

# Impact of Fuel Supply Chain Disruptions on Energy Resilience: A case for Nuclear Energy

Guillaume L'Her, Mark Deinert



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  - Hurricanes, seismic, landslides, floods, temperature extremes, ...
  - Hurricanes are notably important in the caribbean region as they can cause high wind, flooding, and landslides

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## Puerto Rico, U.S. Virgin Islands closer to getting \$2 billion for electric grid repairs

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Recent power outages across the island, including one that left nearly ...  
3 days ago



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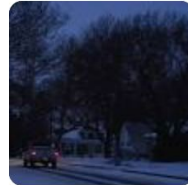
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**Go read this investigation into the real death toll from the Texas freeze**

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Texas has so far acknowledged 151 winter storm-related deaths.

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The New York Times

Texas Power Grid, Strained Last Winter, Now Faces an Early Heat Wave

Power outages were already a problem in Pueblo de Palmas, ... across the nation face worsening wildfires, flooding, hurricanes and other ...  
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Power outages in Texas  
national news  
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Power blackout leaves darkened Puerto Rico isolated and paralyzed

Hurricane Maria's devastation of the U.S. territory of Puerto Rico last week left the entire island and its 3.4 million residents without power.

Sep 25, 2017



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WSJ Wall Street Journal

Hurricane Maria Bears Down on Puerto Rico After Battering  
Dominica

Rivera was bracing for a long period without electricity. Many areas in Puerto  
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Miami Herald

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UCS blog

Pacific Standard

## Hurricane Maria Leaves the Caribbean in Shambles

The third in a string of cataclysmic hurricanes, Maria hit the islands just ... homes, dousing streets, and leaving the entire island without power.

Sep 21, 2017



## Why People in the Dark?

...n, through the entirety of ...  
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## Rico After Battering



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# Energy Impact of Natural Hazards

- Resilience:
  - Being able to absorb, and very quickly recover from, hazard events
- Most developing countries and at risk regions in developed countries do not have a resilient enough power infrastructure
- Three main avenues for resilience:
  - Impact on transmission lines
  - Impact on power plants
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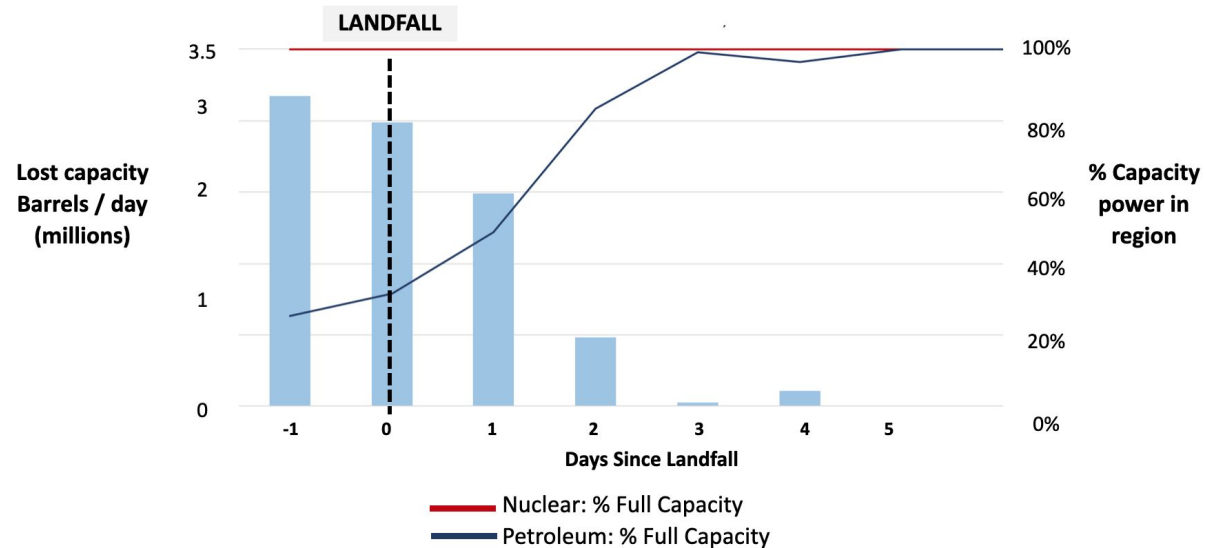
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	Fossil	Wind	Solar	Nuclear
Transmission	Red	Red	Red	Red
Power plant	Orange	Red	Red	Green
Supply chain	Red	Green	Green	Green

