

Land use change in mangrove areas of southern Vietnam using satellite images

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Abstract:

This study aims to clearly understand land use change in mangrove areas of southern Vietnam by using remote sensing techniques. Vietnam is not an exception out of the countries which are suffering from mangrove degradation due to rapid development of shrimp aquaculture, although reforestation of mangroves has been strongly promoted since the Vietnam War. In order to achieve mangrove conservation and sustainable land use, it is important to understand the spatial distribution of both mangroves and shrimp ponds and the transformation of land use.

The target area of this study spreads over coastal zones in Tien Giang Province and Ben Tre Province. Using Terra/ASTER data sets (2004) and a Landsat/TM image (1989), land use change was interpreted. Research suggests the effectiveness of remote sensing techniques in understanding land use change in mangrove areas in relation to shrimp aquaculture. It has become clear that the areas of mangroves have decreased by half and those of shrimp ponds have increased by about three times as much on the whole in Ben Tre Province. In addition to that, two inconsistent types of land use change were clearly observed in many sites: afforestation of mangroves by plantation; deforestation of mangroves owing to large shrimp aquaculture development. It implies that there is a conflict between environmental protection policies and the encouragement of shrimp aquaculture. The political and institutional backgrounds behind them and the process of the changes should be investigated further in order to lay a suitable long-term plan.

Keywords: mangrove, shrimp aquaculture, Vietnam, land use change

1. Introduction

The purpose of this study is to clearly understand land use in mangrove areas of Vietnam and its changes by using remote sensing techniques. Areas of mangroves are decreasing all over the world despite its well-known ecological and social importance. This trend is especially remarkable in several Asian developing countries where the rapid development of shrimp aquaculture is being exercised under the pressure of development requirement. Among those countries, Vietnam is also suffering from mangrove degradation in spite of its tremendous effort for reforestation since the Vietnam War.

Understanding of the spatial distribution of mangroves and shrimp ponds and the transformation of land use is highly significant from viewpoints of mangrove conservation and sustainable land use, as current development of shrimp aquaculture constitutes the main threat to mangrove ecosystems and at the same time, mangrove is said to be indispensable to realize high productivity of shrimp aquaculture. The usefulness of remote sensing techniques in mangrove monitoring is broadly suggested [1][2]. There are, however, not many studies in which remote sensing techniques are applied to observe land use of mangrove areas in relation to shrimp aquaculture. The study [3] is one of the few studies focusing on the impact of shrimp aquaculture on mangrove ecosystems with satellite surveys. The study [3] defined five ecologically distinct classes of land use in the Mekong Delta using SPOT scenes. This study partly applied its method to define distinct classes of land use of the target area, and furthermore, tried to detect land use change using satellite images of two periods.

2. Materials and Method

The target area of this study (Fig. 1.) spreads over the coastal zones of Tien Giang Province and Ben Tre Province in southern Vietnam. In the area, a variety of mangrove ecosystems could be seen and shrimp aquaculture has been widely developed under the stress of development requirement.

Satellite data sets used in this study were a set of Terra/ASTER images and a Landsat/TM image acquired on 12th Dec., 2004 and 16th Jan., 1989, respectively. Subsets of both images are shown in Fig. 2.

First of all, unsupervised classification (ISODATA) was employed to the images of both periods to understand land cover of the area and its changes. The result was verified through a field survey conducted in June, 2005. By using the results of the classification, the total area of mangroves and that of the shrimp ponds per village were calculated in the coastal zones of Ben Tre Province. In addition to that, Terra/ASTER data sets in 2004 were visually interpreted. Five land use units were delineated referring to the results from the classification and to the field survey mentioned above. Focusing on the relationship between mangrove and shrimp aquaculture, five distinct land use units were identified. Land use units in 2004 were overlaid on a Landsat/TM image obtained in 1989, to interpret the land use change concerning with mangrove deforestation, mangrove afforestation and shrimp aquaculture development.



