



OAP

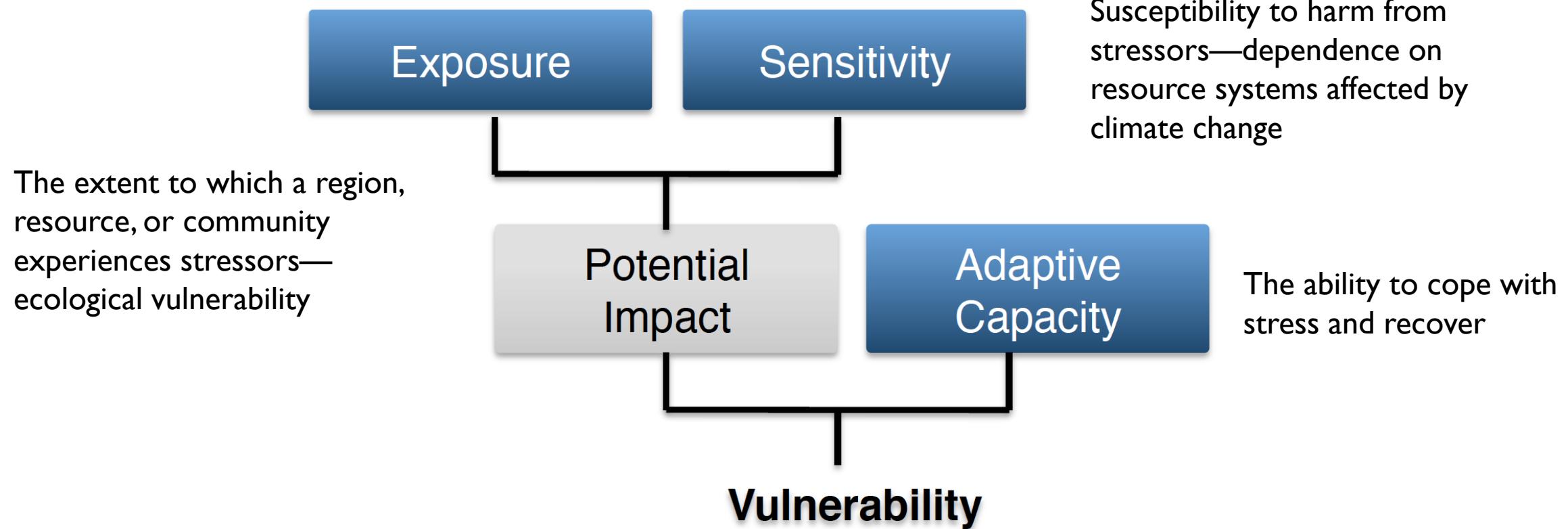
NOAA OCEAN ACIDIFICATION PROGRAM

# Spatial Vulnerability Assessment across Main Hawaiian Islands

Lansing Perng, Mariska Weijerman, Kirsten Leong, Lucia Hosekova, and Kirsten Oleson  
Atlantis Developer: Elizabeth Fulton

# VULNERABILITY FRAMEWORK

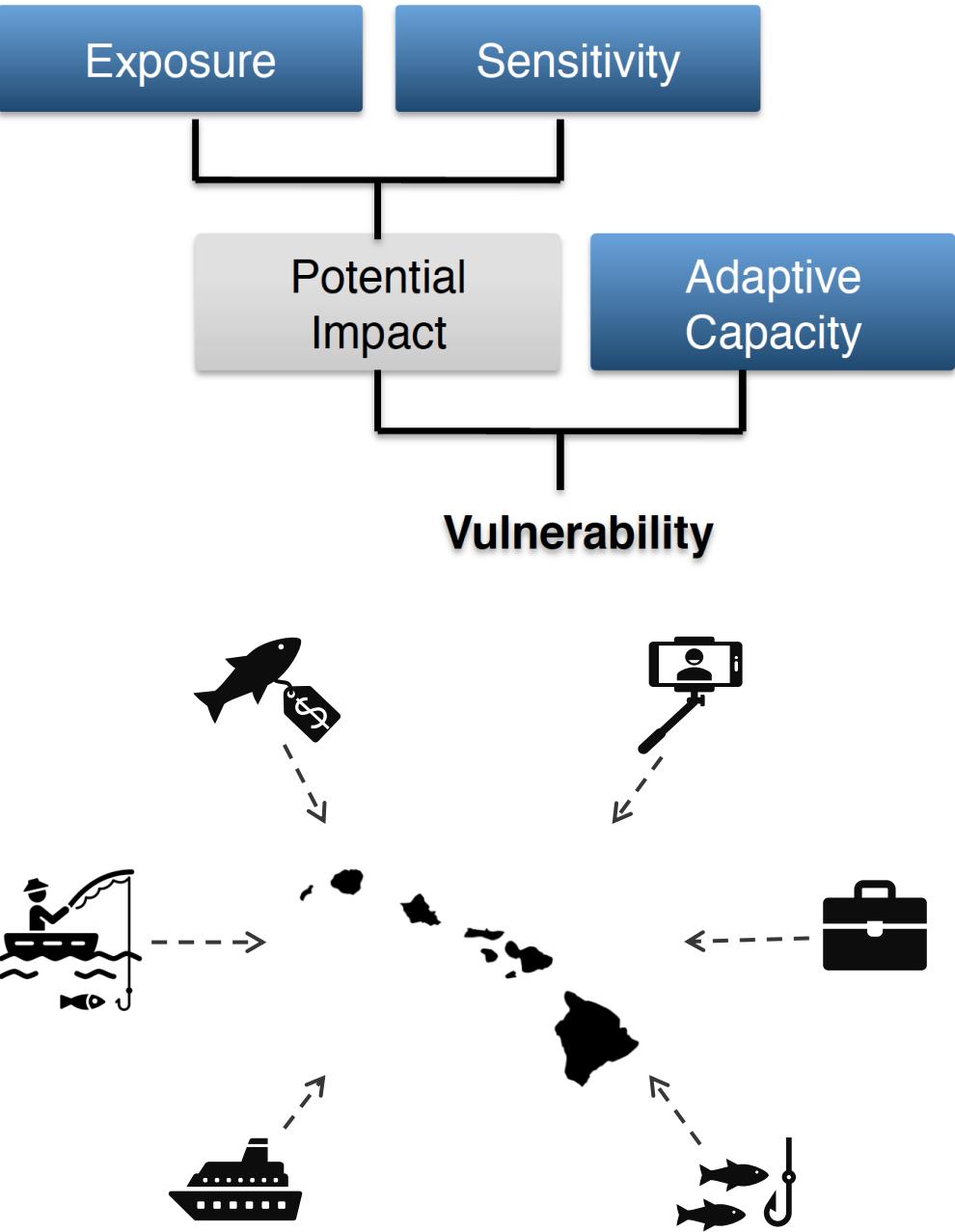
Marshall et al., 2009



# BUILDING INDICES FOR 3 DIMENSIONS OF VULNERABILITY

- Data Envelopment Analysis (DEA)
  - Scores system performance based on multiple indicators
  - Flexible and data driven
  - No subjective weighting
  - Build composite indices to identify vulnerable communities

