National Accounts and Environment Division

Division des comptes nationaux et de l'environnement

Estimating Changes in Gross Agricultural Soil Erosion by Water - A Case Study for Manitoba

Discussion Paper
Number 13

Document de travail
Numéro 13

Statistics Canada
Statistique Canada

Canada

Estimating Changes in Gross Agricultural Soil Erosion by Water - A Case Study for Manitoba

The principal author of this article is Doug Trant. For further information on the materials please contact him at 613-951-3829.

L'auteur principal de cet article est Doug Trant. Pour plus de renseignements, veuillez communiquer avec lui au 613-951-3829.

This paper is one in a series of internal discussion papers produced in Statistics Canada's National Accounts and Environment Division. These papers address topics related to environmental statistics and the National Accounts components which are currently under development.

Ce document fait partie d'une série de documents internes produits dans la Division des comptes nationaux et de l'environnement de Statistique Canada. Ces documents traitent de sujets reliés aux statistiques de l'environnement et composantes des comptes nationaux au stade de la recherche.

Discussion papers in this series are made available in the official languages in which they were written. Translated versions are not available in most cases.

Le documents de travail de cette série sont disponibles dans la langue officielle dans la quelle ils sont écrits. Les versions traduites ne sont pas disponibles dans la plupart des cas.

March 1994
Ottawa

Mars 1994
Ottawa

Estimating Changes in Gross Agricultural Soil Erosion by Water - A Case Study for Manitoba[1]

D.F. Trant[2]
D.R. Coote[3]
L.C. Carpentier[4]
H.L. Trépanier[2]

Introduction

The five major land degradation processes taking place in Canada today include water and wind erosion, soil acidification, soil compaction and soil salinization. Land degradation processes have many impacts both economic and environmental. They have been estimated to cost Canadian farmers as much as 1 billion dollars annually (Fox and Coote, 1986, Dumanski *et al.*, 1986). This on-farm cost includes: declines in crop quality, reductions in crop yield and increased expenditure for the inputs required to maintain reasonable yields. The environmental impacts of land degradation include: water quality deterioration, wildlife habitat destruction, increased water run off and air pollution resulting from wind erosion. The cost of these environmental impacts have yet to be calculated for Canada, but available evidence in North America suggests that the off-farm impacts are considerably greater than the on-farm impacts (Fox *et al.*, 1991).

Water erosion is Canada's most costly land degradation problem. In 1985 it was estimated that the economic impacts of water erosion were more than 500 million dollars (Fox and Coote, 1986). In the United States, the Environmental Protection Agency identified soil erosion as one of the five most important environmental problems. American estimates indicate that the combined environmental and economic costs of their soil erosion problem range between 4.4 and 43.5 billion dollars and that erosion exceeds levels that will permit sustained high production levels on 40 percent of cropland (Steiner, 1990).

The study reported here uses agricultural cropping information in conjunction with detailed soils data to estimate changing gross agricultural soil erosion by water for the Province of Manitoba. This study is primarily methodological, and does not attempt to address the policy implications of soil loss. Nor does it make predictions about the longevity or sustainability of the soil resource given the gross soil erosion rates that are calculated. It is an elaboration of a larger study which estimated gross agricultural soil erosion for all of Canada (Carpentier, 1992).

In early 1992 the United Nations Environment Program (UNEP) prepared a first-ever study of world soil degradation (Oldeman *et al.*, 1992). The UNEP study indicates a 'serious concern' for more than half of Manitoba's agricultural soils, claiming that they have been damaged by agricultural activity (Crabb, 1993). The study reported here will examine cropping trends in these areas and estimated soil erosion trends over the last 20 years. Manitoba is also a good testing ground for the methodology used in this study, because it has a reasonable cross section of agricultural activity, both dryland and mixed agricultural systems. These new estimates are based on micro-level soil and crop information and represent the most detailed estimates calculated at this scale in Canada.

---

1. Centre for Land and Biological Resources Research contribution # 93-93
2. National Accounts and Environment Division, Statistics Canada, Ottawa, Ontario.
3. Centre for Land and Biological Resources Research, Agriculture Canada, Ottawa, Ontario.
4. MacDonald College, McGill University, Ste Anne de Bellevue, Quebec.

In soil science there are several ways of estimating soil erosion loss on land. The scale of the project largely determines the method used. At the largest and most detailed scale measurements are made in the field using specialized equipment to determine soil removal rates from given parcels of land. Studies for larger areas require models that allow researchers to simulate events taking place in the field. Modelling methods lack the precision of actual field sampling methods, but results are generally consistent with larger scale sampling. Given the size of Canada, the only practical way to estimate gross soil erosion is through the application of a generalized model. The *Universal Soil Loss Equation* (USLE) is the most widely used generalized water erosion model in North America, and has been adapted for the study reported here.

Methods

The USLE was used to compute a relative index of soil loss in Manitoba. The USLE is made up of five basic physical parameters that, when assessed collectively, determine the water erosion potential on a parcel of land (Wischmeier and Smith, 1978). The equation and physical parameters are as follows:

$$A = R * K * LS * C * P \qquad (EQ\ 1)$$

Where:

A is computed soil loss per unit area per year measured in tonnes per hectare per year.

R is a rainfall and run-off factor which includes a factor for run-off from snow melt. It is derived from rainfall intensity expressed as kinetic energy per hectare per hour of rainfall.

K is a soil erodibility factor as determined by the particle size distribution and organic matter content of a specified soil. The relationship is based on experimental observations and regression analysis.

LS is a topographic factor estimated from slope length and steepness.

C is a crop cover and management factor, determined by the type of vegetation, and the cultivation method used. An index value of 1.0 represents the maximum erosion potential of a tilled fallow field.

P is a conservation practice factor where 1.0 represents the use of no conservation practices while a value of 0.0 represents total protection from erosion.

Three of these five factors, rainfall erosivity, soil erodibility and the topographic factor *(R,K,LS)* are relatively constant and are not normally affected by typical agricultural practices in the short term. In other words, farmers cannot readily adjust the amount of rainfall they receive, or the particle size distribution of their soil, or the steepness or length of the slopes on their fields. However, the crop cover and management factor (*C*) is largely determined by farmers as they decide what crops to plant and what tillage and management practices they will employ. The C-factor is subject to variation seasonally, and from year to year, across the landscape. The P-factor is also determined by farmers who can vary the type and intensity of conservation practices used on farms (Trant, 1993).

