remote sensing

The Applicability of LandTrendr to Surface Water Dynamics: A Case Study of Minnesota from 1984 to 2019 using Google Earth Engine

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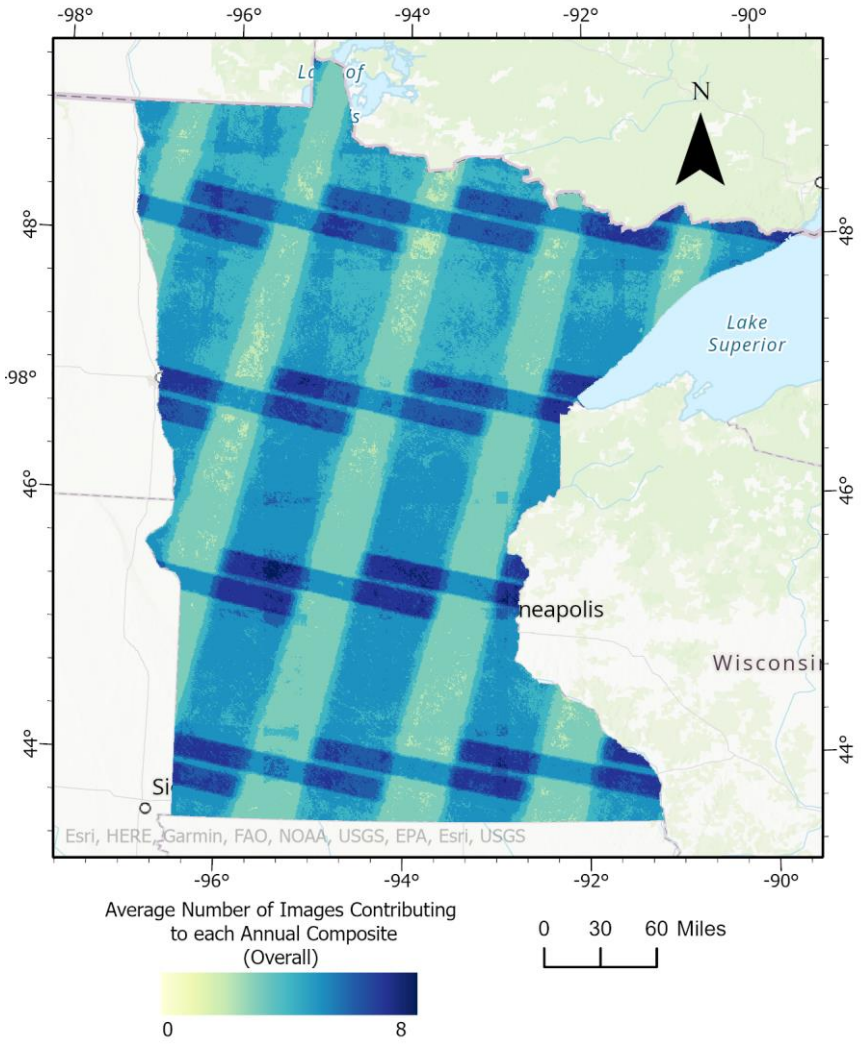
Contents:

1. Number of images contributing to the time series:

A satellite image time series from 1984 to 2019 was created in Google Earth Engine to characterize surface water change over time. Images were compiled from Tier 1 catalogs of Landsat 4 ETM, Landsat 5 ETM, Landsat 7 ETM+, Landsat 8 OLI, and Sentinel-2 MSI surface reflectance. For each year, images over the state of Minnesota were selected between the calendar dates of May 1st and June 30th and masked for snow, cloud, cirrus, cloud shadow, saturated pixels, and impervious surface. Each satellite catalog used covers different subsets of the total time series, therefore, the number of images contributing to each annual composite varies each year. Annual composites are sparsest from the 1980s to 2000, with the average number of images contributing to the composite ranging from 0 to 8. The average number of images contributing to the composites increase in the 2000s and 2010s, ranging from 0 to 11 and 0 to 14, respectively. Throughout the time series, the average number of images contributing to the annual composite is 4 (Supplementary Figure S1).