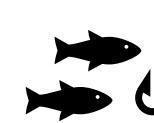
$$\text{Vulnerability} = \frac{\text{Exposure} \times \text{Sensitivity}}{\text{Adaptive Capacity}}$$



# BUILDING INDICES FOR 3 DIMENSIONS OF VULNERABILITY

- Exposure
  - More stressed = high exposure

## Atlantis Projections



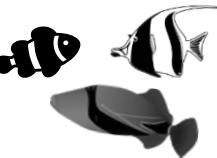
Biomass of targeted species



Reef herbivore biomass



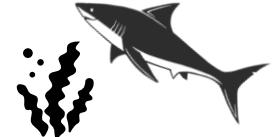
Coral cover



Reef fish diversity



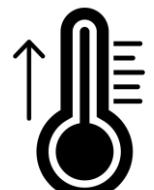
Megafauna abundance



Mean trophic level



pH

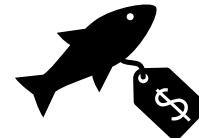


Temperature

# BUILDING INDICES FOR 3 DIMENSIONS OF VULNERABILITY

- Exposure
  - More stressed = high exposure
- Sensitivity
  - More dependent = high sensitivity

**Snapshot**  
(multiple sources)



**Commercial Catch**  
(Ocean Tipping Points)



**Recreational Catch**  
(Ocean Tipping Points)



**Recreational Trips**  
(CSVI)



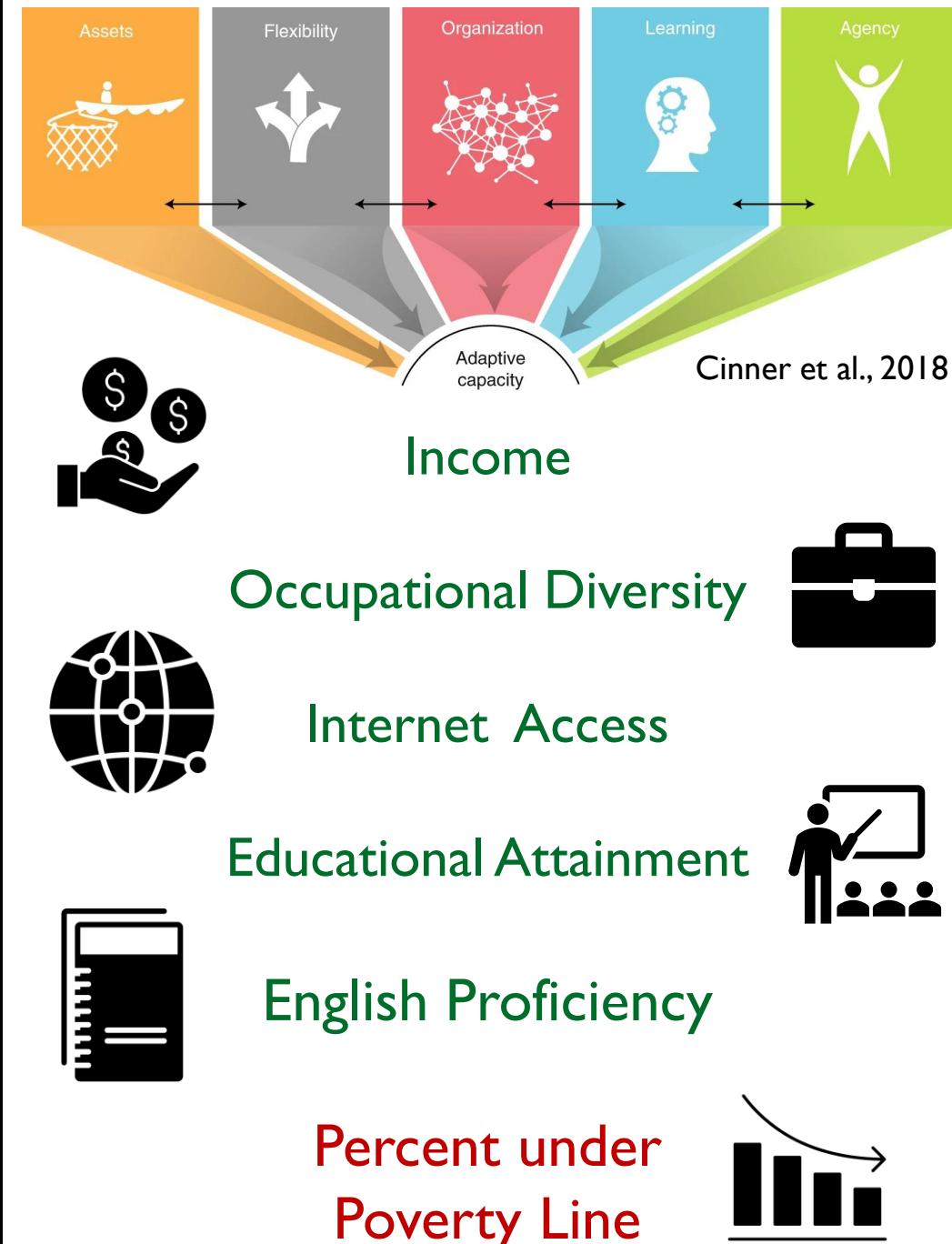
**Fishery Revenue**  
(CSVI)



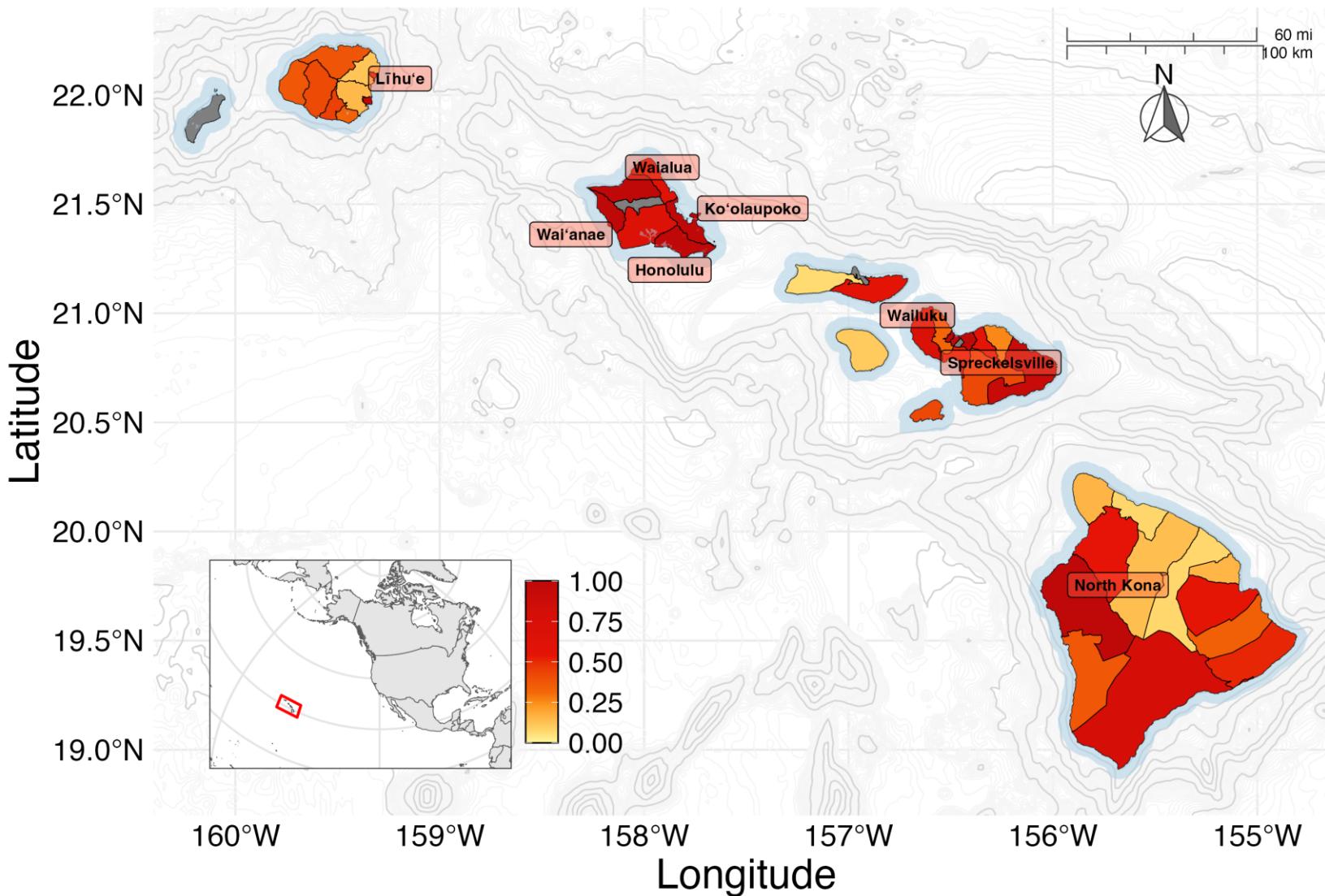
**Recreational Site Popularity**  
(Google Ratings)