Calculations were done at Statistics Canada using physical data from Agriculture Canada's Centre for Land and Biological Resources Research (CLBRR), and time series cropping information for 1971,1976, 1981, 1986, and 1991, obtained from Census of Agriculture. This data is stored in Statistics Canada's GIS (Geographical Information System) based Environmental Information System (EIS). Trends derived from quinquennial observations can misrepresent annual variations significantly. However, for Manitoba, fluctuations in the annual cropland areas planted in specific crops are low for this study period. Cropping data were overlaid at the Enumeration Area level and aggregated to Agriculture Canada's Agroecological Resource Areas(ARA) to provide detailed crop data. (Huffman *et al.*, 1993). There are just over 60 ARAs in Manitoba, some containing as many as 1,000 farms.

A consistent set of crops was selected to estimate the change in expected gross soil erosion taking place on more than 98 percent of Manitoba's cultivated area. The remaining 2 percent of cultivated

area is a residual composed of many specialty type crops occupying small areas. Erosion is not estimated separately for these crops but is calculated as an aggregate. The crops in Table 1 are listed from least protection from water erosion (summerfallow) to most protection from water erosion (improved pasture). Crops more likely to be associated with erosion have higher *C* values. Regional climatic effects are accounted for by varying the value of *R* and its resultant impact on calculated *C* values by rainfall erosivity region. Regions with higher rainfall and run-off erosivity have more intense rainfall or rainfall of longer duration. Five rainfall erosivity regions were identified for this study. Each is an aggregation of the 60 ARAs which in turn are an aggregate of the more than 200 Soil Landscape Units (SLUs).

Physical data were taken from Agriculture Canada's Soil Landscapes of Canada (SLC) map series. The *R,K* and *LS* portion of the USLE was estimated by Eilers et al (1989) at the SLU level. Because of geographic resolution errors Census data could not be merged with SLU level physical data, requiring that both physical data and cropping information be aggregated for combination at the ARA level. The distribution of cultivated land in each SLU was estimated by Agriculture Canada for the 1981 crop year. Using these distributions as areal weights it was possible to estimate *R*, *K* and *LS* for each ARA.

Table 1

Crop Cover and Management Factor by Rainfall Erosion Region - Manitoba

	C-factor				
Crop Type	**Region 1**	**Region 2**	**Region 3**	**Region 4**	**Region 5**
Summerfallow	0.58	0.73	0.56	0.52	0.78
Sugar beets	0.57	0.58	0.57	0.56	0.59
Silage corn	0.57	0.58	0.57	0.56	0.59
Grain corn and sunflowers	0.53	0.54	0.53	0.52	0.55
Peas and beans	0.55	0.60	0.55	0.54	0.57
Potatoes	0.41	0.42	0.41	0.40	0.43
Flax and canola	0.26	0.34	0.26	0.25	0.31
Grain[a]	0.29	0.34	0.34	0.24	0.51
Pasture	0.00	0.00	0.00	0.00	0.00

a. Grains are usually grouped into separate spring and winter categories because winter grains have a much lower erosion potential. A single C - factor was used for grain in Manitoba because less than 2 percent of grain is winter grain.

Source: Carpentier 1992.

Table 2

Estimated P-factors for Manitoba Conservation Practices[a]

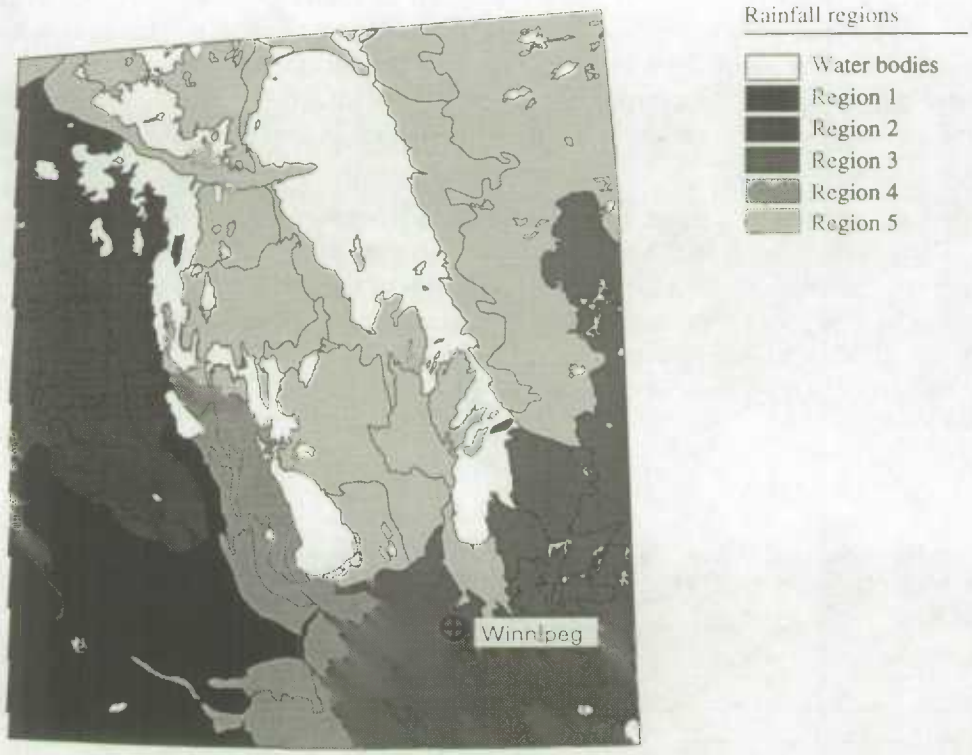
Conservation Practice	P-factor
No-till cultivation	0.50
Strip cropping	0.50
Contour cultivation	0.65
All Other types	0.65
Conservation tillage	0.75
Winter cover	0.85

a. Estimated by Coote after Wischmeier and Smith, 1978.

Table 2 indicates the P-factors used to correct erosion estimates for the 1991 crop year, the only year for which detailed conservation data is available.

Map 1

Rainfall Erosion Regions - Manitoba



Sources: Statistics Canada, National Accounts and Environment Division. Agriculture Canada, Centre for Land and Biological Resources Research.

