



## CHANGES OF MANGROVE COVER, SPECIES COMPOSITION AND SEDIMENTATION RATE IN XUAN THUY NATIONAL PARK, VIETNAM

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### Abstract

*The changes of mangrove cover, plant species composition of mangroves and sedimentation rate in Xuan Thuy National Park were investigated and analyzed to evaluate the responses of mangrove ecosystems to climate change and sea level rise in Xuan Thuy National Park. The results confirmed that mangrove area in Xuan Thuy National Park increased about 600 ha in the period 1995 - 2010. It was recorded with a total of 12 true mangrove species belonging to 11 genera and 9 families in Xuan Thuy National Park. In comparison to the previous observations, two species *Lumnizera littorea* and *Nypa fruticans* are no longer found in this study. The results also indicated that mangroves could migrate seaward because the sedimentation rate in Xuan Thuy National Park is much higher than that of sea level rise (i.e., the sea level has dropped compared to the mangrove surface).*

**Keywords:** Climate change; Mangroves; Xuan Thuy National Park.

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### 1. Introduction

Global warming, changes in precipitation and sea level rise have been considered major challenges for mangroves beside the human impacts. Those manifestations of climate change affect the growth and survival of mangrove forests through sediment accumulation, erosion, salinity, time and inundation [1]. The response of mangroves to climate change depends on the nature, magnitude of climate change as well as the sensitivity and adaptability of mangroves.

It is estimated that in Xuan Thuy National Park, the average temperature increase was about 0.013°C/year; the

rainfall decreased by about 4,145 mm/year and sea level has increased by 1.9 mm/year since 1970 [2, 3]. The warming temperature and decreased rainfall can increase the water salinity leading to productive reduction, species composition or coverage of mangroves [4].

In order to improve the mangrove management and conservation in Xuan Thuy National Park, we investigated and assessed the changes of mangrove cover, species composition and sedimentation rate in Xuan Thuy National Park in the context of climate change and sea level rise.

### 2. Materials and methods

## **2.1. Study site**

Xuan Thuy National Park is a wetland national park which is close to the estuary of the Red River. It is a silt-rich, wide tidal flat and suitable for mangrove trees which are mostly *Kandelia obovata* (L.) Druce, *Aegiceras corniculatum* (L.) Blanco and *Sonneratia caseolaris* (L.) Engl. The park comprises mangroves, canals, lagoons, and sand dunes with a core area of about 7,100 ha and the buffer zone area of approximately 8,000 ha in 5 communes of Giao Thien, Giao An, Giao Lac, Giao Xuan and Giao Hai of Xuan Thuy district, Nam Dinh province (Fig. 1).

## **2.2. Data collection and analysis**

We used Landsat and SPOT images for the Xuan Thuy National Park in 1995 and 2010 acquired through Department of Remote Sensing and GIS (Forest Resources and Environment Center, Forest Inventory and Planning Institute) to map the recent and historical mangrove area coverage. An analysis of individual images was then undertaken and the mangrove cover change was estimated through an overlay methodology using ArcGIS 9.x software.

True mangrove species composition was investigated along four surveying transects. The field surveys were conducted on 23 - 26 April and on 11 - 13 August, 2014. We compared our observation to the others which had been done before to determine the change in the composition of mangrove species in Xuan Thuy National Park.

The bamboo stakes approach was used to measure the sedimentation rate. We selected three locations per transect for the measurement of the sedimentation rate. At each location, we put into the mud three sedimentation stakes, spaced

1 m apart by pushing each stake into the mangrove substrate so that 30 cm of the stake is sticking out of the sediment surface. Then we measured the height from sediment surface to the top of each sedimentation stake. These works were done in October 2013. Remeasurements were done twice, once in March 2014 and the other in August 2014. The sedimentation rate was calculated from the values of height changes.

