Supporting Information for

Seasonal variation in landcover estimates reveals sensitivities and opportunities for environmental models

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Introduction

This supporting information includes supplementary tables and figures from the study. These include diagrams of the modeling approach, background landcover and study area information, model parameters, and the landcover lookup table for the SWAT model.

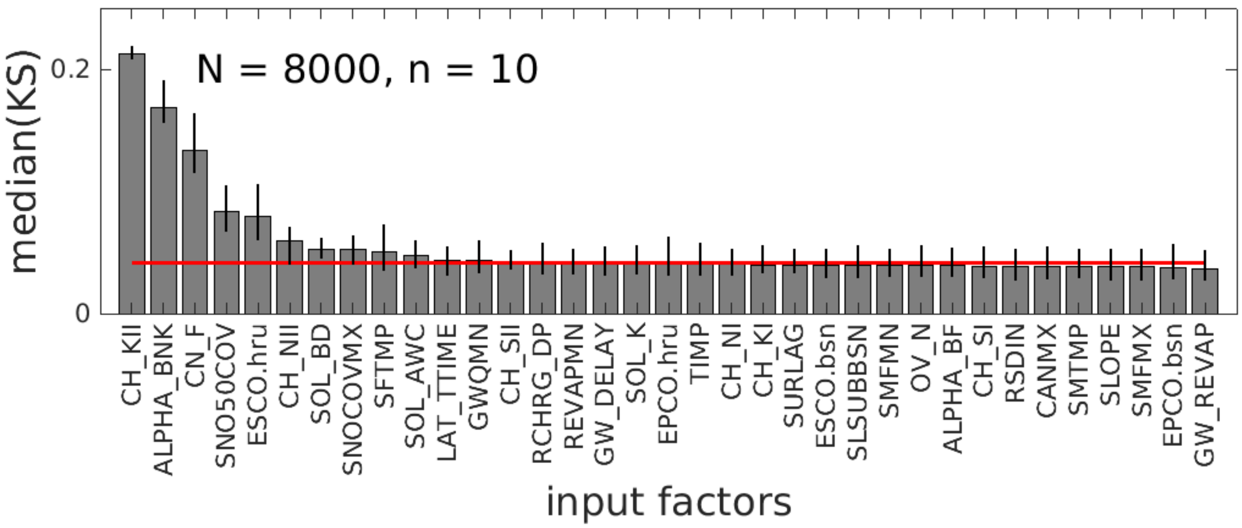

Figure S1. PAWN sensitivity analysis results ranking the SWAT parameters from most to least sensitive, using 8,000 samples (N) and conditioning intervals (n) of 10. The red line is the "dummy" parameter and bars are 95% confidence intervals. KS: Kolmogorov-Smirnov statistic. Higher median KS indicates higher sensitivity of SWAT model streamflow output to the parameter.

