



World Forum on
Urban Forests
Mantova 2018

*PS 4.4 The Present 3:
Changing Environment*

Understanding post-hurricane tree damages at the Arboretum Doña Inés Park, an urban forest in San Juan, Puerto Rico

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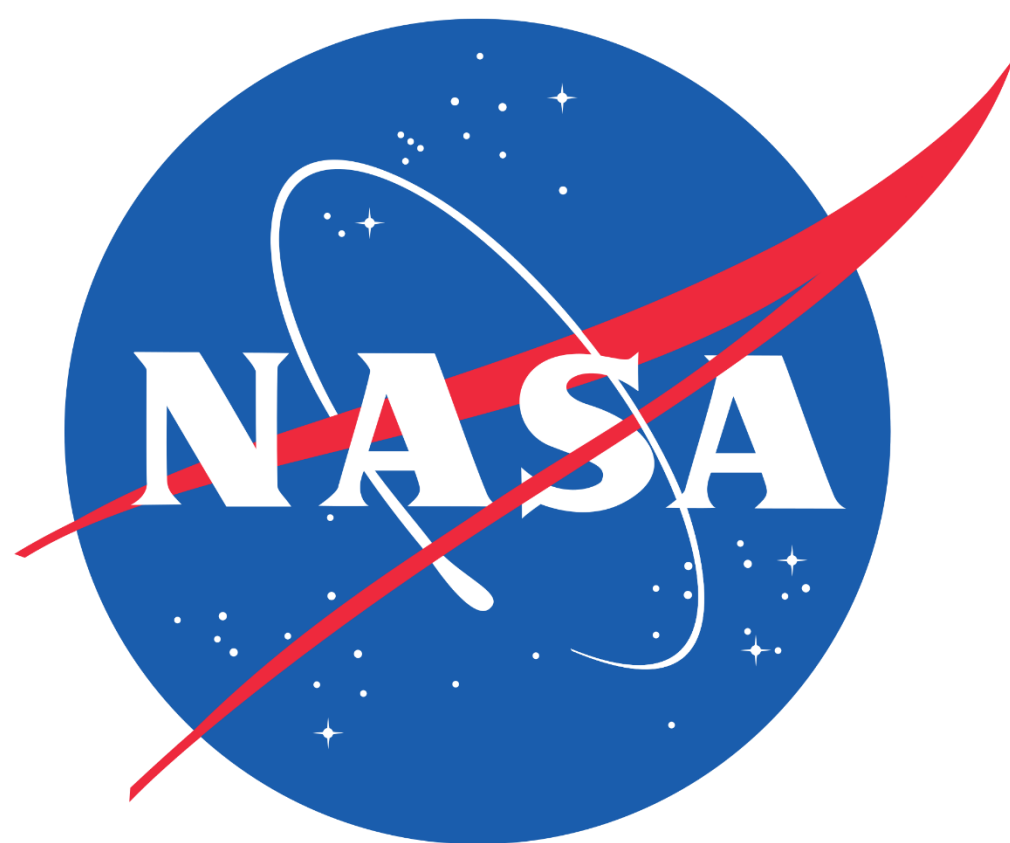
FLMM

Fundación
Luis Muñoz Marín

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Collaborators



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Bruce Cook,
Sebastian Martinuzzi, and
Ian Paynter**

NASA Goddard Space Flight Center, Maryland, USA



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Overview

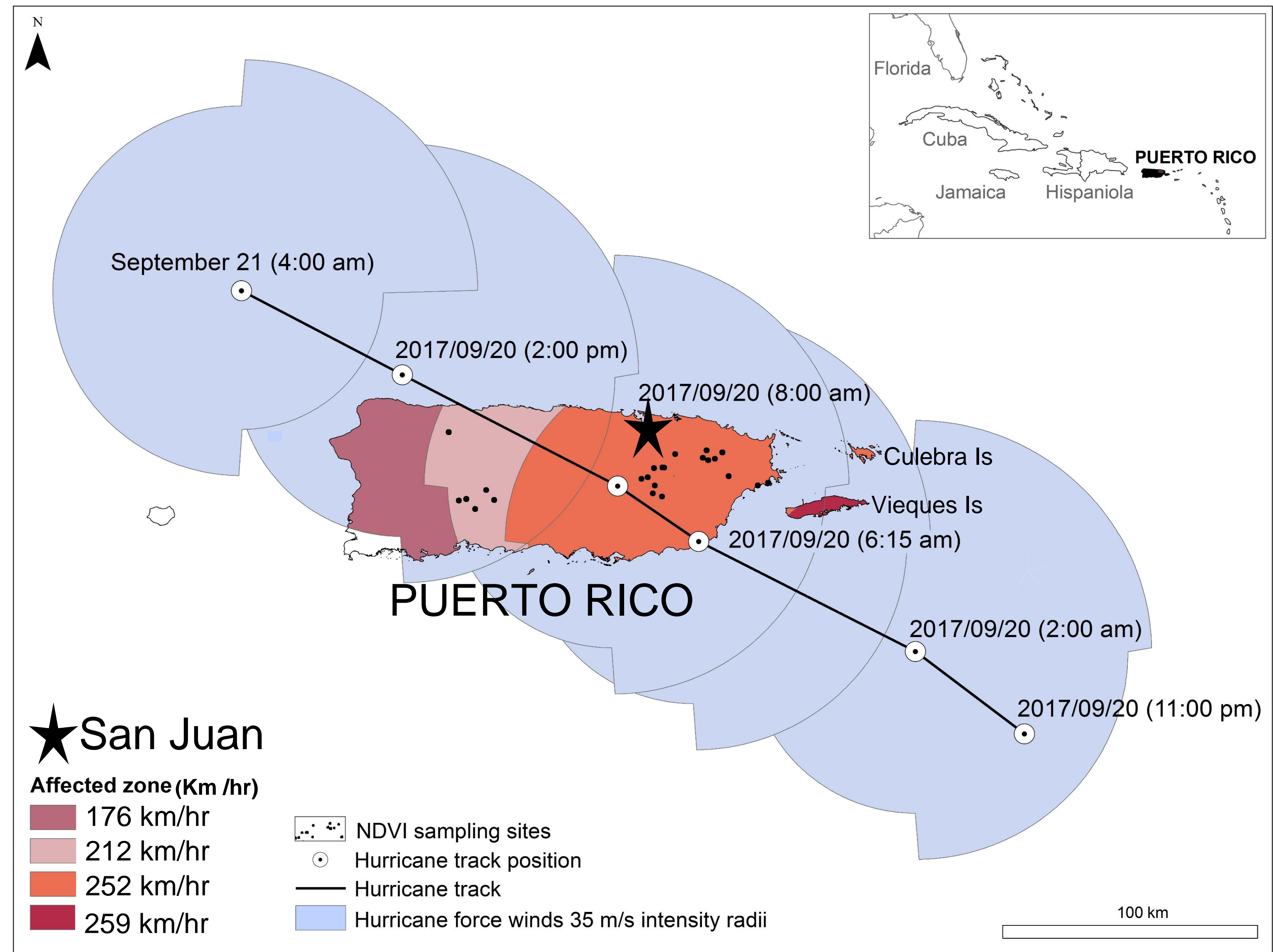
- In September 2017 hurricanes Irma and María struck Puerto Rico causing ca. \$90 Billions (USD) in damages (NOAA 2017) and nearly 3,000 deaths (GWU 2018).
- Preliminary studies from Landsat 8 images suggested it may have caused mortality or severe damage to 23-31 millions trees (Feng *et al.* 2018). However, newer and more robust studies are underway.
- Severe damages was caused to the Arboretum Doña Inés Park, an urban forest composed native and endemic species in San Juan.
- **Hurricanes are part of our ecosystems.**

