POTENTIAL SOIL EROSION ADOPTION RATES OF THE LAKE HURON WATERSHED WITHIN THE ST. CLAIR REGION CONSERVATION AUTHORITY

Mapping Methodology

Alison Seidler
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Required Data

Table 1. Data Required for Potential Soil Erosion Adoption Rates Analysis

Title	Use	Source
Southern Ontario Land Resource Information System (SOLRIS) 3.0	Define permanent cover	Ministry of Natural Resources and Forestry
Crop Rotations in Canada	Define crop rotations	Agriculture and Agri-Food Canada
Inherent Water Erosion Risk	Define soil erosion potential	Ontario Ministry of Agriculture, Food and Rural Affairs

Soil Erosion Potential

Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA) provided Inherent Water Erosion Risk mapping for the Lake Huron Basin. The Inherent Water Erosion Risk mapping is composed of three of the five factors in the Universal Soil Loss Equation (USLE), R the rainfall and runoff factor, K the soil erodibility factor, and LS the slope length factor.

The USLE equation is calculated as,

$A = R \times K \times LS \times C \times P$

where A is the potential long-term average annual soil loss, R is the rainfall runoff factor, K is the soil erodibility factor, LS is the slope length factor, C is the crop/vegetation and management factor, and P is support practice factor (Stone and Hilborn, 2012).

Agriculture and Agri-Food Canada (AAFC) developed potential soil erosion classes based on tolerable soil loss rates (Wall et al. 1997). **Table 2** presents the five potential soil erosion classes developed by AAFC, as well as BMP recommendations to address potential soil erosion in each class.

Table 2. AAFC Potential Soil Erosion Classes (Wall et al. 1997)

Soil Erosion Class	Description
Severe	Severe soil losses will occur unless a soil cover of permanent vegetation is maintained. Potential soil erosion losses are greater than 33 tonnes/hectare/year (>15 tons/acre/year).
High	High soil losses will occur unless measures such as zero tillage, sod-based rotations, terraces, cross slope or contour strip cropping are employed. Potential soil erosion losses range from 22 to 33 tonnes/hectare/year (10 - 15 tons/acre/year).
Moderate	Moderate to high soil losses will occur unless conservation measures such as conservation tillage, contour cropping, and grass waterways are used. Potential soil erosion losses range from 11 to 22 tonnes/hectare/year (5 - 10 tons/acre/year).
Low	Low to moderate soil losses will occur without the use of crop rotations and cross slope farming. Potential soil erosion losses range from 6 to 11 tonnes/hectare/year (3 - 5 tons/acre/year).
Very Low	Soils in this class have very slight to no erosion potential. Minimal erosion problems should occur if good soil conservation management methods are used. Long-term sustainable productivity should be maintainable under average management practices. Potential soil erosion loss for this class is less than 6 tonnes/hectare/year (<3 tons/acre/year)

The Inherent Water Erosion Risk mapping provided by OMAFRA was reclassified into the five potential soil erosion classes developed by AAFC. A sixth, No Data class was also used in the reclassification because the Inherent Water Erosion Risk mapping provided by OMAFRA does not contain data over watercourses, bottomlands, and built-up areas.

