RURAL ECONOMY

STAFF PAPER

Department of Rural Economy
Faculty of Agriculture and Forestry
University of Alberta
Edmonton, Canada

Reflecting Productivity Losses due to Erosion in Physical and Financial Accounts for Agricultural Soils

David Watson and Mel Lerohl

Staff Paper 94-03

Department of Rural Economy

University of Alberta

Edmonton, Canada T6G 2H1

David Watson is Research Associate and Mel Lerohl is Professor, Department of Rural Economy, University of Alberta, Edmonton, Alberta.

Paper presented at the International Symposium "Models of Sustainable Development", Paris, France, March 16-18, 1994.

Summary

The paper describes an approach to estimating the long-term impact of soil erosion, and applies that approach to data from the Province of Alberta, Canada. This paper relies upon a soil classification system established in Canada, known as the Canada Land Inventory (CLI). It also employs available evidence relating yields to various classes of soils, and relating erosion to its effect on crop production.

The approach is employed to develop both a set of physical accounts for agricultural soils, classified by soil type, as well as a set of financial accounts for agricultural soils, since the value of those soils is influenced by yield potential. The results provide a long-term indication of the sustainability of the soil resource in the province, and permit developing estimates of future natural resource accounts for land in (1) physical accounts classified by soil type, and (2) in capital accounts by value of soil class.

Keywords: natural resource accounts, soil productivity, sustainability, erosion.

Reflecting Productivity Losses due to Erosion in Physical and Financial Accounts for Agricultural Soils

Introduction

Nations throughout the world use systems of national income accounts in order to guide their actions and in order to evaluate the consequences of past actions. The accuracy of these accounts is obviously a major concern, but even more pressing is the need to ensure that these accounts measure important economic or social changes taking place in those economies. This issue has become especially important for countries or regions which are strongly dependent upon a particular natural resource for employment and incomes. It is increasingly recognized that conventional national accounts do not in principle or in fact measure some of the most important changes which take place in the natural resources sectors of most economies. The issue, raised by Repetto (1989a, 1989b) and by others, has led to a broadened interest in what has come to be known as *natural resource accounting*, an approach which attempts to apply, to the natural resources sector, the accounting principles appropriate to traditional capital assets.

Traditional national or regional accounts have long reflected the depreciation of man-made capital, in the difference between Gross National Product (GNP) and Net National Product (NNP). The development of similar national accounts for natural resources implies the need for new information, however (Statistical Office of the United Nations 1990a, 1990b). These accounts must be able to reflect any loss (or gain) of usefulness of this capital which occurs during the process of producing food, fibre or mineral products. Both conceptual and empirical studies have been attempted on various long-lived resources (Hartwick 1990b, Smith 1992), and there has considerable public and quasi-public discussion of the issue (Repetto 1989a , Newsweek 1991).

The main aspect of the depreciation of soil which has yet to be recognized in regional accounts is the loss of fertility which may occur during production, due largely to soil or fertility losses from applying agriculture practices.

There is another impact of economic forces on the capital base of land in agriculture, however. That is the shift of land out of agriculture into other uses, which may be higher or lower value uses. Abandonment of agricultural land is one extreme, and shifting agricultural land into urban, industrial or public uses represents another shift of land use. The common thread is that either represents a change in the asset base of the agricultural industry, although shifts in land use into or out of agriculture may or may not represent losses to society as a whole. On the other hand, lost fertility unequivocally represents a net loss to society.

A possible approach to developing national/regional accounts for natural resource capital may lie with the treatment of the natural resource environment as a renewable (depreciable) resource (Hartwick 1990). The resource gives off a flow of real goods or services, and in the process changes value. Essentially, the approach involves incorporating a measure of capital value of natural resource flows in order to permit adjusting income accounts by changes in capital values associated with degradation or incrementation. The approach deals with changes in capital due to degradation or pollution of capital in natural resources in precisely the same manner as loss of produced capital due to wastage, depreciation or misuse. The attempt in the approach is to assess the effect of use on the existing stock, and derive a consistent series of extended national accounts based on the changes in capital aggregates which the measures show.

