Hurricanes, Ecosystem Services, and Management in El Yunque National Forest

Tania López Marrero and L. Annie Hermansen-Báez

Introduction

In September 2017, Hurricane Irma passed about 70 km northeast of Puerto Rico as a category 5 hurricane (**Figure 1**). Two weeks later, Hurricane María made landfall in the southeast of the island as a category 4 hurricane with about 250 km/h winds. El Yunque National Forest (El Yunque, hereafter) was greatly affected by the hurricanes. Forest defoliation and damage, tree mortality, landslides, floods, and infrastructure damage were among the most visible and immediate effects. In addition, other direct and indirect impacts occurred beyond the ecological systems.

In this fact sheet, we summarize the input of stakeholders regarding the effects of Hurricanes Irma and María on El Yunque's ecosystem

Figure 1. Trajectories of Hurricanes Irma and María over and near Puerto Rico.

services. We also provide stakeholder feedback regarding forest management and research situations after the hurricanes. Within this context, recommendations for managing such situations are included.

Assessing participant perspectives on the effects of Hurricanes Irma and María

Individual interviews were conducted with stakeholders from different groups to document their perspectives regarding hurricanes as a factor driving change in El Yunque. Stakeholders included scientists who work in El Yunque, El Yunque's forest managers, municipal planners from the municipalities in which El Yunque is located, community leaders, and residents living near El Yunque (López Marrero and Hermansen-Báez 2025). Some interviews were conducted in person, while others were conducted by phone or video conference due to the COVID-19 pandemic. Data was collected between 2019 and 2021.

The interviewees were asked their views regarding the effects of Hurricanes Irma and María on El Yunque and its ecosystem services. Specifically, they were asked about the ecosystem services most affected, both negatively and positively, after the passage of the hurricanes. They were also asked to provide recommendations on managing the effects of hurricanes and the challenging situations that can arise.

Key Findings

Negative effects of Hurricanes Irma and María on El Yunque's ecosystem services

Most interviewees focused on the immediate- and short-term adverse effects of the hurricanes on the forest and its ecosystem services. Although they mentioned individual impacts on ecosystem services, they also emphasized the interacting effects between different types of services. The ecosystem services most mentioned by participants as being negatively affected by Hurricanes Irma and María included:

- flora and fauna and associated ecosystem services such as habitat and maintenance of biodiversity. Regarding flora, the most frequently noted impacts included defoliation, detachment of branches, and the fall and mortality of vegetation (**Figure 2**). Proliferation of some vegetation (vines, for example) was mentioned as a negative effect. Regarding fauna, the impact on endangered species, such as the Puerto Rican parrot, was mentioned.
- recreation, human well-being, research, and economic development were identified with limited forest access due to damaged or obstructed roads or trails (**Figure 3**).
- water quality and an associated decrease in erosion control (another often-mentioned impacted ecosystem service), along with landslide occurrences.
- temperature regulation, scenic value, air purification, and carbon sequestration were negatively impacted.

Photo: El Yunque National Forest

Figure 2. Defoliated trees and landslides resulting from Hurricane María's passage.

Photo: El Yunque National Forest

Figure 3. La Coca waterfall, a highly visited destination, after the passage of Hurricane María.

Positive effects of Hurricanes Irma and María on El Yunque's ecosystem services

Several interviewees recognized that hurricanes are part of natural ecosystem processes and positively affect forest ecosystem services. The ecosystem services most mentioned as positively impacted by the hurricanes included:

- research related to the ecological effects of hurricanes in forested ecosystems (**Box 1**). This included development of new research topics and the study of different species, as well as long-term or comparative research within the context of past hurricanes.
- medium and long term effects on flora and fauna. For example, some participants mentioned that

Box 1. Ecological studies of Hurricanes Irma and María in El Yunque

The passage of tropical storms and hurricanes provides opportunities to conduct studies that increase our knowledge and understanding of these disturbances in forest ecosystems. This is the case for El Yunque National Forest, also known as Luquillo Experimental Forest, as revealed by a systematic literature review regarding ecological research conducted in El Yunque by López Marrero and Heartsill Scalley (2024).

A categorization of 45 articles published between 2018 and 2023 related to Hurricanes Irma and María showed that more than three-quarters of the articles addressed hurricane effects on the biotic component of the forest ecosystems, with plants (primarily trees) being the focus of analysis. Fewer studies focused on non-woody vegetation, including ferns, palms, orchids, and herbaceous plants. Animals were the second most studied organism in the biotic-related articles, with effects on insects and snails most studied. Although in smaller numbers, birds, amphibians, mammals, and reptile studies were included in the animal-related articles. Less than a quarter of articles studied hurricane effects on forest ecosystem abiotic components, and primarily focused on fluxes and accumulation of nutrients.

