

USING MULTI-TEMPORAL REMOTE SENSING DATA TO MANAGE THE MANGROVE FOR COASTAL ENVIRONMENTAL PROTECTION

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ABSTRACT:

Coastal erosion is the interest subject has been taken into account between researchers especially for vietnamese. One of the economic and effective method to reduce the coastal erosion, it means to protect many marine engineering and sea product nursery areas concentrated along coastal line, is the biological method - mangrove planting. In other side, mangrove plays the role of green lung for surrounding cities or towns. Using multi-temporal remote sensing data to detect mangrove changes and manage them, shows their non-replaced advantages it able to cover a large area, where are difficulties of moving around. Case study is taken the Can Gio mangrove forest. It is located in the Southern East Gate of Ho Chi Minh city between $10^{\circ} 22' - 10^{\circ} 40' N$ and $106^{\circ} 46' - 107^{\circ} 01' E$. Total area is 75.740 ha, which differentiates to 3 parts: the heart (4,721 ha), the buffer (41,139 ha) and the transfer (29,880 ha).

1. INTRODUCTION

Mangrove is an important ecological system for coastal zone. It's the living place for many marine creatures. It prevents the coast destroy and coastal erosion of waves and gale. It's the condition for alluvial accumulation. Vietnam has a long coastal line – about 3,200 km. It brings many economic profits to our people. But in another side, it's caused of many problems like coastal erosion, tsunami,...

Coastal erosion is the interest subject has been taken into account between researchers especially for vietnamese. One of the economic and effective method to reduce the coastal erosion, it means to protect many marine engineering and sea product nursery areas concentrated along coastal line, is the biological method - mangrove planting. In other side, mangrove plays the role of green lung for surrounding cities or towns. At present, the mangrove has been degraded seriously, caused by cutting down for sea nursery areas and fire-woods. The planning strategy for suitable exploration and new planted mangrove plan is required to make now. It will based on, first of all, the inventory statistics like: total areas, distribution, change tendential For that purpose, Remote Sensing technique shows its advantage through the case study in Can Gio district (it's located in the Southern East Gate of Ho Chi Minh city).

2. METHODOLOGY

2.1 Used methods

There are many methods used for that research:

- Inherit method:* To take full advantage of the predecessor.
- Expert method:* Cooperation of soil, forestry and ecological experts.
- Image processing method:* selection of channel or channels combination to best differ the objects.
- Complex investigation method:* field data collection, field check...

2.2 Study area

Can Gio is the Southern East Gate of Ho Chi Minh city, between $10^{\circ} 22' - 10^{\circ} 40' N$ and $106^{\circ} 46' - 107^{\circ} 01' E$. Total area is 75.740 ha, which differentiates to 3 parts: the heart (4,721 ha), the buffer (41,139 ha) and the transfer (29,880 ha). Can Gio District consists of Can Thach Town and 6 communes: Binh Khanh, An Thoi Dong, Ly Nhon, Tam Thon Hiep, Long Hoa and Thanh An. Its population is about 63,000 people. The relief of Can Gio district has been divided by rivers and developed drain system. Mangrove forest covers over 40% of area.

From 1964-1970, herbicides was sprayed on the Can Gio District (665,666 gallons of Agent Orange, 343,385 gallons of Agent White and 49,200 gallons of Agent Blue). In the consequence of that, 57% of the mangrove forest in this district was destroyed (Ross, 1975). In some areas the vegetation was completely destroyed. Only *Avicennia* and *Nypa* were able to survive and regenerate after the herbicide. In 1978, a vast program of reforestation has been approved by People Committee of Ho Chi Minh City. Up to now, the reforestation effort has brought big ecological improvements to the environment. Wild animals such as monkeys, otters, pythons, wild boars, crocodiles and various kinds of birds have returned to the artificially regenerated mangrove forests. Since 1991, the Can Gio mangrove forest has been declared an "Environmental Protection Forest" by the Council of Ministers (Decree No. 173 CT/H date May 29, 1991). The relief of Can Gio in general is plane with altitude range from 0 m to 1.5 m, the highest point is 10.1 m.

