HABITAT MONITARING FOR ECOSYSTEM IN IRIOMOTE ISLAND WITH SATELLITE DATA

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ABSTRACT:

Generally, investigation for protection of the wildlife is difficult because it takes much work and time, and frequent monitoring. Therefore, studies of monitoring with remote sensing and GIS were carried out for solving such a problem. In this study, a habitat of an ecosystem was estimated by remote sensing and GIS in Iriomote Island. The objective creatures were an Iriomote cat and a coral reef. The habitat estimate for an Iriomote cat was carried out with HSI, the values of which ere showed in all areas of Iriomote Island. Next, the coral reef mapping for its cover evaluation was made with a depth correction algorithm. This result coincided with the sighting points of the Iriomote cat for two years. As a result, the habitat areas of the Iriomote cat were showed mostly on the edge outside the island. Also, the habitat areas of the Iriomote cat did not coincide with the National Park areas. Moreover, the estimate of the number of Iriomote cats would be carried out with HSI. Especially, the classification with ALOS would be carried out more exactly than JERS-1 and ASTER, because of ALOS with higher resolution and higher transmissivity to the seawater. In the above, the ecosystem evaluation of the land and sea was carried out in a short time and with low cost by GIS and a satellite image. Remote sensing was considered valuable for monitoring of an ecosystem. This study would be contributed for monitoring and protection of Iriomote Island ecosystem.

1. INTRODUCTION

The present status of the wildlife ecology is required for its protection. But it needs manpower and time for monitoring the field. Therefore, our study was carried out by monitoring with satellite data and GIS. Herewith, the manpower and time would be reduced, capacitated monitoring widely and frequently. In this study, Iriomote cat habitat was estimated by a habitat model with satellite data and GIS in Iriomote Island. Also, a coral reef cover was estimated with the Bottom Index algorithm. Herewith, comprehensive monitoring was carried out for the ecosystem.

2. OBJECTIVE AREA

This study was carried out in Iriomote Island, Okinawa prefecture (Figure 1). This island is located at latitude 24° 15' to 25'north and longitude 123° 40' to 55' east. This island is a part of the Yaeyama islands with Ishigaki Island and other islands. The island is on southwest of Japan, nearer Taiwan than the Okinawa main island and the Japan main island. Iriomote island is almost covered with arboreal forest, mangrove forest in estuary, and coral reef around the island. The island has many 300-m-high ridges. Also, a lot of rare creatures inhabit, such as Iriomote cat and Crested serpent eagle, in the island. This island has biodiversity, called "Oriental Galapagos" or "Oriental Amazon".

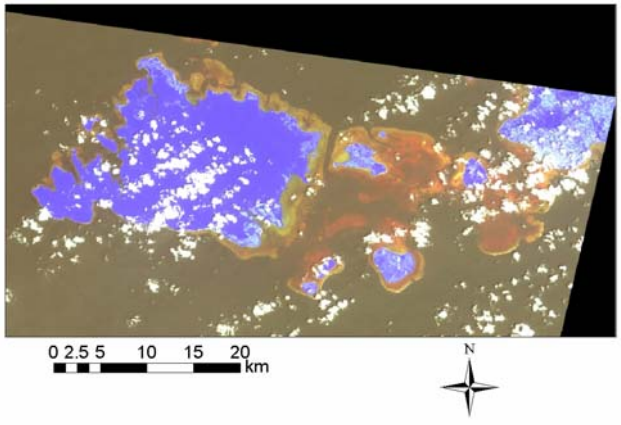

Figure 1. Objective area (ASTER/VNIR)

The biggest island is Iriomote Islamd in the image. The big coral reef community that is called Sekisei Logoon is observed east of the Iriomote Island.

3. OBJECTIVE CREATURES

3.1 Iriomote cat

An Iriomote Cat (Felis iriomotensis) was found out in 1967. It is wild relatives Leopard Cat (*F. bengalensis*) distributing out in Iriomote Island, Okinawa. The number of a living Iriomote cat was estimated at about 100 in 1985 and 1994. The number did not change very much, but the threatening life factors would

be a habitat change and a traffic accident. Now, a Iriomote cat has been protected as rare species of wild animals in Japan.