# BUILDING INDICES FOR 3 DIMENSIONS OF VULNERABILITY

- Exposure
  - More stressed = high exposure
- Sensitivity
  - More dependent = high sensitivity
- Adaptive Capacity
  - Higher coping ability = high adaptive capacity
  - Cinner et al., 2018 framework
  - ACS 5 year average (2019-2023)

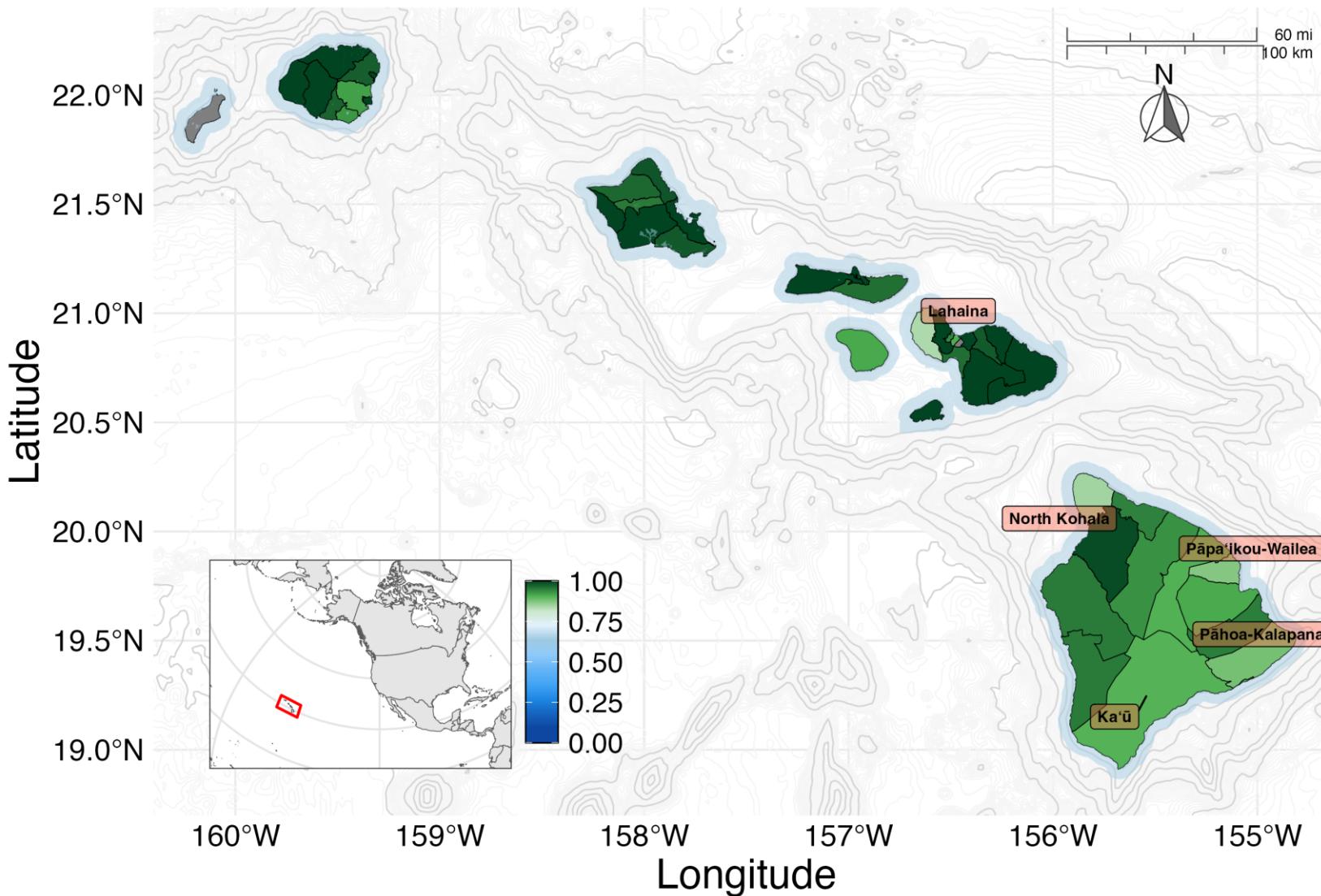


# SENSITIVITY



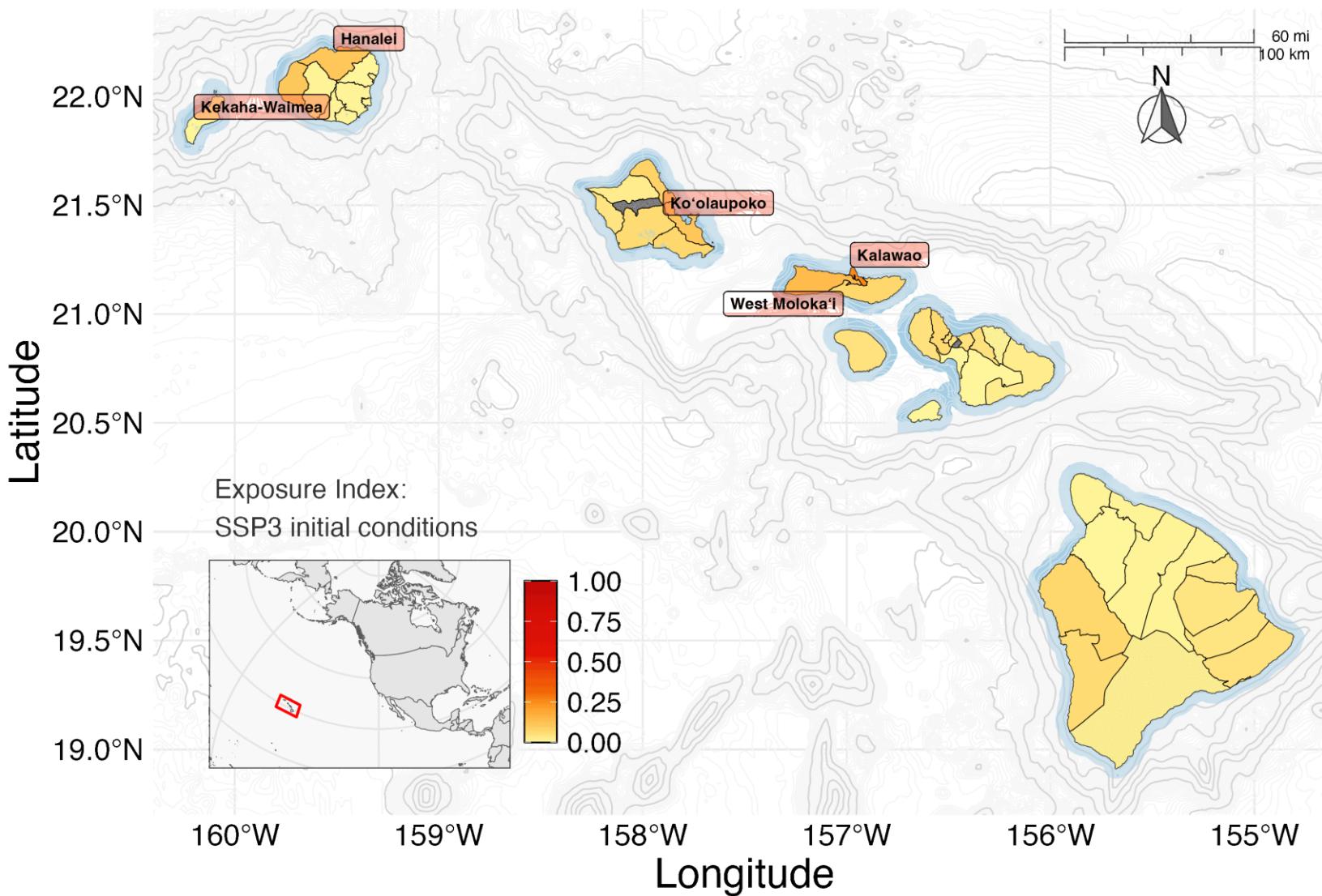
