Urban spatial expansion and its effect on island ecosystem

A case study of the island city of Xiamen, Southeast China

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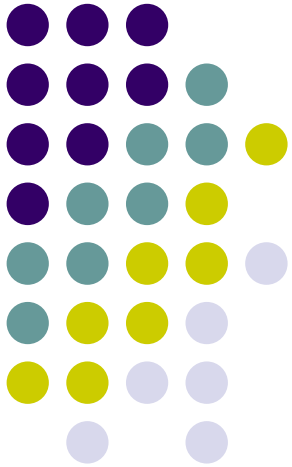

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Marine spatial planning – ocean zoning
Marine ecosystem management – integrated assessment

- **THEME 6 Pollution Reduction and Waste Management**
  - **WORKSHOP 2 (14:30, 24 November)**
  - **Theme 2 Innovative Policies and Practices in Water Supply, Sanitation and Pollution Reduction**

OUTLINE

- Introduction
- Method and study area
- Results
- Discussion

Introduction（1）

- **China has more than 6900 islands (over 500 m^2), with a population of more than 40 million.**

- **Island, an indispensable part of coastal ecosystem, is facing increasing stress from urbanization in China. (reclamation, mining, deforestation → erosion, ecosystem degradation, disappearance, etc.)**

- **Rapid urbanization in coastal areas is always associated with environmental pollution, impediments to natural ecological processes, biodiversity loss …**

Introduction（2）

- **Cities are heterogeneous, dynamic landscapes and complex, adaptive, socio-ecological systems, in which the delivery of ecosystem services links society and ecosystems at multiple scales.**

- **Ecosystem services and landscape patterns are highly related to and can be used to quantitatively assess the land use changes driven by urbanization.**

Study area

Xiamen Island and surrounding seas

Xiamen is an island city in southeastern China, situated at the mouth of Jiulong River, and is connected to the mainland by a long causeway.

Since its establishment in 1980 as a Special Economic Zone, Xiamen has undergone rapid urbanization and its urban population has been 100% of the total population since 2004. In 2008, the resident population of Xiamen Island reached 0.94 million. (plus transient population amount to ~ 2 millions)

Method（1）

- **Data collection and processing**
  - **historic statistic data**
  - **historic maps and satellite images**
- **Analysis of urban spatial expansion**
  - **land use conversion matrix by the ArcGIS**
  - **land use types were assigned the human land use intensity values**
  - **calculated the Land Use Intensity Index (LUII)**

$$LUII = \sum_{i} (G_i \times C_i) \times 100\%$$

Where Gi is the human land use intensity value for land use category i, whereas Ci is the area ratio of land use category i in the whole of Xiamen Island

Method （2）

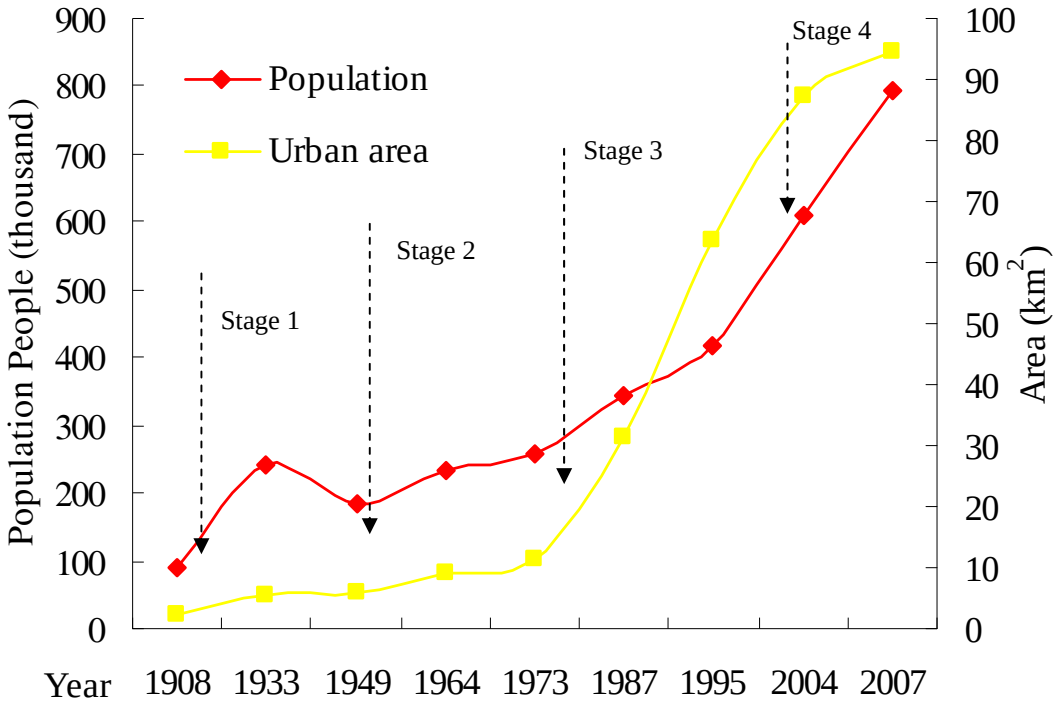
- Analysis of effects on the island ecosystem
  - Ecosystem service evaluation
  - $$ESV_i = \sum_f A_i \times VC_{if} \qquad ESV = \sum_i ESV_i$$
  - Stress of urban expansion on ecological landscape
  - Natural Ecosystem Eroded Index (NEEI)

