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Locating suitable mangrove plantation sites along the Saudi Arabia Red Sea Coast

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ABSTRACT

This paper describes a method to locate suitable sites for mangrove plantations along the southern Saudi Arabian Red Sea Coast based on the geological setting of the area. Geological characteristics such as soil type, geomorphology and drainage were considered as siting criteria. Satellite imagery and digital elevation models were interpreted to determine most of the parameters.

The study determined that mangrove stands are primarily concentrated in the southern part of the study area and that they are sparsely found northward. Using data provided by satellite imagery, topographic maps and soil samples, the study was able to determine that three areas now barren of vegetation have the environmental elements necessary to support mangroves. One, in particular, would be especially suitable for establishing a plantation. In this paper, we describe the methods we used to make this determination and show the results of the analysis.

1. Introduction

We limited our study to physical factors necessary for successful mangrove plantation development vies-a-vies economic or political factors because (1) the land in question is owned by the Saudi.

Arabian government and (2) the land is undeveloped. Therefore, there were no issues with respect to existing land use or ownership. If a site was found to be physically well suited for mangroves, it can be developed without legal constraints. Whether of not a mangrove plantation project makes good sense economically was not considered in this research.

Mangrove forests are one of the most diverse wetland ecosystems on earth (Lugo and Sneaker, 1974). They are the home for many unique species of birds and fish and provide food and wood for local communities, stabilize coastlines and provide a barrier from high waves. Mangrove forests once lined three-quarters of the world's tropical coasts, today less than half remain and they are rapidly disappearing (Tomlinson, 1986). Indonesia, with more than 13,000 islands, possesses the most mangrove forestland of any country, but they are in decline. Brazil and Australia also have extensive mangrove habitats. The mangroves in Australia are protected and stable, whereas the Brazilian mangroves are declining (Dittmar et al., 2006).

Along the Red Sea, the extent of mangroves has been declining due to factors such as coastal development including both resorts and the oil industry (Hussain and Khojat, 1993). In Saudi Arabia, more than 40 percent of the coastline has been infilled resulting in a loss of 50 percent of the mangrove stands (Ellison, 1999).

More than 500 species of plants and animals have been recorded among mangroves and sea grasses in the Red Sea (Ellison, 1999). Mangroves and sea grass beds support the production of more than two million kilograms of fish annually (Khalil, 2004). Oil and domestic, urban, and industrial pollutants are an occurrence along the Saudi Arabian Red Sea Coast, although their effects on ecosystem structure and function are generally not well known. This coastal zone is becoming the repository for solid wastes. On field trips to the study area for this project, tons of plastic garbage was observed on the beach. Major ecological problems have arisen from loss or degradation of productive coastal habitats caused by landfill, dredging and sedimentation (Khalil, 2004).

A study on locating suitable sites for establishing mangrove plantations along the southern Egyptian Red Sea Coast was done by Monsef and Smith (2008) found that a number of barren sites had an excellent potential for establishing mangrove plantations. Many other studies have used remote sensing for mapping mangroves and location suitable sites for mangrove plantations including Azlan and Othman (2009), Coleman et al. (2008), Fromard et al. (2004), Green et al. (1998), Howari et al. (2009) and Ramsey and Jensen (1996).

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There have been a number of studies on site suitability for establishing mangrove plantations (Macintosh et al., 2002; Ren et al., 2008; Walters, 2000). In each of these cases, the same basic criteria necessary for successful establishment of a mangrove plantation were the same as those identified in this paper, namely, water salinity and temperature, tidal and wave energy, soil type and stability and flood risk.

Healthy dense mangrove stands do exist in the study area as shown in Fig. 1. An example is shown in Fig. 2.

Some of these stands are several kilometers in length, while others exist only in small patches. Most of the coastline is barren of mangroves. Using recent satellite IKONOS and SPOT satellite imagery, mangroves were mapped using heads-up hand digitizing off a computer monitor and are shown in Fig. 3.

The highest concentrations of mangroves are found near the coastal city of Jizan. North and south of Jizan are long stretches of coastline barren of any type of vegetation and stretches with relatively small patches of mangroves.

2. Environmental parameters necessary for mangrove plantations

The six critical environmental factors that determine if a coastline is capable of starting and maintaining a mangrove plantation are: (1) air temperature, (2) water temperature (3) water salinity, (4) tidal and wave energy, (5) flash flood potential and (6) soil type and stability (Bhat and Suleiman (2004).

The suitability value ranges for these environmental parameters are:

Air temperature: 8–47 °C.
Water temperature: 22–34 °C.
Water salinity: 36–3.8%.
Wave and tide energy: low.
Flash flood potential: low.
Soil type: sandy to sandy loam.

With these environmental boundaries in mind, our approach was be to determine where, if anywhere, on the southern Saudi Arabian Red Sea Coast these environmental requirements were met.

2.1. Air temperature

Mangroves tolerate air temperatures as low as 8 °C for short periods of time and as high as 42 °C (Teas, 1984). They thrive in the 28–30° temperature range. Data taken from the Jizan Airport

Fig. 1. Map of study area.