The Problem

The development of a set of physical accounts would be a useful beginning stage to assessing the impact of erosion and related forces on the agricultural land base. It would permit developing a set of physical accounts parallel to those for other types of farm capital, it would permit assessing the change in the land base in terms of the number of hectares affected, and it would lay the base for understanding the sources of changes in the land base. There exists, in most countries of world, a set of physical accounts which indicates the area (perhaps by use or quality) of agricultural land, as well as a set of financial accounts which indicates the values society places on that agricultural land at different points in time. From either the physical or financial accounts, however, it is normally impossible to separate the effect on area or value of any one of the numerous possible factors which cause area or value to change. One of those factors which causes land to change in value, and may cause the area of a particular kind of land to change over time, is loss of fertility due to soil erosion. The desire to measure the effect of erosion on value or area is essentially the desire to assess the effect of using the land on its ability to sustain yields over time. Sustainability in this context can be defined as capacity to produce the same yields from the same plot of land over time. Depending upon the definition, sustainability may or may not permit yield-enhancing technological change. Our definition considers only the effect of erosion on yield without permitting increased yields from technological change to offset the effect of lowered productivity due to erosion.

Changes in sustainability of the agricultural soils in a region are a result of changes in the amount of agricultural land, as well changes in yields on that land. Data are typically available indicating the extent to which agricultural land shifts between farming and other uses, but rarely are data available indicating the relationship between land area and land productivity. By analogy with systems of national accounts for produced capital, the central problems are two-fold: First, there is limited knowledge of the effects of agricultural practices on the sustainability of agricultural soils. At a minimum, an attempt to develop such accounts needs both to acquire and to use evidence on the changes in capital values of agricultural land, changes which are precipitated in part by changes in the underlying productivity of farm land, just as the changes in the values of non-natural resource capital are affected by the use and obsolescence of such capital as farm buildings and machinery. Second, there is no capacity to develop a set of physical accounts of land changes unless there is an ability to illustrate the shifts in productivity of land as erosion takes place and reduces the yield potential of farmed land. This occurs in part because land has typically been denominated in hectares, and changes in the sustainability of a hectare of land are by no means obvious unless it is possible in some way to quantitatively illustrate the change. One possibility is a change which would permit illustrating shifts among types of land. A way to show that shift is by basing it on a categorization of land by yield potential.

Data Sources

In order to establish a baseline productivity value for agricultural land in the province, tables and maps developed for the Canada Land Inventory (CLI) are used. The CLI was carried out between 1960 and 1968, using existing and newly surveyed information, and it classifies soils according to their capability for agriculture (Department of Forestry and Rural Development 1966, Canada Land Inventory 1976). Table 1 shows the CLI classification scheme. The tabular data of CLI category by municipality are from Agriculture Canada (Personal Communication 1993).

More detailed inventory of eco-physical divisions now exist for the province. However, in order to create tables that match the changes in the land base (including shifts in land between agriculture and other uses), it is necessary to use data sources (such as Economic Services Division, annual), which depend upon the CLI classification.

The strength of the CLI system is that it cross tabulates capability of agriculture by municipality and four broad soil types. These soil types are correlated with 3 main regions of the province, and municipality boundaries.

The CLI gives the potential for agriculture of the province. The Canada Census of Agriculture (Statistics Canada, various years), undertaken every five years, was used to obtain the actual amount of land used for various agricultural activities. The Census groups municipalities and counties into Census Divisions. The CLI and Census information combined gave a base from which to measure the changes in the agricultural land base since the initial year of the study. Certain of the groupings of municipalities within the Census Divisions have changed since the original formulation of the CLI, and data had to be adjusted to reflect these changes in regional boundaries.

The amount of land transferred into and out of use for agriculture is tabulated on a regular basis by the provincial department of agriculture. The period 1976-1990 is covered by Birch (1982), Woloshyn (1983), Wehrhahn (1987) and Wright and Pearson (1993). The information is cross tabulated by soil type, and three main ecophysical regions of the province, with groupings for final end use of the land. Further information for historical land transfers was obtained from Thompson (1981), and Warren and Rupp (1981).

In order to assess the impact of agricultural practices on yields, it is possible to use one of a range of soil erosion simulators to assess the effect on rate of erosion of employing established farm practices, and hence the effect on the sustainability of particular soils. Sufficient information is available to establish these relationships a level of detail which permits assessing the erosion consequences by type of soil, topography and climate. There are estimates of both the rate of erosion and of the yield consequences of that erosion which can be developed from models such as the *Erosion-Productivity Impact Calculator (EPIC)*, a model developed within the United States Department of Agriculture (AAEA 1986, Benson *et al.* 1989), but which has been used in or adapted to use in other countries as well (Larney *et al.* 1992, Lerohl 1991, Cabelguenne *et al.* 1990). In addition, in parts of western Canada, there is some corroborative evidence concerning the relationship between erosion and yield. Some of those data are from the (nearby) provinces of Manitoba (Smith and Shaykewich nd) and Saskatchewan (Zentner 1988). Recent work has been undertaken in Alberta by various groups to measure the effect of erosion on agricultural productivity (Larney et al. 1992). This work simulated erosion on different soil classes, in different parts of the province, by mechanical removal of varying amounts of topsoil. Crops were then grown on the plots, and productivity measured.