- Spatial variation across and within islands
  - Oahu: commercial fishery engagement, recreational popularity
  - Other islands: recreational fishery engagement

# ADAPTIVE CAPACITY



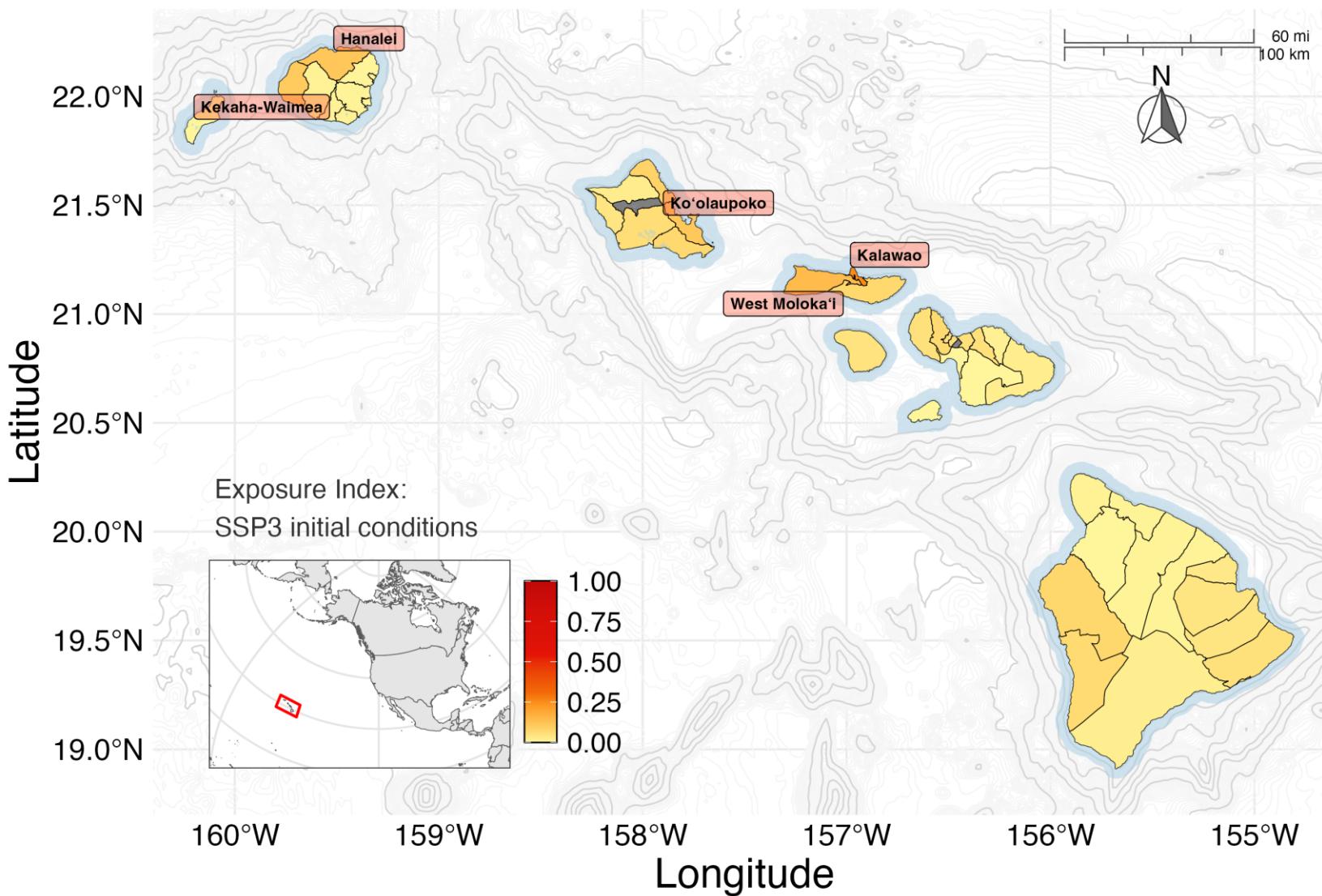
- Relatively high AC across MHI (0.83 – 1)
- Lower range AC largely on Hawai'i Island
- Low values mostly in assets, learning, agency