Fig. 1. Location of the study area

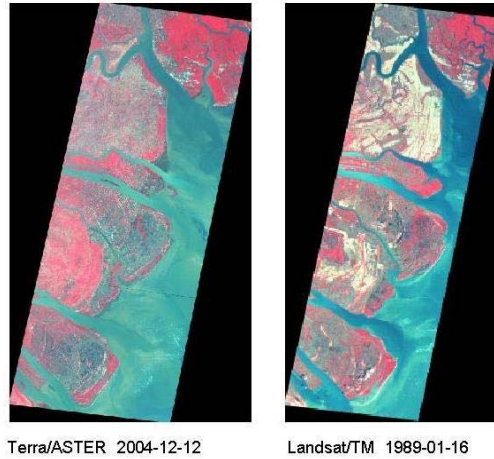


Fig. 2. Images of the study area

3. Results and Discussion

1) Total Area of Mangroves and Shrimp Ponds

Classified land cover of the study area was used to calculate the area of mangroves and shrimp ponds in Ben Tre Province. Fig. 3. shows an example of the land cover classification applied to Than Phu District. Land cover which was identified as shallow water was assumed to be shrimp pond. The calculated results are shown in Fig. 5. The results shown are in percentages here because the total areas of villages bordering on the sea have changed. Numbers indicated next to the names of villages are corresponding to those in Fig. 4. which shows village boundaries. According to the calculated results, the total areas of mangroves have decreased by half and the total areas of shrimp ponds have increased threefold on the whole. Paying attention to the villages bordering on the sea, area of mangroves in Bao Thanh village (8) has exceptionally increased. This owes much to plantation of mangroves in the area forming the boundary between the land and the sea. The results in the inland zones should be further inspected in the future.

