In : Lee, Jeffrey A. and Zobeck, Ted M., 2002, Proceedings of ICAR5/GCTE-SEN Joint Conference, International Center for Arid and Semiarid Lands Studies, Texas Tech University, Lubbock, Texas, USA Publication 02-2 p. 220

Wind Erosion Risk Assessment of Alberta Soils

G. M. Coen, Agriculture and Agri-Food Canada, Lethbridge, AB T1J 4B1
(coeng@em.agr.ca).

J. Tatarko, USDA-ARS-WERU, KSU, Manhattan, KS 66506.

T. C. Martin, Alberta Agriculture, Food and Rural Development, Edmonton, AB.

K. Cannon, Alberta Agriculture, Food and Rural Development, Edmonton, AB.

T. W. Goddard, Alberta Agriculture, Food and Rural Development, Edmonton, AB.

N. J. Sweetland, Agriculture and Agri-Food Canada, Lethbridge, AB.

Introduction

Alberta has significant agricultural acreage that is at risk to wind erosion. The recent availability of AGRASID (Agricultural Region of Alberta Soil Inventory Database), a seamless, standardized digital soil map at a scale of 1:100,000 (CAESA Soil Inventory Working Group, 1999) and hourly, geographically referenced spatial weather data (Shen et al., 2001) made this work possible. The WEPS (Wind Erosion Prediction System) is a process-based, continuous daily time step model (Wind Erosion Research Unit, 2001) which has the ability to respond to environmental and management variations to predict erosion events. With the use of the most recent data and understanding of wind erosion processes it should be possible to provide the most useful predictions. The objective of this study is to evaluate the use of available databases and the WEPS model to assess the susceptibility of Alberta agricultural soils to wind erosion risk and the degree of exposure Alberta soils experience under current management.