# Context by example: Harvey

- Harvey hit Texas, USA on August 26, 2017
- Diverse energy sources allowing for anecdotal comparisons of impacts:
  - Oil/Gas shortages
  - High wind, no sun: renewables offline
  - Nuclear stayed online



# Keeping climate change in mind

- Climate change will increase the frequency and severity of natural hazards
- Fossil fuels need to be replaced by carbon-free energy sources, notably:
  - Hydroelectricity
  - Wind
  - Solar
  - Nuclear

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- Nuclear energy is a clean and stable energy source
  - Designed to be resilient to external events
  - Remove the need for frequent refueling



# Our Analysis

- Quantify the fossil fuel refueling risk
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  - Siting possibilities
  - Follow US Nuclear Regulatory Commission rules

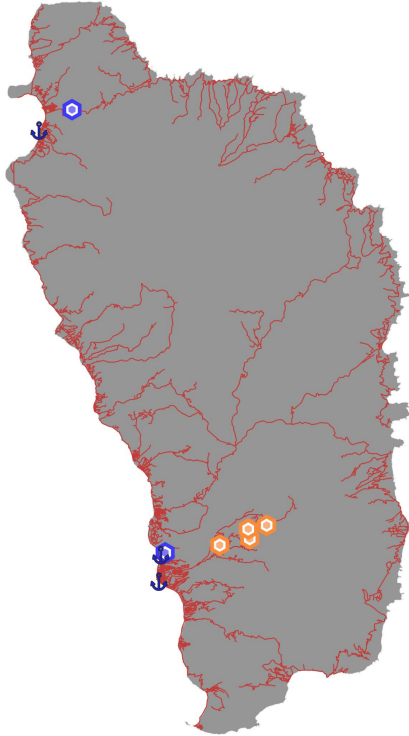
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- Demonstrate on the Commonwealth of Dominica

Dominica



# Existing Infrastructure In Dominica



 Hydropower

 Diesel plant

 Seaport

2 Diesel plants:

- Fond Cole (south) → 13.3 MW
- Sugar Loaf (north) → 6.8 MW

Hydropower:

- Roseau river → 6.6 MW

3 Ports

# Exposure Assessment and Informed Probabilities

*An example of road **exposure** to natural hazards*

*Failure probabilities are obtained for each road segment*

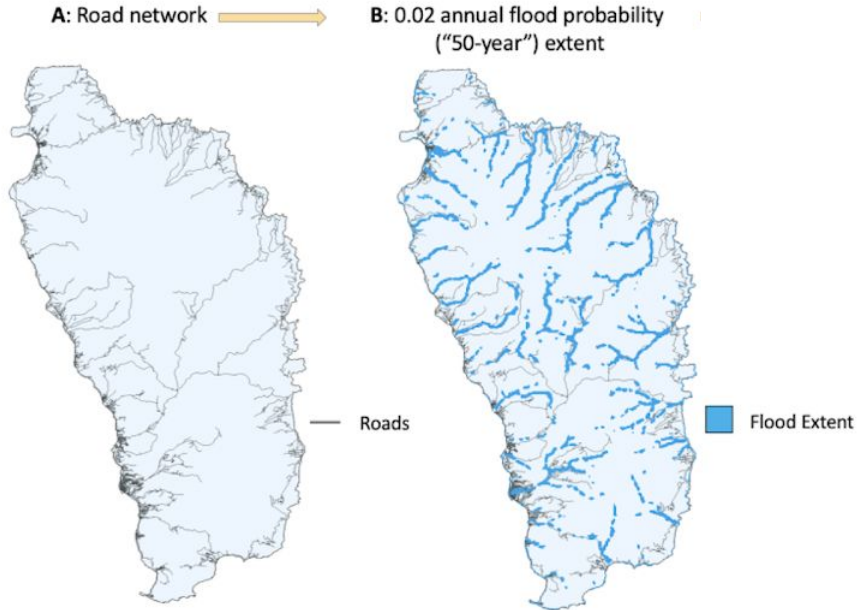
A: Road network



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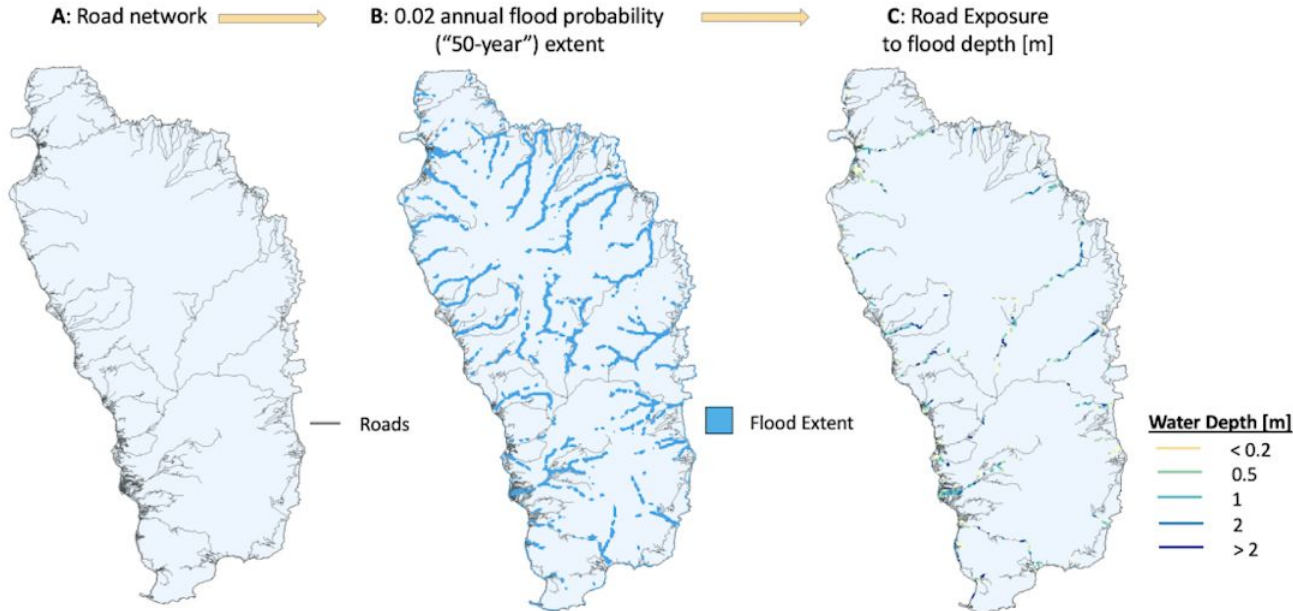
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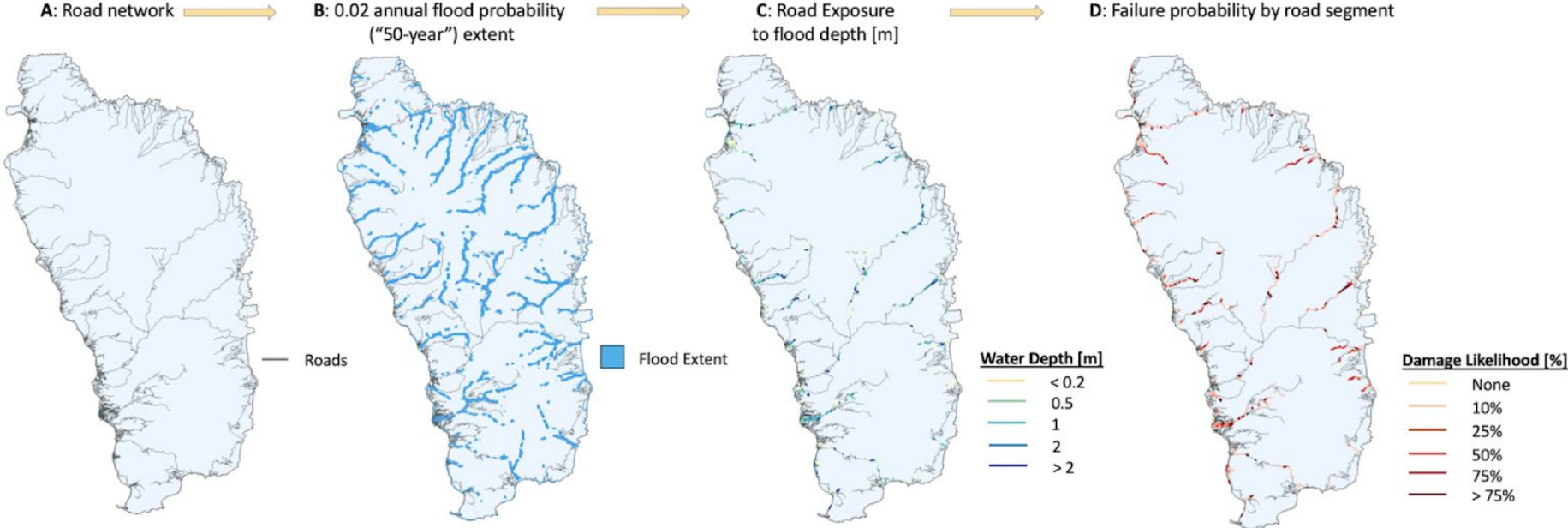