Max sustained winds
 259 km/hr (161 mph reported
 in Vieques)
 Cat 4 in Puerto Rico

Waves up to 10m in the
 coast

Hurricane eye remained in
 PR for ca. 7 hrs

Most damage was from
 winds and flooding.

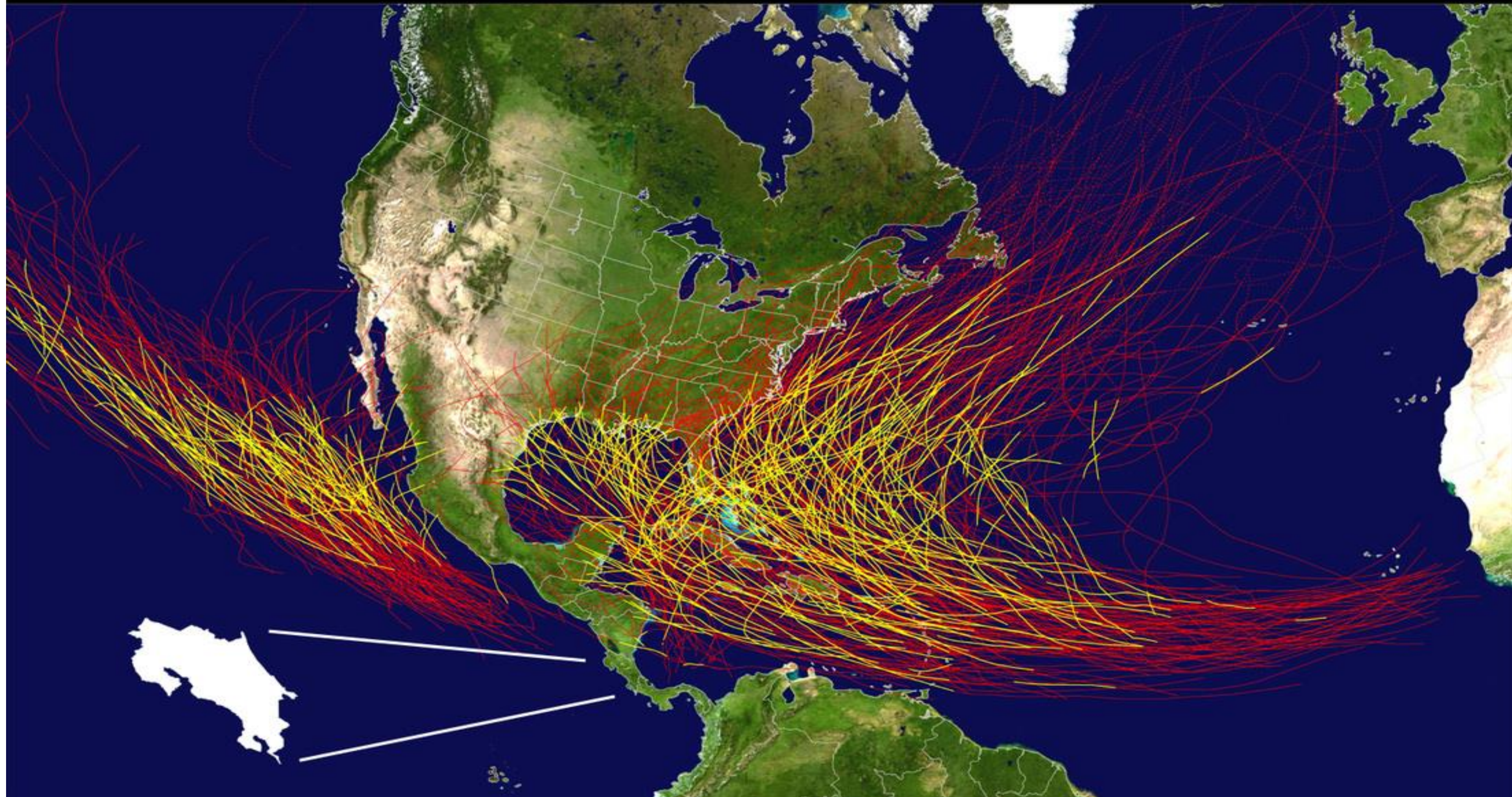




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Major Hurricane History

Data from 1949 in the Pacific, from 1851 in the Atlantic





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Arboreto Parque Doña Inés

4.85 ha

**Planted since
2004**

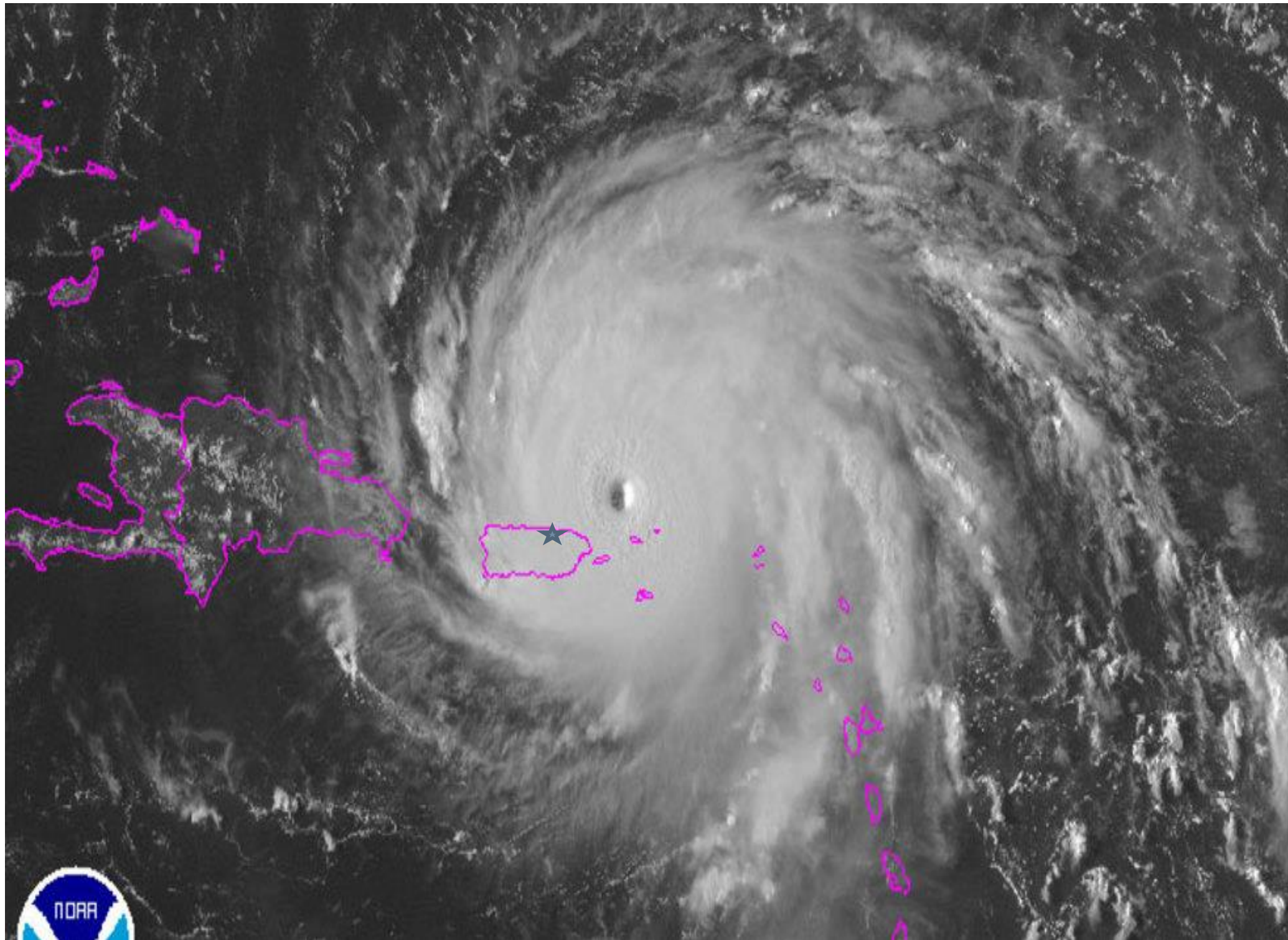




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Our worst nightmare in September 2017 (89 years since the last catastrophic one)

San Juan (Arboretum Parque Doña Inés)

