GEO-Amazon Earth Observation Cloud Credits Program: A Global Modeling Tool for Nature's Contributions to People in Sustainable Development

Preliminary Report

June, 2020

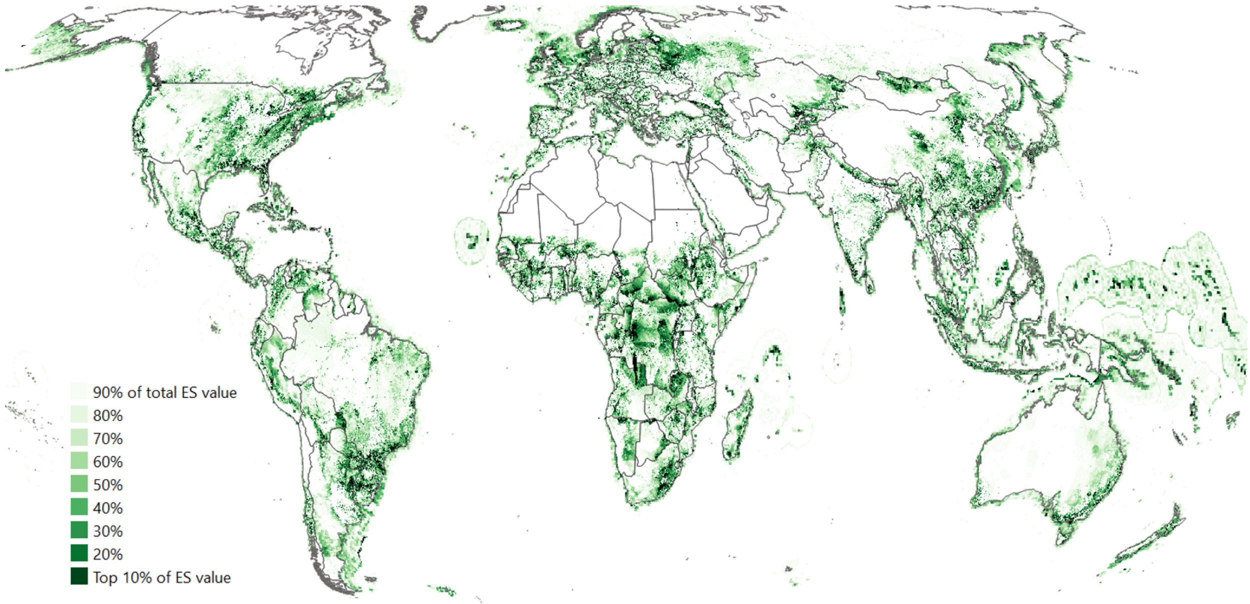
The magnitude and pace of global change demands rapid assessment of nature and its benefits to people. As governments, business, and lending institutions are increasingly considering investments in natural capital as one strategy to meet their operational goals and society's demands for sustainable development, the importance of actionable information on ecosystem services has never been greater. Rapid improvements in spatial data, computation and visualization present new opportunities for ecosystem service modeling—especially in terms of its integration with Earth observations (EO) from satellite remote-sensing. EO can provide near real-time information of the current states of ecosystems at global extents but cannot necessarily predict benefits provided to people or how these may change under different management or other drivers. Ecosystem services models are designed to do exactly that but are often hindered by lack of data at the appropriate spatial or temporal resolution or extent or that can resolve differences in management or condition within land cover types, and EO can help fill these gaps. Scaling up and integrating EO in ecosystem service modeling can provide more relevant, accurate, and readily available information for decisions, and I'll touch on a few of the growing number of opportunities for such science to inform investments in nature to support human well-being around the world.

We have modeled four ecosystem services globally using the AWS cloud credits, that have fed into a global optimization of 15 services to identify "critical natural capital" for the CBD and the SDGs. These datasets are not yet public, and are not being hosted anywhere yet, but the intent is to host them through public platforms .