# EXPOSURE



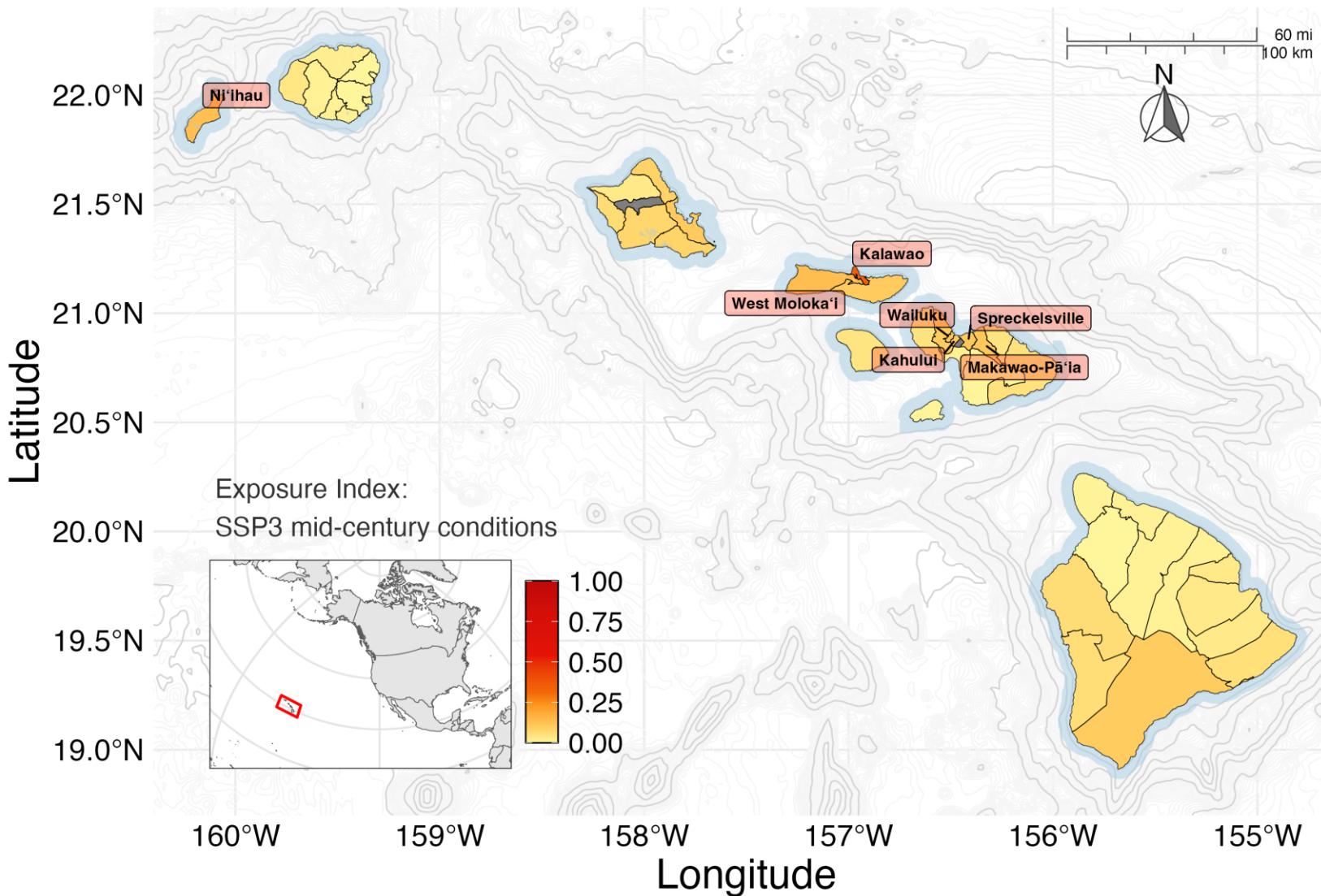
- SSP3 (high-emission) exposure index

# EXPOSURE



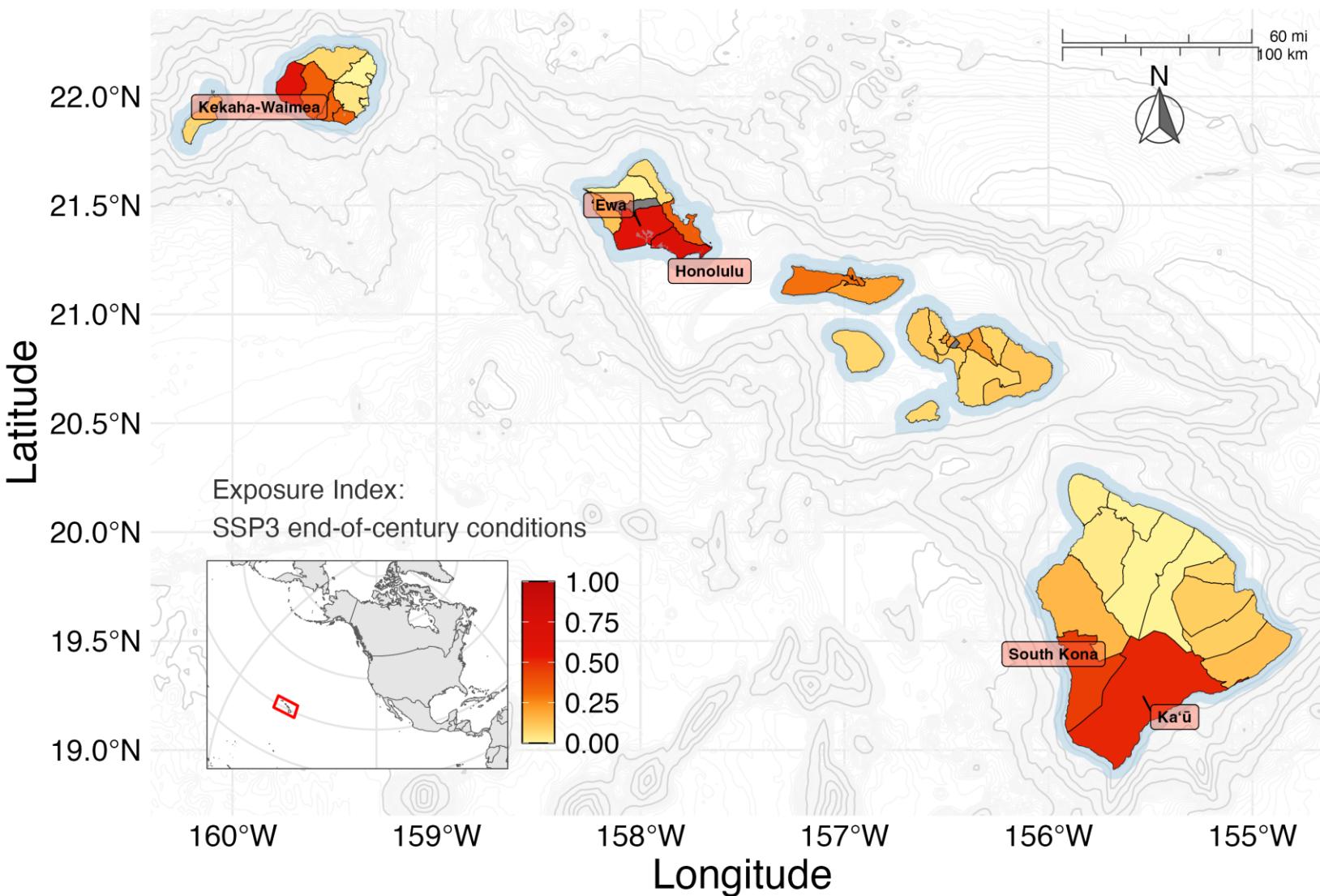
- SSP3 (high-emission) exposure index
- Initial: low exposure across MHI

