GIS supported optimal site selection for coastal structure integrated wave energy converters

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Near Shore Energy Potential for Coastal Structure Integrated Wave Energy Converters

(in TWh/year)

Sea level rise in US projected to rise **~1ft by 2050**

350,000 homes & buildings are located w/in 500 ft of a coastline that is vulnerable to erosion and coastal storms

Current rate of coastline hardening is **124 mi/year**

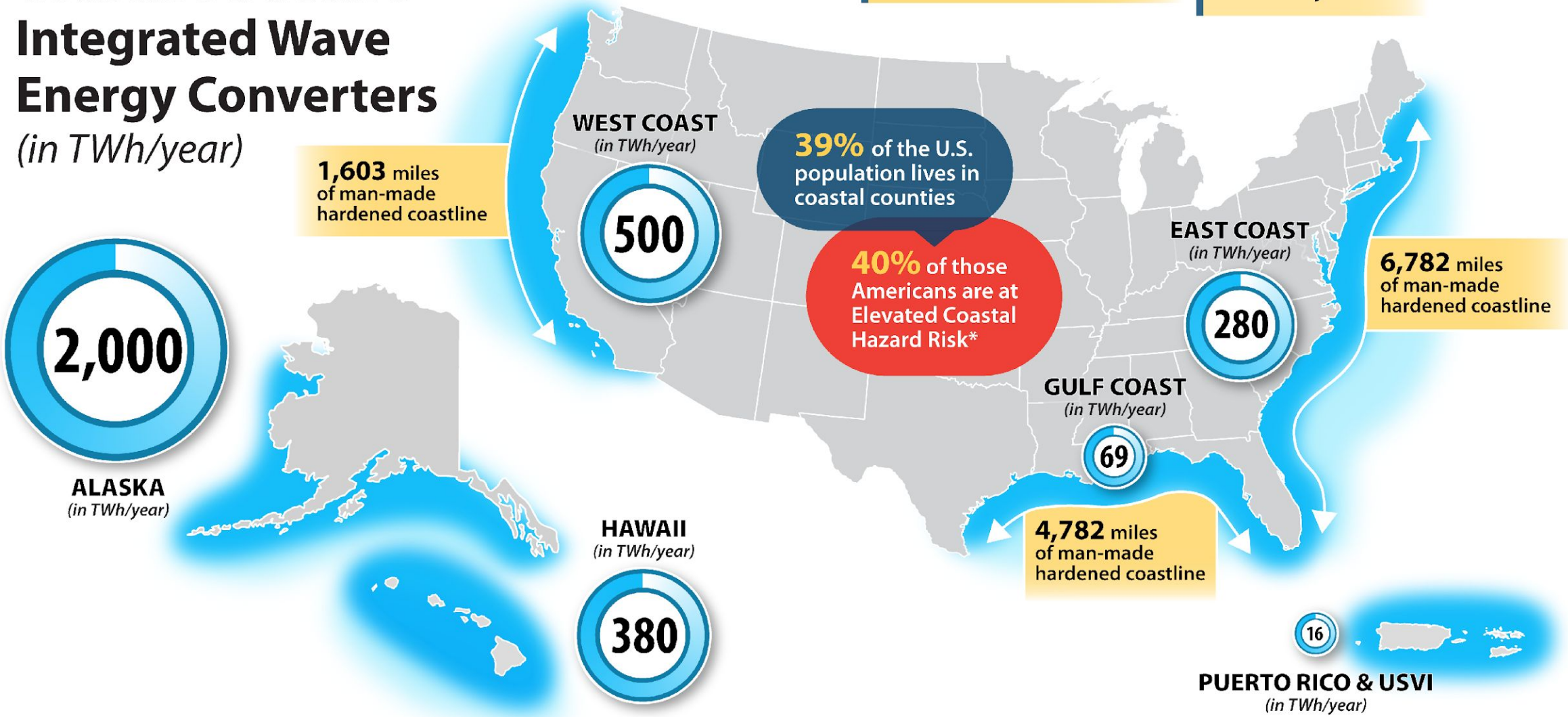


Illustration by Tara Smith, NREL

*This estimate includes children, the elderly, households where English is not the primary language, and those in poverty (NOAA)