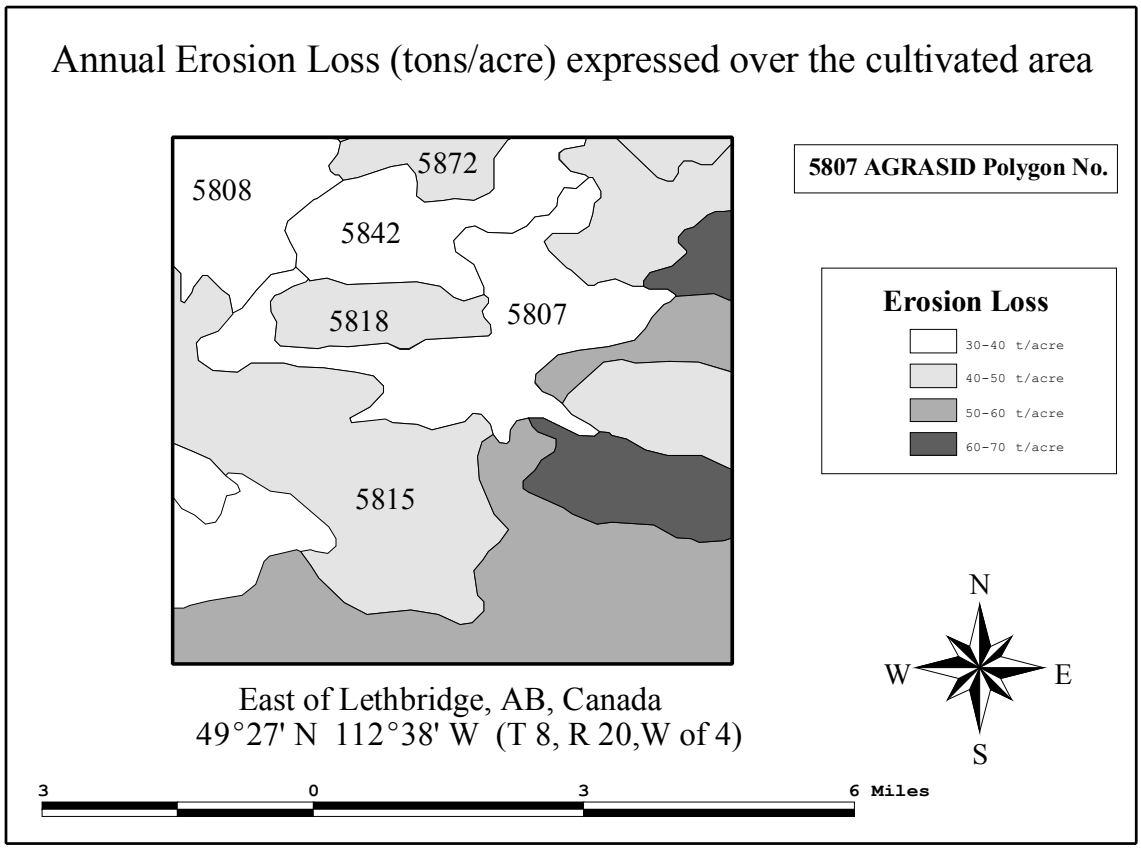
Materials and Methods

Weather files were prepared by interpolating daily weather station data to Soil Landscapes of Canada Polygons (Shen et al., 2001; Soil Inventory Staff, 1988). A survey of field management practices (Dey, 2000) supplemented by interviews with Alberta Agriculture, Food and Rural Development regional specialists was used to assign crop rotations and percentages to Ecodistrict polygons (Ecological Stratification Working Group, 1995). Soils data characterizing AGRASID polygons was prepared from the soil names and soil layer files supplemented by relationships derived from the Alberta pedon database. An unreleased version of the AGRASID file *ag30smu* (personal communication, May 2002, J.A. Brierley, Agriculture and Agri-Food Canada, 7000 - 113 Street, Edmonton, AB T6H 5T6) provides an estimate of the percent of each polygon that is occupied by a soil series. All files were formatted to meet the requirements of WEPS. The soils database is the most detailed (1:100,000), so each AGRASID polygon was assigned the same weather and management as the Soil Landscapes of Canada or

Ecodistrict polygon where the AGRASID polygon centroid was located. Each unique soil-crop rotation-weather combination was run using a batch procedure from the WEPS command line. The total erosion attributed to each soil-management combination was apportioned to the AGRASID polygon to estimate a mean loss per acre in the polygon. These values are then used to rank the erosion susceptibility of each polygon.

Results and Discussion

The WEPS 1.0 beta 8.0 release can only estimate erosion losses on a relatively homogeneous area, rectangular in shape and for a single soil type and land use. For this study a quarter section (64 ha, 160 ac) was chosen as the type situation for a WEPS run. In order to derive an estimate of erosion risk for an entire AGRASID polygon it was necessary to run WEPS for each soil type that is usually cultivated as well as the associated management files (common crop rotations) and sum their separate contributions. For the batch runs a 30(±)-year simulation was used. Total erosion was estimated (kg m^{-2}) for each combination of soil and management. For each combination, the total erosion values were then manipulated to represent the total cultivated portion of the polygon (Table 1). The average loss per ha (acre) was calculated per polygon and the result mapped (Fig. 1). The average soil loss can then be grouped into erosion risk



classes.

Figure 1. Example of an erosion susceptibility map of a Township in Alberta, Canada.

WEPS is an example of a site model that provides fairly specific information given uniform environmental and management scenarios. The methodology described here provides a procedure to extrapolate site results to soil landscapes. The resulting spatial representation is
appropriate to display at a map scale of 1:100,000. The format of the Soil Landscapes of Canada database (which is similar to many larger scale provincial soils databases, such as AGRASID) is fairly easily modified to match the requirements of WEPS. Some data required by WEPS is not part of these databases and must be derived from various other databases and relationships. The weather database was prepared from the Environment Canada weather records (Shen et al.) 2001 to meet the requirements of WEPS and WEPP; a significant effort but now available for continued application.

The methodology will allow temporal comparison of crop rotations used in the future with those used at present or with past management procedures thereby providing an opportunity to evaluate environmental sustainability. It will also allow a more spatially precise evaluation of the inherent wind erosion susceptibility of Alberta soils than previously published (Coote and Pettapiece, 1989; Padbury and Stushnoff, 2000).