An adaptation of the USLE was used for calculating soil loss. Gross erosion by water (*A*) on agricultural land was calculated as follows.

$$A = \sum_{a}\sum_{cr} \{ ([0.675 \times Dom_{cr,a}] \times C_{cr,a} \times P \times Cenarea_{cr,a}) + ([0.325 \times Sdom_{cr,a}] \times C_{cr,a} \times P \times Cenarea_{cr,a}) \} \quad \text{(EQ 2)}$$

When Sdom = 0, or when there are only dominant soil characteristics:

$$A = \sum_{a}\sum_{cr} ([1.0 \times Dom_{cr,a}] \times C_{cr,a} \times P \times Cenarea_{cr,a}) \quad \text{(EQ 3)}$$

Where:

A - soil loss per unit area per year
a - ARA (Agroecological Region)
C - Crop cover and management factor
Cenarea - Estimated Census Crop Area
cr - crop type
s - soil landscape unit (SLU)
Dom and Sdom - are the RKLS factors for dominant and subdominant soils

The two constants 0.675 and 0.325 are the assumed proportions of dominant and subdominant soil in each SLU. The values for *C* by crop type were estimated by Carpentier (Carpentier, 1992).

Results and Discussion

Manitoba covers an area of roughly 450 000 km^2. Of this area approximately 77 250 km^2, or 17 percent, is agricultural land. Of this agricultural land in 1991, 47 610 km^2 or 62 percent was cropland and summerfallow. Cropland provides the foundation for most of Manitoba's diverse agricultural industry.

Agricultural soil erosion occurs primarily on cropland. Cropland that is tilled or cultivated is left unprotected from rainfall and runoff energy for substantial periods during crop growth and after harvest. Soil erosion rates vary in relation to cultivation technique and soil management. Information from the 1991 Census of Agriculture indicates that 66 percent of the area seeded in Manitoba is conventionally tilled (no measures to conserve surface residues), 29 percent of seeded area was conservation tilled (used measures to conserve surface residues), while 5 percent of seeded area used no-tillage for seed bed preparation (Trant, 1993).

Two soil erosion estimates were calculated in this study. The first is an unadjusted soil erosion rate based on changing crop distributions only. The second takes conservation measures into account, and as a result provides a better indication of actual soil erosion in 1991 (Figure 1). Unfortunately, conservation practices data were gathered only in 1991 and interpolation is required to obtain erosion values for conservation in 1986. Historical data on these practices are not available, making detailed calculations at the SLU level impossible. However, the use of conservation tillage and no-till methods did not begin in any substantial way until 1981 in Manitoba (R.G.Eilers, personal communication). Future erosion estimates will be able to incorporate census conservation data at the SLU level.

Figure 1

Gross Soil Erosion by Water - Rates, 1971 - 1991

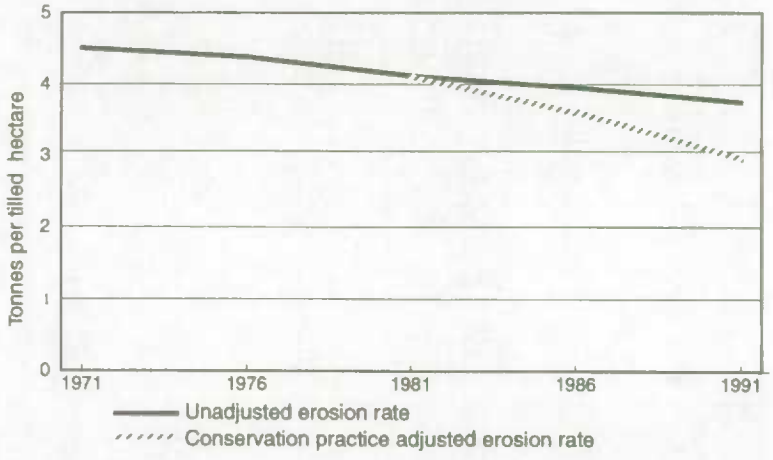
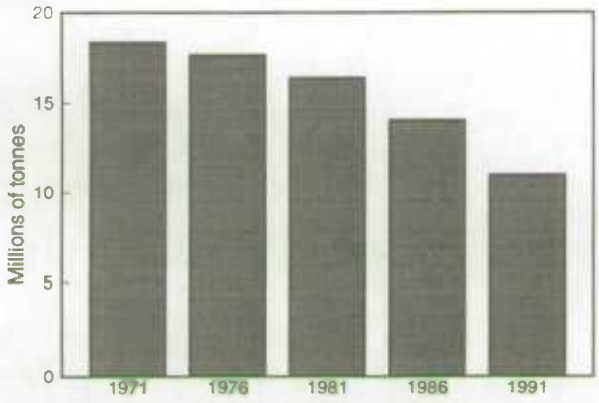


Figure 1 indicates trends in soil erosion rates since 1971. Average unadjusted erosion rates have declined from 4.5 to 3.75 tonnes per hectare on tilled land. Changing crop and summerfallow combinations have been the principal cause of this shift. Soil loss rates have generally declined as less and less land is summerfallowed and more land has been seeded with crops that protect soil surfaces. The conservation adjusted rate moved from 4.5 to 3.0 tonnes per hectare assuming negligible use of conservation practices in 1981.

Figure 2 shows the estimated decline in gross soil erosion resulting from both cropping pattern changes and the increasing use of conservation practices.

Figure 2

Gross Soil Erosion by Water, 1971 - 1991



The area of land in summerfallow declined by 72.4 percent between 1971 and 1991 (Table 3). Summerfallow erosion rates are higher than those associated with crops. Average estimated erosion rates for summerfallow consistently exceed 7 tonnes per hectare in Manitoba (Table 4). The unit area estimates represent average losses and as such do not reflect maximum or minimum erosion loss rates on given parcels of land. The gross erosion estimates for land in summerfallow, unadjusted for conservation practices, parallel the decline in summerfallow area with a 72.3 percent decrease, going from 8.2 million tonnes in 1971 down to 2.3 million tonnes by 1991 (Table 4).

