A PROPOSED PROCEDURE FOR DISTRIBUTING ASSESSMENTS AMONG BENEFICIARIES OF SMALL WATERSHED PROJECTS

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Conservancy districts can plan and apply land treatment and structural measures to reduce flooding and associated damages. The Conservancy District Act permits conservancy districts to appraise benefits and levy assessments to pay the cost of installing, operating, and maintaining works of flood protection not included in legislative appropriations. We are concerned with the method whereby these specified costs are distributed among flood plain farmers.

The assessment criterion is: Each beneficiary shall be assessed in relation to the proportion of benefits received. That is, flood plain farmers are to pay the proportion of specified flood protection costs that equal the proportion of total benefits received. The objective of assessing is consistent and equitable, but there is yet to be developed a method for computing assessments which meet this norm or objective.

Individual farm operator benefits of flood protection are typically measured by the reduction in damages incurred. This method lacks dynamic appeal in that present land use (land use at the time of flood control planning) is projected into the future. Any estimates of benefits for particular farmers or tracts of land resulting from land enhancement or land use changes attributable to flood protection consist of judgements and intuition. For the most part, estimated benefits of flood protection by farm operators are based on the reduction in flood damages assuming present flood plain land use.

In effect, assessments based on the reduction in flood damages, assuming present land use or land use before flood protection, penalizes the efficient farmer. In many flood plains, returns net of production costs and average annual flood damages could be significantly increased by a more intensive utilization of flood plain; i.e., production of alfalfa, row crops, and other crops in place of pasture [1]. Based on the land use before flood protection, the efficient farmer receives a much greater reduction in flood losses than the farmer making inefficient use of flood plain and is so assessed. The farmer making inefficient use of flood plain is assessed (based on reduced flood damages for pasture) a very low per acre assessment compared to uses such as cotton, soybeans, and alfalfa, but receives flood protection benefits on the land uses to which he converts after protection is provided.

zing) flood plain land use pattern, both with and without flood protection, results in a more equitable distribution of conservancy district costs among flood plain occupants. The increase in returns net of production costs and average annual damages is a more appropriate measure of the potential flood protection benefits. Distribution of flood protection assessments based on increased net revenue, assuming optimum land use patterns, also provides an incentive for improving efficiency in flood plain land use and penalizes, if anyone, the farmer making inefficient use of flood plain.

Underlying such an assessment procedure is the assumption that all flood plain operators are rational and have as their objective maximization of profit. In this case, with knowledge of the actual flood hazard, flood plain operators adjust land use in each field so as to maximize returns net of production costs and average annual flood damages.

METHODOLOGY

A reliable and accurate model for estimating the incidence of agricultural flood damages is a prerequisite to the proposed assessment procedure. Such a model has been developed as a simulation program [3]. The simulation model utilizes the frequency method of estimating flood damages. However, the computation of flood damages is based on a point sample rather than the presently utilized composite acre. (A composite acre is a hypothetical acre com-

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posed of the same percentage of each land use as in an evaluation reach.) Sample points are uniformly assigned throughout the flood plain with each point representing a specified number of flood plain acres. Average annual flood damages are computed at each sample point, based on the characteristics of the point; i.e., land use, elevation, coordinate location, productivity, and flood plain condition (with or without flood protection measures).

The simulation model includes a routine which computes returns net of production costs and average annual flood damages for each crop considered applicable to a sample point. The model is designed to consider up to 15 alternative crops. The crop that maximizes returns net of production costs and average annual flood damages is designated as the optimum land use. The most profitable (optimum) crop and associated net returns can be established by sample point before flood protection and after installation of a system of flood retention structures. Flood damages and net returns applicable to individual flood plain operators are obtained by accumulating over the sample points representing the bottomland of each operator.

EFFECT OF PROPOSED ASSESSMENT PROCEDURE

The assessing technique was applied to the Nuyaka Creek flood plain located in Okfuskee County, Oklahoma. A watershed protection plan has been drafted by SCS and approved by Congress for construction in Nuyaka Creek. The approved watershed project is referred to as SS II. Discussion of the results of the assessment procedure is limited to one cross section area (cross section area N-8) of 21 cross section areas comprising the Nuyaka Creek flood plain.[1] Cross section area N-8 contains 150 acres of flood plain. Each sample point in this study represents five acres; hence, there are 30 sample points for cross section area N-8. The 1968 land use, referred to as present land use in the remainder of this report, is primarily pasture and alfalfa with a limited amount of corn and soybeans.

