

Supplementary Materials

1. Sediment Delivery Ratio (SDR)

We extracted sediment delivery ratio factors, including crop cover factor (usle_c) and management practice factor (usle_p) from various sources. We used default values for Borselli IC_0 and k_b , and maximum SDR parameters as suggested by Sharp et al., (2016). We set a threshold flow accumulation to 1,111, which is the number of 30m-cells in a 1 km² contributing watershed [1]. Most of the usle_p factors are set to 1, meaning conventional tillage is applied. Those in grass/pasture and switchgrass are set to 0.25, meaning no-tillage [2].

Table S1. InVEST parameter values for the sediment delivery ratio (SDR) mode: biophysical table. Column headings follow naming conventions in Sharp et al. (2016)

LULC	lucode	usle_c	usle_p	References
Soybeans	1	0.37	1	[3]
Corn	2	0.48	1	[3], [4]
Grass/Pasture	3	0.1	0.25	[2], [5]
Wetlands	4	0.0001	1	[6]
Urban	5	0.03	1	[5]
Forest	6	0.002	1	[4]
Alfalfa	7	0.026	1	[4]
Open Water	8	0.0001	1	[4]
Fallow/Idle Cropland	9	0.59	1	[3]
Small grain	10	0.5	1	[4]
Shrubland	11	0.04	1	[4]
Sorghum	13	0.25	1	[5]
Background	14	1	1	[4]
Sod/Grass Seed	15	0.1	1	[4]
Switchgrass	16	0.004	0.25	[2], [4]
Apples	17	0.12	1	[4]
Nodata	128	0	1	[6]

2. Annual water yield model

We derived most K_c coefficients based on the K_c calculator provided by InVEST. The K_c is calculated using monthly average potential evapotranspiration (mm/month), growth stage/phenology of vegetation in each month, and monthly average K_c coefficients. If K_c is not available, we used a method based on Angus (1987) and Kristensen (1974) [1]. To define the Z parameter, we followed Xu et al. (2013), with ω ranged from 2.7 - 3.1. So, we used the Z parameter equal to 6. Depth of restrictive, plant-available content and average precipitation layers are derived from the USDA/NRCS database. The root depth of each vegetation type is extracted from the FAO Report No. 56 [7]. Where root depths are not available in this report, we used values from a similar plant. To calculate K_c of Forest and Switchgrass, we used equation $K_c = (1 - \exp(-0.7 \cdot (LAI)))$ [1], where LAI is an average leaf area index. LAI of the forest in the Midwest range from 3-5 and LAI of switchgrass is 6 [8].

Table S2. InVEST parameter values for the annual water yield model: biophysical table. Column headings follow naming conventions in Sharp et al. (2016)

lucode	LULC_desc	LULC_veg	root_depth	K _c	References
1	Soybeans	1	1300	0.729	[1], [7]
2	Corn	1	1200	0.602	[1], [7]
3	Grass/Pasture	1	3700	0.844	[1], [7]
4	Wetlands	0	500	0.774	[1], [7]
5	Urban	0	500	0.56	[1], [7]
6	Forest	1	2900	0.95	[1], [9]
7	Alfalfa	1	2000	0.736	[1], [7]
8	Open Water	0	500	0.192	[1], [7]
9	Fallow/Idle Cropland	1	1000	0.704	[1], [7]
10	Small grain	1	1500	0.753	[1], [7]
11	Shrubland	1	5100	0.55	[1], [7]
13	Sorghum	1	2000	0.753	[1], [7]
14	Background	0	500	0.5	[1], [7]
15	Sod/Grass Seed	1	1000	0.844	[1], [9]
16	Switchgrass	1	3700	0.78	[1], [9]
17	Apples	1	1500	1.2	[1], [9]
128	NoData	0	500	0	[1], [7]

3. Carbon storage

While above-ground and below-ground biomass data of most crops are well documented, finding woody debris or carbon from dead biomass (c_{dead}) values is a challenge. As IPCC (2006), most of the crops' c_{dead} is set at 0, unless documented. We derived wetlands, forest, and shrubland c_{dead} from William H. S. (1977). Above-ground and below-ground carbon coefficients are calculated from above-ground/below-ground biomass as IPCC (2006, 2019) guideline. We did not calculate carbon sequestration since we only compared carbon storage between different land use land cover types.