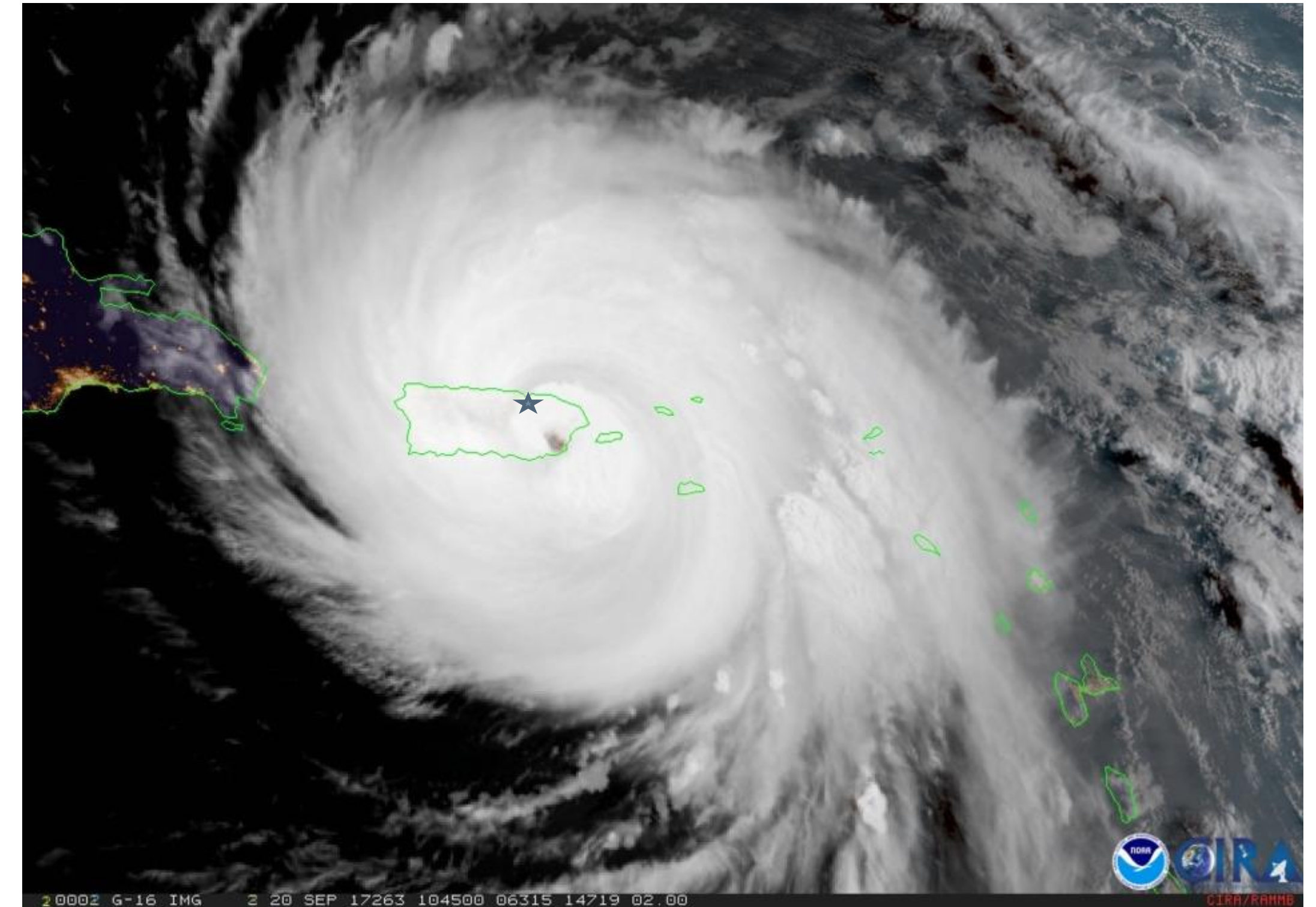


Hurricane Irma

Landfall in PR: Sept 6, 2017

Cat 5 (297 km/hr)

San Juan received ~130 km/hr



Hurricane María

Landfall in PR: Sept 20, 2017

Cat 4 (252 km/hr)

San Juan received all its force, but it left PR as Cat 3



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Drone images – 7 days after Hurricane María

