

Spatial Management on Mangrove response to Sea Level Rise (SLR) in Kukup Island

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Abstract. Mangroves are known for their global environmental and socioeconomic value. It lives in two worlds at once which growing in the intertidal areas and estuary mouths between land and sea. Despite their importance, mangrove like other ecosystems is now being threatened by natural and human- induced processes that damage them at alarming rates, thereby diminishing the limited number of existing mangrove vegetation. If sea level is rising relative to the mangrove surface, the mangrove's seaward and landward margins retreat landward where unobstructed, as mangrove species zones migrate inland in order to maintain their preferred environmental conditions, such as period, frequency and depth of inundation and salinity. The capability of storing data using GIS will reduce vulnerability coastal risk and evacuation models, raising the issues of integration, visualization, and proliferation of mapping applications, and the ease of use and intended audience of these products. Monitoring and predicting mangrove forest became easier using GIS tools.

1. Introduction

Mangrove forests live in two worlds at once which growing in the intertidal areas and estuary mouths between land and sea. Mangrove is salt-tolerant tree and they sheltered tropical shores, island and estuaries. The largest mangrove area in the world is in Southeast Asia with 6.8 million hectares. The largest areas of mangrove are found in Indonesia, Malaysia, Myanmar, Papua New Guinea and Thailand. Mangrove forest is one of sixteen forest type found in Malaysia. Malaysia harbours approximately 12% of Southeast Asia's mangrove area and occurs mainly along the coast of Sabah (57%), Sarawak (26%) and Peninsular Malaysia (17%) [2].

The stability mangrove provide essential for preventing shoreline erosion. By acting as buffers catching materials washed downstream, it helps stabilize land elevation by sediment accretion to balancing sediment loss. Mangrove is also useful in treating effluent as it absorb nutrient such as nitrates and phosphates. It can improve water quality through filtration of sediments and pollutants. Besides that, mangrove absorbs carbon dioxide to lessening the impact of global warming.

Scientists are still trying to understand exactly how Earth's climate change and sea level rise affected cultivation of mangrove? How do we predict the outcomes and impact of the sea level rise to mangrove then adapt and mitigate accordingly?

Fig. 1 is three general scenarios for mangrove response to relative sea level rise [3]. No change in relative sea level – When sea level is not changing relative to the mangrove surface, the mangrove margins will remain in the same location Fig. 1 A. Relative sea level lowering: When sea level is



dropping relative to mangrove surface, this forces the mangrove and landward boundaries to migrate seaward (Fig. 1 B) and depending on the topography, the mangrove may also expand laterally.

Relative sea level rising : If sea level is rising relative to the mangrove surface, the mangrove's seaward and landward margins retreat landward where unobstructed, as mangrove species zones migrate inland in order to maintain their preferred environmental conditions, such as period, frequency and depth of inundation and salinity (Fig. 1 C). Depending on the ability of individual true mangrove species to colonize new habitat at a rate that keeps pace with the rate of relative sea level rise, the slope of adjacent land, and the presence of obstacle to landward migration of landward boundary of the mangrove, such as seawalls and other shoreline protection structures, some sites will revert to narrow mangrove fringe or experience extirpation of the mangrove community (Fig. 1D)