Table S3. InVEST parameter values for the carbon storage model: biophysical carbon table. Column headings follow naming conventions in Sharp et al. (2016)

lucode	LULC_Name	c_above	c_below	c_soil	c_dead	References
1	Soybeans	3.67	1.11	91.62	0	[10]–[12]
2	Corn	9.27	1.11	93.18	0	[11], [12]
3	Grass/Pasture	6	2.16	49.3	5	[13], [14]
4	Wetlands	7.9	5.8	117	803	[13], [14]
5	Urban	1.45	0.38	82	0	[15]
6	Forest	31.9	10	91.5	118	[13], [14], [16]
7	Alfalfa	1.42	0.37	21.27	0	[13], [17]
8	Open Water	0	0	90.2	0	[1]
9	Fallow/Idle Cropland	5.3	1.27	46.3	0	[13], [18]
10	Small grain	5.57	0.22	111.42	0	[12], [19]
11	Shrubland	2.8	8.2	38.3	69	[13], [14]
13	Sorghum	6.48	1.55	130.3	0	[12], [20]

lucode	LULC_Name	c_above	c_below	c_soil	c_dead	References
14	Background	0	0	0	0	[1]
15	Sod/Grass Seed	3.4	2.16	46.3	0	[13]
16	Switchgrass	9	6.6	80	0	[21]
17	Apples	6.4	1.92	62	0	[18], [22], [23]
128	NoData	0	0	0	0	[1]

4. Data preparation

Apart from biological and physical tables, we derived most of the spatial data from USDA/NRCS with a 30 m resolution. The reference evapotranspiration data was downloaded from the CGIAR database with 30 arc-second resolution. Table 5 describes the spatial datasets used in InVEST models.

Table S4. Spatial data sources used in the InVEST models.

Models	Dataset	Data source	Spatial resolution	Year	Data processing notes
All	Land cover		30m	2011	Reclassified
Annual Water	Precipitation	USDA	30m	1980 – 2010	
Annual water	Reference evapotranspiration	Consultative Group on International Agricultural Research (CGIAR) Global Aridity and Potential Evapotranspiration database	30 arc-seconds	1970-200	
Annual water	Plant available water fraction	NRCS (https://landscape11.arcgis.com/arcgis/)	30m	2019	Derived from SSURGO II database using SDV6.2
Annual water	Depth to root restricting layer	USDA/NRCS	30m	2017	Derived from SSURGO II database using SDV6.2
Annual water and Sediment delivery ratio	Watershed HUC 8	USDA-NRCS (http://pubs.usgs.gov/tm/11/a3/).	Polygon		
SDR	Rainfall erosivity Index	USGS https://water.usgs.gov/lookup/getspatial?nh_d_rfact30	30m	2010	
SDR	Soil erodibility index	NRCS	30m	2019	
SDR	DEM	USDA/NRCS	30m	2010	Void Filled