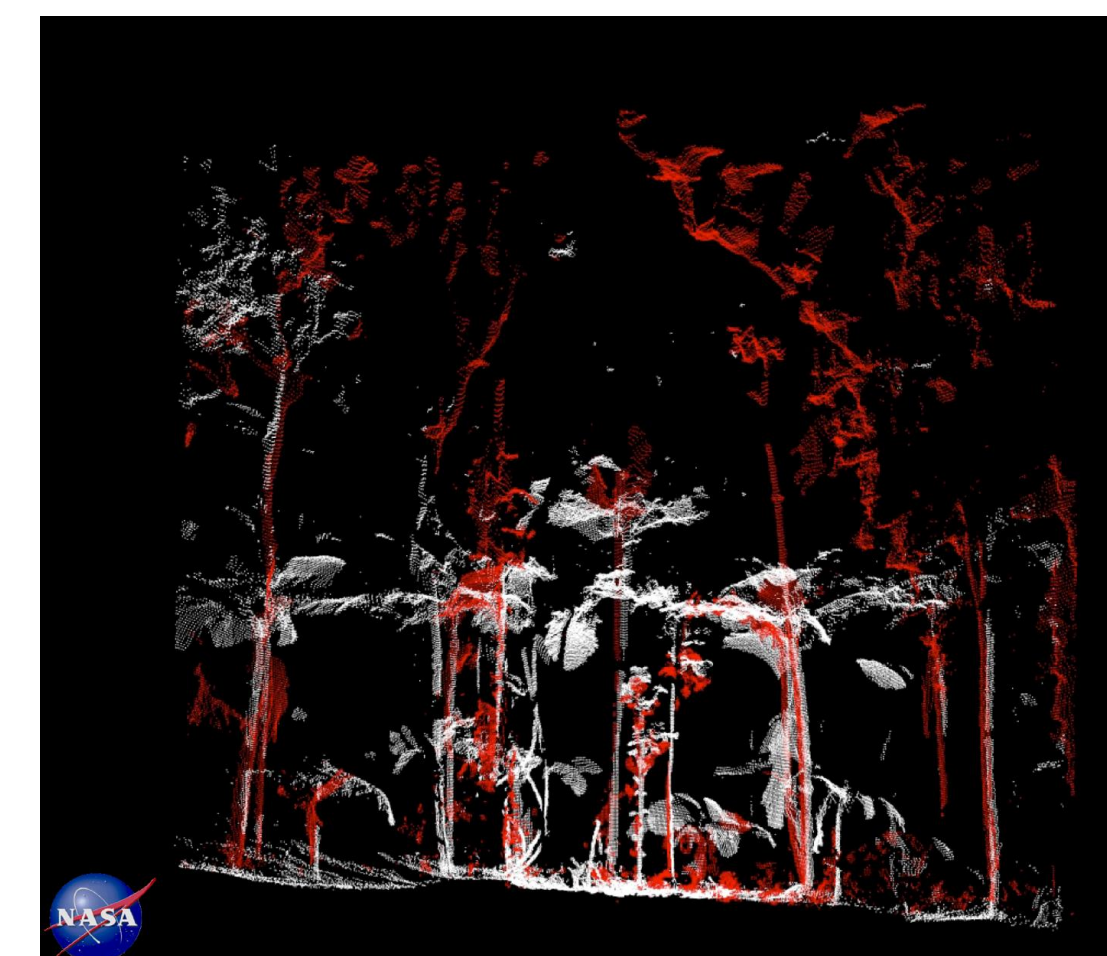