$$NEEI_i = (L_i + U_i)/2$$

  - Landscape Isolation Index (LII)

$$LII_i = \sqrt{m/A} \Big/ 2A_i$$

Results (1)



Dynamic of population and urban area of Xiamen island from 1908-2007

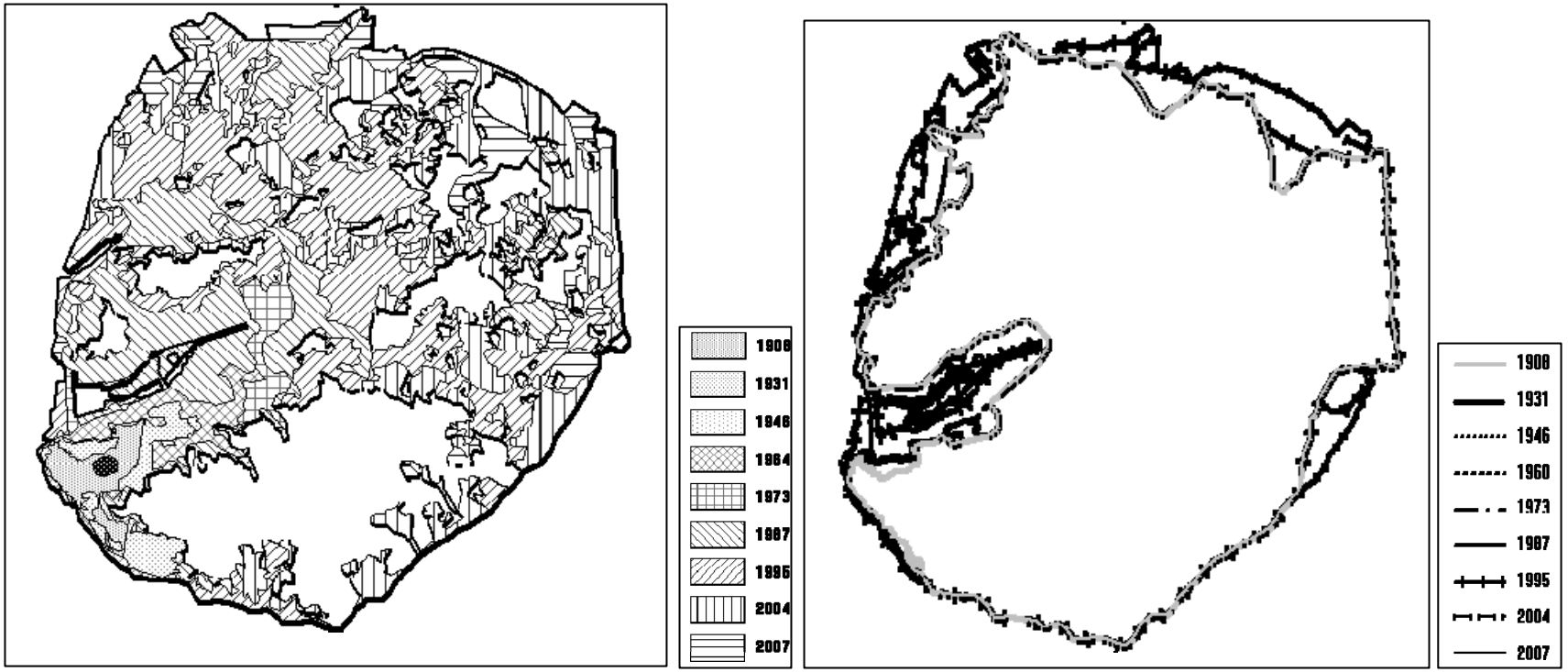
Early urbanization (1908-1949)