Table 3

Tilled Land Areas, 1971 - 1991

Crop Type	1971	1976	1981	1986	1991	change 71-91
	thousands of hectares					percent
Barley	830	667	942	634	544	-34.4
Buckwheat	32	18	51	22	16	-51.6
Mixed grains	115	70	48	32	28	-75.8
Total oats	594	517	273	195	155	-73.8
Total rye	52	38	75	31	33	-36.4
Total wheat	1 020	1 544	1 593	1 993	2 174	113.2
Total Grain	**2 643**	**2 853**	**2 982**	**2 907**	**2 950**	**11.6**
Mustard seed	14	23	66	50	20	58.6
Flaxseed and canola	464	305	530	810	758	63.4
Soybeans	1	0	2	0	0	-90.7
Sunflowers	63	20	110	23	74	17.8
Oilseed Total	**531**	**333**	**661**	**846**	**838**	**57.8**
Silage corn	4	13	20	13	12	196.9
Grain corn	4	7	89	14	40	1 000.1
Field peas	21	15	41	58	52	151.4
Field beans	1	3	1	10	16	1 213.1
Potatoes	13	14	17	19	20	51.4
Sugar beets	13	13	12	11	11	-17.2
Vegetables	2	2	2	1	2	-20.2
Wide-row Crops	**58**	**68**	**182**	**126**	**152**	**164.1**
Summerfallow	**1 075**	**934**	**598**	**509**	**297**	**-72.4**
Total Area Tilled	**4 072**	**4 094**	**4 180**	**3 994**	**3 730**	**-8.4**

Increases in the area of grain have led to increases in total gross erosion from grain crops. Average erosion rates for grain indicate a movement of 3 to 4 tonnes of soil per hectare (Table 4). Land area in grains increased from a 1971 value of 2.64 million to 2.95 million hectares by 1991 (Table 3). Gross erosion estimates parallel this change indicating an 11.7 percent increase in soil erosion from grain crops (Table 4).

An increase in the area planted in oilseeds between 1971 and 1991 led to higher gross soil erosion estimates. In 1986, oilseed production reached a maximum in Manitoba (Table 3). More than 1.5 million tonnes, of a provincial total 17.2 million tonnes of soil erosion, occurred on land planted in oilseeds in 1981. Between 1971 and 1991 the area planted to oilseeds was estimated to have increased by 57.8 percent. At the same time erosion increased by 15.7 percent. However, estimated erosion associated with oilseeds peaked in 1981, apparently because areas planted to sunflowers, which have a high C-factor (Table1) were at a maximum.

Table 4

Gross Soil Erosion Estimates by Major Crop Type, 1971 - 1991

(Unadjusted for Conservation Practices)

Crop Type	1971	1976	1981	1986	1991	change 1971-91
	thousands of metric tonnes					percent
Barley	2 950	3 286	3 286	2 273	1 899	-35.6
Buckwheat	72	34	113	50	35	-51.0
Mixed grains	322	191	127	81	70	-78.2
Total oats	1 886	1625	896	602	457	-75.7
Total rye	174	140	250	86	100	-42.4
Total wheat	3 540	5 305	5 546	7 006	7 430	109.9
Total Grain	**8 944**	**10 580**	**10 218**	**10 098**	**9 992**	**11.7**
Average tonnes per hectare	3.38	3.71	3.43	3.47	3.39	
Mustard seed	14	23	66	50	20	42.9
Flaxseed and canola	631	597	891	1 231	709	12.4
Soybeans	3	2	10	0	0	-88.6
Sunflowers	293	116	589	116	359	22.5
Total Oilseeds	**941**	**737**	**1 556**	**1 398**	**1 089**	**15.7**
Average tonnes per hectare	3.18	3.08	3.72	3.10	3.29	
Silage corn	23	72	102	59	54	140.4
Grain corn	15	23	374	50	145	878.9
Field peas	85	61	173	246	235	175.7
Field beans	5	12	3	39	61	1 208.2
Potatoes	37	39	49	56	75	103.9
Sugar beets	43	44	39	38	37	-13.9
Vegetables	8	9	8	5	7	-15.2
Wide-row Total	**215**	**260**	**748**	**494**	**613**	**185.7**
Average tonnes per hectare	3.73	3.84	4.12	3.91	4.03	
Summerfallow	**8 229**	**7 252**	**4 714**	**3 791**	**2 283**	**-72.3**
Average tonnes per hectare	7.66	7.76	7.88	7.44	7.69	
Total Erosion	**18 329**	**17 920**	**17 236**	**15 780**	**13 978**	**-23.7**
Average tonnes per hectare	4.50	4.38	4.12	3.95	3.75	

The largest increases in estimated gross soil erosion come from the wide-row crop group. Areas planted in wide-row crops more than tripled between 1971 and 1981, while the erosion resulting from these increases went from 215 000 tonnes to more than 748 000 tonnes, an increase of 248

percent. Since 1981, the area of these crops has declined, with a similar decline in estimated erosion.

Map 2 shows estimated erosion trends by Agroecological Region. The largest declines are found in the south where they exceed 50 percent. The largest increases are found east of the Red River (1), in the Souris and Assiniboine valleys (2,3), and in the Swan River Area (4), with values in some cases exceeding 100 percent.

Map 3 shows Soil Landscape Unit polygons and calculated erosion rates (t $ha^{-1}yr^{-1}$). The 1981 census year is the only year information at this more detailed scale is available. The two largest dark shaded areas with greater than 10 tonnes per hectare erosion on cultivated land are the highly sloped Riding Mountain and Duck Mountain areas. However, only very limited agricultural activity takes place in these areas.

Map 4 indicates the general decline in unadjusted gross erosion between 1971 and 1991. Areas in the Turtle Mountain Region and Manitoba Escarpment show the greatest change, going from average values which in some cases exceeded 20 tonnes per cultivated hectare in 1971 to well under 10 tonnes per cultivated hectare by 1991.