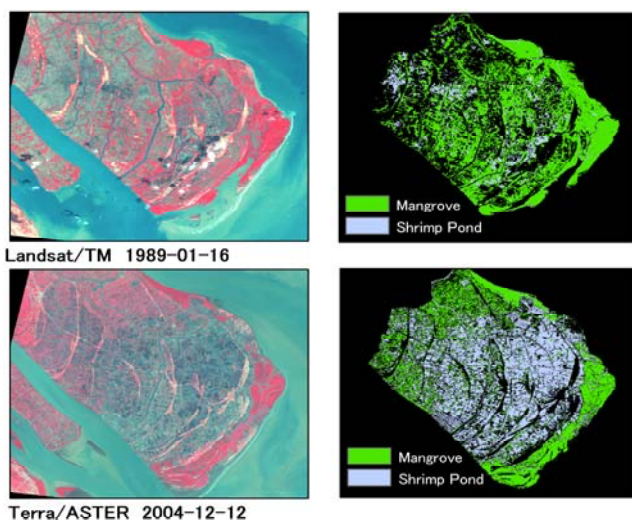


Fig. 3. Land cover change in Than Phu, Ben Tre

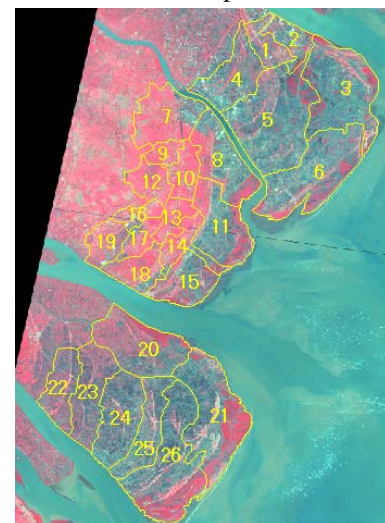


Fig. 4. Administrative boundary in Ben Tre

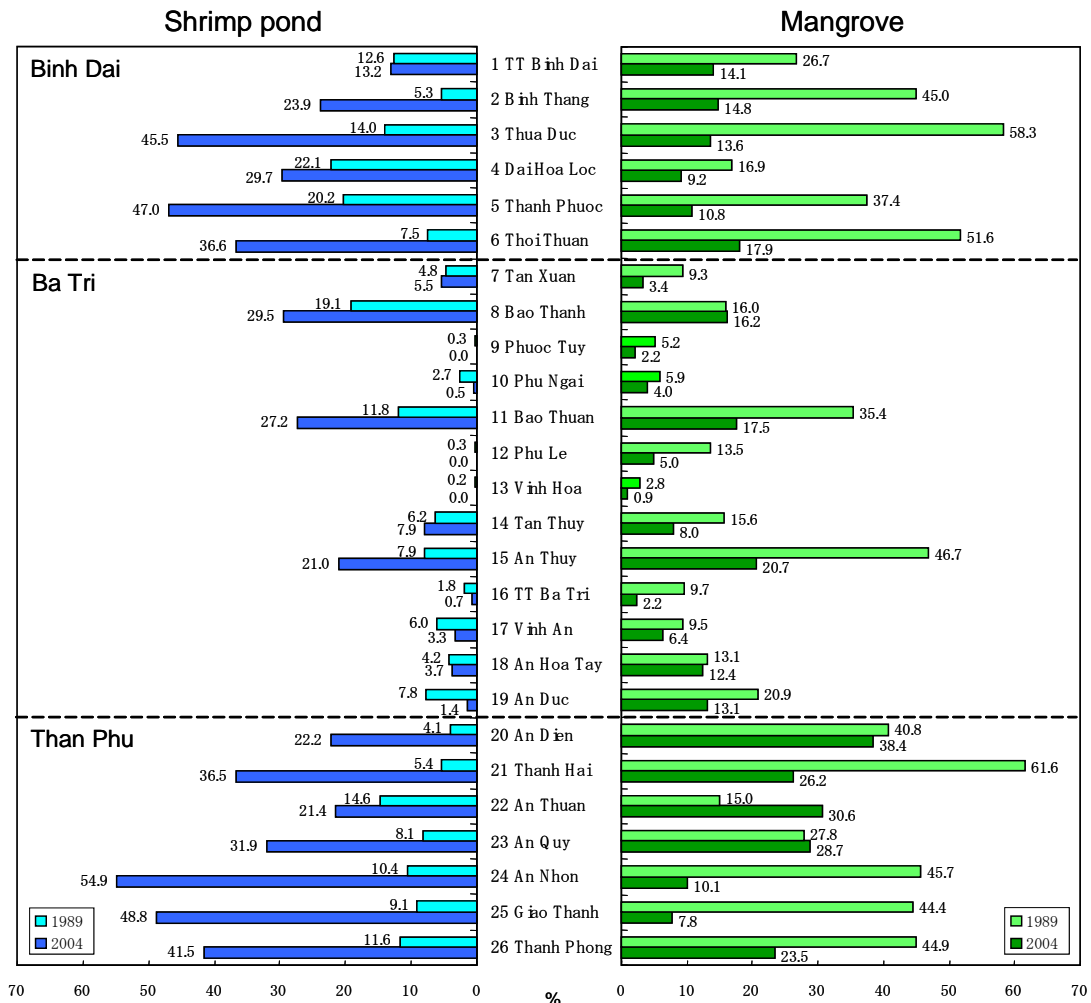


Fig. 5. Calculated areas of mangroves and shrimp ponds in 1989, 2004

2) Land Use Change

Giving consideration to the relationship between mangrove and shrimp aquaculture in 2004, five distinct land use units were successfully identified: (I) Mangrove forests; (II) Mixed shrimp-mangrove forestry farms; (III) Shrimp ponds and some mangrove remnants; (IV) Paddy field and shrimp ponds; (V) Paddy field, food crops and orchards. After delineating five land use units, the results were overlaid on the image in 1989 and land use change was interpreted. Fig.6. shows three sites from the results. The images on the far right show the overlaid image at each site.

In Go Cong Dong District (Site 1.), remarkable land use change was observed. That is, a large area of mangroves have been cut down to accommodate shrimp ponds, however, newly formed mangrove forests can also be seen. In Than Phu District (Site 2.), it also appears to show changes similar to those in Site 1, and furthermore, mixed shrimp-mangrove forestry farms (II) were identified as a land use unit in 2004. Waterways for shrimp aquaculture which could not be seen in 1989 are spread over the mangrove forests in 2004. In Binh Dai District (Site 3.), mangrove deforestation caused by shrimp aquaculture development and mangrove afforestation are also seen. Waterways have developed in mangrove forests to practice mixed shrimp-mangrove forestry farms. Site 3. is the only site in the study area which has inland mixed shrimp-mangrove forestry farms.

In summary, two major inconsistent changes were commonly observed at most sites analyzed in the study: Mangrove deforestation to accommodate the newly developed shrimp ponds; Afforestation of mangroves by plantation. Mangrove deforestation could be influenced by encouragement of shrimp aquaculture, while mangrove afforestation could be affected by environmental protection policies as most newly formed mangrove forests are currently protected. It is implied that there is a conflict of policies. We also see from the results that waterways used to maintain mixed shrimp-mangrove forestry farms have widely developed in mangrove forests in Ben Tre Province. This is where the integration of mangrove protection and the development of shrimp aquaculture is attempted.

