Nitrogen dynamics in the tropical dry forests of Costa Rica

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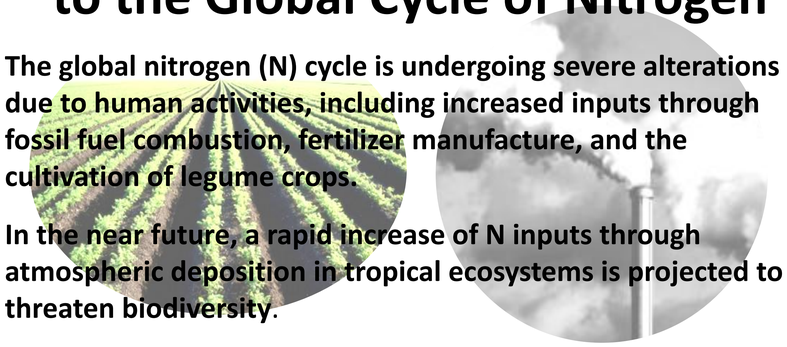
Human alterations to the Global Cycle of Nitrogen



The global nitrogen (N) cycle is undergoing severe alterations due to human activities, including increased inputs through fossil fuel combustion, fertilizer manufacture, and the cultivation of legume crops.

In the near future, a rapid increase of N inputs through atmospheric deposition in tropical ecosystems is projected to threaten biodiversity.

Tropical Forests and the Global Carbon & Nitrogen cycles

- ~50% of all species on the planet are in the tropics
- 42% of the global primary productivity occurs in the tropics
- Tropical forests exchange more water and energy with the atmosphere than any other biome

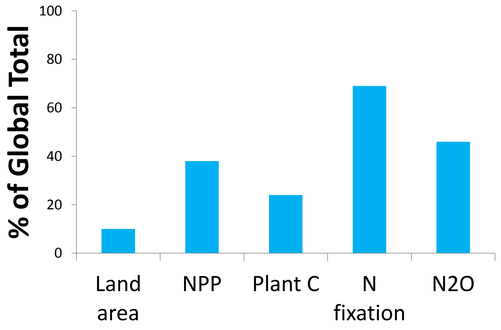


Fig. 1- Effect of Tropical forests in the Global Carbon and Nitrogen cycles. From Townsend *et al.*, Frontiers in Ecology, 2011

Fig. 2- Study site, Área de Conservación Guanacaste (ACG), Costa Rica.

Tropical Dry Forests

Tropical Dry Forests are now considered the most threatened tropical biome and probably some of the least studied.

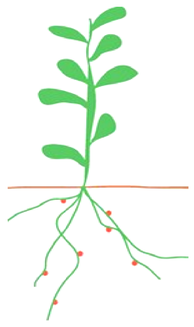
We urgently need to understand how this biome is responding to the rapid ongoing changes in environmental conditions!

Nitrogen fixing plants

Plants with the capacity to form symbiotic associations with N-fixing bacteria in their roots.

Bacteria provide Nitrogen to plants by converting unavailable atmospheric N_2 into forms available to plants in exchange for a carbon source from the plant.

Most N-fixing plants belong to the Legume family.



Objective

We are quantifying the major Nitrogen inputs to tropical dry forest ecosystems of Costa Rica, as well as the major controls on these processes.

How much Nitrogen do free-living bacteria fix?

We are measuring Nitrogen fixation by heterotrophic bacteria in soils and leaf litter as it is an important mechanism of Nitrogen input to ecosystems.

Is there Nitrogen pollution In rainfall?

We are monitoring atmospheric deposition by measuring Nitrogen concentrations in gross rainfall near these forests.

How much Nitrogen circulates with leaf litter?

We are analyzing how much Nitrogen returns to the forest floor with leaf litter.

How much nitrogen do legume trees fix and when?

Our main hypothesis is that legume trees can turn the process of fixation "on and off" depending on environmental variables. We are testing this by evaluating whether or not trees fix nitrogen under different habitat characteristics (light availability, soil moisture, and nutrients readily available in the soil) that we are manipulating experimentally in a shade house.

