USING GIS AND REMOTE SENSING TO MAP COASTLINE CHANGES OF WEDAM_ALSAHEL AREA, BATINAH, OMAN BETWEEN 1998 AND 2008

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Abstract: Coastal erosion is a universal phenomenon because of sea level rise, which is considered a result of climate change. This paper aims to detect and measure coastline changes of Wedam_Alsahel area, Batinah, north of Oman using GIS and remote sensing. For this purpose, two satellite images were used. The first one is IRS image acquired in 1998, while the second one is IKONOS image acquired in 2008. The images were geometrically corrected. Spatial resolution of IKONOS image was modified to conform to spatial resolution of IRS image to perform comparison between images. Coastline was identified and digitized in both images, and then coastline changes were measured in many locations along the coast of the area of study. The size of coastline erosion ranged between 50.81 meter and 112.27 meter. The average coastline erosion is 8.78 meter annually. This size of change is very hazardous and it has great impacts on the population and environment. This critical issue needs to be managed. The study introduced some recommendations to deal with this phenomenon.

INTRODUCTION

The Sultanate of Oman has long coast line of about 3,165 km including a number of islands. A predominant proportion of the populations inhabit the coastal areas, especially Al Batinah Coastal Plain, which has received a large share of development, mainly concentrated along the coastline. This includes recharge dams, fishing harbors, corniches, desalination plants, groins, and ports (Al-Hatrushi, 2012). It is believed that erosion of some localities in Al Batinah beaches in the last decades is due to the coastal engineering activities such as harbor development (Atkins, 2002). Recognition of the important role of beaches and their places in Oman's history and culture is evidenced by the prominence given to them in the Sultanate's Coastal Management Plan (IUCN 1986). Along the Batinah coast, coastal changes in term of erosion and accretion are widespread and are an important factor to consider in coastal engineering activities such as harbor development and dams construction (Atkins, 2001). Indeed, erosion along the Batinah has long been recognized as a problem and was reported on extensively by DOBBIN (1992). The latter study indicated severe erosion at many places, due to reduction in sediment supply by recharge dams and roads, construction of harbours and the long-term process of sea level rise. Moreover, Badenhorst (1995) considered the Batinah coast to be in a state of widespread erosion with recharge dams, sea level rise and harbour construction all being possible causes. Coastal erosion along Al Batinah is conceded to be a local phenomenon rather than being due to global sea level rise. Latter study by Al-Hatrushi and Al-Buloshi (2009) indicated severe erosion at many places, due to reduction in sediment supply by recharge dams and roads, construction of harbors, and the long-term process of sea level rise.

AREA OF STUDY

The Batinah Coastal Plain is located in the northeastern part of the Sultanate of Oman and bounded between the Western Hajar Mountains and the Gulf of Oman (Figure 1). It extends in a NW-SE trend as a crescent shape and parallel to the mountains for about 230 km from the UAE border in the northwest to Ras Al Hamra in Muscat in the southeast. The coastal plain is narrow at its northern and eastern ends, while its width in the middle is around 50km. The coastal plain is composed of continuous delta deposits drained from the mountains. The sediments vary from gravel and coarse sands to fine sands and silt near the coast, which suggest that most of the beach sediments along the coast are of terrestrial origin (Al-Hatrushi, 2012)

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Wedam_Alsahel is a hamlet located on the west side of Al-Musenaa Welayat overlooking the Sea of Oman, Al-Batinah south governorate, about 120 kilometers northwest of Muscat, the capital of Oman. It is located between latitudes (23° 48´ and 23° 48´ 36) north and between longitudes (57° 31´12 and 57° 36´) east. The total area is about twenty-five square kilometers.

