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ABSTRACT

"An Analysis of the Opportunity Costs of Channelization and Land-Use Change in the Obion-Forked Deer River Basin."

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The value of floodplain lands in agricultural use following channelization and the resulting foregone value of these lands were estimated. The latter estimates were incomplete because of the inability to predict effects on potentially important parameters. Estimated differences provide a threshold for decision-making. Policy implications are discussed.

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AN ANALYSIS OF THE OPPORTUNITY COSTS OF CHANNELIZATION AND LAND-USE CHANGE IN THE OBION-FORKED DEER RIVER BASIN

George F. Smith and M. B. Badenhop*

Alternative uses for a particular area or set of resources continue to generate controversy and debate. Economic theory suggests that resources be dedicated to the use which promises the greatest return and indeed Coase has argued that the evaluation of opportunity costs is a desirable approach to any question involving "...alternative social arrangements" (p. 43).

Opportunity cost estimates are often incomplete because many environmental products and amenities do not have established prices. Further, it frequently is not possible to predict the effects of a particular use on potentially important parameters with current levels of knowledge. The concept of a "threshold value" has been proposed to finesse these difficulties (Krutilla). Let us assume adequate estimates of the opportunity costs associated with a proposal cannot be made. If the measurable returns foregone as a result of undertaking the proposed project are greater than the returns from the project, it should not be undertaken. A complete estimate of the foregone returns would only increase the opportunity cost of the project and strengthen this conclusion. If, on the other hand, the measurable returns foregone as a result of the undertaking are less than the estimated returns from the project, the decision becomes a matter of judgment because of the incompleteness of the opportunity cost estimate. The project is economically justified if the value of the unmeasured, and perhaps unmeasurable, parameters are not judged to at least equal the difference between the

returns from the project and the returns foregone because of the project. The project is not economically justified if the opposite judgment is made. Thus, while the analysis is incomplete, it does set economic boundaries for the resource allocation decision by establishing a lower limit, the "threshold value," against which educated opinion and judgment may be evaluated.

This paper reports the results of an analysis of the opportunity costs of a proposed channelization project in the Obion-Forked Deer rivers of western Tennessee. Estimates of the returns foregone by undertaking the project were incomplete and threshold values are examined.

PROCEDURE

The Obion-Forked Deer River Basin is located in the 14 most northwest counties in Tennessee and contains about 3,185,000 acres. The area is predominantly rural; 11 towns in the Basin had more than 5,000 inhabitants in 1970. The floodplain contains about 759,000 acres or 24% of the Basin (Badenhop and Thomsen).

The proposal involves straightening, deepening and enlarging about 160 miles of river channel. About 160,000 acres of the floodplain would benefit from reduced flooding and improved drainage (U. S. Army). Opposition is based on the transformation and loss of the existing wetlands-forest environment through channelization and subsequent land-use changes.[1]

The analysis was based on the proposition that floodplain resources should be dedicated to the use promising greater returns to society regardless of the distribution of benefits and costs within society. The value of the development alternative was defined as the change in net

agricultural returns attributed to the project less its cost. The parameters included are listed in the first column of Table 1.[2] The opportunity cost of this alternative, the preservation value, was defined as: 1) the net value of the foregone timber production; 2) the change in productivity of the remaining bottomland forest because of altered water relations; and 3) the foregone days of recreation activity which existing fish, forest and wetlands wildlife resources could sustain, Table 1. It was not possible to quantify the externalities listed in column three of Table 1 given the current state of knowledge.[3]

The foundations for the analysis were drawn from Goldstein, Brown, and Krutilla. Current farming practices and environmental conditions were used to construct representative cropland and wetlands acres for analysis. Estimates were made for a 50 year planning horizon at discount rates of 8, 9, and 10% with a static model (Smith).

