CHAPTER VI

CONCLUSIONS

The remote sensing studies on the coral reef component distribution at Samui Islands is the first project in Thailand which aims to solve the problem in using the remotely sensed data to research and manage our coral resources. During the process it can be separated into three main ideas; to work out the technique in microBRIAN system, to develop the method for studying of the small and turbid reefs and to study the reef morphology, zonation and classification at Samui Islands. Finally, when the project is over, all objectives are met and are concluded as follows:

6.1 Remote Sensing Studies on Reef

6.1.1 microBRIAN System

By working out the microBRIAN system, the result suggests that this image processing system is useful for reef study. The program is suitable to be employed for different objectives. For example, the image enhancement can be operated by many functions such as band ratio, histogram enhancement, and principle component analysis. The program is open for user definition which can be designed by the statistical number or the user acknowledgement. Furthermore, any function in the program is easy to run through by the reef scientists who lack computer background. It recommends that the people who want to work with this system may be combined for the objective of each programs, and should join their study objectives. It will help to find the best way for searching the requirement with less working time and more significant results.

6.1.2 Techniques in Digital Image Processing

To develop the remotely sensed data for a small and turbid reef study. The classifying routine in a small fringing reef is different from the Great Barrier Reef. The result concludes that the technique used in the reefs at Samui Islands can be expanded for

operating in other reefs in Thailand. Moreover, it can be used with other reefs which have a similar reef pattern especially in Asian countries. The result suggests that the remote sensing studies on the coral reefs may be taken without any difficulty. During the process the statistic number and visible classification will give an idea to study the reef ecosystem. For example using mTRAN it will give a guess reef zonation which will help to select the site for ground survey method.

6.1.3 Ground Truthing

The ground truthing study develops a ground position method and transect ground survey. It is recorded that the ground position method using the low price equipment can be possible to do in the reef area. The new transect method is suitable for combining and examine with the remote sensing result especially mTRAN, and it helps in a research in a large area. Because the user can locate the sample site in the unknown area and go out to report the data, after coming back the data is easy to combine with the imagery result.

6.1.4 Data Integration

There are two new reef studying methods developed from this thesis, the multi-resolution reef map and the data integration. Recently, the multi-resolution method is widely used in the urban studying. However, those applications operate the SPOT data themselves. The processing in this thesis uses the SPOT data combined with TM data, and the result presents a useful data for coral reef survey and study. It recommends that this multi-resolution method can be used with other coastal zone studies. With the high resolution as the aerial photographs and the colour pixels in the reef area it helps to classify the reef with less working time and researchers.

The data integration is different from other processes because it id not based on remotely sensed data, but it is a method to combine the ground data and the remotely sensed data together. In the past there were several investigations about the microBRIAN data integration. However, those researches emphasized on land use, and it needs the special program to transfer the data to microBRIAN system. The processing in this thesis solves the way to use the

common program, SURFER, which transfers the data to microBRIAN file. The result combines the remotely sensed data with the ground data and explains how it works. It is concluded that the result from this thesis may be a good starting point to use the microBRIAN as a geometric information system for the studying of coral reefs or other coastal zones.

6.1.5 Working Process

Finally, the technique using remote sensing studies on reef may run as follows:

- Selecting the image with the whole scene covers all reef areas and the major sediment source in that area.

- Masking the land area and using the histogram enhancement. Using the sediment density slicing technique for the water area.

- The reef area is enhanced by histogram enhancement technique, and using mTRAN to study in its zonation. If there is the mixing reef component, using the principle component analysis to emphasize the zonation, mTRAN may be operated again (run mTRAN with the raw image).

- Before a classification process, all the background data must be reviewed. Along the selecting training site process, try to select the area parallel to the reef. The Chi-square in the coral or other important areas may not rise more than 3 but the Chi-square in the shore line may be 4-5 depending on the shore type (rocky shore may be higher than beach). The training pixels is approximated 25 percent of all pixels, the more training pixels do not mean that the classification is good.

- Run the first classification (with three or four sub-classifications) and cluster the class, the aerial or horizontal photograph will help to group them. The first classification result may be 12-15 superclasses. In those superclasses composed of 4-6 small classes which cover the shore and reef flat areas (the small class depend on the selected training site process), try to group them into 2-3 superclasses. The living coral area may be covered by 2-3 superclasses, try to expand this group.

