Assessment of Habitat Risk and Coastal Vulnerability in Lyudao Based on InVEST

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Abstract

Lyudao, located in the southeastern seas off Taiwan, is a volcanic island surrounded by rich reef habitats. However, the growing number of tourists has severely threatened Lyudao's ecosystems. This study aims to evaluate the coastal habitats' risks and provide a reference for future conservation measures. The analysis utilizes the InVEST Habitat Risk Assessment and Coastal Vulnerability models to assess both human-induced and natural risks, supplemented by BiLISA analysis to explore their correlation. The results indicate that fishing and sewage are the primary stressors posing the greatest risk. Future conservation efforts should focus on enhancing protections against these identified stressors.
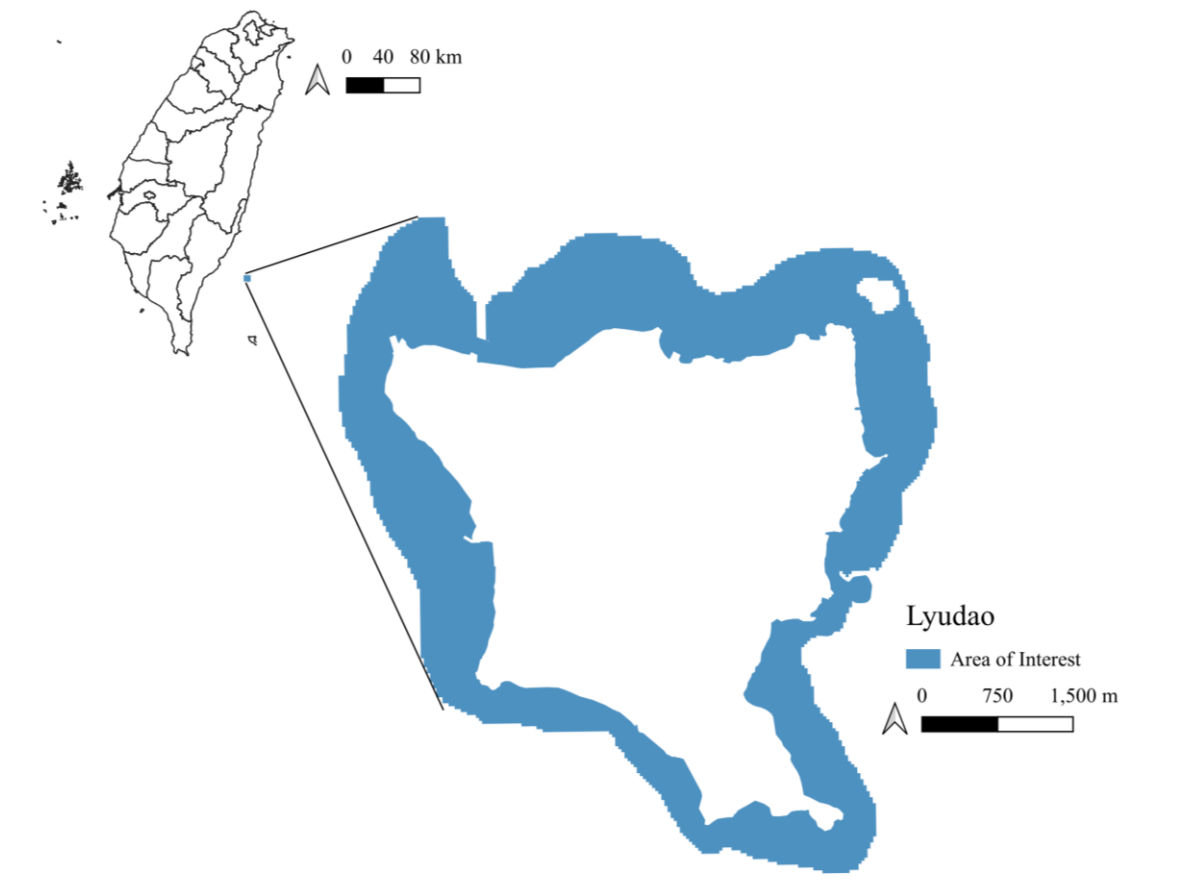
▲ **Fig. 1** Area of interest in Lyudao.