The valuation of the land transfers, and change in productivity of existing land, is based on an annual publication of the Alberta agriculture ministry (Economic Services Division, various years). This measure shows the value of the land for agriculture, by measuring sales of land within agricultural use. Non-agricultural real estate commands a higher price than agricultural land, even within the same geographic boundaries. Also, the value of real estate is influenced by its proximity to urban centres. Near the major cities of Edmonton and Calgary, small parcels received a higher price on a per hectare basis, with Calgary being higher than Edmonton. With the aim of sustainability of agriculture, it is not appropriate for this paper to attempt to measure the land value in non-agricultural use. Such a measure would, however, also need to be calculated for an integrated set of regional accounts.

Methods

The study covers the years 1971 to 1991. 1971 is the earliest it appears possible to develop a data series on physical and financial changes of land sustainability given the data sources currently available. Even for the earliest years of this period, the data on farm land (as opposed to urban land transfers) are incomplete. The basic data employed are (i) CLI estimates of land with a potential for agriculture, and (ii) land in farms data based on the Census of Agriculture (Canada various dates). Combining data from these two sources permits assessing the amount of land used for agriculture, by CLI division, and by soil type, in the base year.

The use of data from several sources makes it necessary to ensure equivalence of measurement units and area boundaries. Basic data manipulation carried out includes conversion (where necessary) of measurements in acres to hectares, summing data to equivalent geographical boundaries, and ensuring that CLI classes report data comparable to those used for agriculture as reported in the decennial census data (Canada various dates).

The relationship between CLI class and yield potential is based on estimates by Shields and Ferguson (1975). Loss of productivity due to erosion is simulated by applying the estimated erosion rates and relating those erosion rates to likely yield loss under typical Alberta conditions (Table 2). The effect of erosion is therefore estimated by shifting land among CLI classes of land when the yield potential of the land is reduced by erosion to such a degree as to place the land in a lower CLI category, using the Shields and Ferguson criteria. As a result, it is possible to show a relationship between acreage and CLI class over time, and to compare what those values would have been in the absence of soil erosion.

The data on land transfers into and out of agriculture, by CLI class, are also important to a complete understanding of changes in the agricultural land base. The two combined (i.e., erosion effects and agricultural/urban land use changes) permit determination of the physical changes in the agricultural land base since 1971. For simplicity, the results are tabulated by five year periods beginning in 1971.

Estimates of the monetary value of changes in the land base use the physical change calculation, multiplied by the average value of land transfers (Economic Services Division, annual) in the appropriate regions of the province.

Conclusions

The magnitudes of changes due to land transfers between farming and other uses has dwarfed the changes as a result of erosion or degradation of the land base (Table 3). Erosion has shifted land into lower quality categories, with class 5 and lower quality soils being the only category to unambiguously increase as a result of erosion. The changes are small, however. During each five year period since 1976, erosion has been responsible for shifting about 300 ha. of agricultural land out of the top four soil classes. Shifts among the (generally non-arable) classes 5-9 have been larger, but have not exceeded 500 ha. for each five year period. It is in the gains and losses of agricultural land due to shifts in land use where the changes have been dramatic. During the period since 1976 (when data became available concerning both additions and removals from agriculture), the net amount of land entering arable agriculture (defined as CLI classes 1 to 4) has been less than the amount leaving the industry. Agriculture to non-agriculture shifts of 260,000 ha. have been partly, but not completely, offset by non-agriculture to agriculture shifts of about 237,000 ha. of land. There has, therefore, been a net decline of about 24,000 ha. of agricultural land between 1976 and 1991, a change in which erosion has had a minor role. The average quality of land in 1991 was not as high as at the beginning of the period, however. Soil classes CLI 1, 2, and 3 have declined: soils of CLI 1 and 2 have declined throughout the period since 1976, and soil of CLI 3 has declined since 1981. Soil of CLI 4 has increased in quantity more than sufficient to offset the declines, but represents a lower level of fertility than the "lost" soil. The gains overall have been small, however, and approximately offset by shifts out of the arable land category due to erosion. The overall result is that total land in agriculture in the province has changed by less than one percent between 1976 and 1991. While that land is of lower average productivity in 1991, the total change in sustainability (area x average yield) is also less than one percent.

