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LAND VALUE METHOD FOR EVALUATING EROSION DAMAGE REDUCTION

Introduction

This Technical Note outlines a land value based procedure for computing the onsite effects of erosion. Although an important consideration in conservation planning, this Technical Note does not address the offsite effects of erosion.

A net income analysis, which accounts for both the costs and benefits of conservation, can be an excellent source of information for the farmer or rancher concerned with selecting a conservation system to control erosion. However, in most cases the beneficial effects of erosion reduction are not readily available to the conservation planner. The lack of readily available economic information about the benefits of conservation stems from the lack of information regarding the physical effects of erosion; the prices, cropping patterns, and input costs; and from the computational effort required.

In short, the usual approach to onsite conservation benefit estimation is to combine crop yield effects with estimates of future commodity prices and cropping patterns. When working with a farmer or rancher, their expectations of prices and crops should be used. In most cases, current prices and crops are used. An alternative approach is to use agricultural land values. This is not the real estate market value of land. It is based on the value of expected agricultural commodity production excluding any speculative land investment values. Agricultural land prices have the advantage of not only being determined by an objective market, they also embody the market's expectation of future commodity prices, cropping patterns, production costs and yields. As such, the advantage of using agricultural land values is three-fold. First, it should require less data and therefore demand less computational effort. Second, it has the potential to include conservation effects, such as reduced risk, that have not been quantified in past net income analyses. Third, in most cases, it places an upper limit on the onsite benefits of conservation based, in part, on the land's value.

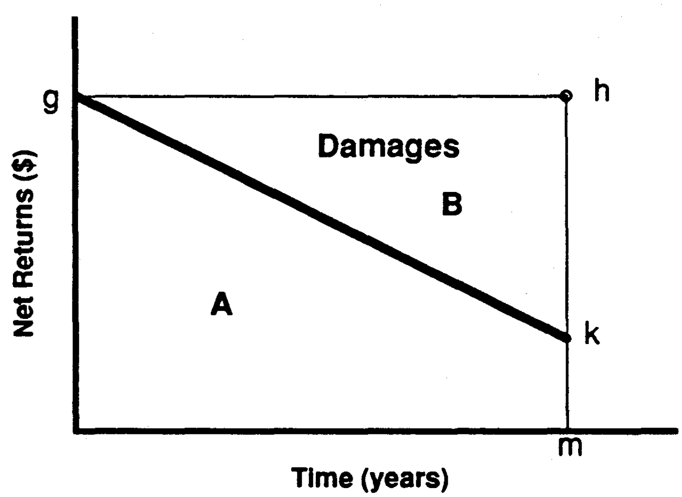
The remainder of this technical note summarizes a procedure that utilizes agricultural land values to assist conservation planners and land users in making a systematic and timely monetary analysis of conservation measures. The model has been incorporated into a Lotus 123 spreadsheet program. **A disk containing this model is included in the back cover of this technical note.**

Model

Generally a number of factors such as soil characteristics, proximity to urban areas, tax laws, and speculation effect the price of land. Economic theory formalizes this general concept by stating that the market value of land is determined by the present value of the land's future net income. Therefore, as the characteristics of the land change, they affect current and future net income and consequently the land's price. Specifically, as soil depth, organic content, and other erosion influenced soil characteristics change, the market value of the land changes. Based on this reasoning, it should be possible to measure the monetary effects of erosion by employing a model of agricultural land prices.

Figure 1 displays the basic agricultural value model. Area A, in Figure 1, represents the undiscounted value of net returns over the 50 year period. The present value of area A is equal to the agricultural value of land without conservation. Line segment "gk" is downward sloping because of the yield depressing effects of erosion. Area B represents the damages caused by excessive erosion.

Figure 1. *Land Damage Model*



The analysis can be effectively truncated at 50 years because of the dominating influence of the discount factor. For example, at an interest rate of 10 percent the present value of one dollar 50 years hence is 0.8 of a cent.

Again, at the current erosion rate the agricultural value of land is equal to the present value of area A in Figure 1. The strategy for estimating the potential benefits (area B) depends on knowing the present value of area A, which is the current agricultural use market value, and assuming that point h represents the zero damage net returns in year m.

Note that in Figure 1 the current net returns are equal to the zero damage net returns at year m (i.e. the net returns from crop production at point g equals net returns at point h). Also note that point k can be expressed as a function of point g if an appropriate yield-soil depth relationship is applied. In short, area A (the market value of land) and the yield-soil depth relationship can be used to determine point g, current net returns. This information can then be used to estimate the damage free, present value of the land's agricultural productivity (i.e. point h). Finally, the current agricultural value can be subtracted from the damage free agricultural value which results in an estimate of area B, or the potential benefits of reducing erosion.

Example

The potential benefits can be expressed in per acre or per ton values and in present value or average annual dollars. The appropriately expressed benefits can be compared to the costs of conservation by land users and therefore help them appraise the economic consequences of applying conservation.