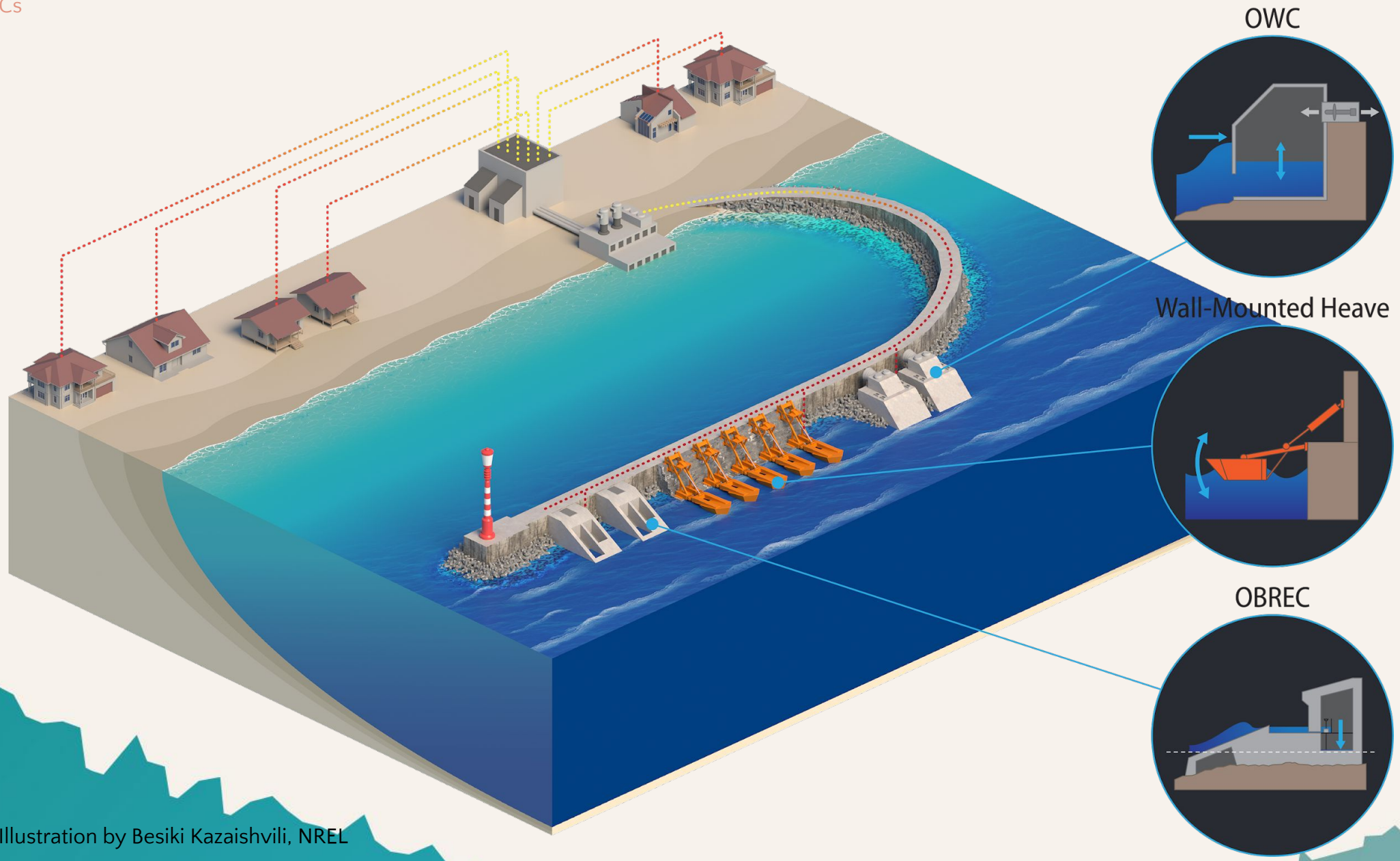


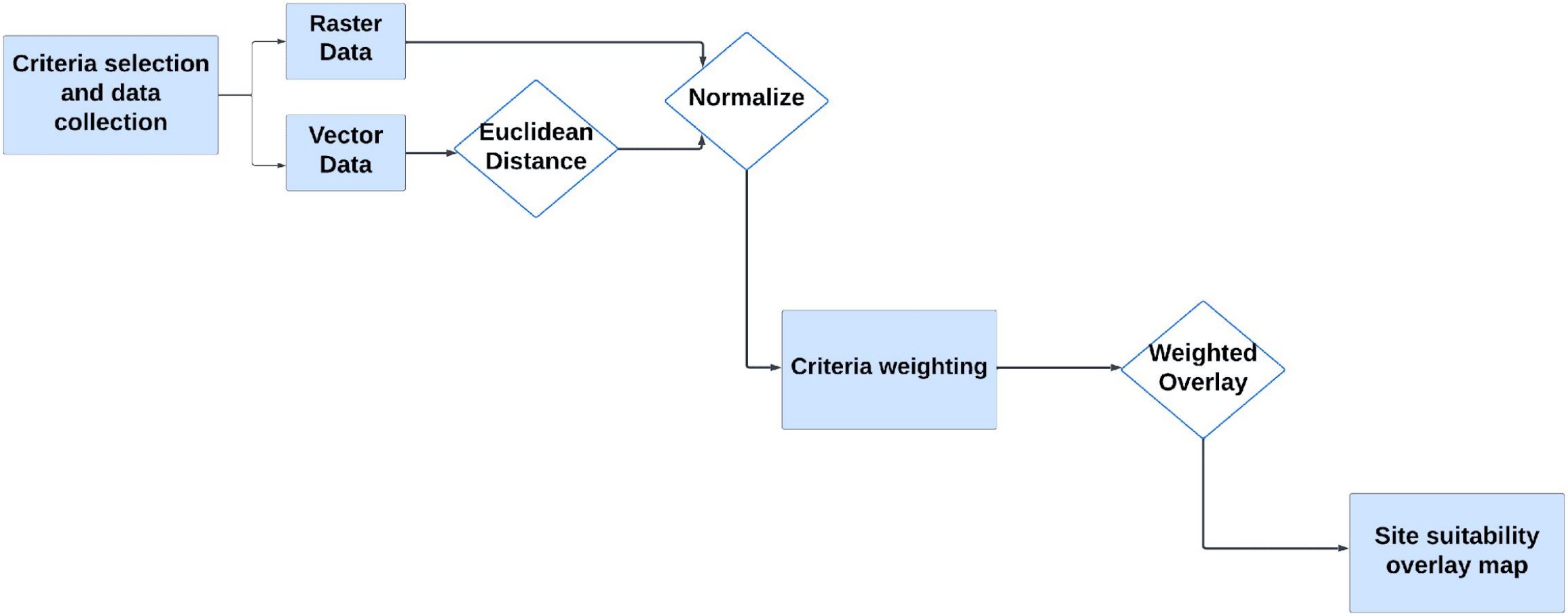
Illustration by Besiki Kazaishvili, NREL

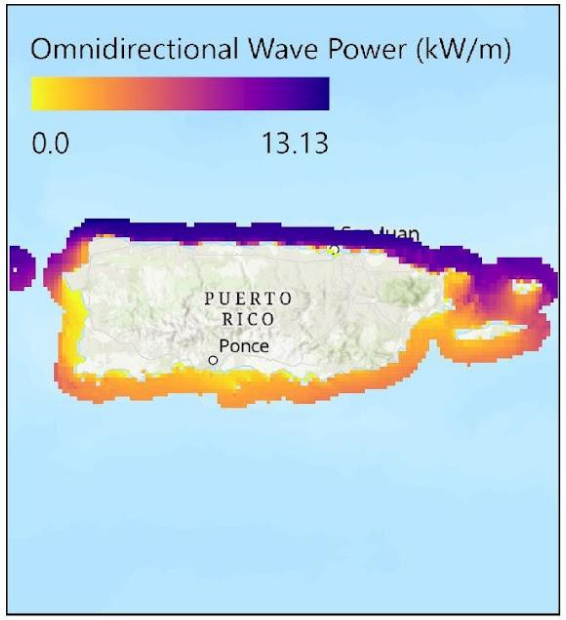
Site Selection

- CSI-WECs require unique siting considerations due to their nearshore location
- GIS visualizes and manipulates geospatial data
- GIS-integrated tools can analyze diverse data for optimal marine energy sites
- Multi-criteria decision analysis (MCDA) allows for the evaluation of multiple criteria

