D-4.3.3 Coral Coverage Analysis using Color Aerial Photograph Images

Contact Person Shuichi Fujiwara
Marine Parks Center of Japan
1-3-1 Atago, Minato-ku, Tokyo 105, Japan
Tel. +81-3-3459-4605 Fax. +81-3-3459-4635

Total Budget for FY1995-FY1996: 18,498,000 Yen(FY1996: 9,243,000 Yen)

Abstract Coverage of the coral community at the moat of reefs was analyzed using images aerial color photograph images in the Yaeyama group, Ryukyu Islands, Okinawa in 1975 and 1976. Photographs chosen were transferred by the digital color scanning camera to a computer, then image domains were counted for their gray values for each R,G,B channel,and grouped by value patterns on the coordinates of R on G. By comparing the coral coverage surveyed in the field with the groups, a low level of R and G indicated a low coral coverage, and a high level of G and R indicated a high coral coverage.

Key Words Coral Reef, Coral Coverage, Aerial Photograph, Image Analysis, Spectrum

Introduction

Image analysis of aerial color photographs is a good tool for obtaining information on the bottom features of a moat in coral reefs. However, the analysis has been done by qualitative criteria but quantitative standards have been required. Especially, the analysis of the degree of coral coverage is needed because the coral community is the dominant one at a moat and often indicates the environmental state of the moat. Therefore, the authors aim was to study the quantitative standards of the image analysis of color aerial photographs on the coral community at a moat using digitalized data and then referring to the coral coverage survey results in the field.

Methods

Study sites

Coral coverage surveys for ground truth were carried out in the Sekisei Lagoon and the east coast of Ishigaki Island that locates the Yaeyama group of the Ryukyu Islands. Both sites are known as fields where coral communities with various coverage degrees occur[1),2)].

Image analysis of aerial color photographs

Sixteen aerial color photographs (S:1/10,000) provided by the Okinawa Prefectural Government in 1994 and 1995 of the study sites were scanned by the digital scanning camera (ProgRes 3012,

Kontron Elektronik) and transferred to a computer.

Stratified image domains including coral communities and sea-grass beds on the photographs were used for counting the gray value of each R,G and B spectrum using the image analysis device (KS400, Kontron Electronik).

The gray value used was 256 degrees and counted at average of the entire domains. After counting the gray values, image domains were sorted for the coral communities and sea-grass beds by image features. Sorted image domains of the coral communities were clustered by the similarity of the gray values of R,G and B.Clustered images domains were made into three groups on the coordinates of R on G.

Coral Coverage Survey

In order to analyze the relation between coral coverage and the group of clustered image domains, two or three image domains for each group were chosen by the dendrogram of the similarity index, area, easy approach and location recognition.

In the field, the coral coverage survey was carried out on the chosen image domains . The survey method is as follows.

a. One research station within the image domains was set up for approximately each 1 ha area at random.

b. Researchers reached the research stations by boat using the aerial color photographs and recorded the locality using GPS.

c. The survey area at each research station was $15m^2$ obtained by area-species curve of branching corals[3] and set along a of 15m long rope line.

d. Researchers with or without SCUBA measured the substratum type, depth and coverage of the corals and vegetation that occurred within each 1m by 1m quadrat and took photographs of each quadrat and repeated 15 times. Nishihira and Veron[4] and Uchida and Fukuda[5] were referred to for identification of the hermatypic corals.

Results and Discussion

Grouping images

The similarity index of the gray values of the counted R, G and B was obtained by the Geodesmic metric and then its dendrogram was made by UPGMA. Clustered Image domains were made into three groups using the similarity index over 0.15(Fig.1).

Fig.2 shows the groups on the coordinates of R on G, B on G and R on B. Group A represents the R value that is almost 0 and the G value that is also under 30. Only the B value is as high as 48 to 84. The group B shows that the R value is lower than 10 but the G value is higher than the group A and is from 39 to 80. The B value is also as high as 69 to107. The group C indicates that the R value is obviously higher than the A and B groups as 22 to 61 and the G value is also as high as 77 to 91. The B value is 97 to 101. Groups are clearly presented in the coordinates of R on G. Others are not very clear because the B value does not have much difference.

Coral Coverage Survey

Table 1 shows the image domains chosen as survey sites. The three domains from the A and B groups and two domains from the C group were selected. Results of the survey are showed in Table 2. Coral coverage at each domain is as follows.

Group A- 9, 9 and 11%

Group B- 48, 51 and 65%

Group C- 40 and 59%

Group A supported high vegetation and was dominated by brown algae such as *Padina minor*, *Dictyota* spp. and *Lobophora variegata* in coverage and frequency. Groups B and C supported a high coverage of corals and were dominated by branching corals such as *Montipora digitata* and *Acropora formosa* in coverage and frequency.

Comparing groups indicated that the coverage of group A is significantly lower than the coverage of groups B and C ($p<0.05$, Tukey test) (Fig. 3).

Sometimes there are color differences between the color aerial photographs taken at different times due to changes in sun illumination. Therefore, we should calibrate it when we analyzed an image.

In this study, the authors used a method where two of the R, G and B values were grouped on the coordinates for analyzing images after ignoring differences in illumination between the R, G and B channels.

At as consequence, image domains were made into three groups. One out of three groups represents a significantly lower coral coverage than the others. It is suggested that the coordinates of R on G are available for analyzing images on coral coverage. The B value was not employed for the analysis because it did not show apparent differences between the groups.

For the G value, Nagaoka[5] et al. reported that it varied with the spectral magnitude on living corals. It is known that hermatypic corals have spectral characteristic in the green band by the spectral study of branching corals in the Ishigaki island, Ryukyu islands and the spectral study of Acropora hyacinthus in Kushimoto, Wakayama prefecture[6,7].

In the next phase, a methodology must be developed for analyzing the serial coverage degree of coral.

In this study, because we did not examine the change in gray values due to depth, we should also study this issue. While the red spectrum tends to absorb below water, it showed that the red spectrum can convey information on the coral community in shallow areas in this study. However, we should calibrate the value change due to depth because the red spectrum varies its brightness with minor depth changes.

The texture analysis of images must also be developed.