A manuscript is being developed now, but the basic questions we're trying to answer with this work are:

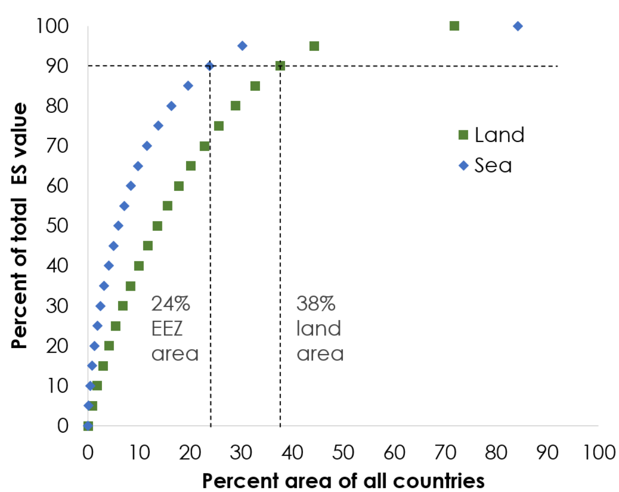
1) Where is the nature that people need?

Below we map critical natural capital, defined as the natural lands and waters required to maintain the majority of current ecosystem service value to their current beneficiaries. The darkest shades show the highest value areas that capture 10% of each country's total ecosystem service value (in <2% of the area), up to the lightest shades that encompass the areas providing 90% of the value (in 24-38% of the area; see Fig. 2). Percentage of total values reached through an optimization within each country across all 13 locally-provided ecosystem services: commercial & domestic timber, flood mitigation, fuelwood provision, freshwater fish provision, grazing production, nature access, nitrogen retention, pollination, sediment retention, coastal risk reduction, marine fish provision, and coral reef tourism.



2) How much area in the land or sea is required to maintain close to the current level of service provision?

To answer this question, we plot a critical natural capital curve, the cumulative density function for the area of land or sea (demarcated as the Exclusive Economic Zone, EEZ) required for each country to maintain increasing levels of current ecosystem service value. Land and EEZ areas selected were added up across all countries to provide global totals, 38% of total land area and 245 of total EEZ area required to reach 90% of current ecosystem service value across 13 services for each country.



3) How does this vary by country?

Values vary widely by country in terms of the percent of area required on land and in the sea (within the Exclusive Economic Zone, EEZ) to maintain 90% of current levels of service provision across 13 services. Countries listed are the 25 largest by land area, comprising >70% global land area; countries are ranked by their percent of natural land remaining. Natural land is defined as vegetated non-developed land (i.e., not bare, rock, snow & ice, urban or cropland). Area requirements exceeding 50% of a country's total land area (or remaining natural land) or total EEZ area are bolded.

Country	Land required for 90% service provision	% EEZ required	*% Natural land* remaining*	*% Natural land required for 90% service*
Democratic Republic of Congo	**82%**	25%	*98%*	***84%***
South Africa	**68%**	10%	*97%*	***70%***
Angola	**70%**	16%	*97%*	***72%***
Indonesia	47%	38%	*96%*	*49%*
Brazil	**58%**	22%	*96%*	***60%***
Peru	**69%**	12%	*94%*	***74%***
Mexico	**56%**	17%	*93%*	***60%***
Argentina	**53%**	29%	*87%*	***61%***
Russia	20%	20%	*85%*	*23%*
United States of America	46%	15%	*83%*	***55%***
Kazakhstan	43%	0%	*81%*	***52%***
Australia	28%	23%	*80%*	*35%*
China	37%	**57%**	*71%*	***53%***
Canada	10%	17%	*60%*	*17%*
Mongolia	35%	--	*59%*	***60%***
India	32%	18%	*51%*	***63%***
Chad	29%	--	*44%*	***66%***
Sudan	28%	**52%**	*41%*	***68%***
Mali	29%	**93%**	*39%*	***77%***
Niger	26%	--	*35%*	***73%***
Iran	16%	43%	*27%*	***58%***
Algeria	4%	27%	*8%*	***54%***
Saudi Arabia	3%	**54%**	*6%*	*49%*
Libya	1%	21%	*4%*	*34%*
Denmark	1%	32%	*2%*	***53%***

Data published

This project has generated 40+ Costa Rica-wide datasets, that are available online, in the portal of the National System of Environmental Information (SINIA), managed by the National Center of Geoenvironmental Information (CENIGA), of the Ministry of Environment and Energy (MINAE). This portal is being supported by the AWS cloud credits.