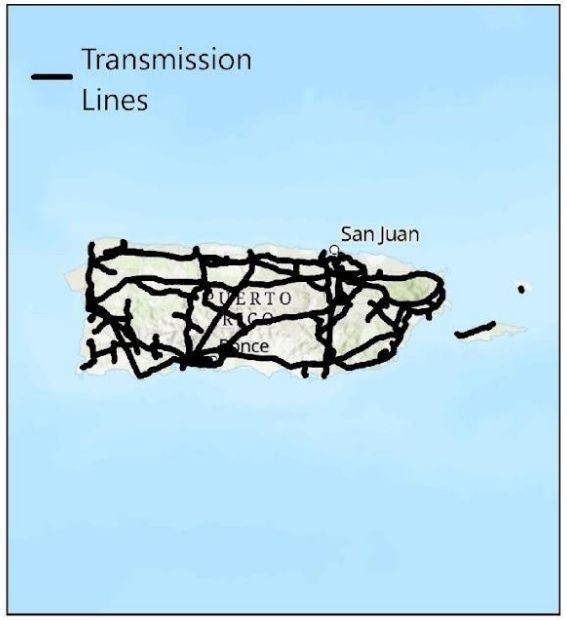
- Hurricane vulnerability
- Energy insecurity

- Immense wave energy resource
- Extensive shoreline

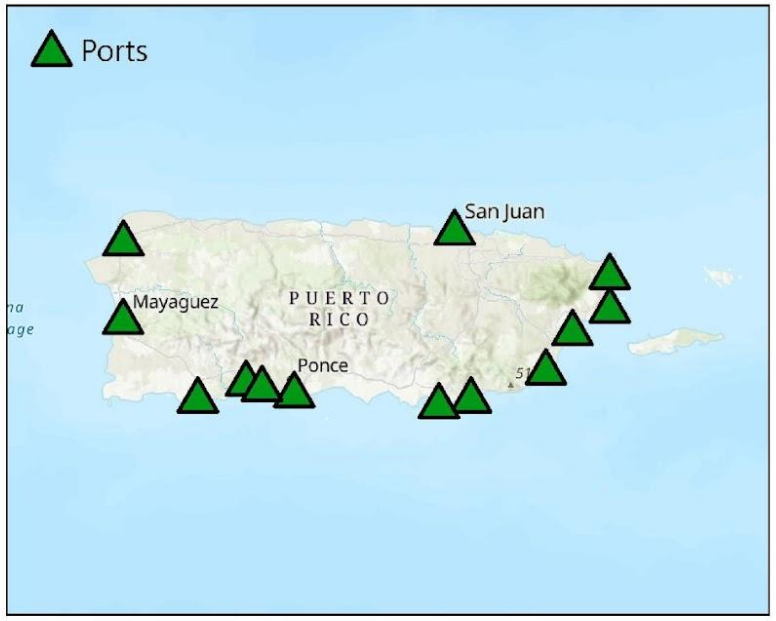

Criteria selection and data collection
Raster Data
Vector Data
Euclidean Distance
Normalize
Criteria weighting
Weighted Overlay
Site suitability overlay map