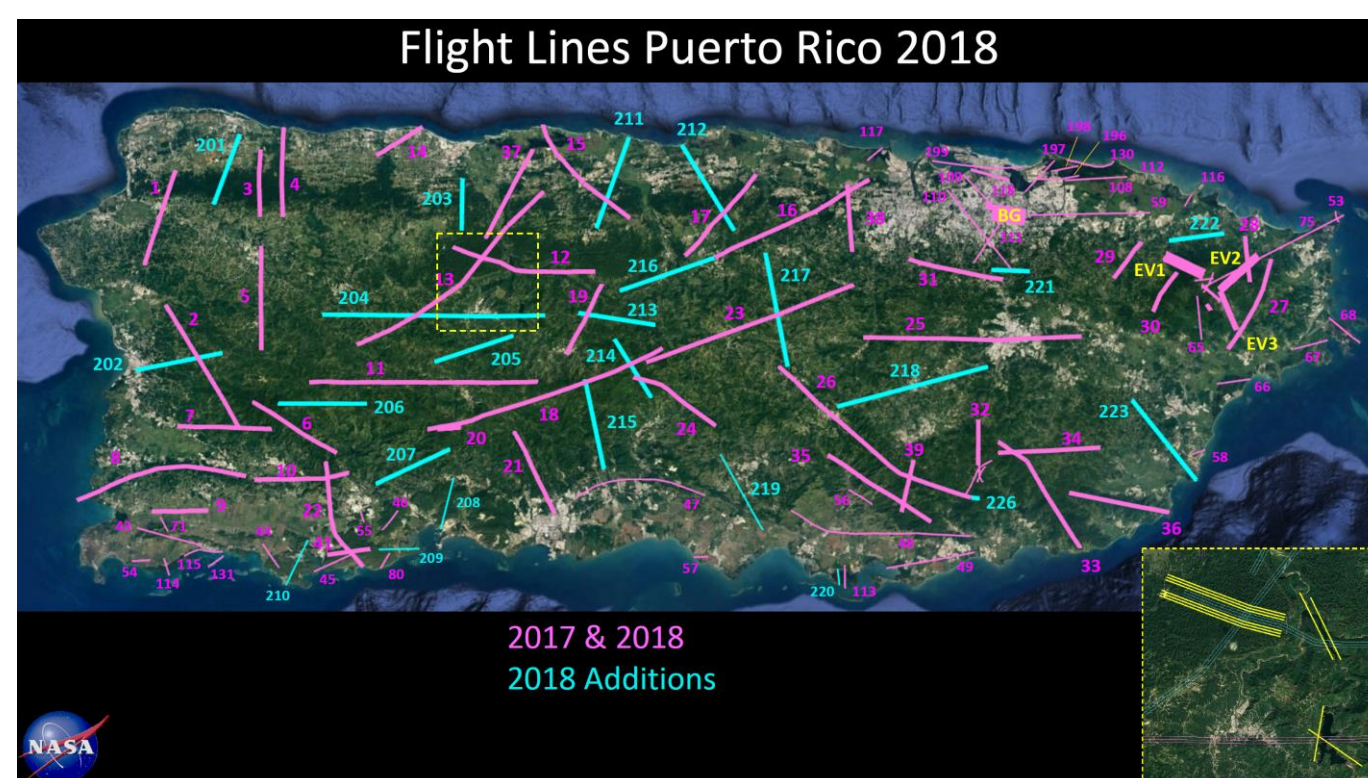
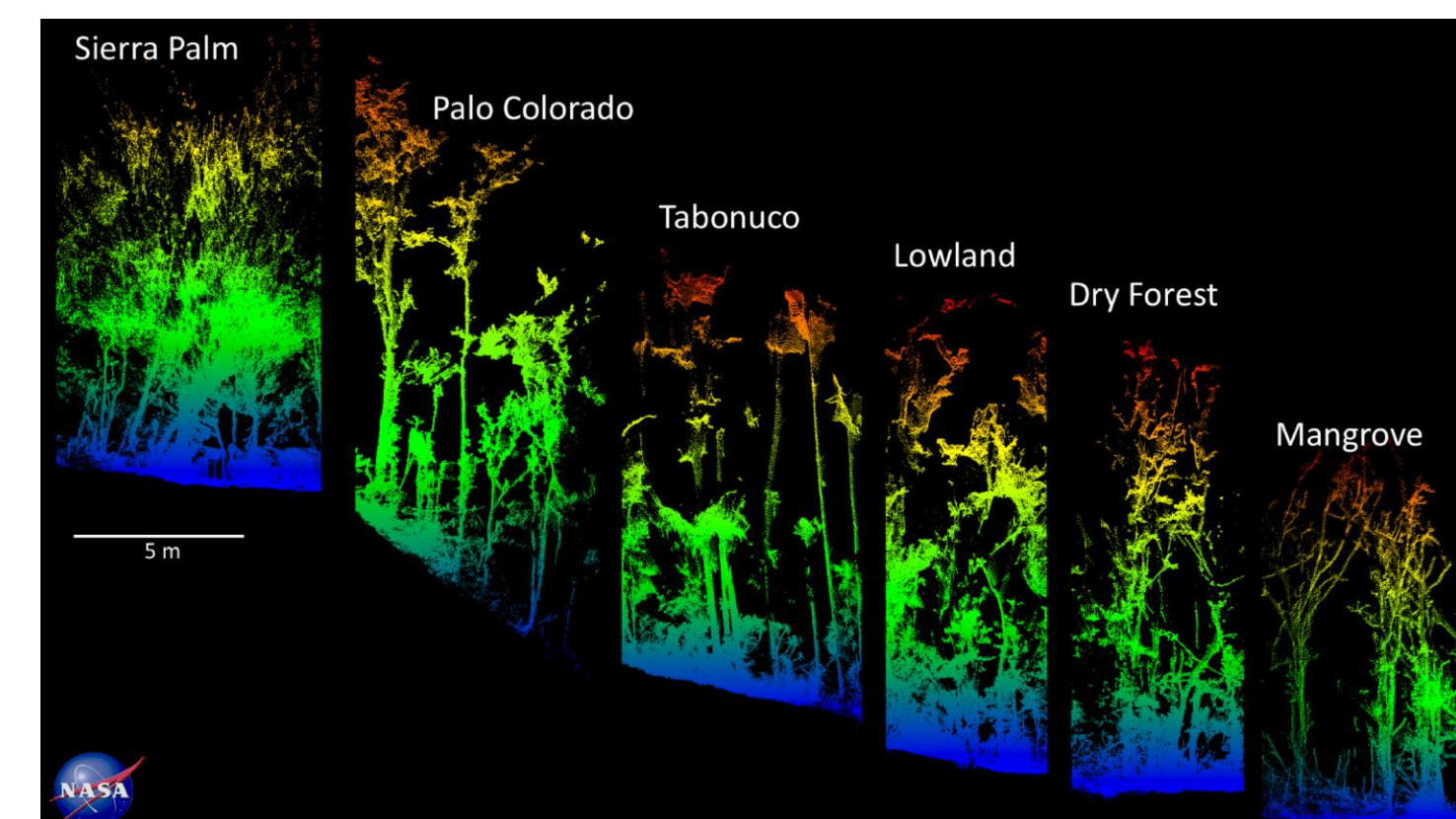