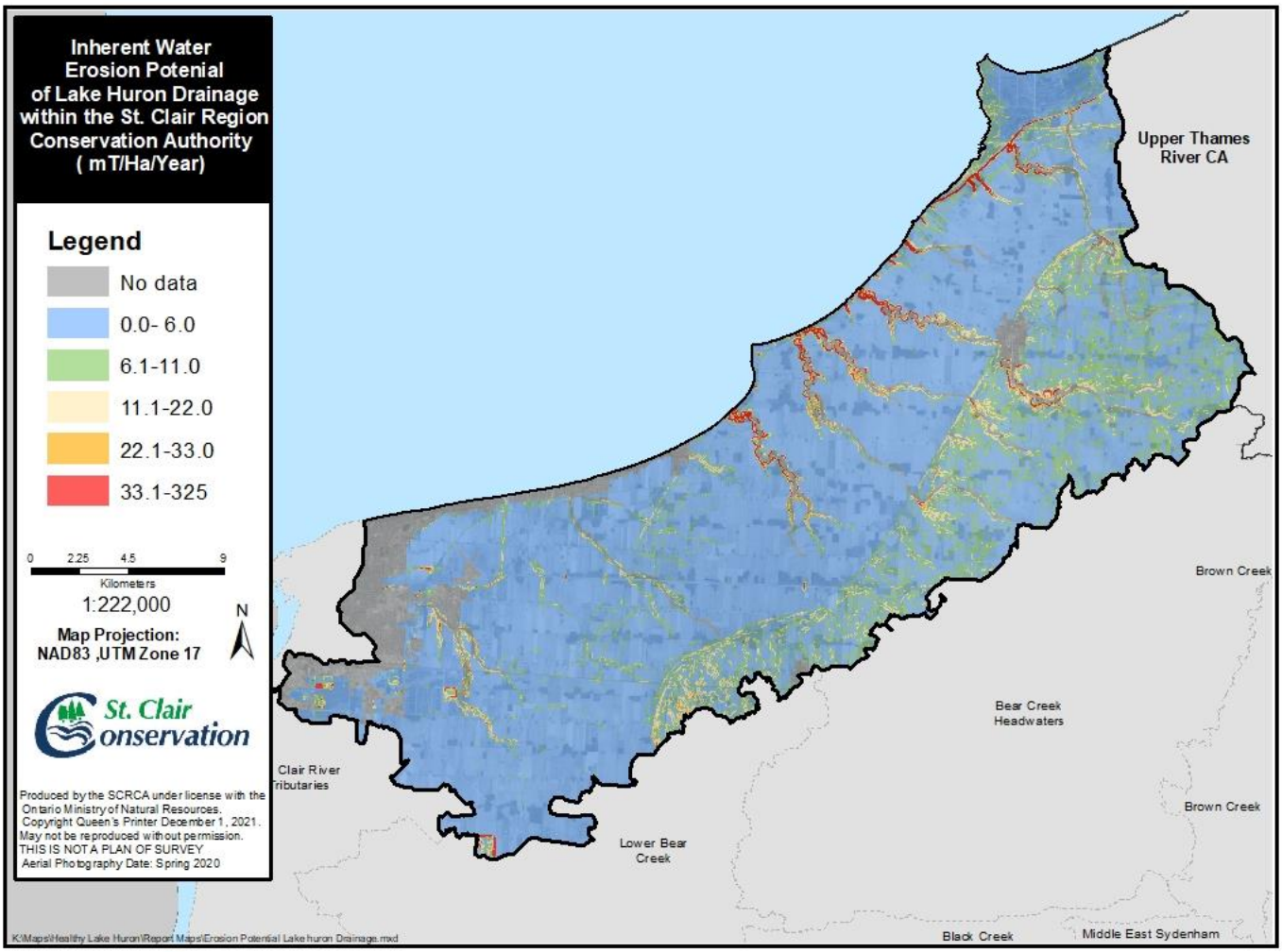
The reclassified potential soil erosion dataset was used to determine how much land area is within each potential soil erosion class. This analysis can be used to identify priority locations for different types of BMPs, as described in **Table 2**. This analysis was done at three scales, the Lake Huron basin scale, the Conservation Authority watershed scale, and the sub-watershed scale.

Table 3 presents the precent land area in each potential soil erosion class within the St. Clair Region Conservation Authority. **Figure 1**. presents the potential soil erosion map of the St. Clair Conservation Authority classified by the five AAFC potential soil erosion classes.

Table 3. Potential Soil Erosion Classes of the Lake Huron Watershed within the St. Clair Region Conservation Authority.

Erosion Potential Class	Land in Erosion Class	
	Acres	%
Severe (>33 t/ha/yr)	1,541	1.0
High (22-33 t/ha/yr)	1,139	0.7
Moderate (11-22 t/ha/yr)	6,158	3.9
Low (6-11 t/ha/yr)	20,657	13.3
Very Low (<6 t/ha/yr)	113,665	72.9
No Data	12,731	8.17
Total	155,890	100

Figure 1. Potential Soil Erosion Map of the Lake Huron Drainage for the St. Clair Region CA



Permanent Cover Adoption Rate

The amount of land under permanent cover in each potential erosion class was analysed to estimate an adoption rate of permanent cover. Moreover, this analysis could also be used to target locations where permanent cover BMP should be promoted.

Permanent cover was defined with Southern Ontario Land Resource Information System (SOLRIS) version 3 and AAFC 2016-2019 Crop Rotations in Canada dataset. SOLRIS was used to define natural cover, such as forests and wetlands, and AAFC 2016-2019 Crop Rotation dataset was used to define pasturelands. Pasturelands are considered permanent cover because the soil maintains cover. SOLRIS was used to define natural cover because not all Conservation Authorities have their own natural heritage maps.