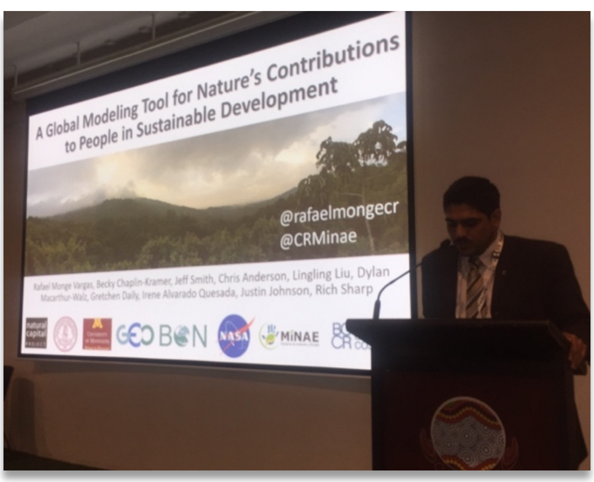
These products include 40+ spatial data layers for: ecosystem level EBVs ("e-EBVs": tree cover, vegetation cover, bare ground), species level EBVs ("s-EBVs": climate-based SDMs for individual pollinator species as well as total pollinator abundance and diversity, climate-based SDMs for bird biodiversity, e-EBV improved SDMs for bird biodiversity), and ecosystem services (s-EBV improved tourism, s-EBV improved pollination, e-EBV improved carbon, e-EBV improved sediment retention). Each product includes detailed metadata in Spanish.

In this [portal](), under the category “Biota”, we uploaded the preliminary products for EBVs and ecosystem services. This serves as a permanent home for the products of this project, hosted by MINAE, and made more accessible and discoverable by different stakeholders throughout the country. This information is already being included as part of the data that is helping shape the new version of the National Payments for Ecosystem Services Program of Costa Rica.

Dissemination

We were invited to present this project in an official side event during the GEO Week 2019, held in Canberra, Australia on 4 November. Rafael Monge, Director of the National Center of Geoenvironmental Information, at the Ministry of Environment and Energy of Costa Rica, participated as panelist in the Earth Observations Cloud Credit Program Side Event.

Pictures, a link to the slides or the presentation, and an image of the poster printed to present the project are included below.



Link to the presentation.

A Global Modeling Tool for Nature's Contributions to People in Sustainable Development

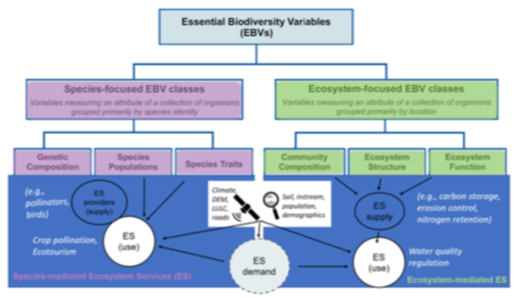
Rafael Monge Vargas, Becky Chaplin-Kramer, Jeff Smith, Chris Anderson, Lingling Liu, Dylan Macarthur-Walz, Gretchen Daily, Irene Alvarado Quesada, Justin Johnson, Rich Sharp

As governments, business, and lending institutions are increasingly considering investments in natural capital as one strategy to meet their operational goals and society's demands for sustainable development, the importance of accurate, accessible information on ecosystem services for use in decisions has never been greater. However, most ecosystem services models and decision support tools are based on categorical representation of land-use and land-cover, with the assumption that all habitat within each LULC type is identical, which poses challenges for both accuracy and accessibility of the information. With advances in Earth Observations from satellites, we now have direct measurements of model parameters or of the ecosystem services themselves, and our models and decision support tools need to catch up.

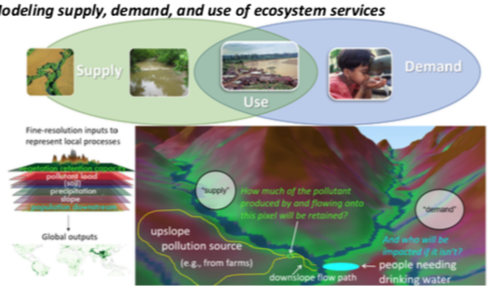
Information on how nature contributes to people can help identify how we can achieve our goals for sustainable development, climate and biodiversity:

Sustainable Development Goals	How much of a country's progress toward different SDG targets could be made through nature-based solutions?
Paris Accord	Where could each country invest in nature to meet their INDC's and maximize benefits to people? What return could be expected on those investments?
Convention on Biodiversity	What area-based targets for biodiversity conservation should be set if we also want to benefit people? Where are the greatest overlaps between the two?