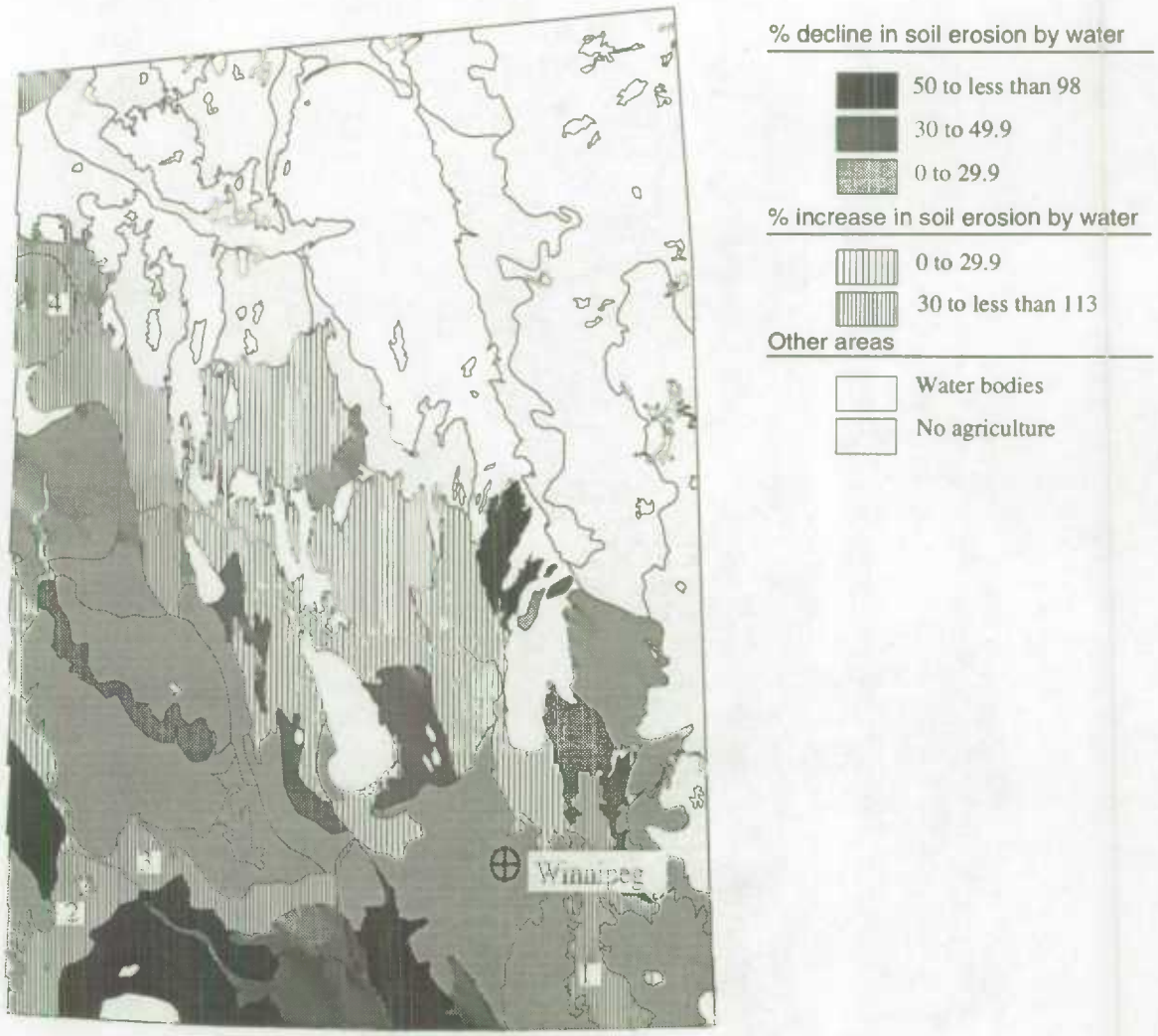
These estimates indicate significant improvement in agricultural soil erosion rates in Manitoba over the last 20 years. When combined with the effects of increasing soil conservation measures (Figures 1 and 2) these estimates become even more encouraging. However, many important questions still remain unanswered. Are these calculated loss rates sustainable for 10 years, 50 years or 100 years? How are the other provinces doing? Are there areas where erosion is still intensifying? How great an impact has soil erosion had on yield? How much land has actually been taken out of production due to soil erosion degradation? Is this land reclaimable in the future? What are the actual environmental costs of soil erosion? These and other related questions will need further investigation if agricultural sustainability is to be achieved in the years ahead.

Conclusion

Changing land management practices and crop distributions relative to slope and soil erodibility factors have considerable influence on estimated soil loss rates on farms in Manitoba. Conservation practices also have significant impacts on reducing expected soil erosion rates. Over the past 20 years changing agricultural crop distributions have reduced expected soil erosion by water by 24 percent or 4.4 million tonnes, while conservation practices may have further reduced soil erosion by an additional 16 percent or 2.9 million tonnes, for a total reduction of 40 percent or 7.3 million tonnes. These declines were achieved with a moderate 8 percent decrease in tilled area, from 4.07 million hectares in 1971 to 3.73 million hectares in 1991. While gross soil erosion by water and tilled land area declined, actual cropland area increased by 29 percent in Manitoba, going from 3.69 million hectares in 1971 to 4.76 million hectares by 1991. The difference in these values is largely the result of reduced summerfallow.