The main policy issue which these data address is the question of agricultural sustainability. It appears that the combined forces of urbanization and erosion have had some, but overall a slight, effect on the sustainability of the agricultural land base. Of the two forces, urbanization clearly is the dominant one, with a capacity for significant net changes in the land base over time. During the period in question, the shifts from agricultural to non-agricultural uses has clearly been muted by the addition of new arable land to the industry. There is no assurance, however, that those additions of land to the agricultural land base will continue, and continue to offset such shifts out of agriculture as occur. On the other hand, soil erosion, while possibly an important factor on selected sites, does not appear to have had significant impacts on the sustainability of the agricultural land base. It should be recognized that the implied definition of sustainability is the capacity of the land base to produce constant amounts of agricultural products without changes in yields. Only modest increases in yields, well below the observed rate of productivity growth, would have been required to compensate for the declines in the amount of quality of the land base due to one or the other of the factors assessed. A broader definition of sustainability would recognize the potentials inherent in growth in agricultural yields, and the potential for sustaining or increasing output by shifting from land intensive to more non-land intensive inputs as those inputs become available.

The paper demonstrates that it is possible to arrive at reasonable, if not ideal, estimates of the consequences of erosion and related forces on the land base. In the process, it appears possible to develop not only a set of capital accounts for agricultural soils, but also a beginning to answering important public questions about the costs to society of depreciating the natural capital which is held by the agricultural sector.

REFERENCES

American Agricultural Economics Association Task Force (cited as AAEA). 1986. *Soil Erosion And Soil Conservation Policy in the United States*. Soil Conservation Policy Task Force (Pierre Crosson et al.) Occasional Paper No. 2.

Anderson, M., and L. Knapik. 1984. *Agricultural Land Degradation in Western Canada: A Physical and Economic Overview*. Ottawa: Regional Development Branch, Agriculture Canada.

Benson, V.W., Oliver W. Rice, Paul T. Dyke, Jimmy R. Williams, and C. Allan Jones. 1989. Conservation impact on crop productivity for the life of a soil. *Journal of Soil and Water Conservation*. 44:6:600-604.

Birch, A. 1982. An Inventory of Changes in Alberta's Agricultural Land Base Between 1976 and 1980. Project Report RE-03-13-82, Resource Economics Branch, Alberta Agriculture, Edmonton.

Brocke, L.K. 1977. *The Canada Land Inventory Soil Capability for Agriculture in Alberta*. Edmonton, Alberta: Alberta Environment.

Cabelguenne, M., C.A. Jones, J.R. Marty, P.T. Dyke and J.R. Williams. 1990. Calibration and Validation of EPIC for Crop Rotations in Southern France." *Agricultural Systems*. 33:153-171.

Canada Land Inventory. 1976. *Soil Capability for Agriculture*. Map 1:1,000,000. map Series. Alberta Lands Directorate, Canada Department of the Environment.

Canada. Various dates. *Census of Agriculture*. Ottawa: Supply and Services Canada.

Department of Forestry and Rural Development. 1966. *The Canada Land Inventory*. Ottawa. Information and Technical Services Division.

Economic Services Division (annual). Agriculture Real Estate Values in Alberta. Production Economics Branch, Alberta Agriculture, Edmonton, Alberta.

Eisner, Robert. 1988. Extended Accounts for National Income and Product. *Journal of Economic Literature*. 26:4:1611-1684.

Food and Agriculture Organization. 1990. GNP and GDP on Trial. *Ceres*. 22:2:5-6.

Hartwick, John M. 1990b. *Degradation of Environmental Capital and National Accounting Procedures*. Ottawa: Economic Council of Canada. Working Paper #11.

Hartwick, John M., and R. Lindsey. 1989. *NNP and Economic Depreciation of Exhaustible Resource Stocks*. Kingston: Queen's University, Department of Economics. Disc. Paper 741.

Hartwick, John M. 1990a. *Natural Resources, National Accounting, and Economic Depreciation*. Kingston: Queen's University, Department of Economics. Discussion Paper 771.