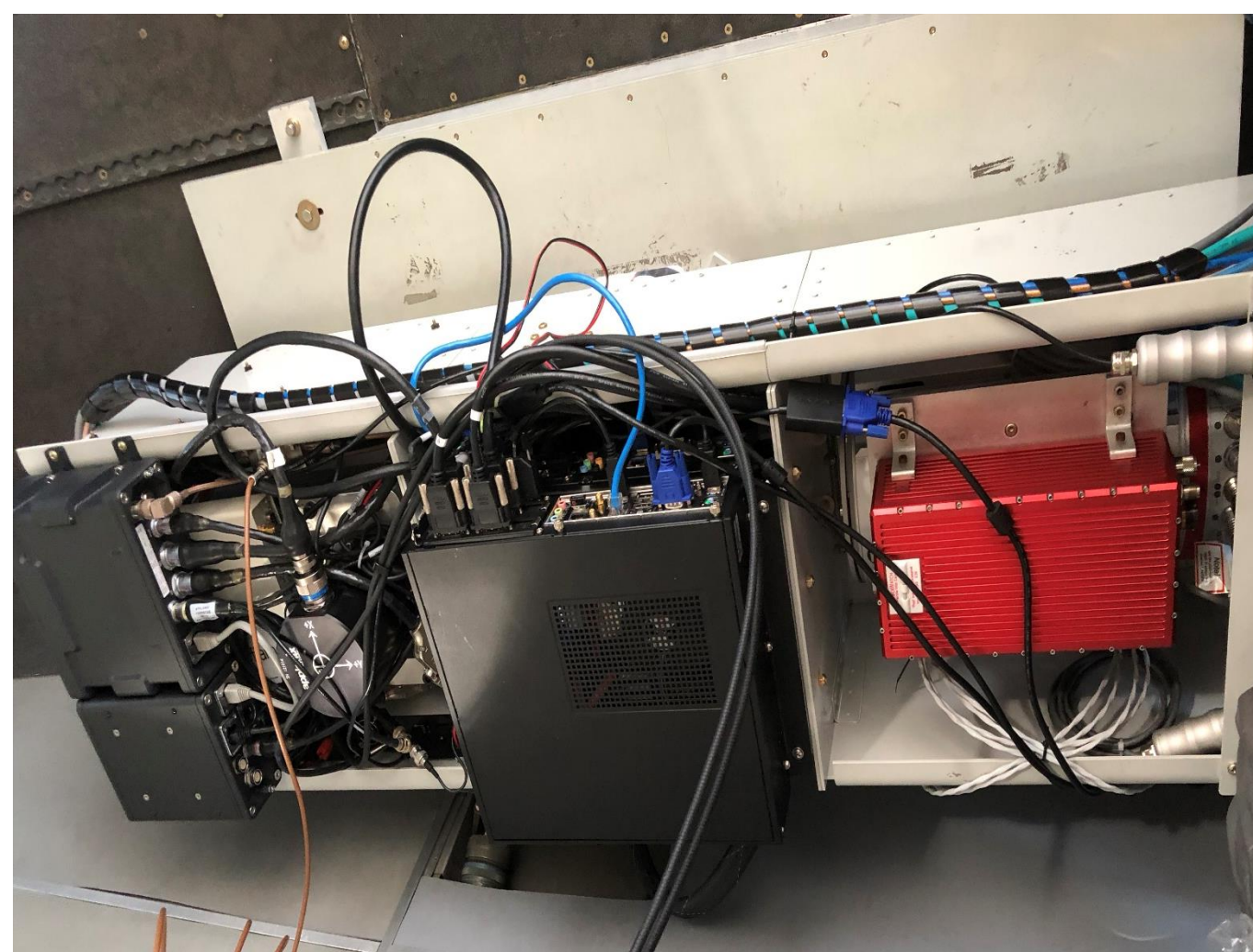


