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: Excellent

Review:

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

The proposed studies in the wet tropical forest biome have a strong potential to advance our understanding of the mechanisms by which the various drivers of global change, and their interactions, will influence communities, and how this will in turn drive changes in biogeochemical cycles.

While some of the parts of the proposed work are not particularly novel (Questions 1 & 2), addressing these two questions is absolutely essential for addressing Question 3, which concerns evaluating and understanding the interactions among the drivers of global change and their various effects on ecosystem properties and processes. It is this topic that is highly likely to provide novel and perhaps transformative insights into our conceptual framework of global change biology. Addressing Question 3 requires the basic research to be done for Questions 1 & 2, and will absolutely require long-term data sets. These are rare in the tropics, but they exist for this LTER site, owing to a variety of funding sources and research efforts that span decades. The rareness of this tropical data base and the plans for its use to address questions regarding global change biology represent a great strength of the proposed work. Given the importance of wet tropical forests in global biogeochemical cycles, the proposed studies address a critical need for advancing our understanding of the drivers and consequences of global change. Addressing the complexity of the interactions will require an array of approaches at multiple scales and this group has described a wide range of experimental approaches and analytical tools to tackle the complexity. This element of the proposed studies is very creative, and their approach could well serve as a model for other studies attempting to address similarly complex ecological questions across scales of organization. The modeling activities will also provide a mechanism for assessing their success.

The plan for carrying out the proposed activities is very well-reasoned, with the three questions well-integrated and their rationales well-articulated. The hypotheses address the questions posed and are testable, and the proposed work plan will allow them to test the hypotheses posed.

One would expect surprises in a study this complex. This group has the right mix of talent to carry out the proposed activities. They have described rigorously planned research activities that will allow them to reach their research goals. This group also has demonstrated the ability to adapt to what nature gives them; this flexibility will allow them to take advantage of serendipitous occurrences and unexpected findings and to make the most of their long-term research data sets. It appears that this group has the resources available to carry out the proposed research.

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

The Broader Impacts are strong in that they encompass a variety of impacts. The output from the research and its ability to inform our understanding of the drivers of global change has the capacity to contribute importantly to our understanding of global change impacts on biogeochemical cycles. The educational impacts are strong and varied in that they include the Schoolyard LTER program, a middle school program, REU experiences, graduate student research and volunteer opportunities. This LTER site is involved in numerous networks for data sharing and synthesis. The plan for carrying out these activities is described well. With the inclusion of a professional educator on the team, they should be able to carry out and assess the proposed activities.

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

Strengths
The major strength of this proposed work lies in the capacity to evaluate the effects of multiple drivers of global change across multiple levels of organization and to evaluate the results with modeling efforts that will be well-integrated. The proposed studies also make excellent use of the long-term data sets.

Weaknesses
None noted.

Additional comments:
I did not review the previous proposal and have not seen it, so I cannot judge the extent to which the previous criticisms have been addressed. The Program Director provided the criticisms of the previous proposal however (with each point labeled with a letter below). My comments address the previous criticisms, but relate to the current proposal only:

Previous Criticism A. The vision for the next 6 years of research was site-based and narrow.

My comment: This point certainly does not apply to the current proposal, for two broad reasons. 1) The proposed modeling effort is so well thought out and comprehensive that it will allow the researchers to generalize across this biome about the drivers and consequences of global change. They propose the use of multiple, widely used models that together span multiple scales. They also articulate how they will integrate the separate modeling efforts. These modeling efforts will allow for development of testable hypotheses in other sites. The knowledge gained by this group from both the modeling with a given model, and the integration among modeling efforts will advance our understanding for modeling this entire biome, thus allowing for generalizability of site-based studies. That knowledge will be critical for informing climate models at the global level. 2) This research group is involved in many collaborative studies, including cross-site research and network-level databases. These activities allow for the site-based activities to contribute to understanding the bigger picture.

Previous Criticism B. Proposed research did not address major ecological questions using hypothesis-driven research.

My comment: The current proposal is very well organized around three well-articulated major ecological questions. The conceptual framework was well described and the hypotheses related to the questions were clearly stated.

Previous criticism C. Hypotheses were not linked or designed to elucidate underlying mechanisms.

My comment: Experimental studies that are designed to evaluate mechanisms are well-described. For example, under Question 1, the hypothesis that increasing drought frequency will lead to changes in community composition is accompanied by mechanistic experiments regarding drought tolerance of individual species and studies of plant traits. For Question 2 about the effects of increased hurricane frequency, they propose experimental trimming and a suite of measurements to address the mechanisms by which hurricanes influence vegetation composition.

Previous Criticism D. The conceptual framework provided was considered 'generic,' and was not adequate to integrate separate research efforts.

My comment. Again, I have not seen the previous version, so perhaps that is why this criticism doesn't make sense. The current version seems fine to me û I thought that the point of a conceptual framework was to present complexity in a generalizable form, which is what the PIs have done very well. The current proposal has a series of four figures depicting the conceptual framework, its evolution over time, the research history at LUQ, and the modeling scheme. Together, these figures provide the context for, and an understanding of, the integration of the separate research efforts.

Previous Criticism E. Key portions of the proposed research were not motivated by long-term data, and long-term data did not inform hypotheses or predictions.

My comment: I don't see how this criticism could possibly by applied to the current proposal. The PIs have clearly described how the long-term data sets have contributed to previous research and how they inform the proposed work. This is accomplished in Figures 3, 5, 7, 8 and Table 1.

Previous Criticism F. Methodological concerns were raised about new research efforts (levels of replication, absence of canopy monitoring, etc.).

My comment: I did not notice any issues here.

Previous criticism G. Problems existed with the website and with access to data.

My comment: These must have been resolved, as I did not find problems with this.

Previous criticism H. The project lacks strong leadership and must recruit highly-productive researchers who are demonstrated leaders.

My comment: This issue has been addressed. The current PIs are certainly highly productive researchers and demonstrated leaders.

Previous criticism I. Mechanisms for PI and student interaction and integration were unconvincing.

My comment: A professional educator is leading the LUQ education and outreach programs, so this issue has been resolved.

Summary Statement

The proposed studies build on decades of research across multiple scales of influence and will address the complex interactions among multiple drivers of global change and their various effects on communities and ecosystems. The combination of observational and experimental studies allows for exploration of a wide range of conditions, and testing of hypotheses in a more controlled setting as well. The use of various modeling approaches in an integrated manner will allow for generalization from these site-based findings to the wet tropical forest biome, in a manner that can be incorporated into global models. The combination of long-term data sets, observational studies, experiments and creative integration of various modeling approaches provides an unprecedented opportunity to evaluate the drivers of global change in this biome and the consequences for global biogeochemistry.