated a practical planning style that emphasized cooperative enterprise between federal, state, and local governments and the private investment required to achieve the target levels of regional economic activity and employment.

The lack of follow through in the Arkansas River project that has resulted in limited riverfront development could result in environmentally costly location

Figure 3. Linear discriminant model.

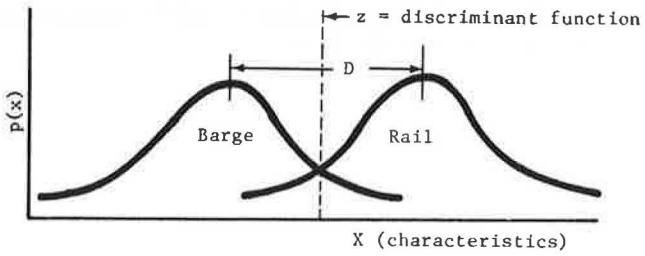


Table 1. Number of complete observations by Standard Industrial Classification Code and transport mode (1972).

Transport Mode	Number of Observations (Standard Industrial Classification Code)						
	Coal (12)	Paper (26)	Chemicals (28)	Primary Metals (33)	Fabricated Metals (34)	Grains (50)	Total
Rail	1	7	22	51	0	10	90
Barge	2	0	5	28	0	0	34
Truck	0	22	8	30	10	0	70
Total	2	29	35	108	10	10	194

decisions, in an otherwise avoidable conflict between competing user groups with respect to operating rules for the project.

Institutions that help transfer initiative from dominantly federal to dominantly local levels may facilitate the completion of projects. Several institutional forms have been recommended and some tentatively adopted, but little progress is visible.

What options are open to facilitate an environmentally successful economic development of this region, which in President Nixon's dedication address was held to be capable of supporting an additional 25 million fully employed people within 30 years? The industrial parks developed as adjuncts to port development have sufficient space and support facilities to accommodate for about 20 years the predictable expansion and location of those manufacturing and marketing industries that are normally located in industrial parks. Sites for free-standing, often environmentally threatening, activities have not been developed or designated. A move by the states, independently or bilaterally, to designate and acquire such sites would be warranted. Since there is now ample space to locate power plants, chemical plants, and paper and pulp mills in sites where environmental disruption would be minimized, timing is critical. Corps management of shorelines owned by the federal government in Oklahoma could be of strategic assistance to state implementation of socially, environmentally, and economically desirable land use patterns. The corps role could be a strategy of keeping options open, developing a continuing public dialog through hearings and impact statements on proposed private and public changes of land use requiring access to the river, and continuing pressure for strong federal-state implementation mechanisms.

Project Has Affected the Transportation Sector

Taylor and others (9) have studied the response of the region to the waterway improvement in terms of port development. Port development has been generally adequate in terms of quantity and its geographic distribution of handling capacity. Port-related industrial parks are important parts of the economic development strategies of some metropolitan areas, but much less in other cases. Taylor recommends that the state governments delegate less port and industrial park development to local governments, to encourage longer planning horizons and the evaluation of alternative strategies and to facilitate coordination between port and waterway-planning activities. This suggestion could be implemented by a process of funneling federal and state planning and construction grants through state port-development organizations.

Although some ports are viewed as local projects, substantial federal funds are invested in the public ports along the McClellan-Kerr Arkansas River Navigation System. However, the relative share of federal funding was highly variable between ports, apparently reflecting local perceptions and investment strategies. The 1972 dollar investments in ports of the various sectors are shown below.

Port	Private	Local	State	Federal
Pine Bluff	1 750 000	2 858 050	–	2 506 000
Little Rock	3 850 000	4 898 235	–	1 798 390
Ft. Smith	–	599 450	–	393 500
Muskogee	–	1 557 000	–	5 222 100
Tulsa	1 500 000	21 582 000	–	573 000

Another major impact on the transportation sector is in the rate structures of competitive transport modes. A recent survey by the Corps of Engineers Southwestern Division (10) has documented rail rate adjustments for commodities that also used water transportation from 1967 to 1974 in the project area. For a sample of 167 358-Mg (184 479-ton) annual shipment of steel products, savings to shippers using rail averaged $2.46/Mg ($2.23/ton), or a 15 percent average weighted reduction in rates. These reductions countered normal increases in rates. For the shipments in the sample, savings from rate reductions totaled $410 777 annually. The savings to shippers of steel products who used waterways were estimated to be $1.75 million in 1971.

A modal-split model was developed from the 1971 survey of shippers using the waterway and shippers of similar commodities using rail and truck modes (7). The choice of transport mode is viewed as a behavior model of transport users and is based on actual choices of the user and the transportation characteristics contained in that choice. These are the quantity shipped each year, quantity per shipment, time of transit, rate of the selected mode, and handling costs. Most of the data are taken from shipping invoices.

Discriminant analysis is a statistical tool for analyzing differences in population groups (2). The linear discriminant model places weights on the variables (in this case the transportation characteristics listed above) in such a way as to maximize the distance (D) between weighted means of the groups. This is shown graphically in Figure 3. In the two-group case, the discriminant function can be duplicated by regression, by using a dummy variable to indicate the group (1 or 0). A discriminant function was estimated and parametric shifts in rates were introduced to estimate the demand function for water transportation in the project area (1). Table 1 shows the number of observations by mode and by the Standard Industrial Classification Code. The price-inelastic demand function (E = -0.225) calculated from this shows that a relative increase in barge rates of 10 percent would result in a 2.25 percent decrease in weight shipped.

This also results in a large consumer surplus, with greater benefits than would be obtained from estimating savings solely in terms of reductions in transport costs.

Since the demand function reflects the competitive influences of rail and truck modes, one would anticipate higher substitution effects that would tend toward greater price elasticity of demand. One possible explanation for the degree of inelasticity is that the shippers were substantially motivated by the savings that resulted from rail rate reductions as well as by the direct savings in transport costs that resulted from using the waterway.

OPERATIONAL PROBLEMS

Substantial flooding in the Arkansas and Mississippi River systems led to restrictions in navigation during 1973. During 1973, there were 198 days having flows in excess of 1960 m^3/s (70 000 ft^3/s), and 59 days in excess of 4200 m^3/s (150 000 ft^3/s) at the Van Buren, Arkansas, gauge (8). The effects of these high flows were to increase delays and to cause a large but temporary decline in sand and gravel movements on the waterway and a small, but apparently permanent, diversion of steel shipments from barge to rail modes.

CONCLUSION

Assessment of the impacts of completed navigation projects must confront the facts that indirect impacts may be as significant as direct, that individual and regional perceptions play an important role, that river ports are significant in determining impacts not only because of their economic and physical transfer functions but also because of the industrial parks that normally develop as conjunctive enterprises, and, finally, that the dynamics of adjustment to a new competitive environment by shippers and the transport modes are not well defined. Assessment of the completed McClellan-Kerr Arkansas River Navigation System indicates a need to study these issues.

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