THE POTENTIAL APLLICATION OF NUMERICAL MODELS AND REMOTE SENSING & GIS TO PREDICT COASTAL PROCESS IN CAN GIO AREA (SAIGON RIVER MOUTH – SOUTH VIETNAM)

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ABSTRACT

The purpose of this research is to present methods for investigating coastal processes by applying remote sensing & GIS technology. The characteristics of shoreline change and sediment transport pattern are investigated by comparing satellite imageries taken in 1992, 1994, 1997, 1998 (JERS-1); 2001, 2002 and 2003 (ASTER) and using GIS data of CanGio. The obtained results are compared with the calculated topography change by the numerical model consisting from wave model, wave-induced current (and river flow and tidal current) model and topography model to ensure the sedimentation characteristics around CanGio region.

KEYWORDS

coastal processes, sedimentation, GIS, remote sensing

INTRODUCTION

Coastal zone in Can Gio area (Figure 1) is an important area for economic activities and a precious mangrove forest ecosystem in southern part of Vietnam.

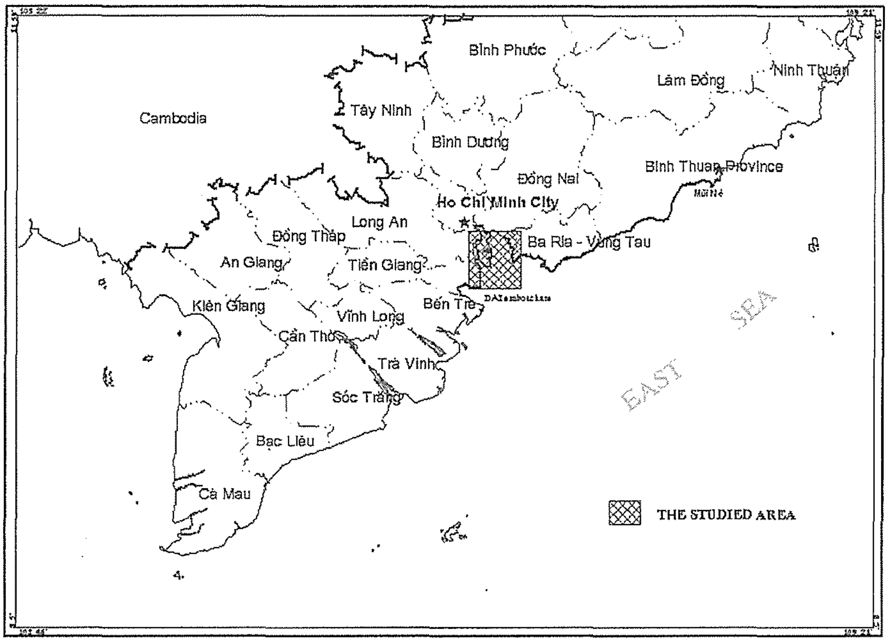


Figure 1. Can Gio coastal zone

This is one of the complex, vulnerable, dynamic and dedicate environment. Because of the hydrodynamic regime and human activities, the erosion - sedimentation process is so complicated that cause the serious loss for both economic income and natural system. As the result, it is necessary to look for the effective methods of environmental management for the studied area to prevent and to minimize the environmental damages. The application of remote sensing & GIS data and numerical models to monitor the effect of dynamic processes are the potential - essential tools.

METHODS

1. Remote sensing & GIS

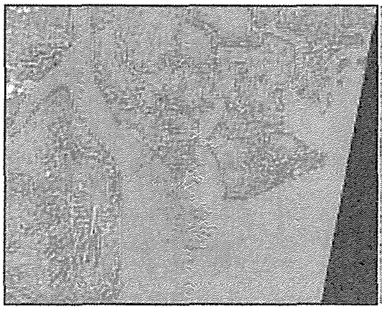
In this research, two types of satellite images such as JERS-1 and ASTER images were used and listed in Table 1. SAR images of JERS-1 and VNIR images of Aster are used to detect the changes in shoreline locations. ENVI 3.5 and Mapinfo 7.0 softwares are used as powerful tools to exact the information.