Map 2

Change in Gross Agricultural Soil Erosion on Tilled Land, 1971- 1991

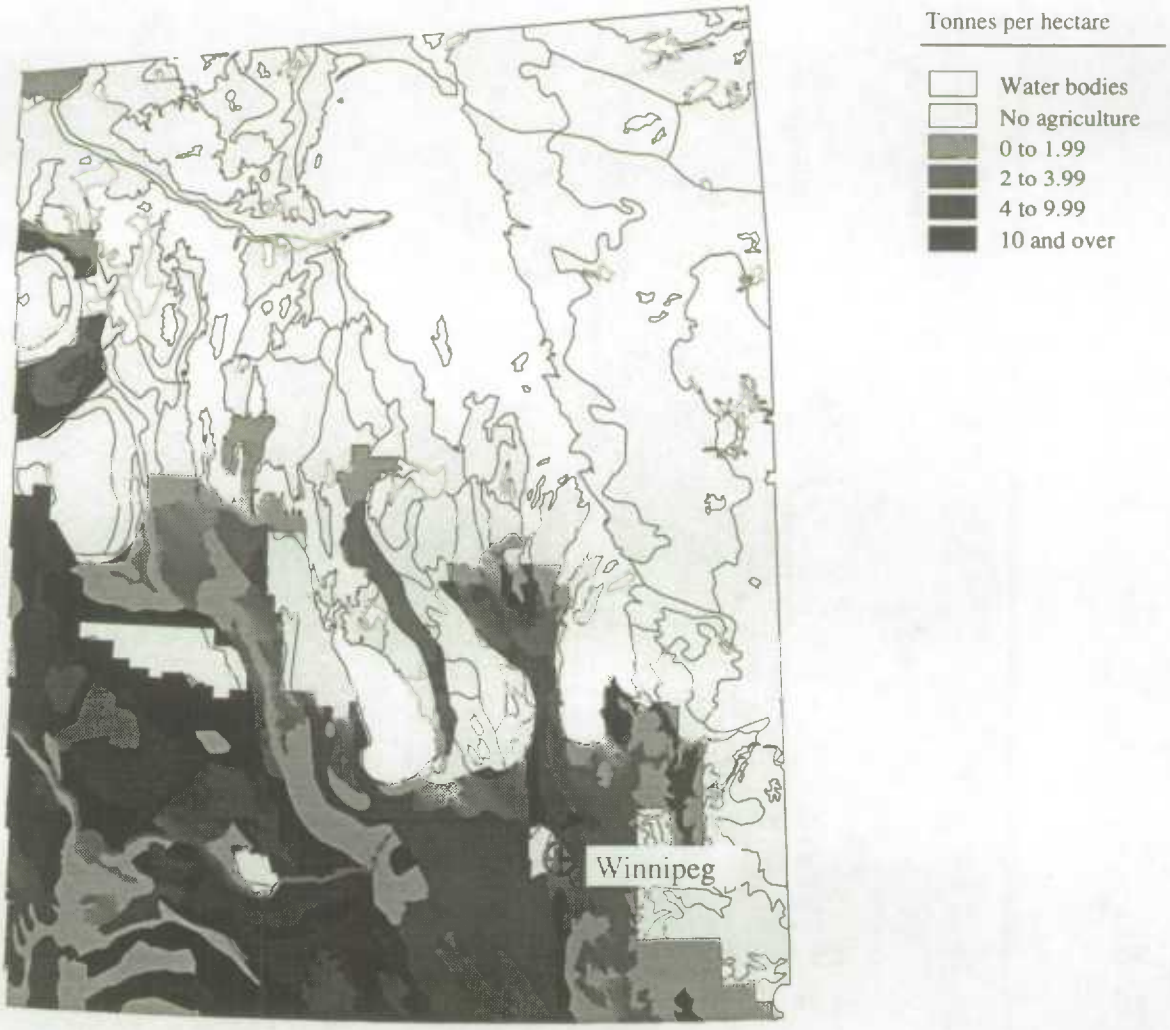


Note: Not adjusted for conservation practices.

Sources: Statistics Canada, National Accounts and Environment Division. Agriculture Canada, Centre for Land and Biological Resources Research.

Map 3

Gross Agricultural Soil Erosion by Water on Cultivated Land, 1981



Note: Not adjusted for conservation practices.

Sources: Statistics Canada, National Accounts and Environment Division. Agriculture Canada, Centre for Land and Biological Resources Research.

Map 4

Gross Agricultural Soil Erosion by Water on Cultivated Land, 1971, 1981 and 1991

Tonnes per cultivated hectare

- Water bodies
- No agriculture
- 0 to 1.99
- 2.0 to 3.99
- 4.0 to 9.99
- 10 and over

1971 – 18.33 million tonnes

1981 – 17.24 million tonnes

1991 – 13.98 million tonnes

Note: Not adjusted for conservation practices.

Sources: Statistics Canada, National Accounts and Environment Division. Agriculture Canada, Centre for Land and Biological Resources Research.

References

Carpentier, L.C. 1992. *Agriculture and Environment: An Ecological Economic Approach to the Canadian Economy*, Unpublished Masters Thesis, McGill University.

Crabb, C., 1993. "Soiling the Planet", *Discover Magazine*, January.

Dumanski, J., Coote, D.R. Luciuk, D. Lok C. 1986. "Soil Conservation in Canada", *Journal of Soil and Water Conservation*. 41:4, July-August.

Eilers, R.G. Langman M.N. and Coote D.R. 1989. *Water Erosion Risk - Manitoba*, Publication 5295-B, Agriculture Canada, Canada - Manitoba Soil Inventory, Land Resource Research Centre, Ottawa (Map and Report).

Fox, G., Weersink, A. Sarwar, G. Duff, S. and Deen, B. 1991. *Comparative Economics of Alternative Agricultural Production Systems: A Review*, New England Journal of Agriculture and Resource Economics. Vol. 20 : 124-142.

Fox, M.G., and Coote, D.R. 1986. *A Preliminary Economic Assessment of Agricultural Land Degradation in Atlantic and Central Canada and Southern British Columbia*, (for Regional Development Branch and LRRC), Development Consulting House (DCH), Contribution 85-70, Ottawa: Agriculture Canada.

Huffman, E.C. Hiley, J.C Kirkwood,V.C. and Toogood, K.E. 1993. *Assessment of Cropping Systems in Manitoba Using Agroecological Resource Regions*, Agriculture Canada, 1993.

Oldeman, L.R., Hakeling, R.T.A., and Sombroek, W.G. 1992. *World Map of The Status of Human-Induced Soil Degradation*, Global Assessment of Soil Degradation, UNEP, International Soil Reference and Information Centre, Netherlands.

Steiner F.K., 1990. *Soil Conservation in the United States*, Johns Hopkins University Press.

Trant, D. 1993. "The 1991 Census of Agriculture: Land Management for Soil Erosion Control", *Environmental Perspectives*, Statistics Canada, cat.#11-507.

Wischmeier, W.H. and Smith, D.D. 1978. *Predicting Rainfall Erosion Losses - A Guide to Conservation Planning*, Agricultural Handook #537, Washington, D.C., United States Department of Agriculture.

ENVIRONMENTAL DISCUSSION PAPERS

The National Accounts and Environment Division (NAED) has a series of discussion papers on topics in environmental statistics which users can obtain without charge. A list of the papers currently available is presented below. For copies, contact the NAED client services representative at 613-951-3640 or write to Statistics Canada, 21st Floor, R.H. Coats Building, Tunney's Pasture, Ottawa, Ontario, K1A 0T6.