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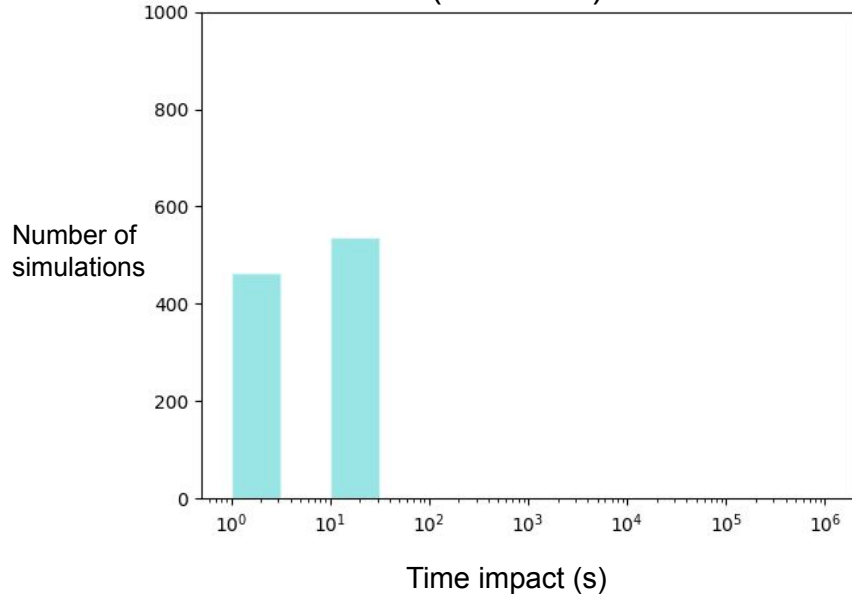