Table 1. Characteristics of satellites images used in the analysis

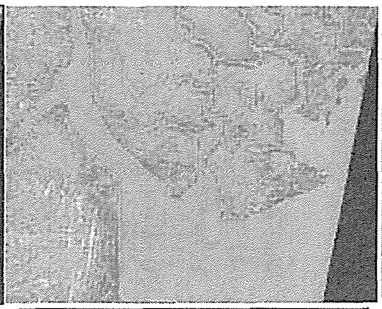
	Date and time	Resolution (m)	Purpose
JERS-1/SAR	1992 Oct.22 (3h26)	18	- Extract the shoreline location
	1998 Aug. 4 (3h26)		
JERS-1/OPS	1994 Nov. 16 (3h26)	15	- Observing sediment transport
	1994 Dec. 30 (3h26)		
	1997 Jan. 16 (3h26)		
ASTER/VNIR (Band 1:2:3N)	2001 Sept. 15 (3h31)	15	- Extract the shoreline location - Observing sediment transport
	2002 Aug. 8 (3h32)		
	2003 Jan. 15 (3h32)		
	2003 Feb. 9 (3h26)		
	2003 Feb. 25 (3h26)		

All satellite images were geo-referenced based on four topographic maps (in scale 1:50.000) in Can Gio area. Water depth data was also digitized from topographic maps.

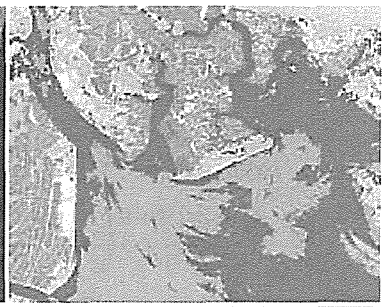
To analyze the changes in shoreline locations, JERS-1/SAR (in 1992 and 1998) and ASTER/VNIR (in 2003) images were used: With JERS-1/SAR, after filtering with Rada tool of ENVI, the panchromatic images with ENVI Color tables (Green-Red-Blue-White) were transferred into Mapinfo data file. These images will be digitized by Mapinfo tool. With ASTER/VNIR images, NDVI (Normalized difference vegetation index)=(Band3N-Ban2)/(Band3N+Band2) were also applied to extract the information of shoreline changes.



F.2. JERS-1/SAR 1992Oct.22



F.3. JERS-1/SAR 1998Aug.4



F.4. ASTER/VNIR 2003 Feb.25

After using NDVI transform, Color Slice was applied to NDVI images. The last images will be transformed to Mapinfo data file to analyze.

The satellite images after using som transforming tools as in Figure 2, 3, and 4 and the map of shoreline locations in 1992, 1998 and 2003 are presented in Figure 5:

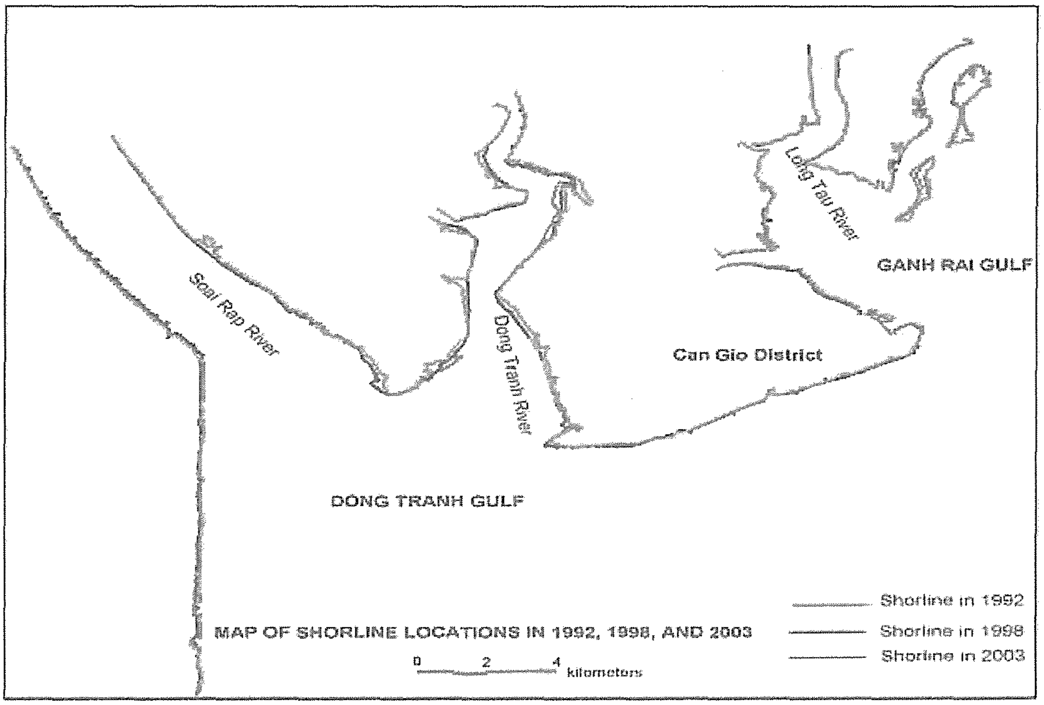
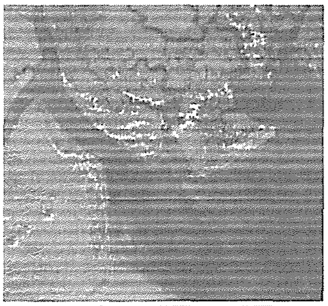