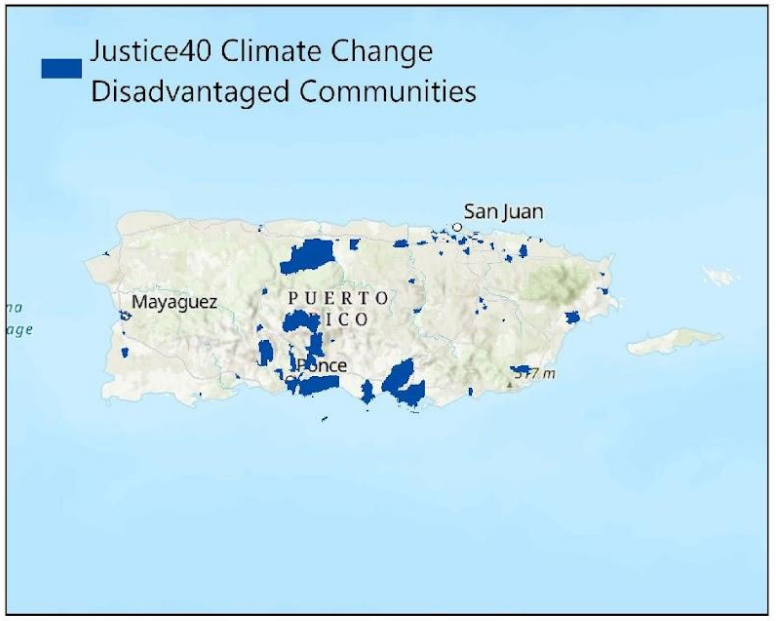

Omnidirectional Wave Power (kW/m)
0.0
13.13
PUERTO RICO
Ponce

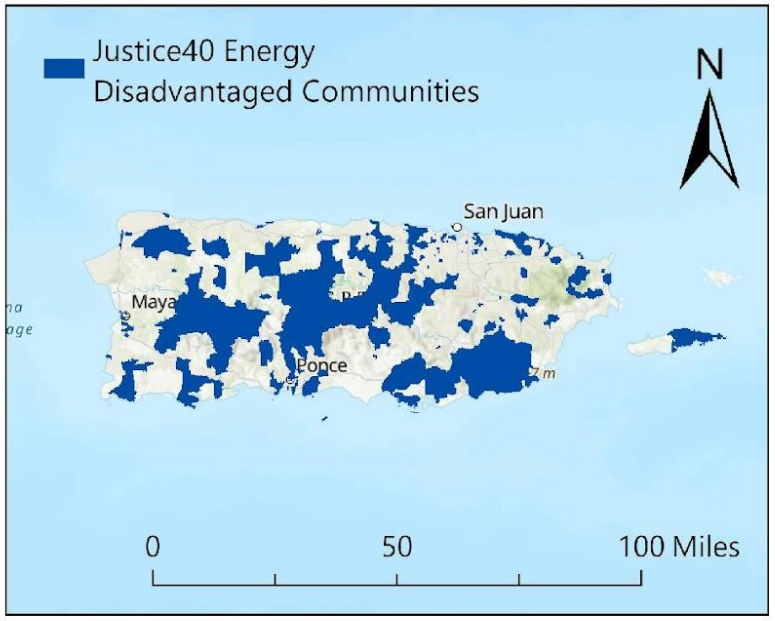

City
PUERTO RICO

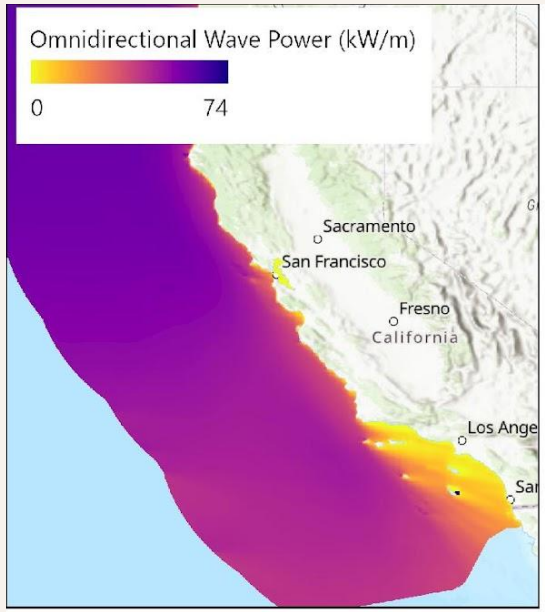

Transmission Lines
San Juan
PUERTO RICO
Ponce

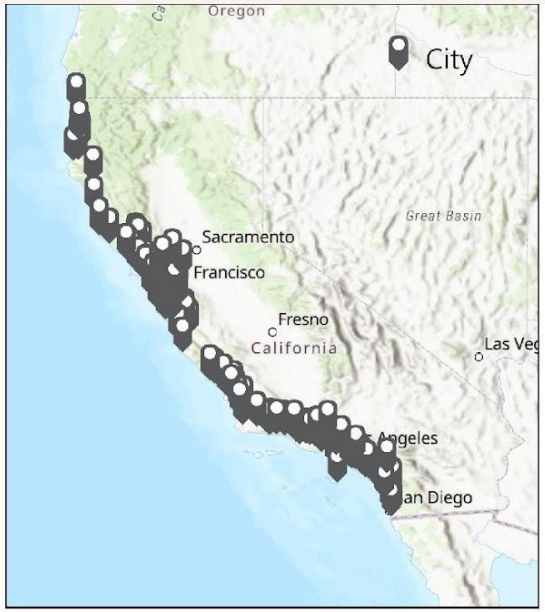

Military Danger and Restricted Zones
San Juan
PUERTO RICO
Ponce


Ports
San Juan
Mayaguez
PUERTO RICO
Ponce

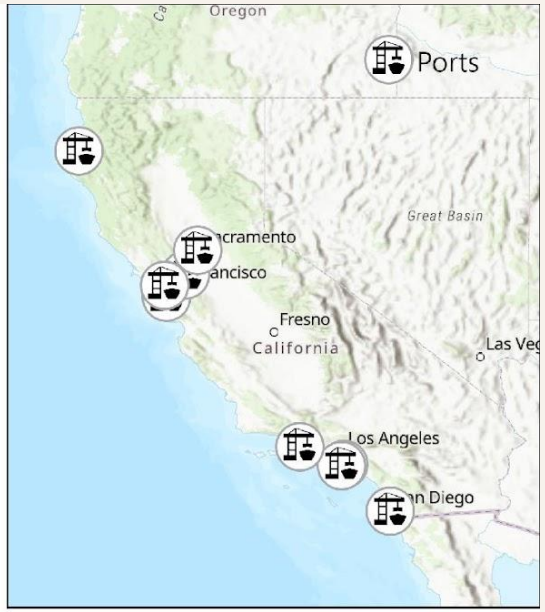

Justice40 Climate Change Disadvantaged Communities
San Juan
Mayaguez
PUERTO RICO
Ponce

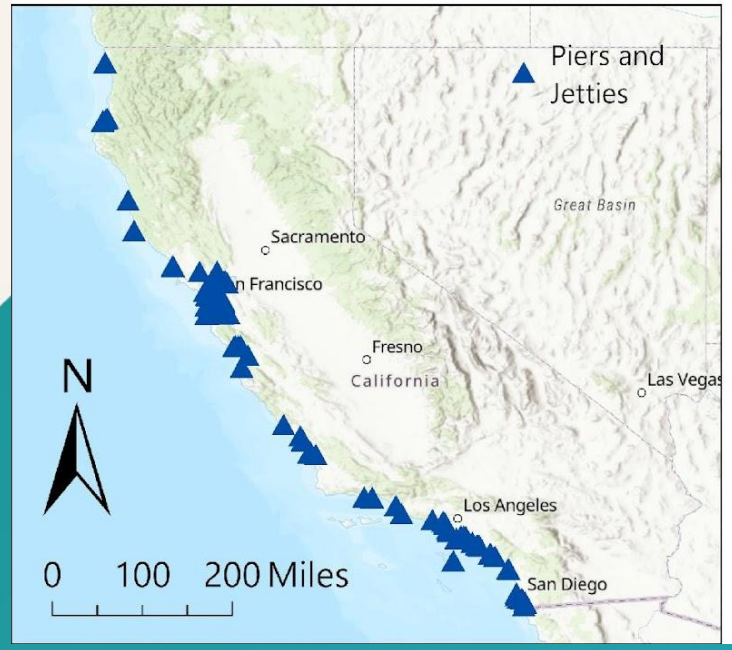

Justice40 Energy Disadvantaged Communities
N
San Juan
Ponce
0
50
100 Miles


Omnidirectional Wave Power (kW/m)
0
74
Sacramento
San Francisco
Fresno
California
Los Ange


Oregon
City
Great Basin
Sacramento
Francisco
Fresno
California
Las Veg
Angeles
an Diego