Development values were estimated for the five assumed crop price sets presented in Table 2.[4] While preservation values were estimated for six value sets, this paper will consider only the results from the largest value set used: $0.29 per cubic foot of timber (Barstow), $2.25 per nonspecialized recreation activity day--sport fishing, small game hunting and general recreation (Water Resources Council 1970), and $20.00 per specialized recreation activity day--waterfowl and big game hunting (Butcher, Rettig and Brown).[5]

Three cases were examined. Case I considered only the predicted benefits of the proposal. The project is expected to enhance the productivity of slightly more than an estimated 30% of floodplain cropland and allow the conversion of about 8% of the forested wetlands to agricultural use. Case II assumed that all wetlands classified as "highly productive"

Table 1. Components of the Opportunity Costs of Floodplain Land in Alternative Uses[a]

Development Value	Preservation Value	Unquantified Parameters
Increased yield on current cropland	Yield of forest products on land converted to crops	Impact on Mississippi Flyway
Yield on developed wetlands	Reduced yield of remaining forest	Wetlands as a source of genetic materials
Channelization cost parameters: - Design and construction - Land - Channel maintenance	Foregone recreation: - Fishing - Hunting - General recreation	Wetlands as an outdoor laboratory Foregone furbearers Vicarious consumption of wetlands

[a]In identifying the better alternative, if the estimated value of column two exceeds column one, the area should be maintained as wetlands; if the estimated value of column one exceeds column two, the area should be maintained as wetlands only if the value of the unquantified, and perhaps unquantifiable, parameters in column three is judged to at least equal the difference between the net development value and the incompletely estimated preservation value.

Table 2. The Crop Price Sets Used in the Estimation of the Development Values

Price Set	Soybeans (bu.)	Corn (bu.)	Cotton (lb.)	Pasture (grazing day)
	----------Dollars----------			
Low	2.50	1.20	0.22	0.10
Low median	3.25	1.45	0.265	0.125
Average	4.00	1.70	0.31	0.15
High median	4.75	1.95	0.365	0.175
High	5.50	2.20	0.40	0.20

and "moderately productive" would be converted to agricultural use even though not all this land would directly benefit from the project. The affected area was estimated to be about 48% of the existing bottomland forest. Case III assumed that 70% of the existing wetland forest would be converted to agricultural use, reflecting predictions of opponents of the project.

RESULTS

The results are presented in Table 3. The first row for each case gives the preservation values estimated at the alternative discount rates. The other rows present the development values estimated for the respective crop price sets.

Development Alternatives

The Case III development value estimates were consistently lower than the Case II estimates for all crop price sets. The Case I development values were relatively larger than the Case II estimates at the three smaller crop price sets while the Case II estimates were larger than the Case I estimates at the two higher crop price sets. Assume the project is undertaken with a goal of maximizing returns from this investment. These results imply that development should be limited to enhanced land if prices are expected to approximate the three lower crop price sets. Further, if prices are expected to approximate the higher sets, development should be limited to the highly productive and moderately productive floodplain lands.

Returns attributable to the project, Case I, were positive at all crop price sets considered. Why then have the owners of the land which would be enhanced by channelization not undertaken the project themselves?

Table 3. Discounted Values of Preservation and Development Estimated for Three Cases and Five Crop Price Sets, Obion-Forked Deer Floodplain

Case, Alternative and Crop Price Set	Discount Rate 8%	9%	10%
	Dollars in Millions		
Case I			
Preservation value	28.2	23.9	20.4
Development value:			
Low	7.3	5.2	3.5
Low median	15.8	12.3	9.7
Average	24.4	19.6	15.9
High median	32.9	26.9	22.1
High	41.5	34.1	28.3
Case II			
Preservation value	32.8	27.7	23.7
Development value:			
Low	-12.1	-11.3	-10.5
Low median	4.7	2.9	1.6
Average	21.6	17.7	13.8
High median	38.4	31.5	26.0
High	55.3	45.8	38.2
Case III			
Preservation value	35.3	29.9	25.5
Development value:			
Low	-27.1	-23.9	-21.3
Low median	- 7.1	- 7.0	- 6.8
Average	13.1	10.1	7.7
High median	33.2	27.1	22.2
High	53.3	44.1	36.8