# EXPOSURE



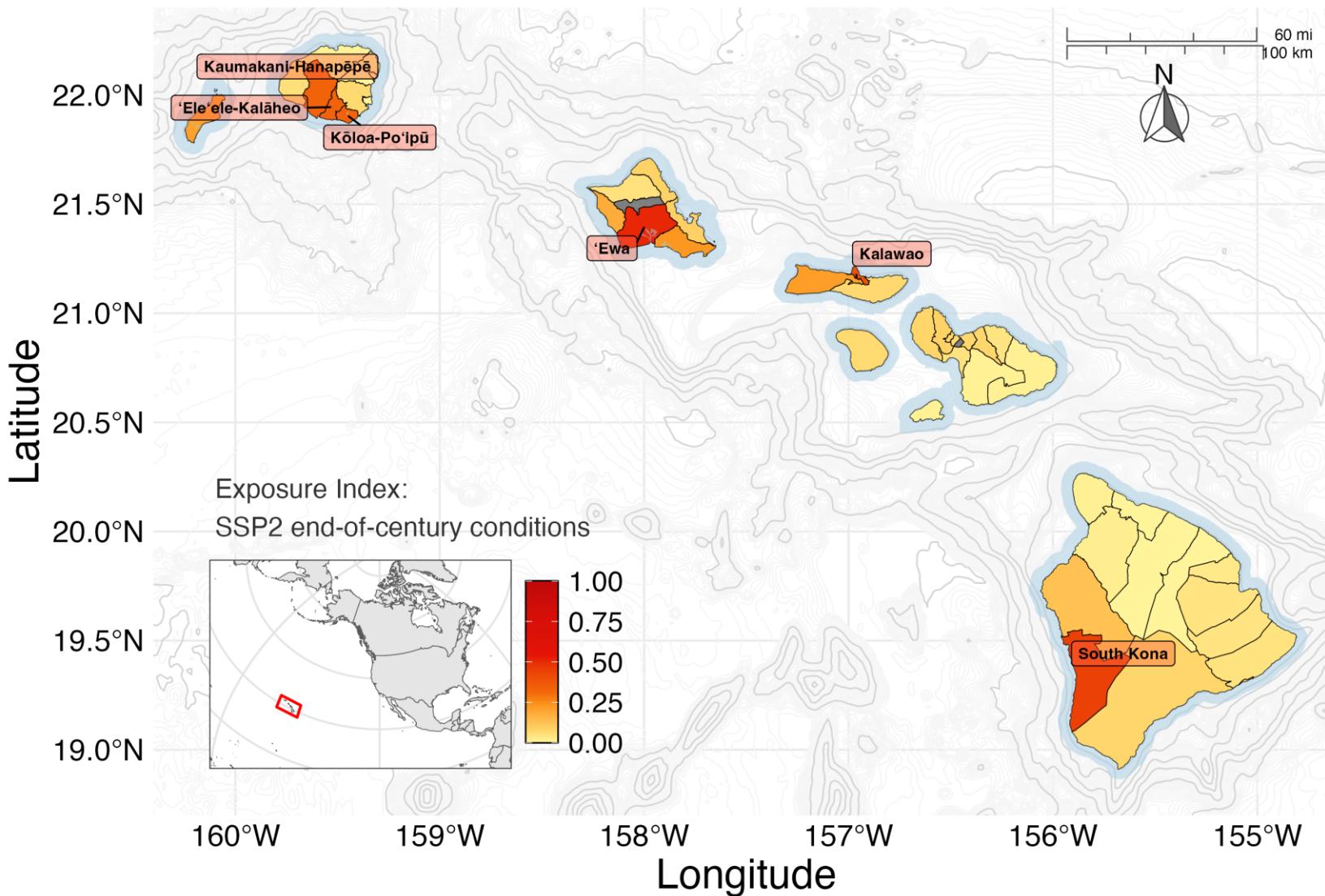
- SSP3 (high-emission) exposure index
- Initial: low exposure across MHI
- Mid-century: increasing exposure in Maui County islands

# EXPOSURE



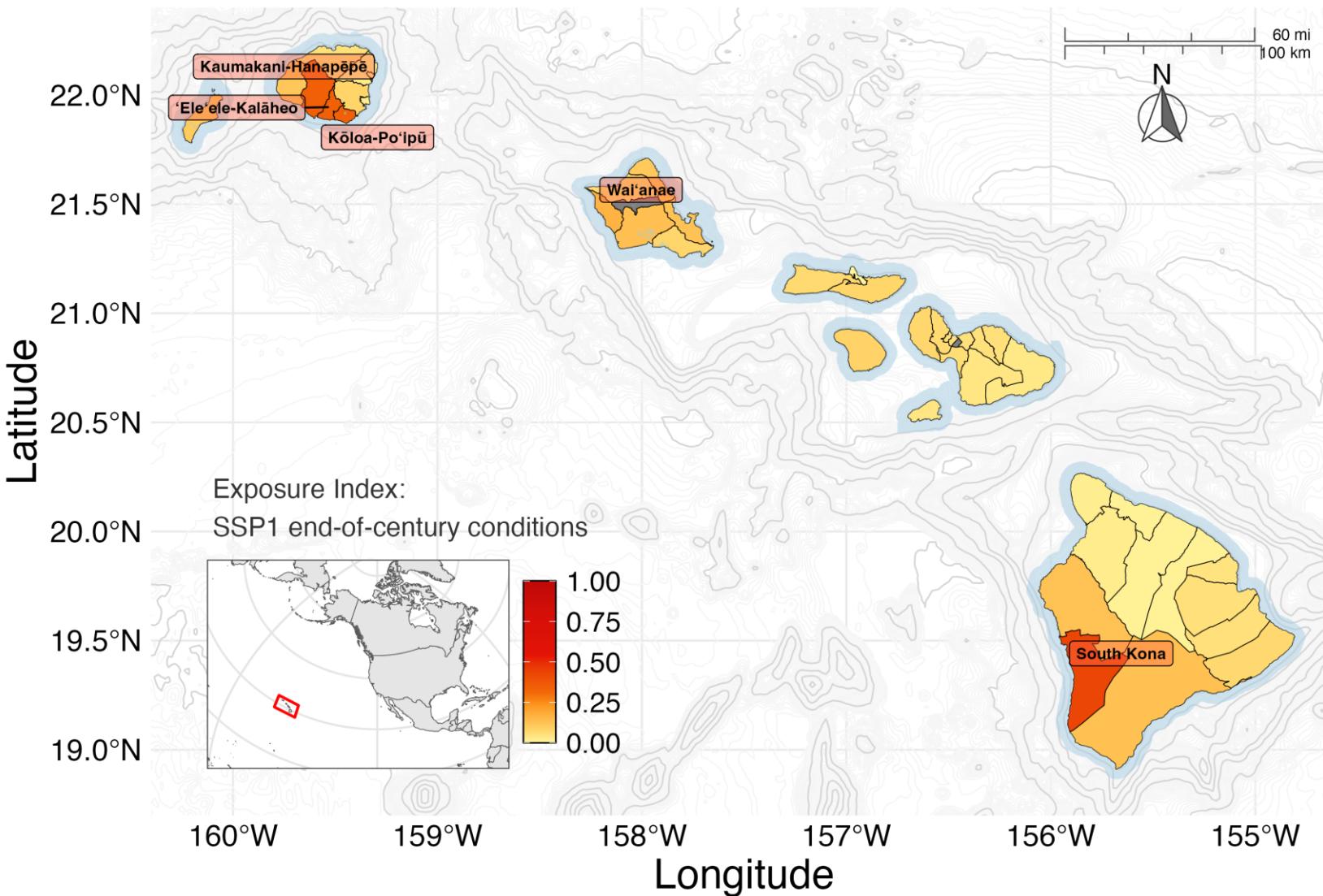
- SSP3 (high-emission) exposure index
- Initial: low exposure across MHI
- Mid-century: increasing exposure in Maui County islands
- End-of-century: high exposure everywhere except Maui County