Initially, sample point assessments are presented, based on a reduction in average annual flood damages attributable to flood protection assuming present land use (1968 land use). This is followed by assessments that evolve, based on the increase in expected net returns, assuming an optimum land use. In this way, shifts among the flood plain occupants of the responsibilities of flood protection between the two assessment procedures are demonstrated.

A total of 11 crops was considered in the analysis. These 11 crops have significance only with respect to determining the sample point optimum land use since present land use is fixed and assumed constant over time. Assumed price per unit for the crops was adjusted normalized prices which remove the influence of government price support programs [6, p. 4]. The prices used are not advocated as "most" appropriate, but simply serve as a facility in demonstrating the assessment procedures. The crops and corresponding price utilized in the study are as follows: (1) grain sorghum @ $1.69 cwt., (2) corn @ $1.05 bu., (3) soybeans @ $2.45 bu., (4) wheat @ $1.30 bu., (5) oats @ $0.60 bu., (6) barley @ $0.85 bu., (7) Bermudagrass pasture @ $2.50 AUM [4, p. 21], (8) alfalfa @ $22.00 ton, (9) native hay @ $22.00 ton, (10) woodland pasture @ $2.50 AUM [4, p. 21], and (11) native pasture @ $2.50 AUM [4, p. 21].[2]

Expected yield for each crop, assuming no flooding, was estimated for alternative productivity groups. Therefore, the expected yield for a specific land use could vary from one sample point to another depending upon the productivity grouping. The yields were taken from published research applicable to the bottomland in the study area [2].

Reduction of Flood Damages Assuming Present Land Use

Table 1 presents each of the 30 sample points comprising N-8 and the associated present land use (1968 land use), average annual flood damages before and after flood protection, reduction in flood damages attributable to flood protection, and proportion of total Nuyaka Creek flood plain reduced damages (benefits) received. The final column of Table 1 (proportion of total Nuyaka Creek benefits received by each sample point) gives the assessment factor for each sample point or percent of beneficiary project costs levied against each sample point of the cross section area.

The reduction in average annual flood damages over the aggregate Nuyaka Creek flood plain is $6,730 of which $462.17 is applicable to cross section area N-8. In this case, 6.867 percent of the total Nuyaka Creek assessment is allocated among flood plain occupants of cross section area N-8. This report considers the distribution of the 6.867 percent assessment among N-8 sample points and indicates the effect of land use on assessment factors.

[1] A cross section area is that part of the flood plain which is represented by one particular cross section.

[2] "AUM" refers to animal unit month and is defined as the amount of grazing required to feed a 1,000 pound cow and her calf for one month.

TABLE 1. PRESENT LAND USE, AVERAGE ANNUAL FLOOD DAMAGES ASSUMING PRESENT FLOOD PLAIN CONDITIONS AND SS II AND REDUCTION IN AVERAGE ANNUAL FLOOD DAMAGES ATTRIBUTABLE TO SS II FOR EACH SAMPLE POINT IN CROSS SECTION AREA N-8a