Hartwick, John M. 1989. *Non-Renewable Resources: Extraction Programs and Markets*. London: Harwood Academic Publishers.

Ives, R. Morrison, and C.F. Shaykewich. 1987. Effect of simulated soil erosion on wheat yields on the humid Canadian prairie. *Journal of Soil and Water Conservation*. 42:3:205-208.

Larney, F.J., R.C. Izaurralde, H.H. Janzen, B.M. Olson, E.D. Solberg, C.W. Lindwall, and M. Nyborg. 1994. Soil erosion-crop productivity relationships for six Alberta soils. *Journal of Soil and Water Conservation*. In press.

Lerohl, M.L. 1991. The sustainability of selected prairie crop rotations. *Canadian Journal of Agricultural Economics*. 9:4:I:667-676.

Manning, T.W. 1986. *Alberta Agricultural Productivity: General Report*. Occasional Paper No. 13, Department of Rural Economy, University of Alberta.

McAndrew, D.W., K. Handford, R.P. Zentner, M. Gorda, and J. Doner. 1993. Agronomic and Economic Considerations in Various Barley Production Systems in East Central Alberta. *Canadian Journal of Plant Science*. In Press.

Newsweek. 1991. "The Price of Progress." June 17, 1991.

Personal Communication 1993; Alberta Land Resource Unit, Agriculture Canada, Edmonton.

Peskin, H.M. 1976. A National Accounting Framework for Environmental Assets. *Journal of Environmental Economics and Management*. 2:April:255-262.

Repetto, Robert. 1989b. *Wasting Assets: Natural Resources in National Income Accounts*. Washington: World Resources Institute.

Repetto, Robert. 1989a. Nature's Resources as Productive Assets. *Challenge*. September-October. 16-20.

Shields, J.A., and W.S. Ferguson. 1975. "Land resources, Production Possibilities and Limitations for Crop Production in the Prairie Provinces." In *Oilsed and Pulse Crops in Western Canada - A Symposium*, ed. J.T. Harapiak, pages 115-156. Calgary: Western Cooperative Fertilizers Ltd. Pp. 703.

Smith, Elwin G., and Carl F. Shaykewich. nd. *The Economics of Soil Erosion and Conservation on Six Soil Groupings in Manitoba*. Mimeo. Pp. 25.

Smith, Roger. 1992. Income Growth, Government Spending, and Wasting Assets. *Canadian Public Policy*. 18:4:387-412.

Solow, Robert M. 1986. On the Intergenerational Allocation of Natural Resources. *Scandinavian Journal of Economics*. 88:1:141-149.

Statistical Office of the United Nations. 1990b. *SNA Handbook on Integrated Environmental and Economic Accounting: Preliminary Draft*. New York

Statistical Office of the United Nations. 1990a. *Revised System of National Accounts: Draft Chapters and Annexes*. New York

Thompson, P.S. 1981. *Urbanization of Agricultural Land*. Environment Council of Alberta, Edmonton.

Toman, Michael A. 1992. Environment and Development. *Resources for the Future*. 106:3-6.

Usher, D. 1982. Accounting for the Depletion of Natural Resources in the National Accounts of Developing Countries. *OECD Development Center.*

Veeman, T.S. 1989. Sustainable Development: Its Economic Meaning and Policy Implications. *Canadian Journal of Agricultural Economics*. 37:4(Part II):875-886.

Warren, C.L. and P.C. Rupp. 1981. *The Urbanization of Rural Land in Canada (1966-1976).* Environment Canada, Ottawa.

Wehrhahn, R.L. 1987. *Agricultural Land Base Monitoring Study (1982-1985).* Resource Economics Branch, Alberta Agriculture, Edmonton.

Woloshyn, P. 1983. *An Inventory of Changes in Alberta's Agricultural Land Base Between 1976 and 1980.* Project Report RE-13-06-83, Resource Economics Branch, Alberta Agriculture, Edmonton.

Wright, C.M. and M.G. Pearson 1993. *Agricultural Land Base Monitoring Study (1986-1990).* Resource Economics Branch, Alberta Agriculture, Edmonton.

Zentner, R.P., and Campbell, C.A. 1988. First 18 years of a long-term crop rotation study in southwestern Saskatchewan-yields, grain protein, and economic performance. *Canadian Journal of Plant Science.* 68:1-22.

