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LAND USE ADJUSTMENT AND SMALL WATERSHED PROJECTS[1]

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Since the enactment of Public Law 566, action agencies have been engaged in the construction of small watershed flood protection systems. Preceding construction of flood retention structures, the economic feasibility is established through an evaluation of the benefits and costs associated with the watershed project. The benefits that accrue to the watershed project must exceed the costs (a B/C ratio greater than unity) to be classified as a "justifiable" public expenditure.

Traditionally, benefits of flood protection include increased revenues associated with an expected intensification of flood plain use, i.e., adjustments from a low value crop produced in the flood plain to a high value crop. Several watershed projects have been completed for many years and evaluations are being conducted regarding changes resulting from flood protection. Studies of these protected watersheds are providing evidence that the expected intensification of flood plain land use resulting from flood protection is, in fact, not occurring in many flood plains. A study in Oklahoma indicated no significant difference in the pattern of bottomland use, and hence, no significant difference between protected and unprotected watersheds for some specific regions (2). An evaluation of a watershed project in Texas found that land use patterns have actually changed in the opposite direction to that projected by the project planners: i.e., a conversion of cropland to pastureland after flood protection was provided (3).

Due to the uncertainty associated with projected land use changes, there is a need to distinguish between the benefits of flood protection and benefits of land use adjustment. A computer program developed at Oklahoma State University in cooperation with the Economic Research Service of the U.S. Department of Agriculture can be used to estimate the benefits attributable to each (5). This paper discusses one application of this model and suggests a logical sequence to planning and developing a flood plain based on its use.

THE MODEL

The model utilizes a uniform assignment of sample points throughout the flood plain (1). The computer program estimates flood damage by sample point with respect to the particular characteristics of that point; i.e., land use, productivity, depth of inundation and location. Flood damages for a field or larger area are obtained by summing the estimates for the appropriate sample points.

In addition to providing estimates of the average annual flood damages, the computer model is also capable of evaluating alternative land uses and selecting the crop that maximizes revenue net of production costs and average annual flood damages. This modified or optimizing model estimates the profit maximizing flood plain cropping patterns, the associated net returns and flood damages for as many systems of flood protection as an agency wishes to consider (4)

A WATERSHED APPLICATION

The computer models were applied to Nuyaka Creek flood plain in East Central Oklahoma. Expected damages and net returns were estimated for present land use (1968 land use) with and without flood protection. The modified model was used to estimate optimum flood plain land use patterns both with and without protection. Comparing these four sets of results made it possible to separate flood protection benefits from land use adjustment benefits.

Effect of Land Use Adjustment

The Nuyaka Creek flood plain includes 3,740 acres. This area is represented in the model by a grid of 748 sample points, with each point representing five acres. The total flood plain effect of specific land use changes can be identified by aggregating the effect at each sample point. Present and optimum land use patterns with associated dollar values assuming flood protection and no flood protection are presented for the watershed in Table 1.

Table 1. Present and optimum flood plain land use patterns and associated dollar values without flood protection and with flood protection: Nuyaka Creek, Oklahoma.

Item	Unit	Present Land Use[a]		Optimum Land Use[b]	
		Without Protection	With Protection	Without Protection	With Protection
(1)	(2)	(3)	(4)	(5)	(6)
Crops					
Cotton	acre	10	10	---	---
Corn	acre	10	10	---	---
Soybeans	acre	35	35	1,435	2,370
Wheat	acre	55	55	---	---
Oats	acre	80	80	---	---
Barley	acre	35	35	---	---
Bermuda Grass	acre	250	250	---	---
Alfalfa	acre	290	290	1,060	540
Native Hay	acre	65	65	190	165
Woodland Pasture	acre	1,745	1,745	630	450
Native Pasture	acre	1,165	1,165	425	215
Flood-plain Values					
Gross Revenue	$1,000	54.6	54.6	216.5	228.8
Production Costs	$1,000	31.3	31.3	105.9	102.6
Average Annual Flood Damages	$1,000	11.6	4.9	29.9	19.0
Net Returns	$1,000	11.7	18.4	80.7	107.2
Net Returns per Acre	$	3.12	4.92	21.57	28.66

[a]Present land use refers to 1968 land use.

[b]Optimum land use is the profit maximizing land use pattern for the flood plain.

The present land use (1968 land use) as given in Column 3. A total of 2,910 acres are in pasture, 325 acres are in soybeans or alfalfa with the remaining acreage devoted to cotton, corn, small grains, bermuda grass, and native hay. Estimated average annual flood damages, production costs, and net returns are $11,600, $31,300, and $11,700 respectively for present flood plain land use without flood protection.

The land use pattern that maximizes returns net of production costs and average annual flood damages without flood protection (present flood plain conditions) is given in Column 5 of Table 1. Substantial shifts in acreage from pasture and small grains to soybeans and alfalfa are indicated. The optimum land use includes 2,495 acres of soybeans and alfalfa with only 1,055 acres of pasture.