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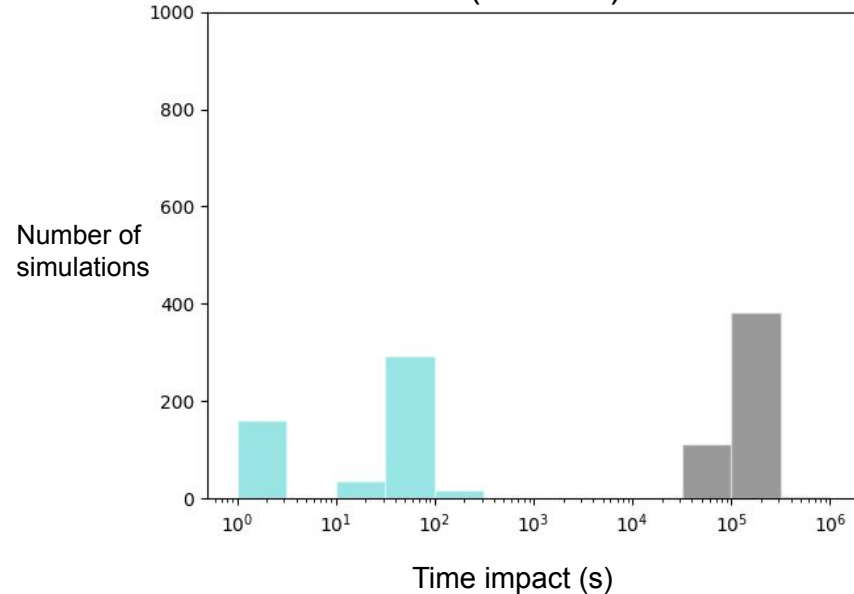
Monte Carlo analysis:

- 1000 simulations
- The network is disrupted according to the road segment failure likelihood in a 50-yr flooding situation.
- Supply chain impact is obtained (in terms of time)

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(13.3 MW)



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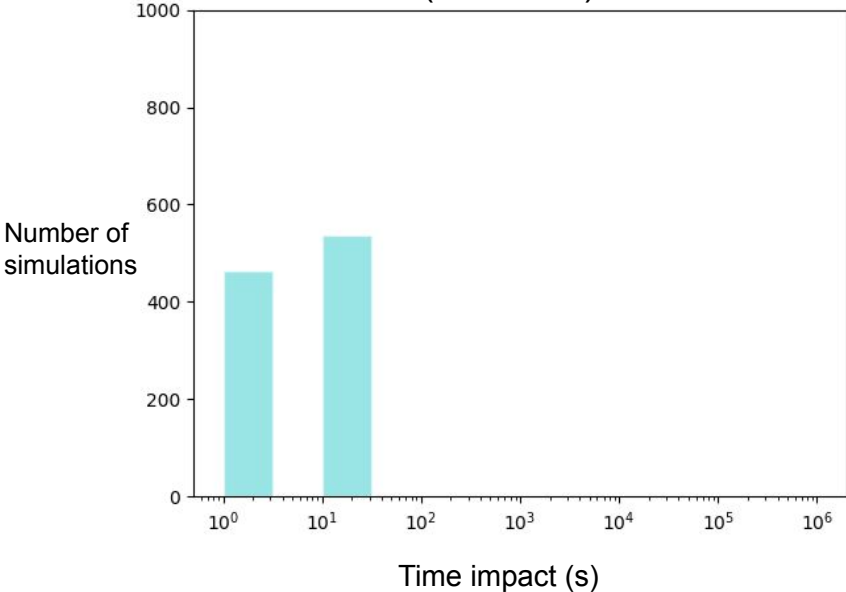