The classes representing natural cover (i.e., classes 11-192) were extracted from SOLRIS. Similarly, the class representing pasture for all years of the 2016-2019 crop rotation (i.e., class 793) was extracted from AAFC 2016-2019 Crop Rotation dataset. These two layers were then combined to define permanent cover, by first erasing any overlap and then merging.

The adoption rate of permanent cover was determined by intersecting the permanent cover layer with the potential soil erosion layer to determine how much of each erosion class is under permanent cover. **Table 4** presents the adoption rate of permanent cover across the potential soil erosion classes within the Lake Huron Basin within the St. Clair Region Conservation Authority.

Table 4. Erosion Potential Classes - Permanent Cover Adoption Rate of the St. Clair Region Conservation Authority

Erosion Potential Class	Land in Erosion Class		Land in Permanent Cover	
	Acres	%	Acres	%
Severe (>33 t/ha/yr)	1,541	1.0	910	59
High (22-33 t/ha/yr)	1,139	0.7	417	37
Moderate (11-22 t/ha/yr)	6,158	3.9	1389	23
Low (6-11 t/ha/yr)	20,657	13.3	3057	15
Very Low (<6 t/ha/yr)	113,665	72.9	15114	13
No Data	12,731	8.17	1744	14
Total	155,890	100	22630	15

Land in Agriculture

The amount of agricultural land in each erosion potential class was calculated to determine the percent of agricultural land in each erosion class. Agricultural land was defined with the AAFC 2016-2019 Crop Rotation dataset, as rotations that contain agricultural land-uses for all 4 years of rotation. The classification of agricultural land-uses and non-agricultural land-uses is presented in **Table 5**.

Table 5. Agricultural and Non-Agricultural Land-use Classification of the AAFC Crop Rotation Classes

	AAFC Crop Rotation Classes
Agricultural Land-use	Agriculture (undifferentiated), Barley, Beans, Berries, Blueberry, Canola and Rapeseed, Corn, Fallow, Ginseng, Hops, Nursery, Oats, Orchards, Other Berry, Other Crops, Other Fruits, Other Vegetables, Pasture and Forages, Peas, Potatoes, Rye, Sod, Soybeans, Spelt, Spring Wheat, Sugarbeets, Sunflower, Tobacco, Tomatoes, Vineyards, Winter Wheat
Non-Agricultural Land-use	Broadleaf, Coniferous, Exposed Land and Barren, Grassland, Greenhouses, Mixedwood, Shrubland, Too Wet to be Seeded, Urban and Developed, Water, Wetland

The area of agricultural land within each erosion potential class was determined by intersecting the agricultural land layer with the potential soil erosion layer. **Table 6** presents the area of agricultural land within each erosion potential class for the St. Clair Region Conservation Authority.

Table 6. Erosion potential classes and the area and percentage of agricultural land within each erosion class for the St. Clair Region Conservation Authority

Erosion Potential Class	Land in Erosion Class		Land in Permanent Cover		Land in Agriculture	
	Acres	%	Acres	%	Acres	%
Severe (>33 t/ha/yr)	1,541	1.0	910	59	407	26
High (22-33 t/ha/yr)	1,139	0.7	417	37	592	52
Moderate (11-22 t/ha/yr)	6,158	3.9	1389	23	4,167	68
Low (6-11 t/ha/yr)	20,657	13.3	3057	15	15,726	76
Very Low (<6 t/ha/yr)	113,665	72.9	15114	13	89,436	79
No Data	12,731	8.17	1744	14	2,653	21
Total	155,890	100	22630	15	112,980	72

Note: 'Land in Permanent Cover' and 'Land in Agriculture' have been defined using different datasets (i.e., SOLRIS and AAFC 2016-2019 Crop Rotations, respectively) and thus cannot be summed to determine 'Land in Erosion Class'.

3+ Crop Rotation Adoption Rate

The amount of land in each erosion class that is in a 3+ crop rotation was analysed to estimate an adoption rate of 3+ crop rotation. 3+ crop rotation is defined as a rotation with three or more crop families or three or more years being perennial crops across a four-year rotation. To expand upon the 3+ crop rotation analysis, land in a rotation with 3+ crop families and land in a rotation with 3+ years of

pasture/forages will also be analyzed to better understand the distribution of pasture/forage rotations across the Lake Huron basin. The AAFC 2016-2019 Crop Rotation dataset was used to define crop rotations for this analysis. **Table 7** presents the crop family definitions used for the 3+ crop rotation analysis, including whether they are perennial or not.

Table 7. Crop Family Definitions used for the 3+ Crop Rotation Adoption Rates Analysis.