Possible reasons include alternative investments offering greater returns for limited capital resources, expectations of public funding, and the difficulties of group action in an undertaking whose benefits cannot be restricted solely to participants. These appear to be short-run considerations. If preservation is the better social alternative, the analysis suggests public action would be required to prevent private channelization. The feasibility of channelization by a group of landowners also raises the question of the appropriateness of public involvement.[6]

Preservation Alternatives

The estimated value of preservation exceeded the value of development estimated at the three lower crop price sets and the Case III development value at the high median crop price set. In terms of the decision criteria, the area should remain as forested wetlands if agricultural output prices are expected to approximate these levels. These results were obtained with an incomplete estimate of the value of preservation. A more complete estimate would probably increase the magnitude of the difference between the values estimated for these two alternatives, as omitted parameters would appear to be wetlands benefits lost through channelization and land-use change.

The incompleteness of the estimate is important for those cases and price sets where the value of development exceeds the value of preservation. If crop prices are expected to approximate the high median-high range, the land allocation decision becomes a question of judgment. The difference between the value of development and the value of preservation, the "threshold value," provides some guidance. If the unquantified, and perhaps unquantifiable, parameters are judged to have a potential social value at least equal to this difference, the area

should be maintained as wetlands. Development for agricultural purposes is justified if the opposite judgment is made. A list of potentially important parameters in this category is presented in the third column of Table 1. The differences are presented in Table 4.

The Case II differences would appear to be the relevant threshold values since the level of land-use change assumed in this case produced the highest estimated returns. There are substantial differences in threshold values. While it might be possible to establish a definite point where a marginal change in the threshold value will alter the optimal land use, a diversity of opinion may exist. The outcome would then be a range of values rather than a definite point within which the decision is uncertain.[7]

SUMMARY AND CONCLUSIONS

This paper presents an analysis of the opportunity costs of two incompatible alternative land uses. Under certain, restrictive assumptions maintaining current conditions is the better alternative. At higher, and perhaps more "realistic," crop prices the better land use becomes a matter of judgment because of the incompleteness of the opportunity cost estimates. The difference between the alternative opportunity costs provides some guidance for the decision. An analysis of this type indicates gaps in the current state of our knowledge. It is tempting to speculate that the value which has been placed on presently unmeasurable parameters could be inferred from an analysis of a series of similar proposals in which different alternatives were chosen.

The analytical approach used in this study can identify the optimal alternative in a specified set but provides no information to

Table 4. Threshold Values: The Positive Differences Between the Present Value of Development and the Present Value of Preservation, Obion-Forked Deer Floodplain[a]

Case and Crop Price Set	Discount Rate		
	8%	9%	10%
	----------Dollars in Millions----------		
Case I			
High median	4.7	3.0	1.7
High	13.3	10.2	7.9
Case II			
High median	5.6	3.8	2.3
High	22.5	18.1	14.5
Case III			
High	18.0	14.2	11.3

[a]A 50-year annuity of approximately $156,000 has a present value of $1 million at the 9% discount rate. A 50-year annuity of approximately $133,000 and $182,000 is required per million dollars in present value of 8 and 10%, respectively.

evaluate the possible existence of superior, unspecified alternatives. A second, perhaps more pragmatic, limitation is that this approach does not consider the social acceptability of alternatives which may of necessity involve public restrictions on the rights of private property owners.

FOOTNOTES

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[1]Pollution from such sources as silt released during construction and agricultural chemicals associated with intensified land use following construction accompanies channelization. However, the pollution issues are rarely mentioned by opponents of channelization.