The soil that has been formed in Can Gio has been created by a combination of clay alluvial deposition, vitriolic processes and a brackish water table. Four main soil types can be found here: Saline soil; Saline soil, with low alum content; Saline soil, with high alum content and Soft sandy soil, with mud deposits at the seashore.

The climate of Can Gio mangrove forest, in general, is characterized by high humidity and temperatures. There are two seasons and the area is affected by equatorial monsoons.

- Rainy season : from May to October

- Dry season: from November to April.

Annual average precipitation in Can Gio is range from 1.300 to 1.400 mm. The daily average temperature amplitude is 5°C – 7°C, but less than 4°C over a month. The annual average temperature is 25.8°C. The daily average radiation is always above 300 cal/cm²/day. The humidity in Can Gio: during the rainy season, humidity ranges from 79% to 83%, - dry season 74%-77%. Rivers cover the 31.76% of the total area of the district. The majority of there rivers flow in a general south eastern direction, their courses affect the relief and vegetation.

The Can Gio lies in a zone with a bi-diurnal tidal regime. Tidal amplitudes range from about 2 m at mean tide to 4 m during spring tides. Maximum tidal amplitudes, in the region of 4.0 – 4.2 m, are the highest observed in the whole of Viet Nam. Tidal amplitude decreases with distance north (i.e. inland), relating to the proximity of the South China Sea. High tides reach their maximum between September and January, at 3.6 - 4.1 m in the southern and 2.8 - 3.3 m in the northern regions of Can Gio. In Can Gio, the maximum high tide occurs in October or November, and the minimum in April or May. Between the 29th and 3rd day of the month (lunar calendar) and between the 14th and 18th day of the month, the whole of the Can Gio mangrove forest is flooded at high tide (twice a day). On the 8th and 25th day of the month the low tide is at its minimum.

Flora and fauna: About 105 plant species, belonging to 48 genera (Nam et.al. 1990) are found in Can Gio mangrove forest, including *Rhizophora apiculata*, *Bruguiera gymnorrhiza*, *Bruguiera parviflora*, *Ceriops sp.*, *Kandelia candel*, *Rhizophora mucronata*, *Sonneratia alba*, *Sonneratia ovata*, *Sonneratia casedar*, *Avicennia alba*, *A. officinalis*, *A. lanata* (stunted trees in abandoned salt fields), *Aegiceras majus*, *Thespesia populnea*, *Hibiscus tiliaceus*, *Lumnitzera racemose*, *Xylocarpus granatum*, and *Excoecaria agallocha*. There are about 150 known species of aquatic fauna. The fish fauna is very abundant since mangrove forests serve as nurseries as well as sources of foods for many species of fish like *Lates calcarifer* and *Mugil affinis*, prawns such as *Pangasius spp.*, *Penaeus spp.*, *Metapenaeus spp.*, and *Mudcrabs: Scylla serrata*. Within the area, there is a variety of wildlife such as wild pig (*Sus scrofa*), monkey (*Macaca fascicularis*), otter (*Lutra lutra*), saltwater crocodile (*Crocodylus porosus*), many species of snakes etc., which are now endangered or have disappeared due to human interference. There are also many birds, including migratory species, some of which are very rare and should be protected. (*Shows Annex – List of flora in Can Gio district*).

According to the population census in April 1985, the population of Can Gio District was 49,328 with a growth rate of 2%.

Most people in the Can Gio mangrove forest are poor and they go to the forest to cut down the trees for sea products nursery areas and firewood. To stop the forest cutting, in 1990, the government invited new settlers to move in to Can Gio forest, offering land, a very small but regular subsidy, and opportunities for additional income generation within allowable resource-use parameters. The agreement between the farmer-household and the Management Board for Ho Chi Minh city Environment Project Forests (MBEPF) had been signed. The

agreement gives each farmer-household a 100 ha of mangrove forest in average and leaseholders tenure for 30 years, and when they settle in to the forest the government provides each household with a grant to cover house-building costs, purchase of water jars and a simple rowboat. In turn, the households that move into Can Gio forest are expected to project, manage and utilize the forest allocated to them in accordance with MBEPF policies and regulations and protect it from illegal cutting by outsiders. The MBEPF gives each household a fee for protecting the forest.

