# Dynamic Monitoring Of Sea Areas Use Based On High-resolution Remote Sensing

## ——A Case Study of Ximen Island

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***Abstract*—According to the interpretation of 2 Ximen Island high-resolution remote sensing images in 2007 and 2010, combined with its wetland land cover and land use status, set up Ximen Island wetland landscape classification system. Used software to calculate landscape pattern index and landscape transition matrix, and analyzed the landscape pattern of the Ximen Island dynamic in the past 4 years. The results show that the number of patches in the study area decreased in four years, patch density is on the decline, the landscape inlaid increased and the landscape heterogeneity decreased, landscape dominance increased and the patch porosity decreased, the distribution of patch types in the landscape gradually concentrated. The area of the ecological land in study area are increasing and the area of construction land, planting areas and farming are decreasing. The ecological environment of Ximen Island is getting better.**

***Key Words*— Remote sensing, landscape pattern, transition matrix, wetlands, Ximen Island**

## I. INTRODUCTION

Coastal wetland is a unique natural complex formed by the interaction of water and land [1], which lies in various spheres Interchange. It is an exchange place of variety of energy flow and logistics flow, which is a unique ecosystem. But due to the irrational exploitation and utilization, the island wetlands disappeared fastly. Therefore, the research of island wetland landscape pattern changes has great significance.

Currently, the evolution of the coastal wetlands, wetland ecosystems health and recovery, as well as the value of ecosystem services has become a hot research [2-4]. Although some scholars have studied Zhejiang's coastal wetlands spatial and temporal changes in ecosystem security and service value, the research results are not very much, there are still some unresolved scientific issues. Meanwhile the research of Ximen Island wetlands is still a blank. Coastal wetlands, especially the evolution of the landscape of the marine protected areas mechanisms are not yet clear.

In order to analyze the coastal wetland landscape pattern evolution mechanism, maximize the function of wetland ecosystems, the author takes Ximen Island special Marine protected areas as the study area, use RS and GIS to analyze the spatial distribution pattern of Ximen Island wetland landscape, provide a theoretical basis for optimization of wetland landscape pattern, Landscape Ecology, rational planning, and monitoring and evaluation of island resources.

## II. INFORMATION AND RESEARCH METHODS

### *A. The Study Area Overview*

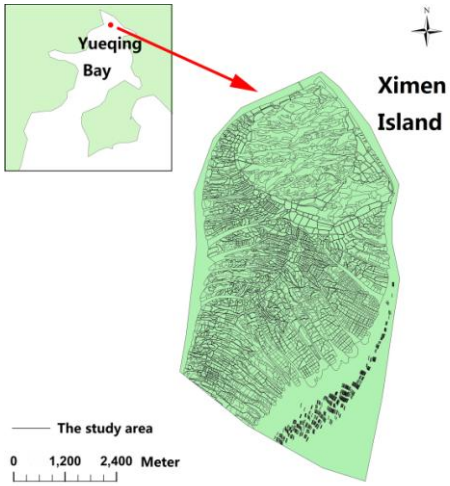


Fig.1. Location and scope of the study area

Ximen Island is located in the north of Yueqing Bay, Zhejiang province, latitude 28°20 'N, longitude 121°11'E, which is also an important coastal wetlands of Zhejiang Province (Fig.1). The island belongs to subtropical monsoon climate, the annual average temperature is 17℃ and the average annual rainfall is 1506.9mm. Ximen Island riches in biodiversity, it was list as Important Bird Areas by the International Bird Conservation Union in 1997 and special marine protected area in 2005, which has become the first national marine Specially Protected Areas of Zhejiang Province. The wetlands have a mangrove, which is the most northern mangrove planting area of China.

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*B. Data Sources and Processing*

In this study, the author use two periods (December 31, 2007 and June 6, 2010) of SPOT-5 remote sensing images (resolution of 5m) as a source of information, at the same time use all kinds of information and data collected in the field as an auxiliary. Before conducting the ground surface information extraction, to band fuse, image correct, cutting to remote sensing images first. Using principal component transformation method to fuse the image, make the remote sensing images with good spectral characteristics and high spatial resolution [5].Then, based on the hue, shape and field survey information of remote sensing image to establish the wetland landscape type interpretation signs of Ximen Island. In this paper, using the maximum likelihood method for supervised classification, the study area landscape type was divided into 17 species (tab.1). For visual interpreting suspects exist in the area, using the data of field investigation verifies the accuracy of remote sensing image classification results. The interpretation accuracy of remote sensing is over 90% and can meet the requirements of this study. Finally, make thematic maps shown in Fig.2 and Fig.3 landscape types.

