Background

Albeit the fact that tropical forests store large amounts of carbon (C) in aboveground tree biomass, the sensitivity of forest C stocks to projected increases in climate fluctuations remains elusive to date. Here, we opt to upscale local findings to the regional level by extrapolating corresponding C stock estimates from these habitat types using the terrain position index (TPI) based on remote sensing products from ASTER digital elevation data to estimate potential landscape-scale C gain/loss under projected climate scenarios (Figure 1).

Results

A previous study investigating aboveground productivity across different forest habitat types i.e. ridge, slope, ravine forests (Figure 2) found that climate sensitivity differed in association to local site characteristics, which in turn affected the growth response of tropical trees to a recent El Niño–Southern Oscillation (ENSO) anomaly (Figure 3). This result suggests that the climate sensitivity of crucial ecosystem processes (i.e. C sequestration) could be affected by local topography (via water availability) and disturbance history (via functional species composition) and thus might prevent uniform responses of tropical lowland forest habitat types under future scenarios.

Affiliations

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Sensitivity of tropical aboveground carbon stocks to climate anomalies in south-western Costa Rica

Methodology

To account for spatial variability of vegetation structure and associated aboveground C stocks along environmental gradients permanent one-hectare forest plots were established in five regional clusters i.e. La Gamba (LG), Riyito (RY), Agua Buena (AB), Rancho Quemado (RQ) and Piro (PR) and four topographic forest habitat types i.e. ridge (Rid), slope (Slo), ravine (Rav), across the Osa peninsula, situated in the Osa Conservation Area i.e. Área de Conservación Osa (ACOSA) in south-western Costa Rica.

Conclusions

We conclude that the impact of climate anomalies on tropical forest productivity is strongly related to local site characteristics. Whereas tropical tree communities at the more exposed ridge forest site (Rid) were adversely affected by anomalous climate extremes of the ENSO event, high-density trees at the moist ravine forest site (Rav) showed less sensitivity to climatic fluctuations. Albeit the fact that ridge forests sites only represent approx. 10% of forest cover at the landscape scale, they harbor a distinct tree species composition, which due to functional adaptation could potentially compensate for short-term C loss in response to projected climate anomalies. Resolving spatial habitat heterogeneity and functional response spectra of tropical forest ecosystems to projected climatic changes should reduce current uncertainty in model projections of tropical C sink strength and improve biodiversity conservation and management strategies.

References


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Figure 1: Elevation data to estimate potential landscape-scale C gain/loss under elevation data to estimate potential landscape-scale C gain/loss under elevation data to estimate potential landscape-scale C gain/loss under