3.2 Coral

A coral reef was breakwater strictures made by an coral and many creatures made calcareous. Coral reef ecosystem has rich biodiversity to many creatures habitats there. However, a coral have decreased by albinism, soil runoff and feeding damage by acanthasters in late years.

4. METHODS

4.1 Land cover classification

Unsupervised land cover classification was carried out from satellite data, ASTER/VNIR (8, May, 2000). The classification was referred to the aerial photograph. Land-cover classification had six categories: forest, bare land, urban area, water body, and coral reef.

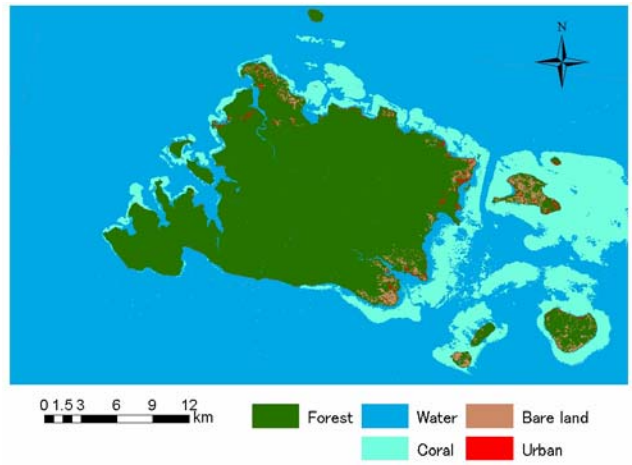

Figure 2. Land cover classification

The island is almost covered up in a forest. A bare land and urban area distribute around the island. Because more people live in the areas. The coral reef is in east of the island.

4.2 Habitat estimate

Iriomote cat habitats were estimated from land cover classification, digital map 25000, and 50-m-grid DEM with creature's parameters made from its refrences.

The habitat estimate for Iriomote cats used Habitat Suitability Index (*HSI*). A habitat model for Iriomote cat was made from a land cover classification map, digital map 25000, and 50-m-grid DEM. Grides (1.4 km by 1.4 km) were made over the island (Figure 3).

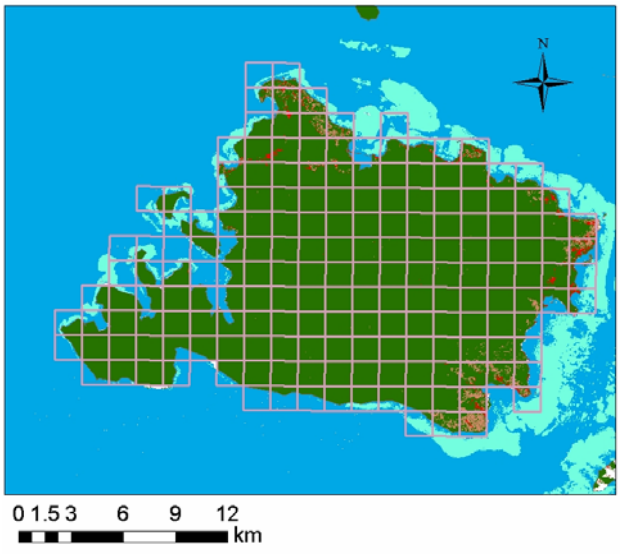

Figure 3. Grids

The Grids are 1.4 km by 1.4 km. The side determines the home range of Iriomoe cat.

The *HSI* was calculated with the next model each grid.
Habitat Suitability Index shows the habitat suitability of animals and how the requisite life conditions (feeding ground, breefing, and land covers) in the objective area satisfy. The value ranges 0 (the habitat was not suitable) to 1 (the habitat was suitable).

The next models (Figures 4, 5, and 6 and Equation 1) were made from Iriomote cat references. Each suitability index were calculated by the models. Finally, *HSI* were obtained from Equation (2).