Motivation

Lyudao, a tourism-oriented island, attracts about 300,000 visitors annually. However, improper tourist behavior and inadequate regulations have severely damaged the island's ecosystems. This study aims to quantify these risks to emphasize the importance of environmental conservation and management in Lyudao.

Methodology

This study uses the InVEST Habitat Risk Assessment (HRA) and Coastal Vulnerability models to rank the relative risk and exposure posed to habitats. Additionally, GeoDa is employed to conduct Bivariate Local Indicators of Spatial Association (BiLISA) analysis, yielding a correlation between risk and exposure.

Datasets

Habitat Risk Assessment

▲ **Fig. 2** Habitat: four types of benthic substrate for reef habitats.

▲ **Fig. 3** Stressor: five human-induced stressors.

▼ **Table 1** Habitat stressor table

Stressors	Stressor Buffer (m)
Docks Wharves Marinas	300
Rec Fishing	200
Intertidal Collection	150
Sewage	600
Solid Waste	600

The HRA model requires data including habitats, stressors, habitat stressor table, and the criteria scores table for exposure and consequence.

Coastal Vulnerability
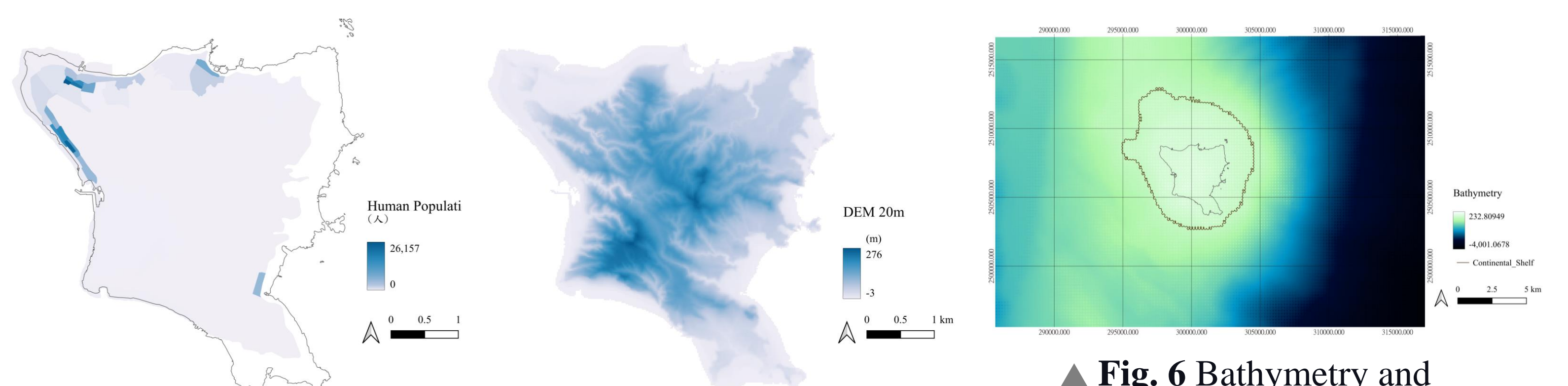
▲ **Fig. 4** Human population