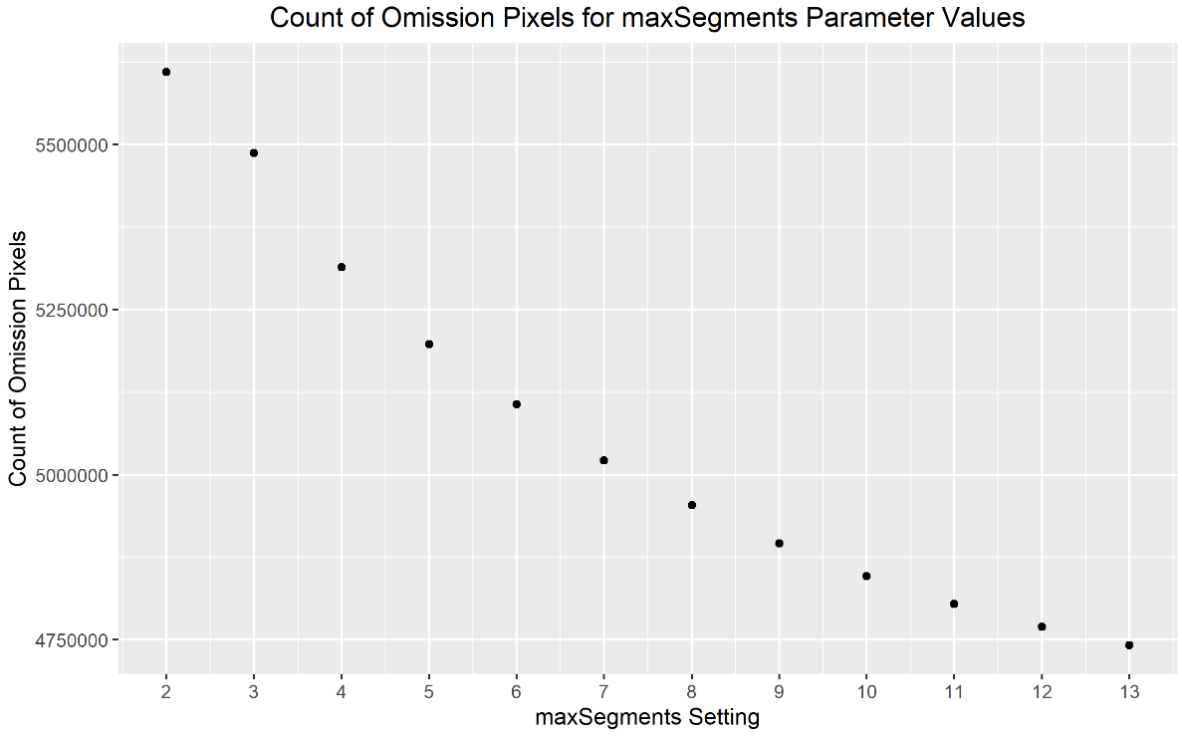
Supplementary Figure S1: The average number of images contributing to each annual composite. The number of images contributing to each year's annual composite are variable depending on the number of satellites collecting images in that year. This leads to annual composites being 'sparser' or 'thicker' depending on the number of cloud-free pixels over a location in a given year. Most pixels average four images per annual composite, but averages range from two to eight.