[2]The implication is that no socially significant externalities are associated with the use of floodplain land for agricultural purposes. Likely diseconomies include pollutants from such sources as agricultural chemicals and animal by-products; however, data are lacking. Vicarious consumption, an external economy, may be associated with the developed environment: given world food shortages, an individual may derive satisfaction from the mere knowledge that world food production capacity has been increased even though he derives no tangible consumption benefits from the increase. The development value will be underestimated (overestimated) if significant external economies (diseconomies) are associated with this alternative.

[3]In addition, three potential externalities--the impact of land-use change on upland wildlife, the effect of rural stream modification on nonagricultural flood damage and effects downstream from the confluence with the Mississippi River--were carefully examined but omitted from consideration because of conflicting evidence.

[4]The prices in these sets appear low relative to current market prices. The price ranges include the normalized prices recommended for public agency use in water and related land resource planning--soybeans, $3.57 per bushel; corn,$1.61 per bushel; and cotton, $0.308 per pound (Water Resources Council 1974). In addition, these prices appeared much more reasonable at the time they were selected.

[5]Use of these values, of course, gives more weight to the preservation alternative and perhaps reflects the conservative bias suggested for decisions involving irreversible alternatives (Fisher, Krutilla and Cicchetti). Data examined in this study suggested that wetlands conversion through channelization is essentially irreversible (U. S. Congress, p. 2142 and p. 2198).

[6]Brown notes that the externalities associated with channelization are predominately diseconomies. If such is the case, then the theoretically appropriate role for the public sector is to represent negatively affected interests and reduce the amount of channelization from what the private sector would produce rather than foster channelization projects.

[7]A possible decision guideline is the concept of maintaining the maximum number of options open when dealing with irreversible environmental transformations. This would suggest preservation of the wetlands until the uncertainty is resolved.

REFERENCES

Barstow, C. J. Fish and Wildlife Resources: Obion and Forked Deer River Basin, Tennessee (Preliminary Report). Tennessee Game and Fish Commission, Nashville, 1970.

Badenhop, M. B., and R. M. Thomsen. An Economic Survey of the Obion-Forked Deer River Basin Area. Agricultural Experiment Station Bulletin 532. The University of Tennessee, Knoxville. 1974.

Brown, J. P. "Stream Channelization: The Economics of the Controversy." Preliminary manuscript draft, Brown University, Providence, Rhode Island (Mimeographed). 1972.

Butcher, W. R., B. Rettig, and G. M. Brown. Proposed New Procedures for Evaluating Water and Land Resources: Some Comments from an Academic Viewpoint. State of Washington Water Research Center, Pullman. 1971.

Coase, R. H. "The Problem of Social Costs," Journal of Law and Economics, 3: 1-44. 1960.

Fisher, A. C., J. V. Krutilla, and C. J. Cicchetti. "The Economics of Environmental Preservation: A Theoretical and Empirical Analysis," American Economic Review, 62(4): 605-619. 1972.

Goldstein, J. H. Competition for Wetlands in the Midwest: An Economic Analysis. John Hopkins Press, Baltimore, Maryland. 1971.

Krutilla, J. V. Evaluation of an Aspect of Environmental Quality: Hells Canyon Revisited. Resources for the Future, Reprint Number 93. Washington, D. C. 1971.

Smith, G. F. "An Evaluation of Environmental Quality: Opportunity Costs of Channelization and Land Use Change in the Floodplain of the Obion-Forked Deer River Basin in Tennessee." Unpublished Ph.D. Dissertation, The University of Tennessee, Knoxville. 1974.

U. S. Army, Corps of Engineers, Office of the District Engineer, Memphis. "West Tennessee Tributaries General Design Memorandum No. 1: Revised." Memphis, Tennessee (Mimeographed). 1960.

U. S. Congress. House. Committee on Government Operations. Stream Channelization. Hearings before a subcommittee of the Committee on Government Operations (4 parts), House of Representatives, Ninety-Second Congress, First Session. 1971.

Water Resources Council. Standards for Planning Water and Land Resources. 1970.

Water Resources Council, Agricultural Price Standards for Water and Related Land Resources Planning. 1974.