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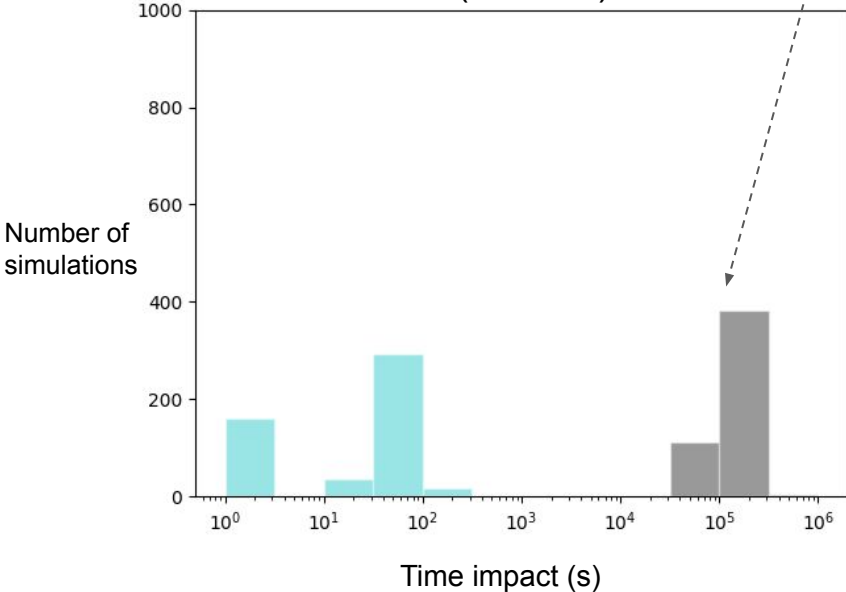
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Stranded asset!

# Market Opportunity For Nuclear Energy

- 20 MW of fossil fuel power to transition
  - 6.8 MW at high risk of supply disruptions
- Another 6.6 MW at high flooding risk (run-of-the-river hydro plants)
  
- Between 6.8 and 26.6 MW market on this developing island nation

# Local Potential of Nuclear Energy

- The potential of Small Modular Reactor (SMR) is assessed locally
  - Using NRC siting regulations, find siting locations of interest to show viability
- Use Geospatial Information System analysis
  - Combine all relevant map data layers to reveal suitable nuclear siting locations