## **3. Results and discussions**

### **3.1. Mangrove cover's change in Xuan Thuy National Park**

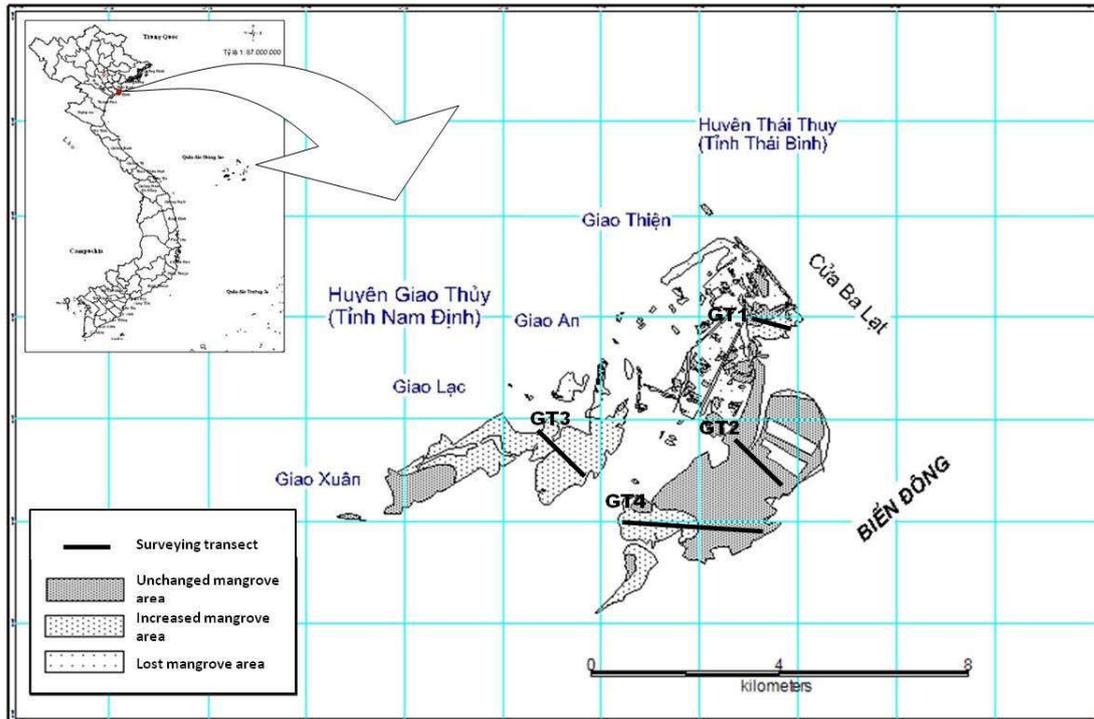
The analysis of the satellite images indicated that the mangrove area of Xuan Thuy National Park increased by approximately 600 ha in the period 1995 - 2010. The mangrove area in the north of Con Ngan decreased because a large area of mangroves has been converted to shrimp, clams ponds while in the south of Con Ngan and Con Lu (belonging to Giao An, Giao Xuan and Giao Lac), hundreds of hectares of mangroves were planted by local communities with the supports from domestic and foreign agencies and institutions (Fig. 1).

The increase and expansion of mangrove area contributed to demonstrate that the vulnerability to the climate change of mangroves in Xuan Thuy National Park is relatively low, which means mangroves are resilient to climate change.

However, according to Van Santen [5], the coastline in the area of Xuan Thuy National Park was unstable because erosion and sedimentation occurred intensively in this area. This could significantly affect the mangrove development and distribution. On the other hand, the results from the field survey also showed that the vulnerability

to climate change of mangroves in Xuan Thuy National Park can increase in near future due to the serious impacts and pressures from local people, environmental and climate change. The

increase of vulnerability could be expected through the observations of seaward margin erosion and rapid development of aquaculture in landward margin which prevent mangrove expansion.



**Figure 1: Mangrove cover change in Xuan Thuy National Park during 1995 - 2010**

**3.2. Mangrove species composition’s change in Xuan Thuy National Park**

The results of mangrove composition along the survey transects in Xuan Thuy National Park show 12 true mangrove species of 11 genera and 9 families (Table 1). As compared to Phan Nguyen Hong et al [6], two species of *Lumnizera littorea* and *Nypa fruticans* are no longer found in this study. That can be explained by the *Nypa fruticans*, which was imported from the South and no longer survived;

*Lumnizera littorea* was extinct in the wild and is only grown at the research station of the Mangrove Ecosystem Research Center in Giao Lac commune.

The changes in the true mangrove species composition noted above may be random and require further investigation to be confirmed. However, besides the human impacts (accession of seedlings, cutting down trees and conversion of mangrove forests to other land uses), climate change and sea level rise may contribute significantly to that change.

**Table 1. True mangrove species observed in Xuan Thuy National Park**

No.	Scientific name	Vietnamese name	Observed		
			1991 <sup>(1)</sup>	2004 <sup>(2)</sup>	2014 <sup>(3)</sup>
1	<i>Acrostichum aureum</i> L.	Ráng biển	x	x	X
2	<i>Acanthus ilicifolius</i> L.	Ô rô	x	x	X
3	<i>Sesuvium portulacastrum</i> L.	Sam biển	x	x	X
4	<i>Nypa fruticans</i> (Thumb) Wurm	Dừa nước		x	

No.	Scientific name	Vietnamese name	Observed		
			1991 <sup>(1)</sup>	2004 <sup>(2)</sup>	2014 <sup>(3)</sup>
5	<i>Avicennia marina</i> (Forsk) Veirh	Mắm biển	x	x	X
6	<i>Lumnitzera littorea</i> (Jack) Voigt	Cóc đỏ		x	
7	<i>Lumnitzera racemosa</i> (Gaud) Presl.	Cóc vàng	x	x	X
8	<i>Excoecaria agallocha</i> L.	Giá	x	x	X
9	<i>Aegiceras corniculatum</i> (L) Blanco	Sú	x	x	X
10	<i>Bruguiera gymnorrhiza</i> (L.) Lam	Vẹt dù	x	x	X
11	<i>Kandelia obovata</i> Sheue Liu & Yong	Trang	x	x	X
12	<i>Rhizophora stylosa</i> Griff	Đang	x	x	X
13	<i>Sonneratia caseolaris</i> (L.) Engl.	Bần chua	x	x	X
14	<i>Sonneratia apetala</i> Buch - Ham	Bần không cánh		x	X