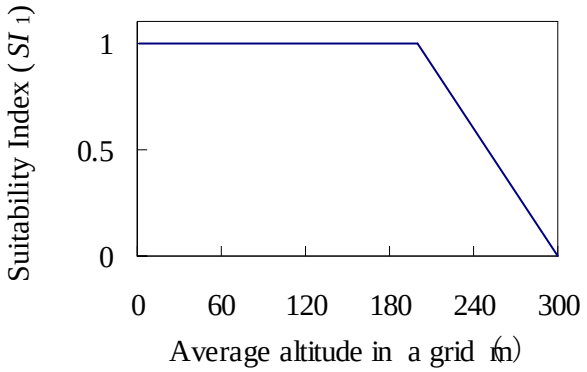

Figure 4. Suitability Index (SI_1)

The abscissa axis is average altitude, the longitudinal axis is Suitability Index (SI_1) in this figure. The Suitability Index (SI_1) is 1 at less than 200 m and decreases as at more altitude than 200 m, and 0 at 300 m.

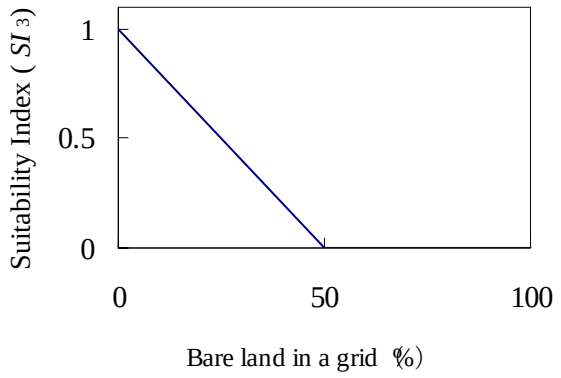

Figure 5. Suitability Index (SI_3)

The abscissa axis is bare land in grid (%), the longitudinal axis is Suitability Index (SI_3) in this figure. Suitability Index (SI_3) decrease between 0 % to 50 % in the bare land in a grid, and 0 between 50 and 100 % of the bare land.

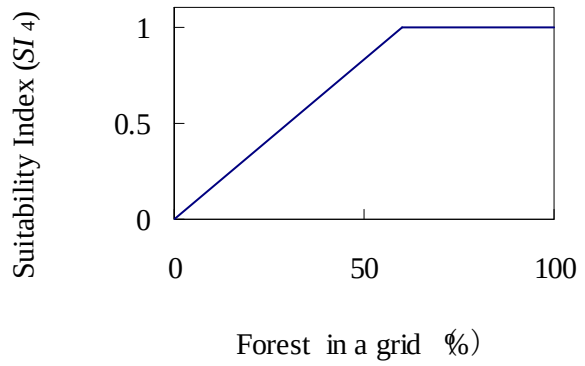

Figure 6. Suitability Index (SI_4)

The abscissa axis is forest in grid (%), the longitudinal axis is Suitability Index (SI_4) in this figure. Suitability Index (SI_3) increase between 0 % to 50 % in the forest in a grid, and 1 between 50 % and 100 % of the forest.

$$SI_2 = 0 \quad \text{(no river)} \\ = 1 \quad \text{(river)} \tag{1}$$

$$HSI = \frac{SI_1 + SI_2 + SI_3}{3} \times SI_4 \tag{2}$$

HSI: Habitat Suitability Index
SI_1, SI_2, SI_3, SI_4: Suitability Indices

The estimated distribution of the Iriomote cat was made from the *HSI* map in Iriomote Island (Figure 5). Moreover, it was overlapped with sighting reports.

4.3 Bottom distribution of coral reef

The satellite image (ALOS/AVNIR-2) was used for this study. Thus, extraction of the undersea remains was approached. The reflectance brightness value decreases as the water depth. Then, the Bottom Index was calculated with its algorism that removed influence of the water depth. Next, the coral reef was classified based on the Bottom Index. The objective area was picked up in the Sekisei Lagoon with much coral reef between Iriomote and Ishigaki Islands.