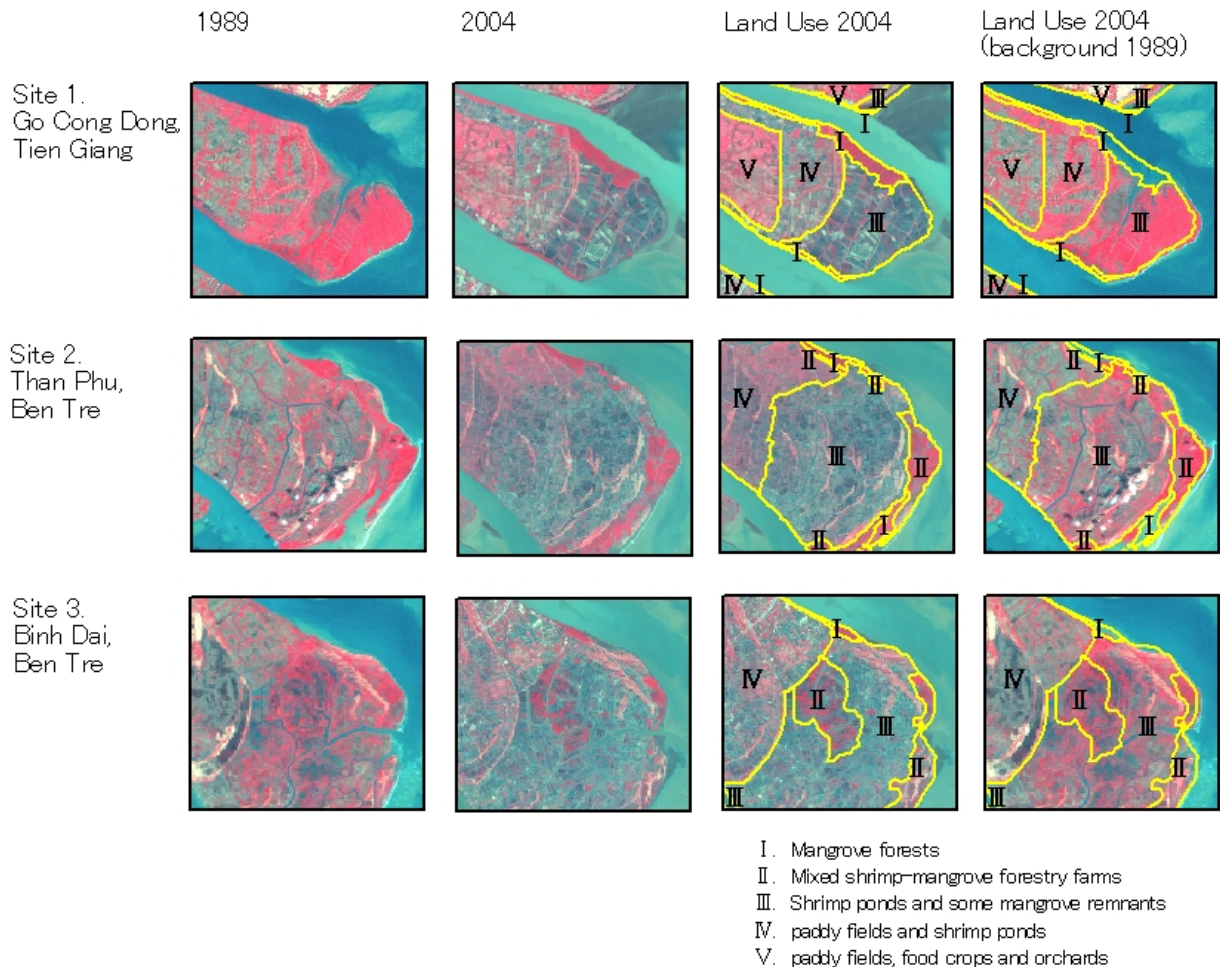


Fig. 6. Land use change in Go Cong Dong, Than Phu and Binh Dai

4. Conclusion

Research suggests the effectiveness of remote sensing techniques in understanding land use change in mangrove areas in relation to shrimp aquaculture. In this study, the extent of land use change and the spatial distribution of both mangroves and shrimp ponds were demonstrated. The total area of mangroves has decreased by half and the total area of shrimp ponds has increased threefold in past fifteen years in Ben Tre Province. In addition to that, both deforestation and afforestation of mangrove forests, which are possibly related to inconsistent policies, are seen in many sites. Political and institutional backgrounds behind them and the process of the changes should be investigated further in order to lay a suitable long-term plan because the conflict between the environment protection policy and the encouragement of economic development is revealed to be prominent especially in mangrove areas in Vietnam.

References

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