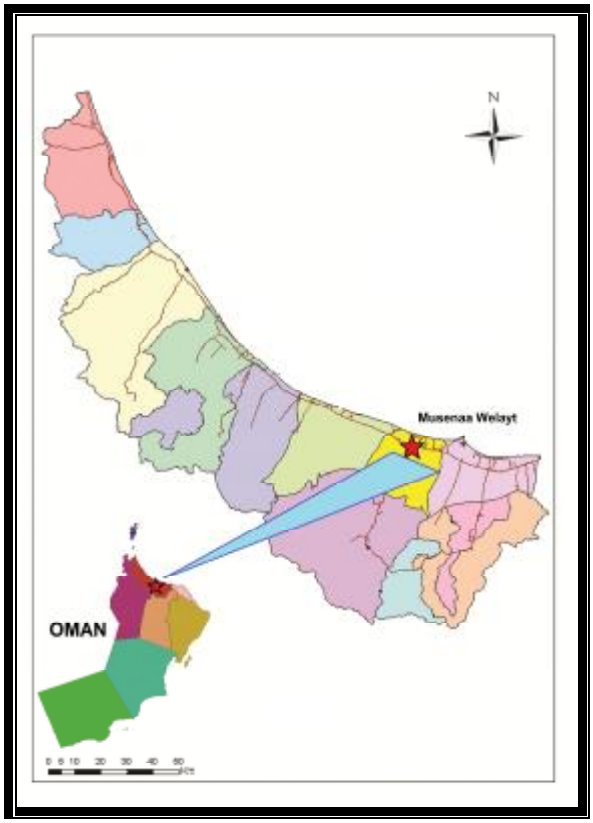

Figure 1: Area of Study

DATA AND METHODS

Natesan et al. (2012) reviewed the using of Remote sensing data to detect shoreline changes in many studies such as (Frihy et al. 1998; Shaghude et al. 2003; Kuleli 2005; Vanderstraete et al. 2006; Ekercin 2007; Bayram et al. 2008; Sesli et al. 2008). Remotely sensed data can provide valuable preliminary estimates of change, and is a unique tool for research and monitoring coastal areas and deltaic environments (Ciavola et al. 1999; Yang et al. 1999; Wu 2007; Kuleli 2010). Integration of the latest techniques of remote sensing with geographical information system (GIS) has been proven to be an extremely useful approach for the shoreline changes studies due to synoptic and repetitive data coverage, high resolution, multispectral database, and its cost effectiveness in comparison to conventional techniques (Chand and Acharya 2010).

These techniques have been applied to study the changes took place in Wedam_Alsahel area. Two satellite images were utilized in this study. The first one was IRS satellite image of 1998 with 5 meter spatial resolution, and the second one was IKONOS satellite image of 2008 with 1 meter spatial resolution. In Erdas Imagine 9.2 environment, the two images were first geometrically corrected using UTM, zone 40 projection and WGS84 spheroid and datum. To facilitate coast lines extraction from the two images to complete fusion process, IKONOS imagery was “degraded” from 1-meter to 5-meter spatial resolution using the Image Degradation tool in ERDAS IMAGINE 9.2. This process reduces the resolution of an image by an integer factor in the X and Y directions and averages all of the original "small" pixels that make up the new "big" pixels (Hurd, and Civco , 2009). Using ArcGIS 9.2 environment, Coast line was extracted from the two images, figures (2) and (3)

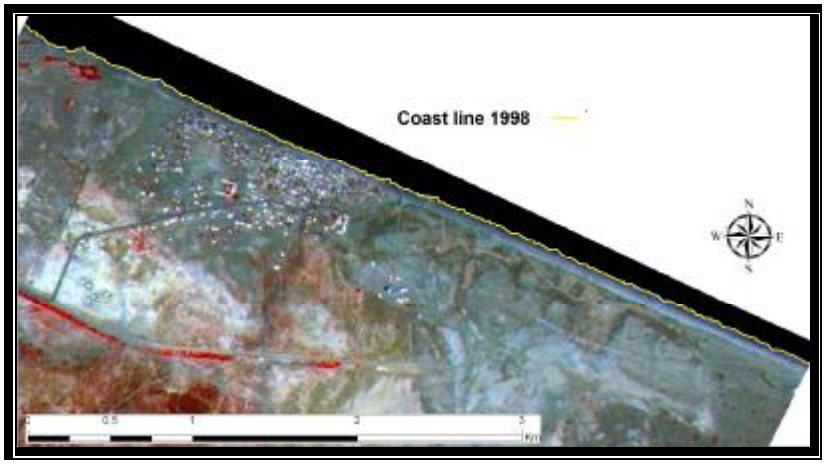

Figure 2: Coast line of the area of study (1998)

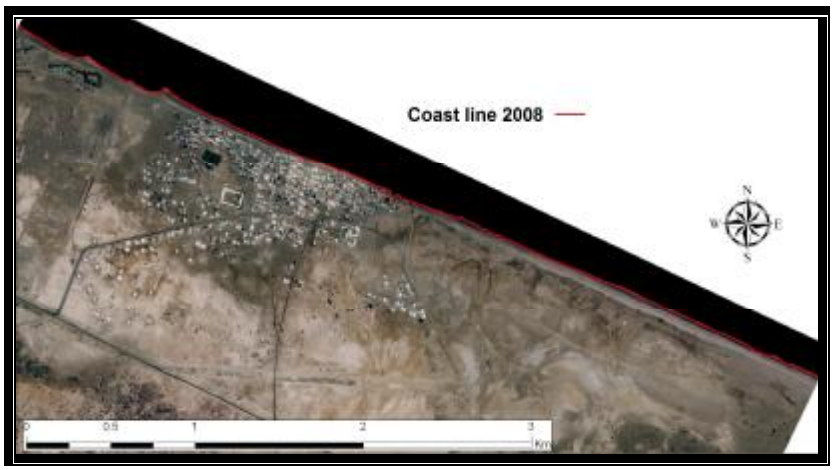

Figure 3: Coast line of the area of study (2008)

The resulted images then were merged, Figure 4. Shows the change of the coast line between 1998 and 2008

