Biophysical modeling challenges and opportunities

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Global ecosystem service modeling (InVEST, Co$ting Nature, and others)

**Models based on LULC**

Challenges with LULC-based ecosystem service modeling:
- Categorical land-use proxies a diversity of functions
- Oversimplistic representation of ecosystem heterogeneity
- Difficult/time-consuming to parameterize
Global ecosystem service modeling opportunities for advancing integration with EO

Models based on EO

Opportunities for EO-based ecosystem service modeling:
- Functional representation of ecological processes
- More accurate representation of ecosystem heterogeneity
- Easier/more replicable parameterization

Ramirez-Reyes et al. 2019 Science of the Total Environment 665: 1053-63
Carbon storage

LULC-based approach

EO-based approach

But how to project scenarios?

Regression between EO-derived biomass and other biophysical and socioeconomic variables
Predictor variables | Effect size
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Bulk density of the fine earth fraction | 116.36
Temperature Annual Range | -115.22
Mean Temp. of Warmest Quarter | 93.88
Precipitation Seasonality | 64.41
Mean Diurnal Range | -57.65
Total nitrogen content of soils | 56.32
Annual Precipitation | 51.46
Available soil water capacity | -43.11
Area of nearby non-forest | -42.77
Depth to bedrock | 33.19
Terrain ruggedness index | 30.4
Precipitation of Driest Month | -28.1
Precipitation of Driest Quarter | 27.07
Proportion of silt particles | -26.72
Proportion of sand particles | 25.99
Precipitation of Warmest Quarter | -24.59
Soil pH | -23.15
Cation exchange capacity | -17.96
Mean Temp. of Driest Quarter | 17.16
Wind speed | -16.56
Slope | -15.78
Accessibility to cities | 15.18
Vol. fraction of coarse fragments | -13.47
Mean Temp. of Wettest Quarter | -11.54
Altitude | -9.74
Soil organic carbon content | 9.68
Proportion of clay particles | 8.61
Livestock density | -5.11
Min Temp. of Coldest Month | 4.16
Organic carbon density of soils | 3.69
Nightlights within 10 km | -1.09
Population within 10 km | -0.66
Nightlights on pixel | -0.2

Difference in accuracy for EO regression vs. original EO dataset
• Process-based model (USLE)
• Routed within watershed

LULC-based C-factor

NDVI-based C-factor

High retention
Low retention

InVEST
integrated valuation of ecosystem services and tradeoffs

LULC-based sediment export

NDVI-based sediment export

Upslope area (transport)

Downslope path (retention)
Sediment Retention

LULC approach

EO approach

Sediment export modeled with LULC

Sediment export modeled with NDVI

Sediment export rate

natural capital PROJECT
Challenges and opportunities

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