Crop Family	Perennial?	Crops
Broadleaf Legumes	No	Soybeans, Edible Beans, Peas
Broadleaf Non-Legumes	No	Winter Canola, Spring Canola
Warm Season Grasses	No	Corn, Sweet Corn, Silage Corn
Cool Season Grasses	No	Winter Wheat, Cereals, Oats, Barley, Spring Wheat, Rye, Spelt
Mixture of Hay/Pasture	Yes	Pasture/Forages
Perennial Specialty Crops	Yes	Berries, Ginseng, Hops, Nursery, Orchard, Vineyards
Annual Specialty Crops	No	Potatoes, Sugarbeets, Sunflower, Tobacco, Tomatoes

The 2016-2019 Crop Rotation dataset was clipped to each Conservation Authority and the resultant attribute table was exported to Excel for further analysis. First, any rotations that contained non-agricultural land-uses (i.e., Shrubland or Coniferous) for any year of rotation were removed from the analysis (see **Land in Agriculture** section above). Second, crops were classified into crop families and crop rotations were evaluated as '3+ Crop Families' if there were 3 or more crop families across the 4-year rotation. Third, crops were defined as either pasture/forages or not and crop rotations were evaluated as '3+ Years of Pasture/Forages' if 3 or more years of the 4-year rotation were pasture/forages. Fourth, crops were defined as either perennial or not and crop rotations were evaluated as '3+ Years Non-Forage Perennial' if there were 3 or more years of perennial non-forage crops, such as fruits or orchards.

The 3+ crop definitions were joined back to the 2016-2019 Crop Rotation dataset and the area of '3+ Crop Families', '3+ Years of Pasture/Forages', and '3+ Years Non-Forage Perennial' within each erosion potential class was determined by intersecting the 3+ crop layer with the potential soil erosion layer. '3+ Crop Rotation' was calculated as the sum of '3+ Crop Families', '3+ Years of Pasture/Forages', and '3+ Years Non-Forage Perennial'. **Table 8** presents the adoption rate of '3+ Crop Rotation', '3+ Crop Families', '3+ Years of Pasture/Forages', and '3+ Years Non-Forage Perennial' across the potential soil erosion classes within the St. Clair Region Conservation Authority.

Table 8. Erosion Potential Classes – 3+ Crop Rotation Adoption Rate of the St. Clair Region Conservation Authority

Erosion Potential Class	Land in Erosion Class		Land in Agriculture		Agricultural Land in 3+ Crop Rotation		Agricultural Land in Rotation with 3+ Crop Families		Agricultural Land in Land in Rotation with 3+ Pasture/Forages		Agricultural Land in Rotation with 3+ Years Non Forage Perennial Crops	
	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%
Severe (>33 t/ha/yr)	1,541	1.0	407	26	287	70	142	35	144	35	0.00	0.0
High (22-33 t/ha/yr)	1,139	0.7	592	52	358	61	202	34	156	26	0.36	0.1
Moderate (11-22 t/ha/yr)	6,158	3.9	4,167	68	2,289	55	1640	39	643	15	5.70	0.1
Low (6-11 t/ha/yr)	20,657	13.3	15,726	76	7,541	48	6322	40	1,206	8	13.30	0.1
Very Low (<6 t/ha/yr)	113,665	72.9	89,436	79	42,160	47	37767	42	4,387	5	6.44	0.0
No Data	12,731	8.17	2,653	21	1,537	58	874	33	663	25	0.00	0.0
Sum/Percent	155,890	100	112,980	72	54,171	48	46947	42	7,200	6	25.80	0.0

Issues Encountered and Next Steps

SOLRIS was used to define permanent cover because not all Conservation Authorities maintain a natural heritage layer. The accuracy of the permanent cover adoption rates analysis could likely be improved if all Conservation Authorities had their own natural heritage layer to define permanent cover.

The adoption rates of additional BMPs could be analyzed using the methodology described above. For instance, the amount of land with spring green cover within each potential soil erosion class could be analyzed to estimate the adoption rate of spring green cover. However, currently there are no datasets available that define spring green cover, and additional resources would be required to develop such a dataset.

References

Wall G.J., Coote D.R., Pringle E.A., Shelton I.J. (1997) RUSLEFAC Revised Universal Soil Loss Equation for Application in Canada. A handbook for Estimating Soil Loss from Water Erosion in Canada. Agriculture and Agri-Food Canada.

Stone R. P., and Hilborn D. (2012) Universal Soil Loss Equation (USLE) Factsheet. OMAFRA. Accessed from: http://www.omafra.gov.on.ca/english/engineer/facts/12-051.htm on 2021-06-14