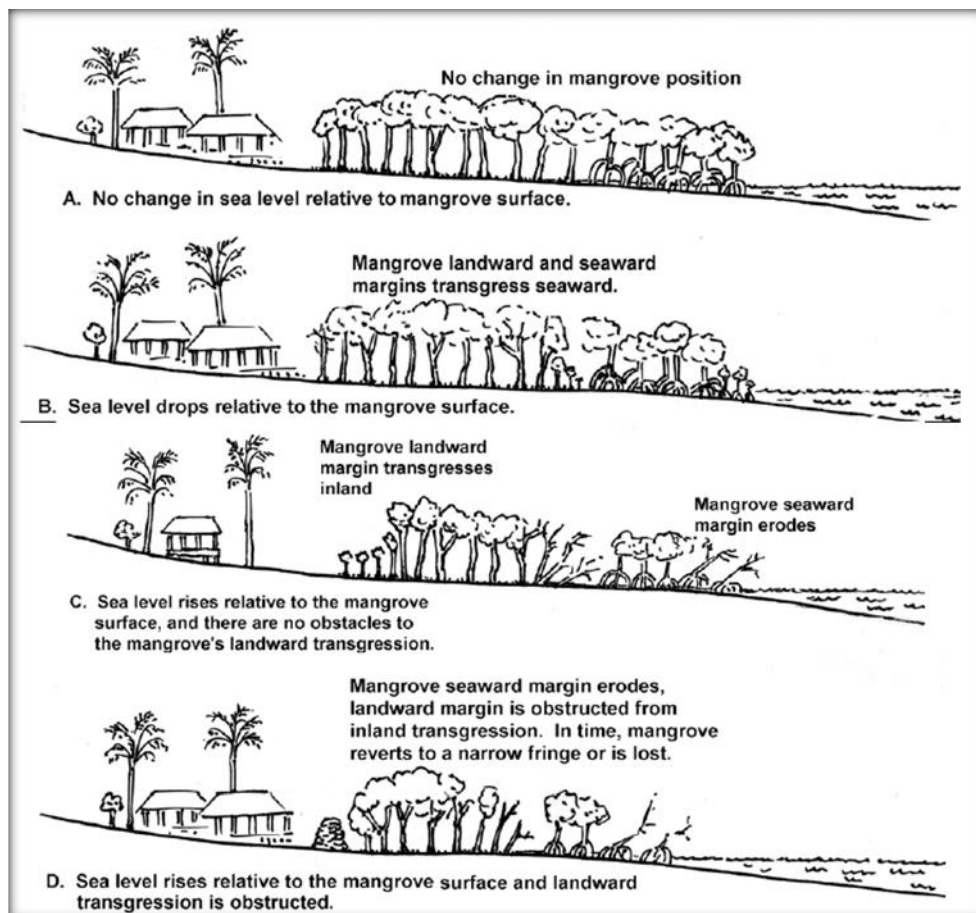


Fig. 1 General scenario response to relative sea level rise for mangrove adapted from [3].

GIS is a key technology for visualizing sea level rise, mangrove scenarios and potential impact (sites of potential mangrove loss, coastal erosion, adequate present of levees, impacts on wetland) and for analyzing how sea level rise may increase the frequency of tidal floods. A Geographic information system (GIS) is a tool by making decisions base on human thinking. Its supports three main views (Fig. 2).

1. The Geodatabase view: A GIS is a spatial database containing datasets that represent geographic information in terms of a generic GIS data model (features, rasters, topologies, networks etc).

2. The Geovisualization view: A GIS is a set of intelligent maps and other views that features and feature relationships on the earth's surface. Various map views of the underlying geographic information can be constructed and used as "windows into the database" to support queries, analysis and editing of the information.
3. The Geoprocessing view : A GIS is a set of information transformation tools that derive new geographic datasets from existing datasets These geoprocessing functions take information from existing datasets, apply analytic function and write result into new derived datasets [1].

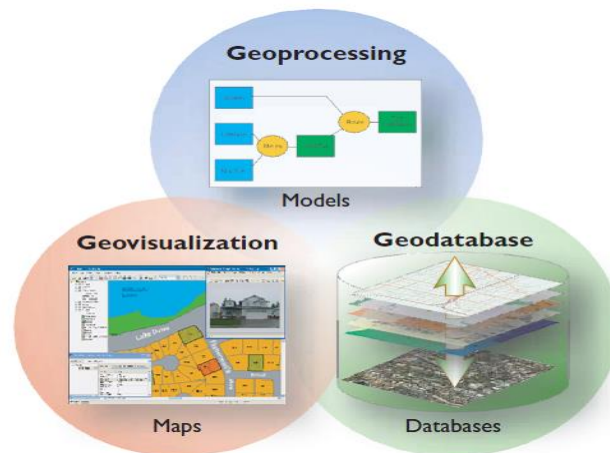


Fig. 2 The three views of GIS [1]

1.1. Statement of the problem

1. How exactly Earth's climate change and sea level rise affected cultivation of mangrove.
2. How to predict the outcomes with the impact of sea level rise to mangrove.
3. What are the solutions to make mangrove adapt from the impact.
4. How can we observe the growth of mangrove and it's affected to the surrounding area.

1.2. Objectives of the study

1. To develop an accurate and efficient GIS database system within the study area.
2. To develop a GIS-based Mangrove Vulnerability Index (MVI) Model for a selected ecosystem.
3. To predict mangrove lost within 50 and 100 year ahead and indentify area that will be affected to the mangrove vegetation base on topographical slope (elevation) and salinity (sea level rise) and then present in map and geographical information point of view.

1.3. Scope of the study

1. To design and develop spatial and attributes database within study area using ArcGIS software.
2. Classify mapping area for mangrove vulnerabilities against sea level rise and storm surg.
3. Determine areas that will affect mangrove lost based on slope and salinity.
4. Design user friendly database for end user access.

