

# Luquillo LTER studying recent environmental changes

Tropical environments are changing fast due to deforestation and regrowth, urbanization, climate change, and other forces. The consequences are immense for biodiversity, global climate, and the whole array of ecosystem services that people require. The Luquillo Long-Term Ecological Research Program (LUQ) is tackling these issues in Puerto Rico. LUQ began in 1988 and focused on natural disturbances (hurricanes, landslides, droughts, floods) and ecosystem responses to them. That work revealed patterns of resistance and resilience to cycles of natural disturbance. But how will the tropics respond to directional changes in land use and climate?

**T**he LUQ study region is well-suited to answering this question. First, urbanization has been rapid, and there is a strong gradient of land use from El Yunque National Forest to the city of San Juan with 1.3 million people. Along this gradient, for example, LUQ is studying how urbanization affects stream chemistry and organisms. Second, there is also a strong gradient in climate, from the coast to the peaks of the Luquillo Mountains at 1075 meters. Along this gradient, for example, LUQ is studying how trends in climate apparently affect the distribution of tree species. Understanding these stream and forest changes in space helps us predict changes in time.

LUQ takes four approaches to understanding environmental change: long-term observations to describe change in time, gradient analyses to describe change in space, experiments to understand mechanisms of change, and

modeling to conceptualize and extend our results. Some examples follow.

Our long-term observations have shown how the Luquillo Mountains area has undergone deforestation, reforestation, and urbanization. By 2002, 19 per cent of the mountain area was urban. Over the past few decades, rainfall in the mountains has decreased between 1 and 2 mm a year whereas the amount of water extracted by humans from Luquillo streams has increased by 190 mm/yr. Air temperatures have increased in nearby urban areas and may be changing in the Luquillo Mountains. The supply of water for humans and healthy streams is threatened.

Our gradient analyses have shown that tree communities change significantly at about 500, 700, and 900 m elevation, probably due to such factors as mean nighttime cloud level. At higher elevation there are restricted, endemic tree and other species. With drying or warming, these boundaries may shift upwards, and endemics may be literally driven off the top of the mountain.

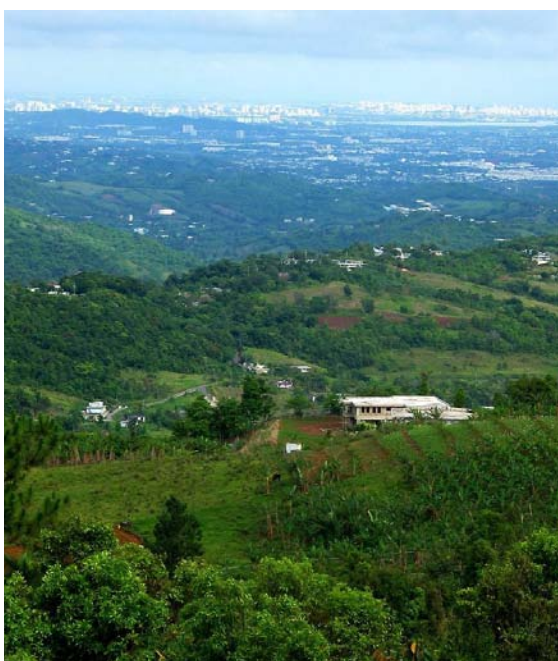
**A** core LUQ project is the Canopy Trimming Experiment (CTE). The hurricanes that strike Puerto Rico have two big impacts that affect forest response—canopy damage, and resulting debris deposition on the forest floor. How do we



Forest damaged by Hurricane Georges in the Luquillo Mountains, Puerto Rico (photo courtesy of Luquillo LTER).

distinguish the light and temperature impacts due to canopy damage versus the soil and nutrient impacts due to debris? By trimming the canopy of forest plots and creating different combinations of canopy removal, debris addition, and controls, the CTE separates the effects of these factors on plant, animal, microbe, and biogeochemical responses. We are repeating the trimming to simulate the effects of increased hurricane frequency. Treatment results are preliminary, but one result so far is that a slight, seasonal temperature increase elevates carbon dioxide (CO<sub>2</sub>) emission from the soil.