2. Parameter selection for the LandTrendr algorithm:

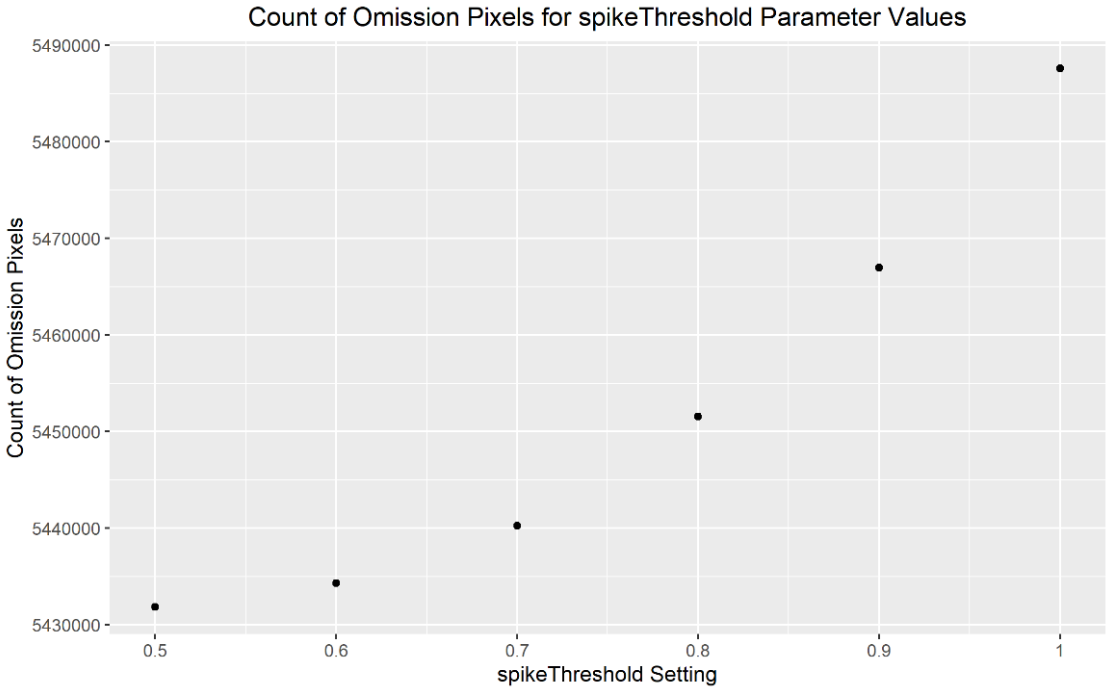
To ensure accurate segmentation of surface water dynamics in Minnesota over time, the parameters for LandTrendr were optimized by systematically varying their values. A parameter value was considered optimal if, of among the range of values tested, it minimized omission of known surface water locations. Known surface water locations were based on Minnesota's updated National Wetlands Inventory (NWI): NWI water regime classes semi-permanently flooded (F), intermittently exposed (G), or permanently flooded (H). If a 30 m pixel expected to be inundated according to the NWI did not have at least 50% predicted SWF for the majority of the years between 2008 and 2015, it was considered omission. The range of values tested, and the value used when another variable was being tested are listed in Supplementary Table S1. The count of omission pixels at different parameter settings used to decide the optimal parameter value are listed in Supplementary Figures S2–S7

Supplementary Table S1: Parameter settings used for optimizing LandTrendr. These settings were used while systematically varying one of the parameters to identify the optimal setting. For example, to identify the optimal *maxSegments* parameter, a LandTrendr model was fit with each *maxSegments* value in the range of all values tested, while all other parameters are set at the baseline value as below. LandTrendr parameters without a range of values tested (*preventOneYearRecovery*, *minObsNeeded*) were not optimized.