# EXPOSURE



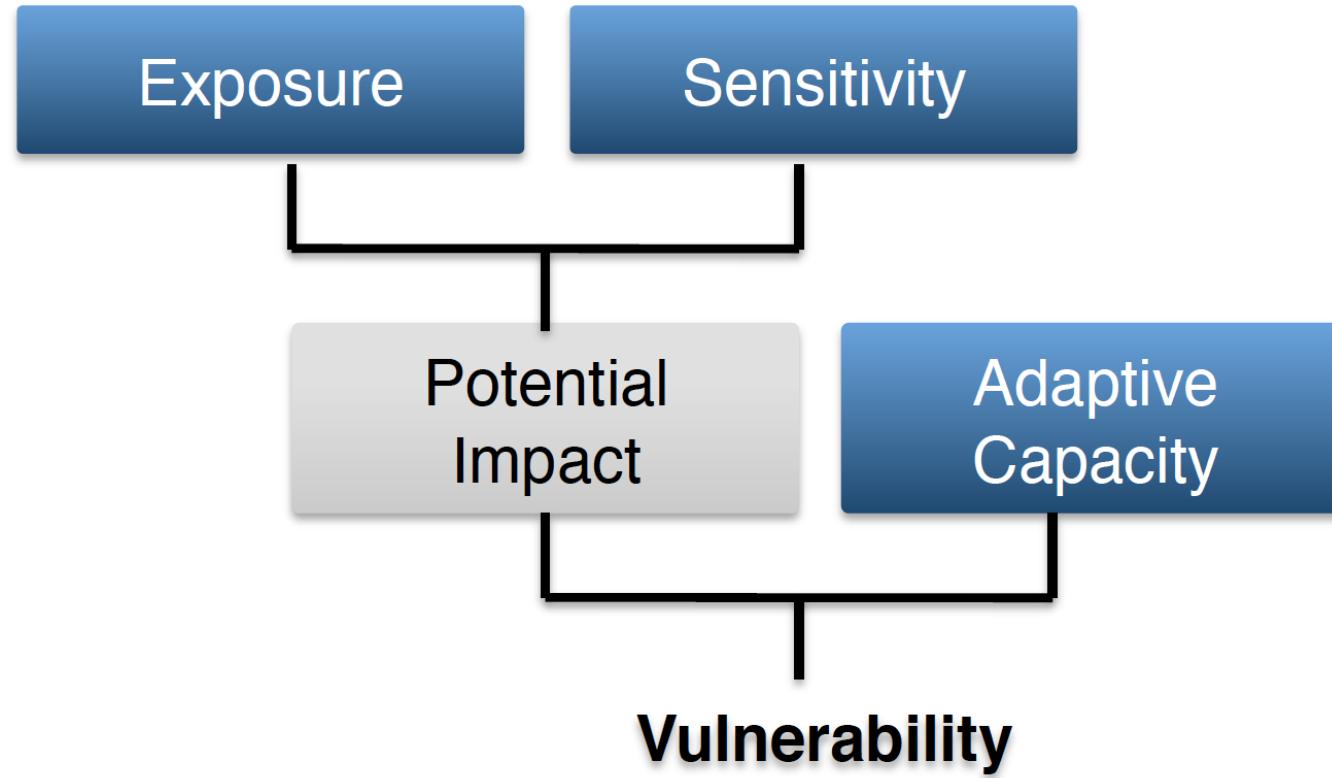
- Compare to SSP2
  - Ewa & South Kona in 10% for SSP2 & SSP3

# EXPOSURE



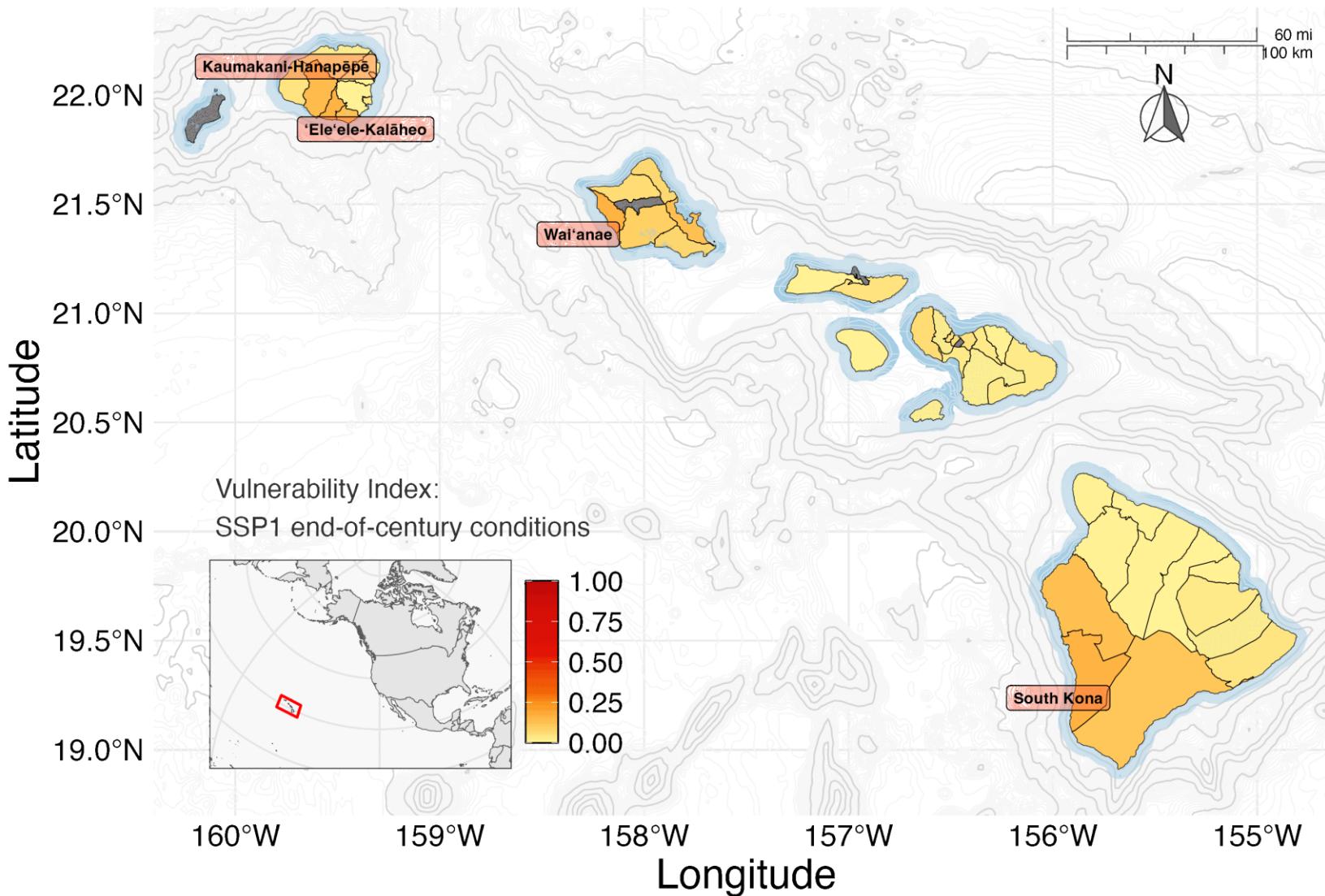
- Compare to SSP2
  - Ewa & South Kona in top 10% for SSP2 & SSP3
- Compare to SSP1
  - South Kona in top 10% for all scenarios