References

CAESA Soil Inventory Working Group. 1999. AGRASID: Agricultural Region of Alberta soils Inventory Database. Edited by J.A. Brierley, B.D. Walker, P.E. Smith and W.L. Nikiforuk. Distributed by Publications Office, Alberta Agriculture Food and Rural Development, Edmonton. CD-ROM. http://www.agric.gov.ab.ca/agdex/000/agrasid.html

Coote, D.R. and W.W. Pettapiece. 1989. Wind erosion risk, Alberta. Agriculture Canada publication 5255/B. 12p, tables, maps.

Dey, D. 2000. Survey of Field Management Practices. AESA Soil Quality Program, Conservation and Development Branch, Alberta Agriculture, Food and Rural Development.

Ecological Stratification Working Group. 1995. A national ecological framework for Canada. Agriculture and Agri-Food Canada, Research Branch, Centre for Land and Biological Resources Research and Environment Canada, State of the Environment Directorate, Ecozone Analyses Branch, Ottawa/Hull. Report and national map at 1:7,500,000 scale. http://sis.agr.gc.ca/cansis/nsdb/ecostrat/

Padbury G. and C. Stushnoff. 2000. Risk of wind erosion. In Environmental sustainability of Canadian Agriculture, McRae, T., C.A.S. Smith and L.J. Gregorich, eds. Publications Section, Agriculture and Agri-Food Canada, Sir John Carling Bldg., Ottawa, ON. Public Works and Government Services Catalog No. A22-201/2000E.

Shen, S.S.P., P. Dzikowski, G. Li, and D. Griffith. 2001. Interpolation of 1961-97 daily temperature and precipitation data onto Alberta polygons of Ecodistrict and Soil Landscapes of Canada. J. Appl. Meteor. 40: 2162 - 2176.

Soil Inventory Staff. 1988. Soil landscapes of Canada: Alberta. Land Resource Research Centre, Ottawa. Agriculture Canada Publication 5237/B. Available in GIS format from CanSIS NSDB http://sis.agr.gc.ca/cansis/nsdb/slc/index.html .

Wind Erosion Research Unit. 2001. The wind erosion prediction system, WEPS 1.0 user manual. USDA - ARS Wind Erosion Research Unit, Manhattan, KS 66506. http://www.weru.ksu.edu/weps .

Table 1. Example of a calculation of predicted soil loss for each AGRASID polygon based on the sum of losses from each soil-crop rotation combination.