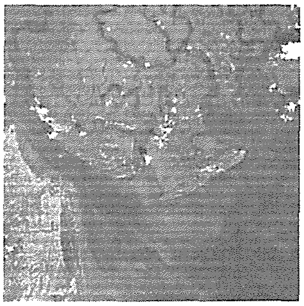
Figure 5. Map of shoreline locations in 1992, 1998, and 2003

To analyze the sediment transport, JERS-1/OPS (in 1994, and 1997) and ASTER (in 2001, 2002, and 2003) images were used.

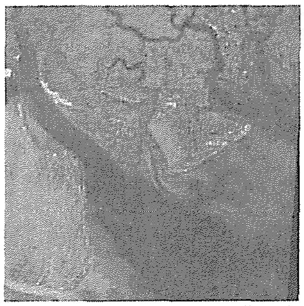
Topographic data were also used to observe the sediment transport in different images in different periods. Satellite images were presented Figure 6, 7, 8, 9, 10, 11, 12, and 13:



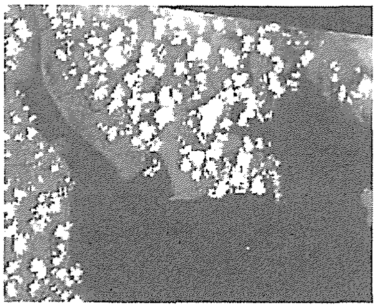
F6. Op1994Nov.6 03h34



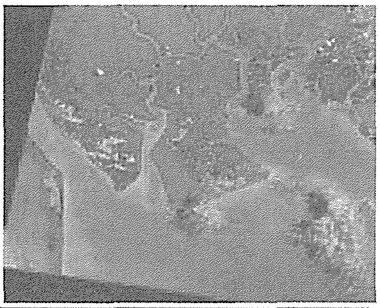
F7. Op1994Dec.30 3h35



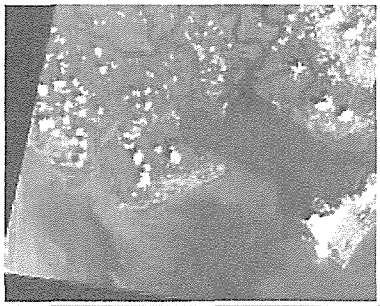
F8. Op1997Jan.16 3h41



F9. Aster 2001Sept.15 3h31



F10. Aster 2002Aug.8 3h32

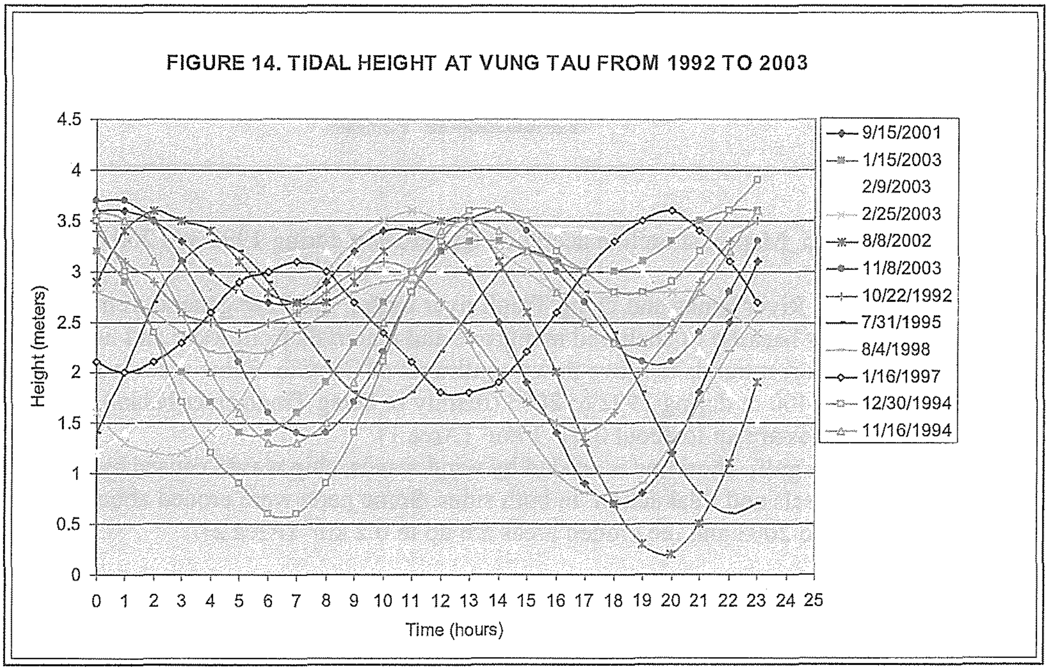


F11. Aster 2003Jan.15 3h32

F12. Aster 2003Feb.9 3h26

F13.Aster 2003Feb.25 3h26

Tidal data were calculated at Vungtau port from 1992 to 2003 as Figure 14:



Results and discussion

a/ From the analysis of JERS-1/SAR and ASTER images some eroded positions and accreted positions are detected as Figure 15:

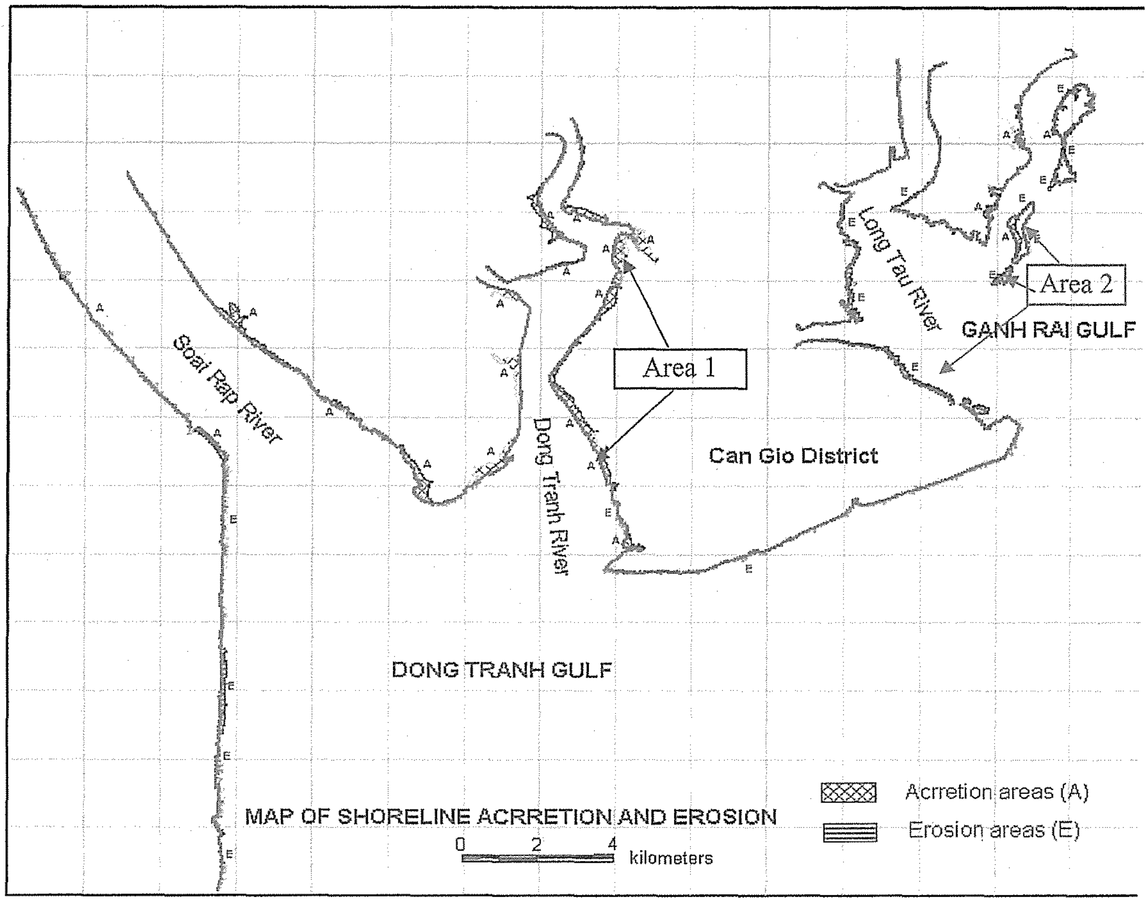


Figure 15. Map of shoreline accretion and erosion during 1992 and 2003

- In Soai Rap River banks and Dong Tranh river banks, there are general trend to sediment at both sides because of sheltered mangrove and materials from wave and tidal action. Mangrove forest trends to move down southwest of CanGio. Some areas were accreted about 370 - 400 m during 1992 to 2003 (mainly in Dong Tranh river banks) and the accreted areas are up to about 0.5 – 1 km^2 (Area 1).
- In Ganh Rai gulf, shoreline is eroded by wind waves, ship waves caused by navigation of large vessels and tidal action in both sides. Some parts were eroded about 250-260 m from 1992 to 2003 and the eroded areas are up to 0.2 km^2 (Area 2).

b/ Based on the analysis of JERS-1/OPS and ASTER images from 1994 to 2003, we can easily recognize that the trend of sediment transport. All images were taken about 3 AM in different date, the tidal effects were also different. The RGB false color of the whole images indicates that the direction of sediment transportation is usually in the southwest and southeast. The bottom topographic data also represented this trend as shown in Figure 16 and Figure 17:

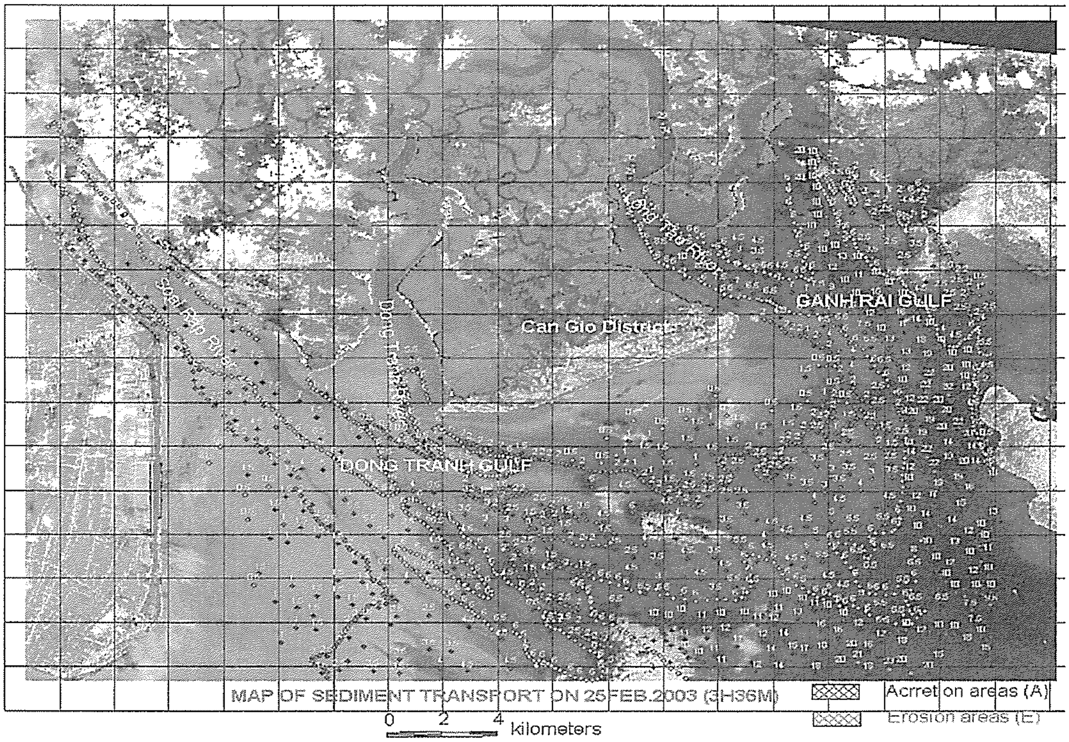


Figure 16. Sedimentation on 25Feb2003 (3h36m)