# VULNERABILITY



$$\text{Vulnerability} = \frac{\text{Exposure} \times \text{Sensitivity}}{\text{Adaptive Capacity}}$$

# VULNERABILITY



- End-of-century vulnerability for all climate scenarios
- SSPs 1 & 2: South Kona and Wai'anae
- SSPs 2 & 3: Ewa and Honolulu



## SUMMARY

- Sensitivity highest in O‘ahu, with some standout communities in other islands
- High AC range, but Hawai‘i Island in lower end of range
- Exposure increases over time, especially SSP3—Honolulu highest in SSP3 end-of-century
- 3 dimensions combine to assess vulnerability in a way that no one index could

# SIGNIFICANCE

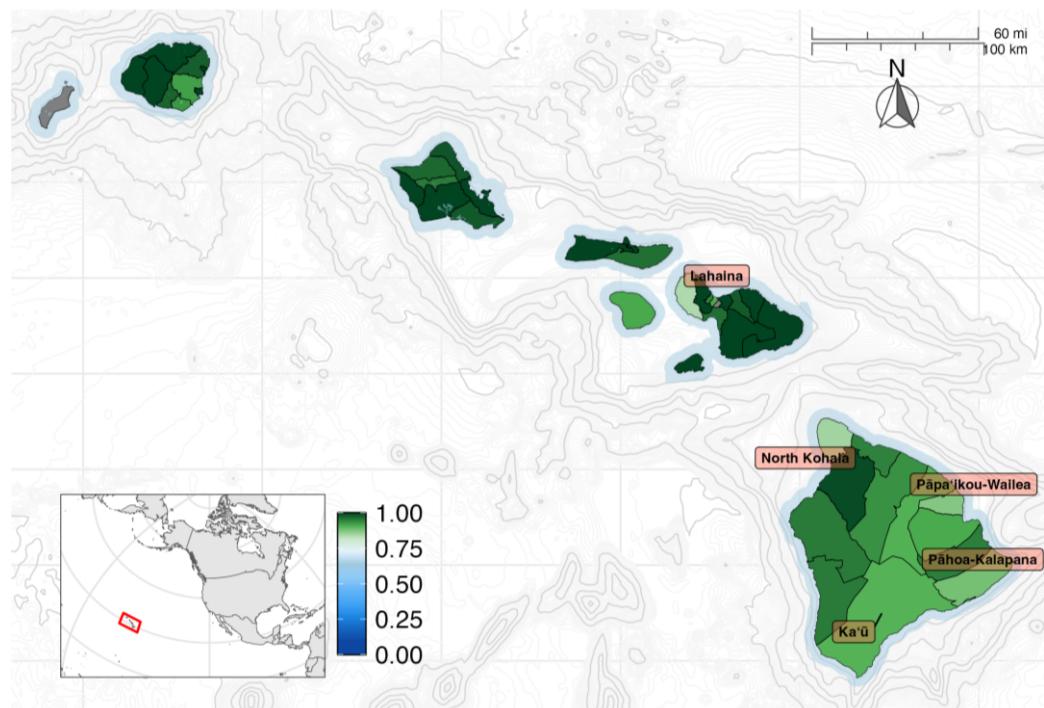
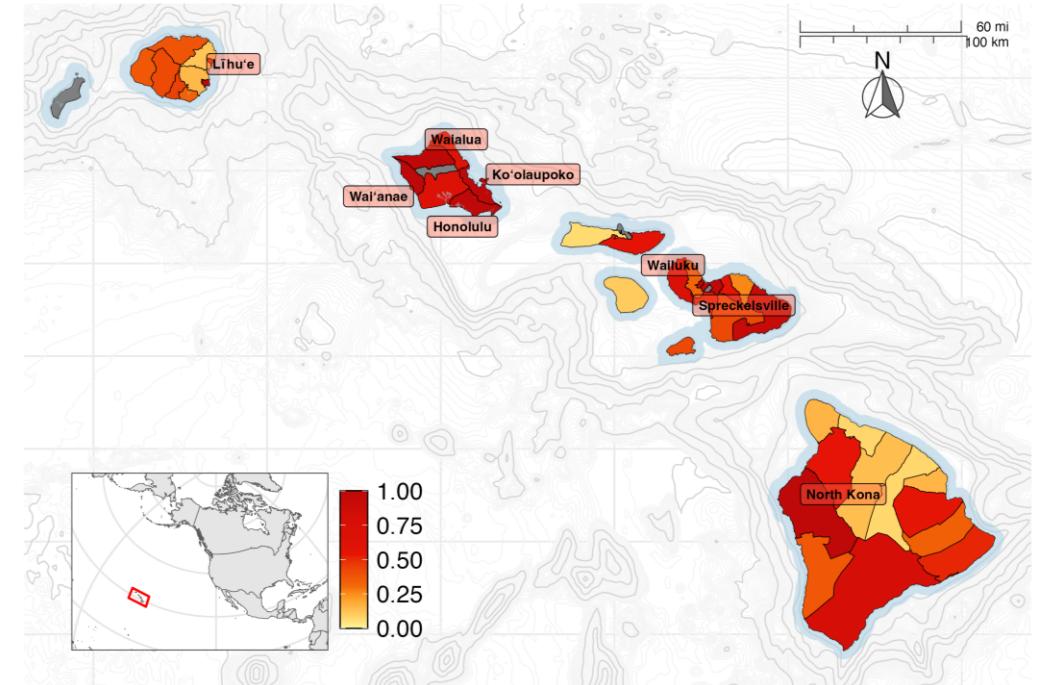
Urban communities—higher sensitivity

Rural communities—lower adaptive capacity

## TAKEAWAYS

Spatial vulnerability varied with climate scenario

Spatially resolved indices inform targeted adaptation strategies



A large green sea turtle swims gracefully over a vibrant coral reef. The water is a clear turquoise, and several small yellow fish are scattered around the turtle and the reef. A white rectangular box with a black border is positioned in the upper center of the image, containing the text "Thank You!".

Thank  
You!

Email: [lyperng@hawaii.edu](mailto:lyperng@hawaii.edu)

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