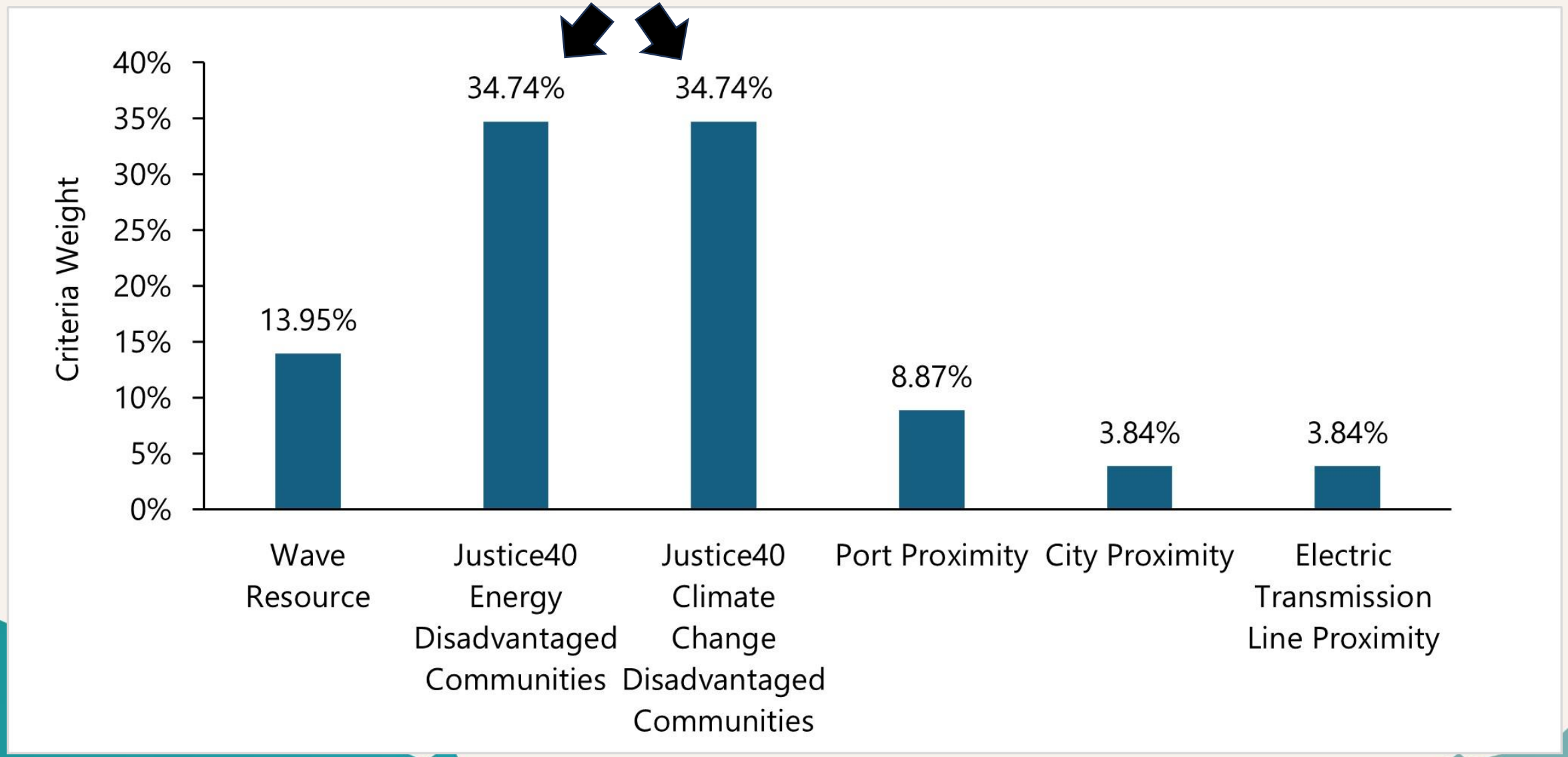

Oregon
Transmission Lines
Great Basin
Las Veg

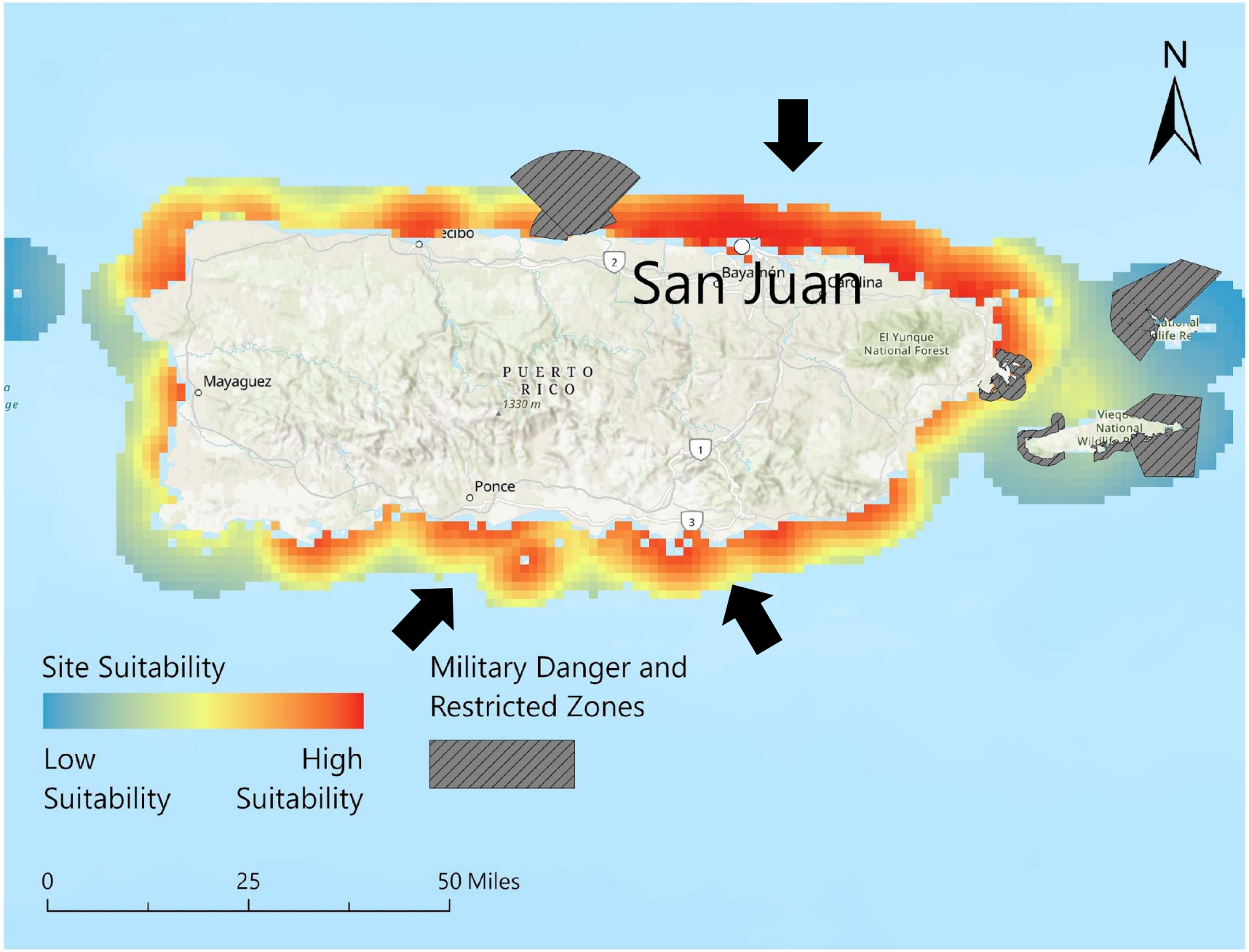

Oregon
Ports
Great Basin
Fresno
California