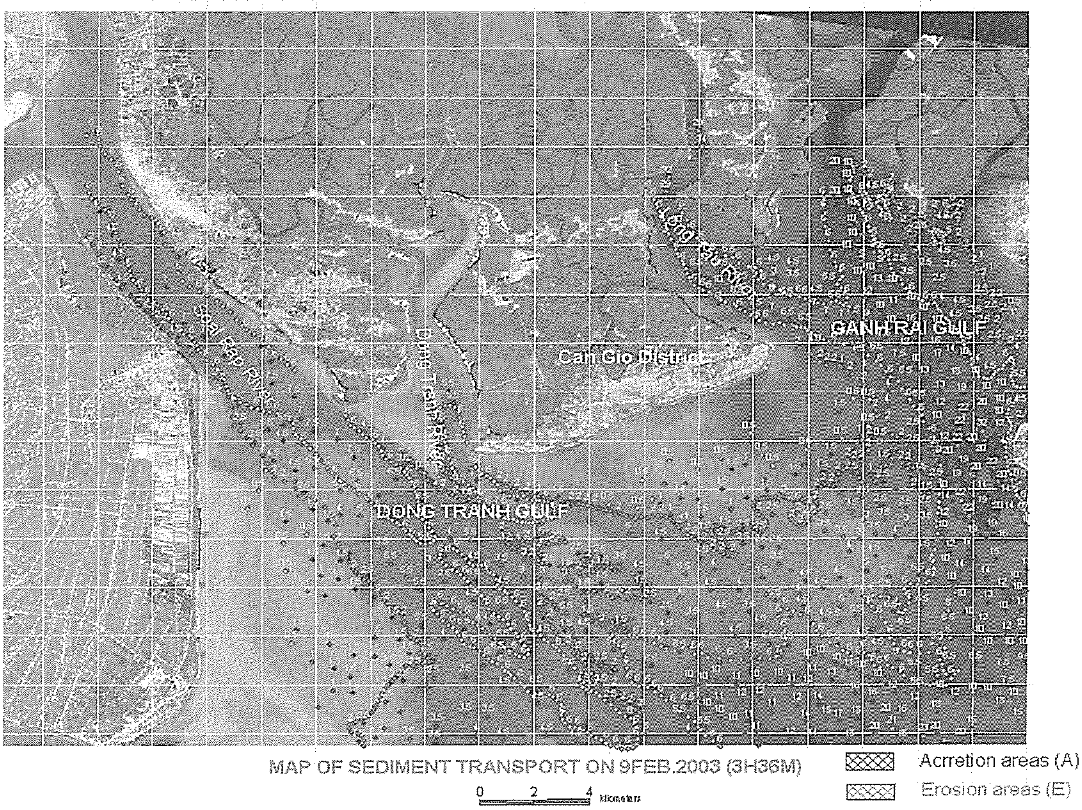
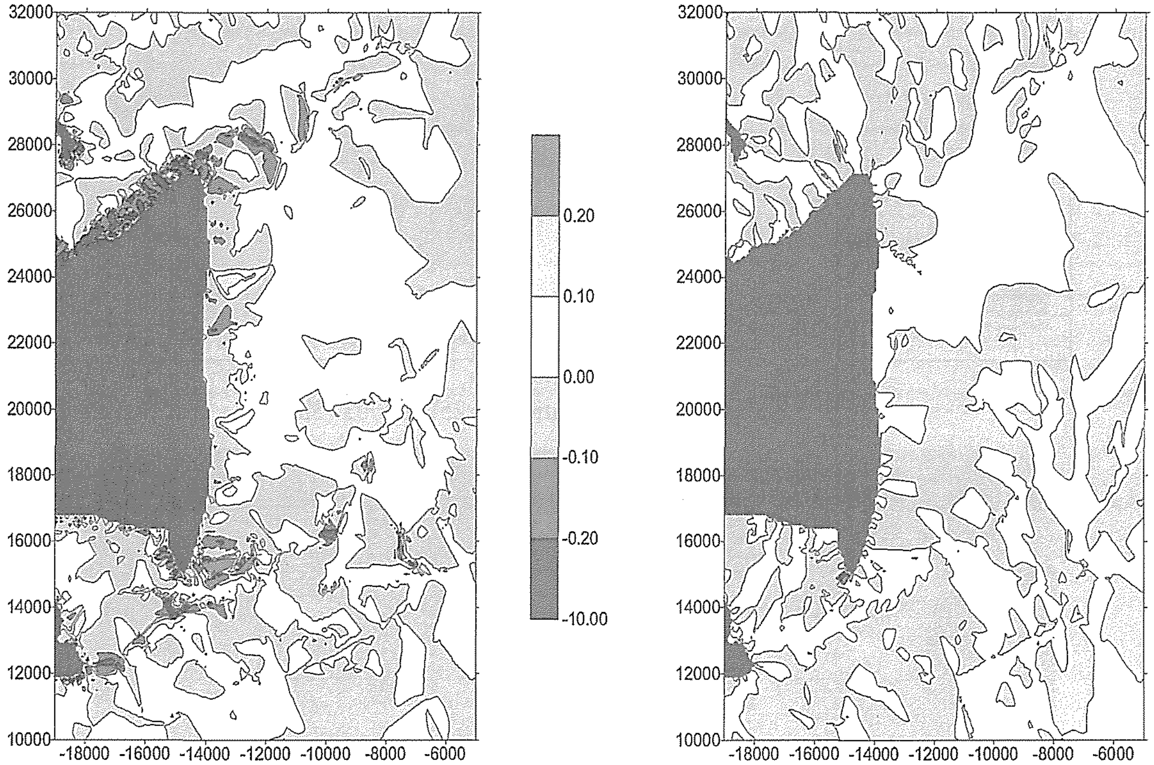