**See “Luquillo”, p. 11**



View from the Luquillo Mountains toward San Juan, Puerto Rico (photo by Jess Zimmerman).

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This result connects with the final example of LUQ's research approach—modeling. The CTE will test predictions of the Century Soil Organic Matter Model (CENTURY) of soil organic matter accumulation and nutrient dynamics, as parameterized for the study site under different hurricane disturbance regimes. The model indicates lower levels of aboveground carbon and higher levels of soil carbon, nitrogen and phosphorous mineralization, and organic soil phosphorous under a regime of frequent hurricanes. CTE results will test these predictions and have implications for ecosystems subject to a changing regime of cyclonic storms.

These examples show how LUQ science relates to environmental issues in Puerto Rico, similar tropical areas, and the globe. While its research addresses these issues, LUQ's education program produces scientists (many minority) to tackle them. The LUQ



**Right:** Meteorological station in the Luquillo Mountains, Puerto Rico. **Above:** Census of trees in forest of the Luquillo Mountains, Puerto Rico. (Photos courtesy of Luquillo LTER).

education program includes high school students who gather climate and vegetation data, undergraduates doing original research with LUQ mentors, and graduate students with LUQ advisors, including PhD students



working in a new IGERT program focusing on natural-human ecosystems in the urbanizing tropics. LUQ also has designed a web-based middle school curriculum for teaching ecology. With both its research and training LUQ is addressing the challenge of changing environments in the tropics.

*By Nick Brokan, LUQ.*

# Reinvigorating the LTER Climate Committee

In 2007, Doug Goodin stepped down as Chair of the LTER Climate Committee. Having worked for the Network for more than a decade, Doug decided to move on to other endeavors. Doug, thanks for your service! At the behest of LTER leadership I have agreed to chair the Climate Committee.

In his report to the LTER Executive Committee dated 11 June 2007, Doug, outlined the purpose of the Climate Committee and offered arguments for its continued existence. He also outlined how the structure and composition of the committee could be changed to better serve the needs of the LTER community. Offering such advice is surely the duty of those who serve as committee chairs for more than a decade.

In his analysis, Doug noted that there were more committee members than there were LTER sites. How could a committee be more successful than that? This demographic statistic reminded me of my University's academic procession committee. When I took over the chair of that committee, I found that it was populated in part by people who

had died in the previous decade. Similarly, the current Climate Committee roster lists "members" whom we might call retired. Doug recommended one committee member per site. To facilitate the Committee's work, he suggested the formation of an executive committee of dedicated colleagues, and that the position of committee chair be term-limited. This is a somewhat problematic proposition because we are a "long-term" network with a history of taking on activities that are never finished or require a protracted and dedicated effort. Like the sites, the Climate Committee needs to plan for the orderly transfer of leadership. Discovery and training of the next chair should be one of the tasks of the Climate Committee.

Doug also recommended that the Committee be constituted in such a way that both climatological and hydrological sciences are adequately represented.

The lifeblood of a network is membership participation. Without communication, participation falters. The glue that holds it all together is an agenda of shared values and activities. That is why the Climate Committee has a long history of completing activities valued by the network.

The proposed reinvention of the Climate Committee must include the crafting of an agenda for the coming decade. This agenda should be completed at the All Scientists Meeting this fall. To that end a roster of Committee activities needs to be built this summer. That will require the help of LTER site representatives.

To get the ball rolling, I am asking committee members to think about a proposed thematic follow up to David Greenland, Douglas G. Goodin, and Raymond C. Smith's 2003 Oxford University Press synthesis volume, "Climate Variability and Ecosystem Response at Long-Term Ecological Research Sites". For such a long-term project, a planning horizon somewhere around 2013 might be appropriate. As we get ourselves reorganized, I will put out the call for suggestions and pester sites for ideas to reinvent the Climate Committee, and get ready for the All Scientist Meeting.

The Goodin report may be found at <http://intranet.lternet.edu/modules.php?name=UpDownload&req=viewsdownload&sid=3>

*By Bruce Hayden, VCR,  
Chair, LTER Climate Committee*