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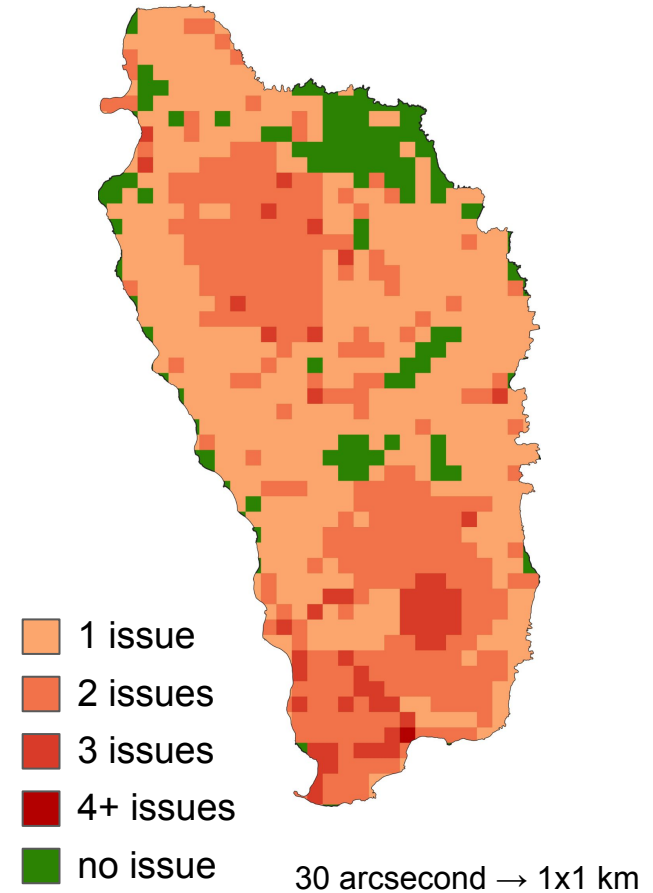
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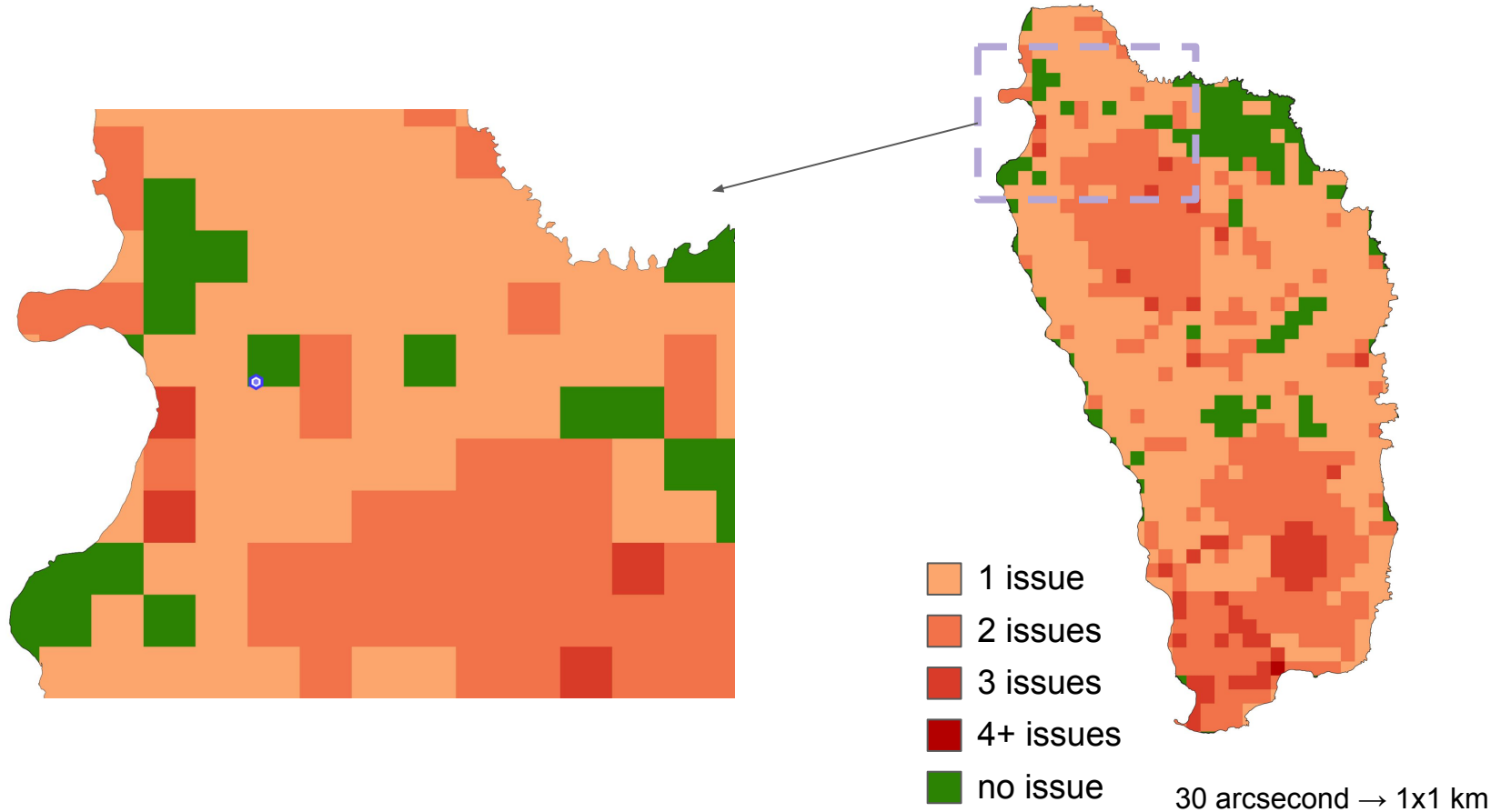
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- Land within a volcanic high risk area is excluded.