Ground sampling methodology

- In the urban forest, **Arboreto Doña Inés Park** in San Juan, a total of **465 native and endemic trees (36%)** of its living collections were killed by uprooting, snapping their trunks and canopy, and almost 100% were defoliated. Ten spp. were lost from the collections. Few specimens were saved.
- DBH, height and took notes on the damage.
- Living trees were GPS and tagged.
- Para La Naturaleza provided assistance.



NASA Goddard's Lidar, Hyperspectral and Thermal airborne imager



<https://gliht.gsfc.nasa.gov>

Arboretum in Mar 2017 and in Apr 2018 (Hurricanes Sept 2017)



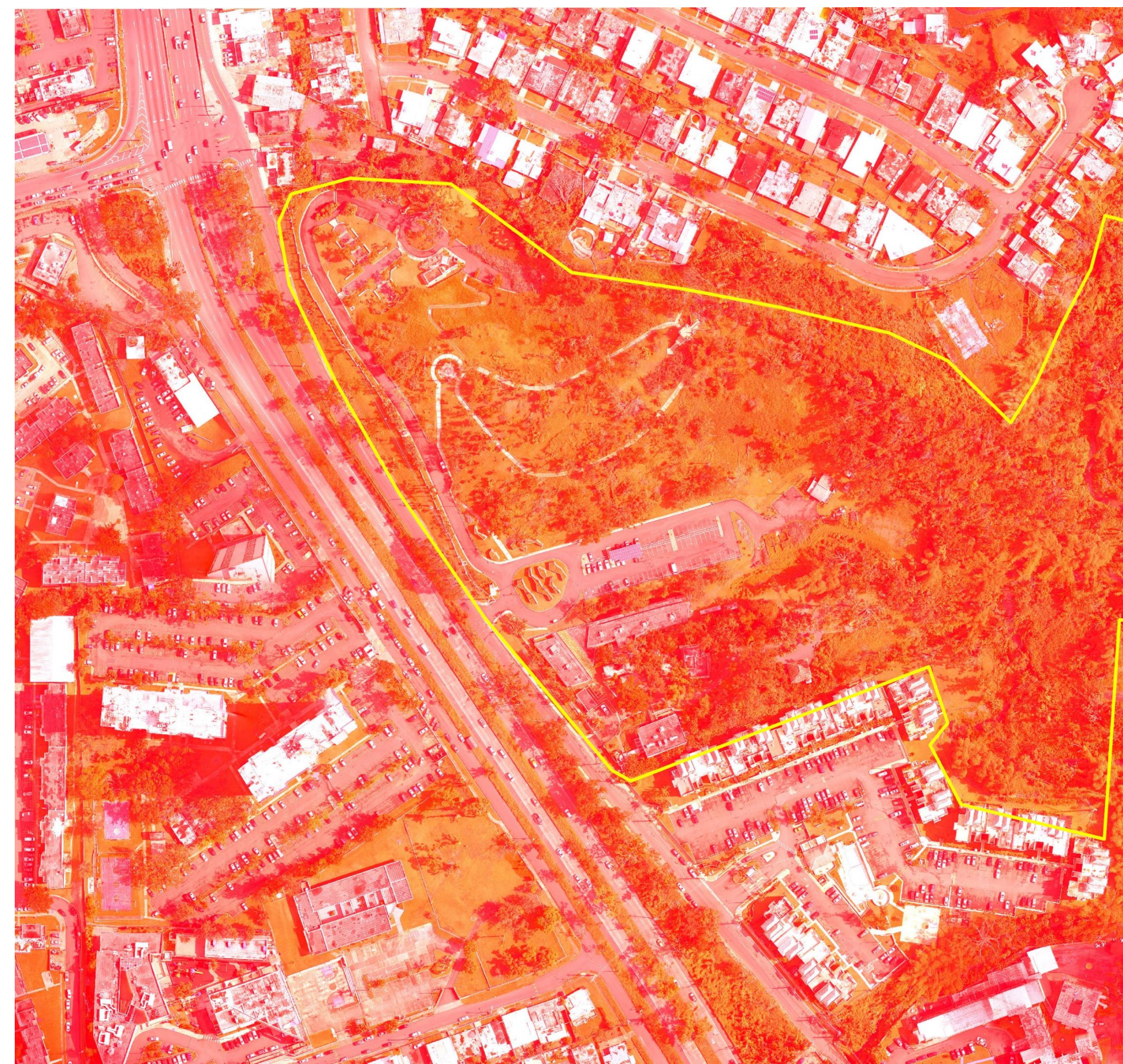


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Infrared



Mar 2017



Apr 2018

Normalized difference vegetation index (NDVI)