Tab.1. Ximen Island Wetland Landscape Type

| ID | Level | Category Description | ID | Level | Category Description |
|---|---|---|---|---|---|
| **1** | enclosing sea and cultivatin | In the area of shallow water for enclosing sea and cultivatin | **10** | wharf | fishing wharfs |
| **2** | Settlement | Rural residential land | **11** | Mudflat aquaculture | Water aquaculture on the tidal flats |
| **3** | Dike | Reservoir, enclosing sea and cultivation and other protective Dikes | **12** | traffic land | Trunk highways, roads, bridges |
| **4** | Woodland | Natural forests, plantations, sparse forest, fruit trees | **13** | Reservoir and Pond | Artificial reservoirs and Pond |
| **5** | Paddy field | paddy field | **14** | Tidal inlet | tidal creek |
| **6** | Mudflats | coastal mudflats of Climax is flooded but exposed at low tide | **15** | Mangrove | Important wetlands |
| **7** | Raft-cultivation | Floating raft, slings, cages and other seafood farming | **16** | Bare land | Bare earth and Bare stone |
| **8** | Ocean | Yueqing Bay isobath-6m shallow waters | **17** | Spartina alterniflora | In the intertidal zone of Spartina alterniflora |
| **9** | Irrigation and drainage ditches | Artificial canal, Both road function | | | |

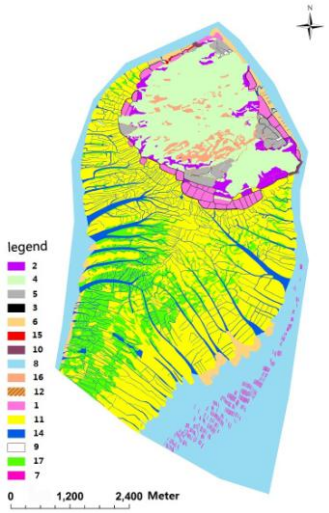


Fig.2. Distribution map of Ximan Island in 2007

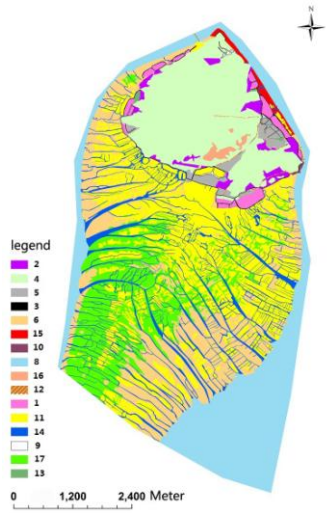


Fig.3. Distribution map of Ximan Island in 2010

*C. Selection of Landscape Pattern Index*

Landscape pattern index have been used widely in landscape ecology in which has various indexes [6-7]. Some of the indexes have no clear ecological meanings, while some are repeated, even contradict with others [8-9]. Therefore, this research selects the landscape pattern indexes with clear meanings, which can be counted out from the analysis software of landscape pattern, such as percentage of landscape types (PLAND), number of patch (NP), landscape area (CA), patch density (PD) and largest patch index (LPI).

## III. Landscape Pattern Dynamic Analysis

*A. Analysis of the Patch Types Level Index*

Patch is the basic element to constitute of landscape, and its change can reflect the change of the area's landscape

pattern. The Ximen Island's landscape pattern index in 2007 and 2010 can obtain by calculation, in fig.2. Compare the result we found, the ratio of each type of the landscape in the research area have some changes, the PLAND increases fastest in the mudflats, but area of Mudflat aquaculture and ocean which occupy the biggest ratio decrease quickly. The main reason is that the planning and integrating make the area of naked land, enclosing sea and cultivation, raft-cultivation decreased, but the woodland, Spartina alterniflora, mangroves increased after the foundation of the protection area of ocean.