<sup>(1)</sup>[7], <sup>(2)</sup>[6], <sup>(3)</sup> Data collected during 23 - 26/4/2014; 11 - 13/8/2014

### 3.3. Sedimentation rate in Xuan Thuy National Park

Sedimentation rate measured at Xuan Thuy National Park from November 2013 to August 2014 was 10.4 mm/year in average (Fig. 2). However, the rates by seasons and locations were highly variable. In the dry season, the sedimentation rate was 13.2 mm/year, which is higher than the rate of 8.8 mm/year in the rainy season. This result can be explained by the fact that in the rainy season, this area is affected by strong waves generated from strong winds of tropical cyclones/storms causing more erosion and less sedimentation. On the other hand, Xuan

Thuy National Park is located at the south of Red River estuary (Ba Lat Mouth), thus sediment load could be carried by fast moving water in the rainy season to farther south of the Park. Therefore, the sedimentation rates measured along the transect GT3 and GT4 were greater than those along the transect GT1 and GT2.

The obtained result is consistent with those from other authors such as [3, 5], who studied at the same site, and in accordance with the observations of the role of mangroves in creating favorable conditions for the deposition of organic and inorganic matter.

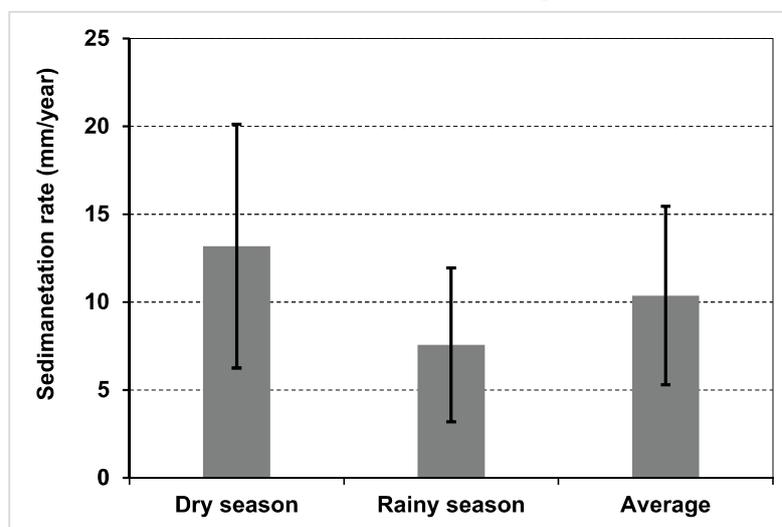
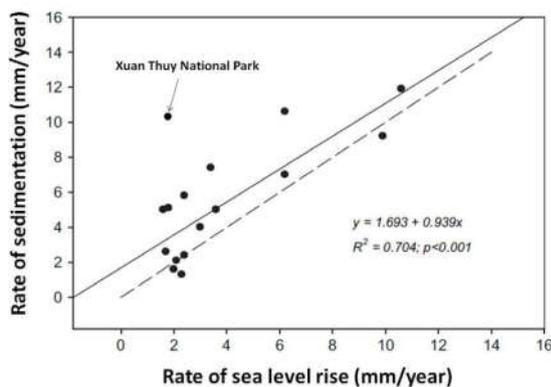


Figure 2: Sedimentation rates measured in Xuan Thuy National Park

The sedimentation rate was chosen as one of the criteria for assessing the vulnerability to climate change of mangroves because the sedimentation rate and the rate of sea level rise both restrict the intertidal, thereby affecting the distribution, growth and development of mangroves. At Xuan Thuy National Park, the sedimentation rate was higher than the rate of sea level rise (10.4 mm/year and 1.9 mm/year, respectively). That result indicates that the mangroves in Xuan Thuy National Park are more keeping pace with sea level rise. This result is also completely consistent with those of Alongi [8] (Fig. 3).



**Figure 3: Relationship between sedimentation rate and sea level rise [8]**

#### 4. Conclusion

The mangrove area in Xuan Thuy National Park increased about 600 ha in the period 1995 - 2010. A total of 12 true mangrove species of 11 genera and 9 families were recorded in Xuan Thuy National Park. In comparison to previous observations, two species of *Lumnizera littorea* and *Nypa fruticans* are no longer found in this study. The results also indicate that the mangroves migrated toward the sea as sedimentation rate were 10.4 mm/year, much higher than the rate of sea level rise. The results confirmed that in recent years mangroves in Xuan Thuy National Park

have not been much vulnerable to climate change and sea level rise.

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