In: 99th ESA Annual Meeting, 2014, Sacramento. Ecosystem Services Assessment, 2014.

Conserving Amazonia s ecosystem services in the face of expanding agriculture

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Background/Question/Methods

The Amazon is a key frontier where agricultural expansion to meet growing global demand for agricultural commodities competes with the preservation of natural systems that provide globally important ecosystem services. Thus, identifying land-use strategies that accommodate increasing agricultural production while also maintaining crucial ecosystem services is essential. Here, we use data from a combination of remote sensing, species distribution models, land-surface model output, and geostatistical datasets to compare the geographic distribution of four important ecosystem services: agricultural production, carbon stored in vegetation and soil, habitat for biodiversity, and regional climate regulation (i.e., the effect of ecosystems on local atmospheric temperature and moisture, which are disrupted after deforestation). To detect locations where preventing deforestation would secure multiple environmental benefits, we identify areas across Amazonia that are most effective at storing carbon, providing species-rich habitat, and regulating regional climate. We explore tradeoffs between agriculture and the environment by experimentally modeling the doubling Amazonia's agricultural lands while minimizing the loss of individual services. Given the dual pressures on Amazonia to provide increased agricultural production and maintain ecosystem services, determining how to balance multiple human benefits on its land resources is of critical importance to conservation practitioners, decision-makers, and stakeholders across the globe.

Results/Conclusions

Our results suggest that the spatial misalignment between carbon, habitat for biodiversity and climate regulation leads to inherent tensions among environmental goals in the face of expanding agriculture in the Amazon. Top performing areas for the delivery of each ecosystem service are not geographically aligned: protecting western Amazonia is most important if the conservation priority is maintaining biodiversity (1026 ± 560 mean relative species diversity per grid cell), while protecting eastern Amazonia is most important for regulating regional climate (post-deforestation mean annual regional atmospheric warming of 0.33 ± 0.29˚C and mean regional atmospheric drying of 0.84 ± 0.31 mm H2O exported per day). Consequently, there are limited opportunities to simultaneously protect both. Minimizing carbon emissions (214.0 ± 98.0 mean MgC released per hectare deforested) provides some opportunity for cobenefit protection, with key areas of carbon storage covering a swath from western to eastern Amazonia. We further find that even if agricultural lands were increased via a “least harm” pathway, the particular environmental harm humans seek to avoid can result in large and differential effects on the earth system. Thus, combining complementary conservation strategies targeting different regions of Amazonia will be essential to achieve multiple environmental outcomes.