Las Veg
Los Angeles
n Diego

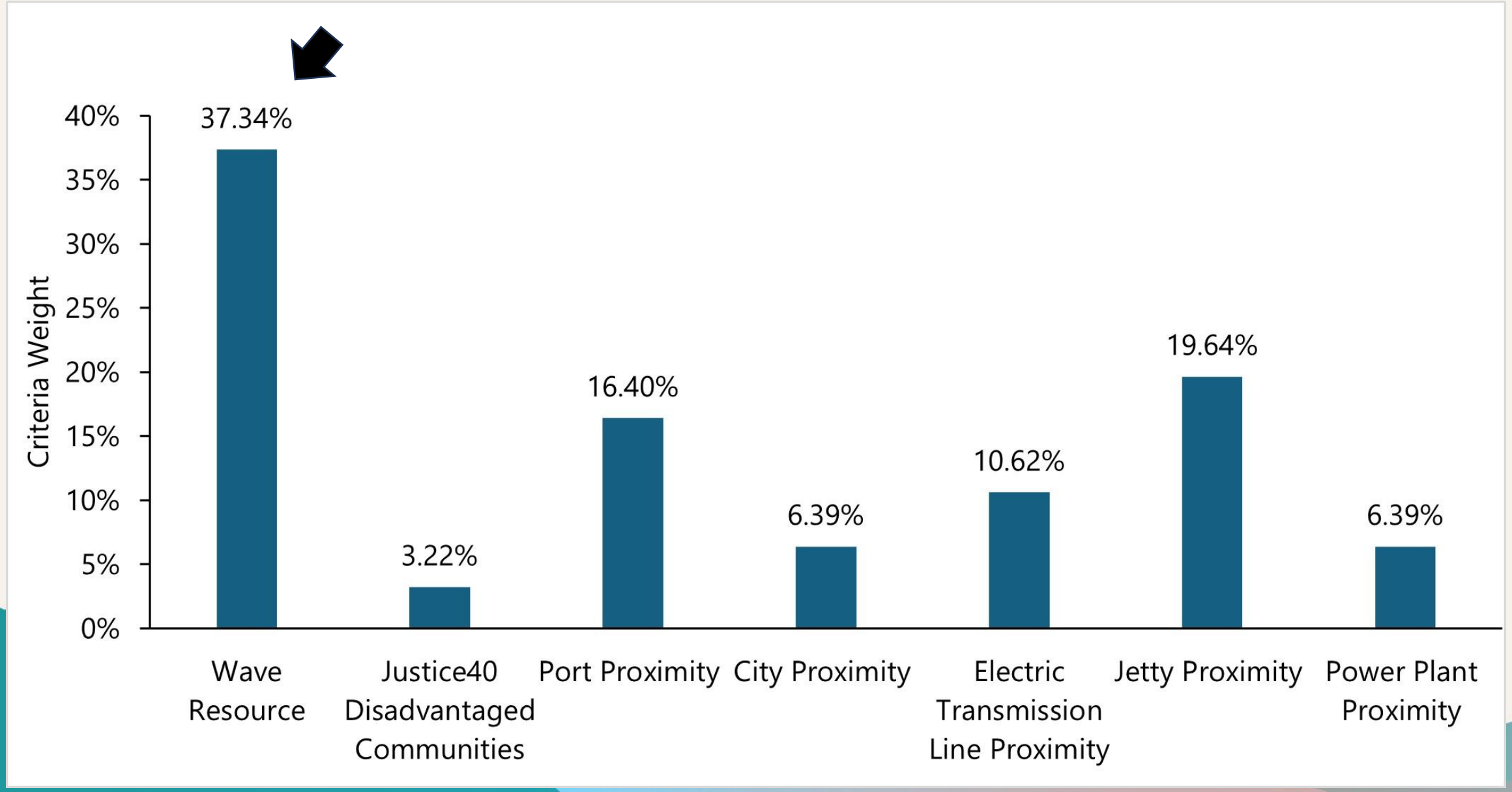

Piers and Jetties
Great Basin
Sacramento
Fresno
California
Las Vegas
Los Angeles
San Diego
N
0 100 200 Miles