▲ **Fig. 5** Digital elevation model


▲ **Fig. 6** Bathymetry and continental shelf contour

The Coastal Vulnerability model requires data including human population, digital elevation model, bathymetry, continental shelf contour, habitats table, and wind and wave data obtained from WaveWatchIII.
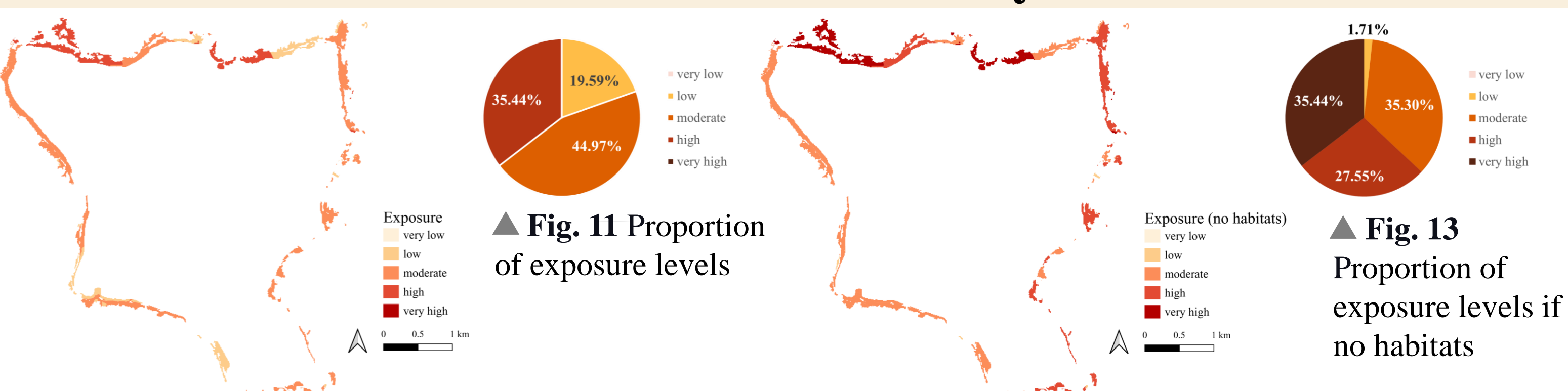
▼ **Table 2** Habitats table

Habitat	Rank	Protection distance (m)
Coral	1	2,000
Rock	1	2,000
Rubble	3	300
Sand	5	65

Result

Habitat Risk Assessment
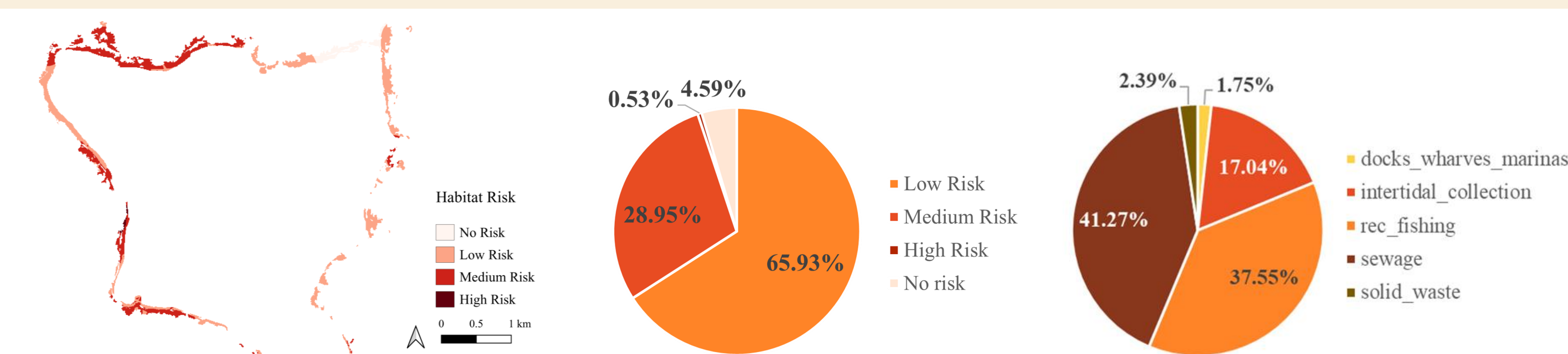
▲ **Fig. 7** Ecosystem risk level