Figure 17. Sedimentation on 9Feb2003 (3h36m)

2. Numerical models

The numerical model for predicting topography change consists of three sub-models. At first, wave field in the objective region is calculated based on a so-called unsteady mild slope equation. Then wave-induced current is calculated together with the mean water level by the shallow water equations (for example, Deguchi, 1993). Finally, the change in water depth is estimated numerically through the continuity equation of sediment transport where the local sediment transport rate is evaluated by using calculated wave field and wave-induced current

Some examples of the results of numerical models in CanGio coastal zone (Le Song Giang et.al, 2001) are shown in Figure 18a and Figure 18b:



a) With wave action

b) Without wave action

Figure 18: Sedimented rate within 24 hours from 0:00AM on

From the results, we also clearly recognize the sediment transport tends to deposited in the southeast of CanGio. This coincides with the result obtained from the analysis of satellite images.

CONCLUSIONS

GIS and Remote sensing data, especially multi-temporal and multi-sensor satellite data provide useful information for coastal monitoring. And numerical models are now the essential tool for monitoring the changes of inshore bottom topography. It is especially useful for monitoring changes in the shoreline and riverbanks.

This study is the first step to combine the numerical model, GIS and remote sensing. We will have good result and powerful tools to get useful information from the coastal zone planning and management for sustainable development in this area.

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