# Optimizing Biodiversity Co-benefits for REDD Programs in Peru

## What is REDD?

Forests provide an important service of capturing and storing carbon. When forests are cut down, they release their carbon in the form of $CO_2$ into the atmosphere. Deforestation and forest degradation accounts for about 20% of global $CO_2$ emissions. Forests also provide other important ecosystem services for people, such as food, shelter, watershed protection, and soil protection. In addition, they provide habitat for some of the world's most critically endangered species.

REDD (Reduced Emissions from Deforestation and Forest Degradation) is an initiative led by forest-rich developing countries and recognized by the United Nations Framework Convention on Climate Change (UNFCCC) to provide these countries with financial incentives to leave their forests standing. The proposed idea is that developing countries will be able to sell carbon credits in an international market, so that developed countries can buy credits to offset their carbon emissions.

## Why Peru?

Peru is one of the world's 10 most "megadiverse" countries (see Table 1), with thousands of different species. Many of these are endemic, and over 200 are endangered.


The country's rich biodiversity is due in part to its diverse ecosystems, which include marine/coastal, mountain highlands, tropical rainforest, and freshwater. Elevation ranges from sea level to 6,768m (22,205 ft).

**TABLE 1: PERU BIODIVERSITY**

| Species Type | Total Species | Endemic Species | % of World Population | World Ranking |
|---|---|---|---|---|
| Fish | 2,000 | 760 | 10% | 1 |
| Birds | 1,736 | | 17% | 2 |
| Mammals | 460 | | 9% | 3 |
| Amphibians | 332 | | 5% | 3 |
| Reptiles | 365 | | 4% | 5 |
| Plants | 25,000 | 5,528 | 10% | 12 |

## Objective

At the 2013 UNFCCC Conference of the Parties (COP19), REDD was one of the few initiatives that made some headway. Countries including the US, the UK and Norway pledged aid money to be allocated towards "REDD readiness programs" that would provide developing countries with resources to design and establish national REDD strategies. Peru has been selected as one of the pilot countries.

A win-win scenario for REDD programs would be selecting sites that would optimize carbon sequestration while also conserving biodiversity. By identifying these sites, Peruvian and other developing country governments could identify where to focus their limited resources on protecting those areas that would be most eligible for REDD funds and simultaneously conserve critical habitat. This would ensure that forests continue to provide ecosystem services to future generations at the local level while also helping to mitigate the effects of climate change globally.

My goal is to demonstrate how spatial analysis can assist governments (or NGOs) with identifying optimal REDD sites through the use of spatial analysis. The primary spatial analysis questions for this project are:

1. **Which areas are ideal to designate as REDD sites in order to maximize co-benefits for biodiversity and carbon sequestration?**
2. **Which of these REDD / biodiversity suitability sites are most at risk?**

Cartographer: Jessica Webb
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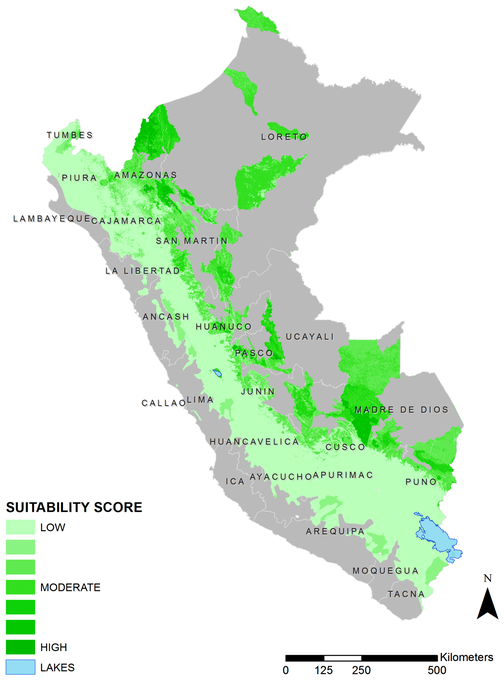
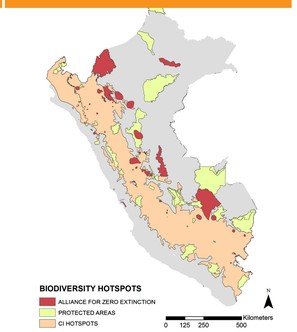
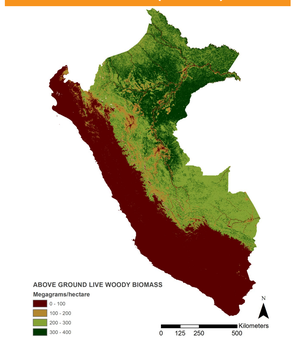
### Suitable REDD Conservation Sites (Fig. 1)




### Biodiversity Hotspots (Fig. 2)




### Carbon (Fig. 3)




## Methodology

**Part 1: Carbon and Biodiversity**

To identify priority areas for biodiversity conservation, I combined data sets on priority areas for plant conservation (Conservation International's Biodiversity Hotspots, CI) and animal species (Alliance for Zero Extinction sites, AZE) with areas that are already protected in Peru (PA). Sites were then ranked for priority (see Figure 2 and Table 2).

