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Editorial

Introduction to the Special Issue on Tropical Forests: Management and Ecology in the Anthropocene

Ariel E. Lugo * and Grizelle González

United States Department of Agriculture, Forest Service, International Institute of Tropical Forestry, Jardín Botánico Sur, 1201 Ceiba St.-Río Piedras, Puerto Rico 00926, USA; ggonzalez@fs.fed.us

* Correspondence: alugo@fs.fed.us; Tel.: +1-787-764-7743; Fax: +1-787-766-6302

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Abstract: This Special Issue of *Forests* is based on papers presented at the 75th anniversary of the United States Department of Agriculture (USDA) Forest Service International Institute of Tropical Forestry as well as other papers relevant to the topic of the Special Issue. The Institute is but one leg of a conservation relay among cultures and institutions that began in Puerto Rico a millennium ago. The Institute began operations in 1939 and celebrated its 75th anniversary on May, 2014. Over its 75 years of operation, the Institute has focused its research on tropical forests, with the scope of the research expanding over the years. An analysis of the lines of research of the Institute showed that over its history about 69 lines of research have been established and that of the original 17 lines of research between 1939 and 1949, all but one remained active in 2014. This history and continuity of the research program has allowed the Institute to observe ecological phenomena over decades, including the evolving forest structure and functioning on degraded land restoration experiments that began before the formal establishment of the Institute and are now over 80 years old.

Keywords: Tropical Forestry Research; Long-Term Ecological Research; Tropical Forest Management; Tropical Forest Conservation

1. Tropical Forestry Research in the Anthropocene

In spite of the continuity of research focus at the United States Department of Agriculture (USDA) Forest Service International Institute of Tropical Forestry [1,2], there have been historical moments when a particular research emphasis or paradigm shift has taken place. For example, the volume celebrating the Institute's 50th anniversary [3] summarized silvicultural and ecological research and their relevance to tropical forests in general, with little attention paid to the importance of disturbances to tropical forest functioning and species composition. The passage in September 1989 of hurricane Hugo over the Luquillo Mountains, where most of the research was focused, caused a paradigm shift not reflected at the time of the 50th anniversary in May 1989. That paradigm shift led to the book 'A Caribbean Forest Tapestry: The multidimensional nature of disturbance and response' by Brokaw et al. [4]. In that book, ideas of tropical forest resilience emerged and added new insights into forest conservation in the face of extreme disturbance events.

The recognition by geologists of the onset of the Anthropocene epoch [5] again changed the emphasis of the research program at the Institute and this shift in emphasis is reflected in this Special Issue. The Anthropocene presents new challenges to forest conservation that research programs must address [6,7]. Amongst the challenges, the most perplexing is the uncertainty of conditions faced by both ecosystems and those who study and conserve them, and the response of forests through species composition changes and novelty [8]. Thus, the title of this Special Issue, *Tropical Forest Ecology and Management in the Anthropocene* on the one hand reflects the continuity of the Institute's research focus on forest ecology and management, while on the other hand it recognizes its application and

innovations in relation the challenges posed by the new epoch of the Anthropocene. We asked our contributing scientists and collaborators to review progress on their lines of research in light of the conditions of the Anthropocene.

The resulting contributions to this Special Issue illustrate some of the principal elements of an adaptive research and development program for the conservation of tropical forests in the Anthropocene, which includes the sustainable management of forests. These elements include:

- A long-term focus, required to develop perspective and insight into time-dependent ecological processes.
- Attention to all lands and all species because all have a role to play (social and/or ecological) in an uncertain and changing world.
- Science at many scales because the functioning of ecosystems involves hierarchical processes operating from molecular to global scales.
- Monitoring of changes in biodiversity as essential for adaptive conservation and for maintaining a pulse on the response of biotic systems to changing environmental conditions.
- Experimentation as a way of seeking causality and improving understanding of social and ecological phenomena.
- Understanding novelty in ecosystems, to verify its adaptive role in light of environmental uncertainty.
- Attention to climate and environmental change, which are drivers of biodiversity changes and novelty.
- Studying urban systems because most of the human population increasingly depends on these environments for their habitation and quality of life.
- A social-ecological focus because the production and application of human knowledge in the Anthropocene transcends disciplines and interdisciplinary action. Addressing the wicked problems of the Anthropocene requires transdisciplinary approaches, which incorporate multiple ways of knowing when addressing problems.
- Fomenting collaboration among many social sectors to optimize the use of available resources in support of human activities and their adaptation to future climate and environmental change.
- Developing novel policies for effective governance because many of the policies of the Holocene are outdated and ineffective under Anthropocene conditions.
- Improving institutions and their knowledge systems to make them learning and adaptive organizations sufficiently nimble to be capable of adjusting and transforming in light of changing social and ecological environments.

In Table 1 we relate these elements to Special Issue contributions. We see these elements as evolving notions of the lines of research that help us deal with the uncertainty of the Anthropocene. We see the Institute as a learning and evolving research and development organization that strives to develop knowledge that helps forests and people adapt and transform in the Anthropocene. We look forward to our 100th anniversary when the program will likely look as different from this one as this one itself is different from what we were doing during the 50th anniversary.

Table 1. List of research and conservation elements or activities that contribute to an effective forest research and development program relevant to addressing the uncertainties of the Anthropocene epoch, and example manuscripts in this Special Issue or in recent Special Issues produced by Institute scientists.

Element of Research or Action	Contributed Manuscripts*
A long-term focus	Brown and Lugo [9], González and Lodge [10], Heartsill-Scalley [11]
Attention to all lands and all species	Gould et al. [12], Jacobs [13]
Science at many scales	Fonseca da Silva et al. [14], Medina et al. [15]
Experimentation as a way of seeking causality	Wood et al. [16], Shiels and González [17,18], Shiels et al. [19], Kimball et al. [20]
Attention to climate and environmental change	Henareh et al. [21], Gould et al. [22], Feng at al. [23], Jennings et al. [24], Van Beusekom et al. [25,26]
Monitoring of changes in biodiversity	Campos-Cerqueira et al. [27], Wunderle and Arendt [28], González et al. [29], Heartsill-Scalley and González [30]
Understanding novelty	Lugo and Erickson [31]
Attention to urban environments and their functioning	Muñoz-Erickson et al. [32]
A social-ecological-technological focus	Lugo and Alayón [33], Lugo [34]
Fomenting collaboration among many sectors of society	González and Heartsill-Scalley [35]
Development of novel policies for effective governance	McGinley [36], Rudel [37]
Institutional improvement	M. Rains [38]

* Manuscripts are part of this Special Issue or are recent products of the Institute's program.

2. Conclusions

Long-term ecological research is required to support tropical forest conservation, including active management. Such research needs to be trans-disciplinary with a focus on the social, ecological, and technological aspects of forest conservation.

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