DOCUMENTS DE TRAVAIL SUR L'ENVIRONNEMENT

La Division des comptes nationaux et de l'environnement (DCNE) a à sa disposition une série de documents de travail sur les statistiques environnementales que les utilisateurs peuvent obtenir sans frais. Voici la liste des documents disponibles. Pour obtenir des copies, communiquez avec la responsable des services aux clients de la DCNE (613-951-3640) ou écrire à Statistique Canada, 21e étage, édifice R.H. Coats, Tunney's Pasture, Ottawa, Ontario, K1A 0T6.

1. Hamilton, Kirk (July 989): ***Natural Resources and National Wealth.***

2. Hamilton, Kirk and Doug Trant (December 1989): ***Statistical Aspects of the Application of Geographic Information Systems in Canadian Environment Statistics***, Joumal of Official Statistics 1989, vol. 5, no. 4, pp. 337-348.

3. Smith, Robert (September 1990): ***An Annotated Bibliography of the Resource and Environmental Accounting and Valuation Literature.***

4. Gervais, Yvan (October 1990): ***Some Issues in the Development of Natural Resources Satellite Accounts: Valuation of Non-renewable Resources.***

5. Mitchell, Bruce and Kirk Hamilton (December 1990): ***Environmental Statistics at Statistics Canada,*** also available in French: ***La statistique environnementale à Statistique Canada.***

6. Mitchell, Bruce and Kirk Hamilton (May 1991): ***Canadian Experience in the Development of Environmental Surveys.***

7. Hamilton, Kirk (August 1991): ***Proposed Treatments of the Environment and Natural Resources in the National Accounts: A Critical Assessment.***

8. Hamilton, Kirk (September 1991): ***Organizing Principles for Environment Statistics.***

9. Smith, Robert (September 1991): ***The Linkage of Greenhouse Gas Emissions to Economic Activity Using an Augmented Input/Output Model.***

10. Trant, Douglas (February 1992): ***The Changing Rural Environment: A Look at Eastern Ontario's Jock River Basin.***

11. Bom, Alice (May 1992): ***Development of Natural Resource Accounts: Physical and Monetary Accounts for Crude Oil and Natural Gas Reserves in Alberta, Canada.***

12. Trant, Douglas (May 1992): ***Land Use Change Around Riding Mountain National Park.***

13. Trant, Douglas (Feb. 1994): ***Estimating Changes in Gross Agricultural Soil Erosion by Water - A Case Study for Manitoba.***

14. Smith, Philip (Feb. 1994): ***The Canadian National Accounts Environmental Component: A Status Report.***

Technical Series

The National Accounts and Environment Division (NAED) has a series of technical paper reprints, which national accounts users can obtain without charge. A list of the reprints currently available is presented below. For copies, contact the NAED client services representative at 613-951-3640 or write to Statistics Canada, 21st Floor, R.H. Coats Building, Tunney's Pasture, Ottawa, Ontario, K1A 0T6.

1. "Laspeyres, Paasche and Chain Price Indexes in the Income and Expenditure Accounts", reprinted from ***National Income and Expenditure Accounts***, fourth quarter 1988.

2. "Technical Paper on the Treatment of Grain Production in the Quarterly Income and Expenditure Accounts", reprinted from ***National Income and Expenditure Accounts***, first quarter 1989.

3. "Data Revisions for the Period 1985-1988 in the National Income and Expenditure Accounts", reprinted from ***National Income and Expenditure Accounts***, first quarter 1989.

4. "Incorporation in the Income and Expenditure Accounts of a Breakdown of Investment in Machinery and Equipment", reprinted from ***National Income and Expenditure Accounts***, third quarter 1989.

5. "New Provincial Estimates of Final Domestic Demand at Constant Prices", reprinted from ***National Income and Expenditure Accounts***, fourth quarter 1989.

6. "Real Gross Domestic Product: Sensitivity to the Choice of Base Year", reprinted from ***Canadian Economic Observer***, May 1990

7. "Data Revisions for the Period 1986-1989 in the National Income and Expenditure Accounts", reprinted from ***National Income and Expenditure Accounts***, first quarter 1990.

8. "Volume Indexes in the Income and Expenditure Accounts", reprinted from ***National Income and Expenditure Accounts***, first quarter 1990.

9. "A New Indicator of Trends in Wage Inflation", reprinted from ***Canadian Economic Observer***, September 1989.

10. "Recent Trends in Wages", reprinted from ***Perspectives on Labour and Income***, winter 1990.

11. "The Canadian System of National Accounts Vis-à-Vis The U.N. System of National Accounts", reprinted from ***National Income and Expenditure Accounts***, third quarter 1990.

12. "The Allocation of Indirect Taxes and Subsidies to Components of Final Expenditure", reprinted from ***National Income and Expenditure Accounts***, third quarter 1990.

13. "The Treatment of the GST in the Income and Expenditure Accounts", reprinted from ***National Income and Expenditure Accounts***, first quarter 1991.

14. "The Introduction of Chain Volume Indexes in the Income and Expenditure Accounts", reprinted from ***National Income and Expenditure Accounts***, first quarter 1991.

Série technique

La Division des comptes nationaux et de l'environnement (DCNE) a à sa disposition une série de tirés à part d'articles techniques, que les utilisateurs des comptes nationaux peuvent obtenir sans frais. Voice la liste des tirés à part disponibles. Pour obtenir des copies, communiquez avec la responsable des service aux clients de la DCNE (613-951-3640) ou écrire à Statistique Canada, 21e étage, édifice R.H. Coats, Tunney's Pasture, Ottawa, Ontario, K1A 0T6.

1. "Les indices de prix Laspeyres, Paasche et en chaîne dans les comptes des revenus et dépenses", tiré à part de ***Comptes nationaux des revenus et dépenses***, quatrième trimestre 1988.

2. "Document technique sur le traitement de la production de céréales dans les comptes trimestriels des revenus et dépenses", tiré à part de ***Comptes nationaux des revenus et dépenses***, premier trimestre 1989.

3. "Révision des données de la période 1985-1988 dans les comptes nationaux des revenus et dépenses", tiré à part de ***Comptes nationaux des revenus et dépenses***, premier trimestre 1989.