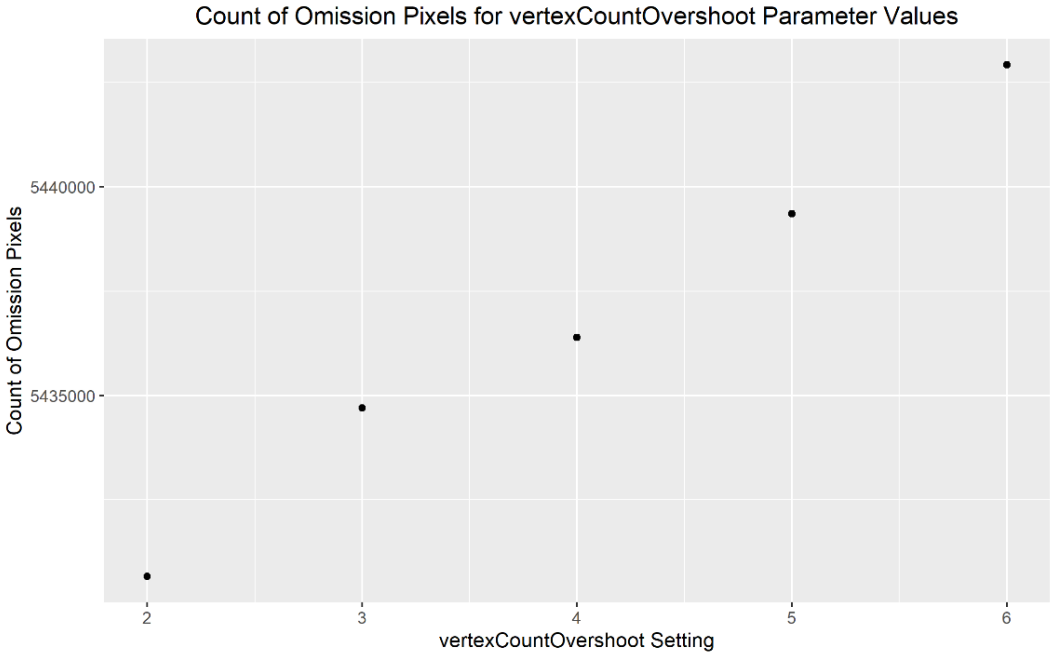
Parameter:	Range of Values Tested:	Baseline Value:
Maximum Segments (*maxSegments*)	2, 3, 4, 5, 6, 7 ,8, 9, 10, 11, 12, 13	3
Spike Threshold (*spikeThreshold*)	0.5, 0.6 ,0.7, 0.8, 0.9, 1.0	1.0
Vertex Count Overshoot *(vertexCountOvershoot*)	2, 3, 4, 5, 6	3
Prevent One Year Recovery (*preventOneYearRecovery*)	-	False
Recovery Threshold (*recoveryThreshold)*	0.1,0.25,0.5,0.75,1,2,5],	1
P-value Threshold (*pvalThreshold*)	0.025, 0.0375, 0.05, 0.0625, 0.075, 0.1	0.05
Best Model Proportion (*bestModelProportion*)	0.5, 0.75, 1.0, 1.25, 1.5	1
Minimum Number of Observations Needed (*minObsNeeded*)	-	3



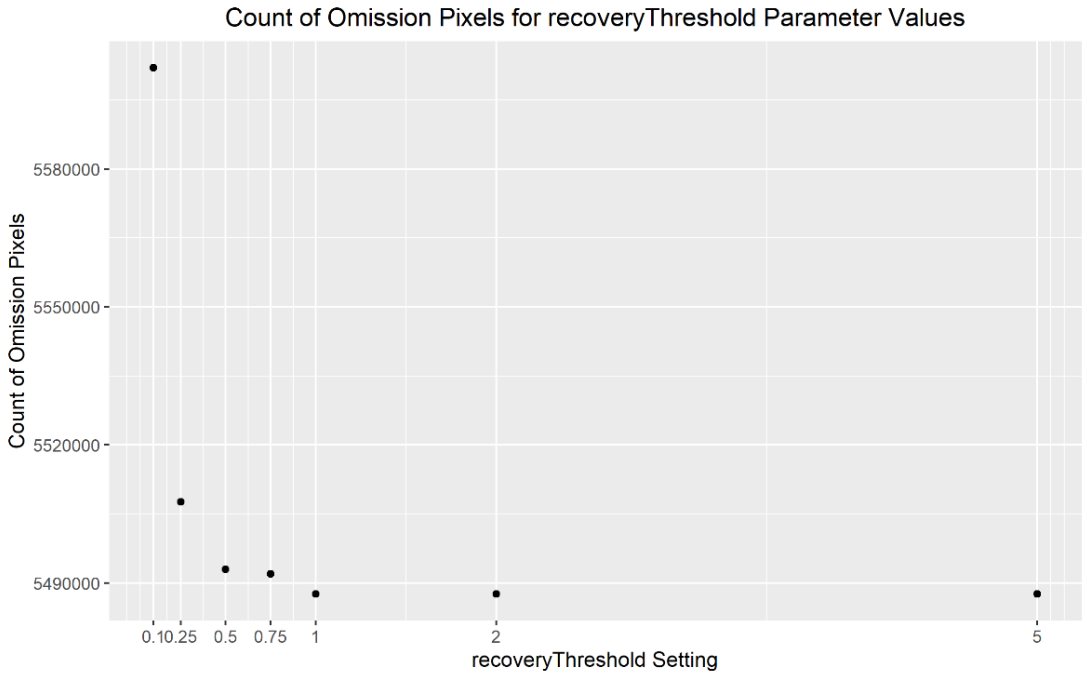
Supplementary Figure S2: Parameter selection chart for the *maxSegments* parameter. The count of known surface water pixels (according to the National Wetlands Inventory) omitted by LandTrendr with the *maxSegments* parameter at a given value. *MaxSegments* = 11 was chosen as the optimal parameter to minimize omission and time required to fit the model.