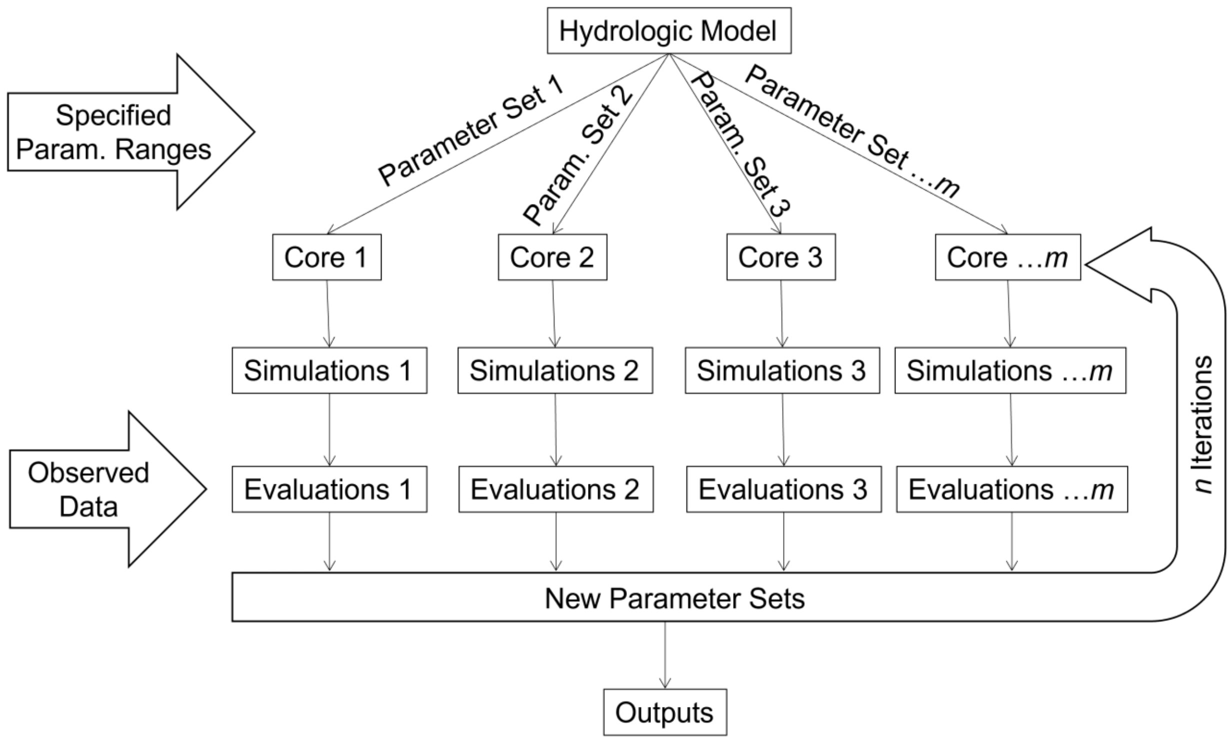

Figure S2. Flowchart of the AMALGAM calibration approach used in this study. Parameter sets are randomly generated within specified reasonable ranges of parameter values. Then, hydrologic models are distributed among multiple computer processing cores, simulations are run, and outputs are evaluated for performance against observed streamflow data. The algorithm learns from these outputs and generates new sets of parameter values. This process is iterated and optimal parameter sets are identified based on model evaluations.

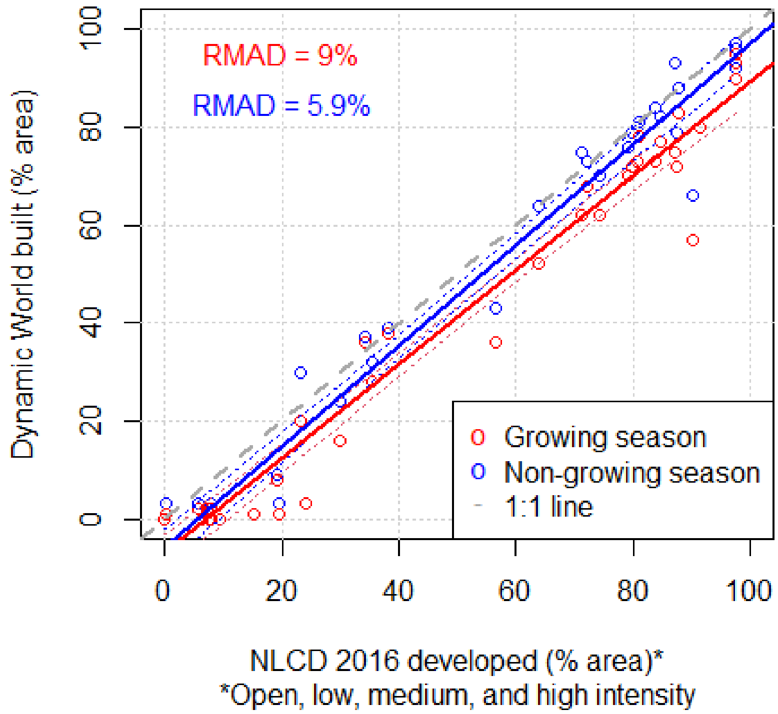

Figure S3. Comparison of Dynamic World 2016 built class and National Land Cover Database (NLCD) developed classes as proportions of watershed area for the 37 currently monitored study watersheds, with 95% confidence intervals as dotted lines. RMAD: Relative mean absolute difference.