If the bottom material is the same, logarithms of digital values DN_i and DN_j of the bands i and j show a linear relationship independent of the water depth. The basic principle utilized for Equation (3) adopted as the Bottom Index free from the effect of the water. Herewith, if an extinction coefficient ratio each band is obtained, the Bottom Index is derived without influence of the water depth. BI_{ij} made consideration influence of the water depth for the ratio of reflectance between two bands and shows the ratio of the sand inside the pixel.

$$BI_{ij} = \ln(DN_i - DN_{deepi}) - k_{ij} \times \ln(DN_j - DN_{deepj}) \tag{3}$$

$$= \ln\left\{ \left(DN_i - DN_{deepi} \right) / \left(DN_j - DN_{deepj} \right)^{k_{ij}} \right\} \tag{4}$$

BI_{ij}: Bottom Index derived from bands i and j.
DN_i: *DN* value of band i
DN_{deepi}: *DN* value of band i in the deep sea.
K_{ij}: An extinction coefficient of bands i and j.

An extinction coefficient ratio was calculated as pretreatment of the water depth offset. The uniform sandy area was chosen as a bottom material with visible bands 1 and 2 of ALOS. Next, natural logarithm of the bands i and j was plotted in the axis after removal of an offset value from *DN* value of the sandy area. A gradient in a regression line becomes an extinction coefficient ratio K_{ij}. An extinction coefficient ratio became 0.76 from this regression equation (Figure 7). In addition, *DN* value of bands i and j in the deep ocean was applied to *DN* value of the Iromote Island offing where the water depth was enough. Next, the Bottom Index was calculated after extinction coefficient ratio and *DN* value of bands 1 and 2 were applied to Equation (3).

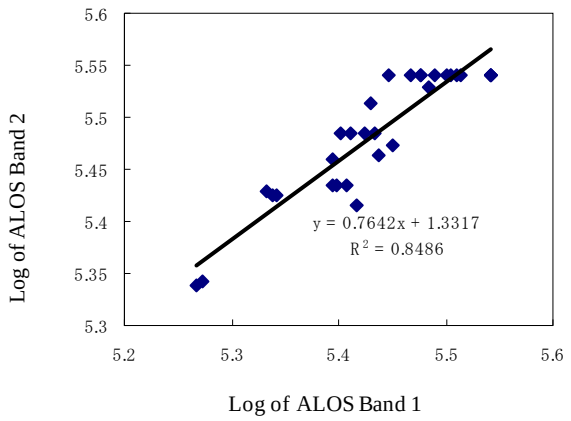

Figure 7. Regression equation for the bands 1 and 2 of ALOS

The abscissa axis is log of ALOS band 1, the longitudinal axis is log of ALOS band 2 in this figure. The slope value of the regression line is an extinction coefficient ratio.

The image was classified by the Bottom Index in Section 4.3. Moreover, it was classified (Sand bottom, Coral, Seaweed bed, and Mud bottom) with Natural Environment Map (Environment Agency, 1995).

5. RESULTS

5.1 Iriomote cat habitat

Iriomote cat habitat areas were illustrated in Figure 8. High *HSI* areas were illustrated outside the island. In addition, high areas were consisted with sighting reports.

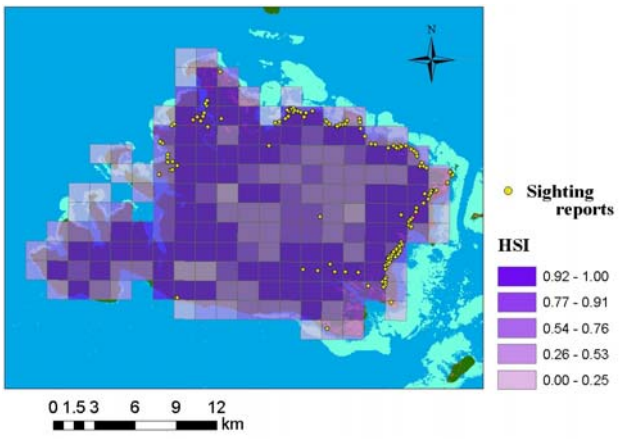

Figure 8. Estimated Iriomote cat distribution

An Iriomote cat habitats would be high *HSI* areas. HSI value was so high as to make strong the color. The Sighting reports were points to see an Iriomote cat in 2001 and 2002.

5.2 Coral reef map

The coral reef map is shown in Figure 9. The black areas were islands, clouds and the ocean. A coral reef distributed between 0.23 and 1.16 of the Bottom Index.