Sample point location in the N-8 matrix[b] row	column	Present land use	Average annual flood damages Present flood plain condition	SS II	Benefits[c] of SS II	Assessment[d] factor
		Crop	Dollars	Dollars	Dollars	Percent
9	1	w. pasture	0.57	0.13	0.44	0.0065
10	1	w. pasture	0.53	0.08	0.45	0.0067
11	1	w. pasture	4.03	2.91	1.12	0.0166
6	2	alfalfa	55.23	10.43	44.80	0.6657
7	2	alfalfa	51.32	7.33	43.99	0.6536
8	2	alfalfa	53.00	7.82	45.18	0.6713
9	2	w. pasture	0.53	0.08	0.45	0.0067
10	2	w. pasture	5.07	5.07	0.00	0.0000
11	2	w. pasture	0.61	0.21	0.40	0.0059
4	3	alfalfa	72.19	44.95	27.24	0.4048
5	3	alfalfa	49.44	6.79	42.65	0.6337
6	3	corn	35.67	5.08	30.59	0.4545
7	3	w. pasture	3.79	2.00	1.79	0.0266
8	3	w. pasture	1.58	0.61	0.97	0.0144
9	3	w. pasture	4.29	3.48	0.81	0.0120
11	3	w. pasture	0.55	0.10	0.45	0.0067
3	4	w. pasture	0.67	0.36	0.31	0.0046
4	4	soybeans	57.16	8.31	48.85	0.7259
5	4	w. pasture	3.98	2.70	1.28	0.0190
6	4	corn	225.75	185.28	40.47	0.6013
7	4	alfalfa	60.65	21.45	39.20	0.5825
8	4	alfalfa	57.95	14.94	43.01	0.6391
2	5	n. pasture	1.76	0.21	1.55	0.0230
3	5	w. pasture	4.24	3.44	0.80	0.0119
4	5	w. pasture	0.65	0.28	0.37	0.0055
5	5	w. pasture	0.62	0.22	0.40	0.0059
6	5	w. pasture	0.61	0.21	0.40	0.0059
7	5	alfalfa	57.71	14.36	43.35	0.6441
1	6	w. pasture	0.61	0.21	0.40	0.0059
2	6	w. pasture	0.53	0.08	0.45	0.0067
N-8 Total			811.29	349.12	462.17	6.8670

[a]Present land use refers to the 1968 flood plain land use.

[b]Each sample point represents five acres; hence, the values given in the table refer to five acre units of flood plain.

[c]Benefits are measured by the reduction in flood plain average annual flood damages attributable to SS II assuming present land use.

[d]Assessment factor refers to the percent of total flood plain SS II benefits each sample point receives.

Each sample point represents five acres and the assessment factors over the 30 sample points of N-8 range from zero to 0.7259. For those sample points presently utilized in the production of pasture, the assessment factor ranges from zero to 0.0266, compared to a range of 0.4048 to 0.7259 for more intensive land uses; i.e., alfalfa, corn and soybeans. Accumulating assessment factors over pasture and, conversely, nonpasture, the 19 sample points (95 acres of flood plain) presently in pasture have an assessment factor of 0.1859 or 2.7 percent of the total for cross section area N-8. This signifies that the more intensive land uses (11 sample points or 55 acres) are being assessed for 97.3 percent of the total N-8 assessment factor of 6.8670, or 6.6711 percent. In this particular illustration, 63 percent of the N-8 flood plain is responsible for only 2.7 percent of the specified project cost allocated to cross section area N-8. This means the N-8 flood plain farms producing corn, alfalfa, and soybeans, which includes 37 percent of the N-8 flood plain, are responsible for the remaining 97.3 percent of N-8 specified project costs.

The initial portion of this report argues that basing assessments on the computed optimum or profit maximizing land use is more appropriate. The following section discusses the distribution of assessments for N-8 based on the optimum land use and contrasts such an assessment procedure with the above example.

Increased Net Returns Assuming Optimum Land Use

Table 2 presents, by sample point in cross section area N-8, the land use that maximizes returns net of average annual flood damages and production costs and the associated net returns. The optimum land use and associated net returns are given for present flood plain conditions (no flood protection) and for flood protection plan SS II. Also given in Table 2, by sample point, is the increase in potential net returns attributable to SS II and the accompanying assessment factor (proportion of total Nuyaka Creek flood plain benefits received by each sample point).

In determining an optimum land use under specified flood plain conditions, a clearing and land improvement cost for those sample points in woodland pasture was included before any land use adjustments could be carried out. Based on interviews with specialists familiar with both the study area and the cost of clearing and preparing land, a clearing and land preparation cost of $100 per acre was estimated [5]. It was further assumed the $100 was borrowed at seven percent interest and repaid over a 35 year period.[3] Amortizing the $100 over 35 years at seven percent interest yields an annual charge of $7.72 per acre. Therefore, $7.72 was added to annual production costs for other crops considered on an acre of flood plain in woodland pasture.

