INT. J. REMOTE SENSING, 1998, VOL. 19, NO. 17, 3383–3397

Detection of shoreline changes for tideland areas using multi-temporal satellite images

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(*Received 3 January 1997; in final form 25 June 1997*)

Abstract. An original scheme to detect shoreline changes using multi-temporal satellite images and tidal measurements is presented here. First, the basic idea behind this investigation is to reconstruct a reference digital terrain model (DTM) for tideland areas from a set of SPOT satellite images sampled over a short period. Each image corresponds to a tidal measurement. Then, the shoreline, as interpreted from a historical satellite image, is compared with one traced from the reference DTM, according to the associated tidal elevations. Experimental results indicate that the area error of the test sand barriers ranges between 7.6% and 12.5%.

1. Introduction

Detection and measurement of terrain and landcover changes for coastal zones is an important task in environmental monitoring. Shoreline variations have a direct impact on economic development and land management. Thus, terrain changes in tideland areas have attracted world-wide interest (Welch *et al.* 1992, Stokkom *et al.* 1993). Approaches for detecting shoreline changes may be roughly divided into three categories: ground surveying, modern altimetric technology, and image measuration. For ground surveying, although high accuracy is possible, it is labour intensive and time consuming. For the newer altimetric technology which uses radar altimeters or laser altimeters has a high potential. However, those detectors are currently less available. For image measuration, airborne imagery provides sufficient pictorial information. Nevertheless, the photogrammetric procedure including data acquisition and data reduction is costly and also time consuming to a certain degree. Satellite imagery, on the other hand, has a larger ground coverage and a revisit capability. In addition, satellite images could be multi-spectral from optical sensors or with multi-frequency/multi-polarization for synthetic aperture radar (SAR) images. An important trend for earth resource satellites is that the spatial resolution is getting higher and higher. Accordingly, satellite imagery provides a good alternative for detecting shoreline changes due to its general availability, large ground coverage, sufficient information contents, and the trend of higher spatial resolution.

Carter (1978) investigated the applicability of satellite images for data collection on wetlands. The spatial resolution of the satellite images, (i.e. Landsat-MSS), was limited to 80 m, at the time. Frihy *et al.* (1994) identified the pattern of shoreline changes in the Nile Delta. However, the dynamic tidal variation was not treated rigorously. Accordingly, three-dimensional terrain analysis for shore areas was not considered. The spatial and temporal resolutions of satellite images have significantly improved in recent years. Thus, the applicability of the images to coastal zone