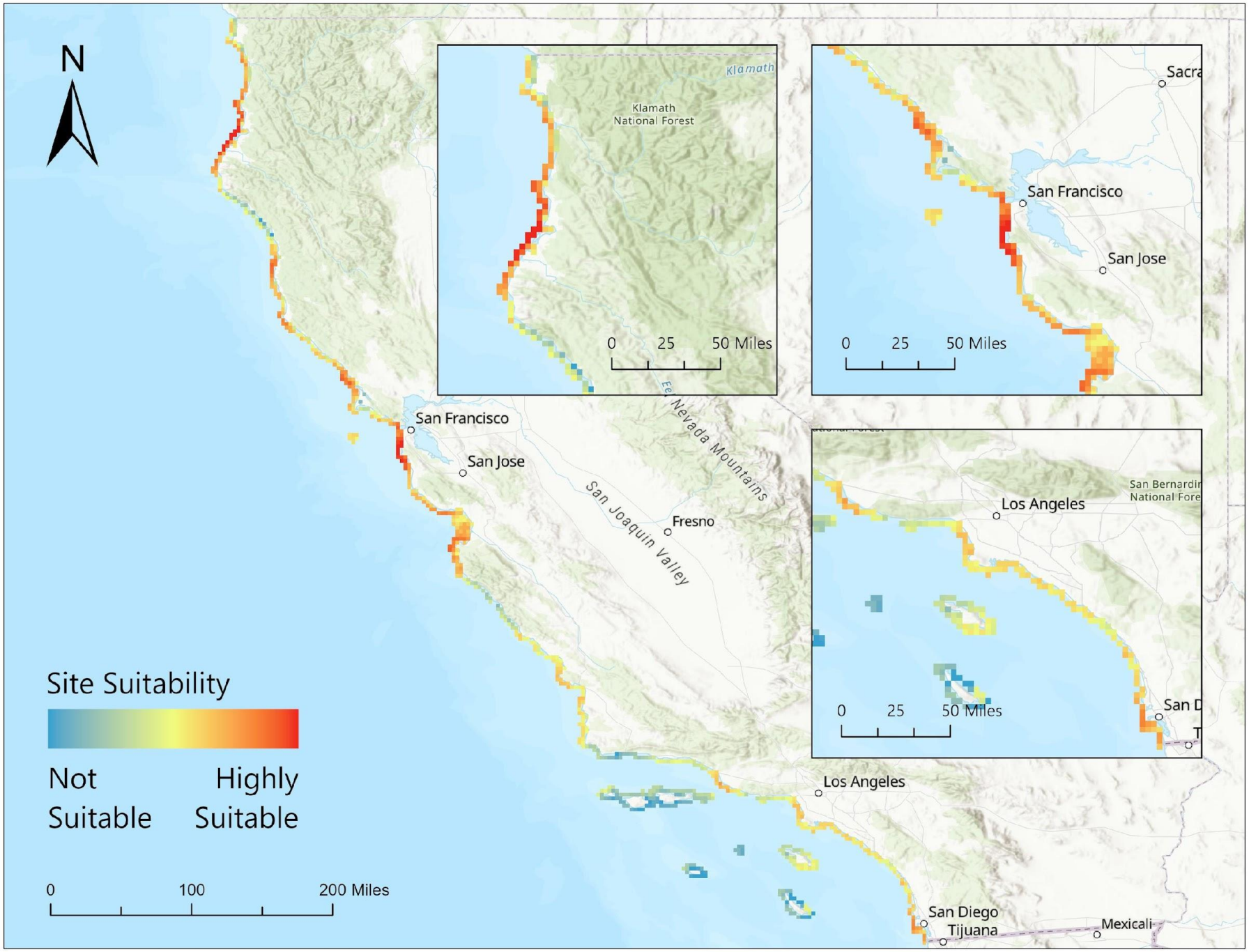

Power Plants
Great Basin
Sacramento
Fresno
California
Las Vegas


Justice40 Disadvantage Communities
Great Basin
Sacramento
San Francisco
Fresno
Las Vegas
Los Angeles
San Diego

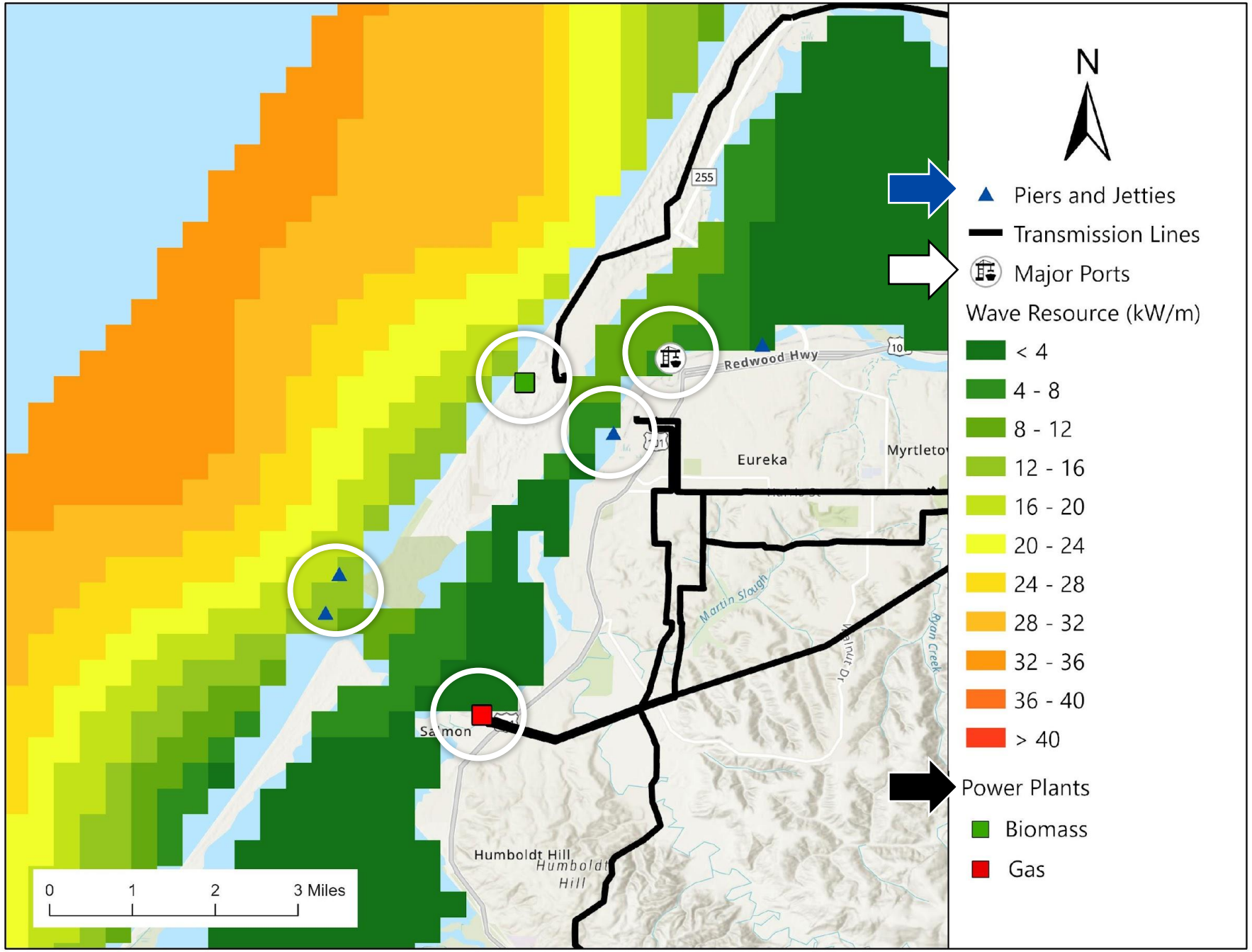

Criteria Weight
40%
35%
30%
25%
20%
15%
10%
5%
0%
13.95%
34.74%
34.74%
8.87%
3.84%
3.84%
Wave Resource
Justice40 Energy Disadvantaged Communities
Justice40 Climate Change Disadvantaged Communities
Port Proximity
City Proximity
Electric Transmission Line Proximity