Tab.2.The Calculation Results in 2007 and 2010 Ximen Island Patch Types Level Index

| Pattern Index | Years | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CA | 2007 | 73.69 | 64.10 | 15.82 | 439.55 | 50.95 | 70.17 | 18.67 | 750.94 | 5.56 | 3.13 | 1030.35 | 4.52 | 0 | 238.99 | 1.20 | 52.51 | 331.21 |
| | 2010 | 43.25 | 45.12 | 15.16 | 494.61 | 44.49 | 509.37 | 0 | 605.48 | 5.68 | 1.24 | 724.98 | 6.27 | 3.33 | 254.14 | 16.89 | 13.41 | 372.06 |
| PLAND | 2007 | 2.34 | 2.04 | 0.50 | 13.96 | 1.62 | 2.23 | 0.59 | 23.83 | 0.18 | 0.10 | 32.71 | 0.20 | 0 | 7.58 | 0.04 | 1.57 | 10.52 |
| | 2010 | 1.37 | 1.43 | 0.48 | 15.71 | 1.41 | 16.17 | 0 | 19.22 | 0.08 | 0.04 | 23.01 | 0.13 | 0.11 | 8.07 | 0.54 | 0.43 | 11.81 |
| NP | 2007 | 36 | 45 | 3 | 23 | 19 | 28 | 391 | 1 | 4 | 2 | 552 | 10 | 0 | 71 | 3 | 52 | 504 |
| | 2010 | 17 | 18 | 5 | 12 | 17 | 284 | 0 | 1 | 12 | 1 | 776 | 8 | 3 | 51 | 7 | 3 | 238 |
| PD | 2007 | 124 | 155 | 10 | 79 | 66 | 97 | 1349 | 3 | 14 | 7 | 1905 | 35 | 0 | 245 | 10 | 179 | 1739 |
| | 2010 | 59 | 62 | 17 | 41 | 59 | 980 | 0 | 3 | 41 | 3 | 2678 | 28 | 10 | 176 | 24 | 10 | 821 |
| LPI | 2007 | 0.18 | 0.18 | 0.47 | 10.86 | 0.22 | 0.50 | 0.002 | 23.83 | 0.07 | 0.06 | 1.46 | 0.06 | 0 | 6.62 | 0.01 | 0.63 | 0.21 |
| | 2010 | 0.36 | 0.19 | 0.40 | 13.20 | 0.30 | 0.68 | 0 | 19.22 | 0.06 | 0.04 | 1.25 | 0.05 | 0.06 | 6.26 | 0.16 | 0.32 | 1.00 |

Judging from the number of patches (NP), the number of mudflats and beach cultivation are significant increased, slight increase in the number of patches of irrigation and drainage ditches, mangrove, other types of NP value are in reducing, Raft-cultivation has completely disappeared by 2010. From the changes in patch area (CA) (Tab.2), during 2007 - 2010, the Mudflat aquaculture, floating raft cultivation have reduced while the mudflats, woodlands, spartina alterniflora, have increased. Although the NP of Mudflat aquaculture has increased, the CA is greatly reduced, the NP of woodlands, spartina alterniflora, and tidal channel also reduced, but its CA increased. This is mainly because that people become considerate the economic and ecological benefits and plans the land use scale, so many regions together as a unit.

Patch density (PD) reflects the overall patch differentiation or fragmentation degree of the landscape. The wetland landscape patch density declining judging from 2007 to 2010 patch density (PD) changes, the landscape inlaid increased and the landscape heterogeneity reduced. In terms of a single landscape in the form, the PD of mudflats and Mudflat aquaculture increased, and this reflects the porosity increases and its distribution is relatively fragmented; on the contrary, the PD of Spartina alterniflora and bare land reduced, indicating the patch's porosity decreased and the distribution is tend to be concentrated.

Largest patch index (LPI) can be used as simple measurements of landscape dominance, as can be seen from the table, from 2007 to 2010, LPI value fluctuations, but slight decrease overall. LPI values of Woodland, Spartina alterniflora land tended to increase, indicating the dominance of the landscape have a more substantial increased, this mainly because of the implementation of the policy of returning farmland to forests, which makes its area gradually improved, and the development of other sites are also more standardized.

### *B. Analysis of Landscape Types Transfer Change*

Matrix elements transferred to another type of landscape area by a landscape, matrix diagonal values indicate various types of landscape area conversion, pursuant to which can visually see the evolution of position of the various types of landscape. Table 3 shows that the type of wetland landscape changes in Ximen Island from 2007 to 2010 have the following characteristics: First, the tidal channels and woodland ecological land area showed an increasing trend, especially the mudflats area have a rapidly increase. Ecological land area of growth was mainly transferred from the beach culture, marine, bare land, residential. Second, dikes, residential and pier construction land decreased, the reduced construction area transformed into a forest. Third, the land area of the ocean, bare land, and planting and breeding area also decreased gradually.