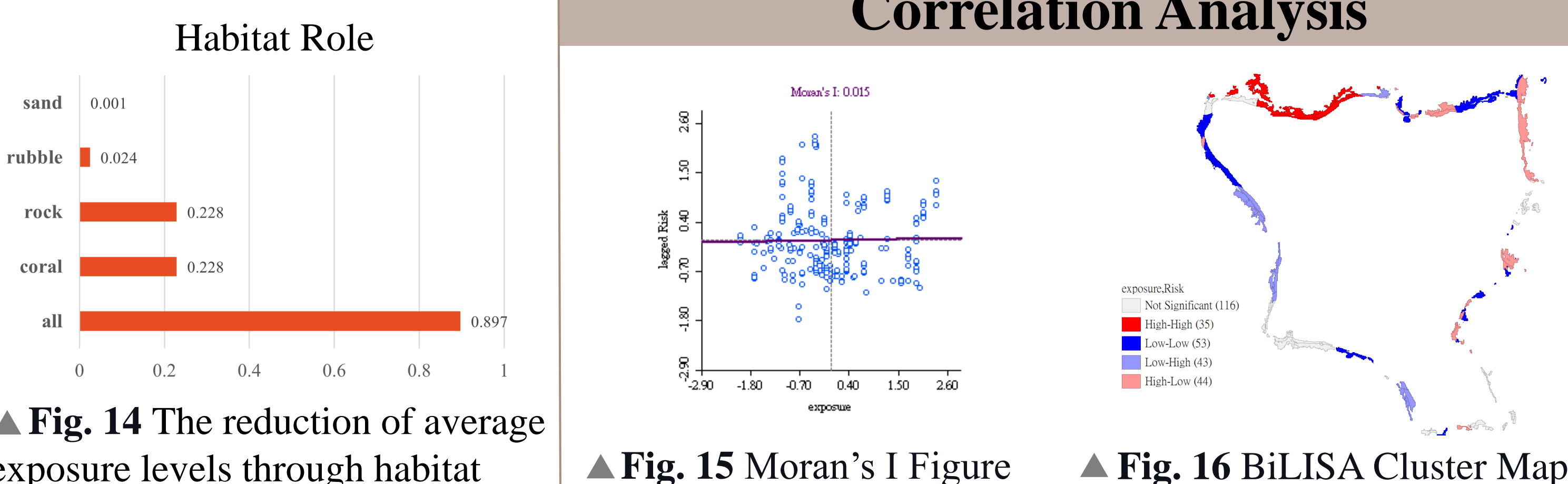▲ **Fig. 8** Proportion of risk levels

▲ **Fig. 9** Proportion of stressors

Coastal Vulnerability

▲ **Fig. 10** Exposure index

▲ **Fig. 11** Proportion of exposure levels

▲ **Fig. 12** Exposure index if no habitats were present

▲ **Fig. 13** Proportion of exposure levels if no habitats

▲ **Fig. 14** The reduction of average exposure levels through habitat

Correlation Analysis

▲ **Fig. 15** Moran's I Figure

▲ **Fig. 16** BiLISA Cluster Map

Conclusion

- Fishing and sewage pose the greatest risks to reef habitats. Habitats near Nanliao fishing port wharf are currently facing high risk.
- The northern and northeastern coastal zones are more susceptible to erosion and flooding, while the habitats play a crucial protective role by reducing the exposure level by 0.897 units.
- The distributions of risk and exposure do not exhibit a significant spatial pattern. (Moran's I=0.015)

Policy Suggestion

- Strengthen management and ecological education around the Zhongliao fishing port wharf area, which is characterized by high risk and high exposure.
- Conservation efforts for the northeastern habitats, characterized by high exposure and low risk, should be strengthened to ensure their role in protecting the coastal area sustainably.
- Implementing an island entry fee to regulate visitor numbers could be considered, with the revenue directed toward enhancing fisheries management, constructing sewage treatment facilities, or fostering the development of eco-tourism.

Reference

Please refer to the QR code!