The following numerical example illustrates the above process. Assume the following:

* An acre inch of soil weighs	150	Tons
* Yield reduction per inch of soil loss	4	Percent
* Current market interest rate	8	Percent
* Zero damage erosion rate	3	Tn/Ac/Yr
* Current erosion rate	30	Tn/Ac/Yr
* Percent of erosion leaving problem area	50	Percent
* Evaluation period	50	Years
* Net returns as a percent of Gross	20	Percent
* Agricultural value of land	$500	/Ac

The percentage of productivity lost over 50 years is:

[50 Yrs (30 Tn/Ac/Yr - 3 Tn/Ac/Yr)] / 150 Tn/Ac Inch = 9.0 inches of soil eroded
50% x 9 in. = 4.5 inches of soil lost
$1 - (1.0 - .04)^{4.5}$ = 16.8 percent of yield lost

In sum, given the above conditions, (assuming that 50% of the eroded soil leaves the problem area) the soil will lose 16 percent of its productivity over the 50 year period. Note that the yield loss, 4.0%/in, is applied to the remaining yield hence its effect per inch declines as erosion moves through the soil profile. This information is used to define point k in Figure 1, as a function of point g. However, it is necessary to recognize that the yield reduction computed above applies to gross returns not net returns. Consequently it is imperative to adjust the change in gross returns to a change in net returns by dividing by an assumed long-run net returns rate, 20 percent in this case.

$$.16/.20 = .81$$

Therefore,

$$k = g - .81g$$
$$k = .19g$$

That is, net returns at year 50 (point k) are 19% of the returns in year 1 (point g).

With this information, current net returns can be computed with the following formula (where PV stands for Present Value):

Ag Value of Land = (PV annuity of 1 per year)(k) + (PV of decreasing annuity)([g-k]/50)

or

$500 = (12.33)(.19g) + (472.08)(.81g/50)

Then solving for g:

$$g = \$50.05/Ac$$

Where g is an estimate of current net returns to land ownership per acre.

Finally, the present value of area B (i.e., erosion damage or potential benefits) can be computed by subtracting the current agricultural value of land from the damage free value of land.

PV of Damage	=	(Zero Erosion Value of Land) - (Current Ag Value of Land)
	=	(PV annuity of 1 per year)(g) - (Current Ag Value of Land)
	=	(12.33)($50.05) - $500
	=	$117.12/Ac

If the present value of $117.12 per acre is amortized over 50 years the annual potential benefits amount to about $.35 per ton of soil saved.

Discussion

A simple spreadsheet program has been developed which allows the user to estimate erosion reduction benefits and to perform a sensitivity analysis on the land value model. The Input/Output screen from that program is displayed in Figure 2. Although the input for both the above numerical example and the spreadsheet program is the same, rounding in the above computations results in a slightly different answer than given by the spreadsheet program.

Figure 2. *Land Value Conservation Benefit Model*

Input Variables	Value	Units
Weight of an Acre Inch of Soil	150	Tn/AcInch
Yield Reduction per Inch of Soil Lost	4	%
Current Market Interest Rate	8	%
Zero Damage Erosion Rate (T)	3	T/Ac/Yr
Current Erosion Rate	30	T/Ac/Yr
Percent of Erosion Leaving Problem Area	50	%
Evaluation Period	50	Years
Agricultural Value of Land	500	$/Ac
Net Returns as a Percent of Gross Returns	20	%

Chg in Yld Over Eval Perd:	16.20%	Inches of Soil Lost:	4.50
Yr One Net Returns ($/Ac):	$50.14	Chg NR at end of Eval Perd:	80.99%
Damage Per Ton (AA$/Tn):	$0.34	Damage Per Ton (PV$/Tn):	$4.20
Total Bene at T (AA$/Ac):	$9.27	Total Bene at T (PV$/Ac):	$113.37
Total Bene at 2T (AA$/Ac):	$8.24	Total Bene at 2T (PV$/Ac):	$100.77
Total Bene at 3T (AA$/Ac):	$7.21	Total Bene at 3T (PV$/Ac):	$88.17

Year at which NR = 0 if less than Eval period: –

(AA indicates Average Annual dollars and PV indicates Present Value dollars.)

If ephemeral erosion is a severe problem the user should only evaluate conservation systems that effectively treat the ephemeral gully erosion.

The model can be used to develop tables or graphs for field office use. An example of such a graph, Figure 3, follows. As an illustration of how the graph could be used, suppose that a soil conservationist is providing information to a land user whose land is valued at $600 per acre, erosion is being reduced from 15 tons to 5 tons per acre per year, and the yield reduction per inch of soil is 4 percent. The intersection of the 4 percent yield reduction line and $600 is at $5.00 per ton. In this case, since the value per ton of soil saved is expressed in present value terms, the land user could expect to economically justify conservation expenditures with a present value of up to $50.00 (10 tons x $5.00 per ton) per acre.

By using estimates of agricultural land values the model incorporates the land market's expectations of future prices, yields, costs, and crop rotations, hence reducing the need to estimate these variables. In addition, this approach may provide an estimate of other beneficial conservation effects such as risk reduction, esthetics, and other nonmonetary factors.

Although the important variable of approximate yield-soil depth relationship is not always available for specific situations, it can be obtained from the agronomic literature. The interest rate used in the model should be the one faced by the farmer or rancher. Using such an interest rate will incorporate an element of debt pressure a farmer might face. That is, the higher the interest rate the lower the present value of potential benefits. Also, the way the program is currently written, time horizons shorter than 50 years can be used but there will be a slight error in the benefit figures. In addition, it is critical that the value of land used in the model is the agricultural use value. In situations where other land uses significantly affect land values care must be taken to adjust market values to levels compatible with agricultural use. Finally, caution should be exercised if changes are made to the long term net return rate (i.e., lowering the net return rate can increase the potential benefits). The spreadsheet program assumes a long run net return rate of 20 percent.

Figure 3. *Dollar benefits per ton of Reduced Sheet and Rill Erosion.*