The result of changing flood plain from present use to the optimum with no flood protection is a sevenfold increase in net returns (from $11,700 to $80,700). However, the higher profit requires accepting an increase in capital requirements and average annual flood damages. Production costs increase from $31,300 to $105,900 and average annual flood damages increase from $11,600 to $29,900. The increased costs and flood damages are a consequence of adjusting from a low value crop to a high value crop; i.e., intensification of flood plain use.

Effect of Flood Protection

One method of considering the effect of flood protection on an area is to assume the present land use (1968 land use) does not change after the flood protection plan is put into effect. This may be an important comparison because studies of some flood plains indicate little or no appreciable change in land use due to flood protection (2,3).

The effect of flood protection assuming no change in land use is shown for Nuyaka Creek by comparing average annual flood damages and expected net returns in Columns 3 and 4 of Table 1. The flood protection plan reduces expected damages $6,700 (from $11,600 to $4,900) and increases net returns by a like amount (from $11,700 to $18,400). Thus, the benefits of flood protection under the stated assumptions are $6,700.

However, land use adjustments may occur as a result of construction of a flood protection plan. The land use maximizing returns net of production costs and average annual flood damages for Nuyaka Creek is given in Columns 5 and 6 of Table 1 without and with flood protection, respectively. The optimum land use with flood protection requires a cropping change on 1,395 acres. The flood protection and land use changes reduce expected flood damages $10,900 and increase net returns $26,500 (from $80,700 to $107,200). In this case, the benefits of flood protection are $26,500.

CONCLUSIONS

Studies of the response to flood protection indicate that care must be exercised in the method by which benefits to flood protection are measured. It may appear reasonable to consider flood protection benefits as the difference between net returns for present land use and no protection ($11,700) and net returns for the optimum land use with protection ($107,200). This would not be accurate, however, since flood plain net returns can be increased from $11,700 to $80,700 without additional flood protection. Perhaps the most reasonable interpretation of these estimates of flood protection benefits is that the difference between net returns with and without flood protection for present land use ($6,700) is an estimate of the minimum benefits expected from flood protection, while the difference between net returns for the optimum land use with and without flood protection ($26,500) is an estimate of the maximum benefits expected from flood protection.

In Nuyaka Creek flood plain, the increase in expected net returns for appropriate land use changes exceeds the benefits of flood protection. This suggests that there is a logical sequence to planning and developing a flood plain. An initial effort should be made to inform farmers of the profit maximizing land use and to aid them in their conversion to the profit maximizing land use before either approval or construction of a flood protection plan. After farmers are informed of the flood plain potential and are willing to make adjustments in their farming operation, the possibility of flood protection can be explored. In conjunction with the installation of flood protection and as part of the planning in a flood plain, farmers again could be informed of the profit maximizing land use in each flood plain field.

The above discussion as well as the studies cited in the introduction to this paper suggest that action agencies should refrain from assuming an intensification of flood plain use in response to flood protection and including the land use adjustments in flood protection benefits. The model utilized in this study identifies profit maximizing land use, but some effort is necessary to make farmers aware of the data. Therefore, it seems appropriate to consider any increased returns from a cropping change as benefits to the program of informing farmers of appropriate land use adjustment rather than benefits to flood protection.

FOOTNOTES

1. Journal Article 2055 of the Agricultural Experiment Station, Oklahoma State University, Stillwater, Oklahoma. This report is based on the results of a cooperative research project between Oklahoma State University and the Economic Research Service of the U.S. Department of Agriculture.

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REFERENCES

1. Berry, Brian J.L., *Sampling, Storing, and Coding Flood Plain Data,* Economic Research Service, U.S. Department of Agriculture, Agriculture Handbook No. 237, August 1962.

2. Cook, Neil R., *Effects of Upstream Flood Protection on Land Use,* Stillwater, Oklahoma State Agricultural Experiment Station Processed Series P-501, April 1965.

3. Gray, Roy Mack, and Warren L. Trock, *An Economic Evaluation of the Green Creek Watershed Project,* College Station, Texas Agricultural Experiment Station, Department of Agricultural Economics and Sociology, Departmental Technical Report No. 2, December 1968.

4. Lacewell, Ronald D., and Vernon R. Eidman, *A Model for Estimating the Incidence of Agricultural Flood Damages,* Western Agricultural Economics Association Proceedings, July 1969.

5. Lacewell, Ronald D., "An Economic Evaluation of the Nuyaka Creek Flood Plain Utilizing a General Model to Estimate the Incidence of Agricultural Flood Damages," (unpublished Ph.D. dissertation, Department of Agricultural Economics, Oklahoma State University, Stillwater, Oklahoma, November 1969.)