4. "Incorporation dans les comptes des revenus et dépenses d'une décomposition de l'investissement en machines et matériel", tiré à part de ***Comptes nationaux des revenus et dépenses***, troisième trimestre 1989.

5. "Les nouvelles estimations provinciales de la demande intérieure finale en prix constants", tiré à part de ***Comptes nationaux des revenus et dépenses***, quatrième trimestre 1989.

6. "Produit intérieur brut en termes réels: sensibilité au choix de l'année de base", tiré à part de ***l'Observateur économique canadien***, mai 1990.

7. "Révisions des données de la période 1986-1989 dans les comptes nationaux des revenus et dépenses", tiré à part de ***Comptes nationaux des revenus et dépenses***, premier trimestre 1990.

8. "Les indices de volume dans les comptes des revenus et dépenses", tiré à part de ***Comptes des revenus et dépenses***, premier trimestre 1990.

9. "Un nouvel indicateur des tendances de l'inflation par les salaires", tiré à part de ***l'Observateur économique canadien***, septembre 1989.

10. "Tendances récentes des salaires", tiré à part de ***l'Emploi et le revenu en perspective***, hiver 1990.

11. "Le système de comptabilité nationale du Canada et le système de comptabilité nationale des Nations Unies", tiré à part de ***Comptes nationaux des revenus et dépenses***, troisième trimestre 1990.

12. "La répartition des impôts indirects et des subventions aux composantes de la dépense finale", tiré à part de ***Comptes nationaux des revenus et dépenses***, troisième trimestre

13. "Le traitement de la TPS dans les comptes des revenus et dépenses", tiré à part de ***Comptes nationaux des revenus et dépenses***, premier trimestre 1991.

14. "L'introduction des indices de volume en chaîne dans les comptes des revenus et dépenses", tiré à part de ***Comptes nationaux des revenus et dépenses***, premier trimestre 1991.

Technical Series - concluded

15. "Data Revisions for the Period 1987-1990 in the National Income and Expenditure Accounts", reprinted from ***National Income and Expenditure Accounts***, second quarter 1991.

16. "Volume Estimates of International Trade in Business Services", reprinted from ***National Income and Expenditure Accounts***, third quarter 1991.

17. "The Challenge of Measurement in the National Accounts", reprinted from ***National Income and Expenditure Accounts***, fourth quarter 1991.

18. "A Study of the Flow of Consumption Services from the Stock of Consumer Goods", reprinted from ***National Income and Expenditure Accounts***, fourth quarter 1991.

19. "The Value of Household Work in Canada, 1986", reprinted from ***National Income and Expenditure Accounts***, first quarter 1992.

20. "Data Revisions for the Period 1988-1991 in the National Income and Expenditure Accounts", reprinted from ***National Income and Expenditure Accounts***, Annual Estimates, 1980-1991.

21. "Cross-border Shopping - Trends and Measurement Issues", reprinted from ***National Income and Expenditure Accounts***, third quarter 1992.

22. "Reading Government Statistics: A User's Guide", reprinted from ***Policy Options,*** Vol. 14, No. 3, April 1993.

23 "The Timeliness of Quarterly Income and Expenditure Accounts: An International Comparison", reprinted from ***National Income and Expenditure Accounts***, first quarter 1993.

24. "National Income and Expenditure Accounts: Revised Estimates for the period from 1989 to 1992", reprinted from ***National Income and Expenditure Accounts***, Annual Estimates, 1981-1992.

25. "International Price and Quantity Comparisons: Purchasing Power Parities and Real Expenditures, Canada and the United States", reprinted from ***National Income and Expenditure Accounts***, Annual Estimates, 1981-1992.

26. "The Distribution of GDP at Factor Cost by Sector", reprinted from ***National Income and Expenditure Accounts***, third quarter 1993.

27. "The Value of Household Work in Canada, 1992", reprinted from ***National Income and Expenditure Accounts***, fourth quarter 1993.

Série technique - fin

15. "Révisions des données de la période 1987-1990 dans les comptes nationaux des revenus et dépenses", tiré à part de ***Comptes nationaux des revenus et dépenses***, deuxième trimestre 1991.

16. "Estimations en volume du commerce international des services commerciaux", tiré à part de ***Comptes nationaux des revenus et dépenses***, troisième trimestre 1991.

17. "Le défi de la mesure dans les comptes nationaux", tiré à part de ***Comptes nationaux des revenus et dépenses***, quatrième trimestre 1991.

18. "Étude sur le flux des services de consommation générés par le stock de biens de consommation", tiré à part de ***Comptes nationaux des revenus et dépenses***, quatrième trimestre 1991.

19. "La valeur du travail ménager au Canada, 1986", tiré à part de ***Comptes nationaux des revenus et dépenses***, premier trimestre 1992.

20. "Révisions des données de la période 1988-1991 dans les comptes nationaux des revenus et dépenses", tiré à part de ***Comptes nationaux des revenus et dépenses***, estimations annuelles, 1980-1991.

21. "Achats outre-frontière - Tendances et mesure", tiré à part de ***Comptes nationaux des revenus et dépenses***, troisième trimestre 1992.

22. "Comment "lire" les statistiques produites par le gouvernement: un guide pratique", tiré à part de ***Options Politiques,*** Vol. 14, N° 3, Avril 1993.

23. "L'Actualité des comptes des revenus et dépenses trimestriels: une comparaison à l'échelle internationale", tiré à part de ***Comptes nationaux des revenus et dépenses***, premier trimestre 1993.

24. "Comptes nationaux des revenus et dépenses: Estimations révisées pour la période de 1989 à 1992", tiré à part de ***Comptes nationaux des revenus et dépenses***, estimations annuelles, 1981-1992.

25. "Comparaisons internationales des quantités et des prix: parités de pouvoir d'achat et dépenses réelles, Canada et États-Unis", tiré à part de ***Comptes nationaux des revenus et dépenses***, estimations annuelles, 1981-1992.

26. "La ventilation par secteur du PIB au coût des facteurs", tiré à part de ***Comptes nationaux des revenus et dépenses***, troisième trimestre 1993.

27. "La valeur du travail ménager au Canada, 1992", tiré à part de ***Comptes nationaux des revenus et dépenses***, quatrième trimestre 1993.