Slow but steady urbanization (1950-1979)

Rapid urbanization (1980-2003)

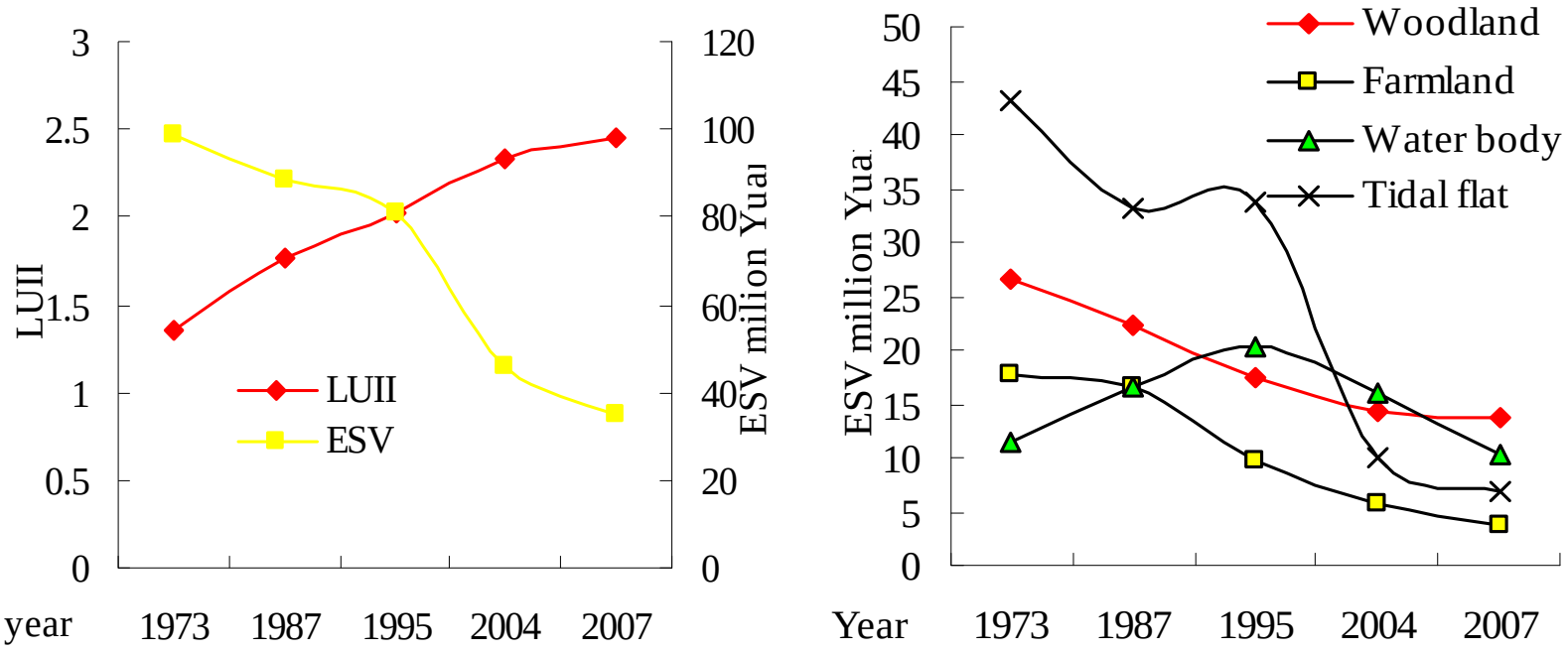
Saturated urbanization (2004-2007)