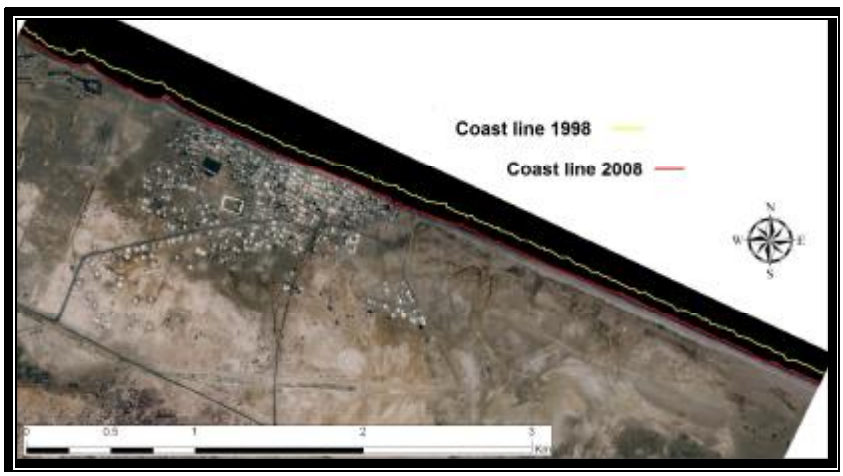

Figure 4: Coast lines of (1998) image and (2008) image

RESULTS & DISCUSSION

GIS has been employed to extract the coast lines of the two images (1998 and 2008). Rate of shoreline change was measured at some areas along the coast (Figure 5) using Measurement Tool of ArcGIS 9.2. The results are presented in table 1.

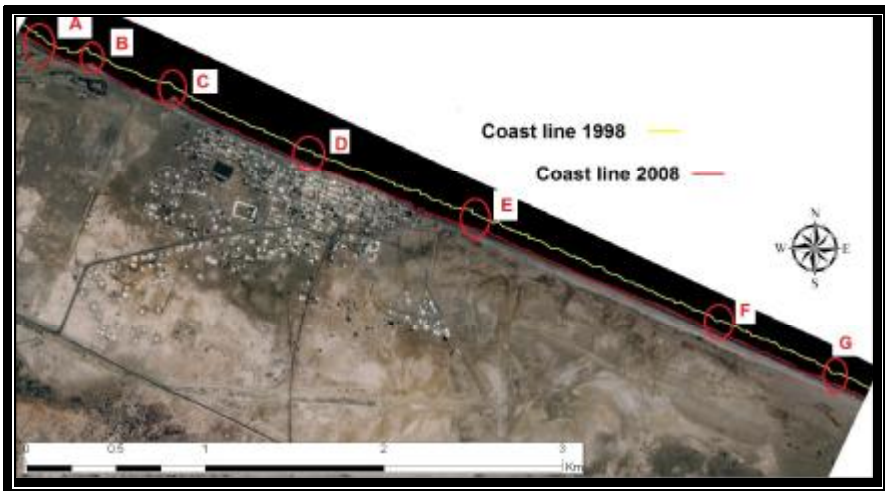

Figure 5: Rate of shoreline change in the area of study between 1998 and 2008

Table 1: Rate of shoreline change in the area of study between 1998 and 2008

Area	Size of change (meter)	Annual change (meter)
A	-50.81	-5.08
B	-95.06	-9.50
C	-107.38	-10.73
D	-105.35	-10.53
E	-112.27	-11.22
F	-73.21	-7.32
G	-71.33	-7.13
Average	-87.91	-8.78

As observed from table 1; the range of coast line change is (-61.46) meter where the highest rate (-112.27) meter was at areat E (Figure 5), while the lowest rate (-50.81) meter was at area A. The average of coast line change is (-87.91) meter between 1998 and 2008. The average of annual change is (-8.78) meter. These figures show high coastal erosion in the area of study. All selected areas are under severe coastal erosion. This refers to a critical environmental problem in the area of study. From the field visit to the area of study, it has been found that the highest rates of coastal erosion occurred in the areas that are very close to the Naval Base there. This explains the main cause of the erosion there (i.e. engineering works along the coast). The homes are now very close to the sea, Figure 6.

Figure 6: The homes are very close to the sea

CONCLUSIONS & RECOMMENDATIONS

Shoreline change analysis between 1998 and 2008 from field and satellite data as well as GIS analysis confirms that Wedam_Alsahel coast undergoes beach erosion. There are many factors for coastal erosion such as wave characteristics, the morphological and topographic features of the coastal zone and the human modifications taking place on them. From this study, it has been found that beach erosion in the area of study is mainly related to human activities along the coast. Wedam_Alsahel coast suffers from dramatic modifications in the beach and the environmental impact is more severe on areas of heavy human intervention (i.e. urbanization, coastal constructions).

A coastal protection strategy must be developed to mitigate the coastal erosion in the area of study and similar areas. Mapping coastal changes using GIS and Remote sensing techniques, and field studies at regular periods would be the first important step to characterize the problem accurately. The second step would be defining the major physical and human factors of coastal erosion and arranging these factors according to their impacts using different weighting tools. The third step would be developing some planning alternatives to deal with this problem taking sustainable development into account. The accurate land use planning seems to be efficient measure to preserve the coastal environment. Action plans would be prepared to implement selected planning alternatives. Continuous assessment should be carried out to evaluate the outcomes of the implemented action plans and rectify it accordingly.

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