AGRASID Polygon No.	Polygon Area ha	Polygon Area ac	% Cult	Soil* Symbol	Soil/ Crop %	Crop Rotation Symb**	Crop Rotation %	Crop %	Erosion Loss# kg m^{-2}	Erosion Loss# t/ac	Tot Soil Loss In Cult Area+ tonnes	Tot Soil Loss In Cult Area+ tons	Mean Loss In Cult Area++ kg m^{-2}	Mean Loss In Cult Area++ t/ac
5807	1263	3121	72	KSR	30	pwcb	50	15	1.1	5	1825	2012		
5807	1263	3121	72	KSR	30	wfcb	50	15	13.2	59	22470	24774		
5807	1263	3121	72	LET	30	pwcb	50	15	0.7	3	1103	1216		
5807	1263	3121	72	LET	30	wfcb	50	15	14.9	66	25208	27792		
5807	1263	3121	72	OAS	10	pwcb	50	5	0.6	3	317	349		
5807	1263	3121	72	OAS	10	wfcb	50	5	12.2	54	6894	7601		
5807	1263	3121	72	RDM	10	pwcb	50	5	2.8	13	1610	1775		
5807	1263	3121	72	RDM	10	wfcb	50	5	28.6	128	16184	17844		
5807	1263	3121	72	ZERzdb	10	pwcb	50	5	0.5	2	na	na		
5807	1263	3121	72	ZERzdb	10	wfcb	50	5	10.3	46	na	na		
5807	1263	3121	72	ZGW	10	pwcb	50	5	74.3	331	na	na		
5807	1263	3121	72	ZGW	10	wfcb	50	5	255.3	1139	na	na		
									Mean Erosion of Polygon				**8.4**	**37**
5808	964	2382	85	KSR	10	pwcb	50	5	1.1	5	553	610		
5808	964	2382	85	KSR	10	wfcb	50	5	13.2	59	6810	7508		
5808	964	2382	85	LET	60	pwcb	50	30	0.7	3	2005	2211		
5808	964	2382	85	LET	60	wfcb	50	30	14.9	66	45838	50538		
5808	964	2382	85	OAS	10	pwcb	50	5	0.6	3	288	318		
5808	964	2382	85	OAS	10	wfcb	50	5	12.2	54	6268	6911		
5808	964	2382	85	ZERzdb	10	pwcb	50	5	0.5	2	na	na		
5808	964	2382	85	ZERzdb	10	wfcb	50	5	10.3	46	na	na		
5808	964	2382	85	ZGW	10	pwcb	50	5	74.3	331	na	na		
5808	964	2382	85	ZGW	10	wfcb	50	5	255.3	1139	na	na		
									Mean Erosion of Polygon				**7.5**	**34**
5815	2084	5149	83	LET	40	pwcb	50	20	0.7	3	2255	2486		
5815	2084	5149	83	LET	40	wfcb	50	20	14.9	66	51552	56838		
5815	2084	5149	83	RDM	20	pwcb	50	10	2.8	13	4938	5444		
5815	2084	5149	83	RDM	20	wfcb	50	10	28.6	128	49647	54738		
5815	2084	5149	83	WNY	40	pwcb	50	20	2.3	10	7931	8744		
5815	2084	5149	83	WNY	40	wfcb	50	20	20.7	92	71691	79042		
									Mean Erosion of Polygon				**10.8**	**48**
5818	388	959	86	LET	50	pwcb	50	25	0.7	3	541	596		
5818	388	959	86	LET	50	wfcb	50	25	14.9	66	12363	13631		
5818	388	959	86	WNY	50	pwcb	50	25	2.3	10	1902	2097		
5818	388	959	86	WNY	50	wfcb	50	25	20.7	92	17193	18956		
									Mean Erosion of Polygon				**9.7**	**43**
5842	807	1994	88	KSR	10	pwcb	50	5	1.1	5	425	469		
5842	807	1994	88	KSR	10	wfcb	50	5	13.2	59	5236	5773		
5842	807	1994	88	LET	10	pwcb	50	5	0.7	3	257	283		
5842	807	1994	88	LET	10	wfcb	50	5	14.9	66	5874	6476		
5842	807	1994	88	RDM	35	pwcb	50	18	2.8	13	3938	4342		
5842	807	1994	88	RDM	35	wfcb	50	18	28.6	128	39599	43660		
5842	807	1994	88	WNY	35	pwcb	50	18	2.3	10	3163	3487		
5842	807	1994	88	WNY	35	wfcb	50	18	2.1	9	2853	3145		
5842	807	1994	88	ZERzdb	10	pwcb	50	5	0.5	2	na	na		
5842	807	1994	88	ZERzdb	10	wfcb	50	5	10.3	46	na	na		
									Mean Erosion of Polygon				**8.6**	**38**
5872	493	1218	100	LET	20	pwcb	50	10	0.7	3	320	353		
5872	493	1218	100	LET	20	wfcb	50	10	14.9	66	7317	8067		
5872	493	1218	100	WNY	80	pwcb	50	40	2.3	10	4503	4965		
5872	493	1218	100	WNY	80	wfcb	50	40	20.7	92	40702	44875		
									Mean Erosion of Polygon				**10.7**	**48**

* Soil symbols beginning with 'Z' were considered to belong to the uncultivated portion of the polygon.

** Crop rotation symbol: pwcb = peas/wheat/canola/barley, wfcb = wheat/fallow/canola/barley.

Rate of erosion on the portion of the polygon where the given soil/crop rotation occurs.

+ Total estimated soil loss associated with the soil/crop rotation combination in the selected AGRASID polygon.

++ The mean erosion rate for the cultivated portion of the AGRASID polygon.