**TABLE 2: CONSERVATION RANKING**

| CI | AZE | PA | Ranking |
|---|---|---|---|
| X | X | X | 4 |
| X | X | | 3 |
| X | | X | 2 |
| | X | X | 2 |
| X | | | 1 |
| | X | | 1 |
| | | X | 1 |

I added these results to a raster dataset of carbon in above-ground woody biomass (see Figure 3) to identify the most suitable sites for REDD and biodiversity conservation ("REDD Conservation") (see Figure 1).

**Part 2: Threats to REDD Conservation Sites**

Agriculture, the construction of roads, and human colonization are the main drivers of deforestation and habitat degradation in the tropics. In this analysis, I combined datasets on each of these three "threats" to identify which areas posed the biggest risk for REDD Conservation (see Figures 5, 6, and 7). Agriculture is represented by the presence of any type of agriculture (intensive or mosaic). For population density, areas with the highest density are considered to carry the highest risk. To indicate the risk from roads, I used the Euclidean Distance tool to calculate areas around major roads — the closer to the road a site is, the higher the risk. Finally, I added these together which yielded the areas with highest overall threats (see Figure 4).

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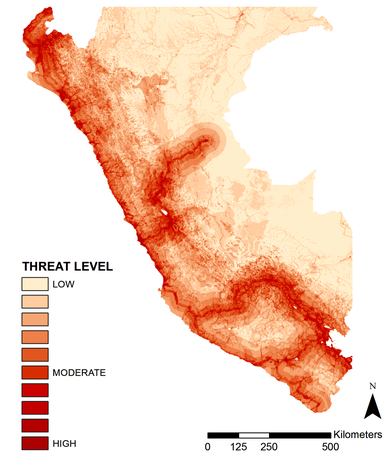
## Analysis

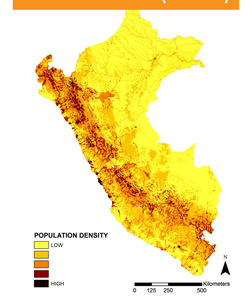
### Threats (Fig. 4)



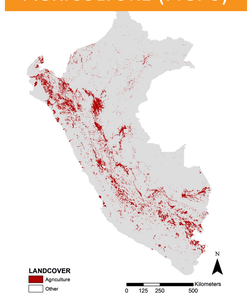

Once suitable REDD Conservation sites and the areas of highest threats had been identified, I multiplied both rasters together to assess which of the prime suitability sites are at the highest risk (see Figure 8). This type of analysis could help governments visualize which sites are of the highest priority to protect.

By outlining current protected areas over the map of REDD Conservation sites, it is easy to see which areas have already been protected and which priority areas lie outside reserve boundaries which can also help governments when establishing priorities (see Figure 9).

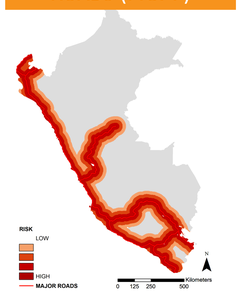
### Pop. Density (Fig. 5)




### Agriculture (Fig. 6)




### Roads (Fig. 7)

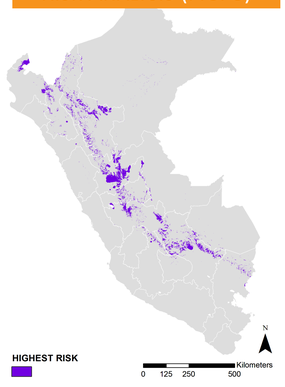



## Conclusion

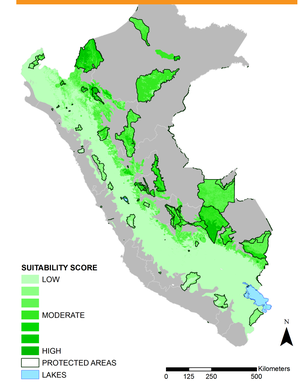
This project is a demonstration to show how GIS can assist with effective REDD planning while optimizing benefits for biodiversity. For future analyses, it would be important to use more locally specific criteria to meet local planning goals.

The incorporation of further socioeconomic data, which was not publicly available at the time of this project, would also aid in identifying the needs of communities living in and around the priority sites. Evidence suggests that conservation initiatives that fail to involve communities living in and around the forests are not as successful as those that do. It is important that international REDD benefits trickle down to the regional and local level through the funding of incentives and programs that support local economic development.

### Risk Analysis (Fig. 8)




### Protected Areas (Fig. 9)




Sources: Convention on Biological Diversity (2014); Conservation International (2004); Alliance for Zero Extinction (2010); Woods Hole Research Center (2012); GfK World Data (1994); Global Landcover (2000); INEI Peru (2007); LandScan 2005 Global Population Project