Photo: María M. Rivera Costa

After the passage of Hurricanes Irma and María, field work included the re-measurement of permanent plots in the forest understory at the Bisley Experimental Watershed within the Luquillo Experimental Forest.

opening the canopy provided better growth for some species, as it creates conducive environmental conditions. The fast-growing trees, in turn, favored some of the forest fauna by providing food.

- economic development, which in the short term provided people with employment (e.g., opening and clearing roads and areas in and around the forest).
- forest products, as fallen trees provided wood (**Figure 4**) that people collected and used for different purposes, including economic sustenance (e.g., distribution to sawmills and to make handicrafts and furniture for sale).
- nutrient cycling, which can be accelerated after hurricanes.

Photo: Tamara Heartsill Scalley

Figure 4. Wood recovered after the passage of Hurricane María.

Hurricanes and El Yunque: Some conflicts and challenges

Beyond the visible and more expected effects, such as those listed above, the passage of Hurricanes Irma and María brought a series of conflictive and challenging situations. As expressed by some participants, this occurred mainly with El Yunque administration, management, and research, given that El Yunque is both a national forest with diverse uses and a research forest, known as Luquillo Experimental Forest. Some participants noted that:

- there were different needs, but no effective communication between members of the same group or between groups.
- conflicts arose after the hurricanes regarding different priorities and time scales between administration, management, and research. For example, researchers prioritized accessing their study sites as quickly as possible to research hurricane effects. At the same time, El Yunque management prioritized safety criteria and management operations, resulting in limited forest access for scientists.
- different management scales (for example, local and federal), the arrival of response teams (who did not necessarily have experience or knowledge of post-disaster work in a tropical forest or with hurricanes), and leadership changes resulted in a somewhat chaotic process. For instance, decision-making, protocols, and priorities as well as who defined these were not always clear.
- day-to-day operations and working conditions in the affected facilities, often without essential services, were challenging and unsafe for employees (**Figure 5**). Also challenging was the fact that the personnel dealing with the disaster and the emergency in the forest were also dealing with the emergency at home and with their families.
- forest access restrictions and insufficient staff to manage visitors also resulted in uncomfortable and unsafe situations for employees working with the public, many of whom did not understand that they could not enter the forest recreation areas.
- delays in reconstruction project approval and disbursement of funds hindered post-disaster initiatives and projects.

Photo: El Yunque National Forest

Figure 5. Aerial view of hurricane damage around Forest Service facilities within El Yunque National Forest.

Some interviewees provided recommendations to lessen future challenges and conflicts, particularly in forest management and research issues. These included:

- improve communication on disaster occurrence issues between El Yunque management and scientists conducting research in the forest.
- coordinate meetings between El Yunque administrators, managers, and scientists to discuss the conflicts and difficulties that arose after Hurricanes Irma and María.
- jointly develop clear protocols for post-disaster management and research processes (e.g., forest managers and scientists).
- develop clear procedures for researchers regarding accessing El Yunque research sites after the passage of an atmospheric system.
- have a clear emergency management action plan that is reviewed annually before hurricane season starts and modify it as necessary.

Conclusion

Tropical storms directly impact forests and the services and benefits they provide. Hurricanes Irma and María had both immediate and long-lasting impacts on El Yunque National Forest that were both negative and positive. Beyond the ecological effects on the forest and its services, there were management and research challenges.

Understanding these issues can help with planning for and management of tropical storm effects in El Yunque. The passage of atmospheric systems on and near El Yunque has resulted in a wealth of studies on their ecological effects on the forest and its benefits. This knowledge could be incorporated into forest management, planning, and response before and after tropical storms. This knowledge can also be used to develop educational materials on the effects of atmospheric systems on the forest, both negative and positive. Additionally, management, administration, research, and relation issues must also be addressed beyond the ecological effects. In this sense, conflicts and challenges experienced after the passage of Hurricanes Irma and María may provide an opportunity to promote dialogue, reflection, and action among different stakeholders on the management of emergencies in El Yunque. We hope the results reported in this fact sheet will contribute to that dialogue.

References

López Marrero, T.; Heartsill Scalley, T. 2024. Tropical storms and ecological research in the Luquillo Experimental Forest: A bibliography. [Bibliography]. USDA Forest Service, Region 8. 136 p.

López Marrero, T.; Hermansen-Báez, L.A. 2025. El Yunque Ecosystem Services Project: A Decade Later. [Fact sheet]. USDA Forest Service, Region 8. 5 p.

Acknowledgements

We acknowledge Antonio González Toro for reviewing, Tamara Enz for editing, and Raghu Consbruck for designing and laying out this fact sheet. This publication is part of a research and science delivery project funded through the USDA Forest Service.

How to cite this publication

López Marrero, T.; Hermansen-Báez, L.A. 2025. Hurricanes, Ecosystem Services, and Management in El Yunque National Forest. [Fact sheet]. USDA Forest Service, Region 8. 6 p.

For more information

For more information or if you have questions, contact Tania López Marrero at tania.lopez1@upr.edu.

USDA United States Department of Agriculture