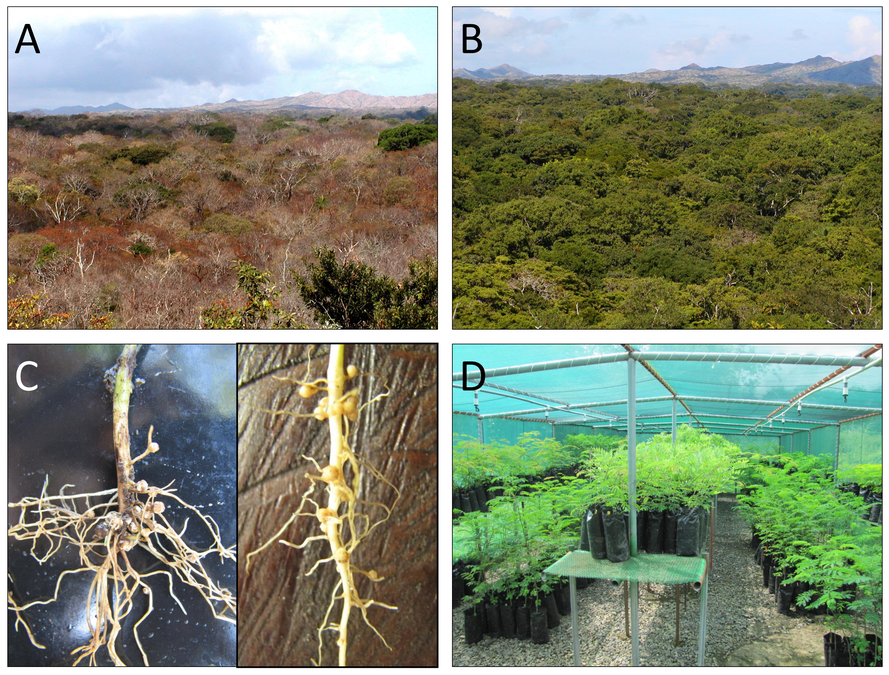


Fig. 3- Panoramic view of the dry forest during a typical dry season (A) and a wet season (B). Nodules in a seedling of *Enterolobium ciclocarpum* (C) and seedlings of five legume trees in a shade house with two light environments (D).

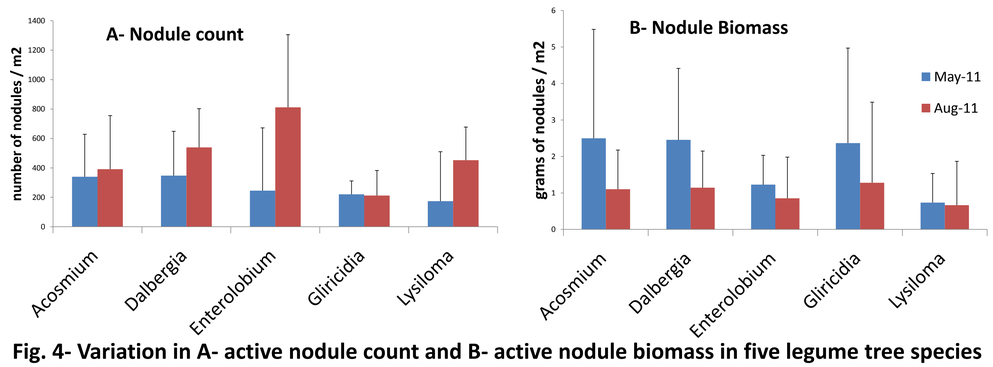


Fig. 4- Variation in A- active nodule count and B- active nodule biomass in five legume tree species under different light conditions in the forest.

Contributions of this project

1- To provide benchmark data to better constrain pool and flux estimates in the global nitrogen cycle.

2- To quantify the potential for legume trees to act as alternative N sources or green manures in agroforestry systems.

3- To contribute to local capacity building through interactions with the **Biological Education Program (PEB)** of the Área de Conservación Guanacaste.

Photo courtesy of PEB, ACG.