Title:LTER: LTER5: Understanding Ecosystem Change in Northeastern Puerto Rico
Institution: University of Puerto Rico-Rio Piedras
NSF Program:LONG TERM ECOLOGICAL RESEARCH
Principal Investigator: Zimmerman, Jess K.

Rating: Very Good

Review:

In the context of the five review elements, please
evaluate the strengths and weaknesses of the proposal with respect to intellectual merit.

Intellectual merit: This proposal seeks to build on many decades' worth of research into tropical forest structure and function at Luquillo with a suite of long-term measurements, new and continuing experiments, and application of existing models to examine the separate and interactive effects of drought and hurricane damage on terrestrial and aquatic biota and biogeochemistry. The proposal arranges the LTER's focus into three central questions (listed as topics I-III below) examining climate change effects on this montane tropical ecosystem. Proposed work is structured around eight organizing hypotheses grounded in past observations and understanding of mechanistic processes. The digest below provides a brief summary of proposed content but does not capture the thoughtful depth and structure of the proposal's questions, hypotheses and corresponding work plan.
(I) Short- and long-term effects of drought on (1) vegetation composition (studied with seedling drought experiments; continued forest monitoring and dendrometer installation; SORTIE modeling) (2) soil biogeochemistry (measured as altered microbial community, litter inputs and decomposition rate and trace gas emissions in the drought experiments), and (3) stream food web structure and ecosystem processes (whole-stream diversion/drought-simulation experiment)
(II) Short- and long-term effects of increased hurricane frequency on (4) plant and animal demography in the Canopy Trimming Experiment (CTE), extrapolated through SORTIE modeling; and (5) soil C stocks (examined by characterizing various soil C properties in archived and new samples along with DayCent modeling, and by measuring microbial biomass and composition in the CTE), and (6) consumer- v producer control in stream ecosystems (monitoring of stream chemistry, litter inputs, and community composition, with SORTIE simulations of changes in light and plant species composition).
(III) Interactive effects of climate change, hurricane disturbance and land cover change on (7) precipitation regimes and cloud cover determined from GCM downscaling and analysis of station records, along with (8) SORTIE and DayCent analysis of how hurricanes, drought, and past land use will affect future plant community composition and soil biogeochemistry.

Strengths: The proposal makes a good case for centering the LTER's research around central questions of climate change impacts, manifested as increased drought and hurricane frequency. These themes provide a clear and substantive organizing framework for both experiments and long-term observations. Each of these proposed sets of ongoing or new measurements are nicely supported within the context of past measurements and other broader background information, with thoughtful hypotheses, and relatively in-depth work plans. In general, each set of proposed activities contains quite a lot of substance, which might well readily fill a dissertation or major investigator's effort. When

tallied, there is an immense amount of work proposed here. Excellent contributions to ecosystem understanding could result even if only a subset were completed in some way close to the description here û for example: the seedling drought experiment, canopy trimming experiment and stream diversion experiment all should yield interesting, useful results, and the long-term observations of forest productivity and demography as well as soil and stream biogeochemistry together form the backbone of vital long-term observations from a aseasonal tropical forest, an globally important but understudied biome.

Weaknesses: Overall, these weaknesses are relatively minor for a proposal of this size and breadth. The first two questions on drought and hurricane frequency are developed more clearly than the third question on more general integration û although the general coherence and organization into these three topics is admirable for the diverse set of interests represented by the LTER investigators. The downscaled climate projections (topic 7) was especially difficult to follow on its own and in how it would link with the other parts of the proposal, although Fig. 11 does set out a general flow diagram for potential broad interactions among various models. In general, the proposed modeling work (with SORTIE, DayCent, and ED2) seemed less well-developed compared to the great thoroughness used to describe the extensive field measurements. These models are reasonably tools, with the SORTIE work best-developed by these investigators seeming to be especially good for applying to the plant successional dynamics. The contained a few examples of where proposed modeling had helped shape hypotheses, but much of the modeling was presented with less detail or clarity than the field measurements, and in some cases seemed perhaps inserted as an afterthought for some sort of all-encompassing integration and extrapolation û which can be useful, and there are few other tools to do so û I know of no single model that would be better suited than the set mentioned here. Ideally, the modeling can work best when also used to help shape the field measurements and test hypotheses on how the ecosystem works.

In the context of the five review elements, please
evaluate the strengths and weaknesses of the proposal with respect to broader impacts.

Broader Impacts: The broader impacts seemed somewhat less well-detailed than the deep content of the Intellectual Merit. The synthesis section focused mostly on noting engagement within various related networks (CloudNet RCN, DoughtNet, etc.), which are good contributions but don't necessarily demonstrate integration of LUQ work across disciplines. The Education and Outreach section contained multiple activities that would appear to nicely meet the needs for the LTER, but few had much detail in the description in their content. e.g., There are quite a few items listed in the LTER Schoolyard program (number of meetings, etc.) but I'd have enjoyed learning more about the content that was being extended and the techniques for doing so.

Please evaluate the strengths and
weaknesses of the proposal with respect to any additional solicitation-specific review criteria, if applicable

I have not previously reviewed a LUQ site proposal, so can't compare this proposal with the 2012 submission. This version was remarkably clear and very substantive.

The leadership team appears solid, and contains highly productive leaders. For example, co-PI Whendee Silver's soil biogeochemisty is some of the most innovative in the discipline, at the forefront of the field, and Advisory Committee member Maria Uriate leads creative forest dynamics work and advanced quantitative techniques; both maintain admirable levels productivity on this work. If possible, it might be helpful to add a few more earlier career scientists to the leadership team, at least at the Advisory or "Additional" level if not co-I. The general leadership management plan seems reasonable.

Summary Statement

Overall, this LTER proposal appears thoroughly grounded in past measurements; it's asking clear, important questions on climate change effects in a globally vital and understudied ecosystem; and the proposed measurements and experiments are well-thought-out and will advance understanding of tropical forests and climate change.