- The ground truthing will be done after the first classification. With the result from mTRAIN and classification they will help you to select the ground survey site. Try to take a photograph in every superclass area.

- Run the second classification by clustering the superclass again. With the ground data it will help in grouping each area. The technique to group depends on the objective. In this project, it is based on reef morphology so it is grouped in the reef zone.

- If there are other diversity areas, for example seagrass beds, try to separate them from the reef classification, and run on itself before pasting it back on the reef image.

- All the data can be pasted back together, it can be modified in many ways. For example, classifying one reef image and putting two water patterns in different periods together for studying the sediment effect to the reef. However, the reef and the water images must have the recorded time closing to each other.

- The multi-resolution technique may be used as a supporting product as well. It can be operated by itself for observing the reef formation with a rapid and high resolution product.

6.2 Reef Morphology, Zonation and Classification

To study the reef morphology, zonation and classification are very interesting. The imagery results serve in the reef morphology which is the significant method to classify the reefs in Thailand. A lack of other data, for example hydrodynamic process, sedimentary zone, coral drilling, makes the explanation emphasize on the coral zonation. The reef area measurement demonstrates that the living coral areas do not correspond with the overall reef area. The sizes of the islands and the reefs are not correlated to each other. The result concludes that the fringing reef in Samui Islands has a different zonation compared with Great Barrier Reef. In stead of lagoon, the characteristic of wave front can be used as the moderate module to classify the reef. The product from sediment density slicing is useful for generating the reef region, the whole sediment and reef areas can be observed in one image which never happen in other methods, and it helps to separate the zones.

Finally, the remote sensing studies on the reef at Samui Islands present the new method to survey, study and manage the reefs in Thailand. The usefulness of this method does not allow only the imagery production, but also the idea which can get along the process. It is not necessary that remote sensing must be done by itself, but it can support other projects as a tool for more information. The remote sensing is a method which requires many ground data, and the data integration can expand the idea for managing the data for any concept. It recommends that remote sensing and data integration are very useful tools for reef research in the future. Other researches on coastal area, and land use may get ideas and products from this equipment.

6.3 RECOMMENDATIONS

In the project there are many advantages which researchers are encouraged to search. However, the concept of this project is to develop a technique and study in reefs. There are many recommendations which are promoted to use remote sensing. The guidance includes the idea to study the reef morphology, zonation and classification which will be supported on the remote sensing studying.

- Samui Reefs were selected because they are a good example for explaining the remote sensing studies in other reefs. However, it is recommended that other reefs may not have the same pattern as Samui Reefs. Further study may run through the major deltas which have the reefs, for example Phuket Island and Chang Island.

- The ground positioning technique in this project is developed to support the transect ground truthing technique. If there is a new equipment, such as ground positioning system, the ground truthing method may be further developed to suit the high accuracy equipment.

- Recently, microBRIAN version 3 is presented, although the program is still based on the remote sensing theory, the command and function are different from version 2.3 which is used in this thesis. The image processing technique may be reviewed along the new version to find out the technique and a new function. It recommends that this new version has a lot of program errors in the system, so it will help the programmer by showing the error function

and giving them a new idea to apply the new program.

- Although the technique result from this project includes the seagrass bed in the reef flat area, to do further study on seagrass beds there are still many problems. It is noted that a seagrass bed is the coastal ecosystem which is suited for remote sensing studying. Further research may start to develop the technique in the seagrass beds, not only the beds in the reef area but others which may be located on the mud flat.

- The remote sensing studies on monitoring the variation of coastal ecosystem. In microBRIAN there is a program to search in this objective. The results recommend that the study may start with the seasonal variation of seagrass beds especially Nai Wog Bed. The coral reef monitoring should be started with the high alternative area, for example Tao Islands which has the effect from the Typhoon Gay. Other researches should be taken on the biological effect, such as the outbreak of Crown-of-Thorn starfish. Adang and Rawi Islands may be nice examples for this research.

- For data integration, the project should be encountered on the Ban Don Bay, transfers the depth data in the whole bay and map the remote sensing land and reef data. Further study may try to transfer other data, for example fishery grounds, in this image (microBRIAN has a supported program for this hypothesis already).