N
San Juan
Bayamón
Carolina
El Yunque
National Forest
Mayaguez
PUERTO
RICO
1330 m
Ponce
Site Suitability
Low
Suitability
High
Suitability
Military Danger and
Restricted Zones
0
25
50 Miles


Criteria Weight
40%
35%
30%
25%
20%
15%
10%
5%
0%
37.34%
3.22%
16.40%
6.39%
10.62%
19.64%
6.39%
Wave Resource
Justice40 Disadvantaged Communities
Port Proximity
City Proximity
Electric Transmission Line Proximity
Jetty Proximity
Power Plant Proximity


N
Klamath
National Forest
0 25 50 Miles
San Francisco
San Jose
0 25 50 Miles
Sacra
San Francisco
San Jose
0 25 50 Miles
San Francisco
San Jose
Fresno
San Joaquin Valley
Nevada Mountains
Los Angeles
San Bernardi
National Fore
0 25 50 Miles
Los Angeles
San Diego
Tijuana
Mexicali
Site Suitability
Not Suitable
Highly Suitable
0 100 200 Miles

Eureka, California



Key Takeaways

- GIS-based MCDA methodology optimizes marine energy site selection
- Flexible applications
- Enhanced stakeholder collaboration

Future Work

- Integration with a publicly accessible platform, like NREL's Marine Energy Atlas
- Inclusion of more data for comprehensive analysis
  - Ex: Seafloor substrate, bathymetry, and extreme sea states
  - Ex: Critical fishing habitat
- Promote streamlining projects and accelerating the deployment of devices

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If you are a user of the **Marine Energy Atlas** please consider filling out this user survey:

https://forms.office.com/pages/responsepage.aspx?id=fp3yoM0oVE-EQniFrufAgDg3N-MsPw1GoZygvG6pnlpUNU9DMkFKVUxSUFNTVDJTVjgwRzZTQ0tQSC4u

Thank you!

Any questions?

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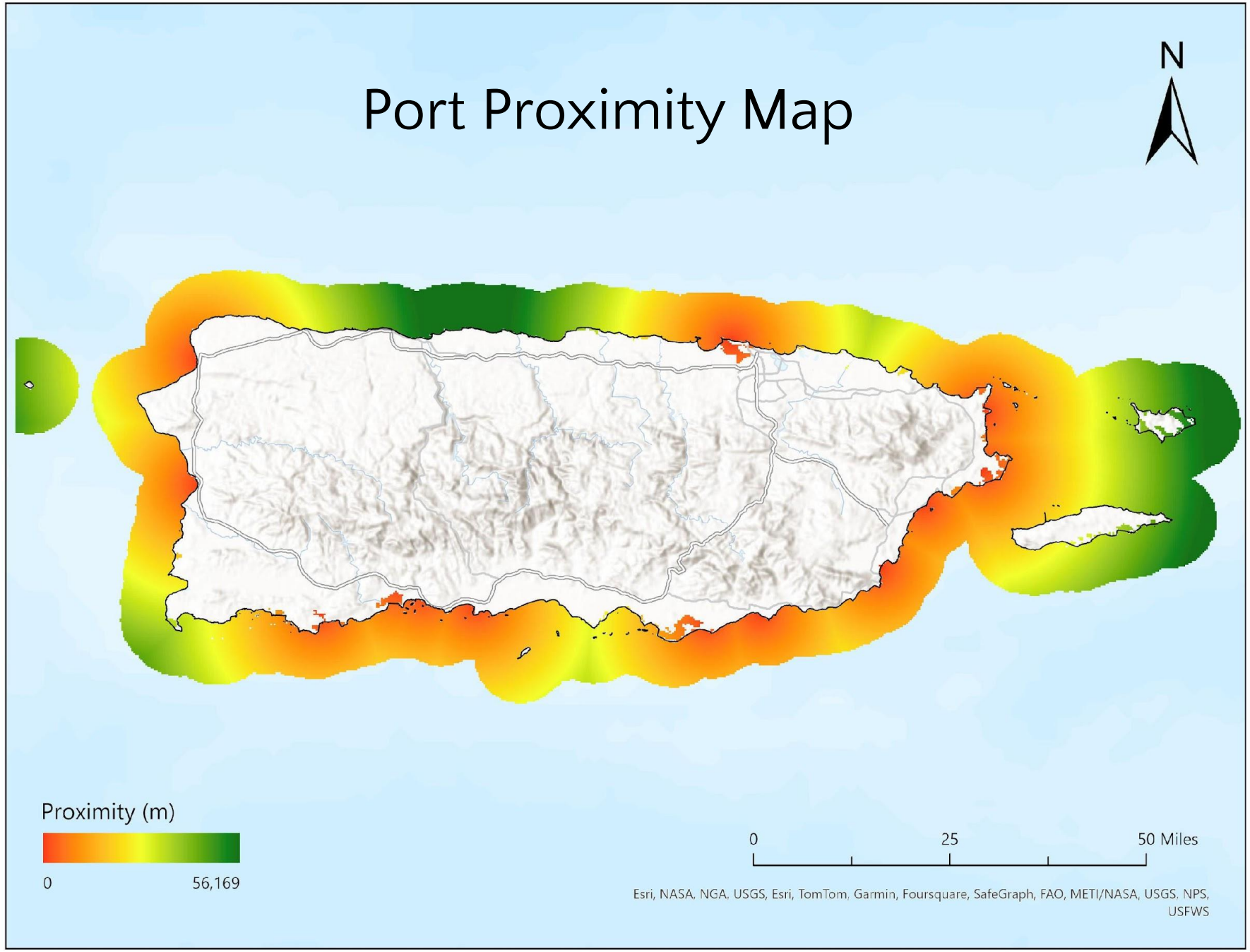
Intensity of Importance	Definition	Explanation
1	Equal Importance	Two criteria contribute equally to the objective
3	Moderate importance	Experience and judgment slightly favor one criteria over another
5	Essential or strong importance	Experience and judgment strongly favor one criteria over another
7	Very strong importance	A criteria is favored very strongly, and its dominance is demonstrated in practice
9	Extreme importance	The criteria favoring one activity over another is of the highest order of affirmation
2, 4, 6, 8	Intermediate values	


Port Proximity Map
N
Proximity (m)
0
56,169
0
25
50 Miles
Esri, NASA, NGA, USGS, Esri, TomTom, Garmin, Foursquare, SafeGraph, FAO, METI/NASA, USGS, NPS, USFWS