1.4. Significance of the study

Mangrove forests are extremely important coastal resources, which are vital to ecology and socio-economic development. [4] conducted a hydraulic experiment on tsunami impact using 5 different models such as mangrove, coastal forest, and wave dissipating block, breakwater rock and houses. This reveals that mangrove is effective solution among the other 4 models. [6] have reported that six-

year's old mangrove forest of 1.5km width reduce the sea waves by 20 times, from 1 meter high wave at the open sea to 0.05 meter at the coast.

Mangrove ecosystems that occur towards the land prevent soil erosion and also trap soil particles. This process helps in supply of clean and nutrient-rich water for associates' ecosystems like coral reefs, seaweeds and seagrass beds. However, when the mangroves are removed, the sediment becomes loose and get deposited on those associated ecosystem and its will be destroys. Thus the mangrove provide protection to other marine ecosystems.

With the popularization of GIS in decision making, related technology will help greatly in the management and analysis of these large volumes of data, allowing for better understanding of processes and management of human activities to maintain world economic vitality and environmental quality. It will increase detail of representation.

2. Subjects or data sources

Data sources (table 1) will be acquired through different methods. They are shoreline vegetation survey, ground truth survey and archived data from government agencies, UTM library, COEI as well as student's own collections. Some spatial data are acquired through Agensi Remote Sensing Malaysia (ARSM), Jabatan Ukur dan Pemetaan Malaysia (JUPEM), Jabatan Hidrografi Malaysia and Perbadanan Taman Negara Johor (PTNJ). Limitation of this study area is covers Pulau Kukup, Johor. Kukup Island is an uninhabited island located in the south-western region of the state of Johor in Peninsular Malaysia. It is located about 1 km offshore from the mainland town called Kukup Laut. The island is about 647 ha in size with an 800 ha intertidal mudflat around the island. The island was gazetted as a State Park in 1997 and it was designated as a Ramsar site of Malaysia in 2003. Pulau Kukup is a popular tourism site [5].

Table 1 Data Sources

Data	Types	Sources
1. Shoreline vegetation distribution 2. Digital Elevation Model	Spatial data	Shoreline Vegetation Survey/Ground Truth Survey
3. Remotely sensed images including Landsat TM and SPOT images (1988, 1997, 2000, 2005, 2011 and 2013)	Spatial data	Agensi Remote Sensing Malaysia (ARSM)
4. Topography Maps (1968 and 1993) 5. Aerial photographs of study area	Spatial data	Jabatan Ukur dan Pemetaan Malaysia (JUPEM)
6. River/ water bodies maps 7. Mudflat maps 8. Kukup Maps.	Spatial data	Jabatan Ukur dan Pemetaan Malaysia (JUPEM)
9. Shoreline vegetation types 10. Salinity data 11. Current data 12. Tide gauge data	Non-spatial data	Perbadanan Taman Negara Johor (PTNJ) Jabatan Hidrografi Malaysia

3. Instrumentation

In this research, researcher is intended to use different instruments to cater all the phases involve in the research. Each instrument will suitably applies for different purposes, thus Erdas Imagine, ArcGIS, DSAS (Digital Shoreline Analysis System) and Object-oriented programming language will be used throughout the research as describe in Table 2:-

Table 2 Propose instruments for research.

No	Instrument	Purpose
1	Erdas Imagine	Pre-processing multi-sources satellite images
2	ArcGIS	Mangroves Database Development All spatial and non-spatial data are converted to shape files and imported into ArcGIS environment. Analysis of mangroves trends of shoreline vegetation, shoreline change and SLR will be done in ArcGIS. Spatial Analysis and Modeling
3	DSAS	Time series analysis, where the change rate measurement is applied. End Point Rate (EPR) and Linear Regression Rate (LRR) approaches will be used to measure the rate of shoreline changes. EPR is calculated by dividing the distance of shoreline movement by the time elapsed between the oldest and the most recent shoreline. A LRR statistic can be determined by fitting a least-square regression line to all shoreline points for a particular transect [7]. LRR uses all the available data to compute long-term rate of changes.
4	Object-Oriented Programming Language	Integrates dynamic modeling in spatio-temporal database.

4. Summary

These images will provide information to classify the variability of mangrove species and to indicate the risk factors in terms of their physical vulnerabilities in response to long-term and short-term coastal impacts from sea level rise. The physical data obtained from the research will also be used to develop a mangrove vulnerability index (MVI) model for the selected sites that will describe a detailed quantitative analysis of the physical characteristic of the mangrove ecosystem services. From the MVI model, a relationship of mangrove area changes as a result of mangrove migration due to the impacts of sea level rise will be developed. The predictive model can be used to predict the mangrove area reduced in 2050 and 2100.

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