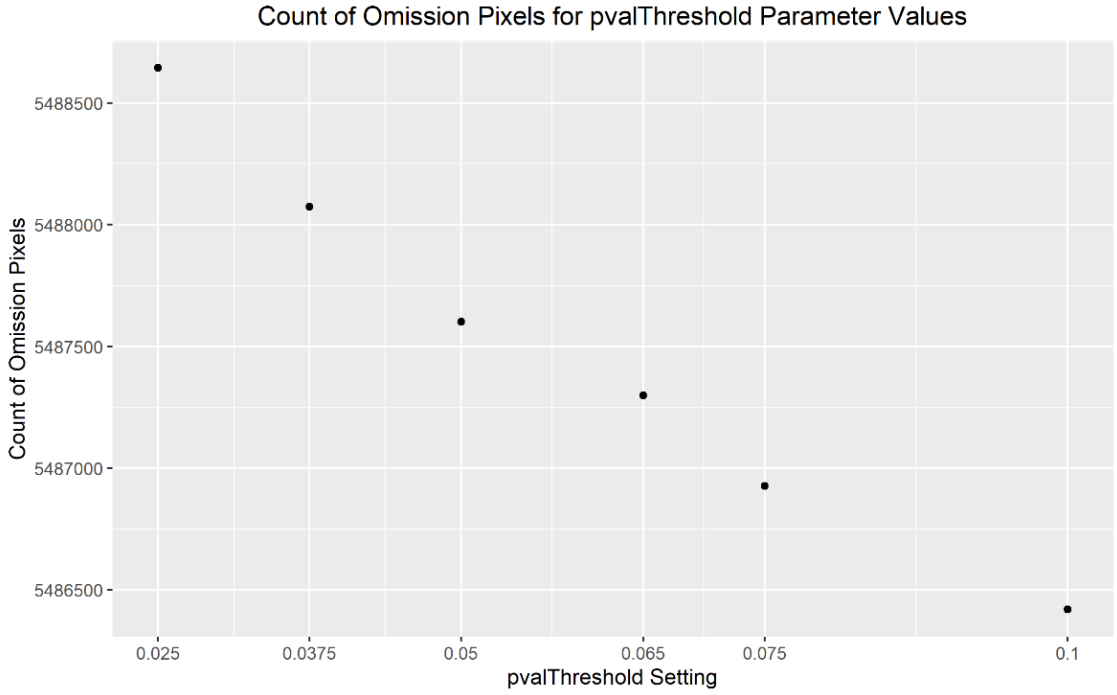
Supplementary Figure S3: Parameter selection chart for the *spikeThreshold* parameter. The count of known surface water pixels (according to the National Wetlands Inventory) omitted by LandTrendr with the *spikeThreshold* parameter at a given value. *SpikeThreshold* = 0.5 was chosen as the optimal parameter to minimize omission.



