Forest Carbon Edge Effect

Summary

The InVEST carbon edge effect model extends the approach of the InVEST carbon model to account for forest carbon stock degradation due to th
relationships between carbon storage and distance from forest edge to calculate edge effects in carbon storage, and combines these estimates wi
overall carbon map. The model for edge effects pertains to above-ground carbon only, because edge effects have not been documented for the ot
dead matter). For all other carbon pools, and for non-tropical forest classes, or if the model is run without edge effects, it follows the IPCC (2006) i
storage values by land cover class.

Introduction

The effects of future land-use change on carbon storage or sequestration can be modeled by applying carbon storage estimates found in the litera
found in a landscape (e.g., Nelson et al. 2010). However, this approach assumes that all habitat is equivalent in its quality of carbon storage, regar
there is substantial evidence that fragmentation can play a dramatic role in altering carbon storage and sequestration rates in tropical forests (Broa
Laurance et al. 1997, 2000, 2001, 2002). For example, core forest has been shown to store more than three times the carbon of edge forest in Bra
Chaplin-Kramer et al. (2015) investigated this pattern for the entire pantropics using remotely sensed data on biomass (Baccini et al 2012) and as
found a continuous relationship of carbon storage degrading gradually toward a forest edge, which varies substantially from region to region. This
effects in tropical forests, assigning carbon storage based on the distance of a pixel to the nearest forest edge. This can improve the overall accura
relative to forest inventory approaches, and better captures the impacts of forest degradation from fragmentation, beyond merely the area of habita

The model

The InVEST carbon edge effect model is an update to the InVEST carbon model, which incorporates the degradation of carbon storage that occur
user designates which land cover classes are forest, and then the model uses pre-generated regression results to predict the carbon throughout a
nearest forest edge. These results are combined with the carbon assigned to non-forest classes through traditional inventory methods (IPCC 2006
generate a map of above-ground carbon storage for all land cover classes. The InVEST carbon edge effect model can be run to calculate only abo
can be run with or without edge effects. It is important to note that the edge effects regression only pertains to above-ground carbon stocks becaus
above-ground biomass. To include the other three carbon pools (below-ground, soil, and standing dead matter), carbon density (Mg/ha) should be
biophysical table.

How it works

This model follows the methodology described in Chaplin-Kramer et al. (2015), which constructs a series of regression models between forest bio
forest edge (km) for 100 km x 100 km grid cells throughout the pantropics. In grid cells where the majority of pixels were from forest biomes, three
to represent the relationship between biomass density and distance to forest edge:

1. Asymptotic: $\text{Biomass} = \theta_1 - \theta_2 \cdot \exp(-\theta_3 \cdot \text{Distance})$
2. Logarithmic: $\text{Biomass} = \theta_1 + \theta_2 \cdot ln(\text{Distance})$
3. Linear: $\text{Biomass} = \theta_1 + \theta_2 \cdot \text{Distance}$

Then, for each grid cell, the candidate with the highest r^2 value is used to best represent the relationship between density and distance to forest ed
suitable (and more simplistic) alternatives in cells where higher distances were generally not observed and as a result the forest core was not firml
cells, model (1) was optimal.

The results of these regressions can be found in the carbon edge regression parameter shapefile (*core_data/forest_carbon_edge_regression_mo*
that is provided for the InVEST carbon edge effect model. For any forest pixel within the study region, the model calculates the distance of that pix
to a predefined number of nearest regression models which is then aggregated to a single result using a distance linear interpolation scheme. The
a user provided conversion factor, defaulted to 0.47 (IPCC 2006). The user can designate the number of local models used in the interpolation sch
anywhere from 1 (only closest point) to 2635 (every regression model on the planet). Note that a selection of 1 may result in artificially large differe
to the next where they fall in different regression grid cells. The higher the number of regression grid cells selected, the smoother the transition fro
select the number of grid cells overlapping the entire study region in order to eliminate any artifacts of model selection. This can be determined by
intermediate_outputslocal_carbon_shape.shp geometry overlaid on the area of interest. The linear interpolation scheme for biomass b on pixel p is

$$b_p = \frac{\sum_{i \in n} \frac{1}{d_i} b_i'}{\sum \frac{1}{d_i}}$$

Where,

- b_p is the interpolated biomass on pixel p
- n is the number of nearest models to interpolate from, a value provided by the user
- i is the i^{th} nearest biomass model from pixel p
- d_i is the distance from pixel p to the centroid of the i^{th} biomass model