2.3 Used data:

Satellite image: SPOT images of 1996, 2004 and 2007

- Topo-maps: topo-maps at scale 1:25,000 of study area are used as the based map
- Others documents, statistics

3. RESEARCH RESULTS

3.1 Digital image processing:

The SPOT images are fusion to 2.5m and transfer to coordinate system VN2, 000.

3.2 Establishment of thematic maps

3.2.a. Establishment of the legend:

The legend of establishment map is based on:

- The certain requirements of thematic map to be established
- Possibility of used satellite images
- Specific condition of study area

3.2.b. Establishment of the land-cover map

For land-cover maps the legend concludes the followings objects:

- Mangrove forest:
 - Dense mangrove forest (with coverage > 80%, height: from 10m., diameter: 20-40 cm)
 - Medium mangrove forest (with coverage 50% -80%, height: 5 - 10m., diameter: 10 - 20 cm)
 - Open mangrove forest (with coverage < 50%)
- Agricultural lands:
 - Paddy field
 - Upland crop
 - Salt-field
- Settlement
- Sea – product nursery areas (pond)
- Barrent land

The landcover maps of 1996, 2004 and 2007 are established based on the above legend.

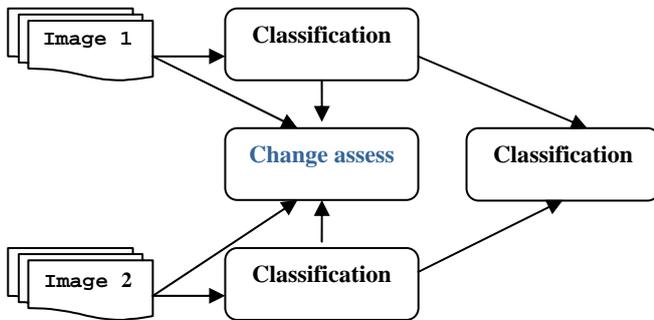
3.2.c. Establishment of the landcover change map

For landcover change maps the legend concludes the followings objects:

- Nonchange
 - Mangrove forest:
 - Dense mangrove forest (with coverage > 80%, height: from 10m., diameter: 20-40 cm)

- b. Medium mangrove forest (with coverage 50% -80%, height: 5 - 10m., diameter: 10 - 20 cm)
 - c. Open mangrove forest (with coverage < 50%)
 - 2. Agricultural lands:
 - a. Paddy field
 - b. Upland crop
 - c. Salt-field
 - 3. Settlement
 - 4. Sea – product nursery areas (pond)
 - 5. Barren land
- B. Change:
- 1. Mangrove forest changed to sea – product nursery area
 - 2. Mangrove forest changed to settlement
 - 3. Mangrove forest changed to barren land
 - 4. Agricultural land changed to settlement
 - 5. Barren land changed to mangrove forest

On the maps we can detect the coastal line change.



Schema 1: One of change assess method

Land cover change maps periods 1996-2004, 2004-2007 and 1996-2007 are established.

No.	Object	Area (ha)		
		1996	2004	2007
1	Dense mangrove forest	12490.22	25683.7	28831.25
2	Medium mangrove forest	8372.53	5954.65	4547.95
3	Open mangrove forest	12083.60	4531.94	1300.07
4	Agricultural lands	944.72	1119.46	1134.99
5	Water surface, Sea – product nursery areas (pond)	40,050.86	36,648.99	38153.29
6	Settlement	1798.08	1801.26	1772.45
	Total	75.740.00	75.740.00	75.740.00

Table 1: Statistics of main land cover objects in Can Gio in 1996, 2004 and 2007.

We can see the change tendency clearly. As the mangrove trees grow, by nature the areas of medium and open mangrove forest are reduced year by year and area of dense mangrove forest increases. Areas of settlement are increased due to population is increases. Water surface and sea – product nursery areas (pond) after first period (1996-2004) reduced caused by some areas formed by deposit alluvia and after second period they are increased due to movement of cutting mangrove forest for new sea – product nursery ponds.

4. CONCLUSION

In generally the Remote Sensing data is repeatable, so it gives the chance to research change and change assess objectively. In the other side it can be processed digitally so it can give the result very quick. The SPOT imageries of Can Gio dated 1996, 2004 and 2007 used to establish the land-cover and land-cover change maps effectively. Those maps served as base for change monitoring of mangrove forest.

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