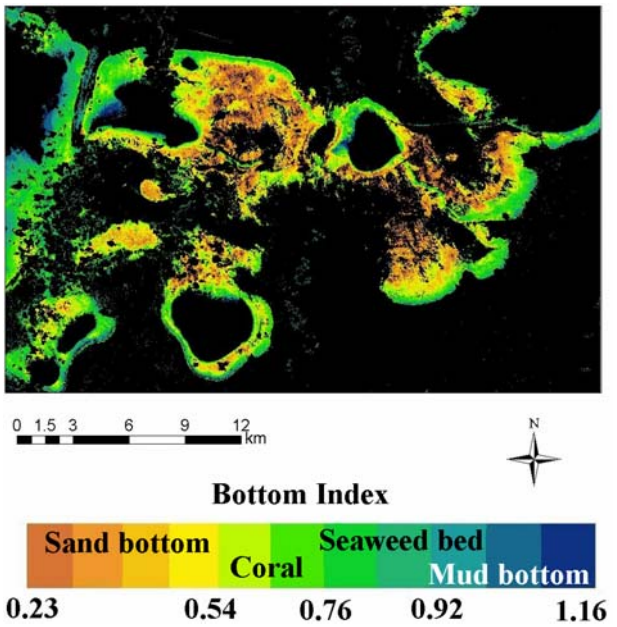

Figure 9. Classification of coral reef

This area is Sekisei Lagoon. The coral reef coustiutes sand bottom, coral, seaweed bed, mud bottom in the order of Bottom Index value. The coral reef would be made almost sand bottom and coral in this area.

6. DISCUSSION

Iriomote cat habitats were shown outside the island, although no habitats inside the island. No habitats areas include the Iriomote national park. In fact, north and east areas with many habitats were not included. Consequently, the range of the national park should be for Iriomote cat protection. Moreover, not only the population estimate modified but also habitats estimate with *HSI* model in satellite image could be carried out. While the estimation was carried out from satellite images in difficult approach area.

The classification of the coral reef coincided with the coral reef report by the Environment Agency. The coral reef in detail was estimated by ALOS with a high resolution. Moreover, much time and manpower were required as the coral reef distribution was very large in the field. But, if the satellite image was used, its cost would be reduced for simultaneously analysis in the study area.

7. CONCLUSIONS

The ecomanagement requires monitoring widely and frequently. This study was to evaluate the habitat of Iriomote cats and the coral with remote sensing and GIS in Iriomote Island, Okinawa prefecture. Iriomote cat habitats were estimated with *HSI* model, while coral reef mapping was made with the Bottom Index algorithm. Iriomote cat habitats were estimated with the satellite image in difficult areas of the field. This result coincided with the sighting reports for the past 2 years. Moreover, the reserved location should be modified. A coral reef distribution was estimated with the satellite image and the Bottom index algorism. This result coincided with the coral reef report.

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APPENDIX

Explanations show the degree of coral cover by the area ratio of the coral.

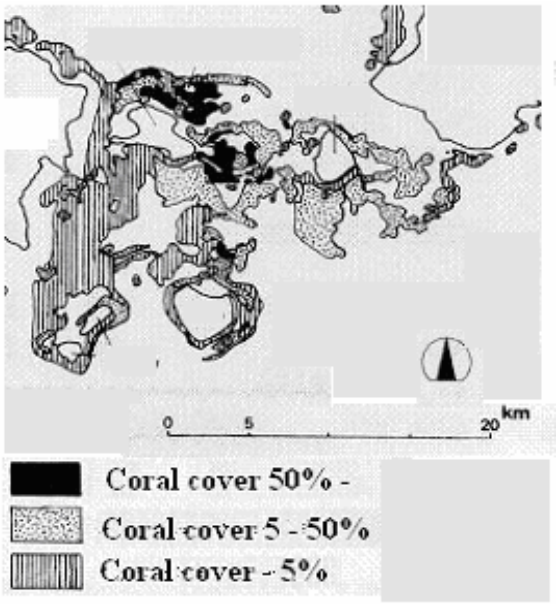

Figure 10. Coral Map around Yaeyama islands [13)]

The number of Iriomote cats decreased to about 100 recently.

Photo 1 Iriomote cat [14)]

The global warming effect impact on coral reef.

Photo 2 Coral reef around Iriomote Island