Judging from the changes of the transfer of landscape types, Ximen Island wetland ecological environment is gradually getting better, especially since 2005 the area was named the first national special marine protected areas, and the local government pays special attention to environmental protection, to implement to prohibit the raft-cultivation, planting trees and other measurement which helps Ximen Island's ecological environment turn better.

## IV. CONCLUSIONS AND DISCUSSION

*A.* During 4 years, the number of patch and the patch density decreased in the study area, the landscape heterogeneity also decreased, as well as the landscape mosaic. The patch porosity decreased while the landscape dominance increased. The distribution of patch types in the landscape became more concentrated, the ecological environment of Ximen Island tended to be better.

*B.* The ecological land area such as tidal channels, woodland and mudflats of the study area showed an increasing trend while the dikes, residential and pier

construction land area decreased sharply and the growing areas and breeding area are decreasing gradually.

Currently, Ximen Island wetland landscape pattern index and spatial association of human disturbance and its impact, wetland landscape of human disturbance index spatial distribution rule pending further study. This study have great significance of the analysis of socio-economic causes of temporal and spatial change of Ximen Island anthropogenic interference, monitoring and evaluating the wetland landscape changes by human activity, prevent degradation of the ecosystem and ensure the ecosystem to provide mankind with sustainable natural resource.

Tab.3.The Area Shift Matrix of Ximen Island Wetland Landscape Type of 2007—2010 (Unit: $hm^2$)

| 2007a \ 2010a | 14 | 3 | 9 | 8 | 15 | 17 | 12 | 2 | 4 | 16 | 10 | 6 | 13 | 5 | 11 | 1 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **14** | 119.58 | 0.03 | | 0.06 | 0.74 | 40.41 | | | 0.01 | | | 43.03 | | | 35.14 | |
| **3** | 1.19 | 6.69 | 0.07 | | 0.12 | | 0.12 | 0.48 | 0.26 | | | 1.3 | 0.23 | 0.36 | 3.22 | 1.77 |
| **7** | | | | 18.67 | | | | | | | | | | | | |
| **9** | | 0.11 | 4.39 | | | | | 0.01 | 1.57 | | | | 0.72 | 0.55 | 1.51 | |
| **8** | 33.2 | | | 584.8 | 0.94 | 3.74 | 0.32 | 0.06 | 0.03 | | 0.12 | 101.88 | | | 26.17 | |
| **15** | 0.01 | 0.32 | | | 0.05 | | | | 0.01 | | | 0.43 | | | 0.03 | 0.35 |
| **17** | 20.81 | 0.004 | | | | 259.08 | | | | | | 18.25 | | | 33.06 | |
| **12** | | 0.87 | 0.08 | | | | 0.84 | 0.66 | 2.22 | 0.09 | | 0.004 | 0.0003 | 1.37 | 0.12 | 0.02 |
| **2** | | 0.83 | | 0.02 | | | 1.18 | 33.63 | 23.24 | | | 0.39 | 0.01 | 4.75 | 0.03 | 0.02 |
| **4** | 0.21 | 1.02 | | 0.08 | 0.16 | | 1.16 | 8.31 | 418.87 | 3.77 | | 0.55 | 0.14 | 4.51 | 0.47 | 0.28 |
| **16** | | | | | | | 0.41 | 1.71 | 37.83 | 9.56 | | | | | | |
| **10** | | 0.28 | | 0.09 | | | | | 0.11 | | 1.13 | 0.34 | | | 1.18 | |
| **6** | 6. 20 | 0.66 | | 1.43 | 14.79 | 3.28 | | 0.01 | 0.36 | | | 33 | | | 10.46 | |
| **5** | | 1.01 | 1.15 | | 0.05 | | 0.34 | 0.04 | 7. 61 | | | | 0.16 | 32.19 | 7.11 | 1.3 |
| **11** | 71.35 | 0.21 | | 0.21 | | 65.56 | 0.16 | 0.03 | 0.54 | | | 306.49 | 0.12 | 0.75 | 583.51 | 1.4 |
| **1** | 1.57 | 3.13 | | 0.11 | 0.03 | | | 0.18 | 1.94 | | | 3.71 | 1.95 | | 22.97 | 38.1 |

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