Results （2）



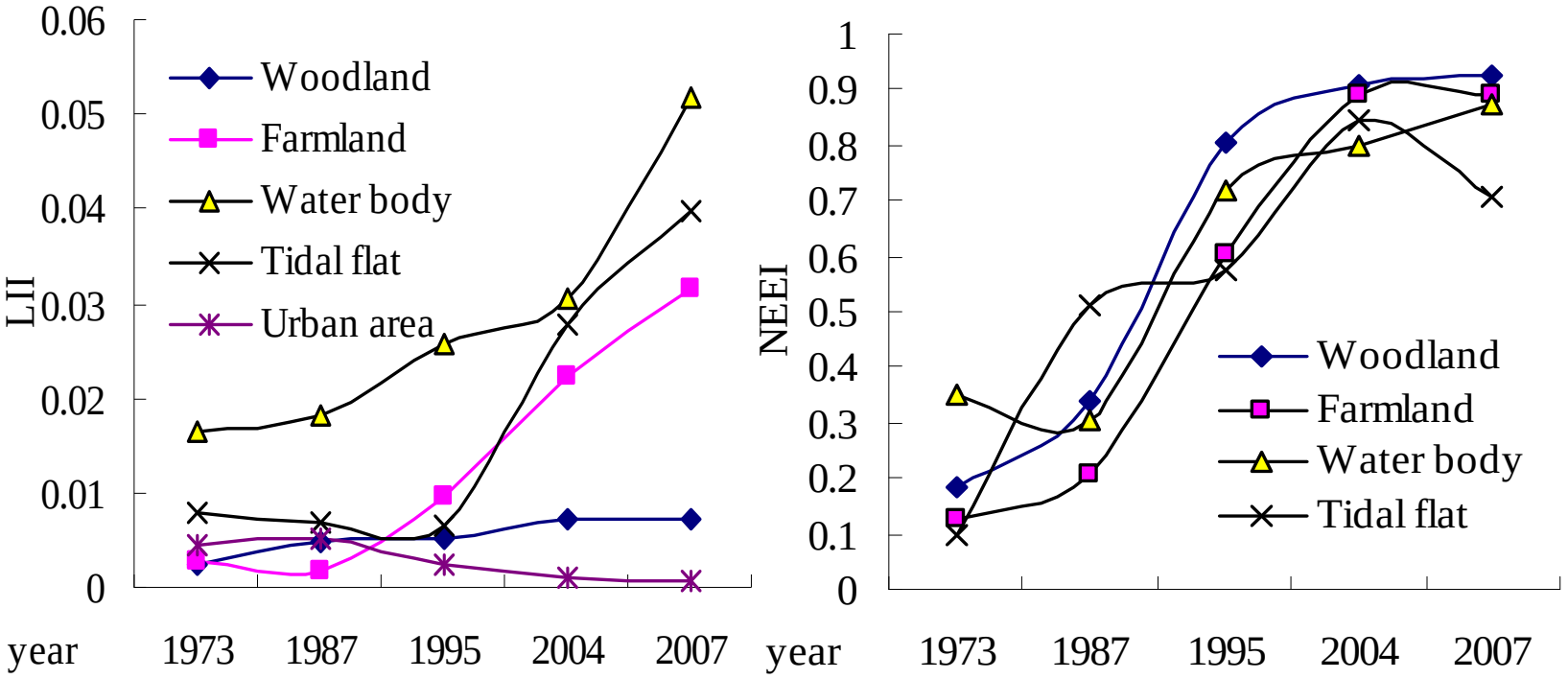
Urban spatial expansion and coastal line changes during the past 100 year

Results （3）



Dynamic changes of land use intensity index and ecosystem service of Xiamen Island during 1973-2007

Results （4）



Dynamic changes of LII and NEEI of Xiamen Island during 1973-2007

Discussion（1）

- **Urban planning change and its impact on coastal management**
- **Urban spatial expansion can be considered as a process of continually occupying the spatial resource suitable to urban development, to satisfy the demand of social economic development.**
- **Urban planning is the most influential guidance on urban spatial development in current China.**
- **To coordinate the development and protection of coastal resources and environment, Xiamen introduced the integrated coastal management system in 1994 and formulated the first marine functional zoning in China in 1997.**

Discussion（2）

- **Establishing urban coastal planning considering both land use and sea use**
- **Island and its surrounding sea are integrated system and both marine ecosystem service and land ecosystem service should be considered to establish urban coastal planning.**
- **Conserving or restoring the ecosystem with high value coefficients, such as tidal flat, would contribute to maintaining ecosystem services during the urban spatial expansion.**
- **Ocean orienting land may be the one of the basic principles for coastal urban planning.**

Thanks