GEO-BON created a framework of Essential Biodiversity Variables (EBVs), and Earth Observation (EO) of EBVs can improve modeling of ecosystem service by better linking to the individual species or ecosystem structure and functions that provide them.

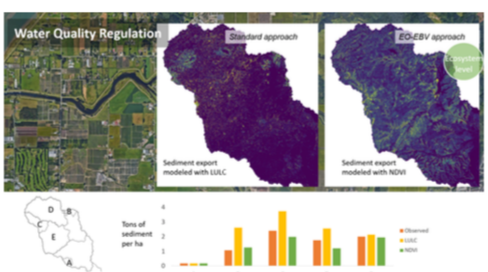


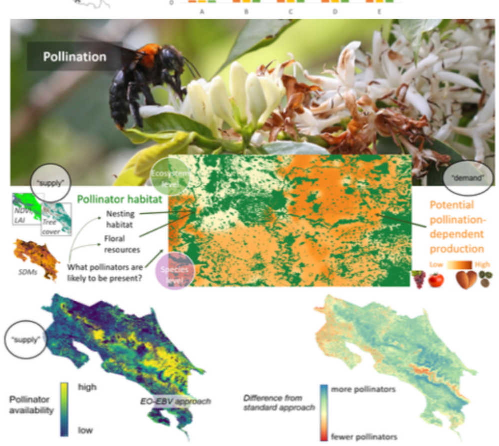
Modeling supply, demand, and use of ecosystem services



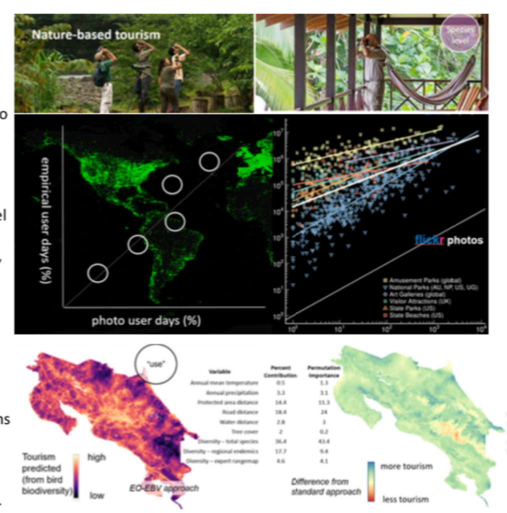
Global modeling with attention to local processes. Many ecosystem services (ES) are highly localized. To take the example of water quality regulation, we need to know the topography of a hillside and exactly where vegetation is relative to a pollution source uphill and the path that water takes downhill to determine how much pollutant it can retain. And then to know whether that retention matters to people, we need to know where vulnerable populations are, and ideally where they take their water from. This all falls under a general framework for ES, defining a SUPPLY based on the structure and function of ecosystems, and a DEMAND based on the location and activities of people, that combine to form USE which leads to BENEFIT, in this case clean drinking water that leads to better health or lower cost of treatment.

Scaling up using EBVs. Ecosystem service model coefficients are often assigned as single or average value to every category of land cover, even though we know forest across a landscape might vary widely in the understory to intercept particles or canopy to shield the ground from the erosive force of the rain (in the case of sediment retention for water quality regulation) or nesting and foraging habitat (in the case of pollination). Likewise, ecosystem service models do not account for variability in species composition or diversity for organisms that may be driving the flow of benefits to people (for pollinators, or for birds or other charismatic fauna for nature-based tourism).





Faster, more accurate, more relevant information for decisions. Integrating EO-EBV information into ES modeling provides more accurate measurements (in the case of sediment retention), easier model parameterizations (in the case of pollination), or better explanatory power of observed ES use (for nature-based tourism, using social media data as a proxy for visitation). In all cases, we see very different spatial patterns of ES provision, improving targeting of interventions to where they are most effective.



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