Table 1. The Canada Land Inventory Classification System	
CLI Class	Class Description
1.	Soils with no significant limitations in use for crops.
2.	Soils with moderate limitations that restrict the range of crops or require moderate conservation practices.
3.	Soils with moderately severe limitations that restrict the range of crops or require special conservation practices.
4.	Soils with severe limitations that restrict the range of crops or require special conservation practices in both.
5.	Soils that are unsuitable for annual cultivation. These soils could be improved for the production of perrenial forages and pasture.
6.	Soils that have some natural grazing potential and improvement practices are not feasible.
7.	Soils that have no capability for arable culture or permanent pasture.
8.	Organic soils that are frequently found in the wooded regions of the province.
9.	Unclassified due to a lack of CLI maps of the area at a 1:250,000 scale or lower.

Table 2
Linear Yield Predictors for Soil Loss at Selected Alberta Locations

Lethbridge Dryland	$Y = 1215 - 64.0\ X$	(10.6)
Lethbridge Irrigated	$Y = 2269 - 118.3\ X$	(17.2)
Taber	$Y = 1085 - 32.7\ X$	(6.1)
Hillspring	$Y = 1421 - 64.5\ X$	(9.7)
Cooking Lake	$Y = 2441 - 109.5\ X$	(11.6)
Josephberg	$Y = 2768 - 86.8\ X$	(11.5)

Y is yield in kg/ha; X is depth of soil removed in cm. Data in parentheses are standard errors of X coefficient. All regressions exhibit R^2 values in excess of 0.9.

Source: Derived from Larney et al. 1992.

Table 3: Physical Changes in the Land Base, Alberta					
	CLI Class				
Reason for Change	1	2	3	4	5 - 9
1971 Initial Land Base (hectares)					
	824,770	4,389,221	6,213,110	6,170,222	9,073,330
Changes from 1971-1976					
Additions	0	0	0	0	0
Removals	2,103	4,753	2,070	1,176	839
Erosion	42	145	19	111	+317
Net Change	-2,144	-4,898	-2,089	-1,287	-521
Changes from 1976-1981					
Additions	12	4,546	41,111	86,472	89,302
Removals	8,429	27,676	31,250	28,750	45,916
Erosion	42	145	19	111	+317
Net Change	-8,458	-23,276	9,841	57,611	43,704
Changes from 1981-1986					
Additions	366	3,276	18,463	30,405	16,280
Removals	7,361	22,685	27,076	24,710	32,028
Erosion	42	145	19	111	+317
Net Change	-7,038	-19,554	-8,632	5,584	-15,430
Changes from 1986-1991					
Additions	365	3,276	18,463	30,405	16,280
Removals	7,361	22,685	27,076	24,710	32,028
Erosion	42	145	19	111	+317
Net Change	-7,038	-19,554	-8,632	5,584	-15,430

Note: Additions include: public land disposition, abandoned oil and gas wells, and reclaimed strip mines. Removals include: urbanization, roads, oil and gas wells, coal strip mines and public land reservation. Data for additions to land base unavailable between 1971 and 1976. For this period removals are for urban annexation only. Figures may not add due to rounding.

Table 4
VALUE OF AGRICULTURAL LAND BASE CHANGES, ALBERTA($ million)

	1	2	3	4	5-9
1971-1976					
Additions	0	0	0	0	0
Removals	-0.02	-0.05	-0.02	-0.01	0
Erosion	-0.08	-0.15	-0.02	-0.08	0.023
Total	-0.10	-0.20	-0.04	-0.09	0.023
1976-1981					
Additions	0.00	180.58	1.69	4657.77	4.49
Removals	-0.92	-1187.53	-2.22	-1879.33	-1.59
Erosion	-0.027	-0.011	-0.007	-0.035	0.093
Total	-0.95	-1006.96	-0.54	2777.63	2.99
1981-1986					
Additions	0.11	201.95	3.64	2827.49	1.73
Removals	-2.23	-1398.37	-5.34	-2297.88	-2.00
Erosion	-0.031	-0.070	-0.008	-0.035	0.096
Total	-2.15	-1196.5	-1.71	529.57	-0.38
1986-1991					
Additions	0.12	178.53	4.43	2588.64	1.809
Removals	-2.43	-1236.24	-6.50	-2103.78	-3.53
Erosion	-0.034	-0.086	-0.010	-0.048	0.125
Total	-2.34	-1057.79	-2.08	484.81	-1.60

Note: All values in constant dollars, base year is 1986.