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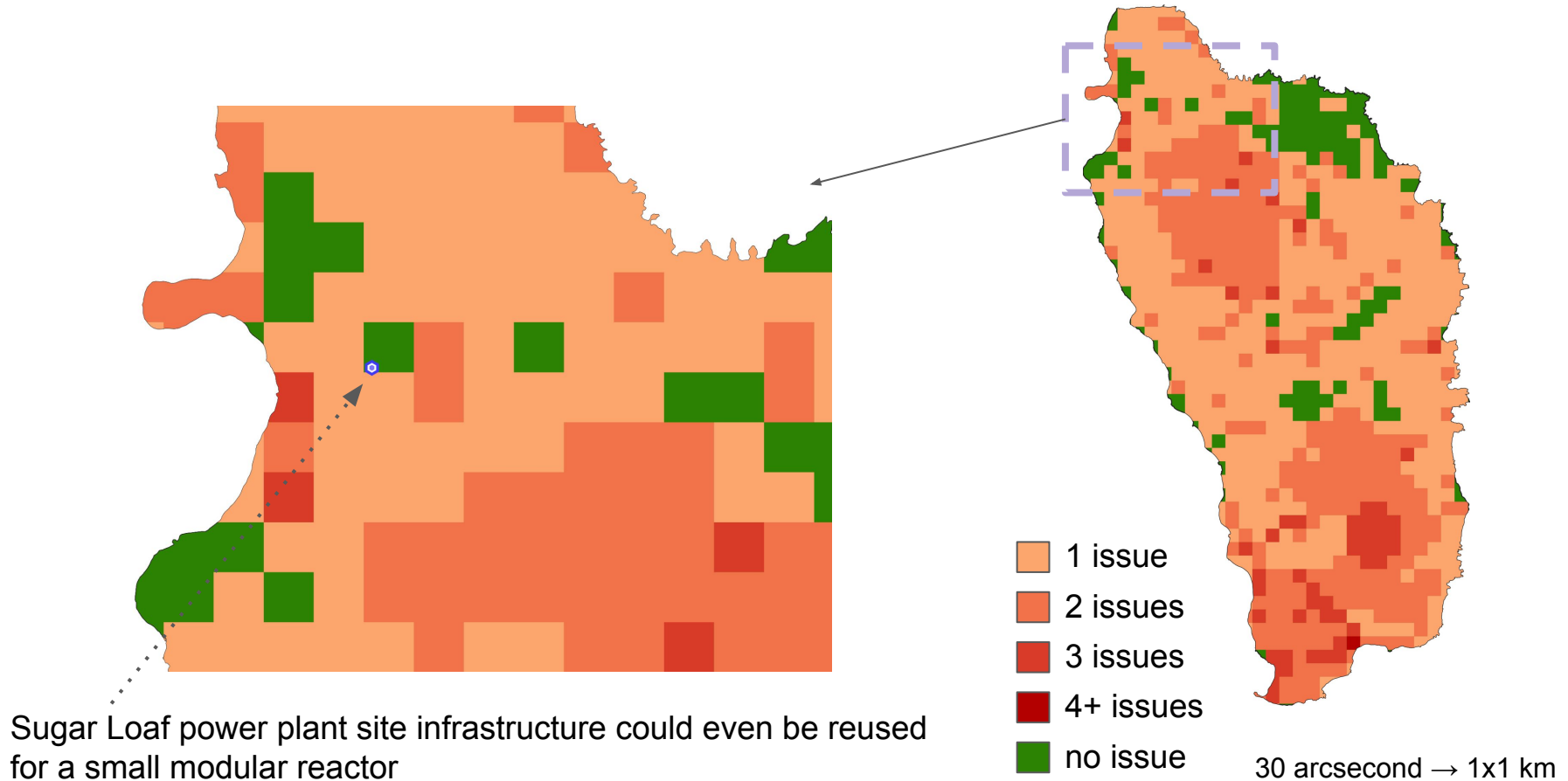




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  - Responsible (clean, and plays well with renewable energy microgrids)
- Emerging grids: SMR and MMR market
  - Adapted to small grids in development
  - Scalable
  - Suitable locations exist