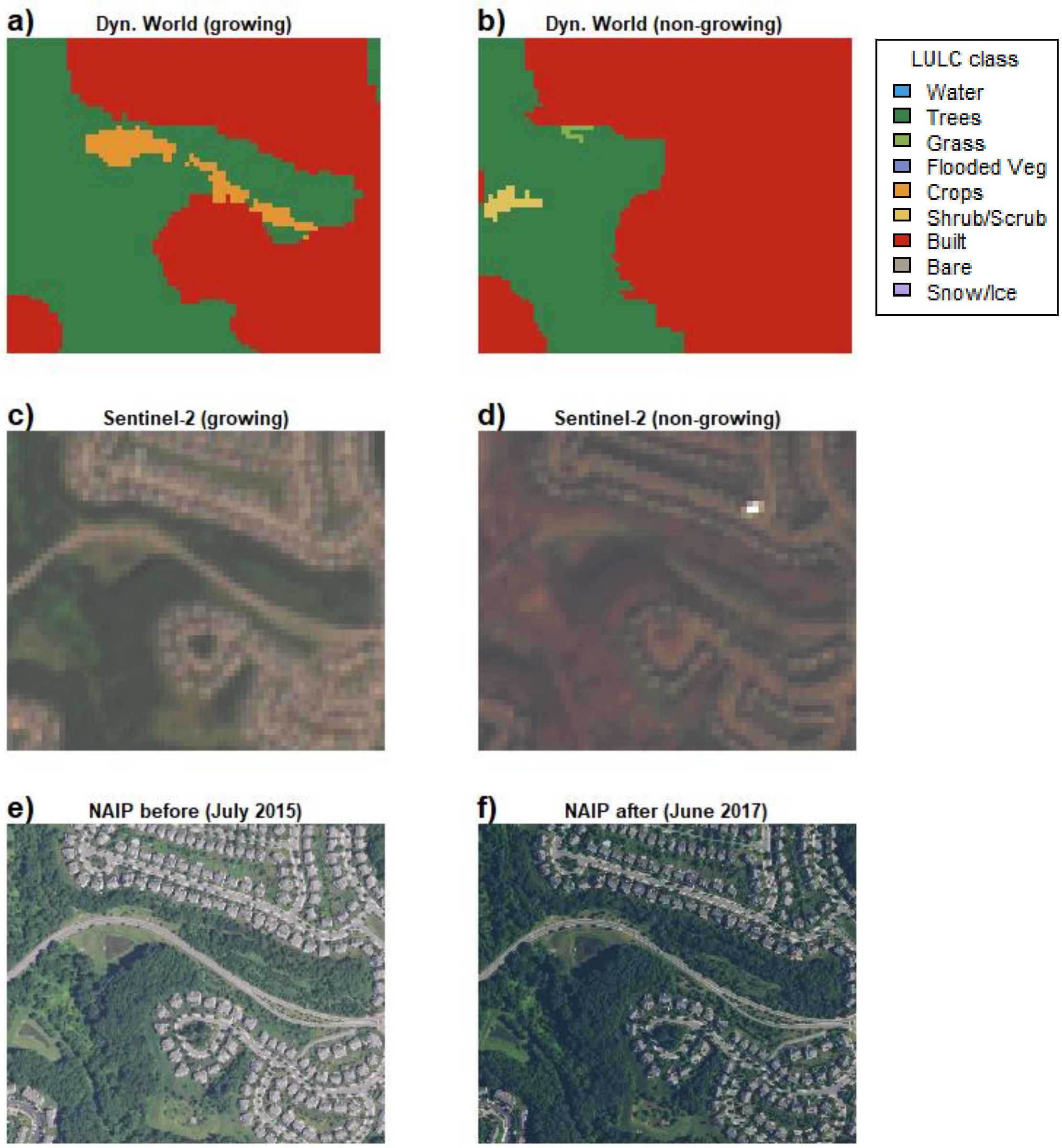

Figure S4. Visual comparison of LULC classification in a mixed landuse area of Maryland, USA showing (a,b) differences in Dynamic World data between growing (spring equinox 2016 to autumn equinox 2016) and non-growing (autumn equinox 2015 to spring equinox 2016) seasons. (c,d) Sentinel-2 imagery examples for growing (20 July, 2016) and non-growing (23 November, 2015) seasons. And, (e,f) before-and-after images from the National Agriculture Imagery Program (NAIP).