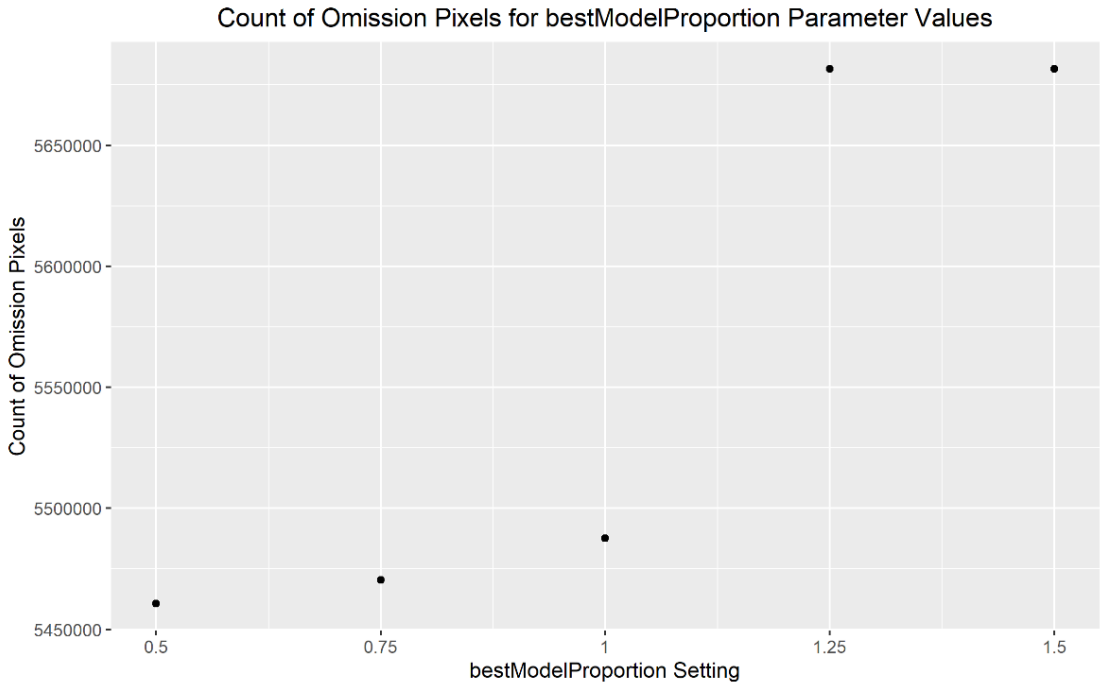
Supplementary Figure S4: Parameter selection chart for the *vertexCountOvershoot* parameter. The count of known surface water pixels (according to the National Wetlands Inventory) omitted by LandTrendr with the *vertexCountOvershoot* parameter at a given value. *VertexCountOvershoot* = 2 was chosen as the optimal parameter to minimize omission.



Supplementary Figure S5: Parameter selection chart for the *recoveryThreshold* parameter. The count of known surface water pixels (according to the National Wetlands Inventory) omitted by LandTrendr with the *recoveryThreshold* parameter at a given value. *RecoveryThreshold* = 0.25 was chosen as the optimal parameter to minimize omission.



Supplementary Figure S6: Parameter selection chart for the *pvalThreshold* parameter. The count of known surface water pixels (according to the National Wetlands Inventory) omitted by LandTrendr with the *pvalThreshold* parameter at a given value. *pvalThreshold* = 0.1 was chosen as the optimal parameter to minimize omission.



Supplementary Figure S7: Parameter selection chart for the *bestModelProportion* parameter. The count of known surface water pixels (according to the National Wetlands Inventory) omitted by LandTrendr with the *bestModelProportion* parameter at a given value. *bestModelProportion* = 1 was chosen as the optimal parameter to minimize omission.