REFERENCES

- [1] R. Sharp *et al.*, "InVEST +VERSION+ user's guide. The Natural Capital Project, Stanford University, University of Minnesota, The Nature Conservancy, and World Wildlife Fund." Stanford University, 2016, Accessed: Apr. 04, 2020. [Online]. Available: <http://data.naturalcapitalproject.org/nightly-build/invest-users-guide/html/index.html>.
- [2] Onafra, "Universal soil loss equation (USLE)." Ministry of Agriculture, Food and Rural Affairs, CANADA, 2010.
- [3] Michigan State University, "Technical Guide to RUSLE use in Michigan: section I-C. State-wide WATER-31AT.3T to 34WW.60," Institute of Water Research, 2002. [Online]. Available: <http://www.iwr.msu.edu/rusle/cfactor.htm>.
- [4] Wischmeier, W.h and Smith, D.D, "A guide to Conservation Planning. US Department of Agriculture, Agricultural Handbook No. 537." US Gov. Print. Office, Washington, DC., Dec. 1978, Accessed: Jun. 24, 2020. [Online].
- [5] R. Benavidez, B. Jackson, D. Maxwell, and K. Norton, "A review of the (Revised) Universal Soil Loss Equation ((R)USLE): with a view to increasing its global applicability and improving soil loss estimates," *Hydrol. Earth Syst. Sci.*, vol. 22, no. 11, pp. 6059–6086, Nov. 2018, doi: 10.5194/hess-22-6059-2018.
- [6] K. J. Bagstad *et al.*, "Towards ecosystem accounts for Rwanda: Tracking 25 years of change in flows and potential supply of ecosystem services," *People Nat.*, vol. 2, no. 1, pp. 163–188, Oct. 2019, doi: 10.1002/pan3.10062.
- [7] Richard G. Allen, Luis S. Pereira, Dirk Raes, and Martin Smith, "FAO Irrigation and Drainage Paper No. 56 - Crop Evapotranspiration (guidelines for computing crop water requirements)," 1998.
- [8] C. M. Gough, P. S. Curtis, B. S. Hardiman, C. M. Scheuermann, and B. Bond-Lamberty, "Disturbance, complexity, and succession of net ecosystem production in North America's temperate deciduous forests," *Ecosphere*, vol. 7, no. 6, Jun. 2016, doi: 10.1002/ecs2.1375.
- [9] J. Canadell, R. B. Jackson, J. B. Ehleringer, H. A. Mooney, O. E. Sala, and E.-D. Schulze, "Maximum rooting depth of vegetation types at the global scale," *Oecologia*, vol. 108, no. 4, pp. 583–595, Dec. 1996, doi: 10.1007/BF00329030.
- [10] J. E. Sawyer, "Nitrogen Fertilizer and Swine Manure Application to Soybean," in *Proceedings of the Integrated Crop Management Conference*, Dec. 2001, p. 11977127, doi: 10.31274/icm-180809-700.
- [11] M. Z. Liebman, M. E. Jarchow, R. N. Dietzel, and D. N. Sundberg, "Above- and Below-ground Biomass Production in Corn and Prairie Bioenergy Cropping Systems," Iowa State University, Digital Repository, Ames, 5753141, 2014. doi: 10.31274/farmprogressreports-180814-1814.
- [12] NRCS-USDA, "Soil organic carbon," Jun. 2006. [Online]. Available: https://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/technical/nra/ceap/pub/?cid=nracs143_014128.
- [13] S. A. Spawn, T. J. Lark, and H. K. Gibbs, "Carbon emissions from cropland expansion in the United States," *Environ. Res. Lett.*, vol. 14, no. 4, p. 045009, Apr. 2019, doi: 10.1088/1748-9326/ab0399.
- [14] William H. Schlesinger, "Carbon Balance in Terrestrial Detritus," *Ann Rev Ecol Syst* 1977, vol. 81, p. 8:51, 1977.
- [15] R. Pouyat, P. Groffman, I. Yesilonis, and L. Hernandez, "Soil carbon pools and fluxes in urban ecosystems," *Environ. Pollut.*, vol. 116, pp. S107–S118, Mar. 2002, doi: 10.1016/S0269-7491(01)00263-9.
- [16] J. E. Smith, L. S. Heath, K. E. Skog, and R. A. Birdsey, "Methods for calculating forest ecosystem and harvested carbon with standard estimates for forest types of the United States," U.S. Department of Agriculture, Forest Service, Northeastern Research Station, Newtown Square, PA, NE-GTR-343, 2006. doi: 10.2737/NE-GTR-343.
- [17] R. Ghimire, J. B. Norton, and E. Pendall, "Alfalfa-grass biomass, soil organic carbon, and total nitrogen under different management approaches in an irrigated agroecosystem," *Plant Soil*, vol. 374, no. 1–2, pp. 173–184, Jan. 2014, doi: 10.1007/s11104-013-1854-2.

- [18] IPCC, "Agriculture, Forestry and Other Land Use - Chapter 5: Cropland," 2019.
- [19] S. Patel, J. E. Sawyer, J. P. Lundvall, and J. Hall, "Root and shoot biomass and nutrient composition in a winter rye cover crop," . *Vol.*, vol. 31, p. 8.
- [20] C. E. Shoemaker and D. I. Bransby, "Chapter 9 The Role of Sorghum as a Bioenergy Feedstock," p. 11.
- [21] L. Wang, Y. L. Qian, J. Brummer, S. J. Wilhelm, and J. E. Leach, "Biomass Production and Soil Carbon Analysis of Switchgrass under Rainfed or Minimal Irrigation in a Semiarid Environment," *Agron. J.*, vol. 111, no. 4, pp. 1704–1711, Jul. 2019, doi: 10.2134/agronj2018.09.0568.
- [22] R. M. Gentile *et al.*, "Quantifying the potential contribution of soil carbon to orchard carbon footprints," *Acta Hortic.*, no. 1112, pp. 461–466, Mar. 2016, doi: 10.17660/ActaHortic.2016.1112.62.
- [23] Katalin Juhos and László Dr. Tőkei, "Carbon content of the biomass of vineyards and orchards in Hungary. An assessment based on large-scale field measurements, case studies and expert judgement." Corvinus University of Budapest, Hungary, 2012.