Six of the 18 sample points in woodland pasture have as an optimum land use woodland pasture, assuming present flood plain conditions. This indicates that any land use change on these six sample points would result in a lower net return value than expected with woodland pasture. The flood protection provided by SS II results in an optimum land use of native hay for sample point 7 x 3 while no change is called for on the other five sample points characterized by an optimum land use of woodland pasture under present flood plain conditions.

Optimum land use in cross section area N-8, assuming present flood plain conditions, is 80 acres of alfalfa, 35 acres of soybeans, and 35 acres of pasture. With flood protection provided by SS II, optimum land use in cross section area N-8 is 110 acres of soybeans, 25 acres of pasture, 10 acres of native hay, and five acres of alfalfa. The increase in net returns resulting from flood protection and appropriate land use changes is $26,516 for the total Nuyaka Creek flood plain and $1,085.58 for cross section area N-8.

The last column of Table 2 gives the assessment factor for the proposed procedure. An examination of the assessment factors reveals a range of zero to 0.333, compared to zero to 0.7259 with present procedures. This indicates the burden of specified flood protection costs is more evenly distributed over the sample points. Also the assessment factor for the aggregate cross section area is 4.092 with the proposed procedure, compared to 6.867 under present procedures, which indicates a reallocation of flood protection financial responsibility among cross section areas as well as among sample points.

Comparing assessment factors in Table 1 and Table 2 for specific sample points provides insight into the net returns assessment procedure and assessment reallocations. Sample points with a present land use of pasture have an assessment factor of approximately 0.01 in Table 1 (present procedures), whereas, the assessment factor for the same sample points based on an optimum land use of soybeans or alfalfa is approximately 0.18; i.e., the assessment factor in Table 2 is approximately 18 times as large as that given in Table 1 for sample points with a present land use of pasture and optimum land use of alfalfa or soybeans. Sample points 9 x 1, 10 x 1, 9 x 2 and 11 x 2 provide specific examples of the conflicting assessment factors.

[3]This is the procedure followed by the Federal Land Bank for loans secured by real estate.

TABLE 2. OPTIMUM LAND USE AND EXPECTED NET RETURNS FOR PRESENT FLOOD PLAIN CONDITIONS AND SS II AND POTENTIAL INCREASE IN NET RETURNS ATTRIBUTABLE TO SS II FOR EACH SAMPLE POINT INCLUDED IN CROSS SECTION AREA N-8

Sample point location in the N-8 matrix[a] row	column	Present flood plain conditions Optimum land use	Net returns	SS II Optimum land use	Net returns	Potential benefits of SS II[b]	Proportion of all SS II Benefits[c]
		Crop	Dollars	Crop	Dollars	Dollars	Percent
9	1	alfalfa	125.82	soybeans	172.61	46.79	0.176
10	1	alfalfa	130.00	soybeans	178.29	48.29	0.182
11	1	w. pasture	4.72	w. pasture	5.84	1.12	0.004
6	2	alfalfa	166.37	soybeans	214.09	47.72	0.180
7	2	soybeans	173.03	soybeans	220.56	47.53	0.179
8	2	soybeans	171.19	soybeans	220.04	48.85	0.184
9	2	alfalfa	130.00	soybeans	178.29	48.29	0.182
10	2	w. pasture	3.68	w. pasture	3.68	0.00	0.000
11	2	soybeans	122.35	soybeans	166.75	44.40	0.167
4	3	alfalfa	149.41	soybeans	176.72	27.31	0.103
5	3	alfalfa	172.16	soybeans	217.99	45.83	0.173
6	3	alfalfa	168.60	soybeans	216.89	48.29	0.182
7	3	w. pasture	4.96	native hay	11.74	6.78	0.026
8	3	alfalfa	33.84	alfalfa	122.14	88.30	0.333
9	3	w. pasture	4.46	w. pasture	5.27	0.81	0.003
11	3	alfalfa	127.93	soybeans	175.69	47.74	0.180
3	4	alfalfa	117.75	soybeans	151.03	33.28	0.126
4	4	soybeans	171.19	soybeans	220.04	48.85	0.184
5	4	w. pasture	4.77	w. pasture	6.05	1.28	0.005
6	4	n. pasture	18.42	native hay	32.13	13.71	0.052
7	4	soybeans	160.95	soybeans	205.35	44.40	0.167
8	4	soybeans	164.56	soybeans	212.37	47.81	0.180
2	5	soybeans	179.10	soybeans	222.48	43.38	0.164
3	5	w. pasture	4.51	w. pasture	5.31	0.80	0.003
4	5	alfalfa	119.32	soybeans	156.52	36.84	0.139
5	5	alfalfa	121.99	soybeans	162.68	40.69	0.153
6	5	alfalfa	122.35	soybeans	163.60	41.25	0.156
7	5	alfalfa	163.89	soybeans	209.85	45.96	0.173
1	6	alfalfa	122.35	soybeans	163.60	41.25	0.156
2	6	alfalfa	130.40	soybeans	178.41	48.01	0.181
N-8 Total			3,290.43		4,376.01	1,085.58	4.092