Table S1. Datasets and sources used in model development and comparison. USGS: United States Geological Survey. NOAA: United States National Oceanic and Atmospheric Administration.

Dataset	Source	Citation
LULC	Dynamic World	(Brown et al., 2022)
LULC	National Landcover Database 2016	(Jin et al., 2019)
Specific conductance	National Capital Region Network	(Norris et al., 2011)
Watersheds	USGS Streamstats and Whitebox Tools	(Lindsay, 2022; Ries et al., 2017)
Elevation	3DEP 30 m DEM	(Sugarbaker et al., 2014)
Soils	Global Soil Database	(Abbaspour et al., 2019)
Streams	WWF HydroSHEDS	(Lehner et al., 2006)
Daily precipitation and air temperature	NOAA weather station USW00093738	(Leeper et al., 2015)
Daily precipitation and air temperature	GridMET	(Abatzoglou, 2013)
Observed streamflow and nitrate-nitrite-nitrogen	USGS NWIS stations 01648010 and 01646000	(USGS, 2022)

Table S2. This LULC lookup table can be read into the QSWAT model so that SWAT uses the Dynamic World LULC image as the LULC input.

LANDUSE_ID	SWAT_CODE
0	WATR
1	FRST
2	RNGE
3	WETL
4	AGRL
5	RNGB
6	UCOM
7	SWRN
8	WATR

Table S3. Parameters used in SWAT model streamflow and nitrate-nitrite-nitrogen calibration for Rock Creek Watershed (Case #2), for models input with growing and non-growing season Dynamic World 2016 data, as well as the model with NLCD 2016 input.

Symbol	**Definition †**	**Lower Limit**	**Upper Limit**	**Calibrated**
CH_K2.rte	Channel hydraulic conductivity (mm/hour) (v)	0.1	150	113
ALPHA_BNK.rte	Bank flow recession constant (v)	0.01	1	0.91
CN2.mgt	Runoff curve number (r)	-0.25	0.25	-0.15
N_UPDIS.bsn	Nitrogen update distribution parameter (v)	0	30	20.7
LAT_TTIME.hru	Lateral flow travel time in days (v)	0.01	180	90
SFTMP.bsn	Snowfall temperature threshold °C (v)	0	3	1.87
CH_N2.rte	Manning's n value for main channel (v)	0.01	0.30	0.10
NPERCO.bsn	Nitrogen percolation coefficient (v)	0.01	1	0.14
CDN.bsn	Denitrification exponential rate coefficient (v)	0	3	0.05
SDNCO.bsn	Denitrification threshold water constant (v)	0	1.1	0.33

† A 'v' indicates that the original parameter from QSWAT was replaced by the calibrated value, in the same unit. An 'r' indicates that the original parameter was modified relatively, multiplying it by 1 + the calibrated value (e.g. a value of -0.2 reduces the original parameter by 20%).

Table S4. Proportions of watershed area that were built or developed, agricultural (crops or pasture/hay), or forested LULC categories for the Rock Creek Watershed (Case #2) and Difficult Run Watershed (Case #3).

LULC type	Rock Creek (% area)	Difficult Run (% area)
Dyn. World 2016 growing season built	57	44
Dyn. World 2016 non-growing season built	66	54
NLCD 2016 open space developed	29	30
NLCD 2016 low intensity developed	26	17
NLCD 2016 medium intensity developed	10	8
NLCD 2016 high intensity developed	5	3
Dyn. World 2016 growing season crops	0	0
Dyn. World 2016 non-growing season crops	2	1
NLCD 2016 cultivated crops	0	0
NLCD 2016 pasture/hay	6	2
Dyn. World 2016 growing season trees	38	54
Dyn. World 2016 non-growing season trees	26	42
NLCD 2016 deciduous forest	19	27
NLCD 2016 evergreen forest	0	0
NLCD 2016 mixed forest	1	8

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