Mar 2017



Apr 2018



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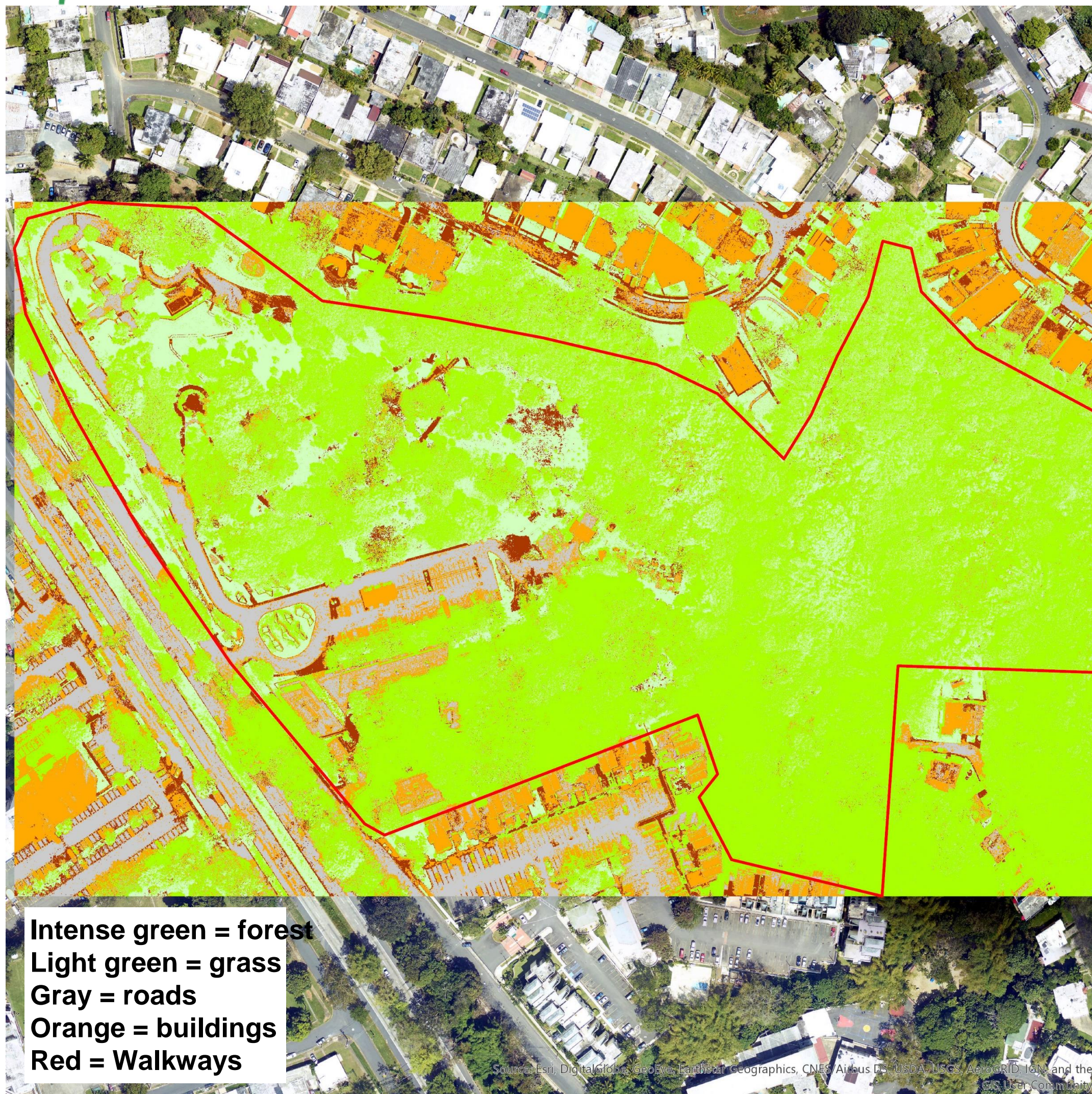
A mix of before and after



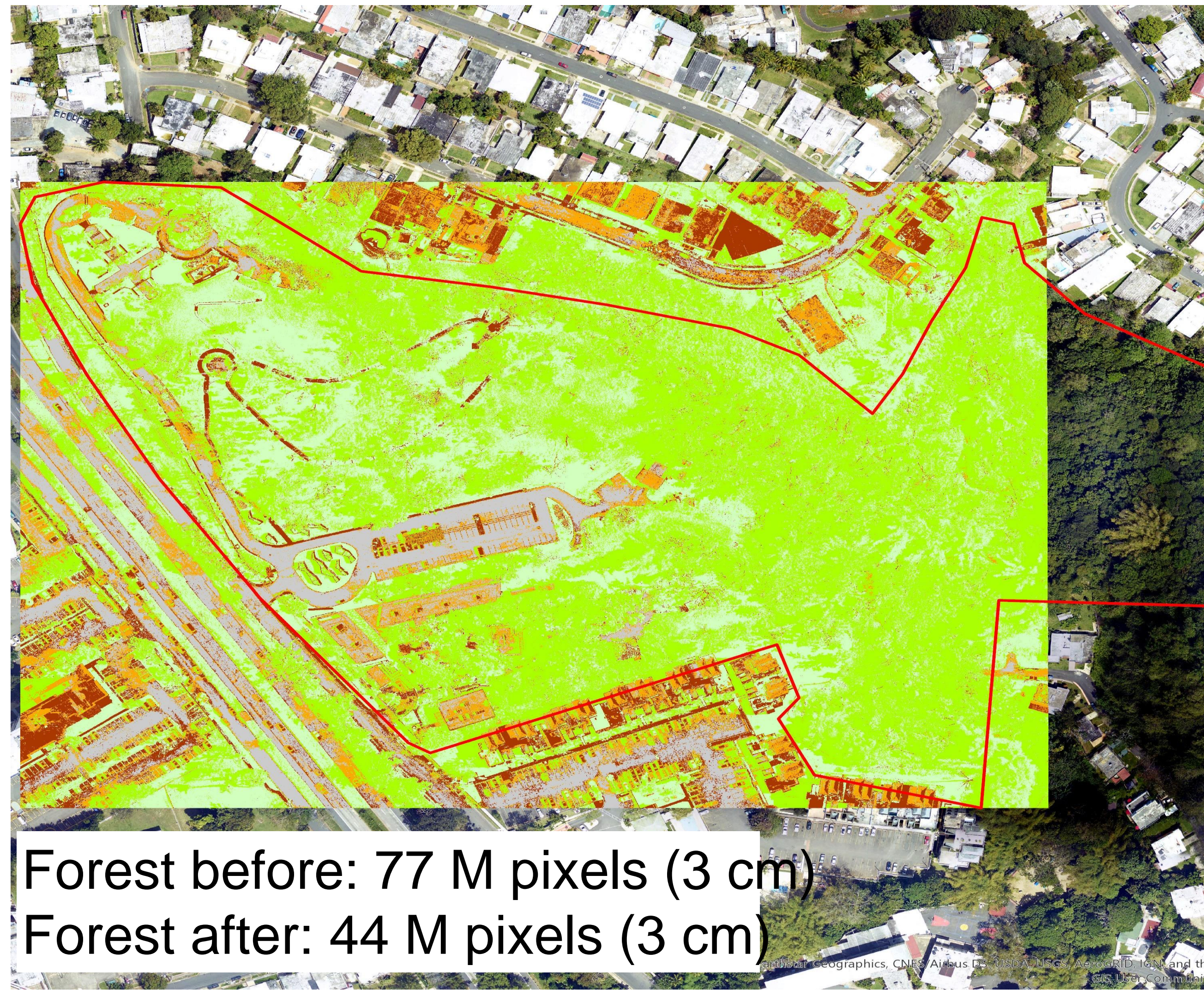


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Maximum Likelihood Analysis (3 cm pixels) – 5 classes



Mar 2017



Apr 2018

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