[a]Each sample point represents five acres; hence, the values given in the table refer to five acre units of flood plain.

[b]Benefits of flood protection as measured by the potential increase in net returns assuming optimum land use before and after flood protection.

[c]This would serve as an assessment factor and refers to percent of total flood plain SS II benefits each sample point receives with benefits measured as the potential increase in net returns.

Conversely, sample points presently in alfalfa or soybeans and which have an optimum land use of alfalfa or soybeans have a net return assessment factor of about one-fourth the assessment factor computed for present land use flood damage reduction (approximately 0.18 compared to 0.63). Examples are sample points 6 x 2, 7 x 2, 8 x 2 and 5 x 3. The aggregated net return assessment factor is 1.757 for the 11 sample points with a present land use other than pasture and 2.335 for the 19 sample points presently in pasture, compared to 6.6711 and 0.1859, respectively, computed with present procedures. This indicates net returns assessment factors will significantly reallocate financial flood protection responsibility. However, the assessment factor for sample points presently in pasture having an optimum land use of pasture either decrease or are unchanged by the proposed procedure. Sample points 11 x 1, 10 x 2 and 7 x 3 are examples.

CONCLUSIONS

Basing assessments on the potential increase in net returns would be a significant change from present techniques and would require foresight and determination on the part of the conservancy district. The aggregate reaction to such a procedure will depend upon the proportion of farmers making efficient use of flood plain to farmers inefficiently utilizing flood plain. If all farmers are operating at about the same level of efficiency, controversy should be a minimum. However, in flood plains similar to cross section area N-8 with fewer farmers efficiently using land than inefficiently utilizing land, criticism will abound with the latter claiming discrimination.

This paper does not advocate the use of the potential increase in net returns for computing a benefit-cost ratio or in enumerating project benefits for project "justification". Optimum land use is a useful aid to extension personnel in alleviating ignorance regarding the flood hazard faced, planning land use in flood plains for profit maximization, and providing a basis whereby assessments of flood protection projects can be more equitably distributed among the flood plain beneficiaries.

The authors recognize there are difficulties associated with the proposed assessment procedure. The flood plain farmer that has attained a satisfactory level of income with pasture or other inefficient land use and plans no land use changes, whether flood protection is provided or not, will surely oppose this procedure. It will be very difficult for the conservancy district to sell this farmer on the principle that he should be assessed on the same basis as a farmer producing soybeans or alfalfa. However, there is no assurance that after flood protection is provided the farmer using his land inefficiently will not undertake a land use adjustment so as to increase profit and derive added benefits from the reduced flood hazard. Even though some farmers may not change land use, they receive other flood protection benefits in addition to reduced flood losses. With an increase in the earning potential of flood plain, there is a larger market value for flood plain and; hence, an increase in net worth for these farmers.

The assessment procedure proposed in this paper, based on the potential increase in net returns assuming optimum land use, is presented as an improvement over present procedures since flood plain occupants are free to make land use adjustments and obtain an increase in net worth even without land use changes. Underlying the proposed procedure are the principles of efficiency and equity in as much as the procedure avoids penalizing